Final Remedial Action Plan
Oakland Army Base
Oakland, California

Prepared for

Oakland Base Reuse Authority
and
Department of Toxic Substances Control
California Environmental Protection Agency

Prepared by

Erler & Kalinowski, Inc.

(EKI A10063.00)

27 September 2002

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Ms. Aliza Gallo
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Subject: Final Remedial Action Plan and Final Risk Management Plan
Oakland Army Base, Oakland, California
(EKI A10063.00)

Dear Ms. Gallo:

Erler & Kalinowski, Inc. ("EKI") is pleased to submit the enclosed Final Remedial Action Plan ("RAP") that includes the Final Risk Management Plan ("RMP") as Appendix E. The Final RAP and Final RMP were prepared by EKI in accordance with Task 6 of our Agreement, Work Authorization No. 2, effective 26 February 2002. Although the RMP is an appendix to the RAP, it is provided in a separate binder.

The Final RAP and Final RMP describe environmental remediation proposed for those portions of the Oakland Army Base ("OARB") that are scheduled to be transferred to the Oakland Base Reuse Authority ("OBRA") by the United States Department of Defense, Department of the Army ("Army") in an Economic Development Conveyance ("EDC"). These documents have been prepared on behalf of OBRA and, at your request, in consultation with, and on behalf of, the California Environmental Protection Agency, Department of Toxic Substances Control ("DTSC").

Please call if you have any questions.

Very truly yours,
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LIST OF ABBREVIATIONS AND ACRONYMS

ACE	U.S. Army Corps of Engineers
1,1-DCE	1,1-dichloroethene
AAFES	Army and Air Force Exchange Services
ACM	asbestos-containing material
Amended Reuse Plan	*Amended Draft Final Reuse Plan for the Oakland Army Base*
Antidegradation Policy	SWRCB Resolution No. 68-16
ARARs	Applicable or Relevant and Appropriate Requirements
Army	United States Department of Defense, Department of the Army
ARPA	Archeological Resources Protection Act
AST	aboveground storage tank
ATSDR	United States Department of Health and Human Services, Agency for Toxic Substances and Disease Registry
BAAQMD	Bay Area Air Quality Management District
BAT	Best Available Technology
Bay Plan	*San Francisco Bay Plan*
BCDC	San Francisco Bay Conservation and Development Commission
BCP	*Base Realignment and Closure Cleanup Plan*
bgs	below ground surface
BRAC	Base Realignment and Closure
BTEX	benzene, toluene, ethylbenzene, and xylenes
CAA	Clean Air Act
Cal / EPA	California Environmental Protection Agency
Caltrans	California Department of Transportation
CAMU	corrective action management unit
CCA	chromated copper arsenate

LIST OF ABBREVIATIONS AND ACRONYMS

CCR	California Code of Regulations
CDM	Camp Dresser & McKee, Inc.
CEDA	City of Oakland Community and Economic Development Agency
CERCLA	Comprehensive Environmental Responsibility, Compensation, and Liability Act
CESA	California Endangered Species Act
CFR	Code of Federal Regulations
cis-1,2-DCE	cis-1,2-dichloroethene
COC	chemical of concern
CTR	California Toxics Rule
CWA	Clean Water Act
cy	cubic yard
CZMA	Coastal Zone Management Act
DHS	State of California Department of Health Services
DOI	Department of the Interior
DPT	direct push technology
DTSC	Department of Toxic Substances Control, California Environmental Protection Agency
EBEP	*California Enclosed Bays and Estuaries Plan, Water Quality Control Plan for Enclosed Bays and Estuaries of California*
EBMUD	East Bay Municipal Utility District
EBRPD	East Bay Regional Parks District
EBS	Environmental Baseline Survey
EDC	Economic Development Conveyance
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
EKI	Erler & Kalinowski, Inc.

LIST OF ABBREVIATIONS AND ACRONYMS

ESA	Federal Endangered Species Act
ESCA	Environmental Service Cooperative Agreement
FOSET	Finding of Suitability for Early Transfer
FOST	Finding of Suitability for Transfer
Foster Wheeler	Foster Wheeler Environmental Corporation
FS	feasibility study
GAC	granular activated carbon
GDA	Gateway Development Area
GWRTAC	Ground-Water Remediation Technologies Analysis Center
HC	Homeless Collaborative
HDPE	high density polyethylene
HEAST	Health Effects Assessment Summary Table
HI	Hazard Index
HRC	Hydrogen Release Compound™
HSC	California Health and Safety Code
HSWA	Hazardous and Solid Waste Amendments of 1984
ICP	Inductively Coupled Plasma
ICP-MS	Inductively Coupled Plasma–Mass Spectrometry
IRIS	Integrated Risk Information System
ISWP	*California Inland Surface Waters Plan, Water Quality Control Plan for Inland Surface Waters of California*
ITSI	Innovative Technical Solutions, Inc.
LBNL	Lawrence Berkeley National Laboratory
LBP	lead-based paint
LDR	land disposal restriction
lf	linear feet

LIST OF ABBREVIATIONS AND ACRONYMS

LLDPE	linear low density polyethylene
LRA	Local Reuse Authority
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
µg/dl	micrograms per deciliter
MNA	monitored natural attenuation
MTBE	methyl tertiary butyl ether
NAGPRA	Native American Graves Protection and Repatriation Act
NAPL	non-aqueous phase liquid
National Register	National Register of Historic Places
NCEA	National Center for Environmental Assessment
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NTU	nephelometric turbidity unit
OARB	Oakland Army Base
OBRA	Oakland Base Reuse Authority
OEHHA	Office of Environmental Health Hazard Assessment
OMI	Oakland Military Institute College Preparatory Academy
ORA	Oakland Redevelopment Agency
ORC	Oxygen Release Compound™
ORP	oil reclaiming plant
PA/SI	Preliminary Assessment/Site Inspection
PAH	polycyclic aromatic hydrocarbon

LIST OF ABBREVIATIONS AND ACRONYMS

PBC	Public Benefit Conveyance
PCB	polychlorinated biphenyl
PCDD	polychlorinated dibenzodioxin
PCDF	polychlorinated dibenzofuran
PCE	tetrachloroethene
PCP	pentachlorophenol
PDA	Port Development Area
PEA	Preliminary Endangerment Assessment
Phase II Investigations	Investigations conducted by Army and OBRA in April and May 2002
PID	photoionization detector
Porter-Cologne	Porter-Cologne Water Quality Act
POTW	publicly owned treatment works
PRG	Preliminary Remediation Goal
QA / QC	quality assurance / quality control
RAO	remedial action objective
RAP	Remedial Action Plan
RBSL	risk-based screening level
RCRA	Resource Conservation and Recovery Act
R*f*D	reference dose
RG_c	soil remediation goal based on carcinogenic effects
RG_{nc}	soil remediation goal based on non-carcinogenic effects
RI	remedial investigation

LIST OF ABBREVIATIONS AND ACRONYMS

RME	reasonable maximum exposure
RMP	Risk Management Plan
RWQCB	Regional Water Quality Control Board, San Francisco Bay Region
SARA	Superfund Amendments and Reauthorization Act of 1986
Seaport Plan	*San Francisco Bay Area Seaport Plan*
sf	square foot or square feet
SF	slope factor
SIP	State Implementation Plan
Soil Lead Guidance	*Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities*
SSD	sub-slab depressurization system
STLC	Soluble Threshold Limit Concentration
SVE	soil vapor extraction
SVOC	semi-volatile organic compound
SW 846	*Test Methods for Evaluating Solid Waste*
SWRCB	State Water Resources Control Board
TBCs	To-Be-Considered
TCE	trichloroethene
TCLP	Toxicity Characteristic Leaching Procedure
TCP	1,2,3-trichloropropane
TDS	total dissolved solids
Title 22 metals	metals regulated under 22 CCR §66261.24
TPH	total petroleum hydrocarbons

LIST OF ABBREVIATIONS AND ACRONYMS

TPHg	TPH quantified as gasoline
TPHd	TPH quantified as diesel
TPHmo	TPH quantified as motor oil
trans-1,2-DCE	trans-1,2-dichloroethene
TSCA	Toxic Substances Control Act
TTLC	Total Threshold Limit Concentration
U.S.C.	United States Code
U.S. EPA	United States Environmental Protection Agency
ULR	Urban Land Redevelopment
USATHAMA	United States Army Toxic and Hazardous Materials Agency
UST	underground storage tank
VOC	volatile organic compound
WET	Waste Extraction Test

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1. EXECUTIVE SUMMARY

1.1 PURPOSE OF REMEDIAL ACTION PLAN

This Remedial Action Plan ("RAP") has been prepared on behalf of the Oakland Base Reuse Authority ("OBRA") and California Environmental Protection Agency ("Cal / EPA"), Department of Toxic Substances Control ("DTSC"). The RAP identifies and evaluates potential remedial alternatives for sites of environmental concern at the Oakland Army Base ("OARB") in Oakland, California, and recommends remedies for implementation at OARB (Figure 1-1).

The portions of the OARB that are covered by this RAP are scheduled to be transferred to OBRA by the United States Department of Defense, Department of the Army ("Army") via an Economic Development Conveyance ("EDC") prior to the completion of all required environmental remediation. This early transfer requires that both the State of California and the Army find that all required remediation will be undertaken after transfer ("Finding of Suitability for Early Transfer" or "FOSET").

The RAP has been prepared consistent with requirements for preparing a RAP under Section 25356.1 of Chapter 6.8 of the California Health and Safety Code ("HSC") including as referenced therein the National Oil and Hazardous Substances Pollution Contingency Plan ("NCP"), set forth in Part 300, Title 40 of the Code of Federal Regulations ("CFR"). Upon approval, this RAP and its appended Risk Management Plan ("RMP") (Appendix E), which constitutes an element of the recommended remedies, will set forth the remediation program that will be implemented at subject portions of the OARB to satisfy applicable state and federal requirements consistent with the FOSET.

1.2 AREAS EXCLUDED FROM REMEDIAL ACTION PLAN

Under the Environmental Service Cooperative Agreement ("ESCA") to be signed between the Army and OBRA, the Army retains responsibility for cleanup of radiological materials, chemical and biologic warfare agents, and unexploded ordnance, if any, that may be present at the OARB. None of these materials are known to be present based on site investigation activities that have occurred over the past six years.

Besides environmental issues which the Army retains responsibility, necessary remediation, if any, of OARB property that is not being transferred to OBRA via the

EDC is not considered in this RAP / RMP[1,2]. The following property is not addressed in this RAP / RMP:

- Former Base Realignment and Closure ("BRAC") Parcel 1[3] or "Spit" totaling approximately 12.8 acres to be transferred to the Department of Interior ("DOI") on behalf of the East Bay Regional Parks District ("EBRPD") through a Public Benefit Conveyance ("PBC"), shown in pink on Figures 1-2 and 4-1. An additional area of approximately 6.4 acres of submerged land, including marine sediments at Outfall 4, are also defined to be part of the "Spit" that is not being transferred via the EDC.

- Army Reserve parcels totaling approximately 26 acres, which comprised former Army BRAC Parcels 6, 7, and 18, and portions of former BRAC Parcels 19 and 21, shown in yellow on Figure 4-1.

- Any property that is not being transferred via the EDC.

1.3 INTENDED REUSE OF OARB

Congress passed legislation in 1995 that designated closure of the OARB for military purposes under the BRAC program. OBRA was created to assist with the closure process as the Local Reuse Authority ("LRA"). The *Redevelopment Environmental Impact Report* ("EIR") prepared on behalf of the City of Oakland, Oakland Redevelopment Agency ("ORA") and OBRA (collectively referred to herein as "City"), indicates that approximately 133 acres of the OARB will be redeveloped with a variety of commercial and industrial uses as part of the Gateway Development Area ("GDA"). Approximately 233 acres (including 56 acres of submerged lands) will be employed for maritime, rail,

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[1] The OARB property being transferred to OBRA excludes approximately 20 acres of OARB property, primarily located beneath I-880, which was transferred from the Federal Highway Administration to the California Department of Transportation ("CalTrans") in March of 2002. Litigation regarding this transfer is ongoing; however, this Caltrans property is not currently being planned for transfer from the Army to OBRA and, thus, is not subject to this RAP.

[2] Off-site property adjacent to the EDC area that may be contaminated from Army activities is excluded from the RAP / RMP except for groundwater contamination caused exclusively by Army activities that occurred on the EDC area. Off-site areas excluded from the EDC area and the RAP / RMP include, for example, former Parcel 1 and off-site pesticide releases described in Section 4.4.3.6 of the RAP.

[3] As discussed in Section 4.1, BRAC Parcels and OUs are terminology that was employed by the Army in administrating its environmental program at the OARB. Such terminology is not used in this RAP/RMP to describe chemical release sites. Chemical release sites are referenced in the RAP/RMP by the designations assigned on Army maps and facility records to the tank, structure or building that was involved with a given release.

and other port activities as part of the Port Development Area ("PDA"). Details of the redevelopment strategy are presented in OBRA's *Amended Draft Final Reuse Plan for the Oakland Army Base (OARB)*, dated 23 July 2001 ("Amended Reuse Plan"). The Port of Oakland's specific land use objectives are presented in its *Strategic Plan Summary, Fiscal Years 2002-2006*, dated June 2001. The combined City / Port of Oakland projects are evaluated in the EIR.

Land surrounding the OARB is zoned Industrial (M) by the City of Oakland. The OARB itself is zoned Heavy Industrial (M-40). Port of Oakland harbor facilities lie west and south of the OARB. Current land uses on and near the OARB are industrial. The nearest off-site residential land use is located approximately 1,000 feet southeast of the OARB and is entirely separated from the OARB by the I-880 interstate freeway, as shown on Figure 1-2, a recent aerial photograph. Planned land uses are commercial and industrial for the portions of the OARB to be transferred to OBRA under the EDC and redeveloped under the Amended Reuse Plan. Potentially complete human exposure pathways, consistent with these land uses, have been identified and evaluated in the RAP. The RAP defines the risk-based remediation goals that will apply during and after redevelopment of OARB (for both the GDA and PDA) and establishes the recommended remedial actions for identified, and reasonably anticipated, locations where chemical releases have occurred that necessitate response when compared with the stated remedial action objectives and site-specific remediation goals. Investigation and remediation of many locations at OARB will be phased to coincide with planned infrastructure upgrades and redevelopment activities, as discussed below.

1.4 SITE HISTORY AND CURRENT CONDITIONS

The site use history and current conditions at the OARB are described in Sections 1.4.1 through 1.4.4.

1.4.1 Former Uses

Background information on site use history and setting is provided in Section 3. Much of the area encompassing the OARB, including the area west of current Maritime Street, was natural tidal marsh or shallow open water before 1916 (Kleinfelder, 1998a). Filling occurred in subsequent years to construct land for manufacturing buildings that predate the OARB and to create the remainder of OARB. As early as 1918, portions of the current OARB were in industrial use. The OARB served as a major Army cargo port and warehousing facility from 1941 until the OARB was officially closed for military purposes under the BRAC program on 30 September 1999 consistent with legislation passed by Congress in 1995 (IT, 2001a). Army activities to support the OARB's primary military mission as a distribution center included maintaining and fueling railroad locomotive engines and trucks, draining fluids from vehicles for overseas shipment, and repairing and servicing vehicles, equipment, and base facilities (IT, 2001a).

1.4.2 Prior Investigations

The Army has been conducting comprehensive site environmental investigations since approximately 1989. These investigations have been overseen by the DTSC, as the primary agency overseeing investigation and cleanup of the OARB, and the Regional Water Quality Control Board, San Francisco Bay Region ("RWQCB") as the agency overseeing the removal and closure of petroleum fuel tanks. The prior removal actions and remedial investigations already completed by others at OARB are summarized in Section 4, and an extensive list of reference documents is provided in Section 13.

1.4.3 Identified Chemicals of Concern

As of March 2002, the computerized database for the OARB contained over 204,000 records of analytical results of soil, water, and air samples collected primarily by the Army between 1989 and 2002. As summarized in Section 5, these existing data were evaluated to identify chemicals of concern ("COCs") found in soil and groundwater on the portions of the OARB property to be transferred to OBRA via the EDC.

1.4.4 Identified Environmental Issues

Chemical release areas at the OARB are shown on Figure 4-1 and were divided into RAP sites and RMP locations. RAP sites are shown in solid green or blue hatching on Figure 4-1. Identified RMP locations are shown in brown. These sites and locations are discussed in Section 4.

1.4.4.1 RAP Sites

RAP sites consist of seven identified chemical release areas that require remediation to protect human health and the environment. Effective cleanup of RAP sites are not anticipated to be cost-effectively implemented as part of redevelopment and must be started prior to redevelopment to prevent conflicts with land reuse. Residual contamination found at the RAP sites may not be sufficiently characterized or is not likely to be adequately remediated as part of activities performed during or after redevelopment. For example, greater amounts of time are potentially needed to implement active measures to reduce volatile organic compounds ("VOCs") in groundwater to concentrations less than applicable remediation goals at sites with VOC-impacted groundwater, such as Building 807, Buildings 808 and 823, and Building 99. Alternatively, if active measures are not selected as remedies to reduce VOC concentrations at these sites, engineering controls can be designed and incorporated into new building construction to mitigate the potential for a vapor intrusion exposure pathway. However, adequate time must still be allowed to incorporate the design of engineering controls in new building construction.

1.4.4.2 RMP Implementation Area

All of the OARB property to be transferred to OBRA via the EDC is included in the RMP Implementation Area. Within the RMP Implementation Area, RMP protocols will be implemented during and after remediation and redevelopment activities. The RMP Implementation Area includes numerous locations that involve documented or suspected small releases of petroleum hydrocarbons to soil. Petroleum releases have impacted groundwater to a minor extent at some of these locations. In response, routine groundwater monitoring is being conducted to fulfill closure requirements imposed by RWQCB. Petroleum-impacted areas are common at former industrial properties undergoing redevelopment (i.e., Brownfields) in the San Francisco Bay Area. Developers, contractors, and governmental agencies have found that these types of releases can be easily managed during new construction through application of an RMP.

The RMP (Appendix E) describes the health protective measures to be implemented, during and after redevelopment, for identified chemical release sites, land uses, and potential exposure pathways in the GDA and PDA. Institutional controls will obligate owners and tenants at the GDA and PDA to update information in the RMP based on conditions encountered or upon changes in land uses, environmental statutes, or chemical toxicity information. The RMP protocols will be implemented unless and until the need for such protocols are terminated on a location-specific or base-wide basis with the approval of the DTSC. Any applicable deed restrictions or notices are also included in the RMP.

The NCP at 40 CFR §300.430(a)(1)(iii)(B) states that "U.S. EPA expects to use engineering controls, such as containment, for waste that poses a relatively low long-term threat or where treatment is impracticable." Buildings, asphalt roadways, concrete pavement, imported clean soil, and other cover types existing and planned at the OARB adequately protect human health against direct contact with petroleum hydrocarbons and other COCs most frequently identified at RMP locations from review of available site use history and environmental data. The releases have generally affected a small quantity of soil and make the RMP locations at GDA and PDA relatively straightforward to address as they are encountered prior to, during, or after redevelopment. For example, as construction proceeds, properly trained workers can be mobilized to excavate identified areas of contaminated soil for subsequent reuse or disposal at an off-site, permitted waste management facility.

OBRA proposes to address RMP implementation requirements in a phased manner at the GDA and PDA that is consistent with the schedule for redevelopment. In the event that the nature and extent of the releases at RMP locations are found to differ significantly from the conditions described in this RAP, the appropriateness of response measures contained in the RMP (Appendix E) will be re-evaluated for such specific RMP locations. The RMP also specifies the situations under which response measures will be re-evaluated in consultation with DTSC.

1.4.4.3 Interim Use Sites

Brief descriptions and site location maps of the interim use sites are provided in Appendix D. Analytical data from investigations conducted at or near these interim use sites are available in the electronic database (Appendix A), and in the Phase II Investigation reports prepared by the Army (IT, 2002a) and OBRA (EKI, 2002). The results of Phase II Investigations conducted at or near these interim use sites are briefly summarized in Appendix D where potentially relevant.

1.5 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Applicable or Relevant and Appropriate Requirements ("ARARs") and To-Be-Considered materials ("TBCs") are evaluated in Section 6. The release or threatened release of a hazardous substance into the environment provides the basis for cleanups under Chapter 6.8 of the California HSC in California and federal NCP requirements.

Chemical-, location-, and action-specific ARARs that pertain to identified RAP sites and RMP locations at the OARB are evaluated in Section 6, and a detailed evaluation is presented in Table 6-1.

1.5.1 Federal ARARs and TBCs

The Clean Water Act ("CWA"), Toxic Substances Control Act ("TSCA"), Resource Conservation and Recovery Act ("RCRA"), and the Clean Air Act ("CAA") are some of the federal environmental laws with requirements that are frequently applicable or relevant and appropriate to site remediation activities. In addition, Section 6 also includes an evaluation of the California Toxics Rule, a regulation identifying water quality criteria that was adopted by the SWRCB, as well as other ARARs and TBCs.

1.5.2 State ARARs and TBCs

Some of the state ARARs and TBCs identified in Section 6 include the RWQCB Basin Plan, risk-based screening levels ("RBSLs"), applicable SWRCB Resolutions, and applicable sections of the California HSC and California Code of Regulations ("CCR").

1.5.3 Oakland Urban Land Redevelopment Program

In addition to the numerous federal and state statutes and regulatory requirements discussed in Section 6, the remediation and reuse of the OARB property by the City will be implemented under the Oakland Urban Land Redevelopment Program ("ULR") (Oakland, 2000). The ULR is the result of a collaborative effort between the City of Oakland and the principal agencies that enforce environmental regulations. Participating agencies included the DTSC, RWQCB, United States Environmental Protection Agency ("U.S. EPA"), and Alameda County Department of Environmental Health. However, for the purposes of the site specific risk analysis in this RAP, DTSC and OBRA modified the human health exposure parameters to calculate remediation goals for the OARB.

The Oakland ULR program is a three-tiered risk-based corrective action process. Tiers 1 and 2 consist of numerical cleanup levels in "look-up" tables that are applicable to properties that involve particular land uses, types of chemical releases, and geologic and hydrogeologic conditions. Tier 3 of the ULR program provides a methodology for calculating site-specific remediation goals that incorporate human health exposure parameters that are specific to Oakland. The City sought public comment on the ULR including elements related to acceptable residual risk. The ULR therefore provides important information on community acceptance of residual risk that can be considered in evaluating various alternative cleanup scenarios.

1.6 STATEMENT OF REMEDIAL ACTION OBJECTIVES

To attain the NCP goals of implementing remedial actions that protect human health and the environment, maintain protection over time, and minimize untreated waste, the remedial action objectives ("RAOs") for soil and groundwater on the OARB property transferred to OBRA by EDC (i.e., "OARB locations") are:

- Establish media-specific individual remediation goals that correspond to a Hazard Index ("HI") of 1 for each non-carcinogenic COC identified at the OARB. Remedial actions implemented at each RAP site or RMP location will be designed to meet individual non-carcinogenic COC remediation goals as established in Section 7.3, unless the cumulative non-carcinogenic risk goal as defined in this RAP can be met by alternative concentration limits demonstrated for a specific RAP site or RMP location to the satisfaction of DTSC. When multiple non-carcinogenic COCs are identified at a specific RAP site or RMP location, the cumulative non-carcinogenic target hazard index can be met by determining aggregate non-carcinogenic risk using the protocols in Section 7.5. Once remediation activities for a RAP site or RMP location have been completed pursuant to the RAP and RMP, confirmation samples will be collected to verify the cumulative non-carcinogenic hazard index of COCs (associated with the potentially complete exposure pathways defined in this RAP) remaining in soil and groundwater at each RAP site or RMP location will not exceed a cumulative HI of 1. The individual remediation goals for non-carcinogens in Table 7-11 represent the maximum allowable concentrations for the respective COCs. However, these remediation goals can be adjusted downward, as needed, if the total HI exceeds 1.

- Establish media-specific individual remediation goals that correspond to a 10^{-6} incremental lifetime cancer risk for each potential carcinogenic COC identified at the OARB. Remedial actions implemented at each RAP site or RMP location will be designed to meet individual carcinogenic COC remediation goals as established in Section 7.3, unless the cumulative carcinogenic risk goal as defined in this RAP can be met by alternative concentration limits demonstrated for a specific RAP site or RMP location to the satisfaction of DTSC. When multiple carcinogenic COCs are identified at a specific RAP site or RMP location, the cumulative carcinogen target risk level can be met by determining aggregate carcinogenic risk using protocols and equations provided in Section 7.5. Once remediation activities for a RAP site or RMP location have been completed pursuant to the RAP and RMP, confirmation samples will be collected to verify the cumulative carcinogenic risk of COCs (associated with the potentially complete exposure pathways defined in this RAP) remaining in soil and groundwater at each RAP site or RMP location will not exceed a cumulative, incremental lifetime human health carcinogen target risk level of 10^{-5}. As discussed in Section 7.3.3.2, the cumulative, incremental lifetime carcinogen target risk level of 10^{-5} is determined to be appropriate for the OARB after considering the applicability of the full risk range acceptable under the NCP and the cumulative carcinogenic risk goal of 10^{-6} as used by DTSC as the "point of departure" for evaluating remedial alternatives at sites in California under Chapter 6.8 of the HSC. The individual remediation goals in Table 7-11 represent the maximum allowable concentrations for the respective COCs. These remediation goals will not be increased to allocate amongst the residual COCs to meet the overarching cumulative risk of 10^{-5}. However, these remediation goals can be adjusted downward, as needed, if the total cancer risk level exceeds 10^{-5}.

- Establish a remediation goal for lead that does not exceed a blood lead concentration greater than 10 micrograms per deciliter ("µg/dl") at the 99th percentile in potentially exposed individuals resulting from the total exposure to lead at OARB locations and to naturally occurring lead in the environment (e.g., air, food, water) as calculated using the DTSC Lead Spread 7.0 computer model or a more stringent site-specific lead goal determined appropriate for OARB.

- Remove, or remove and treat, source material (i.e., principal threat waste) that poses significant human health or environmental threats or is prone to continued leaching of COCs to groundwater.

Action-specific, base-wide RAOs for soil and groundwater at RAP sites and RMP locations predicated on the above aims are as follows:

Soil RAOs:

- Maintain existing conditions at the OARB to prevent direct contact with known or potentially impacted soil prior to implementation of remedial actions or redevelopment.

- Specifically for the ORP / Building 1 area, remove, or remove and treat, tarry residue at ORP / Building 1 area to eliminate hazards associated with this source material and to allow planned land uses consistent with the Amended Reuse Plan.

- Remove or treat impacted soil that interferes with planned land uses, or is encountered during redevelopment or through post-redevelopment activities, or as otherwise necessary to achieve site-specific, soil remediation goals designated in the RAP.

- Contain impacted soil that will not unreasonably interfere with planned land uses by maintaining existing cover or constructing new cover.

Groundwater RAOs:

- Implement institutional controls, alone or in combination with site-specific engineering controls as part of all selected remedies, to prevent incidental ingestion or dermal contact with impacted groundwater under existing and planned land uses consistent with the Amended Reuse Plan.

- Treat VOC-impacted groundwater that interferes with planned land uses or as otherwise needed to achieve site-specific, groundwater remediation goals, or apply engineering controls to new structures to allow planned redevelopment or as otherwise necessary to reduce potential exposure posed by vapor intrusion to the target risk levels stated above.

- Prevent further significant increases of concentrations of metals and other non-volatile COCs in groundwater.

The site-specific numerical remediation levels for COCs in soil and groundwater determined to be consistent with these RAOs are developed in Section 7.3 and are listed in Table 7-11.

1.7 IDENTIFICATION OF REMEDIAL ACTION ALTERNATIVES

Identifying and screening potentially suitable technologies is the initial step in assembling appropriate remedies that achieve the RAOs established in Section 7, comply with ARARs, and satisfy other evaluation criteria established by U.S. EPA and the State of California. Technologies that pass the screening process are developed into remedial alternatives. Section 8 describes the identification and screening of technologies. The remedial alternatives are screened, and then undergo detailed analysis. Section 9 summarizes the development and screening of remedial action alternatives. Table 9-3 summarizes the remedial action alternatives for RAP sites and RMP locations that were retained for detailed evaluation.

1.8 RECOMMENDED REMEDIAL ACTIONS

The results of the detailed analysis determine the remedial alternatives that are recommended for implementation. Section 10 presents the detailed analysis of alternatives against NCP and state criteria and ends with a summary of recommended remedial actions at identified RAP sites and RMP locations and estimated remediation costs (Table 10-32). The implementation schedule is discussed in Section 11 for the recommended remedial actions, including implementation of the RMP as phased redevelopment occurs.

1.9 DECLARATION / STATUTORY DETERMINATION

The selected remedies for the RAP sites and RMP locations at OARB are intended to be protective of human health and the environment. They comply with federal and state requirements that are legally applicable or relevant and appropriate to the remedial actions and they are cost effective.

Because the selected remedies may allow hazardous substances to remain on-site above levels that allow for unrestricted use, a review of selected and implemented remedies will be conducted at five years after remedial action begins to ensure that the selected remedies provide adequate protection of human health and the environment.

The RAP and RMP shall be effective and enforceable only when the Army completes the conveyance of the areas covered in this RAP to OBRA.

Aliza Gallo
Executive Director
Oakland Base Reuse Authority

9/27/2002
Date

Anthony Landis, P.E.
Chief, Northern California Operations
Office of Military Facilities
Department of Toxic Substances Control
California Environmental Protection Agency

9-27-02
Date

2

2. INTRODUCTION

This RAP identifies and evaluates potential remedial alternatives for certain identified and to-be-identified sites of environmental concern at the OARB in Oakland, California. OARB is scheduled to be transferred to the OBRA by the Army via an EDC prior to the completion of all required environmental remediation. This early transfer requires that both the State of California and the Army find that all required remediation will be undertaken after transfer ("Finding of Suitability for Early Transfer" or "FOSET"). This requirement is met when the Governor determines that there is adequate assurance that all remedial actions necessary will be completed and that public health and the environment will be protected in the interim.

Recommended remedial actions in this RAP are based upon evaluation of selection criteria contained in Chapter 6.8 of the HSC including as referenced therein, the NCP, set forth in Part 300, Title 40 of the CFR. Upon approval, this RAP will set forth the remediation program which must be implemented at OARB to satisfy applicable State requirements.

2.1 INTENDED REUSE OF OARB

The OARB consists of approximately 425 acres of land. The Army is proposing to transfer approximately 366 acres of this land (including approximately 56 acres of offshore submerged land) to OBRA under the EDC provisions of the BRAC Act[4]. The Army Reserve is currently in possession of 26 of the remaining acres. Former BRAC Parcel 1[5] or "Spit" totaling approximately 13 acres of uplands will be transferred to the DOI on behalf of the EBRPD through a PBC, which is shown in pink on Figures 1-2 and 4-1. An additional area of approximately 6 acres of submerged land, including marine sediments at Outfall 4, are also defined to be part of the "Spit" that is not being transferred via the EDC. EBRPD will manage the land provided to the agency

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[4] The OARB property being transferred to OBRA excludes approximately 20 acres of OARB property, primarily located beneath I-880, which was transferred from the Federal Highway Administration to Caltrans in March of 2002. Litigation regarding this transfer is ongoing; however, this Caltrans property is not currently being planned for transfer from the Army to OBRA and, thus, is not subject to this RAP.

[5] As discussed in Section 4.1, BRAC parcels and OUs are terminology that was employed by the Army in administrating its environmental program at the OARB. Such terminology is not used in this RAP/RMP to describe known or potential chemical release sites. Chemical release sites are referenced in the RAP/RMP by the designations assigned on Army maps and facility records to the tank, structure or building that was associated with, or nearby, a known or potential release.

by the Army as open space for public recreation and habitat. The Army Reserve is separately pursuing plans to sell its parcels and relocate its activities elsewhere in the San Francisco Bay Area.

The *Redevelopment Environmental Impact Report* ("EIR"), prepared on behalf of the ORA and OBRA (collectively referred to herein as "City"), indicates that approximately 133 acres of the OARB will be redeveloped with a variety of commercial and industrial uses as part of the GDA. Approximately 233 acres (including 56 acres of submerged lands) will be employed for maritime, rail, and other port activities as part of the PDA. Details of the redevelopment strategy are presented in OBRA's *Amended Draft Final Reuse Plan for the Oakland Army Base (OARB)*, dated 23 July 2001 ("Amended Reuse Plan"). The Port of Oakland's specific land use objectives are presented in its *Strategic Plan Summary, Fiscal Years 2002-2006*, dated June 2001.

Redevelopment of the OARB is anticipated to begin at vacant and underutilized parcels shortly after conveyance. To finance a portion of redevelopment costs, existing rented structures are planned to remain under lease for approximately three years after conveyance. These existing interim uses primarily include warehouse, commercial and maritime activities. The Homeless Collaborative ("HC") also operates a large food bank warehousing facility, job training and counseling facilities, and transitional housing. The Oakland Military Institute College Preparatory Academy ("OMI"), a charter middle school, operates in temporary classrooms and an existing administration building. The interim site uses identified and discussed in Appendix D may continue to occupy the sites and buildings for five years post-transfer upon DTSC's issuance of waivers for such specified sensitive reuses. The Amended Reuse Plan anticipates that these interim HC and OMI uses will be eventually relocated as part of the redevelopment program for the OARB. Redevelopment and site remedial activities will not be delayed as a result of the existing leases.

2.2 APPROACH TO ENVIRONMENTAL RESTORATION OF OARB

Congress passed legislation in 1995 that designated closure of the OARB for military purposes under the BRAC program. OBRA was created to assist with the closure process as the LRA. OBRA is managing the OARB and its assets during the time between base closure and transfer. As the LRA, OBRA prepared the Amended Reuse Plan and will accept approximately 366 acres of the OARB from the Army. OBRA will subsequently convey this land to ORA, which will manage this property on behalf of the City of Oakland and will be responsible for implementing the Amended Reuse Plan. ORA, as successor-in-interest to OBRA, will assume responsibility from the Army for addressing specifically identified environmental matters that remain at the OARB at the GDA after transfer. With prior approval by DTSC, Port of Oakland may complete some remedial actions on the PDA. Excluded environmental issues are identified in Section 2.4.

DTSC is the primary state agency overseeing investigation and cleanup of the OARB. Representatives of OBRA have held many discussions, meetings, and negotiations with DTSC and the Army regarding the remediation process to be followed after transfer of the OARB is completed. These efforts have culminated in a proposal that recognizes the planned future commercial and industrial reuses of the OARB and provides for risk-based remediation of soil and groundwater for the portion of the OARB that will be transferred via an EDC to OBRA and, ultimately, to ORA. Implementation requirements for this RAP will be formalized in a Consent Agreement between DTSC, OBRA, and ORA. With certain exceptions discussed in Section 2.4, the Consent Agreement prescribes a binding legal process by which all required remedial actions will be completed. A key element of the Consent Agreement is the completion of the selected remedies in this RAP and implementation of the RMP, which is Appendix E to this RAP.

The RAP identifies institutional controls as an integral component of all remedial actions considered for the OARB. These institutional controls are anticipated to consist of land and groundwater use restrictions and requirements to comply with the RMP. The City has prepared the RMP for two purposes. The first purpose of the RMP is to implement a presumptive-style remedy for a suite of sites with standard contaminant profiles and site conditions. The second purpose of the RMP is to establish site identification and health protective protocols to be implemented at RMP locations as these locations are encountered or identified during redevelopment. DTSC requires that institutional controls be established in a land use covenant signed by DTSC and the City. The procedure for recording the land use covenant is set forth in the Consent Agreement. Upon execution of the land use covenant, the RMP would also become an appendix to the land use covenant.

The RAP defines the risk-based remediation goals that apply during and after redevelopment of the OARB. The RAP also establishes the remedial actions for identified, and reasonably anticipated, locations where chemical releases have occurred and require response when compared with the stated remedial action objectives and site-specific remediation goals for soil and groundwater. Investigation and remediation of many locations at the OARB will be phased to coincide with planned infrastructure upgrades and redevelopment activities.

The approach to remediation presented in the RAP / RMP for the OARB is commonly employed to facilitate cleanup and redevelopment of former commercial and industrial properties. Such sites are often referred to as "Brownfields." DTSC and other state and local agencies have approved many Brownfields projects in the San Francisco Bay Area for commercial/industrial properties that contain residual concentrations of hazardous substances and petroleum constituents. Brownfields projects are also facilitated by the City of Oakland's ULR program and its associated guidance documents and permit tracking system.

2.3 PURPOSE OF RAP / RMP

The purpose of the RAP / RMP is to identify remedies, from among a suite of remedial action alternatives, that are protective of human health and the environment, are cost-effective, and allow reuse of the OARB as intended under the Amended Reuse Plan. The understanding of environmental conditions, establishment of remediation goals, and selection of remedial actions are accomplished in the RAP.

The RMP can be generally described as an operation and maintenance plan, which is intended to ensure that implemented remedies provide protection of human health and the environment, during and after redevelopment. The RMP prescribes, among other things, the measures that will be implemented in the future to ensure that human health and the environment are adequately protected.

The RAP / RMP has been prepared consistent with requirements for preparing a RAP under Section 25356.1 of Chapter 6.8 of the California HSC, including requirements related to the federal NCP. The federal regulations were promulgated under Section 105 of the Comprehensive Environmental Response, Compensation, and Liability Act ("CERCLA"), as amended by the Superfund Amendments and Reauthorization Act ("SARA") of 1986. CERCLA was established in 1980 to identify sites where hazardous substances have been released to the environment, to assess the risk of those releases, and to ensure that the parties responsible for the releases clean up the sites. CERCLA and SARA are often collectively referred to as "Superfund."

It should be recognized that CERCLA governs only the cleanup of a release or threatened release of a "hazardous substance" into the environment, which incorporates substances, elements, compounds, solutions, or mixtures regulated under RCRA, CWA, CAA, or TSCA. The definition of hazardous substances excludes petroleum hydrocarbons. The NCP at Title 40 of the CFR, Part 300.5 states that the term hazardous substances:

> ...does not include petroleum, including crude oil or any fraction thereof which is not otherwise specifically listed or designated as a hazardous

> substance in the first sentence of this paragraph, and the term does not include natural gas, natural gas liquids, liquefied natural gas, or synthetic gas usable for fuel (or mixtures of natural gas and such synthetic gas).

DTSC supervises remediation of hazardous substance and hazardous waste constituent release sites at the OARB. The RWQCB generally oversees actions necessary to protect the waters of the State of California, including the removal and closure of petroleum fuel tanks at the OARB.[6]

For purposes of this RAP / RMP, hazardous substance and petroleum releases are collectively referred to as "chemical release sites." Petroleum releases have been included in the RAP / RMP for completeness and to facilitate an integrated approach toward environmental restoration of the OARB. To maintain continuity with the existing regulatory framework, it is anticipated that DTSC and RWQCB will oversee implementation of the RAP / RMP for hazardous substance and petroleum release sites, respectively.

2.4 ENVIRONMENTAL ISSUES NOT INCLUDED IN RAP / RMP

Under the ESCA to be signed between the Army and OBRA, the Army retains responsibility for cleanup of radiological materials, chemical and biologic warfare agents, and unexploded ordnance, if any, that may be present at the OARB. None of these materials are known or suspected to be present based on site investigation activities that have occurred over the past six years.

The Army also retains responsibility for remediation of the former BRAC Parcel 1 and associated submerged marine sediments at Outfall 4 in the Oakland Outer Harbor. It is anticipated that sediment remediation requirements will be addressed by the Army in connection with the related remediation of the uplands of the 15-acre parcel (also known as the "Spit"). The Army will continue to own the "Spit" and it is anticipated that the Army will transfer the "Spit" via a PBC to DOI and the EBRPD under a "Finding of Suitability for Transfer" ("FOST") after all required remediation has been completed.

Other than these environmental issues for which the Army retains responsibility, necessary remediation, if any, of OARB property that is not being transferred to OBRA

[6] RWQCB is a branch of Cal / EPA. RWQCB's overall mission is to protect the beneficial use of surface water and groundwater within the San Francisco Bay Area.

via the EDC is not considered in this RAP / RMP[7]. The following property is not addressed in this RAP / RMP:

- Former BRAC Parcel 1[8] or "Spit" totaling approximately 12.8 acres of uplands to be transferred to the DOI on behalf of the EBRPD through a PBC, which is shown in pink on Figures 1-2 and 4-1. An additional area of approximately 6.4 acres of submerged land, including marine sediments at Outfall 4, are also defined to be part of the "Spit" that is not being transferred via the EDC.

- Army Reserve parcels totaling approximately 26 acres, which comprised former Army BRAC Parcels 6, 7, and 18, and portions of former BRAC Parcels 19 and 21, shown in yellow on Figure 4-1.

- Any property that is not being transferred via the EDC.

OARB properties not transferred will continue to be owned and managed by the Army and United States and are outside of the scope of the Consent Agreement and this RAP / RMP.

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[7] Off-site property adjacent to the EDC area that may be contaminated from Army activities is excluded from the RAP / RMP except for groundwater contamination caused exclusively by Army activities that occurred on the EDC area. Off-site areas excluded from the EDC area and the RAP / RMP include, for example, former Parcel 1 and off-site pesticide releases described in Section 4.4.3.6 of the RAP.

[8] As discussed in Section 4.1, BRAC parcels and OUs are terminology that was employed by the Army in administrating its environmental program at the OARB. Such terminology is not used in this RAP/RMP to describe chemical release sites. Chemical release sites are referenced in the RAP/RMP by the designations assigned on Army maps and facility records to the tank, structure or building that was involved with a given release.

3

3. SITE BACKGROUND

This section provides background information on the OARB property. Included in this section is a synopsis of the regional setting, and descriptions of the use history, site features, geology, and hydrogeology of the OARB.

3.1 REGIONAL SETTING

Land surrounding the OARB is zoned Industrial (M) by the City of Oakland. The OARB itself is zoned Heavy Industrial (M-40). Port of Oakland harbor facilities lie west and south of the OARB (Figure 1-2). Port of Oakland harbor facilities consist of railroads and marine terminals with large waterfront cranes for loading and unloading cargo containers from ships. Cargo containers are stacked in the yards of the marine terminals and large transport trucks are common on Maritime Street and Port of Oakland roadways either actively moving cargo or waiting in queues to enter the terminals. The East Bay Municipal Utility District ("EBMUD") wastewater treatment plant, railroads, and the elevated Interstate I-880 freeway border the eastern side of the OARB. North of the OARB is the Interstate I-80 freeway and touchdown of the Bay Bridge. The nearest off-site residential land use is located approximately 1,000 feet southeast of the OARB and is entirely separated from the OARB by the I-880 freeway, as shown on Figure 1-2, which is a recent aerial photograph.

3.2 OARB USE HISTORY

Much of the area encompassing the OARB was natural tidal marsh or shallow open water before 1916 (Kleinfelder, 1998a). Prior to the Army's occupancy of the OARB in January 1941, portions of the property were partially filled with dredge spoils placed by the Army Corps of Engineers ("ACE"), the City, and subsequently the Port of Oakland (ACE, undated; City of Oakland, 1918; Minor Woodruff, 2000). During 1941, the ACE and the Army (OARB was referred to at the time as the S.F. Port of Embarkation) placed over 6.5 million cubic yards ("cy") of dredged sand and imported soil to create the remainder of the land area (Army Port Contractors, 1941; Army Port Contractors, 1942; Bechtel-McCone-Parsons Corporation, 1941; Labarre, R.V., 1941; Rogers, David and Sands Figuers, 1991).

According to the review of historical documents conducted for the Army by IT (2000j), industrial activity first took place in the area of the OARB in approximately 1918, prior to Army ownership, when Building 99 was constructed for ship manufacturing. Metalworking operations also reportedly occurred in this building from the 1920s through the 1930s. An oil reclaiming plant ("ORP") began operating on or about 1924 (IT, 2000j). The ORP was situated approximately 400 feet northeast of Building 99. Recycling processes at the ORP may have involved adding concentrated sulfuric acid to waste oil that was followed by distillation to recover useful oil fractions (IT, 2001i).

The Army acquired the property in 1941 for the OARB. The ORP was demolished and Building 99 was converted for use by the Army as a vehicle and electrical maintenance shop (IT, 2000i). The OARB served as a major Army cargo port and warehousing facility from 1941 until the OARB was officially closed for military purposes under the BRAC program on 30 September 1999 (IT, 2001a). Activities that were conducted by the Army to support the OARB's primary military mission as a distribution center included maintaining and fueling railroad locomotive engines and trucks that transported cargo, draining fluids from vehicles for overseas shipment, and repairing and servicing vehicles, equipment, and base facilities (IT, 2001a).

OBRA and the Port of Oakland currently manage an interim leasing program at the OARB. Interim leases expire at various future dates, but none currently extend past mid-June 2003 according to the EIR. Tenants occupying the portion of the OARB west of Maritime Street during the interim leasing period are primarily involved in railroad and marine transportation services, such as berthing; and loading, unloading, storing, and transporting of cargo. Interim uses east of Maritime Street include transportation, commercial, light industrial (e.g., woodworking, mobile recycling), and community services. Certain community services including the Head Start program, the Oakland Military Institute College Preparatory Academy,[9] a seasonal, cold-weather homeless shelter, and a licensed residential drug and alcohol treatment facility for the homeless ("interim use sites") are discussed in Appendix D. All interim uses at the four buildings and associated areas identified in Appendix D may continue to occupy the sites and buildings for five years post-transfer upon DTSC's issuance of waivers for such specified sensitive reuses. No existing residences present on the OARB will be occupied in the future under the Amended Reuse Plan.

[9] The EIR indicates that the school currently has approximately 150 7th grade students, but enrollment is expected to increase as discussed in Appendix D.

3.3 OARB SITE FEATURES

Buildings, railroads, roadways, and paved parking or storage areas dominate the OARB. As a consequence, no significant ecological habitats exist in the upland areas of the OARB being transferred to OBRA via the EDC. The little vegetation that is present in these upland areas consists of exotic and landscaped plant species. Two small, low quality wetlands are located off-site, adjacent to the OARB. The wetlands are situated between railroad tracks east of Building 991. One wetland is 0.34 acre and the other is 0.15 acre. The only undeveloped portion of the OARB is the approximately, referred to as the "Spit". The "Spit" will ultimately be transferred via PBC with a FOST to DOI/EBRPD (Figure 1-2) and is not included in this RAP.

3.4 OARB GEOLOGY

Much of the area encompassing the OARB, including the area west of current Maritime Street, was natural tidal marsh before 1916 (Kleinfelder, 1998a). Filling occurred in subsequent years to construct land for manufacturing buildings that predate the OARB and to create the OARB. According to IT (2001a), gravelly sand fill, which was imported from quarries near Lake Temescal and Oak Knoll Naval Hospital, is encountered below buildings and paved surfaces on the OARB and extends to a depth of approximately 5 feet below ground surface ("bgs"). A second fill layer exists between approximately 5 to 15 feet bgs. This second layer of fill consists of fine-grained sand that was hydraulically dredged from San Francisco Bay (IT, 1998a).

3.5 OARB HYDROGEOLOGY

Groundwater is generally encountered between 5 to 7 feet bgs in the fill layers, which comprise the shallow water-bearing zone at the OARB (IT, 2000m). Beginning at approximately 15 feet bgs, a sequence of clay on the order of 10 feet thick, referred to as Young Bay Mud, underlies the shallow water-bearing zone. The Young Bay Mud is not very permeable. ACE and Port of Oakland (1998) stated in the EIR for proposed dredging of Oakland Harbor that the Young Bay Mud is an aquitard with a low permeability of 1 x 10^{-7} cm/s. The Young Bay Mud restricts downward movement of groundwater to the next deeper water-bearing zone that is located at a depth of approximately 25 feet bgs. This deeper water-bearing zone is referred to as the Merritt Sand, which is the uppermost member of the San Antonio Formation (Kleinfelder, 1998a). The OARB lies in the East Bay Plain groundwater basin.

3.5.1 Groundwater Quality

Groundwater in both the shallow water-bearing zone and Merritt Sand is of poor quality due to the proximity to San Francisco Bay. Brackish conditions beneath the OARB and other near shore areas of Alameda County are due largely to unmanaged pumping of groundwater from the late 1800s through the 1920s that depleted subsurface freshwater reserves and caused significant saltwater intrusion (Figuers, 1998). Analysis of water samples collected from the five monitoring wells completed in the Merritt Sand beneath the OARB finds that groundwater beneath the OARB in the Merritt Sand has total dissolved solids ("TDS") concentrations greater than 10,000 mg/L (IT, 2000m). U.S. EPA (1986) considers groundwater that has a TDS concentration over 10,000 mg/L to be unsuitable for potential drinking water supply and of limited beneficial use.

Saltwater has also significantly affected the water quality of the shallow water-bearing zone in fill. In a study performed between 1997 and 1999, TDS concentrations were measured in 43 monitoring wells completed into the shallow water-bearing zone at the OARB. The TDS concentrations in these wells ranged from 343 to 21,200 mg/L, with the mean TDS concentration calculated to be 4,600 mg/L for all wells measured during this study (IT, 2000m). Kleinfelder (1998a) previously concluded that TDS variability in the shallow water-bearing zone is due to localized infiltration of surface water (e.g., landscape irrigation, leaks in water lines, exfiltration from storm drains and sanitary sewers) that dilutes the otherwise brackish groundwater in the vicinity of certain monitoring wells. RWQCB agreed with this conclusion and stated in its letter, dated 9 December 1998, that freshwater in the shallow water-bearing zone is "most likely due to artificial or man made inputs." RWQCB also commented in the letter that "TDS levels of the shallow fill aquifer at OARB will likely increase when the artificial inputs to the system are reduced."

TDS concentrations in the shallow water-bearing zone and Merritt Sand make the groundwater unsuitable for potable use. For TDS in drinking water, the State of California Department of Health Services ("DHS") has promulgated a recommended secondary Maximum Contaminant Level ("MCL") of 500 mg/L and a short-term secondary MCL of 1,500 mg/L promulgated under Section 64449 of Title 22 of the Code of California Regulations ("CCR"). Although DHS recommends that TDS concentrations in drinking water be below 500 mg/L, TDS concentrations as high as 1,000 mg/L are acceptable if DHS considers it "neither reasonable nor feasible to provide more suitable waters" (22 CCR §64449). Excursions to the short-term level of 1,500 mg/L are acceptable only if on a temporary basis pending construction of new treatment facilities or development of acceptable new water sources.

RWQCB (1999b) recognizes the poor quality of groundwater near the OARB and has proposed a formal determination or de-designation that groundwater along the Oakland shoreline, including the OARB, cannot be used for drinking water supply. RWQCB (2000) bases the proposed de-designation on the fact that groundwater is brackish and meets the exemption criteria under State Water Resources Control Board ("SWRCB") Resolution No. 88-63 (SWRCB, 1988). Under this resolution, SWRCB considers water with a TDS greater than 3,000 mg/L to "be unsuitable, or potentially unsuitable, for municipal or domestic water supply." RWQCB (1998) has stated that the exemption criteria contained in Resolution No. 88-63 applies to the shallow water-bearing zone at the OARB. SWRCB has not yet approved the de-designation proposed by RWQCB.

3.5.2 Potential for Contaminant Migration to San Francisco Bay Via Groundwater

The land surface at the OARB sloped to the west or northwest before filling took place and the original flow of groundwater probably followed these contours. Seawalls constructed along portions of the Port of Oakland harbor facilities, west of the OARB, affects movement of groundwater in the shallow water-bearing zone to San Francisco Bay. Where present, the seawall extends down to a depth of approximately 45 feet bgs and is constructed at the shoreline of the maritime terminals. The seawall penetrates the shallow water-bearing zone, the Young Bay Mud, and terminates in the Merritt Sand, thereby serving as a barrier to lateral groundwater flow in the shallow water-bearing zone. Current groundwater flow is complicated by the presence of the seawall and other manmade features, such as the higher permeability sand or gravel bedding that surrounds storm drains, which may also influence groundwater movement. Studies performed on behalf of the Army have demonstrated that groundwater elevations in the shallow water-bearing zone and Merritt Sand within 600 feet of the shoreline are tidally influenced. However, Kleinfelder (1998a) states that these tidal influences are likely associated with pressure responses in the shallow water-bearing zone and Merritt Sand rather than actual exchange of water with San Francisco Bay.

Groundwater data collected to date, including the Phase II Investigation data described in Section 4.4.4.10, indicate that COC impacts to shallow groundwater are confined primarily to identified RAP groundwater sites entirely within the boundary of the OARB and that COCs are not migrating in groundwater from these RAP sites to San Francisco Bay because the groundwater velocity is low compared with the rate of sorption and degradation mechanisms (Kleinfelder, 1998a). In other words, the VOC distributions in the shallow water-bearing zone at eastern end of Building 807 appear to be at steady state.

Although the movement of contaminants in groundwater through the shallow water-bearing zone appears restricted and subject to natural attenuation, it is possible that groundwater migrates to San Francisco Bay through the sand or gravel bedding that surrounds storm drains or through storm drain piping. Storm drain piping at the OARB is documented to have breaks and cracks. Storm drain piping is often situated in the saturated zone, and groundwater may enter the cracked or otherwise breached storm drain piping. However, groundwater that may enter the storm drains in most areas of the OARB is not likely to be contaminated, and contaminated areas near storm drains are subject to remedial actions discussed in subsequent section of this RAP.

4

4. OVERVIEW OF COMPLETED INVESTIGATIONS AND REMEDIAL ACTIVITIES

The use history and descriptions of the nature and extent of chemical impacts to soil and groundwater, if any, for RAP sites and RMP locations are based upon the results of record reviews, numerous studies, sampling efforts, and remedial activities at the OARB conducted primarily on behalf of the Army.

4.1 ARMY ENVIRONMENTAL PROGRAM

In 1995, pursuant to the Defense Base Closure and Realignment Act of 1990, Public Law 101-510 (10 U.S.C. Section 2687 note, as amended), the OARB was designated for closure. The Army's approach for completing environmental restoration at the OARB necessary to protect human health and the environment is outlined in the *Base Realignment and Closure Cleanup Plan* ("BCP"), dated July 1996. The plan divided the OARB into 26 areas, which were referred to as BRAC parcels. The Army eventually further organized the BRAC parcels into seven OUs for purposes of consolidating investigative and remedial actions at the OARB.[10]

The Army documented its investigations and remedial actions by the parcel and OU nomenclature. Table 4-1 provides a cross reference of sites of environmental concern identified in the RAP with the corresponding former parcel and OU designations used by the Army. These parcels and OUs have no current significance for the GDA or the PDA as the corresponding property boundaries or subdivisions were not surveyed or recorded, and they do not correspond to any reuse plan or program. Accordingly, chemical release sites at the OARB are referenced herein by the designations assigned on Army maps and in facility records to the specific tank, structure, or building that was potentially involved with a given release or present nearby.

Although cleanup efforts by the Army began in 1989, the BCP enabled a more comprehensive approach toward remediation of the OARB (IT, 2001a). The Army subsequently completed an Environmental Baseline Survey ("EBS"); (Foster Wheeler Environmental Corporation ("Foster Wheeler"), 1996a) and performed a Preliminary Assessment/Site Inspection ("PA/SI") (Kleinfelder, 1998b). These efforts involved

[10]The Army established a total of seven OUs even though only six of these OUs (i.e., OU1, OU2, OU3, OU4, OU5, and OU7) were employed to organize BRAC parcels. OU5 was designated for FOST parcels, of which none were approved. OU6 was reserved for future use and no BRAC parcels were ever placed in this OU.

conducting inspections, interviewing personnel who handled chemicals and hazardous materials, reviewing permits and records, examining aerial photographs, and studying geological and historical reports that pertain to the OARB. Soil, groundwater, and soil gas were tested as part of the PA/SI to identify sites at the OARB that required additional investigation and possible remedial action.

4.2 ARMY INVESTIGATIONS AND REMEDIAL ACTIVITIES

In response to the findings of the EBS and PA/SI, the Army conducted remedial investigations ("RIs") of the OARB. The RI results are summarized in several draft reports organized by the OUs defined by the Army (Harding ESE, 2001; IT, 2001b, 2001f, 2000a, 2000f, 2000i, 2000l, 1999). In addition to investigations that were performed as part of the RI, the Army conducted the following additional studies:

- Performed hydrogeologic evaluation (Kleinfelder, 1998a) and assessed groundwater quality at the OARB (IT, 2000m).
- Conducted additional soil, groundwater, and air sampling at the former ORP / Building 1 area (IT, 2002c).
- Surveyed buildings for lead-based paint ("LBP") and asbestos-containing material ("ACM"); (ACE, 1999a, 1997a).
- Investigated environmental conditions of storm drains and sanitary sewers at the OARB and prepared a draft report (ICF Kaiser Engineers, 1999a).
- Evaluated potential remedial actions for contaminated sites by completing draft feasibility studies (IT, 2001i, 2000d).
- Conducted further review of historic records (Foster Wheeler, 2000; IT, 2000j).
- Sampled monitoring wells on a quarterly basis (IT, 2002g).

The Army also performed remedial activities at many locations on the OARB. Remedial activities by the Army included the following:

- Removed aboveground storage tanks ("ASTs") and underground storage tanks ("USTs").

- Excavated contaminated soil and skimmed separate phase petroleum hydrocarbons from monitoring wells at former tank locations.

- Excavated pesticide-containing soil from the off-site wetlands adjacent to the Building 991 area.

- Tested and replaced some transformers and electrical equipment containing polychlorinated biphenyls ("PCBs") with transformers and equipment that do not contain PCBs.

For purposes of this RAP, the findings and data compiled as a result of the Army's investigative and remedial activities have been evaluated together with information derived from investigations not conducted by the Army. The investigations completed by others and those recently performed by OBRA are described below. Environmental data from the Army's investigations at OARB through January 2002, as provided electronically to OBRA, are provided in Appendix A. Recent Phase II Investigations are discussed separately below.

4.3 INVESTIGATIONS BY OBRA AND OTHERS

Besides the Army, the Caltrans, the Army and Air Force Exchange Services ("AAFES"), and, most recently, OBRA have conducted investigations on portions of the OARB.

4.3.1 Caltrans Sampling Associated with I-880 Freeway Reconstruction

The Loma Prieta earthquake in 1989 severely damaged sections of the I-880 freeway system that surrounds the OARB. In 1994, Caltrans retained Environmental Assessors, Inc. to sample soil in the area below the West Grand Avenue overpass that was undergoing reconstruction due to seismic damage. The Caltrans sampling was conducted on OARB property in connection with the reconstruction of the West Grand Avenue overpass that crosses the OARB. Sampling was intended to determine the magnitude of chemical impacts to soil to establish appropriate health and safety protocols within the Caltrans work area, and to characterize the soil for disposal purposes.

Approximately 111 soil samples were collected and analyzed for lead (Environmental Assessors, Inc., 1994). Smaller numbers of samples were tested for total petroleum hydrocarbons ("TPH"), VOCs, semi-volatile organic compounds ("SVOCs"), pesticides, and PCBs. No widespread contamination was found in the area investigated by Caltrans.

The highest lead concentration measured in soil was 1,300 mg/kg (Environmental Assessors, Inc., 1994). Most soil samples contained lead less than 25 mg/kg. Minor amounts of petroleum hydrocarbons were also found in soil below the West Grand Avenue overpass. Analytical results obtained by Caltrans at the OARB are incorporated into the electronic database that was relied upon to prepare this RAP.

4.3.2 AAFES Phase II Investigation

In 1996, AAFES considered acquiring 72 acres of the OARB that included Buildings 802 through 808; Buildings 812, 815, 821, 822, and 823; and the western half of the Knight Railyard. In connection with this potential property acquisition, Camp Dresser & McKee, Inc. ("CDM") performed a Phase II investigation on behalf of AAFES. Soil or grab groundwater samples were collected from approximately 110 locations in this portion of the OARB (CDM, 1996). The findings of the investigation confirmed the presence of VOCs in groundwater at the eastern end of Building 807 that was discovered in 1992. Section 4.4.3.2 discusses this VOC-impacted site in greater detail. CDM also found that "grab" groundwater samples had relatively high concentrations of arsenic, barium, cadmium, chromium, and lead. It must be emphasized that these high metal concentrations are not considered representative because the grab groundwater samples were not filtered to eliminate turbidity effects as explained below.

High levels of turbidity interfere with accurate quantification of metals in groundwater because detected concentrations of metals are often associated with suspended solids that became entrained in groundwater during sampling and are not present otherwise. Puls and Powell (1992) of U.S. EPA state:

> R.S. Kerr Environmental Research Laboratory (RSKERL) personnel have evaluated sampling procedures for the collection of representative, accurate, and reproducible ground water quality samples for metals for the past four years. Intensive sampling research at three different field sites has shown that the method by which samples are collected has a greater impact on sample quality, accuracy, and reproducibility than whether the samples are filtered or not. In particular, sample collection practices that induce artificially high levels of turbidity have been shown to have the greatest negative impacts on sample quality.

U.S. EPA (1997c, 1995a) recommends that groundwater samples be collected by low-flow sampling techniques from properly constructed, developed, and purged monitoring wells to minimize turbidity. However, for groundwater samples that have turbidity levels greater than 5 nephelometric turbidity units ("NTU"), U.S. EPA (1997c) states that an in-line filter should be employed to collect the samples. According to U.S. EPA (1997c), "in-line filtering provides samples which retain their chemical integrity."

Cal / EPA has reached similar conclusions as those of U.S. EPA. In its *Guidance Manual for Groundwater Investigations*, Cal / EPA (1994) states:

> Filtered samples for dissolved metals analysis should be used whenever ground water samples are collected to determine if water quality has been affected by a hazardous substance release that includes metals as a constituent of concern.

With regard to groundwater samples collected at the OARB, DTSC (2001a) commented in a letter to the Army that it:

> recognizes the Army's position that unfiltered groundwater samples, or samples from temporary wells, are not useful because of high turbidity resulting from the use of grab samples. The solution to this problem is to collect better samples. It has been and remains DTSC's position that unfiltered samples or samples from temporary wells, if adequately collected, are needed for risk assessment.

DTSC (2001a) requested that an evaluation be performed to confirm that fill at the OARB is not leaching elevated concentrations of metals to groundwater such as those measured in AAFES grab groundwater samples.

Potential concern about metal contents of the fill at the OARB appears to be unfounded when the analytical results of properly collected water samples are examined. For example, low turbidity groundwater samples were obtained by the Army from 13 monitoring wells throughout the OARB in 2000 to provide additional data for the RI and investigation of former petroleum tank sites (IT, 2001e). The turbidity levels in these groundwater samples were generally less than 5 NTU, and no significant differences were observed between the analytical results of filtered and unfiltered groundwater samples from the monitoring wells. These groundwater samples did not contain metal concentrations greater than federal or State of California promulgated MCLs; thereby demonstrating that groundwater has not been appreciably impacted by metals naturally occurring in fill or otherwise from chemical releases at the OARB.[11] Very low metal concentrations are measured in groundwater at the OARB when care is exercised to collect samples that do not have excessive turbidity. In other words, high turbidity produces analytical results that overestimate concentrations that are actually dissolved in water because naturally occurring metals associated with suspended solids are reported as being dissolved in groundwater when in fact they are not. Metal analyses of unfiltered grab groundwater samples obtained in 1996 by CDM for AAFES and those later generated by others are not considered further in this RAP. Section 5 describes the approach followed by OBRA to screen available data to identify COCs at the OARB.

4.3.3 OBRA Review of Historical Documents

In September 2001, OBRA retained Erler & Kalinowski, Inc. ("EKI") to provide technical assistance for completing the FOSET process for early transfer of the OARB. As part of these services, EKI accomplished a partial review of primary historical documents (e.g., historical property cards, property vouchers, engineering drawings, historical maps, aerial photographs, and other documents) stored in the Army Base Transition Office at the OARB. The findings from this review by OBRA have been incorporated into this RAP / RMP.

4.3.4 Port of Oakland Review of Historical Documents

On behalf of the Port of Oakland and in conjunction with the Port of Oakland's Environmental Health and Safety Compliance Department, BASELINE Environmental Consulting ("BASELINE") conducted a review of historical information pertaining to the PDA (i.e., portions of the OARB to be transferred to the Port). The information reviewed by the Port included historical property cards, property vouchers, historical maps, aerial photographs, and other documents to assess potential sources of chemical impact. The findings from this review were documented in *Additional Information Report, Oakland Army Base, Oakland, California* (BASELINE, 2002). The findings from this review by the Port of Oakland have been incorporated into this RAP / RMP.

4.3.5 Army / OBRA Phase II Investigations

The findings from OBRA's and the Port of Oakland's review of historical documents and the various Army RI and FS reports led OBRA to decide to conduct a Phase II

[11] The comparison with MCLs is intended solely to illustrate that metals in groundwater are not a concern at the OARB. MCLs are not pertinent cleanup standards because groundwater at the base is so brackish that it cannot be used as drinking water supply (see Section 3.5.1).

Investigation in concert with the Army to further refine the understanding of environmental conditions at the OARB prior to transfer. Sampling activities were conducted in May 2002. Analytical results of sampling activities conducted by OBRA are described in EKI's report entitled *OBRA Phase II Investigation Data Report, Oakland Army Base, Oakland, California*, dated 12 June 2002 (EKI, 2002). Analytical results of sampling activities conducted by the Army are described in IT's report entitled *Draft Phase II Supplemental Investigation Report, Oakland Army Base, Oakland, California*, dated 24 June 2002 (IT, 2002a). Phase II Investigation data pertaining to identified RAP sites and RMP locations are briefly summarized in Sections 4.4.3 and 4.4.4, and are included in electronic data files provided in Appendix A.

The Phase II Investigation data collected by the Army and OBRA have been considered in the evaluation of remedial alternatives for the OARB. However, because Phase II Investigation data were collected as part of a voluntary sampling program to support a real estate transfer agreement without the DTSC reviewing sampling proposals, the data may or may not meet the quality objectives required for CERCLA remediation projects. The Phase II analytical results will be further evaluated by the DTSC in consultation with OBRA, as described in Section 5 of the RMP (Appendix E).

4.4 SUMMARY OF CHEMICAL RELEASE SITES AND LOCATIONS

In most instances, contamination of soil and groundwater at the OARB is relatively minor. Army operations were limited chiefly to warehousing and shipping of cargo overseas and did not include the kind of manufacturing activities that occurred at many other, larger San Francisco Bay Area military bases. Identified chemical impacts derive mostly from the use of petroleum products for activities that supported the OARB's primary military mission as a distribution center. Support activities included maintaining and fueling railroad locomotive engines and trucks that transported cargo, draining fluids from vehicles for overseas shipment, and repairing and servicing vehicles, equipment, and base facilities (IT, 2001a).

The most significant subsurface contamination found at the OARB is evidently due to operation of the ORP that took place in the 1920s and 1930s and preceded Army occupancy. Tarry residue from the ORP was deposited in an area near where Building 1 now stands and extends under Building 1. The former ORP / Building 1 area is discussed in Section 4.4.3.1.

4.4.1 Sites with COCs Greater Than Screening Levels for Unrestricted Use

The RAP identifies several RAP sites and RMP locations with releases of COCs at concentrations that exceed risk-based screening levels for unrestricted redevelopment of the OARB. As described in greater detail in Section 5, these areas have been identified by evaluation of representative data pursuant to U.S. EPA protocols (1989d). Any area where chemicals in soil or groundwater have been detected at concentrations greater than screening levels is a site that has been identified as potentially requiring remedial action for purposes of evaluation in this RAP. The RAP also addresses areas for which environmental data are lacking but reviews of use histories conducted by the Army and others suggest the potential for chemical releases that may be incompatible with unrestricted land use.

Although hypothetical, unrestricted land use was assumed in screening chemicals at the OARB, the Amended Reuse Plan contemplates that the OARB will be redeveloped for commercial and industrial purposes only. The NCP and, therefore, a RAP prepared under Chapter 6.8 of the California HSC that must be based upon the NCP do not contemplate remediating contaminated property to allow for unrestricted future residential use if such use is not reasonably anticipated in the future. With respect to this point, U.S. EPA (1995d) states in its Superfund Land Use Directive that "in cases where the future land use is relatively certain the remedial action objective generally should reflect this land use." U.S. EPA (1995d) also states that:

> the volume and concentration of contaminants left on-site, and thus the degree of residual risk at a site, will affect future land use. For example, a remedial alternative may include leaving in place contaminants in soil at concentrations protective for industrial exposures, but not protective for residential exposures. In this case, institutional controls should be used to ensure that industrial use of the land is maintained and to prevent risks from residential exposures.

Consequently, a more realistic view is taken when establishing RAOs for the purpose of assembling remedial alternatives. RAOs for OARB sites reflect the reasonably anticipated commercial and industrial land uses in conjunction with institutional controls prohibiting unrestricted land use. RAOs lead to practicable and cost-effective remedial alternatives consistent with the NCP and U.S. EPA Superfund Land Use Directive. Further, U.S. EPA (2001e) has found that integrating realistic assumptions of future land use into remedial actions is an important step toward encouraging cleanup and redevelopment of contaminated properties. Identification of COCs is discussed in greater detail in Section 5. RAOs for OARB sites are presented in Section 7.

4.4.2 Categorization of Chemical Release Areas

Known and potential chemical release areas at the OARB are shown on Figure 4-1 and were divided into RAP sites and RMP locations as discussed below. RAP sites are shown in solid green or blue hatching on Figure 4-1. RMP locations are shown in brown on this same figure.

4.4.2.1 RAP Sites

RAP sites consist of seven areas that require remediation to protect human health and the environment. Effective remediation of RAP sites is not anticipated to be cost-effectively implemented as part of redevelopment and will be started prior to redevelopment to prevent conflicts with land reuse. Residual contamination found at these locations may not be sufficiently characterized or may not be adequately remediated as part of activities performed during or after redevelopment.

Greater amounts of time are also potentially needed to implement active measures to reduce VOCs in groundwater to concentrations less than applicable remediation goals at currently identified sites with VOC-impacted groundwater, such as Building 807, Buildings 808 and 823, and Building 99. Alternatively, if active measures are not selected as remedies to reduce VOC concentrations at these sites, engineering controls can be designed and incorporated into new building construction to mitigate the vapor intrusion exposure pathway that potentially exists. However, adequate time must still be allowed to incorporate the design of engineering controls in new building construction. The evaluation of potential human health risks associated with vapor intrusion is discussed in Section 7.3.

A RAP site may be added by amendment to this RAP where a location at the OARB cannot be appropriately managed under the RMP or under the remedial technologies retained in this RAP. Protocols for identifying additional RAP sites are discussed in Section 5 of the RMP.

4.4.2.2 RMP Implementation Area

The RMP Implementation Area consists of all areas of the OARB to be transferred to OBRA via the EDC, including, for example, numerous RMP locations which involve documented or suspected small releases of petroleum hydrocarbons to soil. Certain interim use sites, identified in Appendix D, are also included within the RMP Implementation Area. Petroleum releases have impacted shallow groundwater to a minor extent at some of the RMP locations. In response, routine groundwater monitoring is being conducted to fulfill closure requirements imposed by RWQCB. Such petroleum-impacted areas are common at former industrial properties undergoing redevelopment in the San Francisco Bay Area. Developers, contractors, and governmental agencies have found that these types of releases can be easily managed during new construction through application of an RMP.

An RMP is sometimes referred to as a Contingency Plan, a Soil Management Plan, or a Remediation and Risk Management Plan. The RMP is considered analogous to a CERCLA Operation and Maintenance Plan. The Operation and Maintenance Plan is a typical component of remedial actions and includes protocols for conducting inspections, performing routine sampling, maintaining institutional (e.g., covenants, groundwater use restrictions) and engineering (e.g., cover integrity, wells) controls, and fulfilling reporting obligations (U.S. EPA, 2001f). The objectives and contents of the RMP are similar. The RMP for the OARB describes the health protective measures to be implemented in the future, during and after redevelopment, for identified chemical release sites, land uses, and potential exposure pathways. Institutional controls will obligate owners and tenants of the OARB to update information in the RMP based on conditions encountered or upon changes in land uses, environmental statutes, or chemical toxicity information. The RMP is, thus, a component of the institutional controls included for all remedial actions in this RAP.

As discussed in more detail in Section 8, the NCP at 40 CFR §300.430(a)(1)(iii)(B) states that "U.S. EPA expects to use engineering controls, such as containment, for waste that poses a relatively low long-term threat or where treatment is impracticable." Buildings, asphalt roadways, concrete pavement, imported clean soil, and other cover types existing and planned at the OARB may adequately protect human health against direct contact with petroleum hydrocarbons and other COCs most frequently identified at RMP locations. This fact, coupled with available use history information and environmental data that indicate the RMP locations identified at the OARB consist primarily of petroleum hydrocarbon or low threat COC releases that have affected a small quantity of soil, makes the RMP locations relatively straightforward to address as they are encountered during or after redevelopment. For example, as construction proceeds, workers trained in the remediation of hazardous substance release sites can be mobilized to excavate identified areas of contaminated soil for subsequent reuse, if shown to be acceptable, or disposal at an off-site, permitted waste management facility.

For these reasons, OBRA proposes to address RMP implementation requirements in a phased manner that is consistent with the schedule for redevelopment of the OARB. In the event that the nature and extent of COC releases at RMP locations are found to differ significantly from the conditions described in this RAP, the appropriateness of remedial actions adopted for the OARB will be re-evaluated for such specific RMP locations. The RMP, which is provided as Appendix E to this RAP, specifies the situations under which response measures will be re-evaluated in consultation with DTSC and the procedures for elevating a RMP location to a RAP site, if appropriate.

4.4.3 Environmental Conditions at RAP Sites

Environmental conditions at RAP sites tend to be unique in one or more respects. As a result, the use history, and nature and extent of contamination are summarized separately in the sections below for each identified RAP site. Detailed discussions of the environmental conditions at these sites can be found in the RI reports and addenda prepared by the Army; refer to the reference list in Section 13. Analytical results of COCs in soil and groundwater are contained on the compact disc included as Appendix A. Identification of COCs for the OARB is discussed in Section 5.

4.4.3.1 Former ORP / Building 1 Area

The former ORP consisted of a building and several aboveground tanks at the approximate location shown on Figure 4-2. Review of historical aerial photographs taken in 1931 and 1939 show the ground to be stained around the building and tanks. IT (2001i) has postulated that dumping of tarry residue from waste oil recovery operations caused the staining observed in the historical photographs. The tarry residue was apparently covered by fill imported by the Army to construct Building 1 in 1941.

A portion of the tarry residue is a pliable, acidic semi-solid that demonstrates some mobility in the subsurface. In 1994, the asphalt parking lot between Wings 1 and 2 of Building 1 buckled due to tarry residue that flowed to the surface. The Army removed the material and repaired the parking lot. Four years later, in 1998, the Army excavated this same area in an effort to eliminate the tarry residue. The tarry residue could not be completely excavated because it extended under Wing 2 of Building 1.

In 2000, a video camera inspection of a sanitary sewer line that runs through the parking lot found tarry residue had infiltrated the sewer line through joints in the pipe. Also in 2000, tarry residue was observed to have migrated to the surface beneath the crawl space of Wing 1 of Building 1, approximately 120 feet to the southwest where the tarry residue was first noted in the parking lot in 1994. The tarry residue seemed to have exuded through a small gap between a wooden piling that supports the building and an edge of the concrete slab that exists below the building to discourage habitation by burrowing rodents and other vermin. The tarry residue was removed. Army representatives have indicated that the tarry residue has again been observed beneath the crawl space of Building 1 in March 2002. IT (2001i) described the physical appearance of tarry residue found beneath the crawl space of Building 1 as the following:

> The substance had a black skin that was stiff and slightly resilient, appearing to be an oxidized layer over a softer interior. When the outer layer was penetrated, a clear watery liquid welled up in the hole and bubbled and squirted out if under sufficient pressure. The clear liquid reacted with the concrete slab, producing a faint hissing and bubbling. A test with pH paper indicated a very strong acid (pH near zero). Faint traces of sulfurous and nitrous gases were noted.

Laboratory analysis (IT, 2000i) of the tarry residue has confirmed its acidic nature. Lead has been measured at a concentration as high as 11,800 mg/kg in the tarry residue. The material also contains polycyclic aromatic hydrocarbons ("PAHs"), PCBs, polychlorinated dibenzodioxins ("PCDDs"), and polychlorinated dibenzofurans ("PCDFs") at concentrations of concern. PCDDs and PCDFs are general references to dioxin-like compounds that are often found in complex mixtures. Table 4-4 summarizes analytical results for tarry residue samples collected beneath the crawl space of Building 1. The tarry residue does not appear to be contaminated with VOCs, although one sample of fill that overlies the tarry residue contained 320 µg/kg of 1,2,3-trichloropropane ("TCP").

The Army has compiled information on the distribution of tarry residue in soil at the Building 1 area by conducting laboratory analyses, field screening with a photoionization detector ("PID"), and noting on boring logs where discoloration or odor in soil have been observed. Figure 4-2 delineates the potential extent of tarry residue in soil based upon this information.

IT (2001i) calls the tarry residue that has migrated to the surface a "tar-like substance" or "soft, pliable, non-viscous black solid." However, the most common form of the tarry residue observed in soil samples collected from borings and trenches is a material that is characterized as a "dark to light brown fluid with the consistency and look of motor oil." The thickness of tarry residue in the subsurface varies from less than 0.5 feet to at least 3 feet. The full depth of tarry residue has not been determined at all locations. In the draft feasibility study ("FS") that considered the former ORP / Building 1 area, IT (2001i) estimated the in-situ volume of tarry residue to be approximately 6,000 cy that exists primarily between 3.5 to 5.5 feet bgs. IT also estimated the in-situ volume of TCP-impacted fill overlying the tarry residue to be roughly 2,000 cy distributed from ground surface to a depth of 3.5 feet bgs over the approximate 13,700 square foot ("sf") area shown on Figure 4-2. The volume estimates by IT are subject to considerable uncertainty and the actual quantities of tarry residue and any TCP-impacted soil that must be addressed by remedial actions may be greater or less than estimates by IT.

Review of available groundwater data does not suggest that the tarry residue contains significant quantities of soluble contaminants (IT, 2002c). The maximum concentrations of petroleum hydrocarbons in groundwater samples collected within the area believed to be impacted by tarry residue were 2.7 mg/L measured as TPH as gasoline and 6.5 mg/L measured as TPH as motor oil. Detected VOCs in the shallow water-bearing zone within this area have consisted of n-propylbenzene at 0.06 μg/L, vinyl chloride at 3.7 μg/L, toluene at 0.2 μg/L, and xylenes at 0.48 μg/L. No PAHs have been detected in groundwater samples above analytical method reporting limits. The highest concentration of lead measured in groundwater has been 264 μg/L.

The former ORP / Building 1 area is a RAP site because of the potential human health risks associated with the tarry residue. A portion of the tarry residue represents source material that displays mobility in the subsurface.

4.4.3.2 VOCs in Groundwater at Eastern End of Building 807

VOCs in the shallow water-bearing zone at the eastern end of Building 807 were discovered in 1992 during the drilling of foundation piers for a prefabricated building (CDM, 1996). Detected VOCs in groundwater in this area consist primarily of vinyl chloride, cis-1,2-dichloroethene ("cis-1,2-DCE"), trans-1,2-dichloroethene ("trans-1,2-DCE"), trichloroethene ("TCE"), and 1,1,2,2-tetrachloroethane. The VOCs are believed to have been released as a result of the Army's past practice of allowing drums of solvent, paint, or other chemicals that were damaged during shipping to drain along the railroad tracks in this area of the Knight Railyard. The PA/SI attributes the following statement to an environmental assessment of the OARB conducted by the United States Army Toxic and Hazardous Materials Agency ("USATHAMA") in 1988:

> In the past, damaged containers were placed adjacent to the tracks at the Knight Railyard. The containers were allowed to drain on the railroad ballast rock in this area, and any material which did not drain eventually was placed inside other containers for transport and disposal at authorized disposal sites. OARB changed this procedure after it was identified to management personnel as a potential problem. The installation then provided lined drums throughout the warehouses to receive any leaking or damaged containers.

The location where VOC-impacted groundwater was encountered at the eastern end of Building 807 is, however, approximately 200 feet northeast of the area identified by USATHAMA in its 1988 assessment as the location where the Army reportedly drained damaged containers. This latter area is identified as an RMP location and is discussed in Section 4.4.4.3.5.

Maximum VOC concentrations detected in shallow groundwater at the eastern end of Building 807 are vinyl chloride at 442 µg/L, cis-1,2-DCE at 2,020 µg/L, trans-1,2-DCE at 300 µg/L, TCE at 363 µg/L, and 1,1,2,2-tetrachloroethane at 200 µg/L in water samples collected from monitoring well ICFMW202. Nine monitoring wells in the shallow water-bearing zone define the lateral extent of VOC-impacted groundwater as shown on Figure 4-3. Review of water level and analytical data for these wells indicates that VOCs are not migrating. The limited extent of VOC migration in groundwater may reflect that groundwater velocity is low compared with the rate of sorption and degradation mechanisms (Kleinfelder, 1998a). In other words, the VOC distributions in the shallow water-bearing zone at eastern end of Building 807 appear to be at steady state.

Although investigations by the Army do not indicate that a significant chemical source remains in soil at this area, the residual VOC concentrations in groundwater may pose a vapor intrusion threat if a building is constructed over the area in the future. To allow such construction, remediation of VOCs in groundwater may need to be performed or new buildings may have to be designed with engineering controls that prevent infiltration of VOCs inside the structures. For these reasons, the area at the eastern end of Building 807 with VOCs in groundwater is considered a RAP site.

4.4.3.3 VOCs in Groundwater Near Buildings 808 and 823

Vinyl chloride and lesser concentrations of other VOCs are present in shallow groundwater in an area north of Building 808 and south of Building 823 (Figure 4-4). No significant soil contamination has been identified and the source of the VOCs is not known. Possible sources include Building 823, and storm drains and sanitary sewers that run through the area. Building 823 and storm drains and sanitary sewers are identified as RMP locations and are discussed in Sections 4.4.4.3.4 and 4.4.4.7, respectively.

Maximum VOC concentrations detected in shallow groundwater near Buildings 808 and 823 are vinyl chloride at 267 µg/L, cis-1,2 DCE at 13 µg/L, trans-1,2 DCE at 3.6 µg/L, TCE at 4.1 µg/L, and 1,1-dichloroethene ("1,1-DCE") at 2 µg/L. VOCs in shallow groundwater near Buildings 808 and 823 appear to be in steady state and are not migrating.

The lateral extent of VOC-impacted shallow groundwater was further delineated as part of OBRA's Phase II Investigation (EKI, 2002). VOCs at individual concentrations of less than 5 μg/L were detected in groundwater along the southern edge of this area. VOC-impacted groundwater near Buildings 808 and 823 is considered a RAP site because of the potential vapor intrusion threat posed by residual VOCs in groundwater.

4.4.3.4 VOCs in Groundwater Near Building 99

As shown on Figure 4-5, an area of the shallow water-bearing zone near Building 99 is impacted with VOCs. The predominant VOCs detected in groundwater are vinyl chloride and cis-1,2-DCE. No significant soil contamination has been identified and the source of the VOCs is unknown. Possible sources include Building 99 (Section 4.4.3.7) which is identified as a RAP site, and storm drains and sanitary sewers (Section 4.4.4.7) which is identified as a RMP location.

Vinyl chloride and cis-1,2-DCE have been detected at maximum concentrations of 29 μg/L and 41 μg/L, respectively. The impact of vinyl chloride and cis-1,2-DCE to shallow groundwater in this area has been fully delineated. VOC-containing groundwater near Building 99 is considered a RAP site because of the potential vapor intrusion threat posed by residual VOCs in groundwater.

As part of its Phase II Investigation, the Army conducted groundwater sampling to characterize the lateral extent of VOC impacts to shallow groundwater along the eastern edge of this area (IT, 2002a). VOCs detected in groundwater in this area included cis-1,2-DCE at a maximum concentration of 8.3 μg/L, vinyl chloride at a maximum concentration of 13.8 μg/L, PCE at a maximum concentration of 7 μg/L, and carbon disulfide at a maximum concentration of 4 μg/L. VOCs in shallow groundwater near Building 99 appear to be in steady state and are not migrating beyond the defined plume area.

4.4.3.5 Benzene and MTBE in Groundwater Near Former USTs 11A/12A/13A

Building 828 was a former Army vehicle service station. Three 5,000-gallon gasoline USTs, designated USTs 11/12/13, were installed west of Building 828 in 1969. These tanks were replaced with three 6,000-gallon gasoline USTs, designated 11A/12A/13A, in 1990. The Army removed tanks 11A/12A/13A in 1999. Following the tank removals, significant concentrations of petroleum hydrocarbons, and benzene, toluene, ethylbenzene, and xylenes ("BTEX") remain in soil and shallow groundwater near the location of the former tanks. Methyl tertiary butyl ether ("MTBE"), which is a fuel oxygenate, is also detected in the shallow water-bearing zone near Former USTs 11A/12A/13A. Results from recent monitoring well sampling (IT, 2002g) show MTBE concentrations as high as 10,000 µg/L have been detected in groundwater. Recent maximum concentrations of other fuel constituents include TPH measured as gasoline at 26,400 µg/L, benzene at 1,880 µg/L, toluene at 3,910 µg/L, and xylenes at 3,510 µg/L. The lateral extent of fuel constituents in the shallow water-bearing zone is shown on Figure 4-6.

BTEX and MTBE are volatile constituents of petroleum fuels. The area near former USTs 11A/12A/13A impacted by these compounds is considered a RAP site because of the potential vapor intrusion threat posed by BTEX and MTBE in the subsurface. BTEX and MTBE in groundwater at USTs 11A/12A/13A appear to be in steady state, and this area is also in corrective action monitoring with the RWQCB.

4.4.3.6 Building 991 Area

The Army constructed Building 991 in 1942 as a locomotive engine maintenance shop. The building was used from 1942 to 1997 to repair, clean, and fuel engines (IT, 1999). Extensive chemical use and handling has occurred at this area. As a result, petroleum hydrocarbons and lesser concentrations of other COCs have impacted soil and groundwater in the vicinity of Building 991. MTBE has been detected at low concentrations in groundwater near Building 991; the source of the MTBE is unknown.

Sanitary sewage from Building 991 initially discharged to a chemical tank (BASELINE, 2002). It is not known if the tank was removed or remains on-site. Sometime before 1976, the chemical tank was replaced with the septic tank and an associated leach field. The leach field extended outside the boundary of the OARB. Floor drains and a lubrication pit and sump inside Building 991 discharged to a gravel-filled trench adjacent to the west wall of Building 991 and through an oil/water separator (BASELINE, 2002; IT, 1999). The oil/water separator may have been installed in early 1974, but was never maintained (BASELINE, 2002). According to the PA/SI, the oil/water separator discharged to an undersized septic tank that caused the associated leach field to clog. An eight-inch vitrified clay pipe and four-inch cast iron pipe were used to the drain the septic tank and oil/water separator, and the leach field, respectively. The locations of the outfall from these pipes are unknown, and may be located off site (BASELINE, 2002). The outfalls may be the source of an oil-soaked area at the northern boundary of the OARB behind Building 991 (BASELINE, 2002).

A sample of sediment collected inside of the drain line from the septic tank contained 7,300 mg/kg of petroleum hydrocarbons measured as motor oil, 190 µg/kg of PCBs, and various metals (IT, 1999). Although the Army removed the oil/water separator, septic tank, and portions of the septic tank drain line, soil and groundwater in the vicinity of these former structures remain impacted by petroleum hydrocarbons.

A 10,000-gallon AST located outside of Building 991 (Figure 4-7) supplied diesel fuel to a dispenser inside the building. In May 1997, an estimated 780 gallons of diesel fuel spilled while a tanker truck was supplying the AST (IT, 1999). Over 430 tons of impacted soil was excavated, but contaminated soil was not removed near a railroad trestle due to the potential for weakening the structural integrity of the trestle.

Chemical releases may have occurred near Facility 992, which was formerly located west of Building 991. Waste oil and naphtha solvent were stored in this facility. IT (1999) reports that naphtha solvent was used to clean engine parts.

From 1984 to 1995, engines were reportedly washed with water and water-based detergent on the railroad tracks in front of Building 991. Until the late 1970s, engines had been washed on a concrete slab southeast of Building 991 (Figure 4-7). A sump, connected to the slab, discharged wash water to the off-site wetlands situated between the railroad tracks. Besides cleaning engines, pesticide application equipment was occasionally rinsed on the slab (IT, 2002f).

Investigations of the wetlands by the Army confirmed pesticide impacts to soil. In response, the Army sealed the sump in-place with cement grout and excavated approximately 950 cy of impacted soil. Pesticides remain in on-site soil along the eastern property boundary. Residual pesticides, if any, remaining in sediment or groundwater in the off-site wetland area are not considered in this RAP and will be addressed separately as discussed in Section 2.4.

The Army conducted sampling at the Building 991 area as part of its Phase II Investigation to determine the source of immiscible diesel fuel product floating on groundwater in monitoring well CE-3 (IT, 2002a). TPH quantified as diesel ("TPHd") and TPH quantified as motor oil ("TPHmo") were detected in soil at concentrations up to 1,200 mg/kg and 2,100 mg/kg, respectively. TPHd and TPHmo were also detected in groundwater at concentrations up to 590 μg/L and 66 μg/L, respectively. However, no additional product floating on groundwater was found.

The Building 991 area is considered a RAP site because of the multiple releases of petroleum hydrocarbons, pesticides, and other hazardous substances that are known or suspected to have occurred at this area. Abatement of residual soil and groundwater contamination may be necessary to protect human health and the environment, given the planned redevelopment of the Building 991 area.

4.4.3.7 Building 99

Building 99 was constructed in 1918 and used by Union Construction Company for ship manufacturing until the mid-1930s (IT, 2000i, 2000j). From the mid-1930s until the Army's acquisition of the property in 1941, Pacific Coast Engineering Company conducted metalworking operations in Building 99 that were related to production of structural iron and piping. During that time, the northern portion of the building contained a furnace, and blacksmith and machine shops. The middle portion of the building was used for plate rolling. The southern portion of the building contained a plate shop. Metal plates were marked, cut, shaped, and fastened inside the building (IT, 2000i).

In 1941, the Army apparently converted Building 99 to a vehicle and electrical maintenance shop and installed a metal shop and paint room in the structure (IT, 2000i). A report by the Army Industrial Hygiene Laboratory, dated December 1944, indicates that Building 99 also contained a jitney repair shop; truck repair shop for welding and "metallizing" (i.e., spraying metal); and a shop where hot copper pipe was pickled in a 10 percent by weight sulfuric acid solution, and where metal brazing, silver soldering, and "lead burning" were carried out. According to this Army report, sand blasting was performed outside the building and dust produced by the operation was allowed to blow about without any attempt to control it. The exact location of the sand blasting area is unknown.

A gas fired boiler and a steam cleaner inside Building 99 were identified on property cards for Building 99 (BASELINE, 2002). They were removed from the building in June 1961. The location of the steam cleaner room is unknown and was not located on any of the maps reviewed by the Port of Oakland. A used oil accumulation area was also located along the western side of Building 99 (BASELINE, 2002). More recently, the northern portion of Building 99 was used for the repair and maintenance of tractor-trailers operated by AAFES (IT, 2000k).

The Army has advanced four soil borings beneath Building 99 that are identified as ICF10S10, ICF10S11, ICF10S12, and ICF10S13. Soil samples collected from the borings were analyzed for VOCs, PAHs, TPH, and metals. Analytical results of these samples do not suggest significant releases have occurred from the building. Minor concentrations of VOCs, PAHs, and TPH were measured in soil samples collected from borings ICF10S10, ICF10S11, ICF10S12, and ICF10S13. No metals were detected in soil samples collected from the borings at concentrations greater than naturally occurring levels reported for common soil types in Oakland.

Groundwater in the Building 99 area has been extensively investigated, and VOC and petroleum hydrocarbon impacts to the shallow water-bearing zone are generally well characterized (see Section 4.4.3.4). Additional groundwater contamination attributable to Building 99 is not anticipated.

RAP sites near Building 99 include groundwater impacted by vinyl chloride and cis-1,2-DCE (Section 4.4.3.4). RMP locations near Building 99 include a debris area (Section 4.4.4.3.1), Building 85 (Section 4.4.4.3.2) and storm drains and sanitary sewers (Section 4.4.4.7), USTs B, C, and Q; a former paint shop and former paint storage shed; and a vehicle washrack (i.e., Facility 98) with an associated oil/water separator (Figure 4-8).

Building 99 is categorized as a RAP site because it has been used for ship manufacturing, metalworking, and equipment repair beginning in 1918. The Army completed one soil boring at Building 99 as part of its Phase II investigation. The only organic COCs detected were petroleum hydrocarbons in soil samples at concentrations less than the remediation goals in Table 7-11. Selected metals were present in soil and groundwater samples at ambient concentrations. Given the historical uses at Building 99 and the limited nature of the Phase II Investigation, additional sampling at Building 99 may be warranted to confirm the findings of available data that show no significant chemical releases to soil (IT, 2002a). Additional sampling, if any, will be conducted in connection with the remedial actions for Building 99.

4.4.4 Environmental Conditions at RMP Implementation Area

Environmental conditions at the remainder of the OARB, including a variety of RMP locations, generally involve common classes of chemicals (i.e., petroleum hydrocarbons, lead, PCBs) related to oily wastes. RMP locations have been grouped either according to the types of chemicals likely to be present or the historical activities that took place. The following sections summarize the use history, and nature and extent of contamination for each group of RMP locations.

4.4.4.1 Washracks, Sumps, Oil/Water Separators, and Miscellaneous Operations

Approximately 82 washracks, sumps, oil/water separators, other below grade structures, and miscellaneous items have been identified at approximately 55 locations on the OARB. The lower number of actual locations is because many of the structures are often connected to one another. For example, a washrack is often connected to a sump or oil/water separator. As summarized in Table 4-2, this category of RMP locations is further divided into four subgroups: (1) locations requiring the removal of an existing structure, (2) locations requiring additional characterization, (3) location potentially requiring removal of impacted soil during infrastructure installation or redevelopment, and (4) locations with no currently identified environmental issues but which will be inspected for undiscovered contamination in accordance with the soil management protocols in the RMP. Petroleum hydrocarbons and metals in soil are the known or suspected COCs at most of these locations.

The Army and OBRA performed sampling at some of these washracks, sumps, oil/water separators, and miscellaneous operations as part of the Phase II Investigations. The results of these sampling activities are included in reports prepared by the Army (IT, 2002a) and EKI (2002) on behalf of OBRA, and confirm that these locations can be readily addressed by the protocols established in the RMP.

4.4.4.2 Tanks

Approximately 93 USTs and ASTs have been identified at approximately 73 locations on the OARB. Similar to washracks, sumps, oil/water separators, and miscellaneous items, the lower number of actual locations is because certain tanks were clustered together. As summarized in Table 4-3, tank locations are further divided into four subgroups: (1) tank locations that potentially require the removal of an existing tank, (2) former tank locations potentially requiring removal of impacted soil during infrastructure installation or redevelopment, (3) former tank locations potentially requiring both removal of impacted soil during infrastructure installation or redevelopment and groundwater monitoring, and (4) former tank locations with no currently identified environmental issues but which will be inspected for undiscovered contamination in accordance with the soil management protocols in the RMP.

Some of the tank locations were identified from a review of historical drawings and documents conducted by OBRA, the Port of Oakland (BASELINE, 2002) and the Army, and the presence of a tank is only suspected. As part of its Phase II Investigation, the Army researched or otherwise investigated 30 tank locations where it was unclear whether a tank existed (IT, 2002a). The Army investigated 24 of these 30 potential tank locations after information collected by the Army indicated that 6 of the potential tank locations required no further action. The geophysical survey performed by the Army recorded anomalies indicative of buried tanks at 8 of the remaining 24 locations. At 14 locations, the Army completed two borings at each location and collected soil and groundwater samples.

TPHd and TPHmo were detected in soil at 5 of the 14 tank locations sampled by the Army in its Phase II Investigation. At UST 678, TPHd and TPHmo were detected at concentrations up to 3,980 mg/kg and 580 mg/kg, respectively. At UST 688, TPHd and TPHmo were detected at concentrations up to 1,100 mg/kg, and 41 mg/kg, respectively. No VOCs were detected in soil except for acetone measured at concentrations of 0.04 mg/kg and 0.018 mg/kg at USTs 678 and 679, respectively.

Methylene chloride was detected in groundwater at tank locations 673, 678, and 688 at concentrations ranging from 85 μg/L to 560 μg/L. PCE and TCE were also detected in one groundwater sample collected near UST 678 at concentrations of 390 μg/L and 46 μg/L, respectively. Other VOCs detected in groundwater in this area near tank locations 678 and 688 included acetone up to 1,300 μg/L, sec-butylbenzene up to 390 μg/L, and n-propylbenzene up to 320 μg/L. These concentrations of VOCs in groundwater are less than the groundwater remediation goals in Table 7-11, and can be readily addressed by the protocols established in the RMP. TPHd was detected in groundwater at tank locations 673 678, 682, 686, and 688 above the groundwater remediation goals in Table 7-11.

Petroleum fuels and related constituents in soil are the known or suspected COCs at the majority of locations where tanks have been removed. Most former tank locations have been closed by RWQCB. Natural attenuation of petroleum hydrocarbons in shallow groundwater is being monitored at seven tank locations under RWQCB supervision. The newly discovered petroleum tank locations and associated releases will also require closure by RWQCB.

On behalf of OBRA, Innovative Technical Solutions, Inc. ("ITSI") evaluated the potential quantities of contaminated soil that may still remain at the former tank locations. ITSI (2001) estimates that the total volume of petroleum hydrocarbon-containing soil at all tank locations may be on the order of 4,000 cy. These petroleum residuals will be addressed during redevelopment by the soil management protocols in the RMP.

4.4.4.3 Former Industrial and Chemical Handling Locations

Seven locations were identified by OBRA where former industrial activities or chemical handling took place for which little or no subsurface environmental data were available. Although no significant contamination was known to exist at these locations, historical operations suggested the likelihood for past chemical releases. As part of the Phase II Investigations, the Army and OBRA conducted sampling activities at many of these locations to characterize subsurface environmental conditions.

4.4.4.3.1 Debris Area Near Building 99

The Army encountered debris while removing buried waste oil piping in Corregidor Street west of Building 99 (Figure 4-8). The debris consisted of ACM and lesser amounts of charred wood, slag, burned coke material, and refractory brick, which the Army believes originated from a boiler (IT, 2002e). Approximately 15 tons of soil mixed with the so-called "boiler debris" was excavated by the Army during removal of the waste oil piping and disposed as a non-RCRA hazardous waste.

OBRA excavated four test pits and collected samples of debris in the "boiler debris" area as part of its Phase II Investigation. The locations of the test pits and the associated soil sampling locations inside the pits are shown on Figure 3 in the *OBRA Phase II Investigation Data Report* (EKI, 2002). Debris mixed with black and dark brown sand was observed in all four test pits. Debris noted in the test pits included pieces of concrete; burned wood; nails, bolts, and other metal fasteners; possible leather and asbestos scraps; ceramic tile made of 2-inch hexagons; gray slate; and vesicular slag.

The debris and sand mixture contained lead and other metals at concentrations greater than remediation goals in Table 7-11. The debris and sand mixture also contained benzo(a)pyrene at concentrations greater than the remediation goal. Other PAHs were detected, but at concentrations below the remediation goals in Table 7-11. Up to 6,000 mg/kg of petroleum hydrocarbons were measured in samples of the debris and sand mixture.

Lead was also detected at a concentration of 3,550 mg/kg in a soil sample collected from the soil boring for monitoring well ITMW243 by the Army as part of its Phase II Investigation. This monitoring well is located approximately 100 feet north of the debris area.

Given the COC concentrations in the debris and sand mixture and the fact that the lateral extent of this material has not been delineated, additional characterization of the debris area is needed before an appropriate remedial action can be implemented. The scope of investigations to be performed at the debris area near Building 99 will be evaluated in consultation with DTSC as specified in the RMP.

4.4.4.3.2 Building 85

A 1943 map of the OARB designates Building 85 (Figure 4-8) as the area engineer's office. The building appears to have been used chiefly to carry out administrative functions. However, review of floor plans, dated 25 April 1960, show Building 85 was equipped with a photograph-processing laboratory. IT (2000i) states that Building 85 was also historically used as a printing plant, but no basis for this statement is provided. IT may be referring to the photograph-processing laboratory when it concludes that the building was a printing plant.

The Army and OBRA performed soil and groundwater sampling at Building 85 as part of the Phase II Investigations. OBRA analyzed splits of soil and groundwater samples obtained by the Army for petroleum hydrocarbons and PCBs. No petroleum hydrocarbons or PCBs were detected in the split samples at concentrations greater than analytical method reporting limits. Soil samples collected and analyzed by the Army did not contain VOCs, PAHs, TPH, pesticides, or PCBs. Vinyl chloride was detected at 0.6 µg/L in a groundwater sample obtained by the Army. This vinyl chloride concentration is considerably less than the remediation goal in Table 7-11. Selected metals were present in soil and groundwater samples at ambient concentrations. These additional data confirm that Building 85 can be readily addressed by the protocols established in the RMP.

4.4.4.3.3 Building 812

The Army constructed Building 812 in 1944. The Army states the building was used as an "ordnance" maintenance shop until 1950. Building 812 reportedly contained a welding booth, machine shop, and two repair and grease areas (Figure 4-9). The term "ordnance," as applied by the Army to the OARB and certain other embarkation installations in the San Francisco Bay Area, did not mean ammunition or explosives, but instead referred to vehicles and other mechanized equipment shipped from the installations (Hamilton and Bolce, 1946). The notion that the term "ordnance" pertains to vehicles is consistent with the use history of Building 812.

Review of Army historical equipment records reveals the building contained various metal working equipment, including drill presses, metal cutting machinery, lathes, a milling machine, and a shaper. By 1969, Building 812 had been transformed to include a tune-up and lube area, tire shop, battery shop, parts room, office machine repair shop, sheet metal shop, mechanical and welding maintenance shop, and a large centralized crane area in the center of the building. Chlorinated organic solvents were historically used in Building 812. Chlorinated solvent usage was discontinued in the mid-1980s, when a parts-washing system that used high-pressure water and water-based solvents was installed (USATHAMA, 1988). Other industrial operations and storage activities at Building 812 included metal cold cleaning (IT, 2000i) and storing drums containing new and used petroleum products outside on pallets with no secondary containment

(Kleinfelder, 1998b). Used oil tank 8A was formerly located at the southwest corner of Building 812.

No significant contamination has been identified near Building 812 based upon the results of soil gas sampling conducted during the PA/SI, and soil and groundwater testing related to the removal of used oil tank 8A. Soil gas samples contained low concentrations of VOCs. Soil from the excavation pit of used oil tank 8A contained a maximum petroleum hydrocarbon concentration of 250 mg/kg. Residual petroleum hydrocarbons of 7,600 µg/L were measured in water present in the pit at the time of excavation, but no petroleum hydrocarbons or related constituents were detected in groundwater samples collected from borings placed in the shallow water-bearing zone outside of the boundaries of the pit.

The Army and OBRA conducted sampling activities at Building 812 as part of the Phase II Investigations. The only organic COCs detected were PAHs and petroleum hydrocarbons in soil samples at concentrations less than the remediation goals in Table 7-11. Selected metals were present in soil and groundwater samples at ambient concentrations. These additional data confirm that Building 812 can be readily addressed by the protocols established in the RMP.

4.4.4.3.4 Building 823

Building 823 first appears on a 1943 map of the OARB. Army historical documents show that Building 823 contained a paint room, paint booth finishing room, and carpenter shop. A report by the Army Industrial Hygiene Laboratory, dated December 1944, indicates Army personnel stripped paint with chemicals that included chlorinated solvents. IT (2000i) states that Building 823 was also used as a heavy equipment maintenance facility, but the locations and types of equipment and chemicals that were involved with this operation are unknown. Identified chemical release locations near Building 823 include former UST A and the VOC-impacted groundwater near Buildings 808 and 823 (Section 4.4.3.3). Besides petroleum hydrocarbons and related constituents associated with UST A, no residual chemical sources in soil have been identified at Building 823 (Figure 4-10).

Phase II Investigation soil samples contained petroleum hydrocarbons at concentrations below the remediation goals in Table 7-11. No other organic COCs were detected in soil. VOCs were measured in groundwater samples, but at concentrations considerably less than the remediation goals in Table 7-11. VOCs detected in groundwater included chloroform at 5.3 µg/L, toluene at 0.9 µg/L, acetone at 35.4 µg/L, and 1,4-dichlorobenzene at 1.7 µg/L. Selected metals were present in soil and groundwater samples at ambient concentrations. These additional data confirm that Building 823 can be readily addressed by the protocols established in the RMP.

4.4.4.3.5 Potential Drum Drainage Area East of Buildings 805 and 806

USATHAMA (1988) identified the area adjacent to the Knight Railyard that is east of Buildings 805 and 806 as the specific location where Army personnel reportedly allowed damaged drums of chemicals to drain onto railroad track ballast in the past. The suspected area as depicted by USATHAMA (1988) is shown on Figure 4-11.

This potential drum drainage area identified by USATHAMA, as well as additional areas of potential drum drainage were investigated by the Army and OBRA and during the Phase II Investigations in April and May 2002. The results of the Phase II Investigations at the potential drum drainage areas are included in reports prepared by the Army (IT, 2002a) and OBRA (EKI, 2002).

The Army collected soil and groundwater samples within the area adjacent to the Knight Railyard that is east of Buildings 805 and 806. No evidence of chemical spillage in this area is suggested based on a review of the data obtained by the Army.

In an area south of the supposed drum drainage area, OBRA discovered a black tarry stain in shallow soil that smelled of petroleum hydrocarbons and solvents (EKI, 2002). Shallow soil samples collected at 0.5 to 1 foot bgs in this area contained petroleum hydrocarbons up to 3,600 mg/kg and related constituents that included 1,2,4-trimethylbenzene up to 33 mg/kg, 1,3,5-trimethylbenzene up to 9.6 mg/kg, ethylbenzene up to 6 mg/kg, total xylenes up to 37 mg/kg, propylbenzene up to 4.8 mg/kg, toluene up to 7.2 mg/kg, and naphthalene up to 17 mg/kg. The concentrations of all detected COCs were less than the health based remediation goals in Table 7-11. However, napthalene was measured at a concentration greater than the leaching based remediation goal in Table 7-11 but was not detected in groundwater.

COC impacts appear limited primarily to shallow soil. Only 1 of 3 soil samples collected at 3.5 to 4 feet bgs contained COCs. This soil sample contained 1,2,4-trimethylbenzene at 0.011 mg/kg and total xylenes at 0.0148 mg/kg. Trace concentrations of petroleum hydrocarbon constituents were detected in groundwater. COCs measured in groundwater samples included 1,2,4-trimethylbenzene at 6 μg/L, 1,3,5-trimethylbenzene at 2 μg/L, ethylbenzene at 2 μg/L, total xylenes at 14.2 μg/L, propylbenzene at 0.6 μg/L, and toluene at 6.5 μg/L. These relatively minor impacts can be readily addressed by the protocols established in the RMP.

4.4.4.3.6 Former Motor Pool and Salvage Operations at Building 640

World War II era maps of the OARB show a motor pool and salvage area existed in the area where Building 640 currently stands. The motor pool and salvage area included a gasoline station possibly with a UST, a motor repair shop, a paint spray booth, several grease racks and washracks, vehicle storage sheds, 1,535 feet of gasoline pipeline, and several salvage warehouses (BASELINE, 2002) (Figure 4-12). Review of Army historical records indicate these facilities were demolished and Building 640 was constructed by 1945.

The Army conducted sampling at the former motor pool and salvage operations area as part of its Phase II Investigation. PAHs and petroleum hydrocarbons were detected in soil at concentrations less than the remediation goals in Table 7-11. Organic COCs detected in groundwater included TPHd up to 150 μg/L, TPHmo up to 252 μg/L, and toluene, ethylbenzene, and xylenes at individual concentrations less than 1 μg/L. Selected metals were detected in soil and groundwater at ambient concentrations. These additional data indicate that the former motor pool and salvage operations area can be readily addressed by the protocols established in the RMP.

4.4.4.3.7 Benzidine at Former Used Oil Tank 21

Former used oil tank 21 was part of Facility 16, which was constructed in 1986 for preparing privately owned vehicles for overseas transport (IT, 2000i). Facility 16 also included a washrack and an oil/water separator. Used oil tank 21 was a UST situated partially beneath the washrack, which stored oil drained from vehicles before transport. Used oil tank 21, washrack, and oil/water separator were removed in December 1997. Excavation of contaminated soil discovered in the area was completed by March 1997 (Remedial Constructors, Inc., 1997). Figure 4-13 shows the boundaries of contaminated soil that was excavated. Soil beneath the former UST, following excavation of contaminated soil, contained residual concentrations of lead, PAHs, and petroleum hydrocarbons, which are COCs typically associated with used oil releases.

Besides typical used oil constituents, benzidine was reportedly measured at 48 mg/kg in soil remaining beneath the former UST, and at 6.3 mg/kg in stockpiled soil removed from the excavation pit. The Army disposed of the stockpiled soil at an off-site, permitted waste management facility. Benzidine is not typically found in used oil and its detection at this former tank location is unusual. The United States Department of Health and Human Services, Agency for Toxic Substances and Disease Registry ("ATSDR"); (1995b) states that benzidine was used primarily to produce dyes for cloth, paper, and leather. Benzidine has not been manufactured for sale in the United States since the mid-1970s. Major dye companies in this country no longer make dyes that have benzidine as an ingredient given concerns about the potential carcinogenic effects of the chemical.

Testing by the Army after completing excavation activities at former used oil tank 21 did not detect benzidine in soil or groundwater, but analytical method reporting limits of collected samples were higher than concentrations at which benzidine is considered to be a potential human health risk. Thus, additional sampling as described in the RMP will be performed at the former used oil tank 21 area.

4.4.4.4 Historical Spills and Stains

Review of Army documents and historical aerial photographs indicate that numerous spills and stains have been observed over the years at the OARB. Possible chemical releases range from stained pavement caused by minor leakage from parked vehicles to spills of hazardous substances. Figure 4-14 depicts the locations where spills and stains have been historically observed or noted. As part of its Phase II Investigation, the Army investigated some of the locations where spills and stains were observed. PAHs and petroleum hydrocarbons were detected at concentrations less than the remediation goals in Table 7-11. These additional data indicate that the locations of historical spills and stains can be readily addressed by the protocols established in the RMP.

Historical spills and stains are considered to be a basewide RMP issue. As a consequence, soil excavated during new construction will be inspected for contamination. Protocols for inspecting and managing contaminated soil during and after redevelopment are specified in the RMP.

4.4.4.5 Lead in Soil Around Buildings

Federal statutes define paint to be lead-based if it contains lead at concentrations greater than 1.0 mg/cm^2 or 5,000 mg/kg. However, paint manufactured before 1978 may still contain significant amounts of lead even if does not meet the federal definition of LBP (United States Department of Housing and Urban Development, 1995). The EBS identified the buildings that may contain LBP based upon the age of construction.

ACE (1997a) conducted a LBP investigation of buildings at the OARB. Figure 4-15 shows the buildings that tested positive and those that tested negative for LBP. Also depicted on this figure are the structures that possibly contain LBP given their age of construction listed in the EBS but were not included in the LBP investigation by ACE. Figure 4-15 also presents lead analytical results for samples collected by the Army within the upper two feet of soil near buildings, and indicates the areas near buildings where shallow soil (i.e., from ground surface to 2 feet bgs) is suspected to be impacted by lead. Requirements for managing shallow soil known or suspected to contain LBP at the OARB are incorporated into the RMP.

As part of its Phase II Investigation, OBRA collected 60 additional shallow soil samples around the perimeter of buildings that had painted surfaces that tested positive for LBP, or possibly contain LBP based on the building age of construction. These data are not depicted on Figure 4-15 but are provided in Appendix A. Lead concentrations greater than 350 mg/kg were measured in 7 of 60 samples, and lead concentrations greater than 100 mg/kg were measured in 39 of 60 samples. The maximum lead concentration detected in the shallow soil samples was 1,000 mg/kg. These analytical results confirm that shallow soil near buildings that contain LBP can be addressed by the protocols in the RMP for managing shallow soil known or suspected to contain lead.

4.4.4.6 Former PCB-Containing Transformers and Equipment Locations

The PA/SI and the utility survey conducted by EarthTech for the City of Oakland include inventories of PCB-containing transformers and equipment at the OARB. These inventories list approximately 110 pieces of electrical transformers or other equipment that may have contained, or still contain, PCBs. Requirements for managing PCB-containing transformers, equipment, and underlying soils at the OARB are incorporated into the RMP. The management of PCB-containing equipment, and the remediation of PCB-impacted media, must also meet the requirements of TSCA, which is administered by U.S. EPA.

4.4.4.7 Storm Drains and Sanitary Sewers

Reports prepared by the Army indicate that the storm drain system at the OARB consists of 107,484 linear feet ("lf") of pipe (ICF Kaiser Engineers, Inc., 1999a). The storm drains convey water to San Francisco Bay through 13 outfalls (Figure 4-16). Most water discharged from the outfalls appears to originate from the OARB with one notable exception. Outfall 8b receives large flows from the City of Oakland through a 36-inch diameter storm drain that enters the OARB from West Grand Street and through a 42-inch diameter storm drain from the nearby EBMUD wastewater treatment plant (EarthTech, 2000a). The alignments of these two regional storm drains are depicted on Figure 4-16.

The sanitary sewer system consists of approximately 25,000 lf of pipe (ICF Kaiser Engineers, Inc., 1999a). Four pump or lift stations located throughout the OARB convey sewage to the EBMUD wastewater treatment plant. The flat topography of the OARB prevents sewage from flowing by gravity to the EBMUD plant (EarthTech, 2000a).

Several studies (EarthTech, 2000a; ICF Kaiser Engineers, Inc., 1999a; Radian, 1997a, 1997b) indicate that both the storm drain and sanitary sewer systems are in poor condition. Video camera inspections have been conducted of portions of the storm drain and sanitary sewer systems that lie north of 14th Street. These prior inspections reveal that approximately 45 percent of the storm drain pipe and 60 percent of the sanitary sewer pipe that have been examined have defects. Defects are defined as pipe with sags; plant root intrusion; sections that have cracked, developed holes, or collapsed; or joints that have separated or become misaligned. Moreover, EarthTech (2000a) notes that the exceptionally flat grades of the storm drain and sanitary sewer systems allow sediments to accumulate and block the insides of pipes.

Sediment from storm drains on the OARB has likely been discharged to San Francisco Bay in the past. It is unknown if such discharge is ongoing because improvements in storm water management practices (e.g., periodic removal of sediments from catch basins, better chemical handling, and reductions in the frequencies of chemical spills) have likely decreased the sediment and contaminant quantities that are transported through the storm drains.

Sediment that builds up in the catch basins or inlets to the storm drains is periodically removed (ICF Kaiser Engineers, Inc., 1999a). Previous testing of this sediment by the Army revealed that some sediment contained petroleum hydrocarbons, PAHs, lead, and other metals that are reflective of road grime, which likely washes into the catch basins. PCBs and pesticides have occasionally been detected in the sediment.

OBRA tested sediment in storm drain piping as part of its Phase II Investigation. This testing indicates that sediment in portions of the storm drain piping still contain petroleum hydrocarbons, PAHs, lead and other metals, as well as low concentrations of PCBs and pesticides. No COCs were detected at concentrations that would qualify the sediment as a principal threat waste, as described in Section 8.1. The past presence of contaminants in storm drains and sanitary sewer systems combined with breaches in the pipes of these systems may have allowed COCs to leak into soil and groundwater that surround the pipes. However, based on its investigative findings, ICF Kaiser Engineers, Inc. (1999a) concluded that only localized contamination in soil and groundwater exists near storm drains and sanitary sewers. Figure 4-16 indicates the generalized areas where such contamination has been identified to date.

EarthTech evaluated the storm drain and sanitary sewer systems to determine their compatibility with planned redevelopment of the OARB. EarthTech (2000a) finds that both systems will have to be almost completely replaced because they are in poor condition, undersized, and configured in a manner that conflict with the footprint of new construction. The EIR states that infrastructure replacement will be accomplished over a period of five years following base transfer. It is anticipated that the localized soil and groundwater contamination associated with existing storm drains and sanitary sewers described in Army reports can be adequately addressed through implementation of protocols in the RMP as part of infrastructure replacement, as redevelopment proceeds.

4.4.4.8 Railroad Tracks

Approximately 26 miles of railroad track remain at the OARB (Figure 4-17). In addition, former railroad track ballast is covered with imported gravel in the former Baldwin Railyard. According to U.S. EPA (2001d, 1997b), typical contamination in old railyards such as those that exist at the OARB can include:

- Petroleum hydrocarbons from spillage during fueling operation and repetitive minor leakage from engines and rail cars.
- PCBs from the hydraulic systems of locomotive engines and electrical equipment.
- Metal and asbestos dust from brake shoes and other friction sources.
- Solvents, BTEX, and other VOCs.

Surface soil in railyards may also become contaminated with creosote, pentachlorophenol ("PCP") or chromated copper arsenate ("CCA") that originate from preservatives that are often applied to railroad ties (Felton and DeGroot, 1996; U.S. EPA, 1993a). Herbicides sprayed near tracks for weed control may also be present.

To investigate the possibility of such contamination of track areas at OARB, OBRA collected 38 subballast samples beneath railroad tracks as part of its Phase II Investigation. Subballast at the OARB is a sand layer that comprises the interface between the rock ballast placed between railroad ties and the underlying fill imported to construct the OARB. Benzo(a)pyrene was detected at concentrations greater than its remediation goal in Table 7-11 in 4 of 38 subballast samples. Other COCs detected in the subballast included petroleum hydrocarbons at a maximum concentration of 680 mg/kg, PCP at a maximum concentration of 3.8 mg/kg, and PCBs at a maximum concentration of 0.13 mg/kg. petroleum hydrocarbons, PCP, and PCB concentrations measured in the subballast samples were less than the remediation goals in Table 7-11.

Metals detected in the subballast included arsenic at a maximum concentration of 24 mg/kg, total chromium at a maximum concentration of 280 mg/kg, and lead at a maximum concentration of 470 mg/kg. During the OBRA Phase II investigation, only arsenic in one subballast sample was detected greater than its remediation goal. These results indicate that subballast beneath railroad tracks can be readily addressed by the protocols established in the RMP.

4.4.4.9 Marine Sediments

The Army has identified COC impacts to marine sediments near storm drains from the portions of the OARB (i.e., those at former BRAC Parcels 2 and 3) being transferred via the EDC. These storm drains, including Outfalls 5 through 11, are shown on Figure 4-16 and discharge to the Oakland Outer Harbor in San Francisco Bay. Marine sediments at Outfall 4 are defined to be part of the "Spit" that is not being transferred via an EDC, but instead proposed for a PBC transfer to DOI and then EBRPD. The "Spit" and associated Outfall 4 are, thus, not considered in this RAP. The Army concluded that sediments at Outfalls 5 through 7 are "are unlikely to result in unacceptable adverse effects on aquatic or wildlife receptors" (Harding ESE, 2002).

Metals, PAHs, pesticides, and PCBs have been detected in marine sediments at Outfalls 8 through 11 (Harding ESE, 2002). Maximum metal concentrations detected in marine sediments at Outfalls 8 through 11 include arsenic at 19.9 mg/kg, cadmium at 3.52 mg/kg, copper at 97.5 mg/kg, lead at 1,850 mg/kg, mercury at 1.03 mg/kg, selenium at 1.93 mg/kg, silver at 1.09 mg/kg, and zinc at 579 mg/kg. Maximum organic COC concentrations detected in marine sediments at Outfalls 8 through 11 include dieldrin at 790 μg/kg, total DDT isomers at 803 μg/kg, total PAHs at 190 mg/kg, and PCBs at 790 μg/kg. The Army (Harding ESE, 2002) concluded from its ecological risk assessment that "sediments at Outfalls 8 through 11, if not capped in the future, may result in limited impacts to aquatic communities." The Port of Oakland intends to fill 26 acres to provide additional terminal capacity and create two berths in the Oakland Outer Harbor as outlined its Seaport Plan for 2020 (Harding ESE, 2002). The Port of Oakland's berth expansion project, when implemented, will result in covering the marine sediments adjacent to Outfalls 8 through 11, thereby addressing potential impacts identified by the Army's ecological risk assessment.

4.4.4.10 Shallow Groundwater

Data collected to date indicate that chemical impacts to shallow groundwater appear to be limited to a few areas of the shallow water-bearing zone that are entirely within the boundary of the OARB. These impacted areas are identified as RAP groundwater sites, or RMP locations.

As discussed in Section 4.3.5, the Army and OBRA performed Phase II Investigations of the OARB in May 2002. As part of these activities, the Army and OBRA collected a total of 77 groundwater samples from 15 permanent monitoring wells and 62 temporary wells and borings (EKI, 2002; IT, 2002a). Twelve of the monitoring wells are located along the perimeter of the OARB in the downgradient direction of groundwater flow in the shallow water-bearing zone (Figure 4-18).

Groundwater samples were collected from new permanent monitoring wells using low-flow sampling techniques and were analyzed for a suite of organic COCs and metals. Analytical results for groundwater samples collected from monitoring wells are shown on Figure 4-18 and in Table 4-5. Groundwater samples for metals analysis obtained from temporary wells and borings were field filtered. Analytical results for groundwater samples collected from temporary wells and borings are included in Table 4-5.

The Army and OBRA Phase II Investigation data as shown on Figure 4-18 and in Table 4-5 indicate that only the RAP groundwater sites have definable impacts, i.e., plumes, of organic COCs in shallow groundwater (EKI, 2002; IT, 2002a). The RAP groundwater sites consist of isolated areas of vinyl chloride, petroleum hydrocarbons, and related constituents in groundwater in the shallow water-bearing zone that are entirely within the boundary of the OARB. The Phase II Investigation data confirm that organic COCs are not migrating in groundwater from these RAP sites to San Francisco Bay.

Arsenic, manganese, and thallium were the only metals detected in the Phase II Investigation groundwater samples at concentrations greater than U.S. EPA Region IX Preliminary Remediation Goals ("PRGs") for tap water, which were used for reference only (EKI, 2002; IT, 2002a). As shown on Figure 4-18 and in Table 4-5, none of these metals are present in groundwater as definable plumes. As discussed below, these metals do not appear related to chemical releases to soil or groundwater.

Kleinfelder (1998a) concluded that one reason COCs have not migrated far from the suspected points of release is the groundwater velocity is low compared with the rate of sorption and degradation mechanisms. In other words, the COC distributions in the shallow water-bearing zone at the RAP groundwater sites appear to be at steady state. The advective movement of COCs in groundwater is counterbalanced by the rate at which COCs are removed from groundwater by sorption and degradation mechanisms. While plausible, this phenomenon has not been confirmed and will require further evaluation as part of the 5-year review.

4.4.4.10.1 Manganese in Groundwater

Manganese was detected in all 77 groundwater samples collected as part of the Army and OBRA Phase II Investigations and analyzed for manganese. Manganese concentrations ranged from 6.6 to 12,400 μg/L with an arithmetic mean of 1,290 μg/L. No water quality criterion for manganese has been established in either the *Water Quality Control Basin Plan, San Francisco Bay Basin* ("Basin Plan"); (RWQCB, 1995) or Title 40 of the Code of Federal Regulations ("CFR") §131.38, *Establishment of Numerical Criteria for Priority Toxic Pollutants for the State of California*, also known as the California Toxics Rule ("CTR").

The concentrations of manganese detected in groundwater at the OARB likely result from dissolution of naturally occurring manganese in soil due to the creation of local reducing conditions caused by natural organic matter (see for example Drever, 1982). Natural organic matter is present in the shallow water-bearing zone at the OARB, which is a historically filled area of organic rich mud flats. Manganese in groundwater is indicative of mildly reducing conditions.

Manganese concentrations in groundwater samples collected as part of the Phase II Investigations are directly comparable to manganese concentrations collected from porewater in nearshore sediments elsewhere in San Francisco Bay (Rivera-Duarte and Flegal, 1994). Manganese was detected by Rivera-Duarte and Flegal in 38 of 40 submerged sediment porewater samples collected at four nearshore locations. Summarized below are the minimum, maximum, and arithmetic mean manganese concentrations calculated for groundwater samples collected as part of the Phase II Investigation and those reported by Rivera-Duarte and Flegal (1994) for San Francisco Bay porewater:

Data Source	Minimum Manganese Concentration (µg/L)	Maximum Manganese Concentration (µg/L)	Arithmetic Mean Manganese Concentration (µg/L)
OBRA and Army Phase II Groundwater Samples (EKI, 2002; IT, 2002a)	6.6	12,400	1,290
San Francisco Bay Porewater Samples (Rivera-Duarte and Flegal, 1994)	5	13,000	1,700

These available data suggest that manganese in groundwater at the OARB is naturally occurring and not a threat to the environment.

Further, available metals data for soil do not indicate that a release of manganese to soil at the OARB has occurred. The Army calculated the ambient concentration for manganese in soil at the OARB to be 960 mg/kg (Table 5-1). Although manganese was detected in all 87 soil samples collected by OBRA in its Phase II Investigation at concentrations ranging from 53 to 1,400 mg/kg, only three soil samples had reported manganese concentrations greater than the ambient concentration. One of these samples contained manganese at 1,400 mg/kg and the other two samples contained manganese at 1,000 mg/kg. The arithmetic mean concentration of manganese in soil samples obtained as part of OBRA's Phase II investigation is approximately 500 mg/kg.

The absence of manganese contaminated soil coupled with the fact that manganese concentrations in groundwater at the OARB are similar to ambient San Francisco Bay sediment porewater concentrations indicate that manganese in the shallow water-bearing zone at the OARB is naturally occurring and not due to chemical releases.

4.4.4.10.2 Arsenic in Groundwater

Arsenic was detected in 46 of the 77 groundwater samples that were collected as part of the Phase II Investigations and analyzed for arsenic. The arithmetic mean arsenic concentration was 11 µg/L. The arsenic water quality criterion for protection of ecological receptors in the Basin Plan (RWQCB, 1995) and the CTR is 36 µg/L (continuous concentration, i.e., 4 day average, for saltwater aquatic organisms.) Arsenic concentrations in 75 of the 77 Phase II Investigation groundwater samples were less than the arsenic water quality criterion of 36 µg/L. In the other two samples, arsenic concentrations only slightly exceeded this water quality criterion with reported concentrations of 37 µg/L and 43 µg/L. This comparison is for reference only in as much as the criterion applies to arsenic in surface water that directly contacts ecological receptors or aquatic organisms and not to groundwater within the upland areas of the OARB.

Arsenic in groundwater at the OARB is likely a result of dissolution of naturally occurring arsenic in soil under reducing conditions that appear to exist at the OARB. Arsenic concentrations in groundwater collected as part of the Army and OBRA Phase II Investigations are comparable to ambient (i.e., unimpacted) arsenic concentrations measured in other nearshore East San Francisco Bay groundwater (EKI, 1998). Summarized below are the minimum, maximum, and arithmetic mean arsenic concentrations calculated for groundwater samples collected as part of the Phase II Investigation and those reported by EKI (1998) for nearshore East San Francisco Bay groundwater:

Data Source	Minimum Arsenic Concentration (µg/L)	Maximum Arsenic Concentration (µg/L)	Arithmetic Mean Arsenic Concentration (µg/L)
OBRA and Army Phase II Groundwater Samples (EKI, 2002; IT, 2002a)	1.1	43	11
Nearshore East San Francisco Bay Groundwater (EKI, 1998)	7.8	15	11

These Phase II Investigation data suggest that arsenic in groundwater at the OARB is naturally occurring, generally below, or only slightly greater than the potentially applicable arsenic aquatic water quality criterion in the Basin Plan (RWQCB, 1995), and not a threat to the environment.

The Army calculated the ambient concentration for arsenic in soil at the OARB to be 17 mg/kg (see Table 5-1). Arsenic was detected in all 98 soil samples collected by OBRA in its Phase II Investigation at concentrations ranging from 0.43 to 36 mg/kg. Only 5 out of 98 soil samples collected by OBRA had arsenic at concentrations somewhat greater than the ambient concentration. The arithmetic mean concentration of arsenic in soil samples obtained as part of OBRA's Phase II investigation is approximately 5.8 mg/kg. However, other data previously collected by the Army identified specific locations where arsenic concentrations in soil exceeded 34 mg/kg and were detected at concentrations up to 101 mg/kg. These concentrations and the tight spatial grouping of the elevated results indicate possible localized releases of arsenic near storm drains and railroad tracks that may require further investigation and remediation, as discussed later in this RAP.

Thus, the absence of arsenic contaminated soil, except possibly in localized areas noted above, coupled with the fact that arsenic concentrations in groundwater at the OARB are similar to ambient concentrations at other nearshore East San Francisco Bay locations indicates that arsenic in the shallow water-bearing zone at the OARB is naturally occurring and not due to chemical releases.

4.4.4.10.3 Thallium in Shallow Groundwater

Thallium concentrations reported in groundwater samples collected by the Army in its Phase II Investigation and in groundwater samples that have been obtained previously by others are most likely false positives and do not reflect the actual presence of thallium in groundwater above analytical method reporting limits. Thallium analysis by Inductively Coupled Plasma ("ICP"), U.S. EPA Method 6010B, can produce false positive determinations due to spectral interferences. U.S. EPA (1997h) states the following in *Test Methods for Evaluating Solid Waste* ("SW 846") regarding the effect of spectral interferences on thallium analytical results:

> When operative and uncorrected, interferences will produce false positive determinations and be reported as analyte concentrations.

SW 846 lists aluminum as a common interfering compound in the ICP analysis for thallium. Thallium false positives typically display these characteristics:

- No probable source for thallium contamination exists.

- Analysis for thallium was by ICP, not graphite furnace atomic absorption or Inductively Coupled Plasma–Mass Spectrometry ("ICP-MS"), U.S. EPA Method 6020.

- The data are usually produced by a single laboratory analyzing samples from a single sampling event and are often confined to a single analytical batch.

- Re-sampling and/or reanalysis, particularly by ICP-MS, do not confirm the original data.

Groundwater samples collected by OBRA in its Phase II Investigation were analyzed for metals using ICP-MS. No groundwater samples collected as part of OBRA's Phase II Investigation were reported to contain thallium above analytical method reporting limits. Thus, thallium is judged not to be a contaminant of concern in shallow groundwater at the OARB.

5

5. COC IDENTIFICATION

U.S. EPA (1989d) and DTSC (1996) recommend that all chemicals detected in soil, groundwater, or other impacted media be retained as chemicals of concern ("COCs"), if feasible. However, approximately 140 different chemicals have been measured in soil, and approximately 110 different chemicals have been measured in groundwater at the OARB. Many of these chemicals have been infrequently detected at extremely low concentrations. Attempts to calculate and apply risk-based remediation goals for all these chemicals would prove cumbersome and would not provide any true additional protection against exposure to residual chemicals at the OARB. Therefore, chemicals reported in soil and groundwater samples were screened to identify COCs in impacted media that contribute to potential human health risks at OARB BRAC property to be transferred to OBRA.

As described in Section 5.2, U.S. EPA (1989d) screening protocols were employed to identify COCs in soil and groundwater at the OARB. These screening protocols resulted in retaining all metals regulated under 22 CCR §66261.24 ("Title 22 metals"), as well as numerous other chemicals, as COCs in soil and groundwater.

5.1 ASSESSMENT OF DATA QUALITY AND REPRESENTATIVENESS

The quality and representativeness of analytical results contained in the database for the OARB was assessed before screening data to identify COCs. Based on the outcome of this assessment, certain analytical results were not considered in determining COCs because the analytical results were not pertinent or otherwise not representative of current environmental conditions of property being transferred to OBRA via the EDC.

The Army provided OBRA with an electronic database for the OARB in March 2002 (IT, 2002b). This computerized database contained approximately 204,000 records of analytical results. These soil, water, and air samples were collected primarily by the Army between 1989 and January 2002. The analytical results of the Phase II Investigations will be incorporated into the database when the analytical results are fully available in an electronic format. The database will be maintained and periodically updated with new analytical results as specified in the RMP.

The City understands that the Army March 2002 database includes analytical results from the following sources among others:

- RI data compiled by SCS Engineers in 1991, 1993, and 1994; ICF Kaiser Engineers in 1998, 1999, and 2000; and IT Corporation in 2001 and 2002

- Monitoring well groundwater data compiled by ICF Kaiser Engineers from 1998 to 2000, and IT from 2000 to 2002

- Confirmation sampling data compiled by SCS Engineers in 1996 associated with former tank locations

- Sampling data compiled by Caltrans in 1994 associated with reconstruction of the I-880 freeway

- Sampling data compiled by AAFES in 1996 associated with a Phase II investigation of part of the OARB

EKI assessed the quality and representativeness of the analytical results contained in the database for relevance to this RAP. This assessment was performed in two steps. The first step entailed identifying and excluding analytical results for samples that are clearly not germane to understanding current environmental conditions of the BRAC property being transferred to OBRA. The second step also involved eliminating non-representative analytical results, but entailed more careful evaluation and a greater degree of professional judgment than the first step before deciding certain analytical results were not valid for the purpose of identifying COCs. To preserve the integrity of the database, analytical results "removed" in these screening steps were not actually purged from the database, but rather "flagged" so that appropriately stated queries regarding COCs would not include these analytical results unless specifically sought. OBRA's edited database that resulted from screening is referred to as the "COC database" and contains data collected primarily by the Army from 1989 through January 2002. An electronic copy of the COC database is contained on the compact disc included as Appendix A. Analytical results of the OBRA and Army Phase II Investigations are contained in separate reports (EKI, 2002; IT, 2002a) and are also included in Appendix A as separate data files.

5.1.1 Exclusion of Non-Pertinent Data

Data excluded in the first screening step consisted of non-detected chemicals, inorganic chemical and parameters unrelated to anthropogenic releases, analytical results associated with samples from non-pertinent media, analytical data from soil that has been excavated or from property not subject to this RAP, and sample analytical results that are unreliable or have been rejected during validation as discussed below.

5.1.1.1 Non-Detected Chemicals

Chemicals were generally excluded from the COC database when all analytical results for soil and groundwater samples were below laboratory reporting limits, unless the chemical was expected based on previous site use or the chemical was detected in other media sampled at the site. Non-detected chemicals retained as COCs consist of the following:

- Thallium in soil at the former ORP because this chemical is a Title 22 metal and was detected in soil outside the former ORP / Building 1 area.

- Cadmium and beryllium in groundwater at the former ORP because these chemicals are Title 22 metals and were detected in groundwater outside the former ORP / Building 1 area.

- Dibromochloromethane, 1,1,2-trichloroethane, 1,1-dichloroethane, and 1,2-dichloroethane in soil because these chemicals were detected in groundwater.

- Toxaphene in soil because other pesticides are COCs at the OARB and the laboratory reporting limits for toxaphene were greater than criteria used to screen infrequently detected chemicals.

5.1.1.2 Inorganic Chemicals and Parameters Unrelated to Anthropogenic Releases

Many inorganic chemicals are major components of the Earth's crust. Data on inorganic chemicals that are essential nutrients or trace elements present at normal crustal abundance levels were excluded from the COC database. These excluded inorganic chemicals consisted of: aluminum, calcium, iron, magnesium, potassium, sodium, strontium, and titanium. Groundwater parameters (i.e., alkalinity, hardness, carbonate, conductivity, dissolved and total solids, pH, surfactants, and turbidity) were also excluded from the COC database. While such data may prove useful for evaluation of remedial alternatives or design of engineering controls, these data were not considered in the identification of COCs.

5.1.1.3 Samples Collected from Property Not Subject to RAP

Data associated with property not subject to this RAP were excluded from the COC database. Data for the following areas of the OARB or adjacent properties were not used to identify COCs:

- "Spit," which the Army identified as BRAC Parcel 1.
- Submerged marine sediments in the Oakland Outer Harbor.
- Army Reserve parcels, which comprised Army BRAC Parcels 6, 7, and 18; and portions of BRAC Parcels 19 and 21.
- Off-site wetlands located east of Building 991 included in former Army OU2.
- Any other impacted off-site areas (e.g., debris that may extend onto existing Port of Oakland land west of Building 99).

For analytical results of these media, a data flag was set to "armyreserve" or "offsite" in a data field called "samplestatus" that was added to the IT electronic database. These flags were used to exclude analytical results of the above areas when screening the database for COCs.

5.1.1.4 Non-Representative Media

Various sampling matrices are identified in the IT database. Sample matrix information is indicated in the "s_matrix_d" data field. Based upon the nomenclature provided in the IT database, analytical results of samples from the following media were excluded from the COC database because none of these media types are considered relevant to chemicals remaining in soil and groundwater at RAP sites and RMP locations addressed in this RAP / RMP:

- 11 ambient air samples
- 7 sediment samples from within storm drains
- 68 marine sediment samples [12]

[12] The Army has separately evaluated the ecological risks of marine sediments associated with former BRAC Parcels 2 and 3. Refer to Section 4.4.4.9 for a discussion of these marine sediments.

- 1 sediment sample from the interior of a sump
- 1 soil or solid sample of unknown origin
- 11 plant or animal tissue samples
- 5 water samples from storm drain outfalls to San Francisco Bay
- 9 drilling water samples
- 164 equipment rinse water samples
- 238 trip blank samples
- 19 tap water samples
- 3 seawater samples
- 16 samples obtained for classification and disposal of wastes

Although analytical results of the above media types may aid in future evaluation of certain environmental issues (e.g., submerged marine sediments, storm drain contents), the data are not pertinent to RAP sites and RMP locations subject to this RAP / RMP, and these data were not considered in the identification of COCs.

5.1.1.5 Soil That Has Been Excavated

Analytical results of soil that was subsequently excavated as part of remedial activities, which could be verified through review of Army documents, were excluded from the COC database. Analytical results of residual chemical concentrations in soil after excavation (i.e., confirmation samples) were kept in the COC database. A flag in the "samplestatus" data field was set to "excavated" to exclude analytical results of excavated soil from the COC database. Analytical results were retained in the COC database if there was any uncertainty regarding whether the sampled soil had been excavated.

5.1.1.6 Special Analytical Methods

Data that were generated by special laboratory methods or tests unrelated to in-situ soil and groundwater conditions at the OARB were excluded from the COC database. Such data eliminated were analytical results of the Toxicity Characteristic Leaching Procedure ("TCLP") and other tests related to waste disposal classification or chemical mobility in soil.

5.1.1.7 Unreliable or Rejected Data

Data flagged as "R" in the "epaflags" data field in the IT database are assumed to be unreliable or previously rejected by the Army as a result of its quality assurance / quality control ("QA / QC") evaluation. These flagged data were excluded from the database before screening for COCs for the RAP.

5.1.2 Exclusion of Non-Representative Data

Certain analytical results remaining in the database after completing the first screening step, as described above, were determined to be non-representative of COCs currently found in soil or groundwater at RAP site and RMP locations and were excluded from the COC database. Exclusion of analytical results during this second step was based upon more detailed evaluation and greater degree of professional judgment.

5.1.2.1 Common Laboratory Contaminants

Acetone, methyl ethyl ketone, methylene chloride, and phthalate esters are recognized as common laboratory contaminants (DTSC, 1999; U.S. EPA, 1989e). According to U.S. EPA screening protocols (1989d), common laboratory contaminants can be excluded from the COC database if the maximum concentrations detected in the environmental samples are less than 10 times the maximum concentrations detected in any blank sample. For conservatism, all chemicals that can be considered common laboratory contaminants were retained as COCs in soil and groundwater. A more detailed evaluation should be conducted if potential laboratory contaminants govern the need for future remediation at RAP sites or RMP locations.

5.1.2.2 Anomalous Cyanide Concentrations in Soil

A batch of soil samples collected from borings for monitoring wells BB-1 through BB-6 had reported concentrations of 0.15 to 15.1 mg/kg of cyanide. The cyanide analytical results are believed to be "false positives." The samples were tested for cyanide in the laboratory as a single batch by U.S. EPA Method 9010, which is a colorimetric method that is prone to interference caused by natural organic matter and other compounds in soil that may lead to erroneous results (U.S. EPA, 1997h). No current or former metal plating operations, which are a common source of cyanide, have been identified at the OARB. Further, the soil samples from these borings were collected during one sampling event at several different areas of the OARB. Although rarely included as an analyte, cyanide has not been detected in any other soil or groundwater samples obtained at the OARB.

Exclusion of data from borings for monitoring wells BB-1 through BB-6 eliminated cyanide from the COC database.

5.1.2.3 Metal Analytical Results from Unfiltered Groundwater Samples

As discussed in Section 4.3.2, laboratory analysis of unfiltered groundwater samples with high turbidity (i.e., greater than 5 NTU) are not likely to produce representative concentrations of dissolved metals in groundwater. Consistent with U.S. EPA (1997c, 1995a) and DTSC (1999) guidance, only analytical results of unfiltered groundwater samples with low turbidity (i.e., less than 5 NTU) or groundwater samples passed through an in-line filter are considered representative of concentrations of metals dissolved in groundwater at the OARB.

Unfortunately, the structure of the IT database does not allow for easy identification or determination of metal analytical results of unfiltered groundwater samples with high turbidity. Therefore, all unfiltered and filtered groundwater metal data were kept in the database for purposes of identifying chemicals to be retained as COCs. However, summary statistics on metal concentrations in groundwater were not calculated because such statistics are not representative of dissolved concentrations due to artificially high concentrations of metals measured in unfiltered groundwater samples with excessive turbidity. For example, the reported maximum concentration of arsenic in unfiltered groundwater samples is 4,930 µg/L, as compared with a reported maximum concentration of 82.6 µg/L for those samples that were filtered. All Title 22 metals were identified as COCs in groundwater.

5.2 SCREENING OF REMAINING DATA TO IDENTIFY COCs

Upon excluding non-pertinent and non-representative data as described in Sections 5.1.1 and 5.1.2, the database was further screened to identify COCs for: (1) the former ORP / Building 1 area, and (2) for the remainder of BRAC property at the OARB subject to this RAP. COCs were identified separately for the former ORP / Building 1 area because the tarry residue at this RAP site is fundamentally different from the types of contaminants found elsewhere at the OARB. Refer to Section 4.4.3.1 for a summary of the former ORP / Building 1 area use history and description of the tarry residue.

5.2.1 Ambient Metal Concentrations in Soil

Remediation of metal releases to concentrations that are below ambient concentrations (i.e., background levels) in soil is not intended by U.S. EPA (1992b, 1989d) or DTSC

(1999). Reported concentrations of metals in soil were compared with ambient levels to distinguish metals that may originate from a release and from those that exist at ambient levels and do not require remedial actions.

If possible, ambient metal concentrations in soil were determined based on the Army's statistical analysis of data for background soil samples collected at the OARB. Ambient background levels of metals derived from the statistical analysis are presented in ICF Kaiser Engineers' *Attachment A to the Risk Assessment Work Plan, Ambient Data Analysis for Soil, Oakland Army Base, California*, (ICF, 1999e). Because the Army did not derive ambient levels for silver and thallium, naturally occurring concentrations for silver and thallium in soil reported by Lawrence Berkeley National Laboratory ("LBNL"); (1995) were assumed. Metals in the database were compared with the ambient levels compiled in Table 5-1. All Title 22 metals in soil were retained as COCs based upon the results of this comparison.

5.2.2 Infrequently Detected Chemicals Below Risk-Based Screening Levels

Many chemicals in the COC database are rarely detected. Regarding the infrequent detection of chemicals, U.S. EPA (1989d) states that:

> Chemicals that are infrequently detected may be artifacts in the data due to sampling, analytical, or other problems, and therefore may not be related to site operations or disposal practices. Consider the chemical as a candidate for elimination from the quantitative risk assessment if: (1) it is detected infrequently in one or perhaps two environmental media, (2) it is not detected in any sampled media or at high concentrations, and (3) there is no reason to believe that the chemical may be present.

U.S. EPA risk assessment guidance was followed to establish the minimum frequency level for chemical detection. As suggested by U.S. EPA (1989d, 1989e), an infrequently detected chemical at RAP sites and RMP locations was determined to be a chemical that was detected in less than 5 percent of the samples for which it was analyzed.

As suggested by the U.S. EPA (1989d), infrequently detected chemicals with maximum concentrations less than screening levels were excluded from the COC database if the chemicals were not believed to be plausibly associated with chemical releases at the OARB. Screening levels consisted of U.S. EPA (2000b) Region IX PRGs for residential land use for chemicals detected in soil and MCLs or U.S. EPA (2000b) Region IX tap water PRGs, if no MCLs have been promulgated, for chemical detected in groundwater.

These screening levels were intended to be a conservative evaluation of human health risk.[13]

Screening of infrequently detected chemicals was performed with caution in recognition of the fact that not all potentially complete exposure pathways are included in calculation of U.S. EPA PRGs and that exposure to multiple chemicals in several media are not assumed in U.S. EPA PRGs.[14] Consequently, the screening was applied with judgement. Several VOCs (e.g., TCE, vinyl chloride, cis-1,2-DCE, trans-1,2-DCE), although infrequently detected in soil at concentrations below screening levels, were retained as COCs because the chemicals are still present in groundwater and may be found at measurable concentrations in soil during future sampling at the OARB.

The former incinerator (Building 147) that was situated along the northern boundary of the OARB (Figure 4-1) illustrates the importance of the use histories on understanding the detection frequencies of PCDDs and PCDFs. The Army collected two soil samples in the vicinity of this former incinerator and analyzed the samples for dioxin-like compounds because PCDDs and PCDFs can be formed as a by-product of combustion. Historical information indicating that the incinerator had never been used apparently had not been reviewed at the time the Army performed this sampling. PCDDs and PCDFs were measured at low concentrations in one of these two samples, which equates into a detection frequency of 50 percent. Strict adherence to the 5 percent frequency level would result in retaining dioxin as COCs in soil. However, PCDDs and PCDFs found at low concentrations in this single sample likely reflect trace deposition from regional sources (e.g., diesel-powered vehicles traveling the nearby I-80 freeway) as opposed to activities or significant releases at the OARB.[15] The incinerator (Building 147) is a case in point. The incinerator was built but never used. In a memorandum, dated 25 March 1964, the Army (1965) states:

[13] Background metal levels, U.S. EPA residential and tap water PRGs, and MCLs are too stringent to be considered appropriate site-specific remediation goals given the brackish groundwater and planned commercial and industrial uses of the OARB. However, use of screening levels that are based upon consumption of drinking water and residential use provides a sufficient degree of conservatism that it can be concluded with confidence that maximum detected concentrations of chemicals less than these screening levels do not pose appreciable human health risks at the OARB now or in the future.

[14] Taking into account the planned commercial and industrial uses of the OARB, vapor intrusion into buildings is the most significant exposure pathway not included in calculation of U.S. EPA PRGs. Refer to Section 7.3.2.1 for a discussion of how this potential exposure pathway relates to the OARB.

[15] Growing concern over widespread ambient levels of dioxins has led the Association of Bay Area Governments (2001) to study means of reducing PCDD and PCDF emissions from regional sources.

> The above Miscellaneous Structure [i.e., Building 147] was constructed for an incinerator. However, it has never been used for an incinerator; performs no useful function, nor can it be feasibly converted to any other use.

The Army explains why the incinerator was never used in a memorandum, dated 25 February 1963 (Army, 1965):

> At the time the incinerator was designed and programmed, commercial firms were unable to handle the amounts of wet garbage generated by the Terminal [i.e., OARB]. Later, when the incinerator had been built, operations at the Terminal had been cut back to such an extent that it was uneconomical to operate the incinerator with the amount of wet garbage then generated. Also at this time, private firms were able to provide satisfactory removal service.

Therefore, PCDDs and PCDFs are not considered COCs outside of the former ORP / Building 1 area because no dioxin sources at the OARB have been identified or can be reasonably attributed to current or past activities at the OARB. Exclusion of PCDDs and PCDFs outside of the former ORP / Building 1 area are the only chemicals that were detected in greater than 5 percent of the samples but have been excluded as COCs in the RAP based upon historical use information.

5.3 IDENTIFIED COCS

Detected chemicals that remained after completing the screening steps described above were determined to be COCs for the property being transferred to OBRA via the EDC. Identified COCs in soil and groundwater at the former ORP / Building 1 area are listed in Tables 5-2 and 5-3, respectively. Identified COCs in soil and groundwater for the area outside the former ORP / Building 1 area that is subject to this RAP are listed in Tables 5-4 and 5-5. For reference, Tables 5-6 and 5-7 summarize the chemicals excluded as COCs in soil and groundwater as a result of COC screening. The COC database, edited to include data flags reflecting the COC screening described in this section of the RAP, is provided on a compact disc in Appendix A.

6

6. APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

The release or threatened release of a hazardous substance into the environment provides the basis for all cleanups under Chapter 6.8 of the California HSC and related NCP requirements.

To create a list of regulated hazardous substances for CERCLA purposes, Congress incorporated substances, elements, compounds, solutions, or mixtures subject to other federal laws, such as RCRA, CWA, CAA, and TSCA. However, CERCLA, as it was enacted in 1980, did not specifically require remedial actions implemented at Superfund sites to comply with cleanup levels or management standards contained in these laws (U.S. EPA, 1988b). Instead, Congress established a risk-based threshold for cleanups at Superfund sites that was protective of human health and the environment but still afforded significant flexibility in selecting and implementing response actions (U.S. EPA, 1998c). In the absence of numerical cleanup levels and management standards specific to CERCLA, U.S. EPA implemented a policy that remedial actions generally meet or surpass substantive requirements of existing environmental laws, including those laws that Congress had referenced to generate the list of hazardous substances.

In 1986, SARA codified U.S. EPA's existing policy towards compliance with other environmental laws. As a result, the NCP at 40 CFR §300.430(f)(1)(i)(A) provides that releases of hazardous substances at a site be cleaned up to meet ARARs, unless circumstances for a waiver exist. ARARs are used in conjunction with risk-based remediation goals to establish cleanup levels as part of RAOs for a site. According to U.S. EPA (1991d), "ARARs represent the minimum that a remedy must attain; it may sometimes be necessary, where there are multiple contaminants with potentially cumulative and synergistic effects, to go beyond what ARARs require to ensure that a remedy is protective."

The purpose of this RAP is to develop remedial alternatives that are protective of human health and the environment, cost-effective, and consistent with planned reuse. Part of this process includes an evaluation of ARARs. Potential ARARs are evaluated generally for all identified RAP sites and RMP locations in this section. RAP sites and RMP locations also include any associated remote staging areas.[16] Table 6-1 summarizes ARARs for

[16] Remote staging areas are locations separate from the actual remedial site, which are used to implement the remedial activities at the site. Such activities could include contractor vehicle or equipment storage, stockpiling of excavated or

identified RAP sites and RMP locations, including legal citations and specific locations where an ARAR may be expected to apply. In the event of a discrepancy between the text and Table 6-1, the information in the table shall prevail.

6.1 EFFECT OF ON-SITE AND OFF-SITE REMEDIAL ACTIONS ON ARARs

The scope and extent of ARARs that pertain to remedial actions will vary depending based on the nature and source of contamination. This RAP will document compliance with substantive requirements of federal and state environmental laws identified as ARARs.

6.2 APPLICABLE REQUIREMENTS

The NCP at 40 CFR §300.5 defines applicable requirements as:

> ...those cleanup standards, standards of control, and other substantive requirements, criteria or limitations promulgated under federal environmental or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Only those state standards that are identified by a state in a timely manner and that are more stringent than federal requirements may be applicable.

An applicable requirement directly and fully addresses the situation at a site. In other words, an applicable requirement is one that a party would be subject to if it were undertaking the action independently from any CERCLA authority. For example, if any type of action, regardless if it occurs under CERCLA or not, entails injecting treated water into the uncontaminated saturated zone, then compliance with the SWRCB (1968) Resolution No. 68-16 ("Antidegradation Policy") is mandatory. For a requirement to be applicable, all jurisdictional prerequisites of the requirement must be met, including; (1) the party must be subject to the law; (2) the substances or activities must fall under the authority of the law; (3) the action must occur in the time period during which the law

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fill materials, soil or debris handling activities, or other activities required to implement the remedial action which are conducted at a location separate from the site. Action- and chemical-specific ARARs for remote staging areas will be the same as the ARARs for the primary site for which the activities are being staged; location-specific ARARs may be more or less stringent, depending on the location of the staging area.

is in effect; and (4) the action must be one of the types of activities the statute requires, limits, or prohibits (U.S. EPA, 1989a).

State requirements are ARARs only if they are more stringent than federal requirements. State requirements may be considered more stringent than federal requirements in the following ways (U.S. EPA, 1989b; SWRCB, 1992):

- The state is implementing a program that has a federal counterpart and the state program has received federal approval. An approved state RCRA program would be an ARAR because the state program has to be at least as stringent as the RCRA requirements for U.S. EPA to approve the program.

- The state program does not have a federal counterpart because the program has been established due to a state law only.

- State requirements are more stringent than federal requirements. More stringent state MCLs promulgated for drinking water would be ARARs.

State requirements must be identified in a timely manner to be considered as ARARs. The NCP at 40 CFR §300.515(h)(2) indicates that "in a timely manner" means as early as possible but at least before conducting detailed analysis of alternatives.

6.3 RELEVANT AND APPROPRIATE REQUIREMENTS

The NCP at 40 CFR §300.5 defines relevant and appropriate requirements as:

> ...those cleanup standards, standards of control, and other substantive requirements, criteria or limitations promulgated under federal environmental or state environmental or facility siting laws, that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site. Only those state standards that are identified in a timely manner and are more stringent than federal requirements may be relevant and appropriate.

According to U.S. EPA (1989a), determining an ARAR is relevant and appropriate is "site-specific and is based on best professional judgment, taking into account the circumstances of the release or threatened release." Greater flexibility and discretion exists in determining that an ARAR is relevant and appropriate as opposed to it being applicable. U.S. EPA (1989a) states the following:

> Only those requirements that are both relevant and appropriate are ARARs. A requirement may be relevant, but not appropriate, because of site circumstances. Such a requirement would not be an ARAR for the site. Moreover, it is possible for only a portion of a requirement to be considered relevant and appropriate, while other parts may not.

Once a requirement, or part of a requirement, is determined to be relevant and appropriate, the substantive provisions are considered to the same degree as if it were applicable.

6.4 TO-BE-CONSIDERED MATERIALS

The NCP at 40 CFR 300.400(g)(3) describes To-Be-Considered materials ("TBCs") as advisories, criteria, or guidance that may be considered for a particular action or specific issue, as appropriate. TBCs are not ARARs and do not have to be achieved by remedial actions implemented at a site. U.S. EPA (1989a) states the following regarding TBCs:

> TBCs are not potential ARARs because they are neither promulgated nor enforceable. It may be necessary to consult TBCs to interpret ARARs, or to determine preliminary remediation goals when ARARs do not exist for particular contaminants. However, identification and compliance with TBCs is not mandatory in the same way that it is for ARARs.

Use of TBCs in developing CERCLA remedies is discretionary.

6.5 TYPES OF ARARs and TBCs

U.S. EPA (1989a) has divided ARARs (and TBCs) into the following three types to facilitate their identification:

- **Chemical-specific ARARs:** These ARARs are usually health- or risk-based numerical values or methodologies used to determine acceptable concentrations of chemicals that may be found in, or discharged to, the environment (e.g., MCLs that establish safe levels in potential drinking water).

- **Location-specific ARARs:** These ARARs restrict actions or contaminant concentrations in certain environmentally sensitive areas. Examples of areas regulated under various federal laws include locations where endangered species or historically significant resources are present.

- **Action-specific ARARs:** These ARARs are usually technology- or activity-based requirements, or limitations on actions or conditions involving specific COCs.

Chemical- and location-specific ARARs are generally identified early in the RI and remedy selection process, while action-specific ARARs are usually identified during the detailed analysis of remedial alternatives (U.S. EPA, 1988b). Table 6-1 is organized by chemical-specific, location-specific, and action-specific ARARs and TBCs.

6.6 POTENTIAL ARARs AND TBCs FOR OARB

CWA, TSCA, RCRA, and CAA, are some of the environmental laws with requirements that are frequently applicable or relevant and appropriate. ARARs and TBCs associated with these and other laws that pertain to identified RAP sites and RMP locations at the OARB are discussed below. The following discussion provides an overview of the ARARs and TBCs associated with these and other laws that pertain to RAP sites and RMP locations. Table 6-1 provides a more detailed analysis of the ARARs and TBCs that pertain to RAP sites and RMP locations, as well as a list of locations that may be subject to a specific ARAR or TBC. ARARs and TBCs in this table have been grouped by type. Numerical criteria associated with chemical-specific and action-specific ARARs are summarized in Tables 6-2 and 6-3, respectively.

6.6.1 Chemical-Specific ARARs and TBCs

Chemical-specific ARARs and TBCs that may pertain to RAP sites and RMP locations are described in Sections 6.6.1.1 through 6.7.3.

6.6.1.1 Clean Water Act

The CWA of 1972 is the principal federal law governing discharges to surface waters and adjoining shorelines. Even before passage of the CWA, the State of California was protecting its surface water and groundwater through enactment of the Porter-Cologne Water Quality Act ("Porter-Cologne") under the California Water Code in 1967. The SWRCB and nine Regional Boards are responsible for oversight of Porter-Cologne and

CWA requirements. Unlike the CWA, Porter-Cologne does not restrict water quality standards to surface waters and point source discharges authorized by NPDES permits. Porter-Cologne requires that each of the nine Regional Boards adopt *Water Quality Control Plans*, which are applicable to groundwater and non-point sources, as well. *Water Quality Control Plans* are often called Basin Plans because they apply to waters within specific watershed boundaries or drainage basins. The Basin Plan and SWRCB resolutions that have been promulgated to implement Porter-Cologne and CWA requirements, and that pertain to remedial actions at RAP sites and RMP locations, are discussed below.

6.6.1.1.1 RWQCB Water Quality Control Plan

The RWQCB's (1995) *Water Quality Control Plan* sets forth narrative standards and permissible concentrations of organic and inorganic chemical constituents for various types and beneficial uses of surface water and groundwater in the San Francisco Bay Area. These narrative standards and concentration limits are **chemical-specific ARARs** that are or may be **applicable** to certain OARB locations.

6.6.1.1.2 California Toxics Rule

The following plans prepared by SWRCB provided water quality criteria for toxic compounds in enclosed bays, estuaries, and inland surface waters throughout California:

- SWRCB. 11 April 1991. *California Enclosed Bays and Estuaries Plan, Water Quality Control Plan for Enclosed Bays and Estuaries of California* ("EBEP").
- SWRCB. 11 April 1991. *California Inland Surface Waters Plan, Water Quality Control Plan for Inland Surface Waters of California* ("ISWP").

RWQCB enforced the criteria in these plans from 1992 to 1994, at which time the Superior Court of California ordered that numerical water quality criteria in the EBEP and ISWP be rescinded based upon a legal challenge by various municipalities and regulated industries in the state. To replace the standards that were rescinded, U.S. EPA has issued new freshwater and saltwater quality criteria for inland surface waters, enclosed bays, and estuaries in California. These new water quality criteria became effective on 18 May 2000 and are promulgated under 40 CFR §131.38, *Establishment of Numerical Criteria for Priority Toxic Pollutants for the State of California*, also known as the California Toxics Rule ("CTR"). SWRCB (2000) has adopted measures to implement these criteria throughout California.

As discussed in Section 3.5.2, available data do not indicate that COCs in groundwater at the OARB are migrating in the shallow water-bearing zone to San Francisco Bay. However, it is possible that groundwater migrates to San Francisco Bay through storm drain piping. Storm drain piping at the OARB is documented to have breaks and cracks. Storm drain piping is often situated in the saturated zone and groundwater may enter the cracked or otherwise breached storm drain piping. In the event that COCs originating from releases at the OARB are found to be impacting water in the bay, the California Toxics Rule is a **chemical-specific ARAR** that is or may be **applicable** to OARB locations.

6.6.1.2 Toxic Substances Control Act

TSCA was enacted in 1976 to regulate the introduction and use of new hazardous chemicals. TSCA was amended in 1987. As part of these amendments, U.S. EPA added Subpart G that established criteria to determine the adequacy of cleanup of PCB spills. U.S. EPA has concluded that Subpart G is a potential TBC for PCBs released at Superfund sites (U.S. EPA, 1998c, 1990b, 1989c).

Requirements governing cleanup of PCB-containing soil and wastes were broadened by amendments to TSCA in 1998. As part of these amendments, U.S. EPA added 40 CFR §761.61 to Subpart D of TSCA, which provides cleanup and disposal provisions for PCB-containing soil and other types of remediation wastes. Subpart D requires that excavated soil that contains greater than 50 mg/kg of PCBs be managed as a RCRA or TSCA waste. In addition, this section of Subpart D sets cleanup levels for high occupancy areas (e.g., residence) and low occupancy areas (e.g., electrical equipment vaults and unoccupied areas outside a building). The cleanup level for unrestricted use of high occupancy areas is 1 mg/kg of PCBs in soil and the cleanup level for unrestricted use of low occupancy areas is 25 mg/kg of PCBs in soil. A PCB cleanup level of 10 mg/kg for high occupancy areas is permissible if the areas impacted by PCBs are capped and accompanied by land use restrictions. Higher cleanup levels for low occupancy areas are also allowed if the areas impacted by PCBs are either fenced or capped and accompanied by land use restrictions. The PCB cleanup level for low occupancy areas is 50 mg/kg for areas that are fenced and 100 mg/kg for areas that are capped and where land use restrictions are placed into effect.

Although U.S. EPA (63 FR 35407) considers Subpart D to be an ARAR, 40 CFR §761.61(a)(1)(ii) indicates that these requirements are not binding upon CERCLA remedial actions. Cleanup of PCBs to more stringent levels can be enforced. Subpart D of TSCA is a **chemical-specific ARAR** that is or may be **relevant and appropriate** for certain RAP sites and RMP locations at OARB. The Subpart G spill cleanup policy is a **chemical-specific** policy that is or may be a **TBC** for certain OARB locations.

6.6.1.3 Fuel Storage Tank Sites Cleanup Levels

RWQCB is the lead agency supervising closure of former petroleum tank locations at the OARB. Under RWQCB oversight, the Army developed cleanup levels for petroleum hydrocarbons and related constituents in soil and groundwater to assist with closing former tank locations at the OARB (IT, 2001g 2000h). These remediation criteria were designated Fuel Storage Tank Sites Cleanup Levels. Fuel Storage Tank Sites Cleanup Levels are **chemical-specific TBCs** for OARB locations.

6.6.1.4 Oakland Urban Land Redevelopment Program

The ULR (Oakland, 2000) is the result of a collaborative effort between the City of Oakland and the principal agencies that enforce environmental regulations. Participating agencies included DTSC, RWQCB, U.S. EPA, and Alameda County Department of Environmental Health. Creation of the ULR program was funded by U.S. EPA Region IX and is intended to facilitate the cleanup and redevelopment of contaminated properties.

The ULR program is a three-tiered risk-based corrective action process. Tiers 1 and 2 consist of numerical cleanup levels in "look-up" tables that are applicable to properties that involve particular land uses, types of chemical releases, and geologic and hydrogelogic conditions. Tier 3 of the ULR program outlines a methodology for calculating site-specific remediation goals that incorporate human health exposure parameters that are specific to Oakland.

Tiers 1 and 2 of the ULR program are not pertinent because risk-based remediation goals have been calculated for the OARB as discussed in Section 7.3. These risk-based remediation goals were derived using risk equations and exposure parameters from U.S. EPA, DTSC, and the City of Oakland ULR program. Tier 3 of the ULR program is considered a **chemical-specific TBC** for OARB locations.

6.6.1.5 RWQCB Risk-based Screening Levels

RWQCB (2001a) has released interim final soil and groundwater risk-based screening levels ("RBSLs") for over 100 chemicals commonly found at sites where releases of hazardous substances have occurred. RBSLs are used primarily to evaluate whether a chemical release may pose a risk at the site that warrants further investigation. In addition, RBSLs can be used, if appropriate, as cleanup levels if site-specific cleanup levels are not available. Use of RBSLs for RAP sites and RMP locations at the OARB may be appropriate under circumstances where site-specific, risk-based remediation goals do not apply (Section 7.3). For example, risk-based remediation goals for the OARB do not take into account further degradation of the shallow water-bearing zone caused by COCs leaching from soil. RBSLs have been generated for such situations and therefore are included as **chemical-specific TBCs** for OARB locations.

6.6.2 Location-Specific ARARs and TBCs

Location-specific ARARs and TBCs that may pertain to OARB locations are described in Sections 6.6.2.1 through 6.7.8.

6.6.2.1 RWQCB Water Quality Control Plan

The Basin Plan sets forth discharge prohibitions throughout the San Francisco Bay Region (RWQCB, 1995). In addition, the Basin Plan reaffirms the California Wetlands Conservation Policy of ensuring no net loss of wetlands. Certain provisions of the Basin Plan identified in Table 6-1 are **location-specific ARARs** that are or may be **applicable** for some of the OARB locations.

6.6.2.2 SWRCB Resolution No. 88-63

SWRCB Resolution No. 88-63 – *Adoption of Policy Entitled "Sources of Drinking Water"* states that all surface water and groundwater in California should be designated suitable, or potentially suitable, sources of drinking water unless the surface water or groundwater contains greater than 3,000 mg/L of TDS, is not capable of producing an average, sustained yield of 200 gallons per day, or has naturally high concentrations of contaminants. Groundwater in the shallow water-bearing zone and Merritt Sand beneath the OARB are not potential drinking water supply because TDS concentrations are greater than 3,000 mg/L and often 10,000 mg/L. RWQCB has proposed formal de-designation of groundwater along the Oakland shoreline, including the OARB, as potential municipal supply based upon Resolution No. 88-63.

U.S. EPA (1986) has developed guidelines for determining future use of groundwater at a site for purposes of evaluating the appropriateness of remedial actions under CERCLA. However, U.S. EPA (1997i) will generally defer to a state's groundwater use determination (e.g., Resolution No. 88-63), provided it results in cleanup levels that are at least as stringent as would be derived using U.S. EPA's groundwater classification guidelines. Therefore, to the degree Resolution No. 88-63 is more stringent than the federal standards, it is a **location-specific ARAR** that is or may be **applicable** for OARB locations.

6.6.2.3 National Historic Preservation Act

The federal National Historic Preservation Act ("NHPA") requires consideration of the potential effects that remedial actions will have on historic properties included, or eligible for inclusion, on the National Register of Historic Places ("National Register"). The National Register lists historic properties (i.e., cultural resources), which consist of districts, sites, buildings, structures, and objects that are significant in American history or culture for their architectural, archeological, engineering, or other aspects (U.S. EPA, 1989c). While portions of the OARB are included in a registered historic district because of the role the OARB played during World War II and later military conflicts, none of the buildings on the OARB are listed on the National Register. The Army has completed the NHPA consultation process in connection with its Environmental Impact Statement ("EIS") supporting the transfer of the OARB to OBRA for implementation of the Amended Reuse Plan, and a Programmatic Agreement has been entered into by all relevant parties to assure compliance with NHPA requirements. The EIS was prepared to fulfill requirements of the National Environmental Policy Act ("NEPA"). The substantive requirements to survey sites for, and minimize harm to, cultural resources are **location-specific ARARs** that have already been complied with in connection with the OARB locations.

6.6.2.4 Archeological and Historic Preservation Act

The federal Archeological and Historic Preservation Act provides for conservation of historical and archeological data that might otherwise be destroyed as a result of construction projects. If such a project may cause irreparable loss or destruction to significant scientific, pre-historical, historical, or archeological data, the Archeological and Historic Preservation Act requires that the agency undertaking the project preserve the data or request the Secretary of the Interior to do so (U.S. EPA, 1989c). The Archeological and Historic Preservation Act differs from the NHPA in that it encompasses a broader range of resources than those listed on the National Register and mandates only the conservation, analysis, and publication of the data, as opposed to preservation of the resources or artifacts themselves. The Archeological and Historic Preservation Act is a **location-specific ARAR** that is or may be **applicable** for OARB locations. As with the NHPA requirements discussed in Section 6.6.2.3, the Army's completed NEPA process has already resulted in compliance with the Archeological and Historic Preservation Act such that there will be no irreparable loss of historical or archeological resources in connection with the remediation and redevelopment of OARB.

6.6.2.5 Archeological Resources Protection Act

The Archeological Resources Protection Act ("ARPA"), prohibits excavation of, damage to, or destruction of archeological resources on public lands without a permit issued by the federal land manager. However, no permit is required if the activities in question take place under another permit, license, or entitlement for use, and the activities are exclusively for purposes other than the excavation and removal of archeological resources. The ARPA is a **location-specific ARAR** that is or may be **applicable** for OARB locations. The Army's completed EIS process, and its completed consultation with the State Historic Preservation Officer, has verified that there are no archeological resources at OARB.

6.6.2.6 Native American Graves Protection and Repatriation Act

The Native American Graves Protection and Repatriation Act ("NAGPRA") requires that when a planned activity results in the movement or excavation of human remains, funerary objects, sacred objects, or objects of cultural patrimony from federal land, the Indian tribes or Native Hawaiian organizations that are likely to be culturally affiliated with the artifacts must be notified and consulted regarding the appropriate treatment of the discovery. Following such a discovery, work in this area must cease immediately, and the discovery must be reported to the responsible federal land manager. The EIS indicates that Native Americans subsisted by hunting and gathering food from the marshlands that existed along the Oakland shoreline as long as 5,000 years ago. Although no Native American cultural artifacts have been discovered at the OARB, the NAGPRA is a **location-specific ARAR** that is or may be **applicable** for RAP sites and RMP locations at the OARB in the event that Native Americans human remains or artifacts are unexpectedly encountered.

6.6.2.7 Coastal Zone Management Act

The federal Coastal Zone Management Act ("CZMA") requires that activities directly affecting the coastal zone be performed in a manner that is consistent with the state coastal zone management plan. The San Francisco Bay Conservation and Development Commission ("BCDC") is responsible for administering the CZMA for the portion of the California coast within the San Francisco Bay.

Before 1965, roughly 2,300 acres of San Francisco Bay were being filled each year. BCDC was established in 1965 under the McAteer-Petris Act to regulate development in and around San Francisco Bay. BCDC's jurisdiction extends to the first 100 feet from the shoreline around San Francisco Bay, and to most creeks, rivers, sloughs and other tributaries that flow into San Francisco Bay ("BCDC jurisdictional area"). BCDC became the federally designated state agency for conservation of San Francisco Bay with passage of CZMA in 1972.

BCDC, in cooperation with the Metropolitan Transportation Commission, implements the *San Francisco Bay Area Seaport Plan* ("Seaport Plan"). Under the Seaport Plan, the former Baldwin Railyard and Port Development Area of the OARB are designated Port Priority Use Areas. These areas must be used for maritime terminals and other authorized maritime activities.

Remedial actions performed in areas under the jurisdiction of BCDC must comply with the substantive requirements of the CZMA, Seaport Plan, and BCDC's *San Francisco Bay Plan* ("Bay Plan"), and may require may require a BCDC permit (particularly in connection with any excavation or other construction activities in the subsurface area or otherwise in the BCDC jurisdictional area). The CZMA and BCDC's Seaport Plan and Bay Plan are **location-specific ARARs** that are or may be **applicable** for certain OARB locations.

6.6.2.8 Migratory Bird Treaty Act

The federal Migratory Bird Treaty Act and the California Fish and Game Code prevent the taking, killing, or possessing of migratory and other fully protected birds, and their nests, eggs, and young unless permitted by the Secretary of the Interior. Loss of certain trees during nesting season may disrupt breeding birds. Consequently, where remedial actions may necessitate the removal of trees, the Migratory Bird Treaty Act and certain requirements of the Fish and Game Codes regarding protection of birds are **location-specific ARARs** that are or may be **applicable** for certain OARB locations.

6.6.2.9 Amended Reuse Plan

The Amended Reuse Plan describes intended redevelopment of the OARB. Remedial actions implemented at the OARB should be compatible with the land uses described in this document. The Amended Reuse Plan is considered a **location-specific TBC**.

6.6.3 Action-Specific ARARs and TBCs

Action-specific ARARs and TBCs that may pertain to RAP sites and RMP locations at the OARB are described in Sections 6.6.3.1 through 6.7.9.

6.6.3.1 Basin Plan and SWRCB Resolution No. 68-16

The RWQCB's (1995) *Water Quality Control Plan* outlines strategies to achieve the state's policy of maintaining the existing high quality of surface water and groundwater in the San Francisco Bay Area. As discussed in Section 6.6.2.2, this policy is set forth in the SWRCB's Antidegradation Policy. The Basin Plan identifies beneficial water uses and adopts water quality criteria to protect those uses. The Basin Plan contains numerical limits for conventional pollutant objectives (e.g., dissolved oxygen, temperature, pH), and limits for metals and PAHs in discharges to freshwater and saltwater in the San Francisco Bay Area.

The CWA requires every state to establish surface water antidegradation regulations (U.S. EPA, 1990a). Although not specifically required by U.S. EPA, the majority of states have also established some form of groundwater antidegradation provisions. The State of California's Antidegradation Policy is set forth in SWRCB Resolution No. 68-16, *Statement of Policy with Respect to Maintaining High Quality of Waters in California*, which pertains to both surface water and groundwater. Resolution No. 68-16 applies to CERCLA remedial actions that involve extracting, treating, and discharging treated groundwater. Under this resolution, no discharge of chemical-containing groundwater is allowed to high quality groundwater (i.e., groundwater that contains only naturally occurring substances), unless it is in the public interest to allow such a discharge. If discharge of groundwater is allowed, Resolution No. 68-16 states that the groundwater or waste must:

> …meet waste discharge requirements which will result in the best practicable treatment or control of the discharge necessary to assure that (a) a pollution or nuisance will not occur and (b) the highest water quality consistent with maximum benefit to the people of the State will be maintained.

RWQCB enforces this policy by issuing waste discharge requirements for treated water that is reinjected or allowed to percolate into the subsurface and NPDES permits for treated water that is pumped directly to streams, lakes, or other water bodies.

Waste discharge requirements may also be issued to chemical-containing soil to protect the beneficial uses of groundwater and surface water from COCs that may leach or otherwise migrate from impacted soil. RWQCB (1995) states in its Basin Plan that its objective is to have COCs released to soil removed or treated to naturally occurring or ambient concentrations. For those RAP sites and RMP locations where it is impracticable to remove COCs to ambient concentrations in soil, RWQCB will consider site-specific recommendations for cleanup levels based upon the physical characteristics of the site, and mobility and toxicity of chemicals released. Certain sections of the Basin Plan addressing effluent limitations and groundwater discharge and Resolution No. 68-16 are **action-specific ARARs** that are or may be **applicable** for specific OARB locations.

6.6.3.2 SWRCB Resolution No. 92-49

Section 13304 of the California Water Code authorizes the Regional Boards "to require complete cleanup of all waste discharged and the restoration of affected water to background conditions (i.e., the water quality that existed before the discharge)." If background conditions of affected water cannot be attained, then the water shall be restored to the best quality that is reasonable. To assist Regional Boards with oversight of this law, SWRCB promulgated Resolution No. 92-49 – *Policies and Procedures for Investigation and Cleanup and Abatement of Discharges under Water Code Section 13304*. This resolution establishes policies and procedures for investigating and remediating chemical releases that affect or threaten water quality. Resolution No. 92-49 is an **action-specific ARAR** that is or may be **applicable** for some OARB locations.

6.6.3.3 EBMUD Sanitary Sewer Discharge Limitations

EBMUD operates the publicly owned treatment works ("POTW") to which sanitary sewage from the OARB is conveyed. EBMUD Board of Directors have established restrictions pertaining to the discharge of wastewater to the POTW. These restrictions include numerical discharge limitations for certain COCs at the OARB as summarized in Table 6-3. These limitations are **action-specific ARARs** that are or may be **relevant and appropriate** for certain OARB locations.

6.6.3.4 Resource Conservation and Recovery Act

Enacted in 1976, RCRA established the first comprehensive federal program for controlling hazardous waste. RCRA emphasizes the conservation and recycling of wastes whenever practical. RCRA also sets standards for the handling of hazardous wastes within a cradle-to-grave framework that originates with the generator and follows the wastes through its handling, transportation, treatment, and final disposal (Wentz, 1989). Congress significantly broadened the scope of RCRA through passage of the Hazardous and Solid Waste Amendments ("HSWA") in 1984. HSWA introduced several new requirements, including new standards for the construction and operation of solid waste management units, and upgraded criteria for disposing of municipal solid wastes in landfills. Municipal solid wastes are defined to be non-hazardous solid wastes in the State of California. Classification of hazardous and non-hazardous waste, and requirements governing management and disposal of these wastes off-site, are further discussed in Section 8.2.6.

6.6.3.4.1 Hazardous Waste Requirements Under Title 22 of CCR and HSC §25157.8

RCRA Subtitle C (40 CFR §§260-299) sets forth criteria for determining what are federal hazardous wastes, and specifies minimum national requirements for facilities that generate, transport, store, or dispose of hazardous wastes. DTSC has promulgated regulations in Title 22 of the CCR that govern the management of wastes that are hazardous under RCRA or are hazardous under criteria specific to California for the definition of hazardous wastes. These latter types of hazardous wastes are referred to as non-RCRA hazardous wastes, and include wastes that contain metals or organic compounds at concentrations greater than their respective Total Threshold Limit Concentration ("TTLC") or Soluble Threshold Limit Concentration ("STLC"), as measured by the Waste Extraction Test ("WET"). TTLC and STLC limits for COCs at RAP sites and RMP locations at the OARB are summarized in Table 6-3.

Pursuant to HSC §25157.8, additional criteria pertain to the management of lead, copper, or nickel contaminated waste. Waste containing total lead greater than 350 mg/kg, copper greater than 2,500 mg/kg, or nickel greater than 2,000 mg/kg must be disposed at a permitted hazardous waste management facility, unless the waste discharge requirements and solid waste facility permit of a non-hazardous waste management facility specifically allow for the disposal of these types of wastes. HSC §25157.8 remains in effect until 1 July 2006, and as of that date is repealed unless a later statute is enacted that repeals or extends the 1 July 2006 sunset provision.

Although the majority of wastes and soil to be generated by remedial actions performed at the OARB are anticipated to be non-hazardous, the possibility exists that some materials may be managed as hazardous waste. The tarry residue at the former ORP / Building 1 area may fall within this category. Available data suggest that some portion of the tarry residue may be classified as a hazardous waste due to corrosivity or toxicity. Hazardous waste requirements under Title 22 of the CCR, generation, transport, and disposal regulations; and closure, maintenance, and land use restrictions, are **action-specific ARARs** that are or may be **relevant and appropriate** for the former ORP / Building 1 area and other RAP sites and RMP locations at the OARB.

6.6.3.4.2 Non-hazardous Waste Requirements Under Title 27 of CCR

RCRA Subtitle D (40 CFR §§257-258) specifies minimum national requirements for municipal solid waste landfills that apply to new and existing waste management units that have received such wastes after 9 October 1991. Prior to the development of these national requirements, the SWRCB and the California Environmental Protection Agency's Integrated Waste Management Board promulgated regulations in Titles 14 and 23 of the CCR that pertain to the management of non-hazardous wastes and municipal solid waste landfills. Titles 14 and 23 of the CCR were amended to incorporate RCRA Subtitle D and approved for implementation by U.S. EPA. The State of California subsequently consolidated most of the requirements in Titles 14 and 23 that relate to non-hazardous wastes under Title 27 of the CCR. Non-hazardous waste requirements under Title 27 of the CCR are **action-specific ARARs** that are or may be **relevant and appropriate** for some OARB locations.

6.6.3.5 Clean Air Act

The CAA consists of numerous long-standing regulatory requirements with new requirements layered on top that can be likened to a patchwork quilt (Elsevier Science, Inc., 1995). The first federal air pollution-related statute was established in 1967, although not a great deal of regulatory activity resulted. The CAA of 1970 consisted of amendments to the legislation passed in 1967 and laid the foundation for the federal air pollution regulatory programs in existence today. Further amendments to the CAA were passed in 1977 and 1990. A key concept in the federal approach to maintaining and improving ambient air quality involves the relationship between federal and state regulatory agencies. Although the CAA sets overall standards for the nation, the states ultimately have primary responsibility for achieving compliance with these standards. In essence, state regulatory agencies make things happen.

State compliance with the CAA is based upon a State Implementation Plan ("SIP") that designates regions for effective air quality management, and contains enforceable provisions to attain compliance with ambient air quality standards and other federal emission limitations. The SIP incorporates rules and regulations of the state and local districts involved in air pollution control. The California Air Resources Board is responsible for developing the SIP and ensuring that local air pollution control districts are complying with the plan. County and unified air pollution control districts enforce the SIP through permitting and regulation of emissions from stationary and mobile sources. The Bay Area Air Quality Management District ("BAAQMD") is the local regulatory agency responsible for maintaining and improving air quality in the San Francisco Bay Area.

Available soil and groundwater analytical data compiled for RAP sites and RMP locations at the OARB do not suggest that COCs are at high enough concentrations in undisturbed media to volatilize or otherwise become airborne at levels that would be subject to BAAQMD regulations. Impacts to air quality, if any, under BAAQMD jurisdiction are likely to result from the implementation of remedial actions. Several BAAQMD rules and regulations may apply to remedial actions implemented. For example, impacted wastes and soil at the former ORP / Building 1 area may require control of particulates (Regulation 6), odorous substances (Regulation 7), organic compounds (Regulation 8, Rule 40), or hydrogen sulfide (Regulation 9, Rule 2).

The construction and operation of treatment systems that discharge emissions to the atmosphere may also be subject to permitting and the installation of air pollution controls. For example, air stripping and soil vapor extraction operations are subject to Regulation 8, Rule 47. BAAQMD rules and regulations are **action-specific ARARs** that are or may be **applicable** or **relevant and appropriate** for specific OARB locations.

6.7 REQUIREMENTS DETERMINED NOT TO BE ARARs OR TBCs

Some regulations and guidances that could be considered ARARs or TBCs were specifically excluded from the list of ARARs and TBCs for RAP sites and RMP locations at the OARB. These potential ARARs or TBCs, and the reasoning for exclusion, are described below.

6.7.1 Safe Drinking Water Act

The SDWA of 1974, as amended in 1977, 1986, and 1996, establishes minimum national primary drinking water standards known as federal Maximum Contaminant Levels or MCLs. Federal MCLs and MCLs established specifically for drinking water in California are regulated under Title 22 of the CCR. The NCP at 40 CFR §§300.430(e)(2)(i)(B)-(D) states that Maximum Contaminant Level Goals ("MCLGs"), established under the SDWA, that are set at levels above zero, will be attained by remedial actions for surface water or groundwater that are current or potential sources of drinking water. Remedial actions shall achieve MCLs for groundwater containing COCs that do not have MCLGs, or if the MCLGs have been set at zero. For groundwater containing COCs without non-zero MCLGs, MCLs, or state standards; freshwater quality criteria may be potential ARARs when that groundwater is discharged to surface water (U.S. EPA, 1991e). In addition to MCLGs and MCLs, U.S. EPA issues secondary MCLs. However, secondary MCLs are not enforceable and are therefore TBCs. Secondary MCLs are described in Section 6.7.1.2.

6.7.1.1 MCLGs and MCLs

U.S. EPA's Office of Water develops MCLGs as a required first step toward issuance of national primary drinking water standards. MCLGs are not enforceable under the SDWA. MCLGs are health goals that are set at levels at which no known or anticipated adverse human effects occur, and which allow for an adequate margin of safety. MCLGs are strictly health-based levels and are derived from relevant toxicological data (U.S. EPA, 2001g).

MCLs are federally enforceable limits for COCs in drinking water. The MCL for a given COC is set as close to the corresponding MCLG as feasible. When issuing an MCL, U.S. EPA identifies an analytical method with a reporting limit that is set according to the desired MCL. U.S. EPA also identifies the Best Available Technology ("BAT") for removing the chemical to attain the MCL (U.S. EPA, 2001g). Section 8.2.12 addresses BAT for chemicals found in groundwater at RAP sites and RMP locations at the OARB.

Although MCLs were used in Section 5 to identify COCs, MCLs and non-zero MCLGs are not considered potential ARARs or TBCs for RAP sites and RMP locations at the OARB because groundwater at the OARB does not meet federal or State of California criteria for potential drinking water supply. As discussed in Section 3.5.1, groundwater in the shallow water-bearing zone and underlying Merritt Sand is brackish. RWQCB has proposed that the Basin Plan been amended to de-designate municipal supply as a potential beneficial use of groundwater along the Oakland shoreline, including the OARB.

6.7.1.2 Secondary MCLs

Secondary MCLs are established under the SDWA to protect public welfare. Secondary MCLs apply to chemicals in drinking water that adversely affect its odor, taste, or appearance and therefore cause people to discontinue using the water. Secondary MCLs are desirable goals. They are not based upon direct adverse health effects and are not enforceable. Secondary MCLs are not included as a TBC because groundwater at the OARB is not a current or potential source of drinking water.

6.7.2 Proposition 65

In November 1986, California voters approved an initiative to address increasing concerns about exposure to chemicals. This initiative became *The Safe Drinking Water and Toxic Enforcement Act*, which is codified in 22 CCR §12000 et seq. The act, however, is better known by its name on the voter ballot, "Proposition 65."

Proposition 65 prohibits discharges of any chemical "known to the state to cause cancer or reproductive toxicity" to a potential source of drinking water. Proposition 65 also requires "clear and reasonable" warnings to be provided before a significant exposure to any of these chemicals can occur. Cal / EPA, Office of Environmental Health Hazard Assessment ("OEHHA") is responsible for determining and listing chemicals "known to the state to cause cancer or reproductive toxicity."

In addition, OEHHA calculates "no significant risk levels" for carcinogens or reproductive toxicants, which are promulgated in 22 CCR §§12705, 12709, and 12805. Regarding these calculations, OEHHA (1994) states:

> that no significant risk levels are intended to provide "safe harbors" for persons subject to the Act, and do not preclude the use of alternative levels that can be demonstrated by their users as being scientifically valid.

In other words, if potential exposure to carcinogens and reproductive toxicants at a site are less than the no significant risk levels, OEHHA has concluded no clear and reasonable warnings of exposure are necessary. Alternatively, persons can conduct their own risk assessments to take into account site-specific conditions and their effect on potential exposures to chemicals to determine if a significant risk level exists.

No significant risk levels for carcinogens represent the daily intake level calculated not to result in a risk greater than one excess case of cancer in 100,000 individuals (i.e., 10^{-5}) exposed over a 70-year lifetime. No significant risk levels for reproductive toxicants represent the no observable effect level for the reproductive toxicant divided by a safety factor of 1,000.

By its terms, Proposition 65 only applies to persons in the course of doing business. City government and any department thereof are specifically excluded from this designation (refer to California HSC § 25249.11). Proposition 65 is not included as an ARAR or TBC for RAP sites and RMP locations at the OARB.

6.7.3 Soil Lead Guidance for CERCLA Sites

In its *Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities* ("Soil Lead Guidance"), dated 14 July 1994, U.S. EPA recommends using a screening level of 400 mg/kg of lead in soil for residential areas at CERCLA sites. Residential areas with lead concentrations less than 400 mg/kg generally require no further action. However, U.S. EPA clarifies this finding by noting that further study may be warranted below the screening level in some special situations, e.g., wetlands, areas with ecological risk, and areas of higher than expected human exposure. According to the guidance, lead is not anticipated to pose a threat to groundwater because it is usually immobile in soil. U.S. EPA's Soil Lead Guidance is not considered a TBC because no residential land use is planned for the OARB.

6.7.4 U.S. EPA Region IX Preliminary Remediation Goals

U.S. EPA Region IX PRGs are risk-based screening levels for evaluating chemical impacts to a site. Concentrations of chemicals detected at a site greater than their respective PRGs do not automatically trigger a response action. Instead, exceeding a U.S. EPA PRG suggests that further evaluation of the potential risks posed by chemicals at the site is appropriate (U.S. EPA, 2000b). Further evaluation may include additional sampling, consideration of naturally occurring or ambient levels of the chemicals in the environment, or performance of a more detailed risk assessment to account for site-specific conditions and determine if remedial actions are warranted.

U.S. EPA residential soil and tap water PRGs were used to identify COCs at the OARB. However, these PRGs are not appropriate cleanup levels because the OARB will be redeveloped for commercial and industrial purposes only and groundwater is not suitable for drinking water supply. Risk-based remediation goals have been calculated specifically for the OARB (Section 7.3). Therefore, U.S. EPA PRGs are not included as TBCs for RAP sites and RMP locations at the OARB.

6.7.5 California Native Plant Protection Act

The intent of the California Native Plant Protection Act is to preserve, protect, and enhance rare or endangered plants native to California. The Act forbids taking, possessing, or selling rare or endangered native plants unless authorized by an incidental take permit. The California Native Plant Protection Act is not considered an ARAR or TBC because vegetation at the OARB consists entirely of exotic or landscaped species.

6.7.6 Endangered Species Act

The federal Endangered Species Act ("ESA") requires consultation with the United States Fish and Wildlife Service, as appropriate, to ensure that remedial actions do not jeopardize the continued existence of threatened or endangered species, or adversely modify or destroy their habitats. Substantive requirements of the ESA include determining whether a threatened or endangered species, or their habitat, will be affected by a proposed response action.

The California Endangered Species Act ("CESA") generally parallels the main provisions of the ESA. California Department of Fish and Game must be consulted to ensure that remedial actions are not likely to jeopardize the continued existence of any endangered or threatened species, or result in destruction or adverse modification of essential habitat. The ESA and CESA are not considered ARARs or TBCs because no significant habitat exists in the upland areas of the OARB addressed by this RAP.

6.7.7 Marine Mammal Protection Act

The federal Marine Mammal Protection Act prohibits the taking, including harassment, of marine mammals, in the seas and on land. In the unlikely event that marine mammals would enter remedial areas, this Act prohibits their taking. The Marine Mammal Protection Act is not considered an ARAR or TBC because marine mammals do not inhabit the portion of the OARB subject to this RAP.

6.7.8 Executive Order 11990, Protection of Wetlands

Executive Order 11990 and 40 CFR §6.302(a) require federal agencies conducting certain activities to avoid, to the extent possible, the adverse impacts associated with the destruction or loss of wetlands. U.S. EPA must determine if the proposed actions will affect wetlands, and if so, the responsible agency must perform a wetlands assessment, which will be part of the environmental assessment or environmental impact statement. Adverse impacts shall be either avoided or minimized if no practicable alternative to the action exists. As discussed in Section 3.3, two small, non-jurisdictional wetlands are situated off-site east of Building 991. No wetlands are present on the OARB. Federal and State of California wetland regulations do not pertain to the OARB and are not considered ARARs or TBCs.

6.7.9 Stream and Wildlife Protections

Specific sections of federal law and the California Fish and Game Code seek to protect streams and wildlife. These provisions include requiring state or federal agency consultation if stream realignment or modification is proposed; prohibiting dumping of materials into waters of the state; and restricting certain means of "taking" birds or animals. These requirements are not considered ARARs or TBCs because no streams or significant habitat exist in the upland areas of the OARB addressed by this RAP.

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7. REMEDIAL ACTION OBJECTIVES

The NCP, at 40 CFR §300.430(a)(1)(i), explains that the goals of the remedy selection process under CERCLA are to develop and implement remedial actions that protect human health and the environment, maintain protection over time, and minimize untreated waste. To help meet these goals, remedies for contaminated sites are selected that will achieve medium-specific RAOs.[17] RAOs provide the foundation upon which remedial alternatives are assembled.

RAOs should consider potentially complete exposure pathways as well as chemical-specific ARARs and risk-based remediation goals because protectiveness may be achieved by either preventing exposure (such as capping an area or limiting access) or by reducing contaminant concentrations (U.S. EPA, 1988a). In addition, RAOs should allow evaluation of remedial alternatives that will achieve cleanup levels associated with the reasonably anticipated land use of the site in question (U.S. EPA, 1995d). To facilitate understanding the RAOs established for the OARB, a conceptual site model of the OARB is described in Section 7.1. Section 7.2 presents RAOs for OARB. Section 7.3 discusses the methodology employed to calculate site-specific, risk-based remediation goals that serve as the basis for many of the remediation goals adopted for RAP sites and RMP locations at the OARB. Section 7.4 summarizes the remediation goals adopted for the OARB. Section 7.5 summarizes protocols for determining compliance with risk-based remediation goals at identified RAP sites and RMP locations at the OARB using available analytical results or new data obtained as part of additional investigations or collection of confirmation samples after implementation of remedial actions.

7.1 OARB CONCEPTUAL SITE MODEL

In most instances, contamination of soil and groundwater at the OARB is relatively minor because Army operations were limited chiefly to warehousing and shipping of cargo overseas and did not include the kind of manufacturing activities that occurred at many other, larger military bases. Identified chemical impacts derive mostly from the use of petroleum products for activities that supported the OARB's primary military mission as a distribution center. With few exceptions, chemical impacts are limited to soil beneath the specific buildings and locations where activities took place.

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[17] Potentially affected media at a given site may consist of soil, groundwater, surface water, and air.

The high molecular weight and weathered petroleum hydrocarbons found in soil at the OARB are relatively immobile and, except possibly where used oil was stored, do not contain appreciable amounts of other contaminants, such as VOCs, PAHs, or metals that would constitute a human health risk. No non-aqueous phase liquid ("NAPL") or heavily contaminated soil that may leach COCs and act as ongoing contaminant sources have been identified at RAP sites at the OARB involving areas of VOC-impacted groundwater (i.e., eastern end of Building 807, near Buildings 808 and 823, and near Building 99). Significant migration of COCs in groundwater has not occurred anywhere on the OARB. The extent of impacted groundwater appears to be limited to portions of the shallow water-bearing zone entirely within the property boundary of the OARB. Refer to Sections 3.5 and 4.4.4.10 for a discussion of shallow groundwater conditions at the OARB.

The former ORP / Building 1 area is unique in that the tarry residue constitutes the only principal threat waste known to exist at the OARB. The tarry residue is considered to be a principal threat waste because it can be very acidic. A pH of 1 has been measured for some samples of this material. In addition, lead, PAHs, PCDDs, and PCDFs have been detected in the tarry residue at concentrations of concern. The concept of principal threat waste is discussed in greater detail in Section 8.1.

Buildings, railroads, roadways, and paved parking or storage areas now cover the OARB and will in the future under the Amended Reuse Plan. As a consequence, no significant ecological habitats exist in the upland areas of the OARB subject to this RAP. High TDS in the shallow water-bearing zone and underlying Merritt Sand render groundwater at the OARB unsuitable for drinking water supply.

The Amended Reuse Plan outlines redevelopment of the OARB for commercial and industrial purposes only. The OARB after redevelopment will continue to provide barriers to human contact with surface soil through existence of buildings, paving, roads, and landscaped areas. The only exception is for potential exposures related to construction or maintenance work when such barriers are penetrated under protocols allowed by the RMP. Potentially exposed future populations consistent with this site conceptual model are discussed in Section 7.3.1.

7.2 REMEDIAL ACTION OBJECTIVES

To attain the NCP goals of implementing remedial actions that protect human health and the environment, maintain protection over time, and minimize untreated waste, the remedial action objectives ("RAOs") for soil and groundwater associated with OARB property to be transferred to OBRA by the EDC are:

- Establish media-specific individual remediation goals that correspond to a Hazard Index ("HI") of 1 for each non-carcinogenic COC identified at the OARB. Remedial actions implemented at each RAP site or RMP location will be designed to meet individual non-carcinogenic COC remediation goals as established in Section 7.3, unless the cumulative non-carcinogenic risk goal as defined in this RAP can be met by alternative concentration limits demonstrated for a specific RAP site or RMP location to the satisfaction of DTSC. When multiple non-carcinogenic COCs are identified at a specific RAP site or RMP location, the cumulative non-carcinogenic target hazard index can be met by determining aggregate non-carcinogenic risk using the protocols in Section 7.5. Once remediation activities for a RAP site or RMP location have been completed pursuant to the RAP and RMP, confirmation samples will be collected to verify the cumulative non-carcinogenic hazard index of COCs (associated with the potentially complete exposure pathways defined in this RAP) remaining in soil and groundwater at each RAP site or RMP location will not exceed a cumulative HI of 1. The individual remediation goals for non-carcinogens in Table 7-11 represent the maximum allowable concentrations for the respective COCs. However, these remediation goals can be adjusted downward, as needed, if the total HI exceeds 1.

- Establish media-specific individual remediation goals that correspond to a 10^{-6} incremental lifetime cancer risk for each potential carcinogenic COC identified at the OARB. Remedial actions implemented at each RAP site or RMP location will be designed to meet individual carcinogenic COC remediation goals as established in Section 7.3, unless the cumulative carcinogenic risk goal as defined in this RAP can be met by alternative concentration limits demonstrated for a specific RAP site or RMP location to the satisfaction of DTSC. When multiple carcinogenic COCs are identified at a specific RAP site or RMP location, the cumulative carcinogen target risk level can be met by determining aggregate carcinogenic risk using protocols and equations provided in Section 7.5. Once remediation activities for a RAP site or RMP location have been completed pursuant to the RAP and RMP, confirmation samples will be collected to verify the cumulative carcinogenic risk of COCs (associated with the potentially complete exposure pathways defined in this RAP) remaining in soil and groundwater at each RAP site or RMP location will not exceed a cumulative, incremental lifetime human health carcinogen target risk level of 10^{-5}. As discussed in Section 7.3.3.2, the cumulative, incremental lifetime carcinogen target risk level of 10^{-5} is determined to be appropriate for the OARB after considering the applicability of the full risk range acceptable under the NCP and the cumulative carcinogenic risk goal of 10^{-6} as used by DTSC as the "point of departure" for evaluating remedial alternatives at sites in California under Chapter 6.8 of the HSC. The individual remediation goals in Table 7-11 represent the maximum allowable concentrations for the respective COCs. These remediation goals will not be increased to allocate amongst the residual COCs to meet the overarching cumulative risk of 10^{-5}. However, these remediation goals can be adjusted downward, as needed, if the total cancer risk level exceeds 10^{-5}.

- Establish a remediation goal for lead that does not exceed a blood lead concentration greater than 10 micrograms per deciliter ("µg/dl") at the 99th percentile in potentially exposed individuals resulting from the total exposure to lead at OARB locations and to naturally occurring lead in the environment (e.g., air, food, water) as calculated using the DTSC Lead Spread 7.0 computer model or a more stringent site-specific lead goal determined appropriate for OARB.

- Remove, or remove and treat, source material (i.e., principal threat waste) that poses significant human health or environmental threats or is prone to continued leaching of COCs to groundwater.

Action-specific, base-wide RAOs for soil and groundwater at RAP sites and RMP locations predicated on the above aims are as follows:

Soil RAOs:

- Maintain existing conditions at the OARB to prevent direct contact with known or potentially impacted soil prior to implementation of remedial actions or redevelopment.

- Specifically for the ORP / Building 1 area, remove, or remove and treat, tarry residue at ORP / Building 1 area to eliminate hazards associated with this source material and to allow planned land uses consistent with the Amended Reuse Plan.

- Remove or treat impacted soil that interferes with planned land uses, or is encountered during redevelopment or through post-redevelopment activities, or as otherwise necessary to achieve site-specific, soil remediation goals designated in the RAP.

- Contain impacted soil that will not unreasonably interfere with planned land uses by maintaining existing cover or constructing new cover.

Groundwater RAOs:

- Implement institutional controls, alone or in combination with site-specific engineering controls as part of all selected remedies, to prevent incidental ingestion or dermal contact with impacted groundwater under existing and planned land uses consistent with the Amended Reuse Plan.

- Treat VOC-impacted groundwater that interferes with planned land uses or as otherwise needed to achieve site-specific, groundwater remediation goals, or apply engineering controls to new structures to allow planned redevelopment or as otherwise necessary to reduce potential exposure posed by vapor intrusion to the target risk levels stated above.

- Prevent further significant increases of concentrations of metals and other non-volatile COCs in groundwater.

The site-specific numerical remediation goals for COCs in soil and groundwater determined to be consistent with these RAOs are discussed below.

7.3 RISK-BASED REMEDIATION GOALS

According to U.S. EPA (1991a), the NCP establishes two sources that can be used to establish cleanup levels that remedial actions must achieve. These sources consist of chemical-specific ARARs, and risk-based remediation goals. Except for PCBs, lead, and asbestos, chemical-specific ARARs do not exist that adequately consider the scenarios under which humans (e.g., future on-site commercial and industrial workers) may be exposed to COCs in soil and groundwater at the OARB. The chemical specific ARARs for PCBs, lead, and asbestos are generally not as protective as the risk-based remediation goals contemplated in this RAP and are, therefore, not useful in establishing remediation goals. In the absence of useful chemical specific ARARs, risk-based remediation goals to protect human health have been derived in this RAP. These human health risk-based remediation goals serve as numerical values intended to achieve certain RAOs defined in Section 7.2. Ecological remediation goals were not determined because the upland areas of the OARB do not now, and are not anticipated in the future, to sustain any biologically significant populations of plants, soil fauna, wildlife, or aquatic life.[18] Selected submerged areas of land to be transferred to OBRA via the EDC (i.e., marine sediments within former BRAC Parcels 2 and 3) have been evaluated by ecological risk assessments completed by the Army and are discussed in Section 4.4.4.9 of this RAP.

U.S. EPA (1991a) defines remediation goals as "concentration goals for individual chemicals for specific medium and land use combinations at CERCLA sites." U.S. EPA (1991a) discusses development of preliminary remediation goals, commonly referred to as PRGs, that can be finalized as site-specific numerical remediation levels or goals upon approval of the remedy. As U.S. EPA (1991a) explains:

> Final remediation levels are not determined until the site remedy is ready to be selected; final remediation levels are then set out in the ROD. PRGs are refined into final remediation goals throughout the process leading up to remedy selection. The ROD itself, however, should include a statement of final clean-up levels based on these goals, as noted in NCP Section 300.430(e)(2)(i)(A).[19]

In other words, numerical, risk-based remediation goals are site-specific cleanup levels that are derived specifically for a given property. Remediation goals take into account the COCs that have been identified, media that have been impacted, most likely future land use, and pathways and conditions under which exposure may occur at a particular property. In addition, remediation goals are calculated by establishing acceptable or target risk levels that will protect potentially exposed individuals from the non-carcinogenic and carcinogenic effects of COCs. The procedures and assumptions used to derive remediation goals for the OARB are discussed in Sections 7.3.1 through 7.3.6. Identified COCs for the OARB are discussed in Section 5.

7.3.1 Potentially Exposed Populations

Based on the redevelopment strategy for the OARB presented in the Amended Reuse Plan, the primary, on-site future populations or human receptors that may be potentially exposed to COCs in soil or groundwater consist of the following:

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[18] DTSC (2000b, 2000d) has concurred that the minimal habitat at the OARB does not warrant an assessment of ecological effects. Off-site areas near the OARB (i.e., spit and adjacent marine sediments in the Oakland Outer Harbor) where biota may be impacted will be addressed separately by others and are not included in this RAP except for the submerged areas of former BRAC parcels 2 and 3 included in the EDC property transferred to OBRA as discussed in this RAP in Section 4.4.4.9.

[19] This RAP will establish the remediation goals for the OARB in lieu of a ROD.

During Redevelopment:

- Construction workers that will conduct on-site earthwork activities as part of redevelopment ("earthwork construction workers").

After Redevelopment:

- Tenants that will occupy commercial space upon redevelopment ("indoor commercial workers").

- Tenants that will work outdoors and perform industrial activities such as loading, unloading, and transporting of cargo containers ("outdoor industrial workers").

- Groundskeepers, utility maintenance workers, and other personnel that will maintain the new improvements at the OARB ("maintenance personnel").

The measures implemented to protect these core users of the OARB will also safeguard occupants of adjacent properties and infrequent visitors who have a significantly lower potential for exposure to COCs in soil and groundwater at the OARB.

7.3.2 Potential Exposure Pathways

The four potentially exposed populations identified in Section 7.3.1 could be exposed to COCs in soil or groundwater by the complete or potentially complete exposure pathways identified on Figure 7-1. Each of the pathways shown on this figure are discussed in the sections below. Risk-based remediation goals have been calculated only for those pathways that are judged to be complete or potentially complete, and where resultant exposure to COCs by the pathways will contribute appreciably to the potential overall risk to the individual in question.

The identified, potentially complete exposure pathways coupled with the four potentially exposed populations constitute the four exposure scenarios evaluated in detail in this RAP and used for determination of the risk-based, numerical remediation goals as required by the stated RAOs. All four exposure scenarios recognize that cover materials will be used to minimize human contact with surface soil as a component of all remedial actions in this RAP. The required use of cover materials (e.g., paving, engineered clean fill in landscaped areas, building foundations, or ballast in rail areas) renders most exposure pathways incomplete for the typical on-site worker. For example, indoor commercial workers and outdoor industrial workers are assumed to have no direct contact with surface soil, no ingestion of surface soil, and no inhalation of surface soil under their typical work day routines because all surface soil will be covered by materials that prevent contact with such soil. Earthwork construction workers and maintenance personnel have limited exposures by these pathways before installation of cover materials are complete (i.e., during construction for redevelopment) or when cover materials are penetrated (i.e., intermittent utility repair or maintenance activities in the future).

Appendix C quantifies the risks for the hypothetical exposure pathway of an outdoor industrial worker scenario where no cover materials are assumed (i.e., "bare dirt" outdoor industrial worker scenario). The "bare dirt" outdoor industrial worker scenario assumes that workers are present for 25 years on the OARB with exposed surface soil and no cover materials, which is not currently the case nor will be the case in the future. Under such a scenario, as evaluated in Appendix C, all typical dirt contact, ingestion, and inhalation pathways are assumed to be complete. The resultant, calculated health-protective concentrations for many COCs under the bare dirt outdoor industrial worker scenario are more stringent (e.g., approximately one-third of the total COCs are less than the adopted remediation goals for the OARB described in Section 7.4). Risk-based numerical remediation goals calculated for such a scenario are, thus, illustrative of the protective effects of incorporating required cover materials as part of all remedial actions for the OARB considered in this RAP. These hypothetical risk calculations provide a gauge of the sensitivity of these risk evaluations to potential failures in the permanence or long-term effectiveness in a barrier-type remedy.

7.3.2.1 Vapor Intrusion and Inhalation of Volatile COCs in Groundwater

Except for the former ORP / Building 1 area, available analytical results do not indicate that significant, residual sources of volatile COCs exist in soil at the OARB. However, chlorinated VOCs are present in groundwater at the eastern end of Building 807, near Buildings 808 and 823, and near Building 99. BTEX and MTBE due to petroleum fuel releases are found in groundwater near tank location 11A/12A/13A.

All compounds detected in soil or groundwater at the OARB that met the U.S. EPA Region IX (2000b) definition of a volatile compound[20] were evaluated for vapor intrusion to indoor air. These compounds include all the VOCs listed in Tables 5-2 through 5-5 and the SVOCs acenaphthene, anthracene, fluorene, phenanthrene, and pyrene. Under circumstances where there are discoveries of extremely high concentrations of certain low volatility compounds (e.g., PCBs, aldrin, alpha BHC, or gamma BHC – see Appendix C), evaluation of potential volatilization and related exposure pathways may be required. Thus, newly detected contamination of separate phase organics or other

[20] Volatile compounds are defined to be chemicals with a Henry Law constant greater than 10^{-5} atm-m^3/mol and a molecular weight less than 200 consistent with criteria used by U.S. EPA Region IX (2000b).

principal threat levels of potential COCs of even low volatility should be evaluated for vapor risks.

Volatile compounds theoretically have the potential to volatilize into pore spaces within unsaturated soil above the groundwater surface and migrate through diffusion and advection (i.e., air currents) to enter buildings by a mechanism referred to as vapor intrusion. Vapor intrusion is typically assumed to occur through foundation cracks or gaps caused by penetrations through the foundation.

Vapor intrusion begins when volatile COCs in groundwater partition into soil gas in the subsurface. The magnitude to which these compounds partition or volatilize into soil gas depends on the properties of the chemical. Chemicals with higher vapor pressures, lower water solubilities, and lower affinities for sorption to soil, partition into soil gas to a greater extent than other chemicals that do not have these properties. VOCs, BTEX, and MTBE partition readily into soil gas.

Once in soil gas, volatile COCs may migrate upwards or laterally by both diffusion and advection. Diffusion refers to the migration of chemicals from areas of high chemical concentration to areas of low chemical concentration. Diffusion is a relatively slow transport process as compared to advection, which occurs when soil gas containing volatile compounds is induced to migrate by pressure gradients.

Soil gas containing volatile COCs may migrate into a building by diffusing through cracks in the foundation slab. Lower pressure inside a building may also sweep soil gas into the building through cracks by advection. The phenomenon of a lower pressure inside a building is sometimes referred to as a "stack effect." A stack effect can be caused by:

- Warmer air inside the building, which tends to rise and draw air from the lower parts of the building.

- Wind, which tends to impart a lower pressure inside the building.

- Manufacturing equipment exhausts, which tend to draw air into the building and lower the interior pressure.

- Mechanical ventilation systems, which induce a slight negative pressure inside the building.

Vapor intrusion is the primary potentially complete exposure pathway that could affect indoor commercial workers at the OARB. Diffusion can also result in migration of volatile COCs to ground surface where no buildings exist and lead to potential exposures to individuals working outdoors (i.e., earthwork construction workers, maintenance personnel, and industrial workers). However, dilution caused by wind renders the potential for outdoor exposure less than the chance of indoor exposure. Remediation goals have been calculated for the indoor commercial worker, which will protect all identified future populations (as indicated on Figure 7-1) from exposure by the volatilization pathway.

7.3.2.2 Ingestion of and Dermal Contact with COCs in Groundwater

As discussed in Section 3.5.1, high TDS concentrations in the shallow water-bearing zone and Merritt Sand beneath the OARB render the groundwater unusable for drinking water supply. MCLs are not considered ARARs because groundwater at the OARB is not a current or potential source of drinking water. Relevant remediation goals for groundwater are, foremost, the concentrations of volatile COCs in groundwater determined not to pose an unacceptable vapor intrusion risk. Despite the poor quality of groundwater, individuals could be exposed to contaminated groundwater through incidental ingestion or dermal contact if wells were constructed at the OARB to provide water for landscape irrigation, water features, or other purposes. Remedial actions must therefore include institutional controls, alone or in combination with engineering controls, to ensure exposure does not take place by these pathways.

Earthwork construction workers and maintenance personnel can also ingest or absorb COCs in groundwater as a result of incidental contact during dewatering or trenching that may result in exposure to contaminated groundwater. However, on the basis of sensitivity calculations provided in Appendix C, such infrequent, hypothetical exposures by ingestion of or dermal contact with COCs in groundwater are judged to be insignificant when compared to exposure to COCs in soil that may be experienced by these same individuals, as described in Section 7.3.2.3. Such infrequent, hypothetical exposure to COCs in groundwater by these pathways will be mitigated by incorporating appropriate health and safety requirements into activities that may involve contact with contaminated groundwater, consistent with protocols in Section 6.1 of the RMP.

Appendix C provides a sensitivity analysis for infrequent but possible encounters with shallow groundwater by earthwork construction workers and maintenance personnel. The sensitivity analysis indicates that, given groundwater conditions at OARB, occasional contact with groundwater does not result in significant incremental health risks for earthwork construction workers or maintenance personnel. Thus, to simplify the effort of calculating remediation goals, contact with contaminated groundwater has not been incorporated into the exposure pathways for the earthwork construction worker or maintenance personnel.

7.3.2.3 Incidental Ingestion of and Dermal Contact with, and Inhalation of COCs in Soil

Earthwork construction workers and maintenance personnel may also be exposed to COCs through incidental ingestion, dermal contact, and inhalation of contaminated soil and volatile chemicals when digging below cover materials that now exist or will be constructed in connection with redevelopment of the OARB. Incidental ingestion occurs primarily through hand-to-mouth contact with contaminated soil and absorption of COCs into the bloodstream. Dermal contact occurs when contaminated soil adheres to exposed skin and COCs are absorbed through the dermis into the bloodstream. Inhalation occurs when wind or human activities suspend contaminated soil into the air, and human receptors subsequently inhale these dirt particles. Earthwork construction workers or maintenance personnel may also potentially inhale VOCs, BTEX, or MTBE if excavation or disturbance of soil and groundwater causes increased volatilization of these chemicals within the work zone. Remediation goals have been calculated to protect earthwork construction workers and maintenance personnel from exposure by incidental ingestion, dermal contact, and inhalation of contaminated soil or VOCs that become airborne due to contact with such soil.

7.3.2.4 Ingestion and Dermal Contact of Surface Water Impacted by COCs

Contaminated soil on the OARB is covered by existing improvements at the OARB. The potential for rainfall or non-stormwater related surface flows to become contaminated by soil are limited. The OARB will remain covered by buildings, roadways, and pavement after redevelopment. No potentially complete exposure pathways to surface water impacted by COCs exist now or are likely to exist in the future. Remediation goals for surface water have not been calculated in this RAP.

7.3.2.5 Ingestion of COCs in Homegrown Produce

Ingestion of COCs in homegrown produce is final pathway that is included by DTSC in computer models such as Lead Spread. Plants may uptake contaminants in soil that become incorporated in fruits and vegetables that are eventually eaten by humans. This pathway is not considered complete because no gardens presently exist at the OARB, and the anticipated commercial and industrial uses for the OARB make growing of produce on-site highly unlikely in the future. No site-specific remediation goals including this pathway have been calculated in this RAP.

7.3.2.6 Leaching to Groundwater

Leaching of chemicals from vadose zone soils to groundwater is a pathway that is included in *Application of Risk-Based Screening Levels and Decision Making to Sites with Impacted Groundwater* (commonly referred to as "RBSLs"); (RWQCB, 2001b). In the absence of site-specific remediation goals for soil to protect against leaching to groundwater, soil leaching screening levels to protect against non-drinking water sources from Table G of the RBSLs have been used as place holders in Table 7-10, and in cases where these leaching values were lower than any human risk-based remediation goals, the leaching values were carried over to Table 7-11 as final remediation goals. A more detailed, site specific fate and transport evaluation should be considered if these leaching values are found to govern the need for future remediation at RAP sites or RMP locations.

7.3.3 Target Risk Levels

Target risk levels have been established to protect individuals from potential non-carcinogenic and carcinogenic effects of potential chronic exposures to COCs identified at the OARB. A target risk level for lead has also been identified. Lead is considered separately because , although lead affects target organs (e.g., central nervous system) which are affected by other toxicants, the studies in the literature associate the toxicity of lead with blood lead concentration, rather than the applied dose. Hence, a separate modeling approach is utilized to determine an acceptable lead exposure as described in Section 7.3.3.3.

7.3.3.1 Non-carcinogen Target Risk Level

As defined by U.S. EPA (1989d), non-carcinogenic health effects are organ-specific and are manifested only after reaching a certain chemical dose. As a result, a range of exposures exists from zero to some finite value that can be tolerated with essentially no chance of adverse effects. The upper bound on this tolerance range or "safe dose" is identified as a reference dose ("R*f*D").

U.S. EPA (1989d) estimates the potential for non-carcinogenic effects by comparing a site-specific exposure level (i.e., estimated daily dose) over a specified time period (i.e., chronic exposure greater than 7 years) with a reference dose derived for a similar exposure period. This ratio of estimate dose to toxicity reference dose is called the HI.

Consistent with the NCP at 40 CFR §300.430(e)(2)(i)(A)(1), U.S. EPA (1991a) established the standard default non-carcinogenic cumulative target risk level to correspond to a HI of unity (i.e., 1). This target risk level is used to calculate a chemical-specific concentration that equates to the estimated dose from all significant exposure pathways in a given medium below which it is unlikely, even for sensitive populations, to experience adverse health effects. Where multiple COCs are involved, these non-carcinogenic effects can be assumed to be additive and apportioned among several COCs so that the cumulative HI is less than 1.

The remediation goal for an individual non-carcinogenic COC at the OARB is based upon a HI of 1 consistent with the RAOs in Section 7.2. An overarching RAO of a HI of 1 is adopted as the cumulative hazard index for non-carcinogenic COCs at each OARB location. When multiple non-carcinogenic COCs are identified, the overarching RAO of HI equal to 1 can be met by determining the cumulative hazard index, using protocols and equations provided in Section 7.5, for a specific RAP site or RMP location.

7.3.3.2 Carcinogen Target Risk Level

Carcinogenesis, unlike non-carcinogenic health effects, is generally thought to be a phenomenon for which risk evaluation based on presumption of a threshold is inappropriate (U.S. EPA, 1989d). For carcinogens, U.S. EPA assumes that a small number of molecular events can evoke changes in a single cell that can lead to uncontrolled cellular proliferation and eventually to a clinical state of disease. This hypothesized mechanism for carcinogenesis is referred to as "non-threshold" because there is no level of exposure to such a chemical that would not pose a finite probability, however small, of generating a carcinogenic response. No dose is thought to be risk-free. Therefore, in evaluating cancer risks, a safe dose cannot be estimated according to U.S. EPA guidance. Although this issue is subject to scientific debate, U.S. EPA guidance was followed in determining a carcinogenic target risk level for calculating risk-based remediation goals for the OARB.

For carcinogenic effects, U.S. EPA uses a two-part evaluation. In the first part of this evaluation, the chemical is assigned a weight-of-evidence classification, which is related to how convincingly the scientific studies demonstrate that the chemical is carcinogenic to humans. In the second part of this evaluation, a slope factor ("SF") is calculated, which is a measure of the chemical's potency. U.S. EPA (1989d) estimates risks as the incremental probability of an individual developing cancer over a lifetime as a result of any short-term or long-term exposure to the potential carcinogen. This probability is defined as the incremental or excess lifetime cancer risk. The SF is expressed the

95 percent upper confidence limit (i.e., 95% UCL) on the slope of the low-dose linear portion of the dose-response curve as estimated by the multistage linear model. The SF directly relates the incremental risk of cancer over a lifetime (i.e., 70 years) to the degree of chemical exposure averaged over a lifetime.

This potential carcinogenic risk can be summed across potential exposures to multiple chemicals, where such exposures are conservatively assumed to be possible. A scientifically correct procedure would be to add the risk of each chemical that is believed to have the same manifestations of carcinogenic effect in humans (i.e., target organs). However, as a conservative, health-protective step, the risks due to all potentially carcinogenic chemicals are assumed to be additive without consideration of target organs. The target risk level is termed "cumulative" when summed across all chemicals and pathways.

Consistent with DTSC procedures for determining remedies at contaminated sites in California, a range of possible cumulative carcinogen target risk levels are considered in this RAP as discussed below.

- The NCP, at 40 CFR §300.430(e)(2)(i)(A), provides a definition of an acceptable residual cancer risk range of 10^{-6} through 10^{-4} for the remedy selection process under CERCLA to develop and implement remedial actions that protect human health and the environment. U.S. EPA (1991g) has stated that remediation is generally not warranted for contaminated property if the cumulative cancer risk is less than 10^{-4}. If remediation is undertaken at such a site, U.S. EPA (1991g) has expressed a preference for cleanups that achieve the lower end of this target risk range. However, U.S. EPA (1991g) acknowledges that remedial actions that achieve reductions in site risk anywhere within the 10^{-6} through 10^{-4} risk range may be acceptable after considering site-specific conditions.

- Under Chapter 6.8 of the California HSC, DTSC utilizes a cumulative risk of 10^{-6}, in either an industrial or residential exposure scenario, as a point of departure for evaluating remedial actions at contaminated sites in California, i.e., a preference for achieving cleanups at the lower end of the NCP's acceptable range. DTSC evaluation procedures allow selection of remedies that are designed to achieve residual risks within the NCP's acceptable range, but greater than the point of departure after considering site-specific factors. Such factors are generally site conditions or uses that enhance DTSC's confidence in calculated residual risks. The discussion of the conceptual site model in Section 7.1 identifies several unique factors about the OARB and its planned reuse that allow for remediation goals calculated for an industrial exposure scenario, and for consideration of cancer risk target levels, on a site-wide basis, within the NCP acceptable risk range but above the point of departure. These factors include the following:

- The planned reuse of the OARB is for commercial and industrial redevelopment base-wide in accordance with the Amended Reuse Plan. The future land uses on the southern portion of the OARB will be intermodal transportation operations of the Port of Oakland in the PDA. These future PDA uses and activities will include extensive areas covered with thick concrete-interlocking slabs designed to support stacked shipping containers and redesigned, adjacent railroad tracks and railyards covered with ballast or paving. The commercial areas on the northern and western portions of the OARB will be the GDA consisting of new paved roadways, paved parking areas, sidewalks, filled and landscaped areas, and commercial building foundations. All of these site improvements will provide barriers to human contact or other exposures to existing on-site soils, under planned typical commercial and industrial uses.

- Shallow groundwater at the OARB is not currently utilized for domestic supply under policies and guidance of the RWQCB and SWCRB. Planned future uses of the OARB property will be accompanied by specified use restrictions on the land and on use of shallow, on-site groundwater. These use restrictions will be implemented through remedies selected in this RAP and through building permit controls implemented under the City of Oakland's ULR Program. Human exposures to existing site soils and groundwater will not occur except potentially as contemplated for construction and maintenance personnel. All potentially exposed personnel will follow the risk management protocols that will include the worker protective measures described in the RMP (Appendix E), a component of all remedies recommended in this RAP.

- Outside of the RAP sites, the residual concentrations of COCs detected in on-site soils or shallow groundwater generally result in estimated risk to human health that fall within the NCP risk range for industrial exposure scenarios (see prior Army risk assessments prepared for various areas of the OARB).

Site-specific factors that support deviation from the 10^{-6} point of departure include the following:

- An extensive site use history is available for the OARB coupled with a substantial database of laboratory analytical results that define the general nature of residual COCs found on-site. With the exceptions of certain areas identified herein as RAP sites, most areas of the OARB have been found to have low concentrations of low threat COCs consisting largely of petroleum hydrocarbons and related constituents or relatively non-mobile, non-volatile metals and SVOCs.

- As identified in this RAP, RAP sites (i.e., known areas on the OARB of significant releases of COCs) will be actively remediated to remove residual source materials.

- Most remaining areas of the base, including identified RMP locations, have primarily known or suspected releases of petroleum hydrocarbons and its constituents, or low mobility, low volatility constituents like metals and SVOCs that can be readily addressed by planned RMP protocols.

- Measurable concentrations of COCs in many areas of the base are expected to decline over time as a result of planned remedial actions due to natural attenuation of many organic COCs.

- Achieving lower residual concentrations of certain COCs in an effort to attain carcinogen risk targets at the lower end of the NCP acceptable risk range (i.e., the point of departure) would be difficult and costly, given the nature of the fill materials used to construct much of the OARB.

- Achieving consensus among stakeholders on what degree of residual contamination constitutes an acceptable risk is one of the factors in determining remediation goals for potential carcinogens. In particular, U.S. EPA (2002b) finds that community members provide crucial insight into "public values and perceptions on the risk of concern, the preliminary remedial actions being considered and public acceptance of those remedies." Through its ULR program (Oakland, 2000), the City of Oakland has explored the issue of acceptable risk with the Oakland community, and representatives of federal, state, and local regulatory agencies charged with enforcing environmental regulations. The DTSC believes that the City of Oakland dialogue bears on the discussion of acceptability of deviation from the point of departure.

In 1996, staff from the City of Oakland Environmental Services Division met with representatives of the West Oakland Environmental Justice Pilot Project, the Mayor's office, and the Rose Foundation. The purpose of this meeting was to determine what kind of feedback was desired from the community and which types of individuals and organizations should convene the Community Review Panel to evaluate the objectives of the ULR program. On the basis of the meeting, several organizations were contacted directly and a public notice soliciting applications for membership on the panel was published in the *Oakland Tribune* on July 31, 1996. Members of the Community Review Panel ultimately included individuals from the African American Development Association, GEI Consultants, People United for a Better Oakland, Northern California Minority Business Opportunity Community, Sierra Club, Urban Habitat Program, and Uribe & Associates. The panel met twelve times between September 1996 and July 1997 and presented its recommendations in the Community Review Panel report, dated August 7, 1997, entitled *Consensus Recommendations for Implementing the Oakland Urban Land Redevelopment Program* (Oakland, 1997).

Although the panel expressed that the ideal outcome would be the removal of all contaminates from Oakland communities, the panel asserted that the resources to achieve this ideal simply do not exist. The panel concluded that stalling redevelopment will likely result in a greater public health threat, and larger environmental, social, and economic costs to the affected community compared with implementation of risk-based cleanup. The Community Review Panel therefore recommended that the ULR program adopt cleanup levels based upon conservative assumptions that do not result in an incremental lifetime cancer risk greater than 10^{-5} (one in 100,000 potentially exposed individuals).

The recommendations of the Community Review Panel ultimately led the City of Oakland to include a set of tiered cleanup levels into the ULR program as discussed in Section 6.6.1.4. Tier 1 presents a conservative, health protective set of cleanup levels that are based on an individual COC "target" risk of 10^{-6}. Tier 1 cleanup levels apply to properties where information on environmental conditions is limited. Tier 2 cleanup levels are based on a target risk of 10^{-5}. Tier 2 cleanup levels generally apply to properties where geologic and hydrogeologic conditions and uses are better understood. Tier 3 analysis requires performance of a site-specific risk analysis with input parameters appropriate for planned uses and site conditions. The site-specific remediation goals presented in this RAP constitute a site-specific Tier 3 analysis.

- As discussed in Section 6.7.2, the State of California (OEHHA, 1994) has adopted 10^{-5} as the "no significant risk" level for protecting persons from exposure to chemicals in consumer products and commercial establishments under Proposition 65. While this State statute and associated regulations are not ARARs for site remediation as noted in Section 6.7.2, the statutory history and regulatory process for application of Proposition 65 in California provide support for the local community's general acceptance of a cumulative cancer risk target of 10^{-5} and suggest that support and acceptance of such a target are appropriate as a component of all remedies selected for the OARB in this RAP.

In summary, given the precedents set by the community's acceptance of the City of Oakland ULR Program and Proposition 65, consideration of the acceptable risk range of 10^{-6} to 10^{-4} established in the NCP and related U.S. EPA guidance, and evaluation of the 10^{-6} point of departure typically utilized by DTSC for evaluation of remedial alternatives, this RAP establishes media-specific remediation goals for potential carcinogens as elements of all remedies for RAP sites and RMP locations on OARB as follow:

- A maximum allowable 10^{-6} risk level for <u>individual</u> carcinogenic COCs at the OARB property subject to this RAP, and

- When more than ten carcinogenic COCs are present at concentrations exceeding the remediation goals in Table 7-11, the overarching RAO is the <u>cumulative</u> target risk level of 10^{-5} for carcinogenic COCs applicable at each RAP site and RMP location identified at OARB.

Calculations of numerical risk-based remediation goals reflecting these risk target levels for the identified potentially complete exposure scenarios for planned reuse of the OARB are described in Section 7.3.4. Protocols for determining compliance with cumulative risk-based remediation goals are summarized in Section 7.5.

7.3.3.3 Lead Target Risk Level

Ingested or inhaled lead is distributed primarily to the blood, soft tissue (e.g., bone marrow, liver, and brain), and mineralizing tissue (e.g., bones and teeth) of the body. Lead interferes with normal cell function and with a number of physiologic processes, including damage to the central nervous system, inhibition of the body's ability to make hemoglobin, disruption of the endocrine system that may lead to impaired tooth and bone development, and damage to the kidneys (California Department of Health Services, 1997). ASTDR also indicates that lead readily crosses the placenta. According to ATSDR (1995a), lead not only affects the viability of the fetus, but development as well. Development consequences of prenatal exposure to low levels of lead include reduced birth weight and premature birth. Reports have indicated lead to be a teratogen and carcinogen in animals. However, studies in humans have failed to show a relationship between lead exposure concentrations and congenital malformations, and the association of lead levels and cancer observed in humans remains uncertain (ATSDR, 1995). Federal and state health agencies have focused on low-level environmental lead exposures where the primary health effect to be avoided is impaired learning or cognitive capacity in exposed children or adults.

Blood lead concentration is an integrated measure of internal dose resulting from the total exposure of releases of lead at a site and naturally occurring concentrations of lead in the environment and foods consumed. DTSC (1996) has established that the concentration of concern for lead in blood is 10 µg/dl at the 99^{th} percentile (i.e., a one percent chance that blood lead concentrations will be greater than 10 µg/dl) for potentially exposed populations. The 99^{th} percentile is believed to be protective because it establishes an upper bound level for lead exposure that is akin to U.S. EPA's reasonable maximum exposure ("RME") approach (U.S. EPA, 1989d). Determination of a remediation goal for lead in soil for potentially exposed commercial and industrial workers is discussed in Section 7.3.4.3.

7.3.4 Risk-Based Remediation Goal Calculations

Remediation goals were calculated for COCs using hazard and risk equations based on those presented in U.S. EPA (2000a, 1991a, 1989d), DTSC (1996), and City of Oakland (2000) guidance documents or models, as modified by discussion with the DTSC HERD staff regarding appropriate input parameters and default values. For example, inhalation rates are assumed to be 20 m^3 per workday for active work (construction, outdoor industrial, maintenance) and 10 m^3 per workday for less active work (indoor commercial) with no allowance for apportionment over a 9 hour work day out of a possible 24-hour day. The remediation goal for lead was determined separately because of the different toxicological behavior of lead.

7.3.4.1 Groundwater Risk-Based Remediation Goals for Volatile COCs

Groundwater remediation goals to protect against vapor intrusion were derived using the U.S. EPA (2000a) "GW-ADV" version of the Johnson and Ettinger vapor intrusion computer model ("J&E Model"). The "GW-ADV" version is the Tier 2 model which allows the user to input site-specific parameters into the model (e.g., building dimensions, air exchange rate, crack radius), as opposed to relying on default parameters that may, or may not be appropriate. The screening level version of the J&E Model, "GW-SCREEN", is not appropriate for the OARB because it assumes a residential scenario without the ability to modify the inputs to the model (e.g. air exchange rate). The "GW-ADV" and "GW-SCREEN" versions of the J&E Model yield the same numerical results when the default inputs are the same.

Computer modeling of COC volatilization was conducted for those compounds detected in soil or groundwater at the OARB that met the U.S. EPA Region IX (2000b) definition of a volatile compound (see Section 7.3.2.1). All the California-specific toxicity factors available from OEHHA were inserted into the spreadsheet and utilized in the J&E Model runs for this RAP. Sample computer printouts and input parameters from the Johnson and Ettinger model runs are included as Appendix B.

7.3.4.2 Soil Risk-Based Remediation Goals for COCs Other Than Lead

Consistent with U.S. EPA (1991a, 1989d), DTSC (1999, 1996), and City of Oakland ULR program (2000), soil remediation goals based on non-carcinogenic effects ("RG_{nc}") were calculated using the following equation:

Equation 7-1 Non-carcinogen Soil Remediation Goal

$$RG_{nc} = \frac{RfD \times \text{Target HI of } 1}{(\text{Ingestion} + \text{Dermal} + \text{Inhalation})}$$

Soil remediation goals based on carcinogenic effects ("RG_c") were calculated using the following equation:

Equation 7-2 Carcinogen Soil Remediation Goal

$$RG_c = \frac{\text{Target Risk Level of } 10^{-6}}{SF \times (\text{Ingestion} + \text{Dermal} + \text{Inhalation})}$$

Ingestion, Dermal (i.e., direct contact), and Inhalation terms are estimates of exposure that may result from swallowing, absorbing COCs through the skin of an adult, and inhaling particulates and volatilized COCs. Exposure to COCs for various potentially exposed populations at the OARB were estimated by use of the equations listed below:

Equation 7-3 Soil Remediation Goal Ingestion Term

$$\text{Ingestion} = \frac{IR_{soil} \times FI \times EF \times ED \times 10^{-6}\ \text{kg/mg}}{BW \times AT}$$

Equation 7-4 Soil Remediation Goal Dermal Term

$$\text{Dermal} = \frac{SA \times AF \times ABS \times EF \times ED \times 10^{-6}\ \text{kg/mg}}{BW \times AT}$$

Equation 7-5 Soil Remediation Goal Inhalation Term

$$\text{Inhalation} = \frac{IR_{air} \times EF \times ED \times (1/VF + 1/PEF)}{BW \times AT}$$

Definitions of the exposure parameters within the equations are presented in Table 7-1. The above equations are generic and for illustration purposes. They do not indicate the different reference doses for different exposure routes or different cancer slope factors for different exposure routes, which were utilized in the calculations for this RAP. Where available, the route-specific reference doses and slope factors were utilized in these calculations and are tabulated in Tables 7-1 and 7-2. Where route-to-route extrapolations were performed, they are noted in the tables.

Soil remediation goals to protect against vapor intrusion were derived using the U.S. EPA (2000a) "SL-ADV" version of the J&E Model. Also available from the U.S. EPA is a screening level version of the model, "SL-SCREEN". The "SL-ADV" version was used as opposed to the "SL-SCREEN" version primarily because the "SL-SCREEN" version of the J&E model assumes an infinite soil source (i.e., the depth below grade to the bottom of the contamination is unknown). This assumption is not appropriate for OARB where potential soil sources are finite and limited in depth by the groundwater table at approximately 5 feet bgs. Additionally, the "SL-ADV" version of the model allows the user flexibility to input site-specific parameters into the model (e.g., building dimensions, air exchange rate, crack radius), as opposed to relying on default parameters that may, or may not be appropriate. The "SL-ADV" and "SL-SCREEN" versions of the J&E Model yield the same numerical results if the same input parameters are used and the depth below grade to the bottom of contamination is unknown.

7.3.4.3 Soil Risk-Based Remediation Goals for Lead

Potential lead remediation goals for individuals that may contact lead-impacted soil at the OARB (i.e., earthwork construction workers and maintenance personnel) were calculated using the DTSC Lead Spread Version 7.0 computer model. A remediation goal was calculated such that the lead concentration in the blood of these potentially exposed individuals was less than 10 μg/dl at the 99^{th} percentile. The goal takes into account the potential intake of lead from releases at RAP sites and RMP locations, and lead naturally occurring in air, food, tap water, and soil, otherwise assumed to be typical human exposure to lead.

As provided in LeadSpread Version 7.0, DTSC default factors of 0.028 $\mu g/m^3$ and 1.1 kg food/day (at 3.1 μg lead/kg food) were used to account for lead naturally occurring in air and food, respectively, for adults. The concentration of lead in tap water was established as 15 μg/L. A value of 15 μg/L is the DTSC default factor, which is based on the federal action level for lead in municipal drinking water supply. Given the commercial and industrial uses planned for the OARB, the dietary source of lead assumes that no produce will be grown at impacted RAP sites or RMP locations. The lead remediation goals were calculated assuming an adult occupational worker exposure frequency of 5 days per week, as specified by DTSC (1996). Exposures of earthwork construction workers and maintenance personnel to ambient concentrations of lead in air, water, and food were assumed to be equivalent DTSC default factors. Copies of examples of computer spreadsheets used to calculate potential remedial goals for lead in soil are included as part of Appendix B.

These calculations indicated that lead concentrations of 3,500 mg/kg and 77,000 mg/kg in soil at the OARB potentially cause blood lead to increase to 10 μg/dl in earthwork construction workers and maintenance personnel, respectively, based upon the values of exposure parameters and frequencies assumed in the RAP.

Although calculations in LeadSpread model resulted in an allowable concentration of 3,500 mg/kg, DTSC believes that recent studies have indicated that lead exposure routes may exist in addition to those considered in the current model, e.g., fetal blood lead concentrations in women exposed to lead contaminated soils (EPA, 1996d). DTSC believes that with respect to lead in soil at the OARB, further conservatism in the selection of a health protective goal is appropriate. A mean residual concentration of 750 mg/kg at any given project site is, therefore, identified as the remediation goal for lead in soil at the OARB.

7.3.5 Input Parameters

Input parameters used in calculating risk-based remediation goals for the complete exposure pathways at OARB locations as illustrated on Figure 7-1 are discussed below.

7.3.5.1 Human Health Toxicity Values

Following the hierarchy established in DTSC's Preliminary Endangerment Assessment ("PEA") Guidance Manual, toxicity values used to calculate human health PRGs were obtained from the following references in the order listed:

- Carcinogenic slope factors were obtained from the OEHHA website entitled *California Cancer Potency Factors*, dated March 2001 (OEHHA, 2001).
- U.S. EPA's computerized Integrated Risk Information System ("IRIS").
- U.S. EPA's Health Effects Assessment Summary Tables ("HEAST"), dated July 1997.
- U.S. EPA's National Center for Environmental Assessment ("NCEA"), Draft Risk Assessment Issue Papers for individual chemicals.

OEHHA's technical documents and website represent the agency's most current stance on non-carcinogenic and carcinogenic toxicity values for risk assessments in California. U.S. EPA maintains the IRIS computerized database. Toxicity values on IRIS have undergone review and verification by U.S. EPA program offices prior to publication.

Toxicity values were obtained from HEAST if none were available from OEHHA or IRIS. HEAST is not updated as regularly as IRIS and may contain interim toxicity values. NCEA was the final information source consulted. Toxicity values obtained from NCEA have not been verified by U.S. EPA and are considered provisional. Non-carcinogenic and carcinogenic toxicity information for the identified COCs, including the source of the information, is shown on Tables 7-1 and 7-2, respectively. If no toxicity value was available for one of the exposure routes for a particular chemical (shown as a blank on Tables 7-1 or 7-2), the toxicity value from the other exposure route was used in the calculations (i.e., "route-to-route extrapolation").

Toxicity values for surrogate compounds were used for most of the chemicals for which no published toxicity values were available from the above sources. No appropriate surrogate compounds were available for some COCs (e.g., polychlorinated biphenyls). For such chemicals, non-carcinogenic human health remediation goals could not be calculated and are noted as such in the tables.

7.3.5.2 Human Health Exposure Parameters

In accordance with DTSC PEA Guidance Manual, the same exposure parameter values were used to calculate non-carcinogenic and carcinogenic PRGs except for the averaging time. Averaging time is 70 year for carcinogenic risk, but averaging time is set equal to the exposure duration for non-carcinogenic hazards, in accordance with DTSC (1999) guidance.

As shown in Table 7-3, where available, exposure parameters are default factors obtained from U.S. EPA, DTSC, or City of Oakland guidance documents or are calculated based on published values for the potentially exposed populations identified at the OARB (see Figure 7-1). The exposure frequency and duration for earthwork construction workers and maintenance personnel while excavating soil at the OARB locations are the only parameters where default factors do not exist and professional judgment was used to estimate values. Exposure frequency is the number of days per year that an individual is likely to engage in trenching or other activities that involve disturbance and contact with soil (e.g., foundation construction, landscape installation, and utility installation and repairs). The exposure frequency for earthwork is assumed to be 250 days per year for earthwork construction workers and 12 days per year for future maintenance personnel. Non-earthwork exposure frequency is assumed to be 238 days per year for maintenance personnel. Exposure duration is the length of time in years during which an individual performs earthwork. The exposure duration is assumed to be 1 year for earthwork construction workers and 25 years for maintenance personnel.

The U.S. EPA default soil ingestion rate for earthwork construction workers is 480 mg/day, which is often used as an estimated reasonable maximum exposure for daily soil ingestion by unprotected construction workers (U.S. EPA, 1997d; 1991h). This default soil ingestion rate represents a maximum likely exposure scenario in which a hypothetical coating of soil on the fingers and thumbs of both hands is ingested twice per day by hand-to-mouth contact (Hawley, 1985). Other estimates of soil ingestion rates exist for workers; for example, DTSC (1996) recommends a soil ingestion rate of 100 mg/day for an adult agricultural exposure scenario. At OARB, the RMP requires earthwork construction workers and maintenance workers to be informed on site conditions and to follow site-specific health and safety procedures that will limit their soil ingestion (e.g., by directing them to minimize direct contact with potentially contaminated soil and to wash hands before eating or smoking). Thus, a soil ingestion rate of 100 mg/day (equivalent to the agricultural worker) better represents a site-specific reasonable maximum exposure for future earthwork construction workers and for maintenance workers when the latter are digging below covering materials at OARB, who will follow site-specific health and safety plans developed in accordance with protocols specified in the RMP.

7.3.5.3 Physical Parameters

Physical parameters, such as soil properties, depth to groundwater, climatic parameters, and building parameters used to calculate risk based remediation goals are shown in Table 7-4. Physical parameters were obtained from site specific information or default values obtained from U.S. EPA (1989d; 2000a), DTSC (1999), or the City of Oakland ULR Program (2000).

Chemical parameters were obtained from several sources. If available, Henry Law constants were obtained from Gossett (1987). Secondary sources for Henry Law constants included Mackay and Shiu (1981) and Montgomery (2000). Organic carbon partition coefficients, aqueous solubilities, and diffusion coefficients were obtained from Montgomery (2000).

7.3.6 Compilation of Risk-based Remediation Goals

Tables 7-5, 7-6, 7-7, and 7-8 summarize the calculated non-carcinogenic and carcinogenic soil remediation goals for earthwork construction workers, indoor commercial workers, outdoor industrial workers, and maintenance personnel, respectively, at the OARB. Based on this evaluation (see Section 7.3.4.3), a remediation goal for lead in soil of 750 mg/kg is determined to be applicable to OARB locations subject to this RAP. Table 7-9 summarizes the groundwater remediation goals for the indoor commercial worker using the U.S. EPA Johnson and Ettinger vapor intrusion computer model.

7.4 SUMMARY OF REMEDIATION GOALS

Selected cleanup levels for most chemicals are risk-based remediation goals that are the lowest values of RG_{nc} and RG_c for each COC that protect all potentially exposed populations consistent with pathways shown on Figure 7-1. However, chemical-specific ARARs or TBCs are adopted as remediation goals for some COCs. For example, the Army's Fuel Storage Tank Sites Cleanup Levels (IT, 2000n) have been adopted as the site-specific remediation goals for petroleum hydrocarbons in soil and groundwater at the OARB.

ARARs or TBCs were also selected if the values are more stringent than the calculated human health risk-based remediation goals. As shown in Table 7-10, the lowest risk-based remediation goal for each COC was compared with the RWQCB Soil Leaching Screening Level (2001a) intended to protect groundwater that is not potential drinking water supply. The RWQCB Soil Leaching Screening Level was adopted as the OARB soil cleanup level if it was less than the calculated risk-based remediation goal. Remediation goals based upon RWQCB Soil Leaching Screening Levels may be amended by additional site-specific evaluation if the need arises in the future. Amendment of remediation goals will be conducted only with DTSC or RWQCB consent.

As discussed in Section 7.3.2.2, no numerical cleanup levels have been calculated for metals and other non-volatile COCs in groundwater because since ingestion, dermal contact, and inhalation of COCs in groundwater by earthwork construction workers and maintenance personnel are relatively insignificant (see Appendix C).

Available data do not indicate that COCs in groundwater at the OARB are migrating in the shallow water-bearing zone to San Francisco Bay. However, it is possible that groundwater migrates to San Francisco Bay through the storm drains. Storm drain piping at the OARB is documented to have breaks and cracks and contamination has been detected in marine sediment samples obtained adjacent to storm drain outfalls. Storm drain piping is often situated in the saturated zone and groundwater may enter the cracked or otherwise breached storm drain piping. No significant human exposures associated with storm drain conditions are occurring. Environmental impairment related to damaged storm drains will be addressed through implementation of remedial actions described in Section 10.2.2.7.

Remedial actions implemented at each RAP site or RMP location will meet individual remediation goals for soil and groundwater listed in Table 7-11. The individual remediation goals in Table 7-11 represent the maximum allowable concentrations for the respective COCs. These remediation goals will not be increased to allocate amongst the residual COCs to meet the overarching cumulative risk of 10^{-5}. However, these remediation goals can be adjusted downward, as need, if the total cancer risk levels exceeds 10^{-5} or the total hazard index exceeds 1. Cumulative HIs and carcinogenic risks associated with residual COCs at each RAP site or RMP location will be calculated as described in Section 7.5. RAOs are achieved when residual COCs in soil and groundwater are no greater than a cumulative HI of 1 or a cumulative carcinogenic risk of 10^{-5} for each potentially exposed population.

7.5 PROTOCOLS FOR DETERMINING COMPLIANCE WITH CUMULATIVE RISK-BASED REMEDIATION GOALS

Cumulative HIs and carcinogenic risks will be calculated for each RAP site or RMP location after remedial actions have been completed to ensure that residual COCs in soil and groundwater are not present at concentrations that pose an unacceptable potential human health hazard. Cumulative HIs and carcinogenic risks will be calculated using the remediation goals for potentially exposed population summarized in Tables 7-5 through 7-9 and representative concentrations ("RCs") of all COCs detected in soil and groundwater at a RAP site or RMP location. RCs will be based upon appropriate arithmetic or geometric mean values, the 95 percent upper confidence limits ("95% UCL") on the appropriate means, or the maximum COC concentrations detected at a RAP site or RMP location. When there is an insufficient number of data points, the maximum detected COC concentrations can be used as the RCs.

7.5.1 Calculation of Cumulative HI

Cumulative HIs will be calculated for the four potentially exposed populations identified in Section 7.3.1. These populations consist of: (1) earthwork construction worker, (2) indoor commercial worker, (3) outdoor industrial worker, and (4) maintenance personnel. RAOs based upon non-carcinogen human health effects are achieved when the cumulative HI for each potentially exposed population is calculated to be less than 1. Cumulative HIs will be calculated using the following equation:

Equation 7-6 Cumulative Non-carcinogenic Risk

$$\text{Cumulative HI} = \left(\frac{RC_1}{RG_{nc2}}\right) + \left(\frac{RC_2}{RG_{nc2}}\right) + \ldots \left(\frac{RC_N}{RG_{ncN}}\right)$$

where:

$RC_{1,2...N}$ = representative concentration of each COC at RAP site or RMP location

$RG_{nc1,2...N}$ = non-carcinogenic remediation goal for each COC summarized in Tables 7-5 through 7-9 for the potentially exposed population under consideration

Consideration of potential impacts to particular organs, if judged appropriate and with written DTSC approval, can be accomplished using information such as that available in Table L of the RWQCB RBSL document (RWQCB, 2001a, as updated). The above equation would be used only for those COCs judged to have comparable target organs; more than one cumulative HI could be calculated with different groups of potential health effects if appropriate. RAOs based upon non-carcinogen human health effects are achieved when the cumulative HI for each potential grouping of target organs or health effects is calculated to be less than 1.

7.5.2 Calculation of Cumulative Carcinogenic Risk

Cumulative carcinogenic risks will be calculated for the four potentially exposed populations identified in Section 7.3.1. RAOs based upon carcinogenic health effects are achieved when the cumulative carcinogenic risk for each potentially exposed population is calculated to be less than 10^{-5}. Cumulative carcinogenic risks will be calculated using the following equation:

Equation 7-7 Cumulative Carcinogenic Risk

$$\text{Cumulative Carcinogenic Risk} = \left(\frac{RC_1}{RG_{c1}} \times 10^{-6}\right) + \left(\frac{RC_2}{RG_{c2}} \times 10^{-6}\right) + \ldots \left(\frac{RC_N}{RG_{cN}} \times 10^{-6}\right)$$

where:

$RC_{1,2...N}$ = representative concentration of each COC at RAP site or RMP location

$RG_{c1,2...N}$ = carcinogenic remediation goal for each COC summarized in Tables 7-5 through 7-9 for the potentially exposed population under consideration

8

8. IDENTIFICATION AND SCREENING OF TECHNOLOGIES

Identifying and screening potentially suitable technologies is the initial step in assembling appropriate remedies that achieve the RAOs established in Section 7, comply with ARARs, and satisfy other evaluation criteria established by U.S. EPA and the State of California. Technologies that pass the screening process are developed into remedial alternatives. The remedial alternatives are themselves screened and the alternatives that are retained undergo detailed analysis. The results of the detailed analysis determine the remedial alternatives that are recommended for implementation. Section 8 describes the identification and screening of technologies. Section 9 summarizes the development and screening of remedial alternatives. Section 10 presents the detailed analysis of alternatives.

8.1 PRINCIPAL THREAT AND LOW-LEVEL THREAT WASTES

To facilitate the identification and screening of technologies, U.S. EPA (1991b) has developed guidelines to communicate the types of remedies it generally anticipates to find appropriate for different source materials. U.S. EPA (1997d) defines source material as:

> ...material that includes or contains hazardous substances, pollutants, or contaminants that act as a reservoir for migration of contamination to groundwater, to surface water, to air, or acts as a source for direct exposure.

Source material is divided into principal threat waste and low-level threat waste. The definitions of these wastes are as follows:

- **Principal Threat Waste:** Source material that is considered to be highly toxic or extremely mobile that generally cannot be reliably contained or would present a significant risk to human health or the environment should exposure occur. Principal threat waste includes NAPL, extremely mobile liquids (e.g., solvents), or materials having high concentrations of toxic compounds. Although no "threshold level" of toxicity has been established for definition of a principal threat waste, U.S. EPA (1991b) indicates for conditions where toxicity and mobility of source material combine to pose a potential risk of 10^{-3} or greater, treatment alternatives generally should be evaluated.

- **Low-level Threat Waste:** Source material that can be reliably contained and that would pose only a low risk in the event of exposure. Low-level threat waste is source material that exhibits low toxicity, limited mobility in the environment, or has COC concentrations near health-based levels.

As discussed in Section 4.4, except for the former ORP / Building 1 area, source material encountered at the OARB can be characterized as low-level threat waste. The majority of the RMP locations at the OARB consist of former tanks, washracks, or oil/water separators that resulted in the known or suspected release of petroleum hydrocarbons to soil although solvents and other VOCs, and metals have also been detected as well. The detected petroleum hydrocarbons are higher molecular weight compounds. These petroleum hydrocarbons are likely to be weathered residuals that are relatively immobile and generally do not contain appreciable amounts of other contaminants, such as VOCs, PAHs, or metals that would constitute a human health risk. No potential NAPL or heavily contaminated soil that may leach COCs and serve as ongoing contaminant sources have been identified at the OARB. Significant migration of COCs in groundwater has not been documented anywhere on the OARB. The extent of impacted groundwater appears to be limited to portions of the shallow water-bearing zone that are entirely within the property boundary of the OARB. Potential migration of COCs in groundwater to San Francisco Bay through the storm drains is discussed in Section 3.5.2. The former ORP / Building 1 area is unique in that the tarry residue constitutes the only principal threat waste known to exist at the OARB. The tarry residue is considered to be a principal threat waste because it can be very acidic. A pH of 1 has been measured for some samples of this material. In addition, lead, PAHs, PCDDs, and PCDFs have been detected in the tarry residue at concentrations significantly greater than site-specific remediation goals.

8.2 IDENTIFICATION AND SCREENING OF GENERAL RESPONSE ACTIONS, TECHNOLOGIES, AND PROCESS OPTIONS

The NCP at 40 CFR §300.430(a)(1)(iii)(A) states that "U.S. EPA expects to use treatment to address the principal threats posed by a site, wherever practicable. Principal threats for which treatment is most likely to be appropriate include liquids, areas contaminated with high concentrations of toxic compounds and highly mobile materials." On the basis of this expectation, treatment appears to be an appropriate remedy for the tarry residue at former ORP / Building 1 area.

Contaminated soil at the other identified RAP sites and RMP locations can be considered low-level threat wastes. The NCP at 40 CFR §300.430(a)(1)(iii)(B) states that

"U.S. EPA expects to use engineering controls, such as containment, for waste that poses a relatively low long-term threat or where treatment is impracticable." However, the long-term effectiveness of such remedies must be enforced through the use of institutional controls that ensure, among other things, that assumptions regarding the integrity of cover and exposure duration stay relevant. While use of cover systems to address low-level threat wastes is likely to satisfy CERCLA statutory requirements, redevelopment of the OARB may be better served by abating impacted soil and groundwater under certain circumstances and concerns regarding the long-term effectiveness of cover systems. As a result, OBRA anticipates that containment will be used in combination with more active measures to address low-level threat wastes at various RAP sites and RMP locations at the OARB.

Tables 8-1 and 8-2 summarize the screening of general response actions for impacted soil and groundwater at RAP sites and RMP locations at the OARB, respectively. U.S. EPA (1988a) considers general response actions to be those actions that will satisfy RAOs established for a site. General response actions are divided into remedial technologies, which themselves are divided into process options. Remedial technologies refer to general categories of technologies, such as capping, subsurface barriers, or extraction. Process options refer to specific processes within each category of remedial technology. For example, extraction remedial technology would include the process options of using wells or trenches to remove groundwater from the subsurface. As indicated in Tables 8-1 and 8-2, several broad types of remedial technologies may be identified for each general response action, and numerous process options may exist for each category of remedial technology.

In accordance with U.S. EPA's *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA*, OBRA has eliminated for current implementation those general response actions, remedial technologies, and process options that do not achieve the criterion of technical implementability. The physical conditions, types and concentrations of COCs in soil and groundwater, and intended land reuse were reviewed to determine which approaches cannot be effectively implemented at the OARB under known current conditions. The results of screening for general response actions, remedial technologies, and process options are discussed in Sections 8.2.1 through 8.2.13.

8.2.1 No Action

The NCP at 40 CFR §300.430(e)(6) requires that the "no action" alternative be evaluated as a baseline for comparison of other alternatives developed. The no action alternative may be appropriate for selection under certain circumstances. U.S. EPA (1991g) states the following regarding the need to implement remedial actions at a site:

> If the baseline risk assessment and the comparison of exposure concentrations to chemical-specific standards indicates that there is no unacceptable risk to human health or the environment and that no remedial action is warranted, then the CERCLA Section 121 cleanup standards for selection of a Superfund remedy, including the requirement to meet applicable or relevant and appropriate requirements (ARARs), are not triggered.

The no action alternative is viable for RAP sites and RMP locations and basewide environmental issues where COCs in soil and water are less than screening levels for unrestricted use, which are discussed in Section 5. This general response action is **retained** for further consideration.

8.2.2 Institutional Controls

Institutional controls are non-engineering measures designed to limit exposure to hazardous substances left in-place or to ensure the effectiveness of the chosen remedy. Institutional controls that may be applicable to RAP sites and RMP locations and basewide environmental issues consist of land and groundwater use restrictions, and a requirement to comply with the RMP.

DTSC requires the City to enter into a land use covenant to ensure that the State of California will have authority to implement, monitor, and enforce protective restrictions. The land use covenant shall be recorded with the Alameda County Assessor's Office. The land use covenant will be binding on the City and subsequent property owners and will remain in effect until it is formally removed or modified pursuant to the procedures contained in the land use covenant. The land use covenant shall clearly specify the restrictions and prohibitions identified below.

- Sensitive land uses, including, but not limited to, residential housing, schools, day-care facilities, hospitals and hospices are restricted and prohibited. DTSC may issue waivers to allow sensitive uses at sites where DTSC deems appropriate. Waivers currently under consideration for the interim uses are described in Appendix D. The waivers under consideration would be in effect for five years after conveyance.

- The construction of groundwater wells and extraction of groundwater from new and existing wells for all purposes are restricted and prohibited. DTSC may issue written approval for environmental investigation, monitoring, and remediation. Construction dewatering activities shall be conducted pursuant to the RMP.

- The RMP provisions, which include provisions for soil and groundwater management, maintenance of existing cover or construction of new cover, mitigation measures during earthwork, management of below grade structures, etc., shall be followed.

- Submission of annual certifications to DTSC attesting the compliance of institutional controls are required.

The Amended Reuse Plan states that the OARB will be redeveloped for commercial and industrial purposes. The remedial actions described in this RAP are intended to protect human health and the environment based upon these reasonably anticipated land uses. The remedial actions may not be sufficiently protective if the OARB was to be redeveloped for other uses such as residential housing. Accordingly, institutional controls are an integral component of all remedial actions to ensure that the future land uses remain compatible with the remedial actions that are implemented at the OARB.
Institutional controls include land use restrictions, which can also be referred to as deed restrictions. Although the term deed restrictions commonly appears in remedial action plans and other related documents, it is not a traditional real property term and does not have a precise legal meaning (U.S. EPA, 1999c). Deed restrictions and land use restrictions are catchall phrases for legal controls such as easements, restrictive covenants, and zoning ordinances. These controls either prohibit certain kinds of site uses or notify potential owners or tenants of the presence of hazardous substances remaining on-site at concentrations that are not protective of all uses. For such alternatives to be protective, U.S. EPA (1995d) states:

> ...it is essential that the alternative include components that will ensure that it remain protective. In particular, institutional controls will generally have to be included in the alternative to prevent an unanticipated change in land use that could result in unacceptable exposures to residual contamination, or, at a minimum, alert future users to the residual risks and monitor for any change in site use.

U.S. EPA expects that institutional controls typically will be used in conjunction with engineering controls. This expectation is made clear in the NCP. At 40 CFR §300.430(a)(1)(iii)(D), U.S. EPA states the following:

The use of institutional controls shall not substitute for active response measures (e.g., treatment and/or containment of source material, restoration of ground waters to their beneficial uses) as the sole remedy unless such active measures are determined not be practicable, based on the balancing of trade-offs among alternatives that is conducted during the selection of the remedy.

Institutional controls are more effective if they are layered or implemented in series (U.S. EPA, 2000c). Layering institutional controls means using different types of institutional controls at the same time to enhance the protectiveness of remedial actions. Implementing institutional controls in series means using institutional controls at different points in the remediation process to ensure the short- and long-term protection of human health and the environment. The City anticipates that institutional controls implemented as part of remedial actions under the RAP will be both layered and implemented in series. For example, a set of covenants will be established during the interim leasing period prior to redevelopment of the OARB. These covenants will be amended after the OARB has been redeveloped and remedial actions have been performed to reflect changed land use and environmental conditions. Layering of institutional controls will be accomplished through enforcement of covenants, groundwater use restrictions, provisions in the consent agreement to be executed with DTSC, and the specialized building permit requirements instituted through the City of Oakland ULR program.

The City of Oakland ULR program has established a computerized system that ensures land use restrictions are enforced so properties with residual contamination are not redeveloped for unintended uses unless additional remediation is performed. The City's computerized system tracks permits from filing to issuance and provides the user with a permitting and inspection history. The City of Oakland Community and Economic Development Agency ("CEDA") maintains the system. CEDA is responsible for operations related to development, inspection, and enforcement of zoning, planning, building, and housing codes within the City of Oakland. The computerized system allows permits to be properly routed and held, if necessary. The purpose of these procedures is to provide the appropriate City of Oakland staff with the opportunity to review permit applications for work that may either conflict with land use restrictions or trigger further remediation under an approved remedial action plan.

The City does not consider land use restrictions by themselves to be appropriate for sites where source material may remain in-place. However, as discussed in Section 8.2.3, land use restrictions in combination with monitoring may be suitable for sites where no source material exists in soil and COCs in groundwater are therefore likely to decrease due to natural attenuation. Institutional controls are **retained** for further consideration.

8.2.3 Monitored Natural Attenuation

Monitoring is an important component of remedial actions where residual COCs may be left above applicable remediation goals in soil or groundwater. Groundwater sampling, or monitored natural attenuation ("MNA"), can be an appropriate groundwater remedial action at specific locations. However, monitoring alone is not a remedial alternative. Monitoring is an evaluation tool or data gathering activity to demonstrate the effectiveness of the selected remedies over time. For sites where land use restrictions will be imposed, monitoring is essential to confirm that land use restrictions are performing as intended. For example, if land use restrictions prohibit construction of potable water supply wells, routine inspections must be performed to ensure that construction of such wells is not occurring. Similarly, if a cover system is placed over a hazardous substance release site, monitoring is needed to assess if digging beneath the cover is taking place and, if so, whether it is being conducted in such a manner that minimizes potential risk to human health and the environment. U.S. EPA (2000h) states that the details concerning monitoring of land use restrictions should be included in the cleanup order or a document referenced in the order, such as an Operation and Maintenance Plan. As discussed in Section 4.4.2.2, this plan is referred to as a RMP for the OARB. The RMP is included as Appendix E to this RAP.

Monitoring may also entail ongoing soil or groundwater sampling to assess the impacts on environmental conditions of residual COCs at RAP sites and RMP locations at the OARB, such as may be required by RWQCB for some period of time at former petroleum tank locations. Routine groundwater sampling, in particular, is anticipated to be a component of preferred remedial actions for several RAP sites and RMP locations, such as benzene/MTBE-impacted groundwater near Building 828. After addressing source material in soil at this and other similar locations, MNA, may be an appropriate groundwater remedial action. U.S. EPA (1999d) defines MNA as the following:

> …the reliance on natural attenuation processes (within the context of a carefully controlled and monitored site cleanup approach) to achieve site-specific remediation objectives within a time frame that is reasonable compared to that offered by other more active methods. The "natural attenuation processes" that are at work in such a remediation approach include a variety of physical, chemical, or biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in soil and

groundwater. These *in-situ* processes include biodegradation; dispersion; dilution; sorption; volatilization; radioactive decay; and chemical or biological stabilization, transformation, or destruction of contaminants.

U.S. EPA (1999d) stresses that source control and long-term performance monitoring will be fundamental components of any MNA remedy. MNA is an appropriate remedial action for the OARB where its use protects human health and the environment, and where it is capable of achieving RAOs within a time frame that is reasonable compared to other alternatives. Monitored natural attenuation is **retained** for further consideration.

8.2.4 Containment

Containment refers to the use of capping technologies or engineered cover systems to minimize contact of wastes and COCs in soil by humans and ecological receptors. Containment remedies are often compatible with anticipated future land uses. Properties with cover systems have been transformed into wildlife enhancement areas, recreational facilities, and commercial developments (U.S. EPA, 1999b). Containment is a "presumptive remedy" for soil with metals that pose a low-level threat (U.S. EPA, 1999a).[21]

Depending upon the properties of COCs in soil being contained, the cover system may have to be designed to reduce surface water infiltration, control VOC emissions, provide stability, or improve aesthetics. Regardless of the type of cover system selected, institutional controls and ongoing maintenance activities are likely to be included as part of the containment remedy to ensure its long-term protectiveness. A RMP that specifies inspection frequencies, repair methods, and other protocols to protect the cover will be developed as a component of the RAP.

8.2.4.1 Permeable Cover Systems

Permeable cover systems are not designed to restrict the infiltration of surface water. Permeable covers may consist of clean soil, building slabs, asphalt roadways, and

[21] Presumptive remedies are preferred response actions or technologies for sites with similar characteristics. U.S. EPA identifies presumptive remedies based upon information acquired from evaluating and cleaning up sites under Superfund. A primary reason for U.S. EPA establishing presumptive remedies is to streamline remedy selection by narrowing the universe of technologies and alternatives that must be considered. U.S. EPA (1993b) also believes that presumptive remedies will produce the added benefit of promoting consistency in remedy selection and improving the predictability of the remedy selection process for communities and potentially responsible parties. A simpler and less technical discussion of presumptive remedies can be found in U.S. EPA's (1997a) *A Citizen's Guide to Understanding Presumptive Remedies.*

concrete pavement to be constructed as part of redevelopment. Use of permeable covers is appropriate for most RAP sites, RMP locations, and basewide issues at the OARB because COCs consist primarily of high molecular weight petroleum hydrocarbons, metals, or other low mobility COCs that are not volatile and are not prone to leaching to groundwater. Permeable covers are **retained** for further consideration.

8.2.4.2 Low-Permeability Cover Systems

Low-permeability cover systems are designed to promote surface water drainage away from the cap and to minimize infiltration of water into the soil containing COCs. Low-permeability cover systems may also be used as a barrier against vapor intrusion.

Infiltration of surface water is not a significant concern at the OARB. Most COCs identified at the OARB sorb tightly to soil and are not generally considered to be mobile in the environment (e.g., high molecular weight petroleum hydrocarbons, PAHs, metals). VOCs and fractions of petroleum fuels (e.g., low molecular weight petroleum hydrocarbons and BTEX) that can leach from soil appear to have volatilized, degraded, or already migrated to groundwater to the extent possible at the OARB. Review of available analytical results indicates that concentrations of VOCs and fuel constituents at RAP sites and RMP locations with impacted groundwater are relatively stable or declining over time. Further, investigative findings demonstrate that the areas of impacted groundwater in the shallow water-bearing zone are limited. The largest area with VOC-impacted groundwater is near Building 99. This area is approximately 500 feet long and 500 feet across at its widest point but contains low VOC concentrations in groundwater as discussed in Section 4.4.3.4.

A cover system intended as a vapor barrier typically consists of a low-permeability geomembrane placed over a foundation layer, such as compacted sand or aggregate. The geomembranes can consist of sprayed elastomeric material (e.g., LIQUID BOOT®), or be constructed of high density polyethylene ("HDPE"), linear low density polyethylene ("LLDPE"), or polypropylene. HDPE is widely accepted by regulatory agencies. However, in certain cover applications, LLDPE and polypropylene may be advantageous due to their ability to accommodate larger strains induced by settlement. A low-permeability cover system might be incorporated into the design of new buildings at the OARB and could be augmented by sub-slab depressurization technology, which is discussed in Section 8.2.5.1.4. Low-permeability cover systems for use as vapor barriers are **retained** for further consideration.

8.2.5 In-situ Soil Treatment

In-situ soil treatment consists of remedial technologies that destroy COCs or reduce their toxicity or mobility without first having to excavate the wastes or affected soil. With these technologies, soil is treated in-place, which can minimize waste generation. In-situ soil treatment consists of physical / chemical, thermal, and biological remedial technologies.

8.2.5.1 <u>In-situ Soil Treatment Using Physical / Chemical Technology</u>

Soil flushing, immobilization, soil vapor extraction, sub-slab depressurization, and electrokinetics are the process options considered in this RAP that use physical / chemical technology for in-situ treatment of soil.

8.2.5.1.1 Soil Flushing

Soil flushing involves injecting an aqueous solution to remove COCs from the subsurface without first having to excavate the wastes or affected soil. COCs are liberated from or transformed in soil if they are soluble, create an emulsion, or react with the solution injected into the subsurface. After passing through the affected soil, the aqueous solution is collected by strategically placed extraction wells, and brought to the surface for disposal, recirculation, or on-site treatment and reinjection.

Complete recovery of the aqueous solution used to wash soil has been found to be extremely difficult. Substantial amounts of wastewater and slurry may be generated to remove COCs that are present in soil at relatively low concentrations. These residuals require treatment and disposal. Further, soil flushing is an emerging technology that has not been extensively applied to remove inorganic compounds such as metals from soil. Most soil flushing applications involve remediation of VOCs on a bench or pilot scale (Smith, et al, 1995). Under the NCP at 40 CFR §300.430(a)(1)(iii)(E), innovative technologies are to be considered as potential remedial actions when such technologies offer:

> …the potential for comparable or superior treatment performance or implementability, fewer or less adverse impacts than other available approaches, or lower costs for similar levels of performance than demonstrated technologies.

Soil flushing is an emerging physical / chemical process that has not been demonstrated for full-scale application. Soil flushing is **not retained** for further consideration because other suitable and more reliable processes exist for removing or treating COCs detected in soil at the OARB.

8.2.5.1.2 Immobilization

Immobilization refers to mixing chemical reagents with wastes or COC-containing soil to change the toxicity, or physical or leaching characteristics of these materials through solidification and stabilization processes. Solidification entails physically locking COCs within a solidified matrix in the form of a crumbly soil-like mixture or a monolithic block. Stabilization converts COCs to a more immobile form, typically by chemical reaction. Immobilization is a presumptive remedy for soil with metals that pose a principal threat (U.S. EPA, 1999a).

A significant challenge for successfully accomplishing immobilization in-situ is uniform mixing of chemical reagents with the impacted soil (U.S. EPA, 1991c). Approaches used for in-situ mixing of chemical reagents include in-place mixing by conventional earth-moving equipment such as backhoes, draglines, or clamshell buckets, and injection grouting or vertical auger mixing. Injection grouting involves forcing a solution containing dissolved or suspended reagents under pressure into the subsurface. In vertical auger mixing, a system of augers is used to inject and mix reagents into the soil. Crane-mounted vertical augers loosen the soil and mix in reagents. In-situ immobilization with conventional earth-moving equipment is limited to near surface soil. Both shallow (10 to 20 feet bgs) and deep (up to 150 feet bgs) immobilization can be accomplished by vertical auger mixing, which is adapted from the construction industry (Smith, et al, 1995).

The former ORP / Building 1 area is the only RAP site or RMP location at the OARB that contains high concentrations of metals for which in-situ immobilization would be potentially applicable. However, verifying satisfactory mixing of reagents in the subsurface is often difficult. Given the heterogeneous nature of the tarry residue in which high lead concentrations and low pH are found, it may be difficult to stabilize the material. Even if the metals could be stabilized, the tarry residue will still contain elevated levels of PAHs, PCDDs, and PCDFs that may unacceptably restrict commercial and industrial reuse of the former ORP / Building 1 area.

No current application for in-situ immobilization has been identified for RAP sites or RMP locations at the OARB. Remedial alternatives incorporating this process option have not been assembled. Nevertheless, in-situ immobilization is **retained** for possible future use in the event site conditions at the OARB are found to warrant application of this process option.

8.2.5.1.3 Soil Vapor Extraction

Soil vapor extraction ("SVE") is a process for removing VOCs from unsaturated soil. SVE generally does not address non-volatile chemicals, such as metals and higher molecular weight PAHs. SVE requires installing one or more vertical or horizontal extraction wells in the affected soil. A vacuum is applied to the wells to induce air flow through the soil and into the SVE well. VOCs volatilize as air moves through the soil. VOC-laden air is captured by the SVE extraction wells for off-gas treatment or discharge to the atmosphere. Common off-gas treatment systems include granular activated carbon ("GAC") adsorption, and thermal or catalytic oxidation.

For RAP sites or RMP locations with a mixture of VOCs and non-volatile contaminants, U.S. EPA (1996c) states that SVE should be considered only if it can be used in combination with other remedies. SVE is **retained** for possible future use in the event conditions at RAP sites or RMP locations at the OARB are found to warrant application of this process option. However, remedial alternatives incorporating this process option have not been assembled.

8.2.5.1.4 Sub-slab Depressurization

Sub-slab depressurization ("SSD") technology is based on the same principles as SVE. However, the design objective of SSD is not to remediate contaminated soil but to prevent soil gases from infiltrating into a building. An active SSD system is operated continuously to create a slight vacuum beneath the concrete foundation slab of the building. The induced vacuum beneath the building foundation slab overcomes the lower pressure that often exists inside a building thereby preventing soil gas from flowing into the building.

An active SSD system requires installation of vent piping in one or more central, or other appropriately selected locations in the aggregate layer beneath the foundation slab. The vent piping is connected to a small blower or wind-driven turbine to create the vacuum beneath the foundation slab. The vacuum beneath the building foundation must be sufficient to overcome the lower pressure inside the building. Soil gas withdrawn from the vent piping beneath the building is treated to remove VOCs and is subsequently discharged to the atmosphere. The discharge stack of the SSD treatment facility should be sufficiently far from the intakes of mechanical ventilation systems to avoid transferring treated soil gas into buildings. Applicable building codes should be consulted to determine the necessary clearance for mechanical ventilation system intakes.

U.S. EPA (1994a, 1993e) has long recognized the value of SSD in reducing airborne radon concentrations inside residences and commercial buildings. SSD has been adapted at numerous sites across the United States to mitigate VOC vapor intrusion risks. The Massachusetts Department of Environmental Protection (1995) states that "SSD systems are a proven, effective, and economical means for intercepting subsurface vapors that would otherwise infiltrate into a structure of concern. These systems have been successfully installed and operated in residential, commercial, and school buildings throughout Massachusetts." SSD systems would be used together with low-permeability covers as vapor barriers. Although the construction of SSD systems and vapor barriers would be incorporated into the design of new buildings at the OARB, such systems are considered elements of site-specific remedial actions in the RAP. SSD is **retained** for further consideration.

8.2.5.1.5 Electrokinetics

Electrokinetics has been proposed to remove metals and other COCs from soil and groundwater by applying an electric field in the subsurface. The process reportedly works by using a charged electric field to induce movement of ions, particulates, and water through soil (Hinchee et al, 1989). The electric field is applied through anodes and cathodes placed in the soil. Most metals form positively charged ions that migrate towards the negatively charged electrode, or cathode.

A conductive solution must be injected into unsaturated soil to act as a carrier for metals to the cathodes. Like soil flushing, this conductive solution must be recovered for treatment. For this reason, electrokinetics is considered most applicable to saturated soil with nearly static groundwater flow and moderate to low permeability. A low groundwater flow rate is required so that ionic diffusion rather than advective flow is the main transport mechanism. Water is required to provide a polar medium for flow of metal ions. Electrokinetics is less dependent on high soil permeability than soil flushing because electrokinetic separation occurs due to ionic migration rather than bulk fluid flow. Fine-grained soil, such as clay and silt, are reported to be a good medium for electrokinetics (U.S. EPA, 1992a). Heterogeneities or anomalies found at sites, such as building foundations, rubble, significant quantities of iron or iron oxides, large rocks, or gravel may reduce the efficiency of metal removal (Acar et al, 1995).

Electrokinetics is still in the development phase. Electrokinetics is **not retained** for further consideration because other suitable and more reliable processes exist for removing or treating COCs detected in soil at RAP sites or RMP locations at the OARB.

8.2.5.2 In-situ Soil Treatment Using Thermal Technology

Vitrification is the only process option considered in this RAP that uses thermal technology for in-situ treatment of soil. Vitrification converts affected soil into a stable glass or crystalline monolith. Vitrification is based on electric melter technology, and the principle of operation is joule heating, which occurs when an electrical current is passed through a region that behaves like a resistive element. Electric current is applied through an array of electrodes inserted vertically into the zone of affected soil. Because dry soil is not conductive, flaked graphite and glass frit is placed in a small trench between the electrodes to act as the starter path for the flow of electricity. Electricity in the starter path transfers heat that melts the soil. The soil becomes conductive once molten. The melt grows outward and downward as electricity is continually applied. Smith et al (1995) reports that soil has been treated to a maximum depth of approximately 20 feet bgs with this process.

Availability of equipment limits implementability of vitrification (U.S. EPA, 1999a). In addition, the process is expensive to implement with costs highly dependent upon local energy rates, and the characteristics of deposited wastes and soils with COCs. For these reasons, vitrification is **not retained** for further consideration.

8.2.5.3 In-situ Soil Treatment Using Biological Technology

Phytoremediation and bioremediation are the process options considered in this RAP that use biological technology for in-situ treatment of soil.

8.2.5.3.1 Phytoremediation

Phytoremediation involves growing plants in wastes or soil. Plants established in the impacted soil uptake COCs and incorporate the chemicals in their plant structures. Plants that have accumulated the COCs in their biomass are subsequently harvested for disposal at an off-site, permitted waste management facility. The most important limitation to phytoremediation is rooting depth, which can be 0.5, 1, or 3 feet bgs, depending on the plant and soil type. Therefore, one of the favorable site conditions for phytoremediation is that contamination be restricted to surface soil (U.S. EPA, 1997j).

Lead, which is present at low concentration is shallow soil at numerous RAP sites and RMP locations at the OARB, is difficult for plants to uptake (U.S. EPA, 1997j). In addition, the length of time to cleanup sites may be too long to be acceptable for most redevelopment objectives (U.S. EPA, 2001c). The natural growth rates of plants and the length of the growing season limits how quickly phytoremediation can uptake COCs.

Other suitable and more reliable processes exist for removing or treating COCs detected in soil at RAP sites and RMP locations at the OARB. Nevertheless, phytoremediation is **retained** for possible future use in the event site conditions at the OARB are found to warrant application of this process option.

8.2.5.3.2 Bioremediation

Bioremediation involves stimulating indigenous microorganisms, such as bacteria and fungi, to transform hazardous chemicals to less toxic or non-toxic chemicals. Oxygen, water, and nutrients are supplied to wastes or soil to promote biological transformation of petroleum hydrocarbons or other organic chemicals under aerobic (i.e., presence of oxygen) conditions. Bioremediation of COCs, such as chlorinated organic solvents, may also occur under anaerobic (i.e., lack of oxygen) conditions. The applicability of bioremediation depends on the biodegradability of COCs at a site. Petroleum hydrocarbons, such as gasoline and diesel fuel, are known to be readily biodegradable. Other biodegradable COCs include alcohols, phenols, esters, and ketones. Chlorinated organic solvents become more difficult to biodegrade as the number of chlorine atoms increases (U.S. EPA, 1991c).

Although most chemical releases at RAP sites and RMP locations at the OARB involve petroleum hydrocarbons, the volume of impacted soil at each RAP site or RMP location is small and does not lend itself to economical in-situ bioremediation. In-situ bioremediation of soil may be accomplished as part of in-situ bioremediation of groundwater, but it is not relied upon as a stand-alone process option for impacted soil at RAP sites and RMP locations at the OARB. Although remedial alternatives in Section 9 do not incorporate in-situ bioremediation of soil, the process option is **retained** for possible future use in the event site conditions at the OARB are found to warrant application of in-situ bioremediation of soil.

8.2.6 Soil Excavation

Excavation of soil with COCs is a general response action often implemented at sites where releases of hazardous substances have occurred. Excavation is typically accomplished with earth-moving equipment, such as backhoes, bulldozers, and front loaders. Excavating and removing waste materials, waste residues, and contaminated subsoil, also known as clean closure, will eliminate potential long-term risks to humans at RAP sites and RMP locations at the OARB. Although no volume limit has been established for determining the practicality of excavation, U.S. EPA (1996a, 1993c) states that landfills and sites with "a content of 100,000 cubic yards (approximately two acres, 30 feet deep) would normally not be considered for excavation." Soil excavation is **retained** for further consideration.

8.2.7 Ex-situ Soil Treatment

Ex-situ soil treatment requires that soil with COCs be excavated before remedial technologies that destroy COCs, or reduce their toxicity or mobility are employed. Soil is treated aboveground. Ex-situ soil treatment consists of physical / chemical, thermal, and biological remedial technologies.

8.2.7.1 Ex-situ Soil Treatment Using Physical / Chemical Technology

Soil washing and immobilization are the process options considered in this RAP that use physical / chemical technology for ex-situ treatment of soil.

8.2.7.1.1 Soil Washing

Soil washing is sometimes referred to as hydrometallurgical separation. Soil washing is a presumptive remedy for soil with metals that pose a principal threat (U.S. EPA, 1999a). The process requires intimate contact of metal-containing soil with the extraction solution. The presence of large clumps or debris interferes with good contact, so pretreatment to exclude or crush oversize material normally is required. The extraction solution is routinely treated during soil washing to remove accumulated metals. Reuse of the solution is required because the leaching chemicals in the solution tend to be expensive and the disposal cost would be prohibitive if the volume of waste extraction solution was not reduced through recycling (Smith et al, 1995).

Extraction solutions used in soil washing are specific to a limited range of metal species. Thus, most extraction solutions are effective only for a narrow range of metal and soil type combinations (U.S. EPA, 1999a). The extraction solutions may also have toxic characteristics. In spite of these difficulties and the fact that, except for a few isolated samples, metals in soil at identified RAP sites and RMP locations have been detected at relatively low concentrations, soil washing is **retained** for possible future use in the event site conditions at the OARB are found to warrant application of this process option.

8.2.7.1.2 Chemical Oxidation / Reduction

As described in Section 8.2.10.1.3, chemical oxidation or reduction processes are most commonly applied to transform COCs that are dissolved in groundwater as opposed to COCs sorbed to soil. U.S. EPA has recently studied the potential applicability of chemical oxidation / reduction processes developed to destroy chemical weapons to the treatment of contaminated soil. The results of this study (U.S. EPA, 2000d) find that most chemical oxidation / reduction processes are not yet commercially available for the treatment of contaminated soil. According to U.S. EPA (2000d), the limited processes that do exist for full-scale applications appear to be permitted for treatment of PCBs only and require extensive preprocessing of soil before the PCBs can be transformed by chemical oxidation / reduction.

Chemical oxidation / reduction of COCs in soil is still in the development phase. Chemical oxidation / reduction is **not retained** for further consideration because other suitable and more reliable processes exist for removing or treating COCs detected in soil at identified RAP sites and RMP locations at the OARB.

8.2.7.1.3 Immobilization

Because vigorous mixing is needed to disperse solidification or stabilization chemical reagents with affected soil, immobilization is often performed aboveground. Immobilization, which is described in Section 8.2.5.1.2, refers to processes that change the toxicity, or physical or leaching characteristics of COCs in soil by mixing chemical reagents with impacted soil.

Pretreatment is generally performed to separate and crush oversize materials, such as rocks and debris, which can interfere with mixing of chemical reagents. Mixing can be accomplished by a variety of methods, including in-drum, in-plant, or area mixing. In-drum mixing is typically used for highly toxic or small volumes of wastes, and involves combining the reagents and wastes in a small (e.g., 55-gallon) drum. In-plant mixing may consist of either continuous or batch operations. Batch operations generally use a rotary drum mixer. A rotary drum mixer is a slightly inclined vessel, usually with internal baffles, that rotates to tumble and combine the contents. Continuous operations generally involve a pug mill. A pug mill has paddles attached to a horizontal rotating shaft to accomplish mixing. Area mixing entails placing layers of reagent and soil in a bermed location and combining the layers with a backhoe or other earth-moving equipment. Area mixing differs from in-situ immobilization using earth-moving equipment in that the affected soil is excavated and moved to a bermed location for treatment.

The effectiveness of immobilization to reduce the toxicity of metals is well demonstrated (U.S. EPA, 1999a, 1997j, 1993d). The former ORP / Building 1 area is the only identified RAP site or RMP location that contains high concentrations of metals for which ex-situ immobilization would be potentially applicable. The low pH and heterogeneous nature of the tarry residue may make ex-situ immobilization of metals difficult. Treatability studies would need to be performed on the tarry residue to confirm the efficacy of this technology.

On-site disposal of stabilized tarry residue is anticipated to conflict with planned land uses (see Section 8.2.8.1). The greatest benefit of immobilizing tarry residue would result from disposing the stabilized material at an off-site permitted waste management facility in combination with a variance from land disposal restrictions ("LDR") treatment standards. Without a variance, underlying hazardous constituents, such as PAHs, PCDDs, and PCDFs, in the tarry residue may require that this material be incinerated to meet RCRA regulations. Incineration of the tarry residue is likely to be cost prohibitive and may necessitate that the untreated material be left in-place at the OARB, which would severely restrict redevelopment opportunities for the OARB. Ex-situ immobilization at the former ORP / Building 1 area is **retained** for further consideration.

8.2.7.2 Ex-situ Soil Treatment Using Thermal Technology

Thermal desorption, vitrification, and incineration are the process options considered in this RAP that use thermal technology for ex-situ treatment of soil.

8.2.7.2.1 Thermal Desorption

Thermal desorption is any of a number of processes that use either indirect or direct heat exchange to vaporize COCs from excavated soil. Air, combustion gas, or inert gas is used as the transfer medium for the volatilized COCs. Thermal desorption systems provide physical separation and are not designed to destroy COCs. Soil is typically heated to 200 to 1,000°F depending on the thermal desorption system selected. COCs in the off-gas may be incinerated in an afterburner, adsorbed onto vapor-phase GAC, or recovered in condensation equipment.

Thermal desorption has been proven effective in treating VOCs, petroleum hydrocarbons, and some SVOCs (U.S. EPA, 1991f). However, the process is energy intensive and requires that a large volume of soil be treated and reused on-site to justify the costs of the technology. It is not anticipated that soil volumes large enough to allow cost-effective treatment by thermal desorption would be generated at any one time. Most contaminated soil at the OARB will be addressed when it is encountered during infrastructure replacement that will be accomplished over a period of five years following base transfer. Although remedial alternatives in Section 9 do not incorporate thermal desorption, the process is **retained** for possible future use in the event site conditions at the OARB are found to warrant application of thermal desorption.

8.2.7.2.2 Vitrification

Vitrification described in Section 8.2.5.2 can be performed ex-situ as well as in-situ. However, the availability of equipment limits implementability of vitrification (U.S. EPA, 1999a). The process is expensive to implement with costs highly dependent upon local energy rates, and the characteristics of deposited wastes and soils with COCs. For these reasons, vitrification is **not retained** for further consideration.

8.2.7.2.3 Incineration

Incineration involves burning wastes to destroy organic compounds. Incineration employs temperatures typically in the range of 1,500 to 3,000°F to convert organic compounds into water, carbon dioxide, and nitrogen oxides (Freeman, 1989). Depending upon the waste types to be destroyed, incinerators may consist of liquid-injection incinerators, rotary kilns, fluidized bed systems, hazardous waste boilers, or cement kilns. Metals are not destroyed by incineration. Metals either volatilize or remain in ash. Incineration is expensive because it is an energy-intensive process.

Unless a variance is obtained, incineration of tarry residue at the former ORP / Building 1 area may be necessary to comply with LDR treatment standards if this material is excavated for off-site disposal. Such treatment is likely to be cost-prohibitive if required. As a consequence, incineration is **not retained** for further consideration.

8.2.7.3 Ex-situ Soil Treatment Using Biological Technology

Phytoremediation and bioremediation are the process options considered in this RAP that use biological technology for in-situ treatment of soil.

8.2.7.3.1 Phytoremediation

Phytoremediation described in Section 8.2.5.3.1 can be performed on excavated soil that has been transferred to a bermed location to contain water used to irrigate the plants established in the affected soil. Phytoremediation is **not retained** because the length of time to remediate soil is likely to be too long to be compatible with redevelopment of the OARB. Other suitable and more reliable processes exist for removing or treating COCs detected in soil at identified RAP sites and RMP locations at the OARB.

8.2.7.3.2 Bioremediation

Bioremediation described in Section 8.2.5.3.2 can be performed ex-situ as well as in-situ. Ex-situ bioremediation is capable of readily degrading petroleum hydrocarbons and other fuel constituents found at identified RAP sites and RMP locations at the OARB. Unlike in-situ bioremediation, ex-situ bioremediation would allow impacted soil from various locations at the OARB to be aggregated at a location on the OARB for more cost-effective treatment. This process option is **retained** for further consideration.

8.2.8 Excavated Soil Management

Soil that has been excavated and soil that has been excavated and treated must eventually be disposed either on-site or off-site.

8.2.8.1 Disposal of Soil On-site

Except for the former ORP / Building 1 area, soil with COCs most likely can be treated to concentrations less than applicable remediation goals that would allow disposal or reuse at the OARB. Treatment and on-site disposal of tarry residue from the former ORP / Building 1 area is problematic because available data suggest that some portion of the tarry residue may be classified as a RCRA hazardous waste due to corrosivity or toxicity. Unless this material is incinerated, it is likely to contain PAHs, PCDDs, and PCDFs at concentrations greater than site-specific remediation goals and possibly greater than LDR treatment standards for RCRA hazardous waste. Excavated contaminated soil from the former ORP / Building 1 area that does not meet LDR treatment standards may have to be placed in a corrective action management unit ("CAMU") pursuant to 22 CCR §66264.552 if the soil is to remain on-site. Creation of a CAMU, which is functionally a RCRA landfill, on the OARB is incompatible with planned redevelopment. As a consequence, on-site disposal is **retained** for further consideration for excavated soil that has been appropriately treated.

8.2.8.2 Disposal of Soil Off-site

Off-site disposal of soil entails directly transporting excavated material to a permitted waste management facility. Excavated soil and waste must be characterized to determine the type of waste management unit or facility that is permitted to accept the material for disposal. The State of California regulates three specific types of waste management units. These waste management units consist of Class I units that receive hazardous wastes, Class II units that receive designated wastes, and Class III units that receive non-hazardous solid wastes.

Disposal of hazardous wastes is regulated under Title 22 of the CCR. Hazardous wastes are those wastes that are listed to be hazardous or exhibit hazardous characteristics as defined by DTSC or U.S. EPA under RCRA. Disposal of designated and non-hazardous solid wastes is regulated under Title 27 of the CCR. Designated wastes are non-hazardous wastes that contain soluble pollutants in concentrations that exceed applicable water quality objectives or could degrade waters of the state. As discussed in Section 6, non-hazardous solid wastes are defined under 27 CCR §20220 as the following:

> Nonhazardous solid waste means all putrescible and nonputrescible solid, semi-solid, and liquid wastes, including garbage, trash, refuse, paper, rubbish, ashes, industrial wastes, demolition and construction wastes, abandoned vehicles and parts thereof, discarded home and industrial appliances, manure, vegetable or animal solid and semi-solid wastes and other discarded waste (whether of solid or semi-solid consistency); provided that such wastes do not contain wastes which must be managed as hazardous wastes, or wastes which contain soluble pollutants in concentrations which exceed applicable water quality objectives, or could cause degradation of waters of the state (i.e., designated waste).

Investigations performed at RAP sites and RMP locations at the OARB suggest that most soil with COCs meets the definition of non-hazardous solid waste and is so mildly contaminated that it can be possibly used as daily cover over a waste management unit at an off-site, permitted facility.

Daily cover is defined in 27 CCR §20164 as cover material placed on the surface of the active face of a waste management unit at the end of each operating day to control disease vectors, fire, odors, blowing litter, and scavenging. By using mildly contaminated soil instead of clean soil for daily cover, a waste management facility can receive tax benefits because the contaminated soil is considered recycled material. Available tax benefits to a facility can translate into acceptance of mildly contaminated soil at a reduced rate. For example, disposing of soil as a Class II waste may incur a disposal cost on the order of $60/ton. In comparison, disposing of soil as cover material can cost approximately $30/ton.

Any off-site disposal of RCRA hazardous waste, such as tarry residue at the former ORP / Building 1 area, must comply with LDRs (U.S. EPA, 2001b). Treatment to meet LDRs prior to land disposal could include incineration, stabilization, or other technologies. As the required treatment would be conducted at the off-site, permitted disposal facility, any technology required to comply with LDRs is included as off-site disposal. Off-site disposal is **retained** for further consideration.

8.2.9 Groundwater Diversion

Relatively few RAP sites or RMP locations at the OARB involve impacted groundwater. Low concentrations of VOCs, BTEX, MTBE, and petroleum hydrocarbons are found in groundwater at these RAP sites and RMP locations. Impacts are limited and COCs do not appear to be migrating in groundwater at any of the sites affected. Regardless of these facts, groundwater collection/diversion technologies have been screened to assess their implementability at identified RAP sites and RMP locations at the OARB.

8.2.9.1 Subsurface Barriers

Subsurface barriers, such as a slurry wall or sheet piling, are vertical structures installed into the subsurface to contain or redirect groundwater flow. Subsurface barriers are often used in conjunction with groundwater extraction to maintain hydraulic control. To be effective, a subsurface barrier must be completed or "keyed" into a continuous layer of clay deposits or competent bedrock. This layer must have sufficiently low permeability to prevent leakage underneath the barrier, it must have adequate thickness for an appropriate key (e.g., 2 to 3 feet), and it must be of moderate depth (50 to 70 feet bgs) or installation of the subsurface barrier may not be feasible (U.S. EPA, 1991c).

8.2.9.1.1 Slurry Wall

A slurry wall is constructed by excavating a narrow trench, typically 2 to 4 feet wide, and backfilling it with low-permeability material. As excavation proceeds, a bentonite-water mixture is temporarily placed in the trench to stabilize the trench walls, thereby preventing collapse. The bentonite-water mixture also permeates into the soil and creates a filter cake on the walls that seals the soil to prevent loss of the low-permeability slurry that will be used to permanently fill the trench.

Slurry walls are differentiated by the materials used to permanently fill the trench. If slurry of soil, bentonite, and water is employed, then the wall is known as a soil-bentonite slurry wall. In some cases, slurry of portland cement, bentonite, and water is employed. This type of wall is referred to as a cement-bentonite slurry wall. Cement-bentonite slurry walls are used at sites where there is inadequate space to place and mix soil with bentonite and water, or where increased wall strength may be necessary. Cement-bentonite slurry walls may also be used where the site topography makes it impractical to install a soil-bentonite slurry wall. Soil-bentonite slurry will flow if the trench is not within a few degrees of level. Cement-bentonite walls that harden quicker are better suited to irregular topography.

Creation of grout curtains is another process by which low-permeability materials are introduced into the subsurface. The grout is pressure injected into soil or rock. Grout types are divided into particulate grout, and chemical grout. Particulate grouts are fluids that consist of a suspension of cement, clay, bentonite, or a combination of these materials in water. Chemical grouts rely on polymerization reactions to form hardened gels. Chemical grouts include portland cement, cement-bentonite, silicate, and organic polymer mixtures.

Both slurry walls and grout curtains are feasible to implement because these subsurface barriers can be keyed into the low permeability Young Bay Mud that underlies the shallow water-bearing zone at the OARB. However, grout curtains are seldom used for diverting groundwater flow. Slurry walls are less costly and have lower permeability than grout curtains. Grouting is best suited for sealing voids or fractures in bedrock (U.S. EPA, 1991c).

Groundwater diversion may be required if tarry residue is excavated at the former ORP / Building 1 area since some of this material may be present below the groundwater surface in the shallow water-bearing zone. Regarding the removal of tarry residue, IT (2001i) has stated:

> It is, however, probable that a portion of the excavation would need to be conducted below the water table. Experience at OARB indicates that dewatering is difficult, particularly if it involves the highly permeable sand layer underlying the gravelly fill layer. Practice for tank removal at OARB under this situation has been to conduct limited wet excavation in the water table.

In the event that groundwater infiltration is so high that it prevents dewatering of the excavation, subsurface barriers may have to be temporarily installed to divert groundwater from flowing into the excavation. Although remedial alternatives in Section 9 do not incorporate use of a slurry wall, the process is **retained** for possible future use in the event site conditions at the OARB are found to warrant application of a slurry wall.

8.2.9.1.2 Sheet Piling

Sheet piling can consist of interlocking steel, precast concrete, or wood sections. In most applications to divert groundwater flow, steel is employed because concrete is used only in a situation where great lateral resistance is required and wood is a poor barrier against groundwater flow. Steel sheet piling is installed by driving individual sections into the ground with single, double-action impact or vibratory pile drivers. One of the biggest drawbacks of sheet piling is that it is difficult to install in rocky soil. Damage to or deflection of the steel sections is likely to render sheet piling ineffective as a groundwater barrier. Further, it is difficult to use sheet piling for deep groundwater situations because of limitations in the depth that piling can be driven. The maximum depth to which sheet piling can be driven without damage to the interlocks between individual sections is approximately 40 feet bgs (U.S. EPA, 1991c).

Despite these drawbacks, sheet piling can often be installed quicker and at less expense than slurry walls. As discussed in Section 8.2.9.1.1, sheet piling may be effective in reducing the inflow of groundwater while excavating contaminated soil. The temporary use of sheet piling under such circumstances is considered ancillary to the application of the technology to contain or divert contaminated groundwater. Use of sheet piling is **not retained** for further consideration.

8.2.10 In-situ Groundwater Treatment

In-situ groundwater treatment consists of remedial technologies that destroy COCs or reduce their toxicity or mobility without having to extract groundwater.

8.2.10.1 <u>In-situ Groundwater Treatment Using Physical / Chemical Technology</u>

Air sparging, reactive walls, and oxidation / reduction are the process options considered in this RAP that use physical / chemical technology for in-situ treatment of groundwater.

8.2.10.1.1 Air Sparging

Air sparging, recirculating wells, and other similar processes cause VOCs and other volatile compounds to partition from groundwater into an air stream. The air stream containing VOCs is collected through an SVE system for subsequent treatment in most applications. Air sparging is potentially capable of remediating impacted groundwater at the OARB. This technology is **retained** for further consideration.

8.2.10.1.2 *Permeable Reactive Walls*

Permeable reactive walls consist of a permeable and reactive medium installed in a trench constructed across the groundwater flow path. A permeable reactive wall allows passage of groundwater while transforming COCs to harmless byproducts. The Ground-Water Remediation Technologies Analysis Center ("GWRTAC")[22] indicates in its technology evaluation report, entitled *Treatment Walls,* dated October 1996, that zero-valent iron is the most common reactive medium used in permeable reactive walls.

A primary design concern of a permeable reactive wall is ensuring that COC-containing groundwater passes through the structure (U.S. EPA, 1998a). The medium in the permeable reactive wall should be at least as permeable as the soil in the saturated zone. In some cases, a subsurface barrier (e.g., interlocking sheet piling) is installed along the edges of the area containing groundwater with dissolved COCs. The barrier is installed in a configuration similar to a funnel, directing groundwater to flow through the permeable reactive wall, or "gate," at the down gradient end of the "funnel." This arrangement is called a "funnel and gate" design, and can be used to improve confidence in the capture of impacted groundwater.

A primary operational concern with permeable reactive walls is the longevity of the system (U.S. EPA, 1998a). Plugging or coating of the reactive medium can occur if minerals precipitate in or on the medium (e.g., calcium carbonate scale). The reductive dehalogenation process of chlorinated organic solvents tends to increase the pH of the groundwater, enhancing the tendency for scale formation. To mitigate this concern, designs have been developed that allow for periodic replacement or cleaning of the reactive medium.

Use of permeable reactive walls is an emerging physical / chemical process. Application of the process is limited. As of 1998, only thirteen full-scale permeable reactive walls had been installed throughout the United States. These walls were treating either chlorinated organic solvents or hexavalent chromium in groundwater using zero-valent iron as the reactive medium (GWRTAC, 1999; U.S. EPA, 1998a, 1997g, 1995c). BTEX, MTBE, and petroleum hydrocarbons, which are found in groundwater at certain identified RAP sites and RMP locations at the OARB, are not amenable to treatment by

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[22] GWRTAC is operated by Concurrent Technologies Corporation ("CTC"), in association with the University of Pittsburgh, through a cooperative agreement with U.S. EPA Technology Innovation office. According to CTC, GWRTAC reports are developed to provide a state-of-the-art review of a selected groundwater remediation technology or groundwater topic. GWRTAC reports contain information from peer-reviewed papers and publications, and in some instances, from personal communication with involved parties. GWRTAC reports are peer-reviewed before being released.

this technology. Implementation of permeable reactive walls is **retained** for possible future use in the event site conditions at the OARB are found to warrant application of this process option.

8.2.10.1.3 Chemical Oxidation / Reduction

In-situ chemical oxidation or reduction processes involve injecting a chemical oxidant or reductant directly into saturated soil. Common oxidants include hydrogen peroxide and potassium permanganate. Reductants include sodium dithionite and hydrogen sulfide (GWRTAC, 1999; U.S. EPA, 1998b). The desired result of oxidation / reduction treatment is the complete transformation of COCs in groundwater to less toxic or non-toxic organic species, or water, carbon dioxide, and chloride ions.

The stratigraphy and geochemistry at a given site control the ability, amounts, and types of oxidants or reductants that must be delivered to the saturated zone. For example, if hydrogen peroxide is used to oxidize COCs in groundwater, the pH of saturated soil may have to be temporarily lowered and ferrous iron or other catalyst may have to be injected to facilitate the oxidation reaction.

In-situ chemical oxidation / reduction may be appropriate for RAP sites and RMP locations at the OARB with impacted groundwater. The low groundwater velocity observed at the OARB suggests that groundwater extraction may not be necessary to control undesired migration of oxidants and reductants introduced into the subsurface. In-situ chemical oxidation / reduction is an emerging physical / chemical process. Treatability studies will likely be required to evaluate the efficacy of the process at the OARB. In-situ oxidation / reduction is **retained** for further consideration.

8.2.10.2 In-situ Groundwater Treatment Using Biological Technology

Bioremediation is the only process considered in this RAP that uses biological technology for in-situ treatment of groundwater. Bioremediation described in Section 8.2.5.3.2 can be performed by introducing oxygen and/or nutrients to groundwater. Bioremediation has been demonstrated for residual concentrations of VOCs and petroleum hydrocarbons similar to those found in groundwater at identified RAP sites and RMP locations at the OARB. One simple approach for accomplishing in-situ aerobic bioremediation is to inject Oxygen Release Compound™ ("ORC") or similar products into the subsurface with direct push technology ("DPT"). Vinyl chloride, cis-1,2-DCE, trans-1,2-DCE, and MTBE are amenable to aerobic bioremediation. Regarding vinyl chloride, which is a primary COC in shallow groundwater at Building 807, Buildings 808 and 823, and Building 99, U.S. EPA (2000f) states that vinyl chloride is "more commonly remediated using aerobic mechanisms than anaerobic mechanisms." Alternatively, anaerobic bioremediation of more chlorinated VOCs, such as TCE or tetrachloroethene ("PCE") can be accomplished by injecting molasses or commercially available mixtures, such as Hydrogen Release Compound™ ("HRC"), into the subsurface with DPT. In-situ bioremediation is **retained** for further consideration.

8.2.11 Groundwater Extraction

Extraction provides hydraulic containment of chemical-containing groundwater by altering the direction of groundwater flow through creation of a depression in the piezometric surface. Extracted groundwater containing COCs must be treated or otherwise managed. Possible ex-situ treatment and management approaches are described in Sections 8.2.12.1 and 8.2.13, respectively.

Although extraction and ex-situ treatment is a presumptive remedy for sites with contaminated groundwater, restoration of chemical-containing groundwater generally will not be possible unless the source of COCs has been addressed. U.S. EPA (1996b) states that "source control is a critical component for active restoration remedies (e.g., extraction and treatment and in-situ methods) as well as for natural attenuation."

The characteristics of the chemicals released and the hydrogeologic properties of the site govern the potential for restoring groundwater to cleanup levels defined by ARARs or risk-based levels (U.S. EPA, 1996b). Relevant chemical characteristics include its volatility, how strongly it sorbs to soil, its potential for natural attenuation, quantities in which it was released, and whether it has formed NAPL. Relevant hydrogeologic properties include the stratigraphy (e.g., degree of interbedded and discontinuous soil layers), types (e.g., sand or clay) and heterogeneity of soil present, saturated soil hydraulic conductivity, extent of vertical groundwater flow, and temporal variation in the rate of groundwater movement.

8.2.11.1 Wells

Although horizontal wells can be constructed for extraction of groundwater, vertical wells are almost exclusively used because of the relative ease and lower cost of construction. Vertical wells can be completed to essentially any depth and at any location that allows access for the drilling equipment. Vertical wells are strategically placed to contain and collect the groundwater with COCs. Wells are **retained** for further consideration.

8.2.11.2 Trenches

Trenches or drains may be used to collect groundwater. Drains are typically installed perpendicular to the direction of groundwater flow. Drains are constructed by excavating a trench and installing perforated pipe on aggregate base laid at the bottom of the trench.

The portion of the trench in saturated soil is then backfilled with aggregate or other envelope material. The remainder of the trench is backfilled with soil. A geotextile may also be installed in the trench to prevent fine soil particulates from clogging the drain. If the saturated soil has a moderate or high hydraulic conductivity, then a low-permeability geomembrane may be placed on the down gradient side of the trench to prevent groundwater from passing through the drain. Gravity drains could discharge to a sanitary sewer manhole, storm drain manhole or catch basin, or directly to a free-flowing stream or creek, if there is enough slope to the terrain. If the drain terminates below the entry point to the sewer, storm drain, or water body, a pump would be necessary to lift the water to the discharge point.

Trench excavation is also complicated by underground utilities, or in areas where buildings and roads exist. Despite these limitations, drains may be more cost effective in certain circumstances. Drains may be particularly well suited to sites with relatively low hydraulic conductivities, where the costs to install wells may be high because of the need to locate wells close together. Use of trenches or drains is **retained** for further consideration.

8.2.12 Ex-situ Groundwater Treatment

Ex-situ groundwater treatment is necessary only if extraction is performed. Ex-situ groundwater treatment consists of physical / chemical and biological remedial technologies.

8.2.12.1 Ex-situ Groundwater Treatment Using Physical / Chemical Technology

Air stripping, adsorption, membrane separation, precipitation/coagulation, ion exchange, and advanced oxidation are the process options considered in this RAP that use physical / chemical technology for ex-situ treatment of groundwater.

8.2.12.1.1 Air Stripping

Air stripping is a physical process that transfers VOCs from water to air. VOC-containing groundwater is pumped to the top of a tower and distributed across trays or random packing. The water flows downward as a thin film across these surfaces. Air is blown into the base of the tower and travels upward. The trays or packing in the tower provide a large surface area and the flow of air creates a high level of turbulence. These two factors enhance mass transfer to the air. Subsequent treatment is often performed to recover or destroy VOCs in the air stream leaving the top of the tower.

Air stripping is a presumptive remedy for treatment of VOCs in groundwater (U.S. EPA, 1996b). Air stripping may have to be used in combination with adsorption to remove less volatile compounds such as petroleum hydrocarbons if present in extracted groundwater. Air stripping alone or in combination with adsorption is considered a contingent process option for treating groundwater at RAP sites at the OARB. Air stripping is **retained** for further consideration.

8.2.12.1.2 Adsorption

Adsorption of COCs onto GAC, activated alumina, or other media is commonly used for treatment of chemical-containing groundwater. The media is placed as columns or beds in cylindrical vessels. GAC adsorption is a presumptive remedy for treatment of organic compounds in groundwater (U.S. EPA, 1996b). Physical adsorption of COCs onto GAC results from the action of van der Waals forces, which are relatively weak interactions produced by the motion of electrons in their orbitals. Adsorption is **retained** for further consideration.

8.2.12.1.3 Membrane Separation

Membrane separation includes reverse osmosis, ultrafiltration, and electrodialysis. These processes involve forcing chemical-containing groundwater through a semi-permeable membrane to separate the COCs in a concentrate stream and clean water in a permeate stream. Reverse osmosis is a presumptive remedy for treatment of metals in groundwater (U.S. EPA, 1996b). U.S. EPA also designated reverse osmosis as BAT in its establishment of the lead and copper rule for drinking water (40 CFR §141). Reverse osmosis was found to remove lead to concentrations of 5 μg/L (53 FR 31516-31578). Extraction to remove metals in groundwater is not anticipated because metal concentrations detected in the shallow water-bearing zone do not now, and will not in the future, pose potential risks to human health and the environment. Membrane separation is **not retained** for further consideration.

8.2.12.1.4 Precipitation/Coagulation

Precipitation involves mixing chemical reagents in water to convert soluble COCs to insoluble forms. Coagulation involves mixing chemical reagents in water to cause soluble COCs to aggregate into flocs. Precipitates and flocs are subsequently removed from water by settling and/or filtration. Precipitation/coagulation is a presumptive remedy for treatment of metals in groundwater (U.S. EPA, 1996b) and is BAT for treatment of lead and copper in drinking water (40 CFR §141). Although precipitation/coagulation can reduce lead concentrations to approximately 5 µg/L, it is unlikely that extraction will be conducted for the purpose of removing metals from the shallow water-bearing zone at the OARB. This process option is **not retained** for further consideration.

8.2.12.1.5 Ion Exchange

Ion exchange captures ionic COCs in groundwater on a resin. The resin is placed as columns or beds in cylindrical vessels. According to Freeman (1989), ion exchange resins can be described "simply as solid, insoluble acids or bases that are capable of entering into chemical reactions in the same way as their mineral or organic acid analogs."

Ion exchange is a presumptive remedy for treatment of metals in groundwater (U.S. EPA, 1996b) and is BAT for treatment of lead and copper in drinking water (40 CFR §141). Although ion exchange can reduce lead concentrations to approximately 5 µg/L, it is unlikely that extraction will be conducted for the purpose of removing metals from the shallow water-bearing zone at the OARB. This process option is **not retained** for further consideration.

8.2.12.1.6 Advanced Oxidation

Advanced oxidation entails using strong oxidants to destroy COCs in groundwater. Common oxidants include hydrogen peroxide, ozone, and ultraviolet light. These oxidants can be used alone or in combination to destroy COCs. Advanced oxidation is a presumptive remedy for treatment of organic compounds in groundwater (U.S. EPA, 1996b). Advanced oxidation is **retained** for further consideration.

8.2.12.2 <u>Ex-situ Groundwater Treatment Using Biological Technology</u>

Bioremediation described in Section 8.2.5.3.2 can be performed ex-situ as well as in-situ. Bioremediation is **not retained** for further consideration because COCs are present at low concentrations in groundwater that make it difficult to maintain the performance of ex-situ biological treatment systems. Other suitable and more reliable processes exist for treating groundwater in the event extraction must be conducted at identified RAP sites at the OARB.

8.2.13 Extracted Groundwater Management

In the event that groundwater and surface water is extracted or collected from RAP sites at the OARB, the resulting water produced must be managed. Potential means of management evaluated in this RAP consist of reclamation, discharge to the sanitary sewer, and discharge to the storm drain.

8.2.13.1 Groundwater Reclamation

No opportunities for reclamation of treated groundwater have been identified at the OARB. The areas with impacted groundwater are limited in size and the VOC or fuel constituent concentrations in groundwater at these areas are relatively low. These conditions suggest that extraction would have to be performed for only a short duration (i.e., on the order of five years) to remediate groundwater at the affected RAP sites. If groundwater extraction were to be implemented as a remedial action, it would most probably be conducted at RAP sites within the first five years after transfer of the OARB. Redevelopment activities occurring during this time frame are anticipated to consist primarily of infrastructure replacement. No irrigation systems, ponds, or water features that may be part of redevelopment of the OARB and could potentially accept treated water will be designed or constructed within the period that groundwater extraction would most likely be accomplished at the OARB. Reclamation is **not retained** for further consideration.

8.2.13.2 Groundwater Discharge to Sanitary Sewer

EBMUD operates the POTW that treats the sanitary sewer effluent from the OARB. Although COCs in groundwater at certain RAP sites are greater than site-specific remediation goals, concentrations of these chemicals are generally less than the numerical limitations on wastewater discharge to the sanitary sewer established by EBMUD (Table 6-3). These circumstances would suggest that extracted groundwater could be disposed to the sanitary sewer without having to be treated, but this is generally not the case. Section 5 of Title I of EBMUD Ordinance 311 prohibits the discharge of storm, drainage, and groundwater to the POTW. However, the ordinance allows EBMUD to enter into an agreement under "unusual conditions" that compels special terms and fees for POTW treatment of groundwater. As a means of discouraging discharge of groundwater to the sanitary sewer, EBMUD typically levies higher fees for POTW treatment and imposes much stricter numerical limitations than those established for wastewater discharge. In some instances, the limitations are so low that available treatment technology is incapable of consistently removing COCs to meet the discharge limitations. For these reasons, discharge of treated groundwater to the sanitary sewer is **not retained** for further consideration.

8.2.13.3 Groundwater Discharge to Storm Drain

Discharge of treated groundwater to the storm drain may require a NPDES permit depending upon whether the discharge to the receiving water is determined to occur on-site or off-site. RWQCB (2001c) has adopted NPDES General Permit No. CAG912002 for discharge of groundwater that has been treated for impacts by petroleum fuel releases. NPDES General Permit No. CAG912003 has been adopted for discharge of groundwater that has been treated for impacts by VOC releases (RWQCB, 1999a). Treated groundwater conveyed to storm drains at the OARB may need coverage under these general permits or a site-specific permit may have to be obtained from RWQCB.

Before authorization is granted to discharge treated groundwater to surface water under General Permits Nos. CAG912002 and CAG912003, a demonstration must be made to the RWQCB that it is technically or economically infeasible to reclaim the water or discharge it to a POTW. As discussed in Sections 8.2.13.1 and 8.2.13.2, neither reclamation nor discharge to the sanitary sewer at the OARB is judged to be technically feasible. Discharge to the storm drain is **retained** for further consideration.

8.3 SUMMARY OF TECHNOLOGIES RETAINED FOR FURTHER CONSIDERATION

Based upon the results of screening performed in Section 8.2, the general response actions, remedial technologies, and process options retained for further consideration at this time, organized by medium, are as follows:

SOIL AND GROUNDWATER:

- No Action
- Institutional Controls
- Monitored Natural Attenuation

SOIL:

- Permeable Cover Systems
- Low-Permeability Cover Systems for Use as Vapor Barriers
- Sub-slab Depressurization or SSD
- Soil Excavation
- Ex-situ Immobilization
- Ex-situ Bioremediation
- Disposal of Soil On-site that has been Appropriately Treated
- Disposal of Soil Off-site

GROUNDWATER:

- Air Sparging
- In-situ Chemical Oxidation / Reduction
- In-situ Bioremediation
- Groundwater Extraction Using Wells or Trenches
- Ex-situ Groundwater Treatment Using Air Stripping, Adsorption, or Advanced Oxidation
- Groundwater Discharge to Storm Drain

Section 9 summarizes the development and screening of remedial alternatives using the technologies retained from this section. Section 10 presents the detailed analysis of alternatives.

9. DEVELOPMENT AND SCREENING OF ALTERNATIVES

General response actions, remedial technologies, and process options passing the screening performed in Section 8 have been developed into remedial alternatives for identified RAP sites and RMP locations at the OARB.

9.1 DEVELOPMENT OF REMEDIAL ALTERNATIVES

Following the methodology in U.S. EPA (1988a) *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA*, general response actions, remedial technologies, and process options for soil and groundwater have been combined to create potential alternatives that address COCs at identified RAP sites and RMP locations as a whole. A range of options has been developed that include the no action alternative; a limited action alternative consisting of groundwater monitoring only; groundwater response actions; and soil removal or soil removal and treatment response actions. Potential remedial alternatives for identified RAP sites and RMP locations at the OARB consist of the following:

- No action for soil and groundwater.
- Institutional controls.
- Monitored natural attenuation.
- Perform chemical oxidation / reduction in shallow water-bearing zone and monitor groundwater.
- Perform in-situ bioremediation in shallow water-bearing zone and monitor groundwater.
- Extract, perform ex-situ treatment, and discharge groundwater to the storm drain, and monitor groundwater.
- Perform air sparging in shallow water-bearing zone and monitor groundwater.
- Install vapor barrier beneath new building and monitor groundwater.
- Install vapor barrier with sub-slab depressurization system beneath new building and monitor groundwater.

- Excavate, conduct ex-situ bioremediation, and dispose of soil on-site, and monitor groundwater.
- Excavate and dispose of soil off-site, and monitor groundwater as needed.
- Excavate and dispose of soil off-site and perform in-situ treatment of shallow water-bearing zone and monitor groundwater.
- Excavate, conduct ex-situ immobilization, and dispose of soil off-site, and monitor groundwater.

Given the varied environmental conditions at identified RAP sites and RMP locations at the OARB, not all potential remedial alternatives will pertain to each site or location. For example, review of available analytical results indicates that a significant chemical source does not remain in soil where VOCs are present in shallow groundwater at the eastern end of Building 807. Therefore, remedial alternatives that involve soil excavation or soil excavation and treatment need not be considered for this RAP site.

9.2 SCREENING OF REMEDIAL ALTERNATIVES

To potentially reduce the remedial alternatives that must undergo detailed analysis, the NCP at 40 CFR §300.430(e)(7) provides the opportunity to screen alternatives against the short- and long-term aspects of the following three criteria:

- **Effectiveness:** Alternatives are judged on the degree to which an alternative reduces toxicity, mobility, or volume through treatment, minimizes residual risks and affords long-term protection, complies with ARARs, minimizes short-term impacts, and how quickly it achieves protection. Alternatives providing significantly less effectiveness than other, more promising alternatives may be eliminated. Alternatives that do not provide adequate protection of human health and the environment shall be eliminated from further consideration.

- **Implementability:** This criterion focuses on the technical feasibility and availability of the technologies each alternative would employ and the administrative feasibility of implementing the alternative. Alternatives that are technically or administratively infeasible, or require equipment, specialists, or facilities that are not available within a reasonable period of time may be eliminated from further consideration.

- **Cost:** Costs of construction and any long-term costs to operate and maintain the alternatives shall be considered. Costs that are grossly excessive compared to the overall effectiveness of alternatives may be used as a factor to exclude alternatives from further consideration. Alternatives providing effectiveness and implementability comparable to that of another alternative by employing a similar method of treatment or engineering control, but at greater cost, may also be eliminated.

Table 9-1 summarizes the screening of remedial alternatives against these three criteria. Screening of alternatives was conducted to eliminate from this current evaluation those remedial alternatives that can be eliminated based upon the criteria of effectiveness, implementability, and cost. However, in the event that additional future RAP sites or RMP locations are identified that may be amenable to remediation from a additional remedial alternatives, all remedial alternatives are retained for either current or potential future use. The nature and extent of COCs at RAP sites and RMP locations is described in Section 4.4 are used to determine which of the retained alternatives apply to individual sites and undergo detailed analysis in Section 10.

9.3 RESULTS OF REMEDIAL ALTERNATIVE SCREENING

Results of remedial alternative screening are discussed in Sections 9.3.1 through 9.3.13 and summarized in Table 9-2.

9.3.1 No Action for Soil and Groundwater

The no action alternative for soil and water will not achieve RAOs at identified RAP sites and RMP locations at OARB with COCs in soil or groundwater greater than screening levels for unrestricted use because this alternative does not include institutional controls to limit land and groundwater use. This alternative can be easily implemented and costs are negligible because no further activities need to be performed. The NCP at 40 CFR §300.430(e)(6) requires that the no action alternative be evaluated as a baseline for comparison of other alternatives developed. This alternative is **retained** for detailed analysis.

9.3.2 Institutional Controls

Institutional controls will be implemented at the entire OARB. Institutional controls are inherent components of all remedial alternatives evaluated in this RAP, with the exception of the no action alternative described in Section 9.3.1. Institutional controls will restrict the OARB to commercial and industrial uses, prevent the use of groundwater, and obligate owners and tenants of the OARB to implement the procedures specified in the RMP and to update information in the RMP as appropriate. The institutional controls also include the maintenance of existing cover or construction of new cover at the RAP site or RMP location. This alternative is **retained** for detailed analysis.

9.3.3 Monitored Natural Attenuation

This alternative will be implemented at RAP sites or RMP locations found to have residual COCs in groundwater and no significant chemical source in soil. Examples where this alternative applies include the seven former petroleum tank locations where natural attenuation of petroleum hydrocarbons in shallow groundwater is being monitoring under supervision of RWQCB.

MNA is effective in mitigating the concentration trends of COCs in the shallow water-bearing zone over time and can be easily implemented. Implementation of the MNA alternative is expected to have low capital cost, and low to moderate annual cost. This alternative is **retained** for detailed analysis.

9.3.4 Perform Chemical Oxidation / Reduction in Shallow Water-Bearing Zone and Monitor Groundwater

In-situ chemical oxidation / reduction would involve using DPT to inject oxidants or reductants into the shallow water-bearing zone. This alternative is applicable to RAP sites that have chlorinated VOCs in groundwater. Potassium permanganate or hydrogen peroxide are two common chemical oxidants that could potentially be used to convert chlorinated VOCs to non-toxic compounds. The ability to implement this alternative is contingent upon the ease in which COCs present in groundwater can be chemically oxidized or reduced and the demand for oxidants or reductants exerted by saturated zone soil. Naturally occurring minerals in some soils can consume a large percentage of the oxidant or reductant introduced into the subsurface thereby rendering the alternative cost prohibitive when compared with other remedial actions. Treatability studies are required to confirm the efficacy of the process at the OARB.

Implementation of the alternative is expected to have low to moderate capital cost, and low to moderate annual cost. In-situ chemical oxidation / reduction is **retained** for detailed analysis.

9.3.5 Perform In-situ Bioremediation in Shallow Water-Bearing Zone and Monitor Groundwater

In-situ bioremediation would entail using DPT to inject ORC or a similar product into the shallow water-bearing zone. ORC is a proprietary formulation of magnesium peroxide. Upon contacting water, magnesium peroxide in ORC is converted to magnesium hydroxide and oxygen is liberated in the process, which is used by microorganisms to degrade COCs. The mass of ORC that must be injected into the shallow water-bearing zone depends upon the quantities of COCs and naturally occurring organic matter in the subsurface. If COCs and naturally occurring organic matter consume significant amounts of oxygen, the injection of ORC may have to be repeated more than once.

It is expected that this alternative can be readily implemented. Vinyl chloride and cis-1,2-DCE are the primary VOCs in groundwater near Buildings 808 and 823 and near Building 99. U.S. EPA (2000f) notes that vinyl chloride and cis-1,2-DCE can be aerobically degraded, and magnesium peroxide (e.g., ORC) is commonly added to the subsurface to facilitate in-situ bioremediation of these compounds. Although ORC has been demonstrated to assist with the degradation of vinyl chloride, cis-1,2-DCE and most petroleum constituents detected in the shallow water-bearing zone at the OARB, certain chlorinated VOCs, such as TCE, are resistant to aerobic biodegradation. In-situ biodegradation with HRC or in-situ chemical oxidation / reduction might be used at locations where TCE or other chlorinated VOCs with a greater number of chlorine atoms are found in shallow groundwater (e.g., at the eastern end of Building 807). It is also possible that after compounds that are readily degraded under aerobic conditions have been removed, it may be necessary to allow the system to revert to an anaerobic environment to facilitate the degradation of residual VOCs that may be resistant to aerobic degradation (e.g., PCE, TCE).

Implementation of in-situ bioremediation is expected to have low to moderate capital cost, and low to moderate annual cost. This alternative is **retained** for detailed analysis.

9.3.6 Extract, Perform Ex-situ Treatment, and Discharge Groundwater to the Storm Drain, and Monitor Groundwater

Extraction would be essential if hydraulic containment of impacted groundwater had to be achieved. However, review of available data does not suggest that this is case at the OARB. COCs do not appear to be migrating in groundwater at the OARB. Given that the areas impacted with COCs in groundwater are stable, the use of extraction to accomplish chemical removal is costly and may not be as effective as in-situ chemical oxidation / reduction or in-situ bioremediation.

Implementation of groundwater is expected to have moderate to high capital cost, and moderate to high annual cost. This alternative is **not retained** for detailed analysis. However, the alternative would be considered for detailed analysis in the future if site conditions warrant evaluation of this alternative.

9.3.7 Perform Air Sparging in Shallow Water-Bearing Zone and Monitor Groundwater

Air sparging could be performed at RAP sites with VOCs or fuel constituents in groundwater. Implementation of this alternative at the OARB is complicated compared with in-situ chemical oxidation / reduction or in-situ bioremediation. Air sparging requires the installation of wells, air compressors, vacuum pumps, SVE collection piping, and possible off-gas treatment systems that must operate and be maintained throughout the period that groundwater is being remediated. In-situ chemical oxidation / reduction or in-situ bioremediation involve the injection of chemical solutions into the subsurface that ideally is performed only once. The presence of air sparging equipment may be intrusive and hinder redevelopment activities.

Implementation of air sparging is expected to have moderate to high capital cost, and moderate to high annual cost. This alternative is **not retained** for detailed analysis because other suitable alternatives exist for removing or treating COCs detected in groundwater. However, the alternative would be considered for detailed analysis in the future if site conditions warrant evaluation of this alternative.

9.3.8 Install Vapor Barrier Beneath New Building and Monitor Groundwater

Incorporating the installation of a vapor barrier beneath new buildings would limit vapor intrusion of COCs into buildings. This alternative can be easily implemented during building construction. Implementation of the alternative is expected to have moderate capital cost, and low to moderate annual cost due to required groundwater monitoring. Installation of a vapor barrier beneath new buildings is **retained** for detailed analysis.

9.3.9 Install Vapor Barrier with Sub-slab Depressurization System Beneath New Building and Monitor Groundwater

This alternative combines installation of a vapor barrier with installation of a SSD system to protect a greater degree of protection against vapor intrusion in new buildings through redundancy of engineering controls. This alternative can be easily implemented during building construction. Implementation of the alternative is expected to have moderate capital cost, and low to moderate annual cost due to required groundwater monitoring. Installation of a vapor barrier with SSD system beneath new buildings is **retained** for detailed analysis.

9.3.10 Excavate, Conduct Ex-situ Bioremediation, and Dispose of Soil On-site, and Monitor Groundwater

Ex-situ bioremediation would readily degrade petroleum hydrocarbons and fuel constituents found at RAP sites and RMP locations at the OARB. Application of this technology on-site would likely require a centralized area on the OARB where contaminated soil could be spread or piled for treatment. Creation of such an area could potentially conflict with redevelopment because ex-situ bioremediation may have to be performed for five years or more as impacted soil is discovered during infrastructure replacement.

Ex-situ bioremediation could prove advantageous if a large volume of soil impacted with petroleum hydrocarbons is excavated at one time from a RAP site or RMP location at the OARB. However, no such site or location has been identified to date.

Implementation of this alternative is expected to have low to moderate capital cost, and low to moderate annual cost. Ex-situ bioremediation is **not retained** for detailed analysis given the current uncertainty regarding the technical implementability of this technology at the OARB. However, the alternative would be considered for detailed analysis in the future if site conditions warrant evaluation of this alternative.

9.3.11 Excavate and Dispose of Soil Off-site, and Monitor Groundwater if Needed

This alternative will be implemented at RAP sites or RMP locations found to have residual COCs in soil greater than site-specific remediation goals. Groundwater monitoring will be conducted at sites also found to have minor impacts to groundwater that do not warrant active measures. Excavation and off-site disposal of some quantity of contaminated soil is assumed for most RAP sites and RMP locations at the OARB, even if available data is insufficient to determine if soil contamination exists. For sites lacking environmental data, investigations will be conducted as part of the alternative to confirm the nature and extent of chemical releases to soil, if any. Excavation will not be performed if the investigations do not reveal evidence of soil contamination.

This alternative can be readily implemented. Excavation and disposal of soil off-site with no action for groundwater is expected to have low to high capital cost depending upon the volume of soil that must be managed, and low annual cost. Low to moderate annual cost may be experienced if groundwater monitoring must be performed. This alternative is **retained** for detailed analysis.

9.3.12 Excavate and Dispose of Soil Off-site and Perform In-situ Treatment of Shallow Water-Bearing Zone and Monitor Groundwater

This alternative is similar to the one described in Section 9.3.11 in that excavation would be accomplished to remove soil impacted with COCs at concentrations greater than site-specific remediation goals or that serves as an ongoing source of contamination to groundwater. However, at the Building 991 area, soil removal coupled with groundwater monitoring may not be sufficient to adequately remediate the shallow water-bearing zone. This alternative therefore includes groundwater treatment consisting of either in-situ chemical oxidation / reduction or in-situ bioremediation to address impacted groundwater.

Soil excavation and in-situ treatment of the shallow water-bearing zone is also considered for RAP sites or RMP locations that have use histories that suggest the potential for significant chemical releases but where no sampling has been performed to assess actual environmental conditions. Such sites include the potential drum drainage area east of Building 805 and 806 and the former motor pool and salvage operations at Building 640. These sites and locations will be investigated and not all remedial actions included in this alternative will be performed if impacts to soil and groundwater are less than those presumed and do not require remediation based upon comparison with site-specific remediation goals and protocols outlined in the RMP.

Soil excavation and in-situ treatment of the shallow water-bearing zone can be readily implemented. This alternative is expected to have moderate to high capital cost depending upon the impacts to soil and groundwater discovered, and low to moderate annual cost. This alternative is **retained** for detailed analysis.

9.3.13 Excavate, Conduct Ex-situ Immobilization, and Dispose of Soil Off-site, and Monitor Groundwater

Ex-situ immobilization is considered solely for the tarry residue at the former ORP / Building 1 area because this material may be acidic and contain high concentrations of lead that could exceed TCLP standards. It is assumed that the Army will complete demolition of Building 1 to allow access for excavation and removal of tarry residue and potentially impacted soil. Ex-situ immobilization would only be performed if a variance from LDR treatment standards could be obtained and off-site permitted waste management facilities are willing to accept the stabilized tarry residue for land disposal.

Without a variance, underlying hazardous constituents in the tarry residue may require that this material be incinerated to meet RCRA regulations. Incineration of the tarry residue is likely to be cost prohibitive and may necessitate that the untreated material be left in-place at the OARB, which would severely restrict redevelopment opportunities for the OARB.

Implementation of this alternative is expected to have high capital cost, and low annual cost. Ex-situ immobilization alternative is **retained** for detailed analysis only for the tarry residue at the former ORP / Building 1 area.

9.4 SUMMARY OF RETAINED REMEDIAL ALTERNATIVES

Listed below are remedial alternatives that undergo detailed analysis in Section 10.

- No action for soil and groundwater.
- Institutional controls.
- Monitored natural attenuation.
- Perform chemical oxidation / reduction in shallow water-bearing zone and monitor groundwater.
- Perform in-situ bioremediation in shallow water-bearing zone and monitor groundwater.
- Install vapor barrier beneath new building and monitor groundwater.
- Install vapor barrier with sub-slab depressurization system beneath new building and monitor groundwater.
- Excavate and dispose of soil off-site, and monitor groundwater as needed.
- Excavate and dispose of soil off-site and perform in-situ treatment of shallow water-bearing zone and monitor groundwater.
- Excavate, conduct ex-situ immobilization, and dispose of soil off-site, and monitor groundwater.

Application of the above alternatives to RAP sites and RMP locations at the OARB is intended to be conservative because environmental conditions at some RAP sites and

RMP locations have not been sufficiently defined. For such sites and locations, additional investigation or inspection during redevelopment activities will be conducted. In the event that these additional site characterization activities do not reveal evidence of soil or groundwater impacts, the selected remedial alternative for a given site or location may not be fully implemented.

Table 9-3 provides a summary of key parameters for remedial actions on a location specific basis. Potentially applicable remedial action alternatives developed in this section were identified for each of the RAP sites and RMP locations, based on available site-specific information. Estimated quantities for the known environmental issues were used to develop location specific cost estimates. The cost estimates are one component of the detailed analysis discussed in Section 10.

10. DETAILED ANALYSIS OF ALTERNATIVES

Section 9 describes the remedial alternatives that have been retained for consideration in this RAP. Consistent with the NCP at 40 CFR §300.430(e)(9), a detailed analysis of these alternatives has been conducted in Section 10 to identify the remedial alternative that is selected for implementation at each identified chemical release location, and suspected release locations, at the OARB property being transferred to OBRA. The detailed analysis consists of an assessment of individual alternatives against each of nine evaluation criteria and a comparative analysis that focuses upon the relative performance of each alternative against those criteria. All alternatives selected for implementation at the identified RAP sites and RMP locations at the OARB must meet the following two "Threshold Criteria:"

Threshold Criteria:

- Provide short- and long-term protection of human health and the environment from unacceptable risks posed by the hazardous substances released into the environment.
- Comply with ARARs, unless the circumstances for a waiver apply. Site-specific ARARs are identified in Table 6-1.

Besides Threshold Criteria, five "Balancing Criteria" and two "Modifying Criteria" must be considered when selecting remedial alternatives to be implemented. Balancing and Modifying Criteria consist of the following:

Balancing Criteria:

- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, or volume through treatment
- Short-term effectiveness
- Implementability
- Cost

Modifying Criteria:

- State acceptance
- Community acceptance

Balancing Criteria are used to select the remedial alternatives from those that meet the Threshold Criteria. Modifying Criteria further shape the selected alternatives by taking into account the concerns of state agencies and the public. The following six factors must be taken into account when preparing a RAP under Section 25356.1 of Chapter 6.8 of the California HSC:

- Overall protection of human health and the environment
- Compliance with federal and state requirements
- Reduction of toxicity, mobility, and volume through treatment
- Long-term effectiveness and permanence
- Cost effectiveness
- Short-term effectiveness

Remedial alternatives for OARB locations have also been evaluated against these six factors.

Tables 10-1 through 10-9 summarize an analysis of individual, general remedial action alternatives against each of the nine evaluation criteria specified in the NCP and the six factors specified under the California HSC. This assessment is general in that the alternative itself is compared against evaluation criteria and does not incorporate site-specific information. Remedial action alternatives are then assembled as appropriate at specific RAP sites and RMP locations. Tables 10-11 through 10-31 compare the No Action alternative and the site-specific alternatives that could be applicable to the RAP sites or RMP locations to the NCP and California HSC criteria. The results of the comparative analysis of remedial alternatives for RAP sites and RMP locations are summarized in Tables 10-11 through 10-31. These tables also indicate the selected remedial action alternatives.

Table 10-32 presents the present worth of total estimated costs of the selected remedial alternatives. Section 10.1 describes the manner in which costs of remedial alternatives were estimated for purposes of this RAP. Discussion of the selected remedial alternatives is presented in Sections 10.2 and is organized by RAP sites and RMP Implementation Area, which includes RMP locations.

10.1 REMEDIAL ALTERNATIVE COST ESTIMATION

Costs presented in this RAP were prepared by a detailed cost estimating approach that follows guidance jointly prepared by U.S. EPA and ACE (2000e). Detailed estimating is often referred to as "bottom up" estimating because costs are built on an item-by-item basis. Bottom up estimating relies upon quantity take-offs and assembled unit cost information. ACE (1999b) states that detailed estimating is the most accurate methodology of the approaches principally used to estimate remediation costs. Spreadsheets with line item costs supporting the summary costs presented in Table 10-32 have been prepared. The spreadsheets containing supporting cost information are voluminous and are not included in the RAP. Pertinent design assumptions, key cost factors, and assumptions are discussed in this section.

10.1.1 Design Criteria Assumptions

Detailed cost estimating requires that the environmental conditions at a site be defined, or reasonably assumed, so that a remedy can be conceptually designed and costs of the key items that comprise the remedy can be generated. Table 10-32 and the following sections summarize the key design assumptions (e.g., volumes of impacted soil) that govern the estimated costs of remedial alternatives presented in this RAP. Although many of the assumptions are subject to uncertainty, available data on the nature and extent of chemical releases that have been identified at the OARB provide reasonable assurance that the chosen remedial alternatives can be implemented within the cost ranges estimated herein and will be protective of human health and the environment. Most releases at the OARB involve relatively small quantities of petroleum hydrocarbons that have locally impacted soil only.

Conditions that may be encountered at the various RMP locations are not expected to differ greatly. U.S. EPA and ACE (2000e) state the following regarding the quality of cost estimates prepared in a RAP or FS:

> During the FS, cost estimates are developed for each remedial action alternative for comparison purposes. The accuracy of these estimates is linked to the quality of the RI data, which helps define the scope of each alternative. Because the RI/FS cannot remove all uncertainty no matter how good the data may be, the expected accuracy of cost estimates during the FS is less than that of estimates developed during the later stages of the Superfund process.

U.S. EPA and ACE (2000e) expects cost estimates prepared as part of the "detailed analysis of alternatives phase of the FS" to have an accuracy of –30 to +50 percent. Cost estimates presented in this RAP were generated with this accuracy range as a goal. Accordingly, the selected remedial alternatives and their associated estimated present worth of total costs are intended to be conservative to account for the uncertainty regarding environment conditions at RAP sites and RMP locations. As such, estimated costs, particularly for the RMP Implementation Area, have been developed to bracket plausible environmental conditions. As summarized in Table 10-32, actual costs may be lower than those estimated for selected remedial actions when environmental conditions at each chemical release location are evaluated following completion of Phase II investigations or in accordance with the RMP during redevelopment.

10.1.2 Direct and Indirect Costs of Remedial Alternatives

Costs associated with implementing remedial actions at specific RAP sites have been allocated to those sites by the site-specific alternatives and are referred to herein as direct costs. Direct costs include estimated contractor overhead and profit, design and management construction services, and contingencies. In addition to these expenditures, estimated costs have been included for the City to coordinate implementation of remedial actions with DTSC and RWQCB, conduct annual reporting, perform 5-year reviews, and supervise compliance with the RMP. These latter costs are referred to herein as indirect costs. The identified indirect costs are not assigned to individual RAP sites or RMP locations and are shown separately in Table 10-32. Indirect costs do not include premiums for insurance policies for environmental coverage or reimbursement for DTSC or RWQCB oversight of environmental restoration of the OARB. Such costs, if any, would be in addition to those stated in Table 10-32.

10.1.3 Sources of Cost Information

Unit costs included in the detailed estimates were assembled from a combination of quotations from local contractors, laboratories, vendors, and disposal facilities; EKI project experience from similar, recent San Francisco Bay Area redevelopment projects; and published cost estimating guides, including R.S. Means.

10.2 SELECTED REMEDIAL ALTERNATIVES

Selected remedial alternatives for RAP sites and RMP locations are discussed in Sections 10.2.1 and 10.2.2, and are summarized in Tables 10-11 through 10-31.

10.2.1 RAP Sites

Selected remedial actions for RAP sites are described below.

10.2.1.1 Former ORP / Building 1 Area

The selected remedial action for the tarry residue at the former ORP / Building 1 area is to excavate and neutralize, as needed, the pH of the material with lime, fly ash, or other appropriate binders. The addition of lime, fly ash, or other appropriate binders would also aid in stabilizing high concentrations of lead that are found in the tarry residue. It is assumed that the Army will complete demolition of Building 1 to allow access for excavation and removal of tarry residue and potentially impacted soil. Approval of the RAP will constitute authorization pursuant to 40 CFR §270.85 and other applicable federal or State of California laws and regulations to store temporarily and to treat on-site the tarry residue as needed to facilitate off-site transport and disposal site acceptance of the waste material.

It is assumed that the stabilized material would be disposed as a RCRA hazardous waste at an off-site permitted RCRA Subtitle C waste management facility. To minimize the amount of material that must be treated and disposed, effort would be made to segregate the relatively clean fill that overlies the tarry residue. The overburden would be reused as fill if testing indicates it does not contain COCs greater than site-specific remediation goals. Five years of groundwater monitoring is included in this remedial action.

The viability of this alternative depends upon obtaining a variance from LDR treatment standards for PAHs, PCDDs, and PCDFs in the tarry residue. Without a variance, the tarry residue may have to be incinerated to achieve LDR treatment standards for these underlying hazardous constituents. Incineration of the tarry residue is likely to be cost prohibitive and may necessitate that the untreated material be left in-place at the OARB, which would severely restrict redevelopment opportunities for the OARB. At 40 CFR 268.44, U.S. EPA has established variances for remediation waste in response to this particular sort of dilemma. These variances apply if treatment to meet LDR standards would discourage aggressive remediation or would require incineration of large volumes of contaminated soil. Both of these circumstances pertain to the tarry residue at the former ORP / Building 1 area. An application for a variance from LDR treatment requirements has been submitted to the U.S. EPA (United States Department of Defense, Department of the Army, 2002).

10.2.1.2 VOCs in Groundwater at Eastern End of Building 807

Residual VOCs in groundwater at this site consist of vinyl chloride, cis-1,2-DCE, trans-1,2-DCE, TCE, and 1,1,2,2-tetrachloroethane. Vinyl chloride and cis-1,2-DCE are capable of being degraded aerobically by in-situ bioremediation, but TCE and 1,1,2,2-tetrachloroethane are more recalcitrant to this treatment process because of the greater number of chlorine atoms on these compounds. Consequently, in-situ chemical oxidation / reduction is selected as the remedial action for VOCs in groundwater at the eastern end of Building 807. Treatability studies will be conducted to establish the types and amounts of oxidants or reductants required and the approximate grid spacing of DPT injection points across the surface area of the shallow water-bearing zone impacted at this site.

10.2.1.3 VOCs in Groundwater Near Buildings 808 and 823

Vinyl chloride is the primary COC in groundwater at this site. In-situ bioremediation of vinyl chloride in groundwater is well demonstrated. Other remedial actions evaluated for VOCs at this site consist of the use of vapor barriers alone or in combination with SDD beneath new buildings that may be constructed over the area with impacted groundwater. While the use of vapor barriers and SSD are expected to protect human health and the environment and comply with ARARs, in-situ bioremediation was selected instead of these alternatives because of the preference for treatment expressed in the NCP and California HSC. In-situ bioremediation will be accomplished by injecting ORC into the subsurface with DPT.

10.2.1.4 VOCs in Groundwater Near Building 99

Vinyl chloride and cis-1,2-DCE are the predominant COCs in the shallow water-bearing zone near Building 99. Although detected vinyl chloride and cis-1,2-DCE concentrations are less than the remediation goals (Table 7-11), the source(s) of these contaminants to groundwater was never identified. Treatment of the shallow water-bearing zone is warranted to eliminate residual quantities of vinyl chloride and cis-1,2-DCE that are likely present in the capillary fringe or otherwise in unidentified impacted soil at or near the groundwater surface, which could allow these COCs to desorb from soil in the future and cause increases of vinyl chloride concentrations in groundwater. Further, the presence of vinyl chloride and cis-1,2-DCE in groundwater or future concentration increases could interfere with planned redevelopment in the area near Building 99 if not addressed. Both vinyl chloride and cis-1,2-DCE are amenable to aerobic degradation by microorganisms. The selected alternative for this site is in-situ bioremediation with ORC to remove or significantly reduce remaining COC quantities prior to redevelopment.

10.2.1.5 Benzene and MTBE in Groundwater Near Former USTs 11A/12A/13A

Impacted soil that may act as a source of petroleum hydrocarbons and fuel constituents to groundwater will be addressed by excavating contaminated soil in the vicinity of the former location of the tanks. For cost estimating purposes, it is assumed that 170 cy of non-impacted overburden will be removed and stockpiled for reuse; 110 cy of contaminated soil will be excavated and disposed as non-RCRA hazardous waste at an off-site permitted facility. Benzene and MTBE remaining in the shallow water-bearing zone will be treated by in-situ bioremediation using ORC.

10.2.1.6 Building 991 Area

Soil and groundwater at the Building 991 are also contaminated by petroleum hydrocarbons. Contaminated soil that may continue to leach petroleum hydrocarbons to groundwater will be excavated and disposed as non-RCRA hazardous waste at an off-site permitted facility. It is assumed that 500 cy of petroleum hydrocarbon-containing soil necessitate removal at the Building 991 area. Residual petroleum hydrocarbons in groundwater will be addressed by in-situ bioremediation using ORC.

10.2.1.7 Building 99

Building 99 is categorized as a RAP site because of its long industrial use history that includes prior ship manufacturing, metalworking, and equipment repair. Only limited testing that has been done inside the building. This testing has not revealed evidence of significant chemical releases. However, the possibility remains that contaminated soil may be present under Building 99. Groundwater in the Building 99 area has been extensively investigated, and VOC and petroleum hydrocarbon impacts to the shallow water-bearing zone are generally well characterized. Additional groundwater contamination attributable to Building 99 is not anticipated. Required remedial actions, if any, are likely to consist of excavating soil with COCs greater than site-specific remediation goals after Building 99 has been demolished. For cost estimating purposes, it is assumed that 400 cy of contaminated soil will be excavated and disposed as non-RCRA hazardous waste at an off-site permitted facility.

10.2.2 RMP Implementation Area

The RMP Implementation Area is not as well characterized as RAP sites. It is not known if chemical releases have occurred at many of the identified RMP locations included within the RMP implementation area. However, the fact that information within the

RMP Implementation Area is incomplete does not interfere with selecting remedial actions that are sufficient to address any impacts that may be found or developing protocols in the RMP for proper implementation of these remedies. The success of these remedies and the manner in which they have been implemented has been demonstrated at other properties in the San Francisco Bay Area that have undergone redevelopment. The use history and data compiled for the OARB provide further confidence that the RMP approach is appropriate for environmental restoration of the OARB. Review of available information yields a strong understanding of the types of COCs and manner of potential releases that can be expected at RMP locations. In the event that the nature and extent of the releases at RMP locations are found to differ significantly from the conditions assumed in the RAP, the appropriateness of selected remedial alternatives will be re-evaluated for such specific RMP locations in accordance with the RMP. If the response measures contained in the RAP are inappropriate for newly identified releases at RMP locations, the City will consult with DTSC to determine appropriate actions. Amendment of the RAP may be required to select other appropriate remedies.

10.2.2.1 Washracks, Sumps, Oil/Water Separators, and Miscellaneous Operations

These RMP locations are divided into four subgroups depending upon the environmental conditions known or suspected to exist at the RMP locations as discussed in Section 4.4.4.1. A single remedial alternative cannot be selected that is appropriate for all RMP locations because of these varying conditions. Therefore, the range of potential remedial alternatives evaluated (Table 10-17) for washracks, sumps, oil/water separators, and miscellaneous operations provide responses that are adequate for the four subgroups. Inspection and sampling requirements during redevelopment to confirm the appropriate remedial actions for each washrack, sump, oil/water separator, and miscellaneous RMP location are provided in the RMP. The RMP also specifies the protocols for implementing remedial actions at these RMP locations and performing confirmation testing to verify adequate remediation has been achieved.

Site-specific cost estimates were not generated for washracks, sumps, oil/water separators, and miscellaneous operations. The cost estimates presented in Table 10-17 are meant to represent expenditures typical of those that will be incurred to remediate the RMP locations based on available analytical results and experience with similar remedial actions at other properties in the San Francisco Bay Area. While actual costs will vary by RMP location, it is believed that the overall expenditures to address washracks, sumps, oil/water separators, and miscellaneous operations are reasonably captured in the sum of costs presented in Table 10-17. Remedial actions for each of the four subgroups in this category are discussed in Sections 10.2.2.1.1 through 10.2.2.1.4.

10.2.2.1.1 Locations Requiring Removal of an Existing Structure

This subgroup consists of seven RMP locations (Table 4-2) where the oil/water separator, washrack, or another type of structure (e.g., hydraulic lift) still remains and must be removed during redevelopment. It is assumed for cost estimating purposes that an average of 50 cy of debris and contaminated soil will be removed at each of these RMP locations and disposed as non-RCRA hazardous waste at an off-site permitted facility.

10.2.2.1.2 Locations Requiring Additional Characterization

This subgroup (Table 4-2) consists of washracks, sumps, oil/water separators, and miscellaneous operations where it is not known if soil and groundwater have been impacted. These RMP locations will be inspected and sampled for potential contamination during infrastructure replacement or during new building construction as outlined in the RMP. For cost estimating purposes, it is assumed that additional characterization will identify an average of 50 cy of impacted soil that must be removed at each of these RMP locations and disposed as non-RCRA hazardous waste at an off-site permitted facility. Excavation will not be performed if no contaminated soil is identified.

10.2.2.1.3 Locations Potentially Requiring Removal of Impacted Soil During Redevelopment

Available data or use histories for this subgroup (Table 4-2) suggest the presence of residual contaminated soil. It is assumed that an average of 50 cy of contaminated soil will be removed at each of these RMP locations and disposed as non-RCRA hazardous waste at an off-site permitted facility.

10.2.2.1.4 Locations With No Currently Identified Environmental Issues

The RMP locations in this subgroup (Table 4-2) are not expected to be contaminated because they have been adequately characterized and no COCs were detected (e.g., former indoor firing range at Former Building 682, pesticide storage sheds on northwest of Building 840) or their use histories do not suggest the potential for significant chemical releases of (e.g., kitchen grease traps, household incinerators). Although no impacts necessitating remediation are expected, chemical releases are still considered to have potentially occurred at these RMP locations and will be inspected in accordance with the RMP during redevelopment to confirm no contamination exists at these RMP locations.

10.2.2.2 Tanks

Similar to washracks, sumps, oil/water separators, and miscellaneous operations, the types of remedial actions to be performed at tank locations are predicated upon the environmental conditions known or suspected to exist at these RMP locations. Three subgroups of tank locations have been identified.

10.2.2.2.1 Tank Locations Potentially Requiring Removal of an Existing Tank

Removal of any USTs existing at the OARB will be performed during infrastructure replacement or during new building construction. Review of historical records indicates that 13 heating oil USTs may still remain at the OARB. For cost estimating purposes, it is assumed that one tank and an average of 50 cy of impacted soil will be removed and disposed at an off-site permitted facility at each RMP location where a tank must be excavated.

10.2.2.2.2 Former Tank Locations Potentially Requiring Removal of Impacted Soil During Redevelopment

Soil containing petroleum hydrocarbons exist at many former tank locations. Table 4-3 lists the former tank locations believed to have petroleum hydrocarbons in soil based upon the evaluation conducted by ITSI (2001). While concentrations of petroleum hydrocarbons in soil at these RMP locations may be less than the Army's Fuel Storage Tank Sites Cleanup Levels, residual petroleum hydrocarbons may still pose odor or other nuisances if the impacted soil is excavated during redevelopment activities. The removal of such soil is expected to result in higher disposal costs because the contaminated soil must be managed at a permitted off-site facility instead of being used as clean fill. Consequently, protocols have been established in the RMP for management of such soil. It is assumed that an average of 50 cy of contaminated soil will be removed at each of these RMP locations and disposed as non-RCRA hazardous waste at an off-site permitted facility.

10.2.2.2.3 Former Tank Locations Potentially Requiring Both Removal of Impacted Soil During Redevelopment and Groundwater Monitoring

As described in Section 10.2.2.2.2, soil containing petroleum hydrocarbons exists at many former tank locations; some of these RMP locations are anticipated to require groundwater monitoring to meet regulatory closure requirements. Natural attenuation of petroleum hydrocarbons in shallow groundwater is currently being monitored at seven tank locations under RWQCB supervision. For such tank locations, it is assumed that an average of 50 cy of contaminated soil will be removed at each of these tank locations and disposed as non-RCRA hazardous waste at an off-site permitted facility. In addition to the costs of managing contaminated soil during redevelopment, five years of groundwater monitoring and associated reporting are assumed.

10.2.2.2.4 Former Tank Locations With No Currently Identified Environmental Issues

Analytical results of confirmation soil samples at the RMP tank locations in this subgroup (Table 4-3) do not indicate that significant releases from the former tanks at these locations occurred. Although no impacts necessitating remediation are expected, these locations are still considered potential chemical release locations and will be inspected in accordance with the RMP during redevelopment to confirm no contamination exists at these locations.

10.2.2.3 Former Industrial and Chemical Handling Locations

Seven locations have been identified at the OARB where former industrial activities or chemical handling took place for which little or no subsurface environmental data are currently available. Investigations will be performed to characterize subsurface environmental conditions at these locations. Remedial actions to address soil, or soil and groundwater contamination, have been conservatively assumed at all of these locations. Actual remedial actions will depend upon investigative findings and will be implemented as part of the RMP.

10.2.2.3.1 Debris Area Near Building 99

The alternative for this location assumes that 200 cy of soil mixed with debris will be excavated and disposed as non-RCRA hazardous waste at an off-site permitted facility.

10.2.2.3.2 Building 85

This alternative assumes 100 cy of contaminated soil will be excavated and disposed as non-RCRA hazardous waste at an off-site permitted facility.

10.2.2.3.3 Building 812

This alternative assumes 100 cy of contaminated soil will be excavated and disposed as non-RCRA hazardous waste at an off-site permitted facility.

10.2.2.3.4 Building 823

This alternative assumes 200 cy of contaminated soil will be excavated and disposed as non-RCRA hazardous waste at an off-site permitted facility.

10.2.2.3.5 Potential Drum Drainage Area East of Buildings 805 and 806

Chlorinated solvent releases similar to those that took place at the eastern end of Building 807 are assumed for the potential drum drainage area east of Buildings 805 and 806. For cost estimating purposes, it is assumed that the presence of chlorinated solvents render 250 cy of excavated soil as RCRA hazardous waste that is disposed at an off-site permitted facility. Residual VOCs in 2,800 sf of the shallow water-bearing zone are addressed through in-situ chemical oxidation / reduction.

10.2.2.3.6 Former Motor Pool and Salvage Operations at Building 640

The remedial action for this location assumes that soil and shallow groundwater have been impacted by petroleum hydrocarbons. For cost estimating purposes, it is assumed that a total of 250 cy of contaminated soil will be excavated and disposed as non-RCRA hazardous waste at an off-site permitted facility. In addition, in-situ bioremediation of approximately 6,300 sf of the shallow water-bearing zone is assumed to be necessary.

10.2.2.3.7 Benzidine at Former Used Oil Tank 21

This alternative assumes 50 cy of contaminated soil will be excavated and disposed as non-RCRA hazardous waste at an off-site permitted facility.

10.2.2.4 Historical Spills and Stains

Figure 4-14 depicts the locations where spills and stains have been historically observed or noted. Given the use history of the OARB, most of these releases likely involved petroleum hydrocarbons associated with diesel fuel or motor oil. Historical spills and stains are considered to be a basewide RMP issue. As a consequence, soil excavated during new construction will be inspected for contamination. Protocols for inspecting and managing contaminated soil during and after redevelopment are specified in the RMP.

10.2.2.5 Lead in Soil Around Buildings

The EIR contemplates demolition of buildings and improvements at the OARB as part of redevelopment. Planned demolition includes those buildings where LBP is known or suspected to be present in shallow soil around the structures (Figure 4-15). Testing near these buildings will be conducted in exposed soils adjacent to painted structures built on or before 1978 to determine if lead concentrations in shallow soil are greater than the site-specific remediation goal of 750 mg/kg, as provided in Table 7-11.

Soil management protocols of the RMP will be followed. Excavated soil with representative total lead concentrations less than 350 mg/kg may be reused anywhere on-site provided such reuse complies with the risk-based remediation goals in Table 7-11 and applicable law and regulations. Excavated soil with representative total lead concentrations between 350 mg/kg and the remediation goal of 750 mg/kg will be disposed at an off-site permitted waste management facility unless specifically approved by DTSC for reuse at the OARB or upon termination of the requirements of HSC §25157.8. Soil with representative lead concentrations exceeding the site-specific remediation goal of 750 mg/kg will be excavated and disposed at an off-site permitted waste management facility. Other requirements for managing shallow soil known or suspected to contain LBP and other COCs at the OARB are incorporated into the RMP.

10.2.2.6 Former PCB-Containing Transformers and Equipment Locations

Electrical equipment at the OARB that still contains PCBs will be removed from service and managed in accordance with TSCA regulations prior to building demolition. Outdoor areas where transformers were located will also be inspected and sampled for the presence of PCBs in concrete, asphalt, and underlying soil as specified in the RMP before improvements are razed. Soil containing PCBs greater than remediation goals will be excavated and disposed at an off-site permitted facility. Management of PCB-containing equipment and media contaminated by PCBs is also subject to U.S. EPA requirements under TSCA.

10.2.2.7 Storm Drains and Sanitary Sewers

Soil contamination associated with existing storm drains and sanitary sewers, as described in the Army reports, can be adequately addressed through the RMP as part of infrastructure replacement. Removing contaminated soil will also serve to remediate minor localized impacts to groundwater by eliminating the source of COCs to the shallow water-bearing zone. Monitored natural attenuation will be relied upon to degrade low concentrations of petroleum hydrocarbons or VOCs that may remain in shallow groundwater at these locations.

Investigation of sediment inside the storm drains will be conducted in advance of infrastructure replacement. The purpose of this investigation is to determine if significant quantities of contaminated sediment exists in the storm drains. Interim remedial actions will be performed if COC-containing sediment is discovered. Such actions may consist of flushing segments of storm drain line with water to remove and capture the contaminated sediments for disposal at an off-site permitted facility. Alternatively, cement grout or similar means can be used to seal the ends of storm drain branch lines that are collapsed or otherwise can be removed from service without exacerbating flooding concerns.

10.2.2.8 Railroad Tracks

Approximately 26 miles of railroad track remain at the OARB. Like storm drains and sanitary sewers, existing railroad tracks at the OARB will be removed or replaced during redevelopment. One of the primary functions of the Port Development Area is to act as a new joint intermodal terminal that will load and unload container cargo from trucks and railroad cars for transport to and from destinations across the United States.

Besides preliminary sampling conducted during the Phase II investigations, protocols for inspecting and testing potentially contaminated railroad track ballast or sub-ballast during redevelopment have been established in the RMP. Sub-ballast found to contain COCs greater than remediation goals will be excavated for disposal at an off-site permitted facility or, if specifically approved by DTSC, may be incorporated into the on-site railroad beds upon which new tracks will be laid and covered with clean ballast.

10.2.2.9 Marine Sediments

COC impacts to marine sediments near storm drain outfalls in the Oakland Outer Harbor on former BRAC Parcels 2 and 3 have been identified by the Army. Marine sediments at Outfall 4 are defined to be part of former BRAC Parcel 1 and, thus, are not included in this RAP. The Army (Harding ESE, 2002) concluded that sediments at Outfalls 5 through 7 are "are unlikely to result in unacceptable adverse effects on aquatic or wildlife receptors." No further action is proposed for Outfalls 5 through 7.

The Port of Oakland intends to fill 26 acres to provide additional terminal capacity and create two berths in the Oakland Outer Harbor as outlined its Seaport Plan for 2020 (Harding ESE, 2002). The Port of Oakland berth expansion project will cover impacted sediments. Thus, no ecologically significant exposures to the impacted sediments will remain upon completion of the Port of Oakland's berth construction project. Implementation of remedial actions for marine sediments on former BRAC Parcels 2 and 3 will be coordinated with the Port of Oakland's berth construction project.

10.3 SUMMARY OF RECOMMENDED REMEDIAL ACTIONS

The results of the above detailed analysis determine the remedial alternatives that are recommended for implementation at portions of OARB to be transferred to OBRA via an EDC. Section 10.2 presents the detailed analysis of alternatives against NCP and state criteria and ends with a summary of recommended remedial actions at identified RAP sites and RMP locations. The recommended remedial actions for identified RAP sites and RMP locations and areas are presented in Table 10-32, along with estimated remediation costs. An implementation schedule is discussed in Section 11 for the recommended remedial actions, including implementation of the RMP as phased redevelopment occurs.

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11. REMEDIAL ACTION IMPLEMENTATION SCHEDULE

The implementation schedule for the selected remedial actions at the RAP sites and RMP locations at the OARB, as summarized in Section 10, will conform to the overall redevelopment schedule outlined in OBRA's Amended EDC Application, dated 29 November 2001 (OBRA, 2001a) (the "EDC Application"). OBRA's development plan anticipates a phased approach to the redevelopment of the properties at OARB to be transferred to OBRA under the EDC. The phased approach allows the precise timing and scale of the development to remain flexible to local market conditions. The EDC Application outlines a development plan that extends ten years after conveyance.

The Army's FOSET funding criteria generally require that environmental remediation be implemented within five years after conveyance of the OARB properties under the EDC, i.e., Army funding for remedial actions should be expended within five years of transfer. OBRA's plans to complete all remedial actions at RAP sites within five years in accordance with Army requirements outlined in Section 11.1. Thus, the available funding from the Army will be expended first on the most significant sites requiring remediation. Remaining funding from the Army will be expended on the RMP locations encountered in this period during infrastructure repair and replacement, which, for example, will address known and discovered contamination near existing storm drains and sanitary sewers. Extensions of the Army's funding obligations will also be sought to complete RMP implementation activities through the OARB redevelopment program.

The RMP locations identified in this RAP are low threat, potential COC release areas, primarily consisting of former base areas where petroleum hydrocarbons, associated constituents, and possibly other COCs such metals and SVOCs may have been used, stored, or released. Anticipated environmental conditions at these locations are comparable to those commonly encountered and managed during re-development construction activities at former industrial sites, in the Bay Area and around the country. RMP locations at OARB are not known to be or are not expected to become RAP sites, i.e., such conditions would often not be remediated under Section 6.8 of the HSC when encountered at typical construction sites around the Bay Area. Many RMP locations are simply former UST or AST locations at the OARB that have already been closed or are in corrective action monitoring by RWQCB. In general, these locations are likely to be relatively lower cost sites to manage and remediate, if needed, than the identified RAP sites. Most RMP locations will involve simple removal actions for TPH-contaminated or metal-contaminated soils, abandoned pipelines, oil-water separators, and similar subsurface or shallow buried structures. Many of these RMP locations are located within the PDA, and the Port of Oakland has found, in similar areas along the Oakland Harbor, that such encountered structures can be addressed cost-effectively and with great efficiency during redevelopment. The schedule for completing implementation of investigation and remediation activities, if necessary, at RMP locations is discussed in Section 11.2.

11.1 SCHEDULE FOR RAP SITES

As discussed in Section 10, there are seven identified RAP sites at which the selected remedial actions will be implemented. The City will implement the selected remedies for all seven RAP sites and, as noted below, for particular RMP locations within five years after conveyance. The City will evaluate all existing data in conjunction with the recently obtained Army and OBRA Phase II investigation results, in consultation with DTSC, to determine the scope of additional site characterization for the RAP sites. RMP locations for which additional data from Phase II investigations are available will also be reviewed with DTSC following transfer to identify RMP locations for consideration of prioritization for investigation and remediation during the initial five year period post-transfer, or elevation to RAP site status as discussed in the RMP. The City will obtain DTSC's approval on the remedial design at each of these RAP sites prior to implementation of the remedies selected in this RAP. The City will continue to provide public participation activities (e.g., issue fact sheets, hold community meetings, and forward project documents to repositories) during the design and implementation phases of the remedial actions for the RAP sites.

Three of the RAP sites, VOCs in Groundwater near Buildings 808 and 823, VOCs in Groundwater near Building 99, and the former ORP / Building 1 area are within the planned GDA. The remaining RAP sites are outside of the planned GDA.

Buildings 808 and 823 are within the area slated the first phase of development of the GDA. Therefore, OBRA anticipates remedial actions for the VOCs identified in groundwater in this area to be initiated as a first priority after conveyance. The selected remedial action is in-situ bioremediation of COCs in groundwater, which will have minimal surficial impacts after the injection of the chemicals in to the subsurface. Monitoring wells will be protected during subsequent development activities.

The former ORP / Building 1 area and VOCs in Groundwater near Building 99 RAP sites are also within the GDA, but development of this central portion of the GDA is planned as a later phase of redevelopment, following development of areas north of West Grand Avenue, and east of Maritime Street according to the EDC Application. This will allow remedial actions at these areas to be initiated and performed within the first one to three years after conveyance, with remedial actions to be completed before the end of Year Five after conveyance, exclusive of any longer-term monitoring or maintenance required. With the complexity of issues surrounding the former ORP / Building 1 area, including demolition, excavation, disposal of residuals with an LDR variance, and site restoration, a slightly later starting date for construction within this period may be required to effectively plan implementation of remedial actions in this area.

The remaining RAP sites (VOCs in Groundwater at the Eastern End of Building 807, Benzene and MTBE near Former USTs 11A/12A/13A, Building 991 Area, and Building 99) are not within the GDA. The investigations and remedial actions for these sites will likely be initiated within the first two years after conveyance, such that remedial actions can be substantially completed prior to the end of Year Five after conveyance. Most of these sites also incorporate in-situ groundwater treatment, and several include potential soil excavation. These activities will be completed in a manner to coordinate with the initiation of redevelopment activities in their respective areas.

11.2 SCHEDULE FOR RMP LOCATIONS

The RAP site areas, before and after remediation, and the remainder of the OARB properties included in the early transfer to OBRA under the EDC will constitute the RMP Implementation Area. The RMP will be implemented within the RMP Implementation Area until such time, and at such locations, as remediation to unrestricted, health protective levels is accomplished or termination of the RMP is achieved with concurrence of the DTSC as provided in Section 5 of the RMP.

Remediation in the RMP Implementation Area will occur in phases consistent with redevelopment projects, and the RMP will remain in effect even after redevelopment until such time as DTSC is requested to approve, and does approve, such locations for unrestricted future uses. The City will implement the RMP protocols and removal and cover remedies for the RMP locations within ten years after the conveyance, with the schedule linked to both the redevelopment program and the ongoing availability of the Army's environmental remediation funding.

A major component of the remedial actions associated with RMP locations is directly related to the infrastructure development, as the process of removing, replacing, or installing new roads and subsurface utilities may reveal the potential environmental impacts within the RMP Implementation Area at the OARB. The applicable remedial actions associated with known or encountered environmental impacts will be implemented in accordance with the procedures identified in the RMP. For property areas where redevelopment is scheduled for later phases, OBRA's EDC Application states that the infrastructure development will be accelerated so as to be completed with the five-year period post-conveyance. Thus, although complete development of the properties may occur after Year Five following conveyance, the main infrastructure (roads and utilities) will be in place for the future buildout, and associated remedial activities for many RMP locations will, therefore, be completed by the City prior to the end of the fifth year after conveyance. DTSC will require the City to comply with the RMP in subsequent redevelopment activities as actual site preparation and construction occurs on all portions of the transferred property.

Implementing the protocols of the RMP at all RMP locations within the ten years provided for the EDC redevelopment plan is not only efficient, it is consistent with the planned remediation cost-cap environmental insurance policy to be purchased as part of the conveyance from the Army. Thus, if significant new releases of COCs are discovered at RMP locations, this schedule will allow claims for insured liabilities under the available insurance coverages funded by the Army.

This schedule is intended to allow the overall development to proceed in accordance to local market conditions but still complete major environmental remedial actions by the end of Year Five, in accordance with Army funding requirements, and all remaining RMP locations by the end of Year Ten.

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12. NONBINDING ALLOCATION OF RESPONSIBILITY

HSC Section 25356.1(e) requires the preparation of a nonbinding allocation of responsibility (the "NBAR") among all identifiable potentially responsible parties ("PRPs"). HSC Section 25356.3(a) allows PRPs with an aggregate allocation in excess of 50 percent to convene an arbitration proceeding by submitting to binding arbitration before an arbitration panel. If PRPs with over 50 percent of the allocation convene arbitration, then any other PRP wishing to do so may also submit to binding arbitration.

The sole purpose of the NBAR is to establish which PRPs will have an aggregate allocation in excess of 50 percent and can therefore convene arbitration if they so choose. The NBAR, which is based on the evidence available to DTSC, is not binding on anyone, including PRPs, DTSC, or the arbitration panel. If a panel is convened, its proceedings are de novo and do not constitute a review of the provisional allocation. The arbitration panel's allocation will be based on the panel's application of the criteria spelled out in HSC Section 25356.3(c) to the evidence produced at the arbitration hearing. Once arbitration is convened, or waived, the NBAR has no further effect, in arbitration, litigation or any other proceeding, except that both the NBAR and the arbitration panel's allocation are admissible in a court of law, pursuant to HSC Section 25356.7 for the sole purpose of showing the good faith of the parties who have discharged the arbitration panel's decision.

DTSC sets forth the following preliminary nonbinding allocation of responsibility for the OARB:

> The Army is currently responsible for the investigation and cleanup activities within the area covered in this RAP, and currently has an aggregate allocation of liability in excess of the 50 percent level required to convene arbitration pursuant to HSC Section 25356.3(a). However, the Army and OBRA / ORA are entering into an Environmental Services Cooperative Agreement for which the Army will provide funds for OBRA's performance of environmental remediation activities at the site. As of the execution of this Agreement and completion of the conveyance, OBRA / ORA would have the aggregable allocation of liability in excess of the 50 percent level required to convene arbitration pursuant to HSC Section 25356.3(a).

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TABLE 4-1
CROSS REFERENCE OF FORMER OPERABLE UNITS, FORMER PARCELS, AND LOCATIONS IN RAP
Oakland Army Base, Oakland, California

Army Operable Unit (a)	Army Parcel Number (b)	Locations Identified in RAP (c)
• OU 1	4	• Benzidine at Former Used Oil Tank 21
	5	• Miscellaneous RMP Locations (d)
	6	• Miscellaneous RMP Locations (Army Reserve Parcel, excluded from RAP)
	7	• Miscellaneous RMP Locations (Army Reserve Parcel, excluded from RAP)
	9	• Former ORP/Building 1 Area
	10	• VOCs in Groundwater Near Building 99 • Building 99 • Debris Area Near Building 99 • Building 85
	11	• VOCs in Groundwater Near Buildings 808 and 823 • Building 812 • Building 823
	12	• VOCs in Groundwater at Eastern End of Building 807 • Potential Drum Drainage Area East of Buildings 805 and 806
	13	• Potential Drum Drainage Area East of Buildings 805 and 806
	14	• Miscellaneous RMP Locations
	15	• VOCs in Groundwater at Eastern End of Building 807
• OU 2	8	• Building 991 Area
• OU 3	16	• Benzene and MTBE in Groundwater Near Former USTs 11A/12A/13A
	17	• Miscellaneous RMP Locations
	18	• Miscellaneous RMP Locations (Army Reserve Parcel, excluded from RAP)
	19	• Miscellaneous RMP Locations
	20	• Miscellaneous RMP Locations
	21	• Miscellaneous RMP Locations
	22	• Miscellaneous RMP Locations
	23	• Former Motor Pool and Salvage Operations at Building 640
	24	• Miscellaneous RMP Locations
	25	• Miscellaneous RMP Locations
	26	• Miscellaneous RMP Locations (Maritime Street)
• OU 4	1	• Spit (Excluded from RAP)
	2	• Miscellaneous RMP Locations
	3	• Miscellaneous RMP Locations
• OU 7	12, 15	• VOCs in Groundwater at Eastern End of Building 807

TABLE 4-1
CROSS REFERENCE OF FORMER OPERABLE UNITS, FORMER PARCELS, AND LOCATIONS IN RAP
Oakland Army Base, Oakland, California

Notes:

(a) The Former Operable Unit ("OU") and Parcel designations developed by the Army are listed in this table. This RAP document has been prepared anticipating future development at the Gateway Development Area ("GDA") and the Port Development Area ("PDA"). Former OU and parcel designations are not carried through this document, and are not shown on RAP figures. OUs 5 and 6 are unused designations.

(b) The GDA includes all or portions of Parcels 1 through 13, and 26. The area outside of the GDA is the PDA, and includes all or part of Parcels 3, 5, 7, 8, and 10 through 26.

(c) Basewide issues span multiple areas and are not specifically included in this table. Basewide issues include Washracks, Sumps, Oil/Water Separators, and Miscellaneous Operations; Tanks; Historical Spills and Stains; Lead in Soil Around Buildings; Former PCB-Containing Transformers and Equipment Locations; Storm Drains and Sanitary Sewer Locations; and Railroad Tracks.

(d) The term "Miscellaneous RMP Locations" indicates no specific RAP sites but possible RMP locations as identified in the RAP are within the former parcel. Identified RMP locations and Basewide issues may be present on all former parcels.

TABLE 4-2
WASHRACKS, SUMPS, OIL/WATER SEPARATORS, AND MISCELLANEOUS OPERATIONS GROUPINGS
Oakland Army Base, Oakland, California

Group 1: Areas Requiring Removal of Existing Subsurface Structure
• Hydraulic lift in eastern courtyard of Building 1. The hydraulic lift has apparently not been removed.
• A washrack with drains is located near Building 70. The washrack has apparently not been removed.
• An oil/water separator located northeast of Building 5 was connected to a floor drain system for Building 5. The oil/water separator may not have been removed.
• Facility 98 is a washrack with a drain near Building 99. The washrack has not been removed. Soil samples collected near the washrack contained polycyclic aromatic hydrocarbons ("PAHs"), total petroleum hydrocarbons ("TPH"), acetone, and methylene chloride. Groundwater samples did not contain volatile organic compounds ("VOCs") or TPH.
• Building 843 was a vehicle washrack. The exact location of the washrack has not been identified in available documents, although it is generally located near former oil/water separators 8 and 9. There is no reported removal of the structure.
• Former Building 42 was a PX gas station with associated tanks 42A and 42B. Soil samples collected near the former building contained low concentrations of TPH, benzene, toluene, ethylbenzene, and xylenes ("BTEX") PAHs, methyl ethyl ketone, naphthalene, vinyl acetate, acetone, and methylene chloride. Groundwater samples contained low concentrations of TPH, BTEX, and chloroform.
• Former Building 41 was a washrack associated with the former PX gas station.
Group 2: Areas Requiring Additional Characterization
• Former Building T-166 was a boat shop.
• Former Building T-165 was a jitney repair shop.
• Former Building T-164 was a boom repair shelter.
• Former incinerator that included a concrete lined storage pit. Incinerator was situated near Buildings 141 and 145. Low concentrations of dioxin detected in soil samples collected near incinerator.
• Vehicle service garage in Building S-4 prior to 1979.
• Former paint shop located north of Building 99.
• Potential impacts to property from storage of pesticides and oil spill near off-site Building 1084.
• Former Building T-815 was a paint and solvent storage shed. No VOCs or TPH were detected in soil or groundwater samples collected near the former shed.
• The western-most bay of Building 806 was used to store hazardous materials, including chlorinated hydrocarbons, pesticides, insecticides, mercuric solutions, and flammable materials.
• Former Building 831 was a vehicle washrack. Although there is no documented removal of the structure, the structure is not apparent on later post maps.

TABLE 4-2
WASHRACKS, SUMPS, OIL/WATER SEPARATORS, AND MISCELLANEOUS OPERATIONS GROUPINGS
Oakland Army Base, Oakland, California

Group 2: Areas Requiring Additional Characterization
• Building 838 was an auto hobby shop and contained a solvent cleaning tank. A storm drain inlet apparently located inside the structure was used to discharge antifreeze and other fluids and was stained with oil.
• Former Building 838 was a vehicle washrack. Although there is no documented removal of the structure, the structure is not apparent on later post maps.
• Former Building 839 was a vehicle washrack. Although there is no documented removal of the structure, the structure is not apparent on later post maps.
• Building 738 contained photographic and ceramic shops. Chemicals used at Building 738 included oils and greases, paints, chlorinated hydrocarbons, solvents, inks, and inorganic chemicals. Methylene chloride and metals were detected in soil samples collected near the structure.
• Former Building 647 was a shop of unknown use.
• Building 645 was a shop of unknown use.
• Former Building 591 reportedly contained a battery maintenance shop and washrack. Elevated concentrations of metals were detected in shallow soil.
• Army reportedly mixed pesticides and herbicides south of Building 590. Pesticides detected in soil.
• Former Building 530 was an incinerator.
• Building 590 reportedly contained a pesticide/herbicide mixing facility inside the building. Building 590 also contained a heating plant with boilers, floor drains, sumps, a small backup fuel oil AST (50-gallons), a carpenter shop, and a sign shop (BASELINE, 2002).
• Former salvage yard with railroad tracks beneath existing Building 590 (BASELINE, 2002).
• Former Building 683 was an autocraft shop with a nearby grease rack (BASELINE, 2002).
Group 3: Areas Anticipated to Require Removal of Impacted Soil
• Building 169 was used as hazardous materials storage area. TPH, PAHs, metals, and VOCs are present in groundwater.
• Building 167 was used as hazardous materials storage area. TPH, PAHs, metals, and VOCs are present in groundwater.
• Temporary hazardous waste storage shed.
• An inactive grease trap as located near the Building 60. TPH and acetone were detected in soil. No chemicals were detected in groundwater.
• Former paint storage shed located north of Building 99.
• OWS-4 was removed in 1999. Visually impacted soil was excavated. Lead, TPH, PAHs, 1,4-dichlorobenzene, acetone, and tetrachloroethene ("PCE") remain in soil.

TABLE 4-2
WASHRACKS, SUMPS, OIL/WATER SEPARATORS, AND MISCELLANEOUS OPERATIONS GROUPINGS
Oakland Army Base, Oakland, California

Group 3: Areas Anticipated to Require Removal of Impacted Soil
• Former Building 992 was used for storage of waste oil and engine cleaning solvent (e.g., naphtha). Detectable concentrations of acetone, methylene chloride, PAHs, and TPH in soil.
• Building T-816 was a hazardous waste accumulation shed. TPH was detected in a soil sample collected near the former shed. No VOCs or TPH were detected in groundwater.
• Facility 815 was a washrack with waste oil sump, associated sand trap, and two associated 550-gal waste oil USTs (Tanks 7 and 8). The structures were removed and the area overexcavated in 1999. TPH, PAHs, and metals remain in soil. TPH, PAHs, VOCs, and metals were detected in groundwater.
• An oil water separator (OWS-2) was located near Facility 815, and was removed and overexcavated in 1999. Low concentrations of TPH, PAHs, and metals remain in soil.
• Building 813 was a former hazardous waste storage shed. VOCs and PAHs detected in soil sample collected near location of former shed.
• A flammable materials storage shed was located near Building 808. A soil sample collected near the shed (on a ground stain) contained benzene, PCE, and methylene chloride.
• Temporary hazardous waste storage shed near Building 807.
• Hydraulic lift #1 inside Building 828. The lift was removed in 1999. TPH remains in soil and groundwater around the lift.
• Hydraulic lift #2 inside Building 828. The lift was removed in 1999. TPH remains in soil and groundwater around the lift.
• Hydraulic lift #3 inside Building 828. The lift was removed in 1999. TPH remains in soil and groundwater around the lift.
• Oil water separator-5 ("OWS-5") was located inside Building 828. Halogenated VOCs, metals, TPH, and PAHs remain soil and BTEX remains in groundwater around OWS-5.
• OWS-6 near Building 830 was removed in 1998. Residual PCE, TPH, and PAHs remain in soil.
• OWS-7 near Building 830 was removed in 1998. Residual PCE, TCE, BTEX, methylene chloride, cis-1,2-DCE, TPH, and PAHs remain in soil.
• An oil water separator was located inside Building 830. Residual TPH, metals, PAHs, and trichloroethene ("TCE") remain in soil and residual TPH remains in groundwater around the oil/water separator.
• Hydraulic lift #1 inside Building 830. The lift was removed in 1999. TPH remains in soil and groundwater around the lift.
• Hydraulic lift #2 inside Building 830. The lift was removed in 1999. TPH remains in soil and groundwater around the lift.

TABLE 4-2
WASHRACKS, SUMPS, OIL/WATER SEPARATORS, AND MISCELLANEOUS OPERATIONS GROUPINGS
Oakland Army Base, Oakland, California

Group 3: Areas Anticipated to Require Removal of Impacted Soil
• Hydraulic lift #3 inside Building 830. The lift was removed in 1999. TPH remains in soil and groundwater around the lift.
• Hydraulic lift #4 inside Building 830. The lift was removed in 1999. TPH remains in soil and groundwater around the lift.
• A parts washing sink was located inside Building 830.
• A hazardous waste storage area is located north of Building 838. TPH detected in soil. No chemicals detected in groundwater.
• Building 832 was a gasoline station and contained a solvent cleaning tank for metal parts cleaning (BASELINE, 2002).
• Former Building 837 was a grease rack. TPH and PAHs detected in soil and TPH detected in groundwater.
• Building 835 was a lube oil storage shed. Residual TPH and PAHs remain in soil and residual TPH remains in groundwater near the lube oil storage building.
• OWS-8 near Building 843 was removed in 1998. Residual methylene chloride, TPH, and PAHs remain in soil.
• OWS-9 near Building 843 was removed in 1998. Residual methylene chloride, TPH, and PAHs remain in soil.
• Army used Building 840 as a former vehicle maintenance shop. Building contained a vehicle paint room and associated floor drain at the east end of the structure. Soil at Building 840 is impacted by lead deposited from paint booth exhaust. Soil gas samples collected near building contained carbon tetrachloride, chloroform, toluene, and xylenes. Low concentrations of methyl tertiary butyl ether ("MTBE"), toluene, 1,1,2,2-tetrachloroethane, and methylene chloride detected in groundwater.
• A boiler room and sump was located inside Building 793. Elevated concentrations of TPH detected in soil.
• Former Building 648 was an auto crafts shop that contained two hydraulic lifts and a grease rack. The structure was demolished and the hydraulic lifts removed in 1995. TPH impacted soil was excavated and residual TPH, PCBs, and methylene chloride remains in soil. PAHs, TPH, and DDT were detected in soil samples collected from borings for monitoring wells. TPH and PAHs were detected in groundwater.
• Residual lead and TPH in soil in vicinity of West Grand Avenue Viaduct project. Benzene detected in groundwater.
• Building 828 was a gasoline station and contained 3 hydraulic lifts.
• Building 830 was an auto hobby shop and contained a parts washing sink, an oil/water separator, and four hydraulic lifts. Low concentrations of TPH, PAHs, and metals (lead and zinc) detected in soil near a storm drain inlet near Building 830. Low concentrations of PCE, MTBE, BTEX, PAHs, and TPH detected in groundwater.

TABLE 4-2
WASHRACKS, SUMPS, OIL/WATER SEPARATORS, AND MISCELLANEOUS OPERATIONS GROUPINGS
Oakland Army Base, Oakland, California

Group 4: Areas With No Currently Identified Environmental Issues
• The northern portion of Building 90 was also used for photograph processing. Floor drain was observed in the structure. A soil sample collected adjacent to the storm drain outside the structure did not contain TPH or VOCs.
• Building 6 contained an incinerator for destroying classified documents.
• Two pesticides storage sheds located northwest of Building 840. Only minimal concentrations of pesticides detected in soil.
• A kitchen washrack was located inside Building 790.
• A grease trap was located inside Building 790.
• A kitchen washrack was located inside Building 792. No chemicals detected in soil or groundwater.
• A grease trap was located inside Building 792. No chemicals detected in soil or groundwater.
• A grease trap was located inside Building 794. No chemicals detected in soil or groundwater.
• A kitchen washrack with sump was located inside Building 794. No chemicals detected in soil or groundwater.
• A grease trap was located inside Building 794. No chemicals detected in soil or groundwater.
• Household incinerator inside housing unit 773.
• Household incinerator inside housing unit 774.
• Household incinerator inside housing unit 775.
• Former Building 682 was an indoor small-bore firing range. Metals, including arsenic and zinc, were detected in soil samples collected near the former structure.
• Building 90 may have been used as an armor-clad indoor firing range. One soil sample collected adjacent to a storm drain near Building 90 contained elevated lead concentrations.
• Former 26th Street overpass. Measurable concentrations of lead in soil.

TABLE 4-3
TANK GROUPINGS
Oakland Army Base, Oakland, California

Group 1: Tank Sites Potentially Requiring Removal of an Existing Tank	
• **UST-G**	One fuel oil underground storage tank ("UST"). The exact location of the tank has not been confirmed (BASELINE, 2002) and there is no documented removal of tank. No further action ("NFA") letter received from RWQCB.
• **UST-H**	One former 1,000-gal fuel oil UST. The exact location of the tank has not been confirmed (BASELINE, 2002) and there is no documented removal of tank. NFA letter received from RWQCB.
• **UST-I**	One former 1,000-gal fuel oil UST. The exact location of the tank has not been confirmed (BASELINE, 2002) and there is no documented removal of tank. NFA letter received from RWQCB.
• **UST-J**	One former fuel oil UST. The exact location of the tank has not been confirmed (BASELINE, 2002) and there is no documented removal of tank. NFA letter received from RWQCB.
• **UST-L**	One former 2,500-gal fuel oil UST. The exact location of the tank has not been confirmed (BASELINE, 2002) and there is no documented removal of tank. Residual petroleum hydrocarbons in soil. NFA letter received from RWQCB.
• **UST-651**	Heating oil tank associated with former Building 651. No documented removal of tank.
• **UST-652**	Heating oil tank associated with former Building 652. No documented removal of tank.
• **UST-660**	Heating oil tank associated with former Building 660. No documented removal of tank.
• **UST-671**	Heating oil tank associated with former Building 671. No documented removal of tank.
• **UST-672**	Heating oil tank associated with former Building 672. No documented removal of tank.
• **UST-673**	Heating oil tank associated with former Building 673. No documented removal of tank.
• **UST-677**	Heating oil tank associated with former Building 677. No documented removal of tank.
• **UST-678**	Heating oil tank associated with former Building 678. No documented removal of tank.
• **UST-679**	Heating oil tank associated with former Building 679. No documented removal of tank.
• **UST-681**	Heating oil tank associated with former Building 681. No documented removal of tank.
• **UST-682**	Heating oil tank associated with former Building 682 (BASELINE, 2002). No documented removal of tank.
• **UST-684**	Heating oil tank associated with former Building 684. No documented removal of tank.
• **UST-686**	Heating oil tank associated with former Building 686. No documented removal of tank.
• **UST-688**	Heating oil tank associated with former Building 688. No documented removal of tank.
• **UST-715**	Heating oil tank associated with former Building 715 (BASELINE, 2002). No documented removal of tank.
• **UST-742**	Heating oil tank associated with former Building 742 (BASELINE, 2002). No documented removal of tank.
• **UST-743**	Heating oil tank associated with former Building 743 (BASELINE, 2002). No documented removal of tank.

TABLE 4-3
TANK GROUPINGS
Oakland Army Base, Oakland, California

Group 2: Former Tank Sites Anticipated to Require Removal of Impacted Soil (a)	
--	Three former 250-gal waste oil aboveground storage tanks ("ASTs") removed in 1995. Locations of the tanks are unknown, but are possibly near Building 99. No soil or groundwater data are available. No NFA letter request has been made.
--	Five former 7,000-gallon fuel oil ASTs. Residual petroleum hydrocarbons in soil. NFA received from RWQCB.
--	Three 1,000-gal asphalt ASTs. Residual petroleum hydrocarbons in soil. NFA letter received from RWQCB.
• **AST-14**	One former 550-gal gasoline AST west of Building 14. Residual petroleum hydrocarbons in soil. NFA letter received from RWQCB.
• **AST-842**	One former 1,000-gal diesel AST-842. NFA letter received from City of Oakland Fire Department.
• **AST-HMA**	One former used oil AST with hazardous materials storage area.
• **UST-10**	One former 10,000-gal diesel UST. NFA letter received from RWQCB.
• **UST-14**	One former 550-gal waste oil UST. Residual petroleum hydrocarbons in soil. NFA letter requested.
• **UST-19**	One former 550-gal waste oil UST. Residual petroleum hydrocarbons in soil. NFA letter requested.
• **UST-1A**	One former 1000-gal diesel UST. Residual petroleum hydrocarbons in soil. NFA letter received from City of Oakland.
• **UST-2, 2A**	Two former 550-gal diesel USTs. Residual petroleum hydrocarbons in soil at both tanks. NFA letter received from RWQCB for Tank 2. NFA letter requested for Tank 2A.
• **UST-42A**	Former gasoline tank associated with PX gasoline station (Building 42)
• **UST-42B**	Former gasoline tank associated with PX gasoline station (Building 42)
• **UST-M**	One former 1000-gal gasoline UST (Tank M). Residual petroleum hydrocarbons in soil and groundwater. NFA letter received from RWQCB.
• **USTs-124A, 124B**	Former gasoline service facility with two 1,700-gallon steel tanks and dispensing pumps.
• **USTs-4A, 5A**	Two former 10,000-gal gasoline USTs (Tanks 4A and 5A). Residual petroleum hydrocarbons in soil. NFA letter received from City of Oakland Fire Department.
• **USTs-O, P, 6**	One former 12,500-gallon diesel UST, one former 2,000-gallon diesel UST, and one former 10,000-gallon diesel UST. Residual petroleum hydrocarbons in soil. NFA letter received from RWQCB.

TABLE 4-3
TANK GROUPINGS
Oakland Army Base, Oakland, California

Group 3: Former Tank Sites Anticipated to Require Removal of Impacted Soil and Groundwater Monitoring (a)	
• **USTs-4, 5**	Two former 10,000-gal gasoline USTs (Tanks 4 and 5). Residual petroleum hydrocarbons in soil. Four groundwater monitoring wells are currently sampled on quarterly basis. NFA letter requested.
• **USTs-7, 8**	Two former 550-gal waste oil USTs. Residual petroleum hydrocarbons in soil and groundwater. One groundwater monitoring well is currently sampled on semi-annual basis. NFA letter received from RWQCB.
• **UST-18**	One former 500-gal waste oil UST. Residual petroleum hydrocarbons in soil and groundwater. Three groundwater monitoring wells are currently sampled on an annual basis. NFA letter requested.
• **AST-994**	One former 10,000-gallon diesel AST (Facility 994) and reported diesel spill (two 20-gal) associated with the AST. Residual chemicals in soil. A 35 ft by 35 ft area of groundwater contains immiscible diesel fuel. Corrective action required. Three groundwater monitoring wells are currently sampled on semi-annual basis. NFA letter requested.
• **UST-A**	One former 1000-gal fuel oil UST. Residual petroleum hydrocarbons in soil and groundwater. NFA letter received from RWQCB. One groundwater monitoring well is currently monitored on semi-annual basis.
• **USTs-B, C**	Two former 1,000-gal gasoline USTs. Residual petroleum hydrocarbons in soil and groundwater. Nine groundwater monitoring wells are currently sampled on semi-annual basis. NFA letter requested.
• **UST-D**	One former 1000-gal fuel oil UST. Residual petroleum hydrocarbons in soil and groundwater. Two groundwater monitoring wells are currently sampled on a semi-annual basis. No NFA letter request has been made.
• **UST-D1**	One former UST. Residual petroleum hydrocarbons in soil and groundwater. Corrective actions assume three groundwater monitoring wells will be constructed and sampled on a quarterly basis. NFA letter requested.
• **UST-F**	One former 500-gal fuel oil UST. The exact location of this UST has not been confirmed (BASELINE, 2002). Residual petroleum hydrocarbons in soil and groundwater. Five groundwater monitoring wells are currently sampled on a semi-annual basis. No NFA letter request has been made.
• **UST-K**	One former 500-gal fuel oil UST. Residual petroleum hydrocarbons in soil and groundwater. No NFA letter request has been made.
• **UST-Q**	One former 1000-gal gasoline UST. Residual petroleum hydrocarbons in soil and groundwater. Eight groundwater monitoring wells are currently sampled on quarterly basis. No NFA letter request has been made.

TABLE 4-3
TANK GROUPINGS
Oakland Army Base, Oakland, California

Group 4: Former Tank Sites With No Currently Identified Environmental Issues	
--	Approximately 12 former and current buildings with small fuel oil ASTs (50 – 100 gal) (BASELINE, 2002).
• **UST-1**	One former 1,000-gal fuel oil UST. NFA letter received from RWQCB.
• **UST-14A**	One former 550-gal waste oil UST. NFA letter requested.
• **UST-15**	One former 12,500-gal fuel oil UST. NFA letter received from RWQCB.
• **UST-17**	One former 8,000-gal fuel oil UST. NFA letter received from RWQCB.
• **UST-20**	One former 2,000-gal diesel UST. NFA letter requested.
• **UST-3**	One former 250-gal fuel oil UST. NFA letter received from RWQCB.
• **UST-8A**	One former 550-gal waste oil UST. NFA letter requested.
• **UST-9**	One former 2,000-gal gasoline UST. NFA letter received from RWQCB.
• **UST-N**	One former 500-gal waste oil UST near Building 835. NFA letter requested.

Note:

(a) Location of former USTs 11/12/13 and 11A/12A/13A is addressed as a Remedial Action Plan ("RAP") site.

TABLE 4-4
SUMMARY OF LABORATORY ANALYTICAL RESULTS FOR TARRY RESIDUE FROM FORMER ORP / BUILDING 1 AREA
Oakland Army Base, Oakland, California

Chemical of Concern (a)	Units	Sample ID, Collection Date, and Laboratory (b)					Universal Treatment Standards for Underlying Hazardous Constituents (c)
		BLDG1 11/9/00 Friedman & Bruya, Inc.	BLDG 1A 2/5/01 Curtis & Tompkins, Ltd.	BLDG 1B 2/5/01 STL Chromalab	BLDG1C 2/5/01 Friedman & Bruya, Inc.	Tarry Sludge 2/4/02 Applied P & Ch Laboratory	
Metals							
Barium	mg/kg	**11.6**	NA (d)	NA	NA	NA	--
Cadmium	mg/kg	**11.1**	NA	NA	NA	NA	--
Chromium	mg/kg	**3.54**	NA	NA	NA	NA	--
Copper	mg/kg	**126**	NA	NA	NA	NA	--
Lead, Total	mg/kg	**11,800**	NA	NA	NA	NA	--
Lead, TCLP (e)	mg/L	NA	NA	NA	NA	**21.4**	0.75
Nickel	mg/kg	**4.07**	NA	NA	NA	NA	--
Vanadium	mg/kg	**1.12**	NA	NA	NA	NA	--
Zinc	mg/kg	**16.4**	NA	NA	NA	NA	--
Corrosivity (f)							
pH	pH	**1.07**	NA	**1.3**	**0.56**	NA	--
Polychlorinated Biphenyls							
PCBs	mg/kg	**13**	NA	NA	NA	NA	10
Polycyclic Aromatic Hydrocarbons							
Acenaphthene	mg/kg	**210**	<970	<200	**48**	NA	3.4
Anthracene	mg/kg	<100	<970	<200	**16**	NA	3.4
Benzo(a)anthracene	mg/kg	<100	<970	<200	<10	NA	3.4
Benzo(a)pyrene	mg/kg	<100	<970	<40	<10	NA	3.4
Benzo(b)fluoranthene	mg/kg	<100	<970	<200	<10	NA	6.8
Benzo(g,h,i)perylene	mg/kg	<100	<970	<400	<10	NA	1.8
Benzo(k)fluoranthene	mg/kg	<100	<970	<400	<10	NA	6.8
Chrysene	mg/kg	<100	<970	<200	**36**	NA	3.4
Dibenzofuran	mg/kg	**170**	<970	<200	**47**	NA	--
Fluoranthene	mg/kg	**150**	<970	<200	**37**	NA	3.4
Fluorene	mg/kg	**180**	<970	<200	**49**	NA	3.4
Indeno(1,2,3-c,d)pyrene	mg/kg	<100	<970	<400	<10	NA	3.4
2-Methylnaphthalene	mg/kg	**240**	<970	<200	**82**	NA	--
Naphthalene	mg/kg	**1,200**	<970	**640**	**410**	NA	5.6
Phenanthrene	mg/kg	**520**	<970	**250**	**140**	NA	5.6
Pyrene	mg/kg	<100	<970	<200	**21**	NA	8.2
Dioxin-like Compounds							
1,2,3,7,8-pentachlorodibenzofuran	mg/kg	**0.075**	NA	NA	NA	NA	--
2,3,7,8-tetrachlorodibenzofuran	mg/kg	**0.0153**	NA	NA	NA	NA	--
Pentachlorinated dibenzofurans, Total	mg/kg	**0.0968**	NA	NA	NA	NA	0.001
Tetrachlorinated dibenzofurans, Total	mg/kg	**0.128**	NA	NA	NA	NA	0.001

TABLE 4-4
SUMMARY OF LABORATORY ANALYTICAL RESULTS FOR TARRY RESIDUE FROM FORMER ORP / BUILDING 1 AREA
Oakland Army Base, Oakland, California

Chemical of Concern (a)	Units	Sample ID, Collection Date, and Laboratory (b)					Universal Treatment Standards for Underlying Hazardous Constituents (c)
		BLDG1 11/9/00 Friedman & Bruya, Inc.	BLDG 1A 2/5/01 Curtis & Tompkins, Ltd.	BLDG 1B 2/5/01 STL Chromalab	BLDG1C 2/5/01 Friedman & Bruya, Inc.	Tarry Sludge 2/4/02 Applied P & Ch Laboratory	
Total Petroleum Hydrocarbons							
TPH Gasoline	mg/kg	NA	NA	<10	NA	NA	--
TPH Diesel	mg/kg	NA	NA	**35,000**	NA	NA	--

__Notes:__

(a) Only chemicals that have been detected in a tarry residue sample are listed.

(b) Table summarizes the laboratory analytical results of samples of tarry residues that exuded to the surface in the crawlspace beneath Building 1.

(c) Universal treatment standards ("UTSs") apply to Resources Conservation and Recovery Act ("RCRA") hazardous wastes that contain underlying hazardous constituents ("UHCs"). Alternative treatment standards exist for contaminated soil that is classified as RCRA hazardous waste. Under 40 CFR § 268.49(c)(1)(A), UHCs in contaminated soil must be treated to achieve a 90 percent reduction in constituent concentrations unless constituent concentrations remaining in treated contaminated soil are less than ten times the relevant UTSs.

(d) NA - Sample was not analyzed for chemical of concern.

(e) Lead concentration as measured in the extract of the Toxicity Characteristic Leaching Procedure ("TCLP")

(f) Under 40 CFR § 261.22(a), a solid waste exhibits the corrosivity characteristc of a D002 RCRA hazardous waste if it is aqueous and has a pH less than or equal to 2 or greater than or equal to 12.5.

TABLE 4-5

ANALYTICAL DATA FOR GROUNDWATER SAMPLES COLLECTED DURING ARMY / OBRA PHASE II INVESTIGATIONS

Oakland Army Base, Oakland, California

Chemicals of Concern (a)	Units	Sample Identification (c)							
		OBAS01 / IT02S26	OBAS02 / IT02S27	OBAS03 / IT02S28	OBAS04 / IT02S32	OBAS05 / IT02S33	OBAS06 (dup) / IT03S106 (d)	OBAS07 / IT03S107	OBAS08 / IT10S101
Inorganic Chemicals (b)									
Arsenic	µg/L	**32**	**43**	**37**	**14**	**21**	**5.9/5.2**	**10**	**6.9**
Manganese	µg/L	**320**	**1,900**	**610**	**140**	**65**	**180**	**1,000**	**1,230**
Thallium	µg/L	<4	<4	<4	<2	<2	<2/<2	<2	**5**
Volatile Organic Compounds									
1,1-Dichloroethane	µg/L	ND (e)	ND	ND	ND	ND	ND	ND	ND
1,2,4-Trimethylbenzene	µg/L	ND	**0.3**	ND	ND	ND	ND	ND	ND
1,3,5-Trimethylbenzene	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
Acetone	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
Benzene	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
Carbon disulfide	µg/L	ND	ND	ND	ND	ND	**0.8**	ND	ND
Chloroform	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
cis-1,2-Dichloroethene	µg/L	**0.5**	**1.4**	**0.9**	**0.34**	ND	ND	ND	**13.3**
trans-1,2-Dichloroethene	µg/L	ND	ND	ND	ND	ND	ND	ND	**1.1**
Ethylbenzene	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
Methylene chloride	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
Methyl tertiary butyl ether	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
n-butylbenzene	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
Tetrachloroethene	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
n-propylbenzene	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
sec-butylbenzene	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
tert-butylbenzene	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
Trichloroethene	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
Toluene	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
Vinyl chloride	µg/L	ND	ND	ND	ND	ND	ND	ND	**0.6**
Xylenes, Total	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
Petroleum Hydrocarbons									
TPHd	µg/L	ND	ND	**170**	ND	**380**	ND	ND	ND
TPHmo	µg/L	ND	**38**	**170**	ND	**1,900**	ND	ND	ND

TABLE 4-5
ANALYTICAL DATA FOR GROUNDWATER SAMPLES COLLECTED DURING ARMY / OBRA PHASE II INVESTIGATIONS
Oakland Army Base, Oakland, California

Chemicals of Concern (a)	Units	Sample Identification (b)							
		OBAS09 / IT10S106 (dup)	OBSB01	OBSB02	OBSB03	OBSB04	OBSB05	OBSB06	OBSB07
Inorganic Chemicals (b)									
Arsenic	µg/L	**5.3/6**	**13**	<10	<5	<5	<5	<10	<10
Manganese	µg/L	**1,090/1,020**	**160**	**34**	**77**	**640**	**1,200**	**130**	**3,400**
Thallium	µg/L	**2.8/2.6**	<4	<4	<2	<2	<2	<4	<4
Volatile Organic Compounds									
1,1-Dichloroethane	µg/L	ND/ND	ND	ND	ND	ND	ND	ND	ND
1,2,4-Trimethylbenzene	µg/L	ND/ND	**0.6**	**0.5**	ND	ND	ND	ND	**3.4**
1,3,5-Trimethylbenzene	µg/L	ND/ND	ND	ND	ND	ND	ND	ND	**0.8**
Acetone	µg/L	ND/ND	ND	ND	ND	ND	ND	ND	ND
Benzene	µg/L	ND/ND	ND	ND	ND	ND	ND	ND	ND
Carbon disulfide	µg/L	ND/ND	ND	ND	ND	ND	ND	ND	ND
Chloroform	µg/L	ND/ND	ND	ND	ND	ND	ND	ND	ND
cis-1,2-Dichloroethene	µg/L	**1.1/1.2**	ND	ND	ND	ND	ND	ND	ND
trans-1,2-Dichloroethene	µg/L	ND/ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	µg/L	ND/ND	ND	ND	ND	ND	ND	ND	ND
Methylene chloride	µg/L	ND/ND	ND	ND	ND	ND	ND	ND	ND
Methyl tertiary butyl ether	µg/L	ND/ND	ND	ND	ND	ND	ND	ND	ND
n-butylbenzene	µg/L	ND/ND	ND	ND	ND	ND	ND	ND	ND
Tetrachloroethene	µg/L	ND/ND	**1.3**	ND	ND	ND	ND	ND	ND
n-propylbenzene	µg/L	ND/ND	ND	ND	ND	ND	ND	ND	ND
sec-butylbenzene	µg/L	ND/ND	ND	ND	ND	ND	ND	ND	ND
tert-butylbenzene	µg/L	ND/ND	ND	ND	ND	ND	ND	ND	ND
Trichloroethene	µg/L	ND/ND	ND	ND	ND	ND	ND	ND	ND
Toluene	µg/L	ND/ND	ND	ND	ND	**0.9**	ND	ND	ND
Vinyl chloride	µg/L	ND/ND	ND	ND	ND	ND	ND	ND	**0.9**
Xylenes, Total	µg/L	ND/ND	**1.2**	**1.6**	ND	**0.6**	ND	ND	ND
Petroleum Hydrocarbons									
TPHd	µg/L	ND/ND	<50	<50	<50	<50	<50	<50	<50
TPHmo	µg/L	ND/ND	ND	ND	ND	ND	ND	ND	ND

TABLE 4-5

ANALYTICAL DATA FOR GROUNDWATER SAMPLES COLLECTED DURING ARMY / OBRA PHASE II INVESTIGATIONS

Oakland Army Base, Oakland, California

Chemicals of Concern (a)	Units	Sample Identification (b)							
		OBSB08	OBSB09	OBSB10	OBSB11	OBSB12	OBSB13	OBSB14	OBSB15
Inorganic Chemicals (b)									
Arsenic	µg/L	**8.6**	<5	-- (f)	--	--	<10	<10	<10
Manganese	µg/L	**250**	**7,500**	--	--	--	**6,500**	**280**	**2,000**
Thallium	µg/L	<2	<2	--	--	--	<4	<4	<4
Volatile Organic Compounds									
1,1-Dichloroethane	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
1,2,4-Trimethylbenzene	µg/L	ND	**0.6**	ND	**0.5**	**0.5**	**6**	ND	**0.8**
1,3,5-Trimethylbenzene	µg/L	ND	ND	ND	ND	ND	**2**	ND	ND
Acetone	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
Benzene	µg/L	ND	ND	**0.8**	**0.7**	ND	ND	ND	ND
Carbon disulfide	µg/L	ND	**0.5**	**3.3**	ND	ND	**0.5**	ND	ND
Chloroform	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
cis-1,2-Dichloroethene	µg/L	ND	ND	ND	**0.9**	ND	ND	ND	ND
trans-1,2-Dichloroethene	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	µg/L	ND	ND	**ND**	**ND**	ND	**2**	ND	ND
Methylene chloride	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
Methyl tertiary butyl ether	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
n-butylbenzene	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
Tetrachloroethene	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
n-propylbenzene	µg/L	ND	ND	ND	ND	ND	**0.6**	ND	**1.4**
sec-butylbenzene	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
tert-butylbenzene	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
Trichloroethene	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
Toluene	µg/L	ND	**0.8**	ND	**0.7**	ND	**6.5**	ND	ND
Vinyl chloride	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
Xylenes, Total	µg/L	ND	**0.6**	ND	**0.8**	ND	**14.2**	ND	ND
Petroleum Hydrocarbons									
TPHd	µg/L	<50	<50	--	--	--	<50	<50	<50
TPHmo	µg/L	ND	ND	ND	ND	ND	ND	ND	ND

TABLE 4-5
ANALYTICAL DATA FOR GROUNDWATER SAMPLES COLLECTED DURING ARMY / OBRA PHASE II INVESTIGATIONS
Oakland Army Base, Oakland, California

Chemicals of Concern (a)	Units	Sample Identification (b)							
		OBSB16 (dup)	OBMW01	OBMW02	ITMW237	ITMW239	ITMW238	ITMW241	ITMW242
Inorganic Chemicals (b)									
Arsenic	µg/L	<10/<10	<5	**13**	**19.3**	ND	ND	ND	ND
Manganese	µg/L	**680**	**3,600**	**250**	**857**	**1,580**	**3,120**	**238**	**438**
Thallium	µg/L	<4/<4	<2	<2	ND	ND	ND	ND	ND
Volatile Organic Compounds									
1,1-Dichloroethane	µg/L	ND/ND	ND	ND	ND	ND	ND	ND	ND
1,2,4-Trimethylbenzene	µg/L	ND/ND	ND	ND	ND	ND	ND	ND	ND
1,3,5-Trimethylbenzene	µg/L	ND/ND	ND	ND	ND	ND	ND	ND	ND
Acetone	µg/L	**<20/35.4**	ND	ND	ND	ND	ND	ND	ND
Benzene	µg/L	ND/ND	ND	ND	ND	ND	ND	ND	ND
Carbon disulfide	µg/L	ND/ND	ND	ND	ND	ND	ND	ND	ND
Chloroform	µg/L	**5.3/9.8**	ND	ND	ND	ND	ND	**0.4**	ND
cis-1,2-Dichloroethene	µg/L	ND/ND	ND	ND	ND	ND	ND	ND	ND
trans-1,2-Dichloroethene	µg/L	ND/ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	µg/L	ND/ND	ND	ND	ND	ND	ND	ND	ND
Methylene chloride	µg/L	ND/ND	ND	ND	ND	ND	ND	ND	ND
Methyl tertiary butyl ether	µg/L	ND/ND	ND	ND	ND	ND	ND	**0.98**	ND
n-butylbenzene	µg/L	ND/ND	ND	ND	ND	ND	ND	ND	ND
Tetrachloroethene	µg/L	ND/ND	ND	ND	ND	ND	ND	ND	ND
n-propylbenzene	µg/L	ND/ND	ND	ND	ND	ND	ND	ND	ND
sec-butylbenzene	µg/L	ND/ND	ND	ND	ND	ND	ND	ND	ND
tert-butylbenzene	µg/L	ND/ND	ND	ND	ND	ND	ND	ND	ND
Trichloroethene	µg/L	ND/ND	ND	ND	ND	ND	ND	ND	ND
Toluene	µg/L	**0.9/1.3**	ND	ND	ND	ND	ND	**0.25**	ND
Vinyl chloride	µg/L	ND/ND	ND	ND	ND	ND	ND	ND	ND
Xylenes, Total	µg/L	ND/ND	ND	ND	ND	ND	ND	ND	ND
Petroleum Hydrocarbons									
TPHd	µg/L	**110/142**	<50	<50	ND	ND	ND	ND	**10**
TPHmo	µg/L	ND/ND	ND	ND	ND	ND	ND	ND	**56**

TABLE 4-5
ANALYTICAL DATA FOR GROUNDWATER SAMPLES COLLECTED DURING ARMY / OBRA PHASE II INVESTIGATIONS
Oakland Army Base, Oakland, California

Chemicals of Concern (a)	Units	Sample Identification (b)							
		ITMW244 (dup)	ITMW243	ITMW245	ITMW246	ITMW247 (dup)	ITMW248 (dup)	ITMW249	ITMW251
Inorganic Chemicals (b)									
Arsenic	µg/L	ND/ND	ND	ND	**10.9**	**9.26/10.8**	ND/ND	**13.9**	**10.5**
Manganese	µg/L	**626/625**	**2,020**	**202**	**782**	**995/952**	**990/956**	**492**	**521**
Thallium	µg/L	**5.7/6.3**	ND	ND	ND	ND/ND	ND/ND	ND	ND
Volatile Organic Compounds									
1,1-Dichloroethane	µg/L	ND/ND	ND	ND	ND	ND/ND	ND/ND	ND	ND
1,2,4-Trimethylbenzene	µg/L	ND/ND	ND	ND	ND	ND/ND	ND/ND	ND	ND
1,3,5-Trimethylbenzene	µg/L	ND/ND	ND	ND	ND	ND/ND	ND/ND	ND	ND
Acetone	µg/L	ND/ND	ND	ND	ND	**3.7/3.6**	ND/ND	ND	ND
Benzene	µg/L	ND/ND	ND	ND	ND	ND/ND	ND/ND	ND	ND
Carbon disulfide	µg/L	ND/ND	ND	ND	ND	ND/ND	ND/ND	ND	ND
Chloroform	µg/L	ND/ND	ND	ND	**0.3**	**0.35/0.34**	ND/ND	ND	ND
cis-1,2-Dichloroethene	µg/L	**17/18.2**	**0.39**	ND	**0.33**	ND/ND	ND/ND	ND	ND
trans-1,2-Dichloroethene	µg/L	ND/ND	ND	ND	ND	ND/ND	ND/ND	ND	ND
Ethylbenzene	µg/L	ND/ND	ND	ND	ND	ND/ND	ND/ND	**0.46**	ND
Methylene chloride	µg/L	ND/ND	ND	ND	ND	ND/ND	ND/ND	ND	ND
Methyl tertiary butyl ether	µg/L	ND/ND	ND	ND	**2**	ND/ND	ND/ND	ND	ND
n-butylbenzene	µg/L	ND/ND	ND	ND	ND	ND/ND	ND/ND	ND	ND
Tetrachloroethene	µg/L	ND/ND	ND	ND	ND	ND/ND	ND/ND	ND	ND
n-propylbenzene	µg/L	ND/ND	ND	ND	ND	ND/ND	ND/ND	ND	ND
sec-butylbenzene	µg/L	ND/ND	ND	ND	ND	ND/ND	ND/ND	ND	ND
tert-butylbenzene	µg/L	ND/ND	ND	ND	ND	ND/ND	ND/ND	ND	ND
Trichloroethene	µg/L	ND/ND	ND	ND	**1.6**	ND/ND	ND/ND	ND	ND
Toluene	µg/L	ND/ND	ND	ND	ND	**0.28/ND**	ND/ND	**0.25**	ND
Vinyl chloride	µg/L	**3.8/4**	ND	ND	ND	ND/ND	ND/ND	ND	ND
Xylenes, Total	µg/L	ND/ND	ND	ND	ND	ND/ND	ND/ND	**0.52**	ND
Petroleum Hydrocarbons									
TPHd	µg/L	**16/40**	ND	ND	ND	ND/ND	ND/ND	**200**	ND
TPHmo	µg/L	**ND/37**	ND	ND	ND	ND/ND	ND/ND	ND	ND

TABLE 4-5
ANALYTICAL DATA FOR GROUNDWATER SAMPLES COLLECTED DURING ARMY / OBRA PHASE II INVESTIGATIONS
Oakland Army Base, Oakland, California

Chemicals of Concern (a)	Units	Sample Identification (b)							
		IT02S29	IT02S30	IT02S31	IT09S69	IT10S100	IT10S102	IT10S103	IT10S104
Inorganic Chemicals (b)									
Arsenic	µg/L	ND	ND	**3.76**	**13.7**	ND	--	--	--
Manganese	µg/L	**840**	**922**	**6.61**	**1,030**	**1,090**	--	--	--
Thallium	µg/L	**10.4**	**8.92**	**11.5**	ND	**6.1**	--	--	--
Volatile Organic Compounds									
1,1-Dichloroethane	µg/L	**1.8**	ND	ND	ND	ND	ND	ND	ND
1,2,4-Trimethylbenzene	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
1,3,5-Trimethylbenzene	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
Acetone	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
Benzene	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
Carbon disulfide	µg/L	ND	ND	ND	ND	**1.9**	ND	**0.4**	**0.4**
Chloroform	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
cis-1,2-Dichloroethene	µg/L	ND	ND	ND	ND	ND	**8.3**	**2**	ND
trans-1,2-Dichloroethene	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
Methylene chloride	µg/L	ND	ND	ND	ND	**0.5**	ND	ND	ND
Methyl tertiary butyl ether	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
n-butylbenzene	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
Tetrachloroethene	µg/L	ND	ND	ND	ND	ND	**0.7**	ND	ND
n-propylbenzene	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
sec-butylbenzene	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
tert-butylbenzene	µg/L	ND	**0.21**	ND	ND	ND	ND	ND	ND
Trichloroethene	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
Toluene	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
Vinyl chloride	µg/L	ND	ND	ND	ND	ND	**13.8**	ND	ND
Xylenes, Total	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
Petroleum Hydrocarbons									
TPHd	µg/L	ND	ND	ND	ND	**64**	--	--	--
TPHmo	µg/L	ND	ND	ND	ND	ND	--	--	--

TABLE 4-5
ANALYTICAL DATA FOR GROUNDWATER SAMPLES COLLECTED DURING ARMY / OBRA PHASE II INVESTIGATIONS
Oakland Army Base, Oakland, California

Chemicals of Concern (a)	Units	Sample Identification (b)							
		IT11S62	IT11S63	IT11S64	IT11S66	IT11S67	IT11S68	IT11S70 (dup)	IT11S71
Inorganic Chemicals (b)									
Arsenic	µg/L	**11**	**4.4**	**1.2**	**15**	**5.7**	ND	**12.3/12.4**	**25.7**
Manganese	µg/L	**543**	**267**	**601**	**1,830**	**120**	**436**	**274/229**	**274**
Thallium	µg/L	**3.2**	**2.2**	**6.2**	**5.8**	**3**	ND	ND/ND	**6.58**
Volatile Organic Compounds									
1,1-Dichloroethane	µg/L	ND	ND	ND	ND	ND	ND	ND/ND	ND
1,2,4-Trimethylbenzene	µg/L	ND	ND	ND	ND	ND	ND	ND/ND	ND
1,3,5-Trimethylbenzene	µg/L	ND	ND	ND	ND	ND	ND	ND/ND	ND
Acetone	µg/L	ND	ND	ND	ND	ND	ND	ND/ND	ND
Benzene	µg/L	ND	ND	ND	ND	ND	ND	ND/ND	ND
Carbon disulfide	µg/L	ND	ND	ND	ND	ND	ND	ND/ND	ND
Chloroform	µg/L	ND	ND	ND	ND	ND	ND	ND/ND	**0.3**
cis-1,2-Dichloroethene	µg/L	ND	ND	ND	**0.6**	ND	ND	ND/ND	ND
trans-1,2-Dichloroethene	µg/L	ND	ND	ND	ND	ND	ND	ND/ND	ND
Ethylbenzene	µg/L	**1**	ND	ND	ND	ND	ND	ND/ND	ND
Methylene chloride	µg/L	ND	ND	ND	ND	ND	ND	ND/ND	ND
Methyl tertiary butyl ether	µg/L	ND	ND	ND	ND	ND	ND	ND/ND	ND
n-butylbenzene	µg/L	ND	ND	ND	ND	ND	ND	ND/ND	ND
Tetrachloroethene	µg/L	ND	ND	ND	ND	ND	**0.6**	ND/ND	ND
n-propylbenzene	µg/L	ND	ND	ND	ND	ND	ND	ND/ND	ND
sec-butylbenzene	µg/L	ND	ND	ND	ND	ND	ND	ND/ND	ND
tert-butylbenzene	µg/L	ND	ND	ND	ND	ND	ND	ND/ND	ND
Trichloroethene	µg/L	ND	ND	ND	ND	ND	ND	ND/ND	ND
Toluene	µg/L	ND	ND	ND	ND	ND	**0.33**	ND/ND	ND
Vinyl chloride	µg/L	ND	ND	ND	ND	ND	ND	ND/ND	ND
Xylenes, Total	µg/L	ND	ND	ND	ND	ND	ND	ND/ND	ND
Petroleum Hydrocarbons									
TPHd	µg/L	**200**	**34**	**75**	**20**	**16**	ND	ND/ND	ND
TPHmo	µg/L	ND	ND	ND	ND	ND	ND	ND/ND	ND

TABLE 4-5
ANALYTICAL DATA FOR GROUNDWATER SAMPLES COLLECTED DURING ARMY / OBRA PHASE II INVESTIGATIONS
Oakland Army Base, Oakland, California

Chemicals of Concern (a)	Units	Sample Identification (b)							
		IT11S72	IT12S31	IT12S32	IT12S33	IT12S34	IT13S21	IT13S22	IT13S24
Inorganic Chemicals (b)									
Arsenic	µg/L	**10.1**	**13.5**	**26.4**	ND	**4.4**	**4.76**	ND	**6.8**
Manganese	µg/L	**2,330**	**8,490**	**12,400**	**9,730**	**1,660**	**15.6**	**95.2**	**117**
Thallium	µg/L	ND	**11.1**	**14.7**	ND	**2.2**	**14.1**	**6.57**	**2.9**
Volatile Organic Compounds									
1,1-Dichloroethane	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
1,2,4-Trimethylbenzene	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
1,3,5-Trimethylbenzene	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
Acetone	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
Benzene	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
Carbon disulfide	µg/L	ND	**0.91**	ND	ND	ND	ND	ND	ND
Chloroform	µg/L	ND	ND	ND	ND	ND	ND	**2.5**	ND
cis-1,2-Dichloroethene	µg/L	**0.36**	ND	ND	ND	ND	ND	ND	**57**
trans-1,2-Dichloroethene	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
Methylene chloride	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
Methyl tertiary butyl ether	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
n-butylbenzene	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
Tetrachloroethene	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
n-propylbenzene	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
sec-butylbenzene	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
tert-butylbenzene	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
Trichloroethene	µg/L	**0.31**	ND	ND	ND	ND	ND	**11**	ND
Toluene	µg/L	ND	ND	**0.5**	**0.26**	ND	**0.3**	**0.5**	ND
Vinyl chloride	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
Xylenes, Total	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
Petroleum Hydrocarbons									
TPHd	µg/L	ND	ND	ND	ND	**15**	ND	ND	**150**
TPHmo	µg/L	ND	ND	ND	ND	ND	ND	ND	ND

TABLE 4-5
ANALYTICAL DATA FOR GROUNDWATER SAMPLES COLLECTED DURING ARMY / OBRA PHASE II INVESTIGATIONS
Oakland Army Base, Oakland, California

Chemicals of Concern (a)	Units	Sample Identification (b)							
		IT13S25	IT14S01	IT14S02	IT16S56	IT16S57	IT23S04	IT23S05	IT23S06
Inorganic Chemicals (b)									
Arsenic	µg/L	**10.5**	ND	ND	ND	**7.9**	**15.3**	ND	**9.3**
Manganese	µg/L	**3,000**	**386**	**1,210**	**125**	**283**	**43.7**	**886**	**27.3**
Thallium	µg/L	ND	**7.46**	**7.4**	**4**	ND	**6.8**	ND	**1.3**
Volatile Organic Compounds									
1,1-Dichloroethane	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
1,2,4-Trimethylbenzene	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
1,3,5-Trimethylbenzene	µg/L	ND	ND	**0.32**	ND	ND	ND	ND	ND
Acetone	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
Benzene	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
Carbon disulfide	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
Chloroform	µg/L	ND	ND	ND	ND	ND	**3**	ND	**0.7**
cis-1,2-Dichloroethene	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
trans-1,2-Dichloroethene	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
Methylene chloride	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
Methyl tertiary butyl ether	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
n-butylbenzene	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
Tetrachloroethene	µg/L	ND	ND	ND	ND	**0.25**	ND	ND	ND
n-propylbenzene	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
sec-butylbenzene	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
tert-butylbenzene	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
Trichloroethene	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
Toluene	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
Vinyl chloride	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
Xylenes, Total	µg/L	ND	ND	**0.38**	ND	ND	ND	ND	ND
Petroleum Hydrocarbons									
TPHd	µg/L	ND	ND	ND	**31**	ND	**82**	ND	**21**
TPHmo	µg/L	ND	ND	ND	**57**	ND	ND	ND	**31**

TABLE 4-5
ANALYTICAL DATA FOR GROUNDWATER SAMPLES COLLECTED DURING ARMY / OBRA PHASE II INVESTIGATIONS
Oakland Army Base, Oakland, California

Chemicals of Concern (a)	Units	Sample Identification (b)							
		IT23S07	IT23S08	IT23S09	IT23S10	IT23S11	IT23S12	IT23S13	IT23S14
Inorganic Chemicals (b)									
Arsenic	µg/L	**5.2**	**9.6**	**10.1**	**3.4**	**4.6**	**1.5**	**12.3**	**11.3**
Manganese	µg/L	**1,110**	**1,140**	**69**	**53.4**	**1,100**	**265**	**108**	**234**
Thallium	µg/L	**5.3**	ND	**4.2**	ND	**5.9**	**3.2**	**3.5**	ND
Volatile Organic Compounds									
1,1-Dichloroethane	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
1,2,4-Trimethylbenzene	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
1,3,5-Trimethylbenzene	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
Acetone	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
Benzene	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
Carbon disulfide	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
Chloroform	µg/L	ND	ND	**0.9**	**30.4**	ND	ND	**0.9**	ND
cis-1,2-Dichloroethene	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
trans-1,2-Dichloroethene	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
Methylene chloride	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
Methyl tertiary butyl ether	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
n-butylbenzene	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
Tetrachloroethene	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
n-propylbenzene	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
sec-butylbenzene	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
tert-butylbenzene	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
Trichloroethene	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
Toluene	µg/L	**0.43**	**0.27**	ND	ND	ND	ND	ND	ND
Vinyl chloride	µg/L	ND	ND	ND	ND	ND	ND	ND	ND
Xylenes, Total	µg/L	ND	**0.26**	ND	ND	ND	ND	ND	ND
Petroleum Hydrocarbons									
TPHd	µg/L	**130**	ND	**23**	ND	ND	ND	**23**	ND
TPHmo	µg/L	**252**	ND	ND	ND	ND	ND	ND	ND

TABLE 4-5
ANALYTICAL DATA FOR GROUNDWATER SAMPLES COLLECTED DURING ARMY / OBRA PHASE II INVESTIGATIONS
Oakland Army Base, Oakland, California

Chemicals of Concern (a)	Units	Sample Identification (b)							
		IT24S14	IT24S15	IT25S15	A991S13	A991S14	A991S16	A991S17	A991S19
Inorganic Chemicals (b)									
Arsenic	µg/L	**2.7**	**9.3**	**1.8**	--	--	--	--	--
Manganese	µg/L	**110**	**157**	**14.2**	--	--	--	--	--
Thallium	µg/L	**5.2**	**2.1**	**2.9**	--	--	--	--	--
Volatile Organic Compounds									
1,1-Dichloroethane	µg/L	ND	ND	ND	--	--	--	--	--
1,2,4-Trimethylbenzene	µg/L	ND	ND	ND	--	--	--	--	--
1,3,5-Trimethylbenzene	µg/L	ND	ND	ND	--	--	--	--	--
Acetone	µg/L	ND	ND	ND	--	--	--	--	--
Benzene	µg/L	ND	ND	ND	--	--	--	--	--
Carbon disulfide	µg/L	ND	ND	ND	--	--	--	--	--
Chloroform	µg/L	ND	ND	ND	--	--	--	--	--
cis-1,2-Dichloroethene	µg/L	ND	ND	ND	--	--	--	--	--
trans-1,2-Dichloroethene	µg/L	ND	ND	ND	--	--	--	--	--
Ethylbenzene	µg/L	ND	ND	ND	--	--	--	--	--
Methylene chloride	µg/L	ND	ND	ND	--	--	--	--	--
Methyl tertiary butyl ether	µg/L	ND	ND	ND	--	--	--	--	--
n-butylbenzene	µg/L	ND	ND	ND	--	--	--	--	--
Tetrachloroethene	µg/L	ND	ND	ND	--	--	--	--	--
n-propylbenzene	µg/L	ND	ND	ND	--	--	--	--	--
sec-butylbenzene	µg/L	ND	ND	ND	--	--	--	--	--
tert-butylbenzene	µg/L	ND	ND	ND	--	--	--	--	--
Trichloroethene	µg/L	ND	ND	ND	--	--	--	--	--
Toluene	µg/L	ND	ND	ND	--	--	--	--	--
Vinyl chloride	µg/L	ND	ND	ND	--	--	--	--	--
Xylenes, Total	µg/L	ND	ND	ND	--	--	--	--	--
Petroleum Hydrocarbons									
TPHd	µg/L	**33**	**18**	**8**	**110**	**310**	**590**	**96**	**180**
TPHmo	µg/L	ND	ND	ND	**44**	**35**	**59**	ND	ND

TABLE 4-5
ANALYTICAL DATA FOR GROUNDWATER SAMPLES COLLECTED DURING ARMY / OBRA PHASE II INVESTIGATIONS
Oakland Army Base, Oakland, California

Chemicals of Concern (a)	Units	Sample Identification (b)							
		A991S20	A991S21	A991S22	ITT651S01	ITT651S02	ITT671S01	ITT673S01	ITT673S02
Inorganic Chemicals (b)									
Arsenic	µg/L	--	--	--	--	--	--	--	--
Manganese	µg/L	--	--	--	--	--	--	--	--
Thallium	µg/L	--	--	--	--	--	--	--	--
Volatile Organic Compounds									
1,1-Dichloroethane	µg/L	--	--	--	ND	ND	ND	ND	ND
1,2,4-Trimethylbenzene	µg/L	--	--	--	**0.26**	ND	ND	ND	ND
1,3,5-Trimethylbenzene	µg/L	--	--	--	ND	ND	ND	ND	ND
Acetone	µg/L	--	--	--	ND	ND	ND	ND	ND
Benzene	µg/L	--	--	--	ND	ND	ND	ND	ND
Carbon disulfide	µg/L	--	--	--	ND	ND	ND	ND	ND
Chloroform	µg/L	--	--	--	ND	ND	ND	ND	ND
cis-1,2-Dichloroethene	µg/L	--	--	--	ND	ND	ND	ND	ND
trans-1,2-Dichloroethene	µg/L	--	--	--	ND	ND	ND	ND	ND
Ethylbenzene	µg/L	--	--	--	**0.31**	ND	ND	ND	ND
Methylene chloride	µg/L	--	--	--	ND	ND	ND	**85**	ND
Methyl tertiary butyl ether	µg/L	--	--	--	ND	ND	ND	ND	ND
n-butylbenzene	µg/L	--	--	--	ND	ND	ND	ND	ND
Tetrachloroethene	µg/L	--	--	--	ND	ND	ND	ND	ND
n-propylbenzene	µg/L	--	--	--	ND	ND	ND	ND	ND
sec-butylbenzene	µg/L	--	--	--	ND	ND	ND	ND	ND
tert-butylbenzene	µg/L	--	--	--	ND	ND	ND	ND	ND
Trichloroethene	µg/L	--	--	--	ND	ND	ND	ND	ND
Toluene	µg/L	--	--	--	ND	ND	ND	ND	ND
Vinyl chloride	µg/L	--	--	--	ND	ND	ND	ND	ND
Xylenes, Total	µg/L	--	--	--	**0.31**	ND	ND	ND	ND
Petroleum Hydrocarbons									
TPHd	µg/L	**35**	**190**	**37**	**130**	**42**	**1,000**	**115,000**	**200**
TPHmo	µg/L	ND	ND	**66**	ND	ND	ND	**2,200**	ND

TABLE 4-5
ANALYTICAL DATA FOR GROUNDWATER SAMPLES COLLECTED DURING ARMY / OBRA PHASE II INVESTIGATIONS
Oakland Army Base, Oakland, California

Chemicals of Concern (a)	Units	Sample Identification (b)							
		ITT677S01	ITT677S02	ITT678S01 (dup)	ITT678S02	ITT679S01	ITT679S02	ITT682S01	ITT682S02
Inorganic Chemicals (b)									
Arsenic	µg/L	--	--	--	--	--	--	--	--
Manganese	µg/L	--	--	--	--	--	--	--	--
Thallium	µg/L	--	--	--	--	--	--	--	--
Volatile Organic Compounds									
1,1-Dichloroethane	µg/L	ND	ND	ND/ND	ND	ND	ND	ND	ND
1,2,4-Trimethylbenzene	µg/L	ND	ND	ND/ND	ND	ND	ND	ND	ND
1,3,5-Trimethylbenzene	µg/L	ND	ND	ND/ND	ND	ND	ND	ND	ND
Acetone	µg/L	ND	ND	**1,300/ND**	ND	ND	ND	ND	ND
Benzene	µg/L	ND	ND	ND/ND	ND	ND	ND	ND	ND
Carbon disulfide	µg/L	ND	ND	ND/ND	ND	ND	ND	ND	ND
Chloroform	µg/L	ND	ND	ND/ND	ND	ND	ND	ND	ND
cis-1,2-Dichloroethene	µg/L	ND	ND	ND/ND	ND	ND	ND	ND	ND
trans-1,2-Dichloroethene	µg/L	ND	ND	ND/ND	ND	ND	ND	ND	ND
Ethylbenzene	µg/L	ND	ND	ND/ND	ND	ND	ND	ND	ND
Methylene chloride	µg/L	ND	ND	**490/290**	ND	ND	ND	ND	ND
Methyl tertiary butyl ether	µg/L	ND	ND	ND/ND	ND	ND	ND	ND	ND
n-butylbenzene	µg/L	ND	ND	**320/290**	ND	ND	ND	**84**	ND
Tetrachloroethene	µg/L	ND	ND	**ND/390**	ND	ND	ND	ND	ND
n-propylbenzene	µg/L	ND	ND	ND/ND	ND	ND	ND	ND	ND
sec-butylbenzene	µg/L	ND	ND	**ND/170**	ND	ND	ND	**46**	ND
tert-butylbenzene	µg/L	ND	ND	ND/ND	ND	ND	ND	ND	ND
Trichloroethene	µg/L	ND	ND	**ND/46**	ND	ND	ND	ND	ND
Toluene	µg/L	ND	ND	ND/ND	ND	ND	ND	ND	ND
Vinyl chloride	µg/L	ND	ND	ND/ND	ND	ND	ND	ND	ND
Xylenes, Total	µg/L	ND	ND	ND/ND	ND	ND	**0.22**	ND	ND
Petroleum Hydrocarbons									
TPHd	µg/L	**320**	**510**	**1,220,000 (g)**	**570,000**	**610**	**3,200**	**440,000**	**470,000**
TPHmo	µg/L	ND	ND	**ND/940**	**24,000**	ND	**110**	**13,000**	ND

TABLE 4-5
ANALYTICAL DATA FOR GROUNDWATER SAMPLES COLLECTED DURING ARMY / OBRA PHASE II INVESTIGATIONS
Oakland Army Base, Oakland, California

Chemicals of Concern (a)	Units	Sample Identification (b)					
		ITT686S01	ITT686S02	ITT688S01	ITT688S02	ITT722S01	ITT722S02 (dup)
Inorganic Chemicals (b)							
Arsenic	µg/L	--	--	--	--	--	--
Manganese	µg/L	--	--	--	--	--	--
Thallium	µg/L	--	--	--	--	--	--
Volatile Organic Compounds							
1,1-Dichloroethane	µg/L	ND	ND	ND	ND	ND	ND/ND
1,2,4-Trimethylbenzene	µg/L	ND	ND	ND	ND	ND	ND/ND
1,3,5-Trimethylbenzene	µg/L	ND	ND	ND	ND	ND	ND/ND
Acetone	µg/L	ND	ND	**1,100**	**1,200**	ND	ND/ND
Benzene	µg/L	ND	ND	ND	ND	ND	ND/ND
Carbon disulfide	µg/L	ND	ND	ND	ND	ND	ND/ND
Chloroform	µg/L	ND	ND	ND	ND	ND	ND/ND
cis-1,2-Dichloroethene	µg/L	ND	ND	ND	ND	ND	ND/ND
trans-1,2-Dichloroethene	µg/L	ND	ND	ND	ND	ND	ND/ND
Ethylbenzene	µg/L	ND	ND	ND	ND	ND	ND/ND
Methylene chloride	µg/L	ND	ND	**350**	**560**	ND	ND/ND
Methyl tertiary butyl ether	µg/L	ND	ND	ND	ND	ND	ND/ND
n-butylbenzene	µg/L	ND	ND	ND	ND	ND	ND/ND
Tetrachloroethene	µg/L	ND	ND	ND	ND	ND	ND/ND
n-propylbenzene	µg/L	ND	ND	ND	**320**	ND	ND/ND
sec-butylbenzene	µg/L	ND	ND	ND	**390**	ND	ND/ND
tert-butylbenzene	µg/L	ND	ND	ND	ND	ND	ND/ND
Trichloroethene	µg/L	ND	ND	ND	ND	ND	ND/ND
Toluene	µg/L	ND	ND	ND	ND	ND	ND/ND
Vinyl chloride	µg/L	ND	ND	ND	ND	ND	ND/ND
Xylenes, Total	µg/L	ND	ND	ND	ND	ND	ND/ND
Petroleum Hydrocarbons							
TPHd	µg/L	**13,000**	**530,000**	**181,000**	**6,570,000**	ND	**200/300**
TPHmo	µg/L	**400**	**19,000**	**2,400**	**73,000**	ND	**170/260**

TABLE 4-5

ANALYTICAL DATA FOR GROUNDWATER SAMPLES COLLECTED DURING ARMY / OBRA PHASE II INVESTIGATIONS

Oakland Army Base, Oakland, California

Notes:

(a) Only selected chemicals analyzed in groundwater during the Army / OBRA Phase II Investigations are listed. Other organic chemicals detected only once or twice at minor concentrations are not listed and include total petroleum hydrocarbons as gasoline, fluoranthene, phenanthrene, benzo(b)fluroanthene, 1,1,1-trichloroethane, 1,2-dichloropropane, 1,4-dichlorobenzene, p-cymene, and isopropylbenzene. For complete laboratory analysis reports, see the Army and OBRA Phase II Investigation reports (IT, 2002a; EKI, 2002) and Appendix A.

(b) Groundwater samples analyzed for inorganic chemicals were either field filtered or collected from monitoring wells using low-flow sampling techniques.

(c) Samples were collected in May 2002, and the sampling depth varied from 5 to 10 feet below ground surface (see EKI, 2002; IT, 2002a).

(d) Laborary analytical results for samples with duplicate ("dup") analysis are indicated by a slash ("/") between the two values.

(e) "ND" indicates that the chemical was not detected above analytical method reporting limits.

(f) "--" indicated that the sample was not analyzed for the chemical of concern.

(g) The duplicate result total petroleum hydocarbons as diesel in this sample was 43,200 micrograms per liter.

TABLE 5-1
AMBIENT METAL CONCENTRATIONS IN SOIL

Oakland Army Base, Oakland, California

Metal	Background Concentration (mg/kg)		
	OARB (a) 95th Percentile	LBNL (b) 95th Percentile	Selected Value (c)
Antimony	2.2	5.5	2.2
Arsenic	17	19.1	17
Barium	260	--	260
Beryllium	0.95	1.0	0.95
Cadmium	1.6	2.7	1.6
Chromium	67	99.6	67
Cobalt	19	--	19
Copper	71	69.4	71
Lead	51	16.1	51
Manganese	960	--	960
Mercury	0.88	0.4	0.88
Molybdenum	--	--	--
Nickel	79	119.8	79
Selenium	2.4	5.6	2.4
Silver	--	1.8	1.8
Thallium	--	27.1	27.1
Vanadium	63	--	63
Zinc	160	106.1	160

Notes:

(a) Background concentrations for the OARB obtained from ICF Kaiser Engineers, April 1999, *Attachment A to the Risk Assessment Work Plan, Ambient Data Analysis for Soil, Oakland Army Base, California.*

(b) Background concentrations for Lawrence Berkeley National Laboratory ("LBNL") obtained from Lawrence Berkeley National Laboratory, 1995, *Protocol for Determining Background Concentrations of Metals in Soil at Lawrence Berkeley National Laboratory.*

(c) If possible, naturally occurring or background metal concentrations in soil are based on ICF Kaiser Engineers statistical analysis of data for background soil samples collected at the OARB.

TABLE 5-2
CHEMICALS OF CONCERN IN SOIL AT FORMER ORP / BUILDING 1 AREA
Oakland Army Base, Oakland, California

Chemical of Concern (a)	Samples Analyzed	Samples Detected	Detection Frequency (%)	Minimum Detected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	Residential PRG (mg/kg); (b)
Metals						
Antimony	48	18	37.5%	0.095	3.3	31
Arsenic	48	48	100.0%	1.4	31.3	0.39
Barium	48	48	100.0%	12.3	505	5,375
Beryllium	48	16	33.3%	0.13	1.03	154
Cadmium	48	28	58.3%	0.024	17	37
Chromium, Total	48	48	100.0%	0.21	213	211
Cobalt	48	48	100.0%	1.4	64.2	4,693
Copper	48	48	100.0%	2.8	104	2,905
Lead	48	48	100.0%	2.1	2,980 (c)	400
Manganese	30	30	100.0%	60	1,150	1,800
Mercury	48	46	95.8%	0.02	2.8	23
Molybdenum	48	13	27.1%	0.53	1.52	391
Nickel	48	48	100.0%	0.75	287	1,564
Selenium	48	39	81.3%	0.15	8.9	390
Silver	48	2	4.2%	1.4	1.9	391
Thallium	48	0	0.0%	ND (d)	ND	5.2
Vanadium	48	48	100.0%	2.8	46.5	547
Zinc	48	48	100.0%	16.3	988	23,000

TABLE 5-2
CHEMICALS OF CONCERN IN SOIL AT FORMER ORP / BUILDING 1 AREA
Oakland Army Base, Oakland, California

Chemical of Concern (a)	Samples Analyzed	Samples Detected	Detection Frequency (%)	Minimum Detected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	Residential PRG (mg/kg); (b)
Volatile Organic Compounds						
1,2,3-trichloropropane	46	1	2.2%	0.32	0.32	0.0014
1,2,4-trimethylbenzene	46	14	30.4%	0.001	10	52
1,3,5-trimethylbenzene	46	12	26.1%	0.001	3	21
Acetone	36	16	44.4%	0.014	0.66	1,570
Benzene	50	5	10.0%	0.002	0.12	0.65
Carbon disulfide	46	6	13.0%	0.0006	0.01	355
Carbon tetrachloride	46	1	2.2%	0.94	0.94	0.24
cis-1,2,-dichloroethene	46	1	2.2%	0.23	0.23	43
Ethylbenzene	50	11	22.0%	0.0004	2.1	230
Isopropylbenzene (Cumene)	46	9	19.6%	0.011	0.8	157
Methylene chloride	46	25	54.3%	0.001	0.74	8.9
Methyl ethyl ketone (2-butanone)	40	11	27.5%	0.00266	5.8	(b)
Methyl isobutyl ketone	46	7	15.2%	0.0008	0.017	790
n-propylbenzene	46	9	19.6%	0.02	1.5	145
p-cymene (p-isopropyltoluene)	46	11	23.9%	0.001	2.2	157
sec-butylbenzene	46	10	21.7%	0.001	1	111
Tetrachloroethene	46	1	2.2%	1.0	1.0	5.7
Toluene	50	10	20.0%	0.0007	0.57	520
Trichloroethene	46	2	4.3%	0.013	2	2.8
Xylenes, Total	50	15	30.0%	0.0008	8.5	210

TABLE 5-2
CHEMICALS OF CONCERN IN SOIL AT FORMER ORP / BUILDING 1 AREA
Oakland Army Base, Oakland, California

Chemical of Concern (a)	Samples Analyzed	Samples Detected	Detection Frequency (%)	Minimum Detected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	Residential PRG (mg/kg); (b)
Semi-volatile Organic Compounds						
Acenaphthene	66	1	1.5%	0.1	0.1	3,682
Acenaphthylene	66	1	1.5%	0.61	0.61	(e)
Anthracene	66	11	16.7%	0.022	0.33	21,896
Benzo(a)anthracene	66	17	25.8%	0.033	26.8	0.62
Benzo(a)pyrene	66	4	6.1%	0.035	1	0.062
Benzo(b)fluoranthene	66	14	21.2%	0.0008	0.51	0.62
Benzo(g,h,i)perylene	66	4	6.1%	0.036	0.22	(e)
Benzo(k)fluoranthene	66	9	13.6%	0.002	0.54	0.61
Chrysene	66	27	40.9%	0.002	11	62
Dibenz(a,h)anthracene	66	9	13.6%	0.039	7.6	0.062
Fluoranthene	66	25	37.9%	0.038	20.8	2,294
Fluorene	66	4	6.1%	0.019	0.519	2,644
Ideno(1,2,3-c,d)pyrene	66	2	3.0%	0.047	0.14	0.62
Naphthalene	112	24	21.4%	0.0004	7.7	56
Phenanthrene	66	21	31.8%	0.003	8.8	(e)
Pyrene	66	19	28.8%	0.024	27	2,309
Total Petroleum Hydrocarbons						
TPH Diesel	53	39	73.6%	2	63,000	(e)
TPH Motor Oil	57	45	78.9%	8	430,000	(e)
TPH Recoverable	2	1	50.0%	790	790	(e)

TABLE 5-2
CHEMICALS OF CONCERN IN SOIL AT FORMER ORP / BUILDING 1 AREA
Oakland Army Base, Oakland, California

Chemical of Concern (a)	Samples Analyzed	Samples Detected	Detection Frequency (%)	Minimum Detected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	Residential PRG (mg/kg); (b)
PCBs, Pesticides, and Herbicides						
(Note: one (1) detection of PCBs is noted in Army documents at the concentration of 0.22 mg/kg, but not found in database).						
Dioxin-like Compounds						
1,2,3,4,6,7,8-heptachlorodibenzofuran	18	9	50.0%	0.0000031	0.00062	0.000004 (f)
1,2,3,4,6,7,8-heptachlorodibenzo-p-dioxin	18	9	50.0%	0.0000068	0.0006	0.000004
1,2,3,4,7,8,9-heptachlorodibenzofuran	18	7	38.9%	0.0000032	0.00019	0.000004
1,2,3,4,7,8-hexachlorodibenzofuran	18	8	44.4%	0.000013	0.00072	0.000004
1,2,3,4,7,8-hexachlorodibenzo-p-dioxin	18	7	38.9%	0.0000094	0.000047	0.000004
1,2,3,6,7,8-hexachlorodibenzofuran	18	8	44.4%	0.0000062	0.0008	0.000004
1,2,3,6,7,8-hexachlorodibenzo-p-dioxin	18	8	44.4%	0.00001	0.00026	0.000004
1,2,3,7,8,9-hexachlorodibenzofuran	18	2	11.1%	0.0000056	0.0000071	0.000004
1,2,3,7,8,9-hexachlorodibenzo-p-dioxin	18	8	44.4%	0.0000041	0.0001	0.000004
1,2,3,7,8-pentachlorodibenzofuran	18	6	33.3%	0.0000058	0.00034	0.000004
1,2,3,7,8-pentachlorodibenzo-p-dioxin	18	8	44.4%	0.0000064	0.00015	0.000004
2,3,4,6,7,8-hexachlorodibenzofuran	18	8	44.4%	0.0000047	0.00063	0.000004
2,3,4,7,8-pentachlorodibenzofuran	18	8	44.4%	0.0000076	0.0006	0.000004
2,3,7,8-tetrachlorodibenzofuran	18	7	38.9%	0.000008	0.00013	0.000004
2,3,7,8-tetrachlorodibenzo-p-dioxin	18	10	55.6%	0.0000012	0.000026	0.000004
Heptachlorinated dibenzofurans, Total	5	4	80.0%	0.000052	0.00097	0.000004
Heptachlorinated dibenzo-p-dioxins, Total	5	4	80.0%	0.00012	0.0011	0.000004
Hexachlorinated dibenzofurans, Total	5	5	100.0%	0.00011	0.0039	0.000004
Hexachlorinated dibenzo-p-dioxins, Total	5	4	80.0%	0.00096	0.0023	0.000004
Octachlorodibenzofuran	18	6	33.3%	0.0000076	0.000089	0.000004
Octachlorodibenzo-p-dioxin	18	9	50.0%	0.000012	0.00024	0.000004

TABLE 5-2
CHEMICALS OF CONCERN IN SOIL AT FORMER ORP / BUILDING 1 AREA
Oakland Army Base, Oakland, California

Chemical of Concern (a)	Samples Analyzed	Samples Detected	Detection Frequency (%)	Minimum Detected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	Residential PRG (mg/kg); (b)
Dioxins						
Pentachlorinated dibenzofurans, Total	5	5	100.0%	0.00022	0.002	0.000004
Pentachlorinated dibenzo-p-dioxins, Total	5	4	80.0%	0.00052	0.0011	0.000004
Tetrachlorinated dibenzofurans, Total	5	5	100.0%	0.00013	0.0011	0.000004
Tetrachlorinated dibenzo-p-dioxins, Total	5	4	80.0%	0.00019	0.0006	0.000004

Notes:

(a) Screening to identify chemicals of concern performed on electronic database provided by IT Corporation on 5 March 2002. Refer to text of RAP for methodology employed to identify chemicals of concern.

(b) U.S. EPA Region IX Preliminary Remediation Goal ("PRG") for residential land use.

(c) Lead found in tarry waste material at 11,800 mg/kg in one sample, but not in database.

(d) Chemical has not been detected in soil samples at concentrations greater than analytical method reporting limits.

(e) No residential PRG is available for compound.

(f) Dioxin-like compounds are often found in complex mixtures. A toxicity equivalency procedure has been developed by U.S. EPA to describe the cumulative toxicity of these mixtures relative to the toxicity of 2,3,7,8-tetrachlorodibenzo-p-dioxin. PRG cited is for 2,3,7,8-tetrachlorodibenzo-p-dioxin.

TABLE 5-3
CHEMICALS OF CONCERN IN GROUNDWATER AT FORMER ORP / BUILDING 1 AREA
Oakland Army Base, Oakland, California

Chemical of Concern (a)	Samples Analyzed	Samples Detected	Detection Frequency (%)	Minimum Detected Concentration (µg/L)	Maximum Detected Concentration (µg/L)	MCL or twPRG (µg/L); (b); (c)
Metals						
Antimony	16	2	12.5%	(d)	(d)	6
Arsenic	16	3	18.8%	(d)	(d)	50
Barium	16	16	100.0%	(d)	(d)	1,000
Beryllium	16	0	0.0%	(d)	(d)	4
Cadmium	16	0	0.0%	(d)	(d)	5
Chromium, Total	17	7	41.2%	(d)	(d)	50
Cobalt	16	6	37.5%	(d)	(d)	2,200
Copper	16	15	93.8%	(d)	(d)	1,400
Lead	17	14	82.4%	(d)	(d)	(e)
Manganese	13	13	100.0%	(d)	(d)	880
Mercury	16	9	56.3%	(d)	(d)	2
Molybdenum	16	8	50.0%	(d)	(d)	180
Nickel	17	12	70.6%	(d)	(d)	100
Selenium	16	1	6.3%	(d)	(d)	180
Silver	16	2	12.5%	(d)	(d)	180
Thallium	16	5	31.3%	(d)	(d)	2
Vanadium	16	6	37.5%	(d)	(d)	260
Zinc	17	6	35.3%	(d)	(d)	11,000

TABLE 5-3
CHEMICALS OF CONCERN IN GROUNDWATER AT FORMER ORP / BUILDING 1 AREA
Oakland Army Base, Oakland, California

Chemical of Concern (a)	Samples Analyzed	Samples Detected	Detection Frequency (%)	Minimum Detected Concentration (µg/L)	Maximum Detected Concentration (µg/L)	MCL or twPRG (µg/L); (b); (c)
Volatile Organic Compounds						
1,2,4-trimethylbenzene	16	1	6.3%	3.2	3.2	120
1,3,5-trimethylbenzene	16	1	6.3%	0.7	0.7	120
1,2-dichloropropane	16	1	6.3%	0.6	0.6	(b)
Acetone	13	2	15.4%	31	32	610
Carbon disulfide	16	1	6.3%	0.5	0.5	1,000
cis-1,2-dichloroethene	16	2	12.5%	1.2	4.8	6
Methylene chloride	16	8	50.0%	0.5	2	5
Methyl isobutyl ketone	16	3	18.8%	5	6	160
Methyl teriary butyl ether	16	3	18.8%	2	2.1	6.2
n-propylbenzene	16	1	6.3%	0.6	0.6	61
p-cymene (p-isopropyltoluene)	16	1	6.3%	0.6	0.6	660
Toluene	21	1	4.8%	1	1	150
Vinyl chloride	16	2	12.5%	0.4	3.7	0.5
Xylenes, Total	21	2	9.5%	0.8	5	1,750
Semi-volatile Organic Compounds						
Chrysene	20	1	5.0%	3.1	3.1	9.2
Fluoranthene	20	1	5.0%	1.1	1.1	1,500
Naphthalene	35	2	5.7%	0.6	3	6.2
Phenanthrene	20	1	5.0%	0.7	0.7	(e)

TABLE 5-3
CHEMICALS OF CONCERN IN GROUNDWATER AT FORMER ORP / BUILDING 1 AREA
Oakland Army Base, Oakland, California

Chemical of Concern (a)	Samples Analyzed	Samples Detected	Detection Frequency (%)	Minimum Detected Concentration (µg/L)	Maximum Detected Concentration (µg/L)	MCL or twPRG (µg/L); (b); (c)
Total Petroleum Hydrocarbons						
TPH Diesel	18	13	72.2%	50	2,700	(e)
TPH Motor Oil	13	12	92.3%	140	6,500	(e)

Notes:

(a) Screening to identify chemicals of concern performed on electronic database provided by IT Corporation on 5 March 2002. Refer to text of RAP for methodology employed to identify chemicals of concern.

(b) Federal or State of California Maximum Contaminant Level ("MCL").

(c) U.S. EPA Region IX Preliminary Remediation Goal for tap water ("twPRG") when no MCL is available.

(d) All unfiltered and filtered groundwater metal data were retained in the COC database for purposes of identifying chemicals to be retained as COCs. However, summary statistics on metal concentrations in groundwater were not calculated because such statistics are not representative of dissolved concentrations due to artificially high concentrations of metals measured in unfiltered groundwater samples with excessive turbidity.

(e) No MCL or twPRG are available for compound.

TABLE 5-4
CHEMICALS OF CONCERN IN SOIL OUTSIDE FORMER ORP/BUILDING 1 AREA
Oakland Army Base, Oakland, California

Chemical of Concern (a)	Samples Analyzed	Samples Detected	Detection Frequency (%)	Minimum Detected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	Residential PRG (mg/kg); (b)
Metals						
Antimony	431	119	27.6%	0.091	673	31
Arsenic	452	331	73.2%	0.222	101	0.39
Barium	430	428	99.5%	4.77	2,952	5,375
Beryllium	418	198	47.4%	0.057	3.8	154
Cadmium	491	124	25.3%	0.01	8.45	37
Chromium, Total	544	526	96.7%	0.02	1,480	211
Cobalt	424	390	92.0%	0.54	1,000	4,693
Copper	428	406	94.9%	0.72	8,120	2,905
Lead	711	586	82.4%	0.0024	15,230	400
Manganese	250	250	100%	24.8	1,620	1,800
Mercury	438	317	72.4%	0.0047	147	23
Molybdenum	418	81	19.4%	0.071	13	391
Nickel	486	422	86.8%	0.24	380	1,564
Selenium	440	110	25.0%	0.2	55	390
Silver	457	47	10.3%	0.07	860	391
Thallium	418	20	4.8%	0.081	3.25	5.2
Vanadium	418	417	99.8%	2.3	104	547
Zinc	484	461	95.2%	0.34	11,050	23,000

TABLE 5-4
CHEMICALS OF CONCERN IN SOIL OUTSIDE FORMER ORP/BUILDING 1 AREA
Oakland Army Base, Oakland, California

Chemical of Concern (a)	Samples Analyzed	Samples Detected	Detection Frequency (%)	Minimum Detected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	Residential PRG (mg/kg); (b)
Volatile Organic Compounds						
1,1,2,2-tetrachloroethane (c)	516	4	0.8%	0.0083	0.067	0.38
1,1,2-trichloroethane (c)	516	0	0.0%	ND (d)	ND	0.84
1,1-dichloroethane (c)	539	0	0.0%	ND	ND	590
1,1-dichloroethene	539	1	0.2%	0.45	0.45	0.054
1,2,4-trimethylbenzene (c)	349	19	5.4%	0.00086	7.9	52
1,2-dichloroethane (c)	536	0	0.0%	ND	ND	0.35
1,3,5-trimethylbenzene (c)	349	15	4.3%	0.0009	2.1	21
Acetone	449	128	28.5%	0.005	0.377	1,570
Benzene	995	50	5.0%	0.0004	70	0.65
Bromodichloromethane (c)	533	1	0.2%	0.054	0.054	1.0
Carbon disulfide	450	31	6.9%	0.0008	0.023	355
Carbon tetrachloride (c)	516	1	0.2%	0.018	0.018	0.24
Chloroform (c)	541	3	0.6%	0.0007	0.00182	0.24
Dibromochloromethane (c)	497	0	0.0%	ND	ND	1.1
cis-1,2-dichloroethene (c)	489	11	2.2%	0.0007	0.052	43
trans-1,2-dichloroethene (c)	538	4	0.7%	0.007	0.047	63
Ethylbenzene	995	83	8.3%	0.00073	800	230
Isopropylbenzene (Cumene); (c)	225	8	3.6%	0.0011	13	157
Methyl ethyl ketone (2-butanone)	450	40	8.9%	0.00275	0.0655	(b)
Methyl isobutyl ketone	450	23	5.1%	0.0004	0.00225	790
Methyl teriary butyl ether (c)	330	14	4.2%	0.00077	2.7	16.7
Methylene chloride	575	99	17.2%	0.0004	0.39	8.9
n-butylbenzene (c)	226	11	4.9%	0.00098	31	145
n-propylbenzene (c)	225	11	4.9%	0.0019	37	145

TABLE 5-4
CHEMICALS OF CONCERN IN SOIL OUTSIDE FORMER ORP/BUILDING 1 AREA
Oakland Army Base, Oakland, California

Chemical of Concern (a)	Samples Analyzed	Samples Detected	Detection Frequency (%)	Minimum Detected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	Residential PRG (mg/kg); (b)
Volatile Organic Compounds						
p-cymene (p-isopropyltoluene)	225	4	1.8%	0.00069	1.2	157
sec-butylbenzene (c)	225	10	4.4%	0.0011	23	111
tert-Butylbenzene (c)	225	6	2.7%	0.00151	1.2	131
Tetrachloroethene (c)	589	31	5.3%	0.0005	0.032	5.7
Toluene	995	94	9.4%	0.0004	730	520
Trichloroethene (c)	547	15	2.7%	0.0016	0.46	2.8
Trichlorofluoromethane (c)	516	1	0.2%	0.00241	0.00241	386
Vinyl chloride (c)	539	5	0.9%	0.004	0.013	0.15
Xylenes, Total	995	120	12.1%	0.0005	4,300	210
Semi-volatile Organic Compounds						
Acenaphthene	493	14	2.8%	0.01	5.2	3,682
Acenaphthylene	493	10	2.0%	0.056	2.4	(e)
Anthracene	493	85	17.2%	0.0003	4.24	21,896
Benzidine	89	2	2.2%	6.3	48	0.002
Benzo(c)anthracene	493	134	27.2%	0.0006	4	0.62
Benzo(c)pyrene	493	124	25.2%	0.0007	2.6	0.062
Benzo(c)fluoranthene	470	142	30.2%	0.0003	3.3	0.62
Benzo(b,k)fluoranthene	23	2	8.7%	1.9	1.9	0.62
Benzo(g,h,i)perylene	493	74	15.0%	0.001	3	(e)
Benzo(k)fluoranthene	470	95	20.2%	0.0003	1.4	0.61
Bis(2-ethylhexyl)phthalate	142	16	11.3%	0.043	4.8	35
Chrysene	493	156	31.6%	0.0002	7.7	62
Dibenz(a,h)anthracene	464	58	12.5%	0.002	1.3	0.062

TABLE 5-4
CHEMICALS OF CONCERN IN SOIL OUTSIDE FORMER ORP/BUILDING 1 AREA
Oakland Army Base, Oakland, California

Chemical of Concern (a)	Samples Analyzed	Samples Detected	Detection Frequency (%)	Minimum Detected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	Residential PRG (mg/kg); (b)
Semi-volatile Organic Compounds						
Fluoranthene	493	131	26.6%	0.0008	130	2,294
Fluorene	493	29	5.9%	0.0006	55	2,644
Indeno(1,2,3-c,d)pyrene	493	78	15.8%	0.001	1.1	0.62
Naphthalene	695	26	3.7%	0.0005	6	56
Phenanthrene	493	151	30.6%	0.0007	280	(e)
Pyrene	493	148	30.0%	0.001	90	2,309
Total Petroleum Hydrocarbons						
TPH Diesel	1,245	425	34.1%	0.0031	11,000	(e)
TPH Gasoline	778	181	23.3%	0.00341	100,000	(e)
TPH Motor Oil	702	375	53.4%	2	28,000	(e)
TPH Recoverable	179	93	52.0%	0.094	22,000	(e)
PCBs, Pesticides, and Herbicides						
Aldrin	113	7	6.2%	0.002	0.16	0.03
Alpha BHC (c)	111	1	0.9%	0.02	0.02	(e)
Alpha endosulfan (Endosulfan I)	99	4	4.0%	0.0003	0.013	367
Alpha chlordane	41	15	36.6%	0.0007	3.4	1.6
Gamma chlordane	41	15	36.6%	0.0009	4.0	2
Dieldrin	113	21	18.6%	0.0004	11.4	0.03
Endosulfan sulfate (c)	111	3	2.7%	0.001	0.002	(e)
Endrin	111	5	4.5%	0.001	1.35	18
Endrin aldehyde	103	3	2.9%	0.001	0.05	(e)
Gamma BHC (Lindane)	113	5	4.4%	0.0004	0.02	0.44

TABLE 5-4
CHEMICALS OF CONCERN IN SOIL OUTSIDE FORMER ORP/BUILDING 1 AREA
Oakland Army Base, Oakland, California

Chemical of Concern (a)	Samples Analyzed	Samples Detected	Detection Frequency (%)	Minimum Detected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	Residential PRG (mg/kg); (b)
PCBs, Pesticides, and Herbicides						
Heptachlor	113	6	5.3%	0.0004	1.2	0.11
Heptachlor epoxide (c)	98	4	4.1%	0.0003	0.02	0.05
4,4'-DDD	113	27	23.9%	0.0003	5.3	2.4
4,4'-DDE	113	29	25.7%	0.0005	1.2	1.7
4,4'-DDT	113	29	25.7%	0.0006	10	1.7
Pentachlorophenol	38	23	60.5%	0.011	3.8	3.0
Toxaphene	113	0	0.0%	ND (d)	ND	0.44
PCB-1248 (Aroclor 1248)	147	2	1.4%	0.25	0.3	0.22
PCB-1260 (Aroclor 1260)	147	8	5.4%	0.016	0.3	0.22

Notes:

(a) Screening to identify chemicals of concern performed on electronic database provided by IT Corporation on 5 March 2002. Refer to text of RAP for methodology employed to identify chemicals of concern.

(b) U.S. EPA Region IX Preliminary Remediation Goal ("PRG") for residential land use.

(c) Chemical is retained as a chemical of concern because its presence has been detected in groundwater.

(d) Chemical has not been detected in soil samples at concentrations greater than analytical method reporting limits.

(e) No residential PRG is available for compound.

TABLE 5-5
CHEMICALS OF CONCERN IN GROUNDWATER OUTSIDE FORMER ORP/BUILDING 1 AREA
Oakland Army Base, Oakland, California

Chemical of Concern (a)	Samples Analyzed	Samples Detected	Detection Frequency (%)	Minimum Detected Concentration (µg/L)	Maximum Detected Concentration (µg/L)	MCL or twPRG (µg/L); (b); (c)
Metals						
Antimony	257	79	30.7%	(d)	(d)	6
Arsenic	336	245	72.9%	(d)	(d)	50
Barium	311	308	99.0%	(d)	(d)	1,000
Beryllium	257	45	17.5%	(d)	(d)	4
Cadmium	458	82	17.9%	(d)	(d)	5
Chromium, Total	458	201	43.9%	(d)	(d)	50
Cobalt	257	112	43.6%	(d)	(d)	2,200
Copper	301	182	60.5%	(d)	(d)	1,400
Lead	463	203	43.8%	(d)	(d)	(e)
Manganese	266	262	98.5%	(d)	(d)	880
Mercury	331	116	35.0%	(d)	(d)	2
Molybdenum	257	117	45.5%	(d)	(d)	180
Nickel	404	182	45.0%	(d)	(d)	100
Selenium	318	101	31.8%	(d)	(d)	180
Silver	311	77	24.8%	(d)	(d)	180
Thallium	256	43	16.8%	(d)	(d)	2
Vanadium	257	135	52.5%	(d)	(d)	260
Zinc	448	278	62.1%	(d)	(d)	11,000

TABLE 5-5
CHEMICALS OF CONCERN IN GROUNDWATER OUTSIDE FORMER ORP/BUILDING 1 AREA
Oakland Army Base, Oakland, California

Chemical of Concern (a)	Samples Analyzed	Samples Detected	Detection Frequency (%)	Minimum Detected Concentration (µg/L)	Maximum Detected Concentration (µg/L)	MCL or twPRG (µg/L); (b); (c)
Volatile Organic Compounds						
1,1,2,2-tetrachloroethane	781	10	1.3%	0.11	200	1
1,1,2-trichloroethane	781	6	0.8%	0.7	19	5
1,1-dichloroethane	788	14	1.8%	0.06	24	5
1,1-dichloroethene	802	19	2.4%	0.3	85.4	6
1,2,4-trimethylbenzene	514	84	16.3%	0.06	117	120
1,2-dichloroethane	802	25	3.1%	0.05	11	0.5
1,3,5-trimethylbenzene	514	49	9.5%	0.06	180	120
Acetone	549	94	17.1%	1.89	99	610
Benzene	1,564	312	19.9%	0.03	2,500	1
Bromodichloromethane	798	1	0.1%	1.8	2	0.18
Carbon tetrachloride	777	4	0.5%	0.4	29.2	0.5
Chloroform	798	28	3.5%	0.17	28	0.16
Dibromochloromethane	777	1	0.1%	0.6	1	0.13
cis-1,2-dichloroethene	656	211	32.2%	0.05	2,020	6
trans-1,2-dichloroethene	802	117	14.6%	0.08	300	10
Ethylbenzene	1,563	277	17.7%	0.06	91,300	700
Isopropylbenzene (Cumene)	444	27	6.1%	0.12	520,000	660
Methyl teriary butyl ether	704	224	31.8%	0.05	28,500	6.2
Methylene chloride	777	86	11.1%	0.3	8	5
n-butylbenzene	444	3	0.7%	1.05	7.3	61
n-propylbenzene	444	23	5.2%	0.05	73	61
p-cymene (p-isopropyltoluene)	444	9	2.0%	0.7	520,000	660
sec-butylbenzene	444	18	4.1%	0.47	570,000	61

TABLE 5-5
CHEMICALS OF CONCERN IN GROUNDWATER OUTSIDE FORMER ORP/BUILDING 1 AREA
Oakland Army Base, Oakland, California

Chemical of Concern (a)	Samples Analyzed	Samples Detected	Detection Frequency (%)	Minimum Detected Concentration (µg/L)	Maximum Detected Concentration (µg/L)	MCL or twPRG (µg/L); (b); (c)
Volatile Organic Compounds						
tert-butylbenzene	444	9	2.0%	0.6	580,000	61
Tetrachloroethene	790	45	5.7%	0.06	31	5
Toluene	1,567	365	23.3%	0.06	7,550	150
Trichloroethene	791	121	15.3%	0.08	363	5
Trichlorofluoromethane	776	1	0.1%	190	190	150
Vinyl chloride	801	153	19.1%	0.07	640	0.5
Xylenes, Total	1,562	412	26.4%	0.11	158,000	1,750
Semi-volatile Organic Compounds						
Acenaphthene	418	15	3.6%	0.3	41,000	370
Acenaphthylene	418	3	0.7%	0.19	0.66	(e)
Anthracene	418	33	7.9%	0.01	30,600	1,800
Benzo(a)anthracene	418	28	6.7%	0.04	44,900	0.092
Benzo(a)pyrene	418	11	2.6%	0.01	12	0.0092
Benzo(b)fluoranthene	378	11	2.9%	0.02	1300	0.092
Benzo(g,h,i)perylene	418	3	0.7%	0.04	8.6	(e)
Benzo(k)fluoranthene	378	6	1.6%	0.01	1,100	0.92
Bis(2-ethylhexyl)phthalate	89	8	9.0%	2.9	6.6	4.8
Chrysene	418	18	4.3%	0.02	6,900	9.2
Dibenzo(a,h)anthracene	394	1	0.3%	1.44	1.44	0.0092
Fluoranthene	418	40	9.6%	0.02	100,000	1,500
Fluorene	418	27	6.5%	0.08	35,000	290
Hexachlorobutadiene	560	1	0.2%	530	530	0.86
Indeno(1,2,3-c,d)pyrene	418	3	0.7%	0.07	6.5	0.092

TABLE 5-5
CHEMICALS OF CONCERN IN GROUNDWATER OUTSIDE FORMER ORP/BUILDING 1 AREA
Oakland Army Base, Oakland, California

Chemical of Concern (a)	Samples Analyzed	Samples Detected	Detection Frequency (%)	Minimum Detected Concentration (µg/L)	Maximum Detected Concentration (µg/L)	MCL or twPRG (µg/L); (b); (c)
Semi-volatile Organic Compounds						
Naphthalene	818	62	7.6%	0.18	115	62
Phenanthrene	418	44	10.5%	0.01	47,900	(e)
Pyrene	418	84	20.1%	0.02	195,000	180
Total Petroleum Hydrocarbons						
TPH Diesel	1,256	533	42.4%	8	641,000,000	(e)
TPH Gasoline	1,081	310	28.7%	7	58,000	(e)
TPH Motor Oil	627	265	42.3%	15	99,000	(e)
TPH Recoverable	197	23	11.7%	500	19,000	(e)
PCBs, Pesticides, and Herbicides						
Aldrin	119	12	10.1%	0.01	120	0.004
Alpha BHC	115	2	1.7%	0.01	0.01	(e)
Dieldrin	119	31	26.1%	0.01	180	0.0042
Endrin ketone	12	2	16.7%	0.02	0.02	(e)
Heptachlor	119	2	1.7%	0.01	0.01	0.01
4,4'-DDD	119	3	2.5%	0.03	230	0.28
4,4'-DDE	113	1	0.9%	12	12	0.2
4,4'-DDT	119	5	4.2%	0.02	360	0.2
Alpha endosulfan (Endosulfan I)	82	1	1.2%	0.01	0.01	220
Endosulfan sulfate	115	1	0.9%	0.73	0.73	220
Endrin	115	8	7.0%	0.04	0.1	2
Gamma BHC (Lindane)	119	1	0.8%	0.01	0.01	0.2

TABLE 5-5
CHEMICALS OF CONCERN IN GROUNDWATER OUTSIDE FORMER ORP/BUILDING 1 AREA
Oakland Army Base, Oakland, California

Notes:

(a) Screening to identify chemicals of concern performed on electronic database provided by IT Corporation on 5 March 2002. Refer to text of RAP for methodology employed to identify chemicals of concern.

(b) Federal or State of California Maximum Contaminant Level ("MCL").

(c) U.S. EPA Region IX Preliminary Remediation Goal for tap water ("twPRG") where no MCL is available.

(d) All unfiltered and filtered groundwater metal data were kept in the COC database for purposes of identifying chemicals to be retained as COCs. However, summary statistics on metal concentrations in groundwater were not calculated because such statistics are not representative of dissolved concentrations due to artificially high concentrations of metals measured in unfiltered groundwater samples with excessive turbidity.

(e) No MCL or twPRG are available for compound.

TABLE 5-6
CHEMICALS IN SOIL ELIMINATED AS A RESULT OF CHEMICAL OF CONCERN SCREENING
Oakland Army Base, Oakland, California

Chemical (a)	Samples Analyzed	Samples Detected	Detection Frequency (%)	Maximum Detected Concentration (mg/kg)	Residential PRG (mg/kg)
Former ORP / Building 1 Area					
1,2,4-trichlorobenzene	72	1	1.4%	0.00584	646
2-hexanone	46	2	4.3%	0.009	(b)
Chloroform	46	1	2.2%	0.01	0.24
Trichlorofluoromethane	46	1	2.2%	0.0021	386
Vinyl acetate	46	1	2.2%	6	426
Outside Former ORP / Building 1 Area					
1,1,1-trichloroethane	524	1	0.2%	0.00233	635
1,2,3,4,6,7,8-heptachlorodibenzofuran	2	1	50.0%	0.0000108	0.000004
1,2,3,4,6,7,8-heptachlorodibenzo-p-dioxin	2	2	100.0%	0.000057	0.000004
1,2,3,4,7,8,9-heptachlorodibenzofuran	2	1	50.0%	0.00000061	0.000004
1,2,3,4,7,8-hexachlorodibenzofuran	2	1	50.0%	0.0000011	0.000004
1,2,3,4,7,8-hexachlorodibenzo-p-dioxin	2	1	50.0%	0.00000032	0.000078
1,2,3,6,7,8-hexachlorodibenzofuran	2	1	50.0%	0.000001	0.000004
1,2,3,6,7,8-hexachlorodibenzo-p-dioxin	2	1	50.0%	0.0000015	0.000004
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	2	1	50.0%	0.00000099	0.000004
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	2	1	50.0%	0.00000036	0.000004
1,2,3-trichlorobenzene	352	2	0.6%	0.00245	(b)
1,2,4-trichlorobenzene	368	3	0.8%	0.0046	646
1,2-dichlorobenzene	801	6	0.7%	0.69	370
1,3-dichlorobenzene	776	2	0.3%	0.0038	13
1,4-dichlorobenzene	776	6	0.8%	0.42	3.4
2,3,4,6,7,8-hexachlorodibenzofuran	2	1	50.0%	0.0000019	0.000004
2,3,4,7,8-pentachlorodibenzofuran	2	1	50.0%	0.0000008	0.000004
2,3,7,8-tetrachlorodibenzofuran	2	1	50.0%	0.0000012	0.000004
2,3,7,8-tetrachlorodibenzo-p-dioxin	2	1	50.0%	0.0000017	0.000004

TABLE 5-6
CHEMICALS IN SOIL ELIMINATED AS A RESULT OF CHEMICAL OF CONCERN SCREENING
Oakland Army Base, Oakland, California

Chemical (a)	Samples Analyzed	Samples Detected	Detection Frequency (%)	Maximum Detected Concentration (mg/kg)	Residential PRG (mg/kg)
Outside Former ORP / Building 1 Area					
2-chlorotoluene	226	1	0.4%	0.15	158
2-hexanone	450	1	0.2%	0.005	(b)
2-methylnaphthalene	141	6	4.3%	0.728	(b)
2-nitroaniline	141	1	0.7%	0.019	3.5
4-chlorotoluene	226	1	0.4%	0.00095	(b)
Bromobenzene	341	1	0.3%	0.00073	28
Carbazole	34	1	2.9%	0.7	24
Chlorobenzene	659	10	1.5%	0.97	152
Dibenzofuran	141	5	3.5%	48	291
Octachlorodibenzofuran	2	1	50.0%	0.0000267	0.000004
Octachlorodibenzo-p-dioxin	2	2	100.0%	0.000353	0.000004
Phenol	142	2	1.4%	0.36	36662
Styrene	450	1	0.2%	0.0051	1,700
Vinyl acetate	354	3	0.8%	0.0109	426

Notes:

(a) Chemicals included in this table were eliminated as chemicals of concern because the detection frequency was less than 5%, the maximum detected concentrations were less than U.S. EPA Region IX Preliminary Remediation Goals ("PRGs") for residential land use, and chemicals were not believed to be plausibly associated with chemical releases at the OARB.

(b) No residential PRG is available for compound.

TABLE 5-7
CHEMICALS IN GROUNDWATER ELIMINATED AS A RESULT OF CHEMICAL OF CONCERN SCREENING
Oakland Army Base, Oakland, California

Chemical (a)	Samples Analyzed	Samples Detected	Detection Frequency (%)	Maximum Detected Concentration (µg/L)	MCL or twPRG (µg/L)
Former ORP / Building 1 Area					
1,3-dichlorobenzene	23	1	4.3%	0.6	6
1,4-dichlorobenzene	23	1	4.3%	0.5	5
Outside Former ORP / Building 1 Area					
1,1,1-trichloroethane	777	1	0.1%	0.9	200
1,1,2-trichloro-1,2,2-trifluoroethane	518	9	1.7%	3.3	1,200
1,2,3-trichlorobenzene	514	4	0.8%	0.5	(b)
1,2-dichlorobenzene	1,030	22	2.1%	35.5	600
1,2-dichloropropane	715	14	2.0%	2.7	5
1,3-dichlorobenzene	1,013	4	0.4%	3	6
1,4-dichlorobenzene	1,009	12	1.2%	2.8	5
2-chlorophenol	103	1	1.0%	7.5	30
2-chlorotoluene	444	1	0.2%	0.08	120
2-hexanone	610	4	0.7%	17	(b)
2-methylnaphthalene	101	2	2.0%	0.8	(b)
4-chloro-3-methylphenol	103	1	1.0%	5.9	(b)
4-nitrophenol	103	1	1.0%	27	290
Benzoic acid	93	2	2.2%	1.5	150,000
Benzyl alcohol	93	1	1.1%	5.4	11,000
Benzylbutylphthalate	110	2	1.8%	20	7,300
Carbon disulfide	605	28	4.6%	29	1,000
Chlorobenzene	909	13	1.4%	60	110
Chloromethane	649	10	1.5%	1.09	2
Diethylphthalate	103	1	1.0%	9.52	29,000
Methyl ethyl ketone (2-butanone)	591	7	1.2%	12	1,900
Methyl isobutyl ketone	610	14	2.3%	0.87	160

TABLE 5-7
CHEMICALS IN GROUNDWATER ELIMINATED AS A RESULT OF CHEMICAL OF CONCERN SCREENING
Oakland Army Base, Oakland, California

Chemical (a)	Samples Analyzed	Samples Detected	Detection Frequency (%)	Maximum Detected Concentration (µg/L)	MCL or twPRG (µg/L)
Outside Former ORP / Building 1 Area					
Phenol	103	2	1.9%	34	22,000
Styrene	610	16	2.6%	0.14	100
Vinyl acetate	497	3	0.6%	8	410

Notes:

(a) Chemicals included in this table were eliminated as chemicals of concern because the detection frequency was less than 5%, the maximum detected concentrations were less than federal or State of California Maximum Contaminant Levels ("MCLs") or U.S. EPA Region IX Preliminary Remediation Goals for tap water ("twPRGs"), if no MCLs have been promulgated, and chemicals were not believed to be plausibly associated with chemical releases at the OARB.

(b) No MCL or twPRG are available for compound.

TABLE 6-1
APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (a)

Oakland Army Base, Oakland, California

ARAR or TBC	Citation or Authority	Type	Locations (b)	Description
Chemical-Specific ARARs and TBCs				
• RWQCB, San Francisco Bay Region, Water Quality Control Plan ("Basin Plan") - Chapter 3	Porter-Cologne Water Quality Control Act promulgated under California Water Code.	See appropriate sections of the Basin Plan listed below.	Locations for appropriate sections of the Basin Plan are listed below.	The Basin Plan identifies beneficial water uses in the San Francisco Bay Area. Chapter 3 of the Basin Plan sets forth water quality objectives for surface waters and groundwaters.
--Pages 3-5 to 3-7: Objectives for Groundwaters	Basin Plan, pp. 3-5 to 3-7.	applicable, chemical-specific	All OBRA locations.	Page 3-6 of the Basin Plan states that at a minimum, groundwaters designated for use as domestic or municipal supply shall not contain concentrations of organic and inorganic chemical constituents in excess of contaminant levels set forth in Table 3-5 of the Basin Plan.
• California Toxics Rule	40 CFR §131.38(b)(1), (2).	applicable, chemical-specific	All OBRA locations.	The final rule, Establishment of Numeric Criteria for Priority Toxic Pollutants for the State of California, "California Toxics Rule," 65 Fed. Reg. 31682 (May 18, 2000) sets forth freshwater and saltwater criterion maximum concentrations and criterion continuous concentrations for a number of metals and chemical compounds. These include arsenic, chromium (III), chromium (VI), copper, cyanide, lead, zinc, carbon tetrachloride, asbestos, and PCBs. See Table, 65 Fed. Reg. at 31712-31715. 40 CFR § 131.38(b)(1). These standards may apply to any impacted groundwater at OARB locations. The enforcement of the federal rule was delegated to the RWQCB.
• Toxic Substances Control Act	15 USC §§ 2602, 2605(e) (regulation of PCBs); 40 CFR 761.1-761.3 (definitions) & Subparts C (§§ 761.40-.45) (marking of PCBs and PCB items), D (§§ 761.50-.79) (storage and disposal of PCBs), G (§§ 761.120-.135) (PCB spill cleanup policy), J & K (§§ 761.180-.193, 202-.218) (PCB record keeping, monitoring and reports), N-R (§§ 761.260-.359) (sampling and analysis of PCB waste).	relevant and appropriate, chemical specific to be considered, chemical-specific (Subpart G spill cleanup standards)	Locations with PCBs.	TSCA regulates the use and disposal of various chemicals, including PCBs. Subpart D of 40 CFR Part 761 outlines disposal and cleanup procedures for "PCB remediation waste" (i.e. waste with a PCB concentration of at least 50 ppm) [40 CFR §§ 761.60-.61] and prohibits the unpermitted discharge of PCBs to navigable waters or a treatment works at more than 3 ppb concentration [id. § 761.50(a)(3)]. Certain PCB remediation waste in soil must be cleaned up and disposed of in accordance with Section 761.61. Certain liquid PCB remediation waste must be incinerated or otherwise disposed of in accordance with Section 761.60(a) or (e) [id. § 761.61(b)]. Subpart G establishes standards for cleanup of certain PCB spills of at least 50 ppm concentration occurring after May 4, 1987. Subparts J and K impose notification and reporting requirements under specified circumstances on facilities using or disposing PCBs. TSCA also contains specified requirements for labeling of containers and equipment with PCB-containing materials, and of transport vehicles carrying a certain amount of liquid PCBs (id. § 761.40).

TABLE 6-1
APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (a)

Oakland Army Base, Oakland, California

ARAR or TBC	Citation or Authority	Type	Locations (b)	Description
• OARB Fuel Storage Tank Sites Cleanup Levels, IT Corporation, Corrective Action Plan ("CAP") for Petroleum Tank Sites, February 2000.	Porter-Cologne Water Quality Control Act promulgated under California Water Code.	to be considered, chemical-specific	OBRA locations with petroleum hydrocarbons.	The Corrective Action Plan presents cleanup levels for petroleum (gasoline and fuel oil) locations at the OARB. Soil and groundwater cleanup levels are presented. The CAIR states that the RWQCB approved the cleanup levels in the CAP. The RWQCB has accepted values within this TPH goal for tank site closures completed at OARB.
• Oakland Urban Land Redevelopment Program	Guidance Document prepared by the City of Oakland Public Works Agency, January 2000.	to be considered, chemical-specific	All OBRA locations.	The Oakland Urban Land Redevelopment Program guidance document was prepared by the City of Oakland Public Works Agency to assist in the cleanup and redevelopment of contaminated property by applying risk-based corrective action at Oakland locations.
• RWQCB Risk-based Screening Levels ("RBSLs")	Porter-Cologne Water Quality Control Act promulgated under California Water Code.	to be considered, chemical-specific	All OBRA locations.	The RWQCB prepared the RBSLs to assist in the evaluation of chemical risks at a site. RBSLs are not cleanup levels. RBSLs can be used as cleanup levels if site-specific cleanup levels are not available.

TABLE 6-1
APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (a)

Oakland Army Base, Oakland, California

ARAR or TBC	Citation or Authority	Type	Locations (b)	Description
Location-Specific ARARs and TBCs				
• RWQCB, San Francisco Bay Region, Water Quality Control Plan ("Basin Plan") - Chapter 4	Porter-Cologne Water Quality Control Act promulgated under California Water Code.	See appropriate sections of the Basin Plan listed below.	Locations for appropriate sections of the Basin Plan are listed below.	Chapter 4 of the Basin Plan sets forth discharge prohibitions throughout the San Francisco Bay region. The discharge prohibitions apply to groundwater at certain OARB locations, including the potential discharge of contaminated groundwater into clean groundwater.
--Pages 4-49 to 4-51, Wetlands Protection and Management.	Basin Plan, pp. 4-49 to 4-51.	applicable, location-specific	Off-site area east of Building 991	The Basin Plan reaffirms the goal of the California Wetlands Conservation Policy of ensuring no overall net loss of wetlands.
• SWRCB Resolution No. 88-63	Authority: Porter-Cologne Water Quality Control Act promulgated under California Water Code.	applicable, location-specific	All areas at OARB locations for which groundwater data are available.	The resolution states that all surface and ground waters of the State are considered to be suitable, or potentially suitable, for municipal or domestic water supply, unless the surface or groundwaters contain total dissolved solids in excess of 3,000 mg/L, the waters contain high levels of contamination, or the water source does not provide sufficient water to supply a well capable of producing 200 gallons per day.
• National Historic Preservation Act	16 USC §§ 470-470x-6; 36 CFR §§ 800.1-.16, 60.2 (effect of listing in National Register), 65.2 (effect of designation as National Historic Landmark), 68.1-.4 (Dept. of Interior standards for historic property projects assisted by the National Historic Preservation Fund).	applicable, location-specific	Applicable to portions of the OARB that are designated in the National Register as an historic landmark.	Under Section 106 of the NHPA, federal agencies and departments that have authority over proposed federal/federally-assisted undertakings affecting historical properties must take into account the effect of the undertakings on the National Historic Landmark ("NHL") (the "Section 106 Process"), and must afford the Advisory Council on Historic Preservation an opportunity to comment on those undertakings (16 USC § 470f; 36 CFR §§ 800.1-800.16). Federal agencies also must take steps to preserve historic properties "owned or controlled by such agency." (16 USC § 470h-2). In addition, federal agencies must ensure that their contractors and employees meet professional preservation standards in dealing with historical properties (16 USC § 470h-4). The U.S. Army's action at the OARB—disposal and transfer of government property—is a federal undertaking. The Army has completed the NHPA consultation process in connection with its Environmental Impact Statement ("EIS") supporting transfer of the base to OBRA.

TABLE 6-1
APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (a)

Oakland Army Base, Oakland, California

ARAR or TBC	Citation or Authority	Type	Locations (b)	Description
• Archeological and Historic Preservation Act	16 USC §§ 469-469c-2; 43 CFR §§ 7.1-.37 (Dept. of Interior regulations for protection of archeological and historic resources).	applicable, location-specific	Applicable to areas of the OARB in which the federal agency's construction or other licensed project may cause irreparable loss of historical or archeological data.	AHPA requires federal agencies, prior to engaging in activities that could cause irreparable loss of scientific, prehistorical, historical, or archeological data, to notify the Secretary of the Interior of the threatened data and the proposed activities, and to preserve the data or request that the Secretary do so (16 USC § 469a-1(a)). The Department of Interior then must conduct a survey and recovery efforts (or cause them to be conducted) if it finds that the data is significant and may be irrevocably lost without such action (16 USC § 469a-2). Department of Interior regulations at 43 CFR Sections 7.1-.37 support both AHPA and ARPA, and are discussed in more detail below.
• Archeological Resources Protection Act	16 USC §§ 470aa-470mm; 43 CFR §§ 7.1-.37 (Dept. of Interior regulations for protection of archeological and historic resources).	applicable, location-specific	Potentially all OARB locations. The Army's completed EIS process, and its completed consultation with the State Historic Preservation Officer, has verified there are no archeological resources at OARB.	ARPA prohibits excavation of, damage to, or destruction of archeological resources on public lands without a permit issued by the federal land manager (16 USC §§ 470cc(a), 470ee(a)), although no permit is required if the activities in question take place under another permit, license or entitlement for use, and the activities are exclusively for purposes other than the excavation and removal of archeological resources (even if there is incidental disturbance of archeological resources) (43 CFR § 7.5(b)(1)). ARPA requires the permittee to be qualified in archeological methods and to turn over all archeological resources to a scientific or educational institution (id. §§ 7.6, 7.8, 7.9). All archeological resources collected on public lands remain the property of the United States (id. § 7.13), and information regarding the nature or location of the resources may not be made public (id. § 7.18). ARPA also requires notification to Native American tribes if the locations affected have religious or cultural importance to that tribe (id. § 7.7).
• Native American Graves Protection and Repatriation Act ("NAGPRA")	25 USC §§ 3001-3013; 43 CFR §§10.1-.17	applicable, location-specific	Potentially all OARB locations.	NAGPRA establishes a system for determining ownership and proper disposal/removal of Native American cultural items discovered on Federal lands (§ 3002) , and requires inventorying and identification of those items (§§ 3003-3004). Such items must be returned to the relevant tribe, if possible (§ 3005). The federal agency also must conduct certain consultation with the affected tribe, if applicable (43 CFR § 10.5).

TABLE 6-1
APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (a)

Oakland Army Base, Oakland, California

ARAR or TBC	Citation or Authority	Type	Locations (b)	Description
• Federal Coastal Zone Management Act; California Gov. Code, title 7.2 (including McAteer-Petris Act); San Francisco Bay Conservation and Development Commission's ("BCDC") San Francisco Bay Plan.	16 USC §§ 1453, 1456; Cal. Gov. Code §§ 66602.1, 66605, 66632; Code Cal. Code Regs., title. 14 §§ 10300-10316; BCDC's San Francisco Bay Plan's Water Quality Policies (pp. 10-11), Recreation Policies (pp. 32-35), Public Access Policies (pp. 36-37).	applicable, location-specific	Certain OARB locations within the jurisdiction of the BCDC.	Remedial actions performed in areas under the jurisdiction of BCDC (e.g., within 100 feet of the Bay) must comply with the CZMA and BCDC's San Francisco Bay Plan. Activities that place fill, extract materials, or make any substantial change in use of any water, land or structure within BCDC's jurisdiction require a permit. BCDC's policies include: protecting and increasing wetlands, maintenance of Bay water quality, protecting the Bay through erosion control, minimizing the impact of polluted runoff from projects, increasing recreational opportunities adjacent to the Bay, and providing maximum public access to the Bay. Cal. Gov. Code § 6602.1 states that if development is proposed for salt ponds and managed wetlands, the project should retain as much water surface area as consistent with the project. Section 66605 limits filling the San Francisco Bay.
• Migratory Bird Treaty Act	16 USC §§ 703-708; 50 CFR §§ 10.12, 10.13.	applicable, location-specific	Certain OARB locations with trees in which birds nest.	The Migratory Bird Treaty Act prohibits the taking of migratory birds, their nests and their eggs, unless permitted by the Secretary of the Interior.
• Amended Reuse Plan	*Amended Draft Final Reuse Plan for the Oakland Army Base,* OBRA, 23 July 2001.	to be considered, location-specific	All OARB locations.	The Amended Reuse Plan describes the intended redevelopment of the OARB. Remedial actions implemented at the base should be compatible with planned land uses in this document.

TABLE 6-1
APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (a)

Oakland Army Base, Oakland, California

ARAR or TBC	Citation or Authority	Type	Locations (b)	Description
Action-Specific ARARs and TBCs				
• Basin Plan - Chapter 4	Porter-Cologne Water Quality Control Act promulgated under California Water Code.	See appropriate sections of the Basin Plan listed below.	Locations for appropriate sections of the Basin Plan are listed below.	Chapter 4 of the Basin Plan sets forth discharge prohibitions throughout the San Francisco Bay region.
--Pages 4-8 to 4-11: Effluent limitations	Basin Plan, pp. 4-8 to 4-11, 4-13 to 4-14.	applicable, action-specific	For alternatives at locations that include groundwater, dewatering, or construction stormwater discharges.	This is an ARAR for alternatives involving a discharge. Pages 4-8 to 4-11 set forth effluent limitations for discharges to ocean waters and discharges to the San Francisco Bay. Pages 4-1 to 4-14 set forth requirements for the implementation of effluent limitations. In addition, pages 4-14 to 4-15 of the Basin Plan affirm that the Regional Board regulates construction stormwater discharges through NPDES permits and requires the use of controls to reduce pollutants in stormwater.
--Pages 4-17 to 4-18: Discharge of Treated Groundwater. Table 4-1; Discharge Prohibitions.	Basin Plan, pp. 4-17 to 4-18; Table 4-1.	applicable, action-specific	Locations with potential discharge of treated groundwater	Remediation efforts at OARB locations may include groundwater extraction, and thus the need for proper disposal of treated groundwater. The Basin Plan requires the discharger to minimize the discharge of toxic substances. Table 4-1 more broadly describes discharge prohibitions, e.g., with respect to toxic substances, solid wastes, silt, sediments, oil, and petroleum byproducts. Page 4-17 of the Basin Plan refers to SWRCB Resolution No. 88-160, Disposal of Extracted Groundwater from Clean-up Projects, which urges dischargers of groundwater extracted from site clean-up projects to reclaim their effluent. It states that when reclamation is not feasible, discharges must be piped to a municipal treatment plant. If neither reclamation nor discharge to a municipal plant is feasible, the Regional Board will issue NPDES permits authorizing discharge from these sites. Page 4-32 states that an NPDES permit will be required for the discharge of stormwater from construction activities involving disturbance of five acres or greater total land area or that are part of a larger common plan of development that disturbs greater than five acres of total land area. Pages 4-40 to 4-41 state that the Regional Board may impose further conditions, restrictions, or limitations on waste disposal or other activities that might degrade water quality. Pages 4-58 to 4-59 discuss the Regional Board's strategies for managing the cleanup of polluted sites, including the setting of groundwater and soil clean-up levels.

TABLE 6-1
APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (a)

Oakland Army Base, Oakland, California

ARAR or TBC	Citation or Authority	Type	Locations (b)	Description
• SWRCB Resolution No. 68-16	Authority: Porter-Cologne Water Quality Control Act promulgated under California Water Code.	applicable, action-specific	Locations with groundwater discharge	This resolution, the Antidegradation policy, implements the requirement contained in 40 CFR § 131.12 that existing instream water uses and the level of water quality necessary to protect existing uses be maintained and protected. The Antidegradation policy applies to both surface and groundwater. It may apply to cleanup activities that lead to discharge of pollutants into State waters, e.g., the San Francisco Bay, including groundwater. Under this resolution, discharge of contaminated groundwater is not permitted to high quality groundwater, unless it is in the public interest to allow such a discharge.
• SWRCB Resolution No. 92-49	Authority: Porter-Cologne Water Quality Control Act promulgated under California Water Code.	applicable, action-specific	OARB locations where groundwater impacts are identified	Resolution No. 92-49 establishes policies and procedures for investigating and remediating chemical releases that affect or threaten water quality. In particular, it sets forth procedures that the Regional Water Board shall apply in determining whether a person shall be required to investigate a discharge, or to clean up waste and abate the effects of a discharge under Water Code Section 13304, and the procedures the Regional Water Board shall follow in reviewing investigative and cleanup and abatement proposals.
• EBMUD Sanitary Sewer Discharge Limitations	EBMUD Ordinance No. 311. Authority: Public Utilities Code of the State of California, Division 6	relevant and appropriate, action-specific	Locations where remediation activities will involve discharge of contaminated groundwater or wastewater from dewatering to the sewer; all locations where groundwater monitoring or testing is part of the remedy.	EBMUD rules, regulations, and ordinances prohibit the discharge of storm, drainage, and groundwater to community sewer systems. The maximum strength of wastewater that can be discharged to the community sewer is identified in the ordinance. The ordinance allows EBMUD to enter into an agreement under "unusual conditions" that compels special terms and conditions and charges for the interception, treatment, and disposal of wastewater by EBMUD. A site-specific permit is typically required for such discharges.

TABLE 6-1
APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (a)

Oakland Army Base, Oakland, California

ARAR or TBC	Citation or Authority	Type	Locations (b)	Description
• Hazardous Waste Requirements	Cal. Health & Safety Code §§ 25100-25249, 25250-25250.26, 25260-25929; 22 CCR §§ 66260.1-68500.35 (standards for management of hazardous waste). Federal statutes may apply to areas not covered by state program, or where incorporated by reference [see 42 USC §§ 6901-6991i; 40 CFR Parts 260-282; 49 CFR Parts 172, 173, 178, 179 (transportation)].	relevant and appropriate, action-specific	Specific locations with action-specific regulatory requirements are identified in the rows below.	California's hazardous waste control laws and regulations have been enacted to function in lieu of federal RCRA pursuant to 42 USC § 6926. Health & Safety (H&S) Code Sections 25110 to 25124 contain definitions of terms (e.g. "waste," "hazardous waste," "hazardous waste facility") used generally throughout the statutes and regulations. The term "hazardous waste" includes, but is not limited to, any substance qualifying as a "hazardous waste" under RCRA. See H&S Code §§ 25117(b).
--Generation, Transport and Disposal regulations	Cal. Health & Safety Code §§ 25100-25166.5, 25179.1-.12 (land disposal restrictions ("LDRs")), 25244-25244.24 (waste reduction and recycling); 22 CCR §§ 66260.10-66262.41, 66264.1-.172, 66265.16-.199; 66268.10-.44, .105-.113 (LDRs + treatment standards); 49 CFR Parts 172, 173, 178, 179 (transportation) [incorporated by reference]	relevant and appropriate, action-specific	Relevant to any location where remedial action results in generation, transport, or disposal of hazardous wastes.	Generators of hazardous waste must observe certain requirements in accumulating, storing, marking and treating the waste while on-site, and in preparing and labeling the waste for transport and disposal off-site. (H&S Code §§ 25123.3 (accumulation); 25123.5 & 25201 (treatment); 25160-25166.5 (transport), 25244.4; 22 CCR §§ 66260.200; 66262.10-.41; 66264.1-.172; 66265.170-.177 (container storage), .190-.199 (tank storage)). Persons responsible for handling and transporting waste must receive appropriate training, and contingency/emergency planning and procedures must be in place (22 CCR §§ 66262.34; 66265.16, .30-.37, .50-.56). Required records must be kept (22 CCR 66262.40). These requirements may be relevant and appropriate to any future generation of hazardous wastes through remediation activities at the OARB (e.g. during drilling and excavating), including manifesting and transporting those wastes off site (22 CCR §§ 66262.10-66262.47).

TABLE 6-1
APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (a)

Oakland Army Base, Oakland, California

ARAR or TBC	Citation or Authority	Type	Locations (b)	Description
Hazardous Waste Requirements (contd) --Corrective Action Management Units ("CAMU")	22 CCR §§ 66264.552	relevant and appropriate, action-specific	Former Oil Reclaiming Plant ("ORP") near Building 1	22 CCR § 66264.552 identifies regulations regarding the on-site placement of remediation waste in a designated CAMU. Placement of remediation wastes within a CAMU does not constitute land disposal. CAMU designation would require DTSC and US EPA review and approval. Site-specific closure requirements are developed for each CAMU.
• Solid (Non-Hazardous) Waste Requirements	Cal. Pub. Res. Code §§ 40000-40201, 43000-44820; 27 CCR §§ 20005-22278	relevant and appropriate, action-specific.	Boiler Debris near Building 99, and potentially other locations.	The regulations require owners and operators of solid (non-hazardous) waste management units (e.g. landfills) that were operating or had received permits for construction or operation on or before November 27, 1984 (see 27 CCR § 20080(d)) to take certain actions during closure or post-closure maintenance of those units (see §§ 20950-21420). The solid waste management, closure and post-closure maintenance regulations are not applicable to the solid waste landfills and other solid waste management units at the OARB because these ceased to operate prior to November 1984. Requirements governing closure and post closure of solid waste management units may be relevant and appropriate to the closure and remediation/excavation of all landfills and other waste management units.

TABLE 6-1
APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (a)

Oakland Army Base, Oakland, California

ARAR or TBC	Citation or Authority	Type	Locations (b)	Description
• Federal Clean Air Act, certain Bay Area Air Quality Management District ("BAAQMD") Regulations	BAAQMD Regulations	Potential applicability is identified in the following rows.	Specific locations with action-specific regulatory requirements are identified in the following rows.	Implementation of Federal Clean Air Act requirements has been delegated, in part, to California. The BAAQMD is the local implementing agency. Where BAAQMD requirements have been incorporated into the State Implementation Plan ("SIP") and approved by EPA, they are federally-enforceable. Where BAAQMD requirements have not been incorporated into the SIP and approved by EPA, they are not federally-enforceable. Several BAAQMD rules and regulations regarding remedial actions are discussed below.
-- Air Requirements	BAAQMD Regulation 6	relevant and appropriate, action-specific	All locations where earthwork or other acts of remediation and removal of soil and debris may occur.	BAAQMD's Regulation 6 limits emissions of particulates (Regulation 6). Excavation and removal of material during remediation activities may result in emissions of particulates. Regulation 6 is not SIP-approved and is not a federally enforceable requirement.
-- Air Requirements	BAAQMD Regulation 7; Regulation 8, Rule 40; and Regulation 9, Rule 2.	Regulation 7 and Regulation 9, Rule 2, relevant and appropriate, action-specific; Regulation 8, Rule 40 (in a prior form), applicable, action-specific	ORP/Building 1 area	Certain BAAQMD regulations limit emissions of pollutants, e.g., odorous substances (Regulation 7), organic compounds (Regulation 8, Rule 40), and hydrogen sulfide (Regulation 9, Rule 2). Excavation and removal of material from landfills may result in emissions of these pollutants. Maintenance of landfills left in place (possibly Landfill E) may also result in such emissions. Regulations 7, and 9, Rule 2, are not SIP-approved. Regulation 8, Rule 40, was approved into the SIP on December 14, 1997 (as amended on June 15, 1994). The current District version of Regulation 8, Rule 40, as amended on December 15, 1999, was submitted to EPA for approval into the SIP on March 28, 2000.
-- Air Requirements	BAAQMD Regulation 8, Rule 15	relevant and appropriate, action-specific	All OARB locations where remediation activities include asphaltic paving.	BAAQMD Regulation 8 (Organic Compounds), Rule 15 (Emulsified and Liquid Asphalts), prohibits the use of certain types of liquid and emulsified asphalts (those that would emit relatively large amounts of organic compounds). The Trust may need to consider use of asphalts not prohibited by this rule. This rule was approved into the SIP on March 22, 1995, as amended by the BAAQMD on June 1, 1994.

TABLE 6-1
APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (a)

Oakland Army Base, Oakland, California

Notes:

(a) Abbreviations used in this table are as follows:

AHPA	Archeological and Historic Preservation Act
ARAR	Applicable or Relevant and Appropriate Requirement
ARPA	Archeological Resources Protection Act
BAAQMD	Bay Area Air Quality Management District
BCDC	San Francisco Bay Conservation and Development Commission
CAIR	Corrective Action Implementation Report
CAP	Corrective Action Plan
CAMU	Corrective Action Management Unit
CCR	California Code of Regulations
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COC	Chemical of concern
CTR	California Toxics Rule
CZMA	Coastal Zone Management Act
EIS	Environmental Impact Statement
H&S	Health and Safety
LDR	Land Disposal Restrictions
NAGPRA	Native American Graves Protection and Repatriation Act
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NHL	National Historic Landmark
NHPA	National Historic Preservation Act
NPDES	National Pollutant Discharge Elimination System
OARB	Oakland Army Base
OBRA	Oakland Base Reuse Authority
ORP	Oil Reclaiming Plant
OSWER	Office of Solid Waste and Emergency Response
PCBs	Polychlorinated biphenyls
RBSL	Risk-based Screening Level
RCRA	Resource Conservation and Recovery Act
RWQCB	California Environmental Protection Agency, Regional Water Quality Control Board, San Francisco Bay Region
SIP	State Implementation Plan
SWRCB	California Environmental Protection Agency, State Water Resources Control Board
TBC	To-Be-Considered
TSCA	Toxic Substances Control Act
U.S. EPA	United States Environmental Protection Agency
USACE	U.S. Army Corps of Engineers
USC	United States Code

(b) Locations for remote staging areas will be identified prior to remedial activities. Remote staging areas will have similar action- and chemical-specific ARARs and TBCs as the primary remedial site. Location-specific ARARs and TBCs may be more or less stringent, depending on the location of the staging area.

TABLE 6-2
NUMERIC VALUES OF POTENTIAL CHEMICAL-SPECIFIC ARARs (a)
Oakland Army Base, Oakland, California

Chemical of Concern	Clean Water Act					Toxic Substances Control Act (mg/kg); (d)
	RWQCB Basin Plan Surface Water Quality Objectives		California Toxics Rule			
	Salinity Greater than 5 parts-per-thousand (µg/L); (b)	Salinity Less than 5 parts-per-thousand (µg/L); (b)	Freshwater (µg/L); (c)	Saltwater (µg/L); (c)	Human Health Risk (µg/L); (c)	
Metals						
Antimony	-- (e)	--	--	--	14	--
Arsenic	36	190	190	36	--	--
Barium	--	--	--	--	--	--
Beryllium	--	--	--	--	--	--
Cadmium	9.3	1.1 (f)	1.1 (f)	9.3	--	--
Chromium, Total	50	11	11	50	--	--
Cobalt	--	--	--	--	--	--
Copper	4.9	11.8 (f)	7	2.9	1,300	--
Lead	5.6	3.2 (f)	3.2 (f)	5.6	--	--
Manganese	--	--	--	--	--	--
Mercury	0.025	0.025 (g)	0.025 (g)	0.025	0.05	--
Molybdenum	--	--	--	--	--	--
Nickel	8.3	158 (f)	56	7.1	610	--
Selenium	--	--	5	71	--	--
Silver	2.3	4.1 (f)	1.2	2.3	--	--
Thallium	--	--	--	--	1.7	--
Vanadium	--	--	--	--	--	--
Zinc	58	106 (f, h)	58	58	--	--
Volatile Organic Compounds						
1,1,2,2-tetrachloroethane	--	--	--	--	0.17	--
1,1,2-trichloroethane	--	--	--	--	0.6	--
1,1-dichloroethane	--	--	--	--	--	--
1,1-dichloroethene	--	--	--	--	0.057	--
1,2,3-trichloropropane	--	--	--	--	--	--
1,2,4-trimethylbenzene	--	--	--	--	--	--
1,2-dichloroethane	--	--	--	--	0.38	--
1,2-dichloropropane	--	--	--	--	0.52	--
1,3,5-trimethylbenzene	--	--	--	--	--	--
Acetone	--	--	--	--	--	--
Benzene	--	--	--	--	1.2	--
Bromodichloromethane	--	--	--	--	0.56	--
Carbon disulfide	--	--	--	--	--	--
Carbon tetrachloride	--	--	--	--	0.25	--
Chloroform	--	--	--	--	--	--
Dibromochloromethane	--	--	--	--	0.401	--
cis-1,2-dichloroethene	--	--	--	--	--	--
trans-1,2-dichloroethene	--	--	--	--	--	--

NUMERIC VALUES OF POTENTIAL CHEMICAL-SPECIFIC ARARs (a)

Oakland Army Base, Oakland, California

	Clean Water Act					
	RWQCB Basin Plan Surface Water Quality Objectives		California Toxics Rule			
Chemical of Concern	Salinity Greater than 5 parts-per-thousand (µg/L); (b)	Salinity Less than 5 parts-per-thousand (µg/L); (b)	Freshwater (µg/L); (c)	Saltwater (µg/L); (c)	Human Health Risk (µg/L); (c)	Toxic Substances Control Act (mg/kg); (d)
Volatile Organic Compounds						
Ethylbenzene	--	--	--	--	3,100	--
Isopropylbenzene (Cumene)	--	--	--	--	--	--
Methyl ethyl ketone	--	--	--	--	--	--
Methyl isobutyl ketone	--	--	--	--	--	--
Methyl tertiary butyl ether	--	--	--	--	--	--
Methylene chloride	--	--	--	--	4.7	--
n-propylbenzene	--	--	--	--	--	--
p-cymene (p-isopropyltoluene)	--	--	--	--	--	--
n-butylbenzene	--	--	--	--	--	--
sec-butylbenzene	--	--	--	--	--	--
tert-butylbenzene	--	--	--	--	--	--
Tetrachloroethene	--	--	--	--	0.8	--
Toluene	--	--	--	--	6,800	--
Trichloroethene	--	--	--	--	2.7	--
Trichlorofluoromethane	--	--	--	--	--	--
Vinyl chloride	--	--	--	--	2	--
Xylenes, Total	--	--	--	--	--	--
Semi-volatile Organic Compounds						
Acenaphthene	--	--	--	--	1,200	--
Acenaphthylene	--	--	--	--	--	--
Anthracene	--	--	--	--	9,600	--
Benzidine	--	--	--	--	0.00012	--
Benzo(a)anthracene	--	--	--	--	0.0044	--
Benzo(a)pyrene	--	--	--	--	0.0044	--
Benzo(b)fluoranthene	--	--	--	--	0.0044	--
Benzo(b,k)fluoranthene	--	--	--	--	0.0044	--
Benzo(g,h,i)perylene	--	--	--	--	--	--
Benzo(k)fluoranthene	--	--	--	--	0.0044	--
Bis(2-ethylhexyl)phthalate	--	--	--	--	1.8	--
Chrysene	--	--	--	--	0.0044	--
Dibenz(a,h)anthracene	--	--	--	--	0.0044	--
Fluoranthene	--	--	--	--	300	--
Fluorene	--	--	--	--	1,300	--
Hexachlorobutadiene	--	--	--	--	0.44	--

TABLE 6-2
NUMERIC VALUES OF POTENTIAL CHEMICAL-SPECIFIC ARARs (a)
Oakland Army Base, Oakland, California

	Clean Water Act					
	RWQCB Basin Plan Surface Water Quality Objectives		California Toxics Rule			
Chemical of Concern	Salinity Greater than 5 parts-per-thousand (µg/L); (b)	Salinity Less than 5 parts-per-thousand (µg/L); (b)	Freshwater (µg/L); (c)	Saltwater (µg/L); (c)	Human Health Risk (µg/L); (c)	Toxic Substances Control Act (mg/kg); (d)
Semi-volatile Organic Compounds						
Indeno(1,2,3-c,d)pyrene	--	--	--	--	0.0044	--
Naphthalene	--	--	--	--	--	--
Phenanthrene	--	--	--	--	--	--
Pyrene	--	--	--	--	960	--
Total Petroleum Hydrocarbons						
TPH Diesel	--	--	--	--	--	--
TPH Gasoline	--	--	--	--	--	--
TPH Motor Oil	--	--	--	--	--	--
TPH Recoverable	--	--	--	--	--	--
PCBs, Pesticides, and Herbicides						
Aldrin	--	--	--	--	0.00013	--
Alpha BHC	--	--	--	--	0.0039	--
Alpha endosulfan (Endosulfan I)	--	--	0.056	0.0087	110	
Alpha chlordane	--	--	0.0043	0.09	0.00057	--
Gamma chlordane	--	--	0.0043	0.09	0.00057	--
Dieldrin	--	--	0.056	0.0019	0.00014	--
Endosulfan sulfate	--	--	0.056	0.0087	110	--
Endrin	--	--	0.036	0.0023	0.76	--
Endrin aldehyde	--	--	--	--	0.76	--
Endrin ketone	--	--	--	--	--	--
Gamma BHC (Lindane)	--	--	--	--	0.019	--
Heptachlor	--	--	0.0038	0.0036	0.00021	--
Heptachlor epoxide	--	--	0.0038	0.0036	0.0001	--
4,4'-DDD	--	--	--	--	0.00083	--
4,4'-DDE	--	--	--	--	0.00059	--
4,4'-DDT	--	--	0.001	0.001	0.00059	--
Pentachlorophenol	--	--	15	7.9	0.28	--
Toxaphene	--	--	0.0002	0.0002	0.00073	--
PCB-1248 (Aroclor 1248)	--	--	0.014	0.03	0.00017	1, 25
PCB-1260 (Aroclor 1260)	--	--	0.014	0.03	0.00017	1, 25

TABLE 6-2
NUMERIC VALUES OF POTENTIAL CHEMICAL-SPECIFIC ARARs (a)
Oakland Army Base, Oakland, California

	Clean Water Act					
	RWQCB Basin Plan Surface Water Quality Objectives		California Toxics Rule			
Chemical of Concern	Salinity Greater than 5 parts-per-thousand (μg/L); (b)	Salinity Less than 5 parts-per-thousand (μg/L); (b)	Freshwater (μg/L); (c)	Saltwater (μg/L); (c)	Human Health Risk (μg/L); (c)	Toxic Substances Control Act (mg/kg); (d)
Dioxin-like Compounds						
1,2,3,4,6,7,8-heptachlorodibenzofuran	--	--	--	--	--	--
1,2,3,4,6,7,8-heptachlorodibenzo-p-dioxin	--	--	--	--	--	--
1,2,3,4,7,8,9-heptachlorodibenzofuran	--	--	--	--	--	--
1,2,3,4,7,8-hexachlorodibenzofuran	--	--	--	--	--	--
1,2,3,6,7,8-hexachlorodibenzofuran	--	--	--	--	--	--
1,2,3,6,7,8-hexachlorodibenzo-p-dioxin	--	--	--	--	--	--
1,2,3,7,8,9-hexachlorodibenzofuran	--	--	--	--	--	--
1,2,3,7,8,9-hexachlorodibenzo-p-dioxin	--	--	--	--	--	--
1,2,3,7,8-pentachlorodibenzofuran	--	--	--	--	--	--
1,2,3,7,8-pentachlorodibenzo-p-dioxin	--	--	--	--	--	--
2,3,4,6,7,8-hexachlorodibenzofuran	--	--	--	--	--	--
2,3,4,7,8-pentachlorodibenzofuran	--	--	--	--	--	--
2,3,7,8-tetrachlorodibenzofuran	--	--	--	--	--	--
2,3,7,8-tetrachlorodibenzo-p-dioxin	--	--	--	--	--	--
Heptachlorinated dibenzofurans, Total	--	--	--	--	--	--
Heptachlorinated dibenzo-p-dioxins, Total	--	--	--	--	--	--
Hexachlorinated dibenzofurans, Total	--	--	--	--	--	--
Hexachlorinated dibenzo-p-dioxins, Total	--	--	--	--	--	--
Octachlorodibenzofuran	--	--	--	--	--	--
Octachlorodibenzo-p-dioxin	--	--	--	--	--	--
Pentachlorinated dibenzofurans, Total	--	--	--	--	--	--
Pentachlorinated dibenzo-p-dioxins, Total	--	--	--	--	--	--
Tetrachlorinated dibenzofurans, Total	--	--	--	--	--	--
Tetrachlorinated dibenzo-p-dioxins, Total	--	--	--	--	--	--

TABLE 6-2
NUMERIC VALUES OF POTENTIAL CHEMICAL-SPECIFIC ARARs (a)
Oakland Army Base, Oakland, California

Notes:

(a) Numeric values for chemical-specific ARARs are listed in this table.

μg/L = microgram per liter
mg/kg = milligram per kilogram

(b) Water quality objectives for surface waters are from Table 3-3 and 3-4 of RWQCB *Water Quality Control Plan, San Francisco Bay Basin,* amended 16 April 1997 ("Basin Plan"). Values are for chronic toxicity to aquatic organisms, except for total polycyclic aromatic hydrocarbon criteria which are for protection of human health, based on setting the acceptable lifetime risk for cancer to one-in-a-million (i.e., 0.031 ug/L for salinity greater and less than 5 parts-per-thousand).

(c) California Toxic Rule water quality criteria listed are freshwater and saltwater aquatic toxicity standards, using 4 days of continuous exposure. Human health standards are for one-in-a-million risk for consumption of water and organisms. Values are from 40 CFR §131.38, *Establishment of Numeric Criteria for Priority Toxic Pollutants for the State of California.*

(d) TSCA specifies cleanup and disposal provisions for Lead-containing soil, PCB-containing soil, and other types of remediation wastes. Subpart D sets cleanup levels for high occupancy areas (e.g., residence) and low occupancy areas (e.g., unoccupied area outside a building). The cleanup level for unrestricted use of high occupancy areas is 1 mg/kg of PCBs in soil and the cleanup level for unrestricted use of low occupancy areas is 25 mg/kg of PCBs in soil. A PCB cleanup level of 10 mg/kg for high occupancy areas is permissable if the areas impacted by PCBs are capped and accompanied by land use restrictions. Higher cleanup levels for low occupancy areas are also allowed if the areas impacted by PCBs are either fenced or capped and accompanied by land use restrictions. The PCB cleanup level for low occupancy areas is 50 mg/kg for areas that are fenced and 100 mg/kg for areas that are capped and where land use restrictions are placed into effect.

(e) Hyphen indicates no value is provided in the reference.

(f) Value listed is a function of hardness. Value shown is based on a hardness of 100 mg/L as calcium carbonate.

(g) U.S. EPA water quality criterion for mercury is 0.012 μg/L, which is below typical analytical method reporting limit of 0.025 μg/L. An objective of 0.012 μg/L is desirable.

(h) Zinc value revised in 1997 amendments to RWQCB Basin Plan.

TABLE 6-3
NUMERIC VALUES OF POTENTIAL ACTION-SPECIFIC ARARs (a)
Oakland Army Base, Oakland, California

Chemical of Concern	Characteristic Hazardous Waste Classification: Toxicity Characteristic Leaching Procedure ("TCLP") (mg/L); (b)	Characteristic Hazardous Waste Classification: Soluble Threshold Limit Concentration ("STLC") (mg/L); (b)	Characteristic Hazardous Waste Classification: Total Threshold Limit Concentration ("TTLC") (mg/kg); (b)	Universal Treatment Standards for Underlying Hazardous Constituents (mg/kg or mg/L TCLP); (c)	East Bay Municipal Utility District Discharge Limitations to Sanitary Sewer (mg/L); (d)
Metals					
Antimony	-- (e)	15	500	1.15 (f)	--
Arsenic	5	5	500	5 (f)	2
Barium	100	100	10,000	21 (f)	--
Beryllium	--	0.75	75	1.22 (f)	--
Cadmium	1	1	100	0.11 (f)	1
Chromium, Total	5	5	2,500	0.60 (f)	2
Cobalt	--	80	8,000	--	--
Copper	--	25	2,500 (g)	--	5
Lead	5	5	1,000 (g)	0.75 (f)	2
Manganese	--	--	--	--	--
Mercury	0.2	0.2	20	0.025 (f)	0.05
Molybdenum	--	350	3,500	--	--
Nickel	--	20	2,000 (g)	11 (f)	5
Selenium	1	1	100	5.7 (f)	--
Silver	5	5	500	0.14 (f)	1
Thallium	--	7	700	0.20 (f)	--
Vanadium	--	24	2,400	1.6 (f)	--
Zinc	--	250	5,000	4.3 (f)	5
Volatile Organic Compounds					
1,1,2,2-tetrachloroethane	--	--	--	6.0	--
1,1,2-trichloroethane	--	--	--	6.0	--
1,1-dichloroethane	--	--	--	6.0	--
1,1-dichloroethene	0.7	--	--	6.0	--
1,2,3-trichloropropane	--	--	--	30	--
1,2,4-trimethylbenzene	--	--	--	--	--
1,2-dichloroethane	0.5	--	--	6.0	--
1,2-dichloropropane	--	--	--	18	--
1,3,5-trimethylbenzene	--	--	--	--	--
Acetone	--	--	--	160	--
Benzene	0.5	--	--	10	--
Bromodichloromethane	--	--	--	15	--
Carbon disulfide	--	--	--	4.8 (f)	--
Carbon tetrachloride	0.5	--	--	6.0	--
Chloroform	6.0	--	--	6.0	--
Dibromochloromethane	--	--	--	15	--
cis-1,2-dichloroethene	--	--	--	--	--
trans-1,2-dichloroethene	--	--	--	30	--
Ethylbenzene	--	--	--	10	--

TABLE 6-3
NUMERIC VALUES OF POTENTIAL ACTION-SPECIFIC ARARs (a)
Oakland Army Base, Oakland, California

Chemical of Concern	Characteristic Hazardous Waste Classification			Universal Treatment Standards for Underlying Hazardous Constituents (mg/kg or mg/L TCLP); (c)	East Bay Municipal Utility District Discharge Limitations to Sanitary Sewer (mg/L); (d)
	Toxicity Characteristic Leaching Procedure ("TCLP") (mg/L); (b)	Soluble Threshold Limit Concentration ("STLC") (mg/L); (b)	Total Threshold Limit Concentration ("TTLC") (mg/kg); (b)		
Volatile Organic Compounds					
Isopropylbenzene (Cumene)	--	--	--	--	--
Methyl ethyl ketone	200	--	--	36	--
Methyl isobutyl ketone	--	--	--	33	--
Methyl tertiary butyl ether	--	--	--	--	--
Methylene chloride	--	--	--	30	--
n-propylbenzene	--	--	--	--	--
p-cymene (p-isopropyltoluene)	--	--	--	--	--
n-butylbenzene	--	--	--	--	--
sec-butylbenzene	--	--	--	--	--
tert-butylbenzene	--	--	--	--	--
Tetrachloroethene	0.7	--	--	6.0	--
Toluene	--	--	--	10	--
Trichloroethene	0.5	204	2,040	6.0	--
Trichlorofluoromethane	--	--	--	30	--
Vinyl chloride	0.2	--	--	6.0	--
Xylenes, Total	--	--	--	30	--
Semi-volatile Organic Compounds					
Acenaphthene	--	--	--	3.4	--
Acenaphthylene	--	--	--	3.4	--
Anthracene	--	--	--	3.4	--
Benzidine	--	--	--	--	--
Benzo(a)anthracene	--	--	--	3.4	--
Benzo(a)pyrene	--	--	--	3.4	--
Benzo(b)fluoranthene	--	--	--	6.8	--
Benzo(b,k)fluoranthene	--	--	--	--	--
Benzo(g,h,i)perylene	--	--	--	1.8	--
Benzo(k)fluoranthene	--	--	--	6.8	--
Bis(2-ethylhexyl)phthalate	--	--	--	28	--
Chrysene	--	--	--	3.4	--
Dibenz(a,h)anthracene	--	--	--	8.2	--
Fluoranthene	--	--	--	3.4	--

TABLE 6-3
NUMERIC VALUES OF POTENTIAL ACTION-SPECIFIC ARARs (a)
Oakland Army Base, Oakland, California

Chemical of Concern	Characteristic Hazardous Waste Classification			Universal Treatment Standards for Underlying Hazardous Constituents (mg/kg or mg/L TCLP); (c)	East Bay Municipal Utility District Discharge Limitations to Sanitary Sewer (mg/L); (d)
	Toxicity Characteristic Leaching Procedure ("TCLP") (mg/L); (b)	Soluble Threshold Limit Concentration ("STLC") (mg/L); (b)	Total Threshold Limit Concentration ("TTLC") (mg/kg); (b)		
Semi-volatile Organic Compounds					
Fluorene	--	--	--	3.4	--
Hexachlorobutadiene	--	--	--	5.6	--
Indeno(1,2,3-c,d)pyrene	--	--	--	3.4	--
Naphthalene	--	--	--	5.6	--
Phenanthrene	--	--	--	5.6	--
Pyrene	--	--	--	8.2	--
Total Petroleum Hydrocarbons					
TPH Diesel	--	--	--	--	--
TPH Gasoline	--	--	--	--	--
TPH Motor Oil	--	--	--	--	--
TPH Recoverable	--	--	--	--	--
PCBs, Pesticides, and Herbicides					
Aldrin	--	0.14	1.4	0.066	--
Alpha BHC	--	--	--	0.066	--
Alpha endosulfan (Endosulfan I)	--	--	--	0.066	--
Alpha chlordane	0.03	0.25	2.5	0.26	--
Gamma chlordane	0.03	0.25	2.5	0.26	--
Dieldrin	--	0.8	8	0.13	--
Endosulfan sulfate	--	--	--	0.066	--
Endrin	--	0.02	0.2	0.13	--
Endrin aldehyde	--	--	--	0.13	--
Endrin ketone	--	--	--	--	--
Gamma BHC (Lindane)	0.4	0.4	4	0.066	--
Heptachlor	0.008	0.47	4.7	0.066	--
Heptachlor epoxide	0.008	--	--	0.066	--
4,4'-DDD	--	0.1	1	0.087	--
4,4'-DDE	--	0.1	1	0.087	--
4,4'-DDT	--	0.1	1	0.087	--
Pentachlorophenol	100	1.7	17	7.4	--
Toxaphene	0.5	0.5	5	2.6	--
PCB-1248 (Aroclor 1248)	--	5 (h)	50 (h)	10 (h)	--
PCB-1260 (Aroclor 1260)	--	5 (h)	50 (h)	10 (h)	--

TABLE 6-3
NUMERIC VALUES OF POTENTIAL ACTION-SPECIFIC ARARs (a)
Oakland Army Base, Oakland, California

Chemical of Concern	Characteristic Hazardous Waste Classification			Universal Treatment Standards for Underlying Hazardous Constituents (mg/kg or mg/L TCLP); (c)	East Bay Municipal Utility District Discharge Limitations to Sanitary Sewer (mg/L); (d)
	Toxicity Characteristic Leaching Procedure ("TCLP") (mg/L); (b)	Soluble Threshold Limit Concentration ("STLC") (mg/L); (b)	Total Threshold Limit Concentration ("TTLC") (mg/kg); (b)		
Dioxin-like Compounds					
1,2,3,4,6,7,8-heptachlorodibenzofuran	--	--	--	0.0025	--
1,2,3,4,6,7,8-heptachlorodibenzo-p-dioxin	--	--	--	0.0025	--
1,2,3,4,7,8,9-heptachlorodibenzofuran	--	--	--	--	--
1,2,3,4,7,8-hexachlorodibenzofuran	--	--	--	--	--
1,2,3,6,7,8-hexachlorodibenzofuran	--	--	--	--	--
1,2,3,6,7,8-hexachlorodibenzo-p-dioxin	--	--	--	--	--
1,2,3,7,8,9-hexachlorodibenzofuran	--	--	--	--	--
1,2,3,7,8,9-hexachlorodibenzo-p-dioxin	--	--	--	--	--
1,2,3,7,8-pentachlorodibenzofuran	--	--	--	--	--
1,2,3,7,8-pentachlorodibenzo-p-dioxin	--	--	--	--	--
2,3,4,6,7,8-hexachlorodibenzofuran	--	--	--	--	--
2,3,4,7,8-pentachlorodibenzofuran	--	--	--	--	--
2,3,7,8-tetrachlorodibenzofuran	--	--	--	--	--
2,3,7,8-tetrachlorodibenzo-p-dioxin	--	--	--	--	--
Heptachlorinated dibenzofurans, Total	--	--	--	--	--
Heptachlorinated dibenzo-p-dioxins, Total	--	--	--	--	--
Hexachlorinated dibenzofurans, Total	--	--	--	0.001	--
Hexachlorinated dibenzo-p-dioxins, Total	--	--	--	0.001	--
Octachlorodibenzofuran	--	--	--	0.005	--
Octachlorodibenzo-p-dioxin	--	--	--	0.005	--
Pentachlorinated dibenzofurans, Total	--	--	--	0.001	--
Pentachlorinated dibenzo-p-dioxins, Total	--	--	--	0.001	--
Tetrachlorinated dibenzofurans, Total	--	--	--	0.001	--
Tetrachlorinated dibenzo-p-dioxins, Total	--	--	--	0.001	--

TABLE 6-3
NUMERIC VALUES OF POTENTIAL ACTION-SPECIFIC ARARs (a)
Oakland Army Base, Oakland, California

	Non-hazardous Waste Classification				
	Designated Waste			Non-hazardous Solid Waste	
Chemical of Concern	TCLP Maximum Concentration Permissible (mg/L); (i)	STLC Maximum Concentration Permissible (mg/L); (i)	TTLC Maximum Concentration Permissible (mg/kg); (i)	STLC Maximum Concentration Permissible (mg/L); (i)	TTLC Maximum Concentration Permissible (mg/kg); (i)
Metals					
Antimony	--	15	500	--	--
Arsenic	5	5	500	--	--
Barium	100	100	10,000	--	--
Beryllium	--	0.75	75	--	--
Cadmium	1	1	100	0.05	0.5
Chromium, Total	5	560	2,500	0.5	5
Cobalt	--	80	8,000	--	--
Copper	--	25	2,500 (g)	20	200
Lead	5	5	1,000 (g)	1.5	15
Manganese	--	--	--	--	--
Mercury	0.2	0.2	20	0.02	0.2
Molybdenum	--	350	3,500	--	--
Nickel	--	20	2,000 (g)	1	10
Selenium	1	1	100	--	--
Silver	5	5	500	--	--
Thallium	--	7	700	--	--
Vanadium	--	24	2,400	--	--
Zinc	--	250	5,000	200	2,000
Volatile Organic Compounds					
1,1,2,2-tetrachloroethane	--	--	--	--	--
1,1,2-trichloroethane	--	--	--	--	--
1,1-dichloroethane	--	--	--	--	--
1,1-dichloroethene	--	--	--	--	--
1,2,3-trichloropropane	--	--	--	--	--
1,2,4-trimethylbenzene	--	--	--	--	--
1,2-dichloroethane	0.5	--	--	--	--
1,2-dichloropropane	--	--	--	--	--
1,3,5-trimethylbenzene	--	--	--	--	--
Acetone	--	--	--	--	--
Benzene	0.5	--	10	--	ND (j)
Bromodichloromethane	--	--	--	--	--
Carbon disulfide	--	--	--	--	--
Carbon tetrachloride	0.5	--	10	--	--
Chloroform	6.0	--	--	--	--
Dibromochloromethane	--	--	--	--	--
cis-1,2-dichloroethene	--	--	--	--	--
trans-1,2-dichloroethene	--	--	--	--	--
Ethylbenzene	--	--	--	--	--

TABLE 6-3
NUMERIC VALUES OF POTENTIAL ACTION-SPECIFIC ARARs (a)
Oakland Army Base, Oakland, California

Chemical of Concern	Non-hazardous Waste Classification				
	Designated Waste			Non-hazardous Solid Waste	
	TCLP Maximum Concentration Permissible (mg/L); (i)	STLC Maximum Concentration Permissible (mg/L); (i)	TTLC Maximum Concentration Permissible (mg/kg); (i)	STLC Maximum Concentration Permissible (mg/L); (i)	TTLC Maximum Concentration Permissible (mg/kg); (i)
Volatile Organic Compounds					
Isopropylbenzene (Cumene)	--	--	--	--	--
Methyl ethyl ketone	200	--	--	--	--
Methyl isobutyl ketone	--	--	--	--	--
Methyl tertiary butyl ether	--	--	--	--	--
Methylene chloride	--	--	--	--	--
n-propylbenzene	--	--	--	--	--
p-cymene (p-isopropyltoluene)	--	--	--	--	--
n-butylbenzene	--	--	--	--	--
sec-butylbenzene	--	--	--	--	--
tert-butylbenzene	--	--	--	--	--
Tetrachloroethene	0.7	--	14	--	--
Toluene	--	--	--	--	ND
Trichloroethene	0.5	204	2,040	--	--
Trichlorofluoromethane	--	--	--	--	--
Vinyl chloride	0.2	--	--	--	--
Xylenes, Total	--	--	--	--	ND
Semi-volatile Organic Compounds					
Acenaphthene	--	--	--	--	--
Acenaphthylene	--	--	--	--	--
Anthracene	--	--	--	--	--
Benzidine	--	--	--	--	--
Benzo(a)anthracene	--	--	--	--	--
Benzo(a)pyrene	--	--	--	--	--
Benzo(b)fluoranthene	--	--	--	--	--
Benzo(b,k)fluoranthene	--	--	--	--	--
Benzo(g,h,i)perylene	--	--	--	--	--
Benzo(k)fluoranthene	--	--	--	--	--
Bis(2-ethylhexyl)phthalate	--	--	--	--	--
Chrysene	--	--	--	--	--
Dibenz(a,h)anthracene	--	--	--	--	--
Fluoranthene	--	--	--	--	--

TABLE 6-3
NUMERIC VALUES OF POTENTIAL ACTION-SPECIFIC ARARs (a)
Oakland Army Base, Oakland, California

Chemical of Concern	Non-hazardous Waste Classification				
	Designated Waste			Non-hazardous Solid Waste	
	TCLP Maximum Concentration Permissible (mg/L); (i)	STLC Maximum Concentration Permissible (mg/L); (i)	TTLC Maximum Concentration Permissible (mg/kg); (i)	STLC Maximum Concentration Permissible (mg/L); (i)	TTLC Maximum Concentration Permissible (mg/kg); (i)
Semi-volatile Organic Compounds					
Fluorene	--	--	--	--	--
Hexachlorobutadiene	--	--	--	--	--
Indeno(1,2,3-c,d)pyrene	--	--	--	--	--
Naphthalene	--	--	--	--	--
Phenanthrene	--	--	--	--	--
Pyrene	--	--	--	--	--
Total Petroleum Hydrocarbons					
TPH Diesel	--	--	20,000	--	100
TPH Gasoline	--	--	5,900	--	ND
TPH Motor Oil	--	--	10,000	--	--
TPH Recoverable	--	--	--	--	--
PCBs, Pesticides, and Herbicides					
Aldrin	--	0.14	1.4	--	--
Alpha BHC	--	--	--	--	--
Alpha endosulfan (Endosulfan I)	--	--	--	--	--
Alpha chlordane	0.03	0.25	2.5	--	--
Gamma chlordane	0.03	0.25	2.5	--	--
Dieldrin	--	0.8	8	--	--
Endosulfan sulfate	--	--	--	--	--
Endrin	0.02	0.02	0.2	--	--
Endrin aldehyde	--	--	--	--	--
Endrin ketone	--	--	--	--	--
Gamma BHC (Lindane)	0.4	0.4	4	--	--
Heptachlor	0.008	0.47	4.7	--	--
Heptachlor epoxide	--	--	--	--	--
4,4'-DDD	--	0.1	1	--	--
4,4'-DDE	--	0.1	1	--	--
4,4'-DDT	--	0.1	1	--	--
Pentachlorophenol	100	1.7	17	--	--
Toxaphene	0.5	0.5	5	--	--
PCB-1248 (Aroclor 1248)	--	5 (h)	50 (h)	--	--
PCB-1260 (Aroclor 1260)	--	5 (h)	50 (h)	--	--

TABLE 6-3
NUMERIC VALUES OF POTENTIAL ACTION-SPECIFIC ARARs (a)
Oakland Army Base, Oakland, California

Chemical of Concern	Non-hazardous Waste Classification				
	Designated Waste			Non-hazardous Solid Waste	
	TCLP Maximum Concentration Permissible (mg/L); (i)	STLC Maximum Concentration Permissible (mg/L); (i)	TTLC Maximum Concentration Permissible (mg/kg); (i)	STLC Maximum Concentration Permissible (mg/L); (i)	TTLC Maximum Concentration Permissible (mg/kg); (i)
Dioxin-like Compounds					
1,2,3,4,6,7,8-heptachlorodibenzofuran	--	--	--	--	--
1,2,3,4,6,7,8-heptachlorodibenzo-p-dioxin	--	--	--	--	--
1,2,3,4,7,8,9-heptachlorodibenzofuran	--	--	--	--	--
1,2,3,4,7,8-hexachlorodibenzofuran	--	--	--	--	--
1,2,3,6,7,8-hexachlorodibenzofuran	--	--	--	--	--
1,2,3,6,7,8-hexachlorodibenzo-p-dioxin	--	--	--	--	--
1,2,3,7,8,9-hexachlorodibenzofuran	--	--	--	--	--
1,2,3,7,8,9-hexachlorodibenzo-p-dioxin	--	--	--	--	--
1,2,3,7,8-pentachlorodibenzofuran	--	--	--	--	--
1,2,3,7,8-pentachlorodibenzo-p-dioxin	--	--	--	--	--
2,3,4,6,7,8-hexachlorodibenzofuran	--	--	--	--	--
2,3,4,7,8-pentachlorodibenzofuran	--	--	--	--	--
2,3,7,8-tetrachlorodibenzofuran	--	--	--	--	--
2,3,7,8-tetrachlorodibenzo-p-dioxin	--	--	--	--	--
Heptachlorinated dibenzofurans, Total	--	--	--	--	--
Heptachlorinated dibenzo-p-dioxins, Total	--	--	--	--	--
Hexachlorinated dibenzofurans, Total	--	--	--	--	--
Hexachlorinated dibenzo-p-dioxins, Total	--	--	--	--	--
Octachlorodibenzofuran	--	--	--	--	--
Octachlorodibenzo-p-dioxin	--	--	--	--	--
Pentachlorinated dibenzofurans, Total	--	--	--	--	--
Pentachlorinated dibenzo-p-dioxins, Total	--	--	--	--	--
Tetrachlorinated dibenzofurans, Total	--	--	--	--	--
Tetrachlorinated dibenzo-p-dioxins, Total	--	0.001	0.01	--	--

TABLE 6-3
NUMERIC VALUES OF POTENTIAL ACTION-SPECIFIC ARARs (a)
Oakland Army Base, Oakland, California

Notes:

(a) Numeric values for action-specific ARARs are listed in this table. See Table 6-1 for complete listing and synopses of ARARs and TBCs.

mg/L = milligram per liter
mg/kg = milligram per kilogram

(b) Waste classification criteria are from 22 CCR 66261.24.

(c) Universal treatment standards for underlying hazardous constituents from 40 CFR 268.48(a). Unless otherwise noted, values are in units of mg/kg.

(d) East Bay Municipal Utility District Ordinance 311 states limitations on wastewater discharges. Ordinance No. 311 limits the discharge to the sanitary sewer. The stated values listed in Ordinance 311 may be revised in a site-specific permit.

(e) Hyphen indicates no value is provided in the reference.

(f) Values noted are in units of mg/L as measured in the Toxicity Characteristic Leaching Procedure extract.

(g) Pursuant to HSC §25157.8, additional criteria pertain to the management of lead, copper, or nickel contaminated waste. Waste containing total lead greater than 350 mg/kg, copper greater than 2,500 mg/kg, or nickel greater than 2,000 mg/kg must be disposed at a permitted hazardous waste management facility, unless the waste discharge requirements and solid waste facility permit of a non-hazardous waste management facility specifically allow for the disposal of these types of wastes. HSC §25157.8 remains in effect until 1 July 2006, and as of that date is repealed unless a later statute is enacted that repeals or extends the 1 July 2006 sunset provision.

(h) For PCBs, the value listed is the sum of all PCB isomers, or all Aroclors. For the universal treatment standards for underlying hazardous constituents, the standard is temporarily deferred for soil exhibiting a hazardous characteristic due to D004 through D011 only.

(i) Non-hazardous waste disposal requirements are from Waste Management *Altamont Landfill and Resource Recovery Facility Waste Acceptance Criteria*, revised June 1999. Waste Management operates Class II and Class III waste management units at its Altamont facility. Values listed are specific to Waste Management's Altamont facility. Acceptance of wastes are at the discretion of permitted waste management facility. Consequently, non-hazardous waste disposal requirements may vary by facility.

(j) ND = None Detected. Disposal requirements state that chemical must be at non-detectable concentrations. Analytical method reporting limits are not specified.

TABLE 7-1
NON-CARCINOGENIC HUMAN HEALTH TOXICITY VALUES FOR CHEMICALS OF CONCERN IN SOIL AND GROUNDWATER
Oakland Army Base, Oakland, California

Chemical of Concern	Chronic Oral Reference Dose (mg/kg-day)	Chronic Inhalation Reference Dose (mg/kg-day)	Potential Health Effect	Reference
Metals				
Antimony	0.0004	--	Longevity, blood glucose	IRIS
Arsenic	0.0003	--	Hyperpigmentation, keratosis	IRIS
Barium	0.07	0.00014	--	IRIS
Beryllium	0.002	0.0000057	Small intestinal lesions	IRIS
Cadmium	0.0005	--	Significant proteinuria	IRIS
Chromium (III)	1.5	--	No effects observed	IRIS
Chromium (VI)	0.003	0.0000023	Nasal septum atrophy	IRIS
Cobalt	0.06	--	--	NCEA
Copper	0.037	--	--	HEAST
Lead	--	--	--	--
Manganese	0.14	0.000014	Central Nervous System effects	IRIS
Mercury	0.000086	0.000086	Hand tremor, memory disturbance	IRIS
Molybdenum	0.005	--	Increased uric acid levels	IRIS
Nickel	0.02	--	Decreased body and organ weights	IRIS
Selenium	0.005	--	Clinical selenosis	IRIS
Silver	0.005	--	Argyria	IRIS
Thallium	0.00007	--	Liver and blood effects	IRIS (b)
Vanadium	0.0070	--	--	HEAST
Zinc	0.3	--	Decreased blood enzyme	IRIS
Volatile Organic Compounds				
1,1,2,2-tetrachloroethane	0.06	--	--	NCEA
1,1,2-trichloroethane	0.004	--	Clinical serum chemistry	IRIS
1,1-dichloroethane	0.1	--	--	HEAST
1,1-dichloroethene	0.009	--	Hepatic lesions	IRIS
1,2,3-trichloropropane	0.006	--	Reduction in red cell mass	IRIS
1,2,4-trimethylbenzene	0.05	0.0017	--	NCEA
1,3,5-trimethylbenzene	0.05	0.0017	--	NCEA
1,2-dichloropropane	--	0.0011	Hyperplasia of the nasal mucosa	IRIS
1,2-dichloroethane	0.03	0.0014	--	NCEA
Acetone	0.1	--	Increased liver and kidney weight	IRIS
Benzene	0.003	0.0017 (c)	--	NCEA
Bromodichloromethane	0.02	--	Renal cytomegaly	IRIS

TABLE 7-1
NON-CARCINOGENIC HUMAN HEALTH TOXICITY VALUES FOR CHEMICALS OF CONCERN IN SOIL AND GROUNDWATER
Oakland Army Base, Oakland, California

Chemical of Concern	Chronic Oral Reference Dose (mg/kg-day)	Chronic Inhalation Reference Dose (mg/kg-day)	Potential Health Effect	Reference
Volatile Organic Compounds				
Carbon disulfide	0.1	0.2	Fetal toxicity, nervous system	IRIS
Carbon tetrachloride	0.0007	--	Liver lesions	IRIS
Chloroform	0.01	--	Marked fatty cyst formation in liver	IRIS
cis-1,2-dichloroethene	0.01	--	Decreased hemoglobin	HEAST
trans-1,2-dichloroethene	0.02	--	Serum alkaline phosphatase	IRIS
Dibromochloromethane	0.02	--	Hepatic lesions	IRIS
Ethylbenzene	0.1	0.29	Liver and kidney toxicity	IRIS
Isopropylbenzene (cumene)	0.1	0.11	Increased kidney weight	IRIS
Methyl ethyl ketone	0.6	0.29	Decreased fetal birth weight	IRIS
Methyl isobutyl ketone	0.08	--	Increased liver and kidney weight	HEAST
Methyl teriary butyl ether	0.86	0.86	Increased liver and kidney weights	IRIS
Methylene chloride	0.06	0.86	Liver toxicity	IRIS/ HEAST
n-butylbenzene	0.01	--	--	NCEA
n-propylbenzene	0.01	--	--	NCEA
p-cymene (p-isopropyltoluene)	0.1	0.114	Increased kidney weight	IRIS
sec-butylbenzene	0.01	--	--	NCEA
tert-butylbenzene	0.01	--	--	NCEA
Tetrachloroethene	0.01	--	Hepatotoxicity and weight gain	IRIS
Toluene	0.2	0.11	Liver and kidney weight changes	IRIS
Trichloroethene	0.006	--	--	PRG
Trichlorofluoromethane	0.3	--	Survival and histopathology	IRIS
Vinyl chloride	0.003	0.029	Liver cell polymorphism	IRIS
Xylenes, Total	2	--	Hyperactivity	IRIS
Semi-volatile Organic Compounds				
Acenaphthene	0.06	--	Hepatotoxicity	IRIS
Acenaphthylene	--	--	--	--
Anthracene	0.3	--	No observed effects	IRIS
Benzidine	0.003	--	Brain cell vacuolization	IRIS
Benzo(b)anthracene	--	--	--	--
Benzo(b)pyrene	--	--	--	--
Benzo(c)fluoranthene	--	--	--	--
Benzo(b,k)fluoranthene	--	--	--	--
Benzo(g,h,i)perylene	--	--	--	--

TABLE 7-1
NON-CARCINOGENIC HUMAN HEALTH TOXICITY VALUES FOR CHEMICALS OF CONCERN IN SOIL AND GROUNDWATER
Oakland Army Base, Oakland, California

Chemical of Concern	Chronic Oral Reference Dose (mg/kg-day)	Chronic Inhalation Reference Dose (mg/kg-day)	Potential Health Effect	Reference
Semi-volatile Organic Compounds				
Benzo(k)fluoranthene	--	--	--	--
Bis(2-ethylhexyl)phthalate	0.02	--	Increased relative liver weight	IRIS
Chrysene	--	--	--	--
Dibenz(a,h)anthracene	--	--	--	--
Fluoranthene	0.04	--	Nephropathy	IRIS
Fluorene	0.04	--	Decreased red blood cells	IRIS
Hexachlorobutadiene	0.0003	--	--	NCEA
Indeno(1,2,3-c,d)pyrene	--	--	--	--
Naphthalene	0.02	0.00086	Decreased body weight	IRIS
Phenanthrene	0.3	--	--	(d)
Pyrene	0.03	--	Kidney effects	IRIS
Total Petroleum Hydrocarbons				
TPH Diesel	--	--	--	--
TPH Gasoline	--	--	--	--
TPH Motor Oil	--	--	--	--
TPH Recoverable	--	--	--	--
PCBs, Pesticides, and Herbicides				
Aldrin	0.00003	--	Liver toxicity	IRIS
Alpha BHC	0.0003	--	--	(e)
Alpha endosulfan (Endosulfan I)	0.006	--	Reduced body weight	IRIS (f)
Alpha chlordane	0.0005	0.0002	Hepatic necrosis	IRIS (g)
Gamma chlordane	0.0005	0.0002	Hepatic necrosis	IRIS (g)
Dieldrin	0.00005	--	Liver lesions	IRIS
Endosulfan sulfate	0.006	--	Reduced body weight	IRIS (f)
Endrin	0.0003	--	Liver lesions	IRIS
Endrin aldehyde	0.0003	--	--	IRIS (h)
Endrin ketone	0.0003	--	--	IRIS (h)
Gamma BHC (Lindane)	0.0003	--	Liver and kidney toxicity	IRIS
Heptachlor	0.0005	--	Increases liver weight	IRIS
Heptachlor epoxide	0.000013	--	Increased liver-to-body weight	IRIS
4,4'-DDD	0.0005	--	--	(i)

TABLE 7-1
NON-CARCINOGENIC HUMAN HEALTH TOXICITY VALUES FOR CHEMICALS OF CONCERN IN SOIL AND GROUNDWATER
Oakland Army Base, Oakland, California

Chemical of Concern	Chronic Oral Reference Dose (mg/kg-day)	Chronic Inhalation Reference Dose (mg/kg-day)	Potential Health Effect	Reference
PCBs, Pesticides, and Herbicides				
4,4'-DDE	0.0005	--	--	(i)
4,4'-DDT	0.0005	--	Liver lesions	IRIS
Pentachlorophenol	--	0.03	Liver and kidney pathology	IRIS
Toxaphene	--	--	--	--
PCB-1248 (Aroclor 1248)	--	--	--	--
PCB-1260 (Aroclor 1260)	--	--	--	--
Dioxin-like Compounds				
2,3,7,8-tetrachlorodibenzo-p-dioxin	--	--	--	--

TABLE 7-1
NON-CARCINOGENIC HUMAN HEALTH TOXICITY VALUES FOR CHEMICALS OF CONCERN IN SOIL AND GROUNDWATER
Oakland Army Base, Oakland, California

Notes:

(a) Abbreviations used in this table are as follows:

4,4'-DDD	1,1-dichloro-2,2-di(4-chlorophenyl)ethane
4,4'-DDE	1,1-dichloro-2,2-bis(4-chlorophenyl)ethane
4,4'-DDT	1,1,1-trichloro-2,2-bis(4-chlorophenyl)ethane
HEAST	Health Effects Assessment Summary Table
IRIS	Integrated Risk Information System
NCEA	National Center for Environmental Assessment
OEHHA	Office of Environmental Health Hazard Assessment
PCB	polychlorinated biphenyl

(b) No reference dose for thallium was available in IRIS, HEAST, or from NCEA. Instead, the reference dose for thallium sulfate corrected for the molecular weight difference was used.

(c) The reference dose used for benzene is based on a subchronic inhalation reference dose from NCEA divided by a factor of 10 for conversion to a chronic reference dose.

(d) No reference dose for phenanthrene was available. At the suggestion of U.S. EPA Superfund Technical Support staff, the reference dose for anthracene was used, which is a structurally similar surrogate compound. was used.

(e) No reference dose for alpha BHC was available. The reference dose for gamma BHC was used, which is a structurally similar surrogate compound.

(f) No reference dose for alpha endosulfan and endosulfan sulfate was available. The reference dose for endosulfan was used.

(g) No reference dose for alpha or gamma chlordane was available. The reference dose for chlordane was used.

(h) No reference dose for endrin aldehyde or endrin ketone was available. The reference dose for endrin was used, which is a structurally similar compound.

(i) No reference dose for 4,4'-DDD and 4,4'-DDE was available. At the suggestion of U.S. EPA Superfund Technical Support staff, the reference dose for 4,4'-DDT was used, which is a structurally similar compound.

TABLE 7-2
CARCINOGENIC HUMAN HEALTH TOXICITY VALUES FOR CHEMICALS OF CONCERN IN SOIL AND GROUNDWATER (a)

Oakland Army Base, Oakland, California

Chemical of Concern	Oral Slope Factor $(mg/kg\text{-}day)^{-1}$	Inhalation Slope Factor $(mg/kg\text{-}day)^{-1}$	Weight-of-Evidence Classification (b)	Reference
Metals				
Antimony	--	--	--	--
Arsenic	1.5	12	A	OEHHA
Barium	--	--	--	--
Beryllium	--	8.4	B2	IRIS
Cadmium	0.38	15	B1	IRIS
Chromium (III)	--	--	--	--
Chromium (VI)	0.42	510	A	OEHHA
Cobalt	--	--	--	--
Copper	--	--	D	IRIS
Lead	--	--	--	--
Manganese	--	--	D	IRIS
Mercury	--	--	D	IRIS
Molybdenum	-	-	-	--
Nickel	--	0.91	A	OEHHA
Selenium	--	--	D	IRIS
Silver	--	--	D	IRIS
Thallium	--	--	D	IRIS
Vanadium	--	--	--	--
Zinc	--	--	D	IRIS
Volatile Organic Compounds				
1,1,2,2-tetrachloroethane	0.27	0.2	C	OEHHA
1,1,2-trichloroethane	0.072	0.057	C	OEHHA
1,1-dichloroethane	0.0057	0.0057	C	OEHHA
1,1-dichloroethene	--	--	C	IRIS
1,2,3-trichloropropane	7	--	B2	HEAST
1,2,4-trimethylbenzene	--	--	--	--
1,3,5-trimethylbenzene	--	--	--	--
1,2-dichloropropane	0.036	0.036	--	OEHHA
1,2-dichloroethane	0.047	0.07	B2	OEHHA
Acetone	--	--	--	--
Benzene	0.1	0.1	A	OEHHA
Bromodichloromethane	0.13	0.13	B2	OEHHA

TABLE 7-2
CARCINOGENIC HUMAN HEALTH TOXICITY VALUES FOR CHEMICALS OF CONCERN IN SOIL AND GROUNDWATER (a)
Oakland Army Base, Oakland, California

Chemical of Concern	Oral Slope Factor $(mg/kg\text{-}day)^{-1}$	Inhalation Slope Factor $(mg/kg\text{-}day)^{-1}$	Weight-of-Evidence Classification (b)	Reference
Volatile Organic Compounds				
Carbon disulfide	--	--	--	--
Carbon tetrachloride	0.15	0.15	B2	OEHHA
Chloroform	0.031	0.019	B2	OEHHA
cis-1,2-Dichloroethene	--	--	D	IRIS
trans-1,2-Dichloroethene	--	--	--	--
Dibromochloromethane	0.094	0.094	C	OEHHA
Ethylbenzene	--	--	D	IRIS
Isopropylbenzene (cumene)	--	--	D	IRIS
Methyl ethyl ketone	--	--	D	IRIS
Methyl isobutyl ketone	--	--	--	--
Methyl teriary butyl ether	0.0018	0.0018	-	OEHHA
Methylene chloride	0.014	0.0035	B2	IRIS
n-butylbenzene	--	--	--	--
n-propylbenzene	--	--	--	--
p-cymene (p-isopropyltoluene)	--	--	D	IRIS
sec-butylbenzene	--	--	--	--
tert-butylbenzene	--	--	--	--
Tetrachloroethene	0.051	0.021	C-B2 (NCEA)	OEHHA
Toluene	- (d)	- (d)	D	IRIS
Trichloroethene	0.015	0.01	C-B2 (NCEA)	OEHHA
Trichlorofluoromethane	--	--	--	--
Vinyl chloride	0.27	0.27	A	OEHHA
Xylenes, Total	--	--	D	IRIS
Semi-volatile Organic Compounds				
Acenaphthene	--	--	--	--
Acenaphthylene	--	--	D	IRIS
Anthracene	--	--	D	IRIS
Benzidine	500	500	A	OEHHA
Benzo(a)anthracene	1.2	0.39	B2	OEHHA
Benzo(a)pyrene	12	3.9	B2	OEHHA
Benzo(b)fluoranthene	1.2	0.39	B2	OEHHA
Benzo(b,k)fluoranthene	1.2	0.39	B2	OEHHA
Benzo(g,h,i)perylene	--	--	D	IRIS

TABLE 7-2
CARCINOGENIC HUMAN HEALTH TOXICITY VALUES FOR CHEMICALS OF CONCERN IN SOIL AND GROUNDWATER (a)
Oakland Army Base, Oakland, California

Chemical of Concern	Oral Slope Factor $(mg/kg\text{-}day)^{-1}$	Inhalation Slope Factor $(mg/kg\text{-}day)^{-1}$	Weight-of-Evidence Classification (b)	Reference
Semi-volatile Organic Compounds				
Benzo(k)fluoranthene	1.2	0.39	B2	OEHHA
Bis(2-ethylhexyl)phthalate	0.003	0.0084	B2	OEHHA
Chrysene	0.12	0.039	B2	OEHHA
Dibenz(a,h)anthracene	4.1	4.1	B2	OEHHA
Fluoranthene	--	--	D	IRIS
Fluorene	--	--	D	IRIS
Hexachlorobutadiene	0.078	0.078	C	HEAST
Indeno(1,2,3-c,d)pyrene	1.2	0.39	B2	OEHHA
Naphthalene	--	--	--	--
Phenanthrene	--	--	D	IRIS
Pyrene	--	--	D	IRIS
Total Petroleum Hydrocarbons				
TPH Diesel	--	--	--	--
TPH Gasoline	--	--	--	--
TPH Motor Oil	--	--	--	--
TPH Recoverable	--	--	--	--
PCBs, Pesticides, and Herbicides				
Aldrin	17	17	B2	IRIS
Alpha BHC	2.7	2.7	B2	OEHHA
Alpha endosulfan (Endosulfan I)	--	--	--	--
Alpha chlordane	1.3	1.2	B2	OEHHA (c)
Gamma chlordane	1.3	1.2	B2	OEHHA (c)
Dieldrin	16	16	B2	IRIS
Endosulfan sulfate	--	--	--	--
Endrin	--	--	D	IRIS
Endrin aldehyde	--	--	D	IRIS
Endrin ketone	--	--	--	--
Gamma BHC (Lindane)	1.1	1.1	--	OEHHA
Heptachlor	4.1	4.1	B2	OEHHA
Heptachlor epoxide	5.5	5.5	B2	OEHHA
4,4'-DDD	0.24	0.24	B2	OEHHA

TABLE 7-2
CARCINOGENIC HUMAN HEALTH TOXICITY VALUES FOR CHEMICALS OF CONCERN IN SOIL AND GROUNDWATER (a)

Oakland Army Base, Oakland, California

Chemical of Concern	Oral Slope Factor $(mg/kg\text{-}day)^{-1}$	Inhalation Slope Factor $(mg/kg\text{-}day)^{-1}$	Weight-of-Evidence Classification (b)	Reference
PCBs, Pesticides, and Herbicides				
4,4'-DDE	0.34	0.34	B2	OEHHA
4,4'-DDT	0.34	0.34	B2	OEHHA
Pentachlorophenol	0.081	0.018	B2	OEHAA
Toxaphene	1.2	1.2	B2	OEHHA
PCB-1248 (Aroclor 1248)	5	2	B2	OEHHA (d)
PCB-1260 (Aroclor 1260)	5	2	B2	OEHHA (d)
Dioxin-like Compounds				
2,3,7,8-tetrachlorodibenzo-p-dioxin	130,000	130,000	--	OEHHA

TABLE 7-2
CARCINOGENIC HUMAN HEALTH TOXICITY VALUES FOR CHEMICALS OF CONCERN IN SOIL AND GROUNDWATER (a)
Oakland Army Base, Oakland, California

Notes:

(a) Abbreviations used in this table are as follows:

4,4'-DDD	1,1-dichloro-2,2-di(4-chlorophenyl)ethane
4,4'-DDE	1,1-dichloro-2,2-bis(4-chlorophenyl)ethane
4,4'-DDT	1,1,1-trichloro-2,2-bis(4-chlorophenyl)ethane
HEAST	Health Effects Assessment Summary Table
IRIS	Integrated Risk Information System
NCEA	National Center for Environmental Assessment
OEHHA	Office of Environmental Health Hazard Assessment
PCB	polychlorinated biphenyl

(b) U.S. EPA weight-of-evidence classifications are as follows:

A	Human Carcinogen
B1 or B2	Probable Human Carcinogen; B1 indicates that limited human data are available; B2 indicates that there is sufficient evidence in animals and inadequate or no evidence in humans.
C	Possible Human Carcinogen
D	Not Classifiable as to Human Carcinogenicity
E	Evidence of Non-Carcinogenicity in Humans

(c) No slope factor for alpha or gamma chlordane was available. The slope factor for chlordane was used.

(d) No slope factor for PCB Aroclor 1248 or 1260 was available. The slope factor for PCBs was used.

TABLE 7-3
EXPOSURE PARAMETERS USED TO CALCULATE HUMAN HEALTH RISK-BASED REMEDIATION GOALS
Oakland Army Base, Oakland, California

Parameter	Symbol	Unit	Value	Note/Reference
Averaging Time	AT			
Carcinogens		year	70	Default value (a)
Non-carcinogens		year	ED	Default value (a)
Body Weight	BW			
Earthwork construction worker		kg	70	Default value (a)
Indoor commercial worker		kg	70	Default value (a)
Outdoor industrial worker		kg	70	Default value (a)
Maintenance personnel		kg	70	Default value (a)
Dermal Absorption Factor	ABS			
Arsenic			0.03	Default value (b)
Cadmium			0.001	Default value (b)
Other metals			0.01	Default value (c)
Chlordane			0.05	Specified by DTSC HERD
DDT			0.05	Specified by DTSC HERD
Other chlorinated pesticides			0.05	Specified by DTSC HERD
Benzo(a)pyrene			0.15	Specified by DTSC HERD
Other polycyclic aromatic hydrocarbons			0.15	Specified by DTSC HERD
Semi-volatile organic compounds			0.1	Default value (b)
Polychlorinated biphenyls			0.15	Specified by DTSC HERD
Volatile organic compounds			0.1	Default value (c)
Exposure Duration	ED			
Earthwork construction worker		year	1	Best professional judgement
Indoor commercial worker		year	25	Default value (a)
Outdoor industrial worker		year	25	Default value (a)
Maintenance personnel		year	25	Default value (a)

TABLE 7-3
EXPOSURE PARAMETERS USED TO CALCULATE
HUMAN HEALTH RISK-BASED REMEDIATION GOALS
Oakland Army Base, Oakland, California

Parameter	Symbol	Unit	Value	Note/Reference
Exposure Frequency	EF			
Earthwork construction worker		day/year	250	Default value (a)
Indoor commercial worker		day/year	250	Default value (a)
Outdoor industrial worker		day/year	250	Default value (a)
Maintenance personnel				
Performing excavation work		day/year	12	Default value (a); (d)
Performing non-excavation work		day/year	238	Default value (a); (d)
Exposure Interval	T			
Earthwork construction worker		s	3.16×10^7	Calculated as 3.16×10^7*ED
Indoor commercial worker		--	--	(e)
Outdoor industrial worker		--	--	(e)
Maintenance personnel		s	7.9×10^8	Calculated as 3.16×10^7*ED
Ingestion Rate for Soil	IR_{soil}			
Earthwork construction worker		mg/day	100	Equivalent to adult agricultural worker (c)
Indoor commercial worker		--	--	(e)
Outdoor industrial worker		--	--	(e)
Maintenance personnel		mg/day	100	Equivalent to adult agricultural worker (c)
Inhalation Rate for Air	IR_{air}			
Earthwork construction worker		m^3/day	20	Default value (a)
Indoor commercial worker		m^3/day	10	Specified by DTSC HERD
Outdoor industrial worker		m^3/day	20	Default value (a)
Maintenance personnel		m^3/day	20	Default value (a)
Particulate Emission Factor	PEF			
Earthwork construction worker		m^3/kg	4.63×10^9	Default value (a)
Indoor commercial worker		--	--	(e)
Outdoor industrial worker		--	--	(e)
Maintenance personnel		m^3/kg	4.63×10^9	Default value (a)

TABLE 7-3
EXPOSURE PARAMETERS USED TO CALCULATE
HUMAN HEALTH RISK-BASED REMEDIATION GOALS
Oakland Army Base, Oakland, California

Parameter	Symbol	Unit	Value	Note/Reference
Skin Surface Area Exposed to Soil	SA			
Earthwork construction worker		cm^2/day	5,700	(f)
Indoor commercial worker		--	--	(e)
Outdoor industrial worker		--	--	(e)
Maintenance personnel		cm^2/day	5,700	(f)
Soil-to-Air Volatilization Factor	VF			
Earthwork construction worker		m^3/kg		Chemical-specific value (g)
Indoor commercial worker		--	--	(h)
Outdoor industrial worker		--	--	(e)
Maintenance personnel		m^3/kg		Chemical-specific value (g)
Soil-to-Skin Adherence Factor	AF			
Earthwork construction worker		mg/cm^2	0.8	(f)
Indoor commercial worker		--	--	(e)
Outdoor industrial worker		--	--	(e)
Maintenance personnel		mg/cm^2	0.2	Default value for industrial worker (b)

Notes:

(a) U.S. EPA. 1991. *Risk Assessment Guidance for Superfund: Volume 1 – Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals), Interim.* Office of Solid Waste and Emergency Response. Publication: 9285.7-01B.

(b) U.S. EPA. September 2001. *Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual – Part E (Supplemental Guidance for Dermal Risk Assessment), Interim*. Office of Solid Waste and Emergency Response.

(c) Cal-EPA. July 1992 (corrected and reprinted August 1996). *Supplemental Guidance for Human Health Multimedia Risk Assessments of Hazardous Waste Sites and Permitted Facilities.*

(d) Exposure frequency for maintenance personnel is based upon best professional judgement and assumes individual will be engaged in earthwork activities for 12 days per year at the OARB and will conduct activities that do not involve excavation for 238 days per year at the base.

(e) Pathway not considered complete for potentially exposed population.

(f) DTSC. 7 January 2000. Memorandum to Human and Ecological Risk Division. *Guidance for the Dermal Exposure Pathway*.

(g) Soil-to-air volatilization factor is chemical-specific. Volatilization factors were calculated using the equation in Section 3.3.1 in U.S. EPA's Risk Assessment Guidance for Superfund, Part B, dated December 1991, and input parameters listed in Table 7-4 of this RAP.

(h) The soil-to-air volatilization factor was not utilized for the indoor worker. This exposure pathway was modeled using the Johnson and Ettinger model.

TABLE 7-4
PHYSICAL PARAMETERS USED TO CALCULATE
HUMAN HEALTH RISK-BASED REMEDIATION GOALS
Oakland Army Base, Oakland, California

Parameter	Symbol	Unit	Value	Note/Reference
Building Parameters				
Length of building	-	cm	6,000	Equivalent to one side of a 40,000 ft^2 building (a)
Width of building	-	cm	6,000	Equivalent to one side of a 40,000 ft^2 building (a)
Height of building	-	cm	488	Default value for Johnson and Ettinger model (b)
Slab thickness	-	cm	15	Default value for Johnson and Ettinger model (b)
Indoor air exchange rate	-	1/hr	1	Specified by DTSC HERD
Indoor pressure differential	-	$g/cm\text{-}s^2$	40	Default value for Johnson and Ettinger model (b)
Floor-wall seam crack width	-	cm	0.1	Default value for Johnson and Ettinger model (b)
Volumetric air content in cracks	-	-	0.163	Equivalent to volumetric air content in soil
Volumetric water content in cracks	-	-	0.196	Equivalent to volumetric water content in soil
Capillary Zone Parameters				
Total soil porosity in capillary zone	n_c	-	0.358	Equivalent to total soil porosity in vadose zone
Volumetric air content in capillary zone	θ_{ac}	-	0.035	One percent of total porosity
Volumetric water content in capillary zone	θ_{wc}	-	0.322	Calculated as n_c-θ_{ac}
Thickness of capillary zone	-	cm	17	Default value for Johnson and Ettinger model (b)
Climatic Parameters				
Mixing zone height	DH	cm	200	Default value (c)
Wind speed above ground surface	V	cm/s	225	Default value (c)
Soil Parameters				
Fraction organic carbon content in soil	f_{oc}	-	0.026	Average of site-specific vadose zone data (d)
Soil dry bulk density	ρ_b	g/cm^3	1.70	Average of site-specific vadose zone data (d)
Soil particle density	ρ_d	g/cm^3	2.65	Average of site-specific vadose zone data (d)
Water content by mass (g water/g soil)	w	-	0.115	Average of site-specific vadose zone data (d)
Total soil porosity in vadose zone	n	-	0.358	Calculated as $1-\rho_b/\rho_d$
Volumetric water content in vadose zone	θ_w	-	0.196	Calculated as $w\rho_b/\rho_w$
Volumetric air content in vadose zone	θ_a	-	0.163	Calculated as $n-\theta_w$
Assumed soil type	-	-	Sand	Review of OARB lithologic logs
Air-filled soil permeability	k_v	cm^2	1×10^{-8}	Typical value for sand (e); (b)
Soil temperature	-	C	15	Default value for San Francisco Bay Area (b)

TABLE 7-4
PHYSICAL PARAMETERS USED TO CALCULATE HUMAN HEALTH RISK-BASED REMEDIATION GOALS
Oakland Army Base, Oakland, California

Parameter	Symbol	Unit	Value	Note/Reference
Soil Source Parameters				
Depth below ground surface to top of source soil	h_2	cm	15	Thickness of slab overlying soil surface (b)
Depth below ground surface to bottom of source soil	h_1	cm	150	Site-specific value (5 feet)
Thickness of soil source	-	cm	135	Calculated as h_2-h_1
Area of soil source	A	m^2	2,025	Default value (c)
Length of side of soil source	LS	m	45	Default value (c)

Notes:

(a) Building size is based on best professional judgement and assumes a typical commercial structure in the Bay Area is 40,000 ft^2.

(b) U.S. EPA. December 2000. User's Guide for the Johnson and Ettinger (1991) Model for Subsurface Vapor Intrusion *Into Buildings (Revised).* Model dated April 2001.

(c) U.S. EPA. 1991. *Risk Assessment Guidance for Superfund: Volume 1 – Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals), Interim.* Office of Solid Waste and Emergency Response. Publication: 9285.7-01B.

(d) Sierra Testing Laboratories, Inc. 10 November 1998. *Laboratory Test Results*. Letter from Michael P. Walker, Project Manager, to Anne Cavazos, ICF Kaiser Engineers, Inc.

(e) Nazaroff, W.W. May 1992. *Radon Transport from Soil to Air.* Review of Geophysics. Vol. 30, pp. 137-160.

TABLE 7-5
SITE-SPECIFIC RISK-BASED REMEDIATION GOALS FOR CHEMICALS OF CONCERN IN SOIL TO PROTECT EARTHWORK CONSTRUCTION WORKERS
Oakland Army Base, Oakland, California

Chemical of Concern	Estimated Soil Saturation Concentration (mg/kg); (a)	RG_{nc} Non-carcinogenic Remediation Goal at HI = 1 (mg/kg); (b); (c)	RG_c Carcinogenic Remediation Goal at Risk = 10^{-6} (mg/kg); (b); (c)	Lowest Remediation Goal to Protect Earthwork Construction Worker (mg/kg); (d)
Metals				
Antimony	(e)	280	(f)	280
Arsenic	(e)	130	20	20
Barium	(e)	43,000	(f)	43,000
Beryllium	(e)	1,300	20,000	1,300
Cadmium	(e)	490	180	180
Chromium (III)	(e)	280,000	(f)	MAX(100,000); (m)
Chromium (VI)	(e)	1,500	86	86
Chromium, Total	(e)	10,000 (l)	600 (l)	600
Cobalt	(e)	42,000	(f)	42,000
Copper	(e)	26,000	(f)	26,000
Lead	--	--	--	3,500 (h)
Manganese	(e)	25,000	(f)	25,000
Mercury	(e)	60	(f)	60
Molybdenum	(e)	3,500	(f)	3,500
Nickel	(e)	14,000	180,000	14,000
Selenium	(e)	3,500	(f)	3,500
Silver	(e)	3,500	(f)	3,500
Thallium	(e)	49	(f)	49
Vanadium	(e)	4,900	(f)	4,900
Zinc	(e)	210,000	(f)	MAX(100,000)
Volatile Organic Compounds				
1,1,2,2-tetrachloroethane	7,000	3,400	18	18
1,1,2-trichloroethane	9,400	140	42	42
1,1-dichloroethane	5,900	1,700	160	160
1,1-dichloroethene	710	63	(f)	63
1,2,3-trichloropropane	3,600	410	0.7	0.7
1,2,4-trimethylbenzene	5,400	170	(f)	170
1,2-dichloroethane	8,100	27	18	18
1,2-dichloropropane	3,600	24	43	24
1,3,5-trimethylbenzene	1,300	87	(f)	87
Acetone	130,000	2,700	(f)	2,700
Benzene	3,000	21	8.5	8.5
Bromodichloromethane	7,900	440	12	12
Carbon disulfide	1,600	1,200	(f)	1,200
Carbon tetrachloride	1,100	4.6	3.0	3.0
Chloroform	14,000	190	64	64

TABLE 7-5
SITE-SPECIFIC RISK-BASED REMEDIATION GOALS FOR CHEMICALS OF CONCERN IN SOIL TO PROTECT EARTHWORK CONSTRUCTION WORKERS
Oakland Army Base, Oakland, California

Chemical of Concern	Estimated Soil Saturation Concentration (mg/kg); (a)	RG_{nc} Non-carcinogenic Remediation Goal at HI = 1 (mg/kg); (b); (c)	RG_c Carcinogenic Remediation Goal at Risk = 10^{-6} (mg/kg); (b); (c)	Lowest Remediation Goal to Protect Earthwork Construction Worker (mg/kg); (d)
Volatile Organic Compounds				
Dibromochloromethane	4,100	860	32	32
cis-1,2-dichloroethene	3,700	140	(f)	140
trans-1,2-dichloroethene	7,100	190	(f)	190
Ethylbenzene	1,200	6,200	(f)	SAT(1,200); (i)
Isopropylbenzene (Cumene)	3,800	7,200	(f)	SAT(3,800)
Methyl ethyl ketone	49,000	12,000	(f)	12,000
Methyl isobutyl ketone	5,500	1,500	(f)	1,500
Methyl tertiary butyl ether	21,000	19,000	850	850
Methylene chloride	5,800	5,200	180	180
n-butylbenzene	3,300	550	(f)	550
n-propylbenzene	1,200	350	(f)	350
p-cymene (p-isopropyltoluene)	3,700	7,200	(f)	SAT(3,700)
sec-butylbenzene	4,000	320	(f)	320
tert-butylbenzene	530	290	(f)	290
Tetrachloroethene	2,200	230	65	65
Toluene	3,900	2,700	(f)	2,700
Trichloroethene	3,000	93	100	93
Trichlorofluoromethane	4,300	4,900	(f)	SAT(4,300)
Vinyl chloride	670	61	0.6	0.6
Xylenes, Total	1,200	42,000	(f)	SAT(1,200)
Semi-volatile Organic Compounds				
Acenaphthene	(e)	8,000	(f)	8,000
Acenaphthylene	(e)	(g)	(f)	(j)
Anthracene	(e)	39,000	(f)	39,000
Benzidine	(e)	390	0.02	0.02
Benzo(a)anthracene	(e)	(g)	7.6	7.6
Benzo(a)pyrene	(e)	(g)	0.8	0.8
Benzo(b)fluoranthene	(e)	(g)	7.6	7.6
Benzo(b,k)fluoranthene	(e)	(g)	7.6	7.6
Benzo(g,h,i)perylene	(e)	(g)	(f)	(j)
Benzo(k)fluoranthene	(e)	(g)	7.6	7.6
Bis(2-ethylhexyl)phthalate	100	3,600	4,150	SAT(100)
Chrysene	(e)	(g)	86	86
Dibenz(a,h)anthracene	(e)	(g)	2.2	2.2
Fluoranthene	(e)	5,100	(f)	5,100
Fluorene	(e)	5,100	(f)	5,100

TABLE 7-5
SITE-SPECIFIC RISK-BASED REMEDIATION GOALS FOR CHEMICALS OF CONCERN IN SOIL TO PROTECT EARTHWORK CONSTRUCTION WORKERS
Oakland Army Base, Oakland, California

Chemical of Concern	Estimated Soil Saturation Concentration (mg/kg); (a)	RG_{nc} Non-carcinogenic Remediation Goal at HI = 1 (mg/kg); (b); (c)	RG_c Carcinogenic Remediation Goal at Risk = 10^{-6} (mg/kg); (b); (c)	Lowest Remediation Goal to Protect Earthwork Construction Worker (mg/kg); (d)
Semi-volatile Organic Compounds				
Hexachlorobutadiene	83,000	49	148	49
Indeno(1,2,3-c,d)pyrene	(e)	(g)	7.6	7.6
Naphthalene	(e)	150	(f)	150
Phenanthrene	(e)	38,000	(f)	38,000
Pyrene	(e)	3,900	(f)	3,900
Total Petroleum Hydrocarbons				
TPH Diesel	--	--	--	(k)
TPH Gasoline	--	--	--	(k)
TPH Motor Oil	--	--	--	(k)
TPH Recoverable	--	--	--	(k)
PCBs, Pesticides, and Herbicides				
Aldrin	(e)	8.4	1.2	1.2
Alpha BHC	(e)	82	7.1	7.1
Alpha endosulfan (Endosulfan I)	(e)	1,300	(f)	1,300
Alpha chlordane	110	140	16	16
Gamma chlordane	110	140	16	16
Dieldrin	(e)	15	1.3	1.3
Endosulfan sulfate	(e)	1,500	(f)	1,500
Endrin	(e)	90	(f)	90
Endrin aldehyde	(e)	91	(f)	91
Endrin ketone	(e)	91	(f)	91
Gamma BHC (Lindane)	(e)	81	17	17
Heptachlor	(e)	120	4.1	4.1
Heptachlor epoxide	60	3.9	3.8	3.8
4,4'-DDD	(e)	150	89	89
4,4'-DDE	(e)	130	54	54
4,4'-DDT	(e)	150	63	63
Pentachlorophenol	(e)	8,200	260	260
Toxaphene	(e)	(g)	1.4	1.4
PCB-1248 (Aroclor 1248)	570	(g)	1.8	1.8
PCB-1260 (Aroclor 1260)	(e)	(g)	1.8	1.8
Dioxin-like Compounds				
2,3,7,8-tetrachlorodibenzo-p-dioxin	(e)	(g)	0.0001	0.0001

TABLE 7-5

SITE-SPECIFIC RISK-BASED REMEDIATION GOALS FOR CHEMICALS OF CONCERN IN SOIL IN SOILTO PROTECT EARTHWORK CONSTRUCTION WORKERS

Oakland Army Base, Oakland, California

Notes:

(a) Soil saturation concentration for COCs are calculated below using equation from U.S. EPA, 1 November 2000, *Region 9 Preliminary Remediation Goals (PRGs) 1999*, Memorandum from Stanford J. Smucker, Ph.D., Regional Toxicologist (SFD-8-B), Technical Support Team. Values of site-specific physical parameters used to calculate soil saturation concentrations are summarized in Table 7-2.

(b) Risk-based remediation goals in this table have been calculated through use of equations presented in Section 7 of the RAP. Human health toxicity values and physical and exposure parameters used in calculating remediation goals are summarized in Tables 7-1 through 7-4.

(c) Risk-based remediation goals assume a non-carcinogenic target risk level that corresponds to a hazard index of 1 and a carcinogenic target risk level of one-in-one million (i.e., 10^{-6}) incremental risk of an individual developing cancer over a lifetime from exposure to a single chemical.

(d) Unless otherwise noted, value cited is the lesser of the non-carcinogenic and carcinogenic risk-based remediation goals when both values could be calculated.

(e) No soil saturation concentrations were calculated for compounds that are solids under ambient temperature and pressure.

(f) U.S. EPA or OEHHA do not classify compound as a potential carcinogen, thus no published carcinogenic slope factor is available for this compound.

(g) No published chronic reference dose is available for this compound, and no suitable surrogate compound was identified.

(h) Risk-based remediation goal for lead calculated using DTSC Lead Spread Version 7.0 computer model (See Appendix B)

(i) Prefix "SAT" denotes risk -based value exceeds calculated soil saturation concentration, thus, the estimated saturation saturation value is listed inside the parenthesis.

(j) No published human health toxicity values available for compound. Consequently, risk-based remediation goal could not be calculated for this compound.

(k) No site-specific risk-based remediation goals were calculated for petroleum hydrocarbons. Fuel Storage Tank Sites Cleanup Levels derived by the Army are adopted as remediation goals for petroleum hydrocarbons. Refer to Table 7-11.

(l) The remediation goal for total chromium was calculated from the chromium (III) and chromium (IV) remediation goal assuming a 1:6 ratio of chromium(VI) to chromium(III), consistent with U.S. EPA Region IX Preliminary Remediation Goals (U.S. EPA, 2000).

(m Prefix "MAX" denotes that the calculated risk-based concentration is 100,000 mg/kg or greater. A non-risk based "ceiling limit" concentration for metals and certain SVOCs that are solids at ambient temperatures is given as 100,000 mg/kg, consistent with U.S. EPA Region IX Preliminary Remediation Goals (U.S. EPA, 2000).

TABLE 7-6
SITE-SPECIFIC RISK-BASED REMEDIATION GOALS FOR CHEMICALS OF CONCERN IN SOIL TO PROTECT INDOOR COMMERCIAL WORKERS
Oakland Army Base, Oakland, California

Chemical of Concern	Estimated Soil Saturation Concentration (mg/kg); (a)	RG_{nc} Non-carcinogenic Remediation Goal at HI = 1 (mg/kg); (b); (c)	RG_c Carcinogenic Remediation Goal at Risk = 10^{-6} (mg/kg); (b); (c)	Lowest Remediation Goal to Protect Indoor Commercial Worker (mg/kg); (d)
Metals				
Antimony	(e)	--	(f)	(h)
Arsenic	(e)	--	--	(h)
Barium	(e)	--	(f)	(h)
Beryllium	(e)	--	--	(h)
Cadmium	(e)	--	--	(h)
Chromium (III)	(e)	--	(f)	(h)
Chromium (VI)	(e)	--	--	(h)
Chromium, Total	(e)	--	--	(h)
Cobalt	(e)	--	(f)	(h)
Copper	(e)	--	(f)	(h)
Lead	(e)	--	--	(h)
Manganese	(e)	--	(f)	(h)
Mercury	(e)	--	(f)	(h)
Molybdenum	(e)	--	(f)	(h)
Nickel	(e)	--	--	(h)
Selenium	(e)	--	(f)	(h)
Silver	(e)	--	(f)	(h)
Thallium	(e)	--	(f)	(h)
Vanadium	(e)	--	(f)	(h)
Zinc	(e)	--	(f)	(h)
Volatile Organic Compounds				
1,1,2,2-tetrachloroethane	7,000	16,000	3.8	3.8
1,1,2-trichloroethane	9,300	220	2.7	2.7
1,1-dichloroethane	5,900	780	2.7	2.7
1,1-dichloroethene	710	43	(f)	43
1,2,3-trichloropropane	3,600	2,300	0.2	0.2
1,2,4-trimethylbenzene	5,400	470	(f)	470
1,2-dichloroethane	8,000	27	0.8	0.8
1,2-dichloropropane	3,600	18	0.1	0.1
1,3,5-trimethylbenzene	1,300	130	(f)	130
Acetone	130,000	10,000	(f)	10,000
Benzene	3,000	17	0.3	0.3
Bromodichloromethane	7,900	650	0.7	0.7
Carbon disulfide	1,600	950	(f)	950
Carbon tetrachloride	1,100	3.6	0.1	0.1
Chloroform	14,000	100	1.5	1.5

TABLE 7-6
SITE-SPECIFIC RISK-BASED REMEDIATION GOALS FOR CHEMICALS OF CONCERN IN SOIL TO PROTECT INDOOR COMMERCIAL WORKERS
Oakland Army Base, Oakland, California

Chemical of Concern	Estimated Soil Saturation Concentration (mg/kg); (a)	RG_{nc} Non-carcinogenic Remediation Goal at HI = 1 (mg/kg); (b); (c)	RG_c Carcinogenic Remediation Goal at Risk = 10^{-6} (mg/kg); (b); (c)	Lowest Remediation Goal to Protect Indoor Commercial Worker (mg/kg); (d)
Volatile Organic Compounds				
Dibromochloromethane	4,000	1,300	2	2
cis-1,2-dichloroethene	3,700	83	(f)	83
trans-1,2-dichloroethene	7,100	95	(f)	95
Ethylbenzene	1,200	9,100	(f)	SAT(1,200); (i)
Isopropylbenzene (Cumene)	3,800	36,000	(f)	SAT(3,800)
Methyl ethyl ketone	49,000	32,000	(f)	32,000
Methyl isobutyl ketone	5,500	1,200	(f)	1,200
Methyl tertiary butyl ether	21,000	18,000	33	33
Methylene chloride	5,800	5,200	4.8	4.8
n-butylbenzene	3,300	1,600	(f)	1,600
n-propylbenzene	1,200	530	(f)	530
p-cymene (p-isopropyltoluene)	3,700	32,000	(f)	SAT(3,700)
sec-butylbenzene	4,000	200	(f)	200
tert-butylbenzene	530	300	(f)	300
Tetrachloroethene	2,200	210	2.8	2.8
Toluene	3,900	4,200	(f)	3,900
Trichloroethene	3,000	54	2.5	2.5
Trichlorofluoromethane	4,300	3,600	(f)	3,600
Vinyl chloride	670	140	0.05	0.05
Xylenes, Total	1,200	110,000	(f)	SAT(1,200)
Semi-volatile Organic Compounds				
Acenaphthene	(e)	3,600,000	(f)	MAX(100,000); (l)
Acenaphthylene	(e)	(g)	(f)	(j)
Anthracene	(e)	200,000,000	(f)	MAX(100,000)
Benzidine	(e)	--	--	(h)
Benzo(a)anthracene	(e)	(g)	--	(h)
Benzo(a)pyrene	(e)	(g)	--	(h)
Benzo(b)fluoranthene	(e)	(g)	--	(h)
Benzo(b,k)fluoranthene	(e)	(g)	--	(h)
Benzo(g,h,i)perylene	(e)	(g)	(f)	(j)
Benzo(k)fluoranthene	(e)	(g)	--	(h)
Bis(2-ethylhexyl)phthalate	100	--	--	(h)
Chrysene	(e)	(g)	--	(h)
Dibenz(a,h)anthracene	(e)	(g)	--	(h)
Fluoranthene	(e)	--	(f)	(h)
Fluorene	(e)	250,000,000	(f)	MAX(100,000)

TABLE 7-6
SITE-SPECIFIC RISK-BASED REMEDIATION GOALS FOR CHEMICALS OF CONCERN IN SOIL TO PROTECT INDOOR COMMERCIAL WORKERS
Oakland Army Base, Oakland, California

Chemical of Concern	Estimated Soil Saturation Concentration (mg/kg); (a)	RG_{nc} Non-carcinogenic Remediation Goal at HI = 1 (mg/kg); (b); (c)	RG_c Carcinogenic Remediation Goal at Risk = 10^{-6} (mg/kg); (b); (c)	Lowest Remediation Goal to Protect Indoor Commercial Worker (mg/kg); (d)
Semi-volatile Organic Compounds				
Hexachlorobutadiene	83,000	--	--	(h)
Indeno(1,2,3-c,d)pyrene	(e)	(g)	--	(h)
Naphthalene	(e)	3,900	(f)	3,900
Phenanthrene	(e)	1,400,000,000	(f)	MAX(100,000)
Pyrene	(e)	490,000,000	(f)	MAX(100,000)
Total Petroleum Hydrocarbons				
TPH Diesel	--	--	--	(k)
TPH Gasoline	--	--	--	(k)
TPH Motor Oil	--	--	--	(k)
TPH Recoverable	--	--	--	(k)
PCBs, Pesticides, and Herbicides				
Aldrin	(e)	--	--	(h)
Alpha BHC	(e)	--	--	(h)
Alpha endosulfan (Endosulfan I)	(e)	--	(f)	(h)
Alpha chlordane	110	--	--	(h)
Gamma chlordane	110	--	--	(h)
Dieldrin	(e)	--	--	(h)
Endosulfan sulfate	(e)	--	(f)	(h)
Endrin	(e)	--	(f)	(h)
Endrin aldehyde	(e)	--	(f)	(h)
Endrin ketone	(e)	--	(f)	(h)
Gamma BHC (Lindane)	(e)	--	--	(h)
Heptachlor	(e)	--	--	(h)
Heptachlor epoxide	60	--	--	(h)
4,4'-DDD	(e)	--	--	(h)
4,4'-DDE	(e)	--	--	(h)
4,4'-DDT	(e)	--	--	(h)
Pentachlorophenol	(e)	--	--	(h)
Toxaphene	(e)	--	--	(h)
PCB-1248 (Aroclor 1248)	570	(g)	--	(h)
PCB-1260 (Aroclor 1260)	(e)	(g)	--	(h)
Dioxin-like Compounds				
2,3,7,8-tetrachlorodibenzo-p-dioxin	(e)	(g)	--	(h)

TABLE 7-6
SITE-SPECIFIC RISK-BASED REMEDIATION GOALS FOR CHEMICALS OF CONCERN IN SOIL TO PROTECT INDOOR COMMERCIAL WORKERS
Oakland Army Base, Oakland, California

Notes:

(a) Soil saturation concentration for COCs are calculated below using equation from U.S. EPA, 1 November 2000, *Region 9 Preliminary Remediation Goals (PRGs) 1999*, Memorandum from Stanford J. Smucker, Ph.D., Regional Toxicologist (SFD-8-B), Technical Support Team. Values of site-specific physical parameters used to calculate soil saturation concentrations are summarized in Table 7-2.

(b) Risk-based remediation goals in this table have been calculated through use of U.S. EPA Johnson and Ettinger vapor intrusion computer model (See Appendix). Human health toxicity values and physical and exposure parameters used in calculating remediation goals are summarized in Tables 7-1 through 7-4.

(c) Risk-based remediation goals assume a non-carcinogenic target risk level that corresponds to a hazard index of 1 and a carcinogenic target risk level of one-in-one million (i.e., 10^{-6}) incremental risk of an individual developing cancer over a lifetime from exposure to a single chemical.

(d) Unless otherwise noted, value cited is the lesser of the non-carcinogenic and carcinogenic risk-based remediation goals when both values could be calculated.

(e) No soil saturation concentrations were calculated for compounds that are solids under ambient temperature and pressure.

(f) U.S. EPA or OEHHA do not classify compound as a potential carcinogen, thus no published carcinogenic slope factor is available for this compound.

(g) No published chronic reference dose is available for this compound, and no suitable surrogate compound was identified.

(h) Vapor intrusion is the only potentially complete exposure pathway for this population. Consequently, risk-based remediation goals for this population are calculated only for those compounds considered to be volatile. Volatile compounds are defined to be chemicals that have Henry Law constants greater than 10^{-5} atm-m^3/mol and molecular weights less than 200 g/mol.

(i) Prefix "SAT" denotes risk -based value exceeds calculated soil saturation concentration, thus, the estimated saturation value is listed inside the parenthesis.

(j) No published human health toxicity values available for compound. Consequently, risk-based remediation goal could not be calculated for compound.

(k) No site-specific risk-based remediation goals were calculated for petroleum hydrocarbons. Fuel Storage Tank Sites Cleanup Levels derived by the Army are adopted as remediation goals for petroleum hydrocarbons. Refer to Table 7-11.

(l) Prefix "MAX" denotes that the calculated risk-based concentration is 100,000 mg/kg or greater. A non-risk based "ceiling limit" concentration for metals and certain SVOCs that are solids at ambient temperatures is given as 100,000 mg/kg, consistent with U.S. EPA Region IX Preliminary Remediation Goals (U.S. EPA, 2000).

TABLE 7-7
SITE-SPECIFIC RISK-BASED REMEDIATION GOALS FOR CHEMICALS OF CONCERN IN SOIL TO PROTECT OUTDOOR INDUSTRIAL WORKERS

Oakland Army Base, Oakland, California

Chemical of Concern	Estimated Soil Saturation Concentration (mg/kg); (a)	RG_{nc} Non-carcinogenic Remediation Goal at HI = 1 (mg/kg); (b); (c)	RG_c Carcinogenic Remediation Goal at Risk = 10^{-6} (mg/kg); (b); (c)	Lowest Remediation Goal to Protect Outdoor Industrial Worker (mg/kg); (d)
Metals				
Antimony	(e)	--	(f)	(h)
Arsenic	(e)	--	--	(h)
Barium	(e)	--	(f)	(h)
Beryllium	(e)	--	--	(h)
Cadmium	(e)	--	--	(h)
Chromium (III)	(e)	--	(f)	(h)
Chromium (VI)	(e)	--	--	(h)
Chromium, Total	(e)	--	--	(h)
Cobalt	(e)	--	(f)	(h)
Copper	(e)	--	(f)	(h)
Lead	(e)	--	--	(h)
Manganese	(e)	--	(f)	(h)
Mercury	(e)	--	(f)	(h)
Molybdenum	(e)	--	(f)	(h)
Nickel	(e)	--	--	(h)
Selenium	(e)	--	(f)	(h)
Silver	(e)	--	(f)	(h)
Thallium	(e)	--	(f)	(h)
Vanadium	(e)	--	(f)	(h)
Zinc	(e)	--	(f)	(h)
Volatile Organic Compounds				
1,1,2,2-tetrachloroethane	7,000	25,000	5.8	5.8
1,1,2-trichloroethane	9,400	2,200	11	11
1,1-dichloroethane	5,900	9,600	34	34
1,1-dichloroethene	710	330	(f)	330
1,2,3-trichloropropane	3,600	3,300	0.2	0.2
1,2,4-trimethylbenzene	5,400	850	(f)	850
1,2-dichloroethane	8,100	140	3.9	3.9
1,2-dichloropropane	3,600	140	9.7	9.7
1,3,5-trimethylbenzene	1,300	440	(f)	440
Acetone	130,000	16,000	(f)	16,000
Benzene	3,000	110	1.8	1.8
Bromodichloromethane	7,900	2,500	2.7	2.7
Carbon disulfide	1,600	6,400	(f)	SAT(1,600)
Carbon tetrachloride	1,100	24	0.6	0.6
Chloroform	14,000	1,000	15	15

TABLE 7-7
SITE-SPECIFIC RISK-BASED REMEDIATION GOALS FOR CHEMICALS OF CONCERN IN SOIL TO PROTECT OUTDOOR INDUSTRIAL WORKERS
Oakland Army Base, Oakland, California

Chemical of Concern	Estimated Soil Saturation Concentration (mg/kg); (a)	RG_{nc} Non-carcinogenic Remediation Goal at HI = 1 (mg/kg); (b); (c)	RG_c Carcinogenic Remediation Goal at Risk = 10^{-6} (mg/kg); (b); (c)	Lowest Remediation Goal to Protect Outdoor Industrial Worker (mg/kg); (d)
Volatile Organic Compounds				
Dibromochloromethane	4,100	5,600	8.4	8.4
cis-1,2-dichloroethene	3,700	750	(f)	750
trans-1,2-dichloroethene	7,100	990	(f)	990
Ethylbenzene	1,200	47,000	(f)	SAT(1,200); (i)
Isopropylbenzene (Cumene)	3,800	60,000	(f)	SAT(3,800)
Methyl ethyl ketone	49,000	65,000	(f)	SAT(49,000)
Methyl isobutyl ketone	5,500	8,600	(f)	SAT(5,500)
Methyl tertiary butyl ether	21,000	110,000	190	190
Methylene chloride	5,800	49,000	50	50
n-butylbenzene	3,300	3,900	(f)	SAT(3,300)
n-propylbenzene	1,200	2,200	(f)	SAT(1,200)
p-cymene (p-isopropyltoluene)	3,700	59,000	(f)	SAT(3,700)
sec-butylbenzene	4,000	2,000	(f)	2,000
tert-butylbenzene	530	1,700	(f)	SAT(530)
Tetrachloroethene	2,200	1,300	20	20
Toluene	3,900	15,000	(f)	SAT(3,900)
Trichloroethene	3,000	510	20	20
Trichlorofluoromethane	4,300	27,000	(f)	SAT(4,300)
Vinyl chloride	670	340	0.1	0.1
Xylenes, Total	1,200	240,000	(f)	SAT(1,200)
Semi-volatile Organic Compounds				
Acenaphthene	(e)	960,000	(f)	MAX(100,000); (l)
Acenaphthylene	(e)	(g)	(f)	(j)
Anthracene	(e)	15,000,000	(f)	MAX(100,000)
Benzidine	(e)	--	--	(h)
Benzo(a)anthracene	(e)	(g)	--	(h)
Benzo(a)pyrene	(e)	(g)	--	(h)
Benzo(b)fluoranthene	(e)	(g)	--	(h)
Benzo(b,k)fluoranthene	(e)	(g)	--	(h)
Benzo(g,h,i)perylene	(e)	(g)	(f)	(j)
Benzo(k)fluoranthene	(e)	(g)	--	(h)
Bis(2-ethylhexyl)phthalate	100	--	--	(h)
Chrysene	(e)	(g)	--	(h)
Dibenz(a,h)anthracene	(e)	(g)	--	(h)
Fluoranthene	(e)	--	(f)	(h)
Fluorene	(e)	1,700,000	(f)	MAX(100,000)

TABLE 7-7
SITE-SPECIFIC RISK-BASED REMEDIATION GOALS FOR CHEMICALS OF CONCERN IN SOIL TO PROTECT OUTDOOR INDUSTRIAL WORKERS
Oakland Army Base, Oakland, California

Chemical of Concern	Estimated Soil Saturation Concentration (mg/kg); (a)	RG_{nc} Non-carcinogenic Remediation Goal at HI = 1 (mg/kg); (b); (c)	RG_c Carcinogenic Remediation Goal at Risk = 10^{-6} (mg/kg); (b); (c)	Lowest Remediation Goal to Protect Outdoor Industrial Worker (mg/kg); (d)
Semi-volatile Organic Compounds				
Hexachlorobutadiene	83,000	--	--	(h)
Indeno(1,2,3-c,d)pyrene	(e)	(g)	--	(h)
Naphthalene	(e)	820	(f)	820
Phenanthrene	(e)	12,000,000	(f)	MAX(100,000)
Pyrene	(e)	2,200,000	(f)	MAX(100,000)
Total Petroleum Hydrocarbons				
TPH Diesel	--	--	--	(k)
TPH Gasoline	--	--	--	(k)
TPH Motor Oil	--	--	--	(k)
TPH Recoverable	--	--	--	(k)
PCBs, Pesticides, and Herbicides				
Aldrin	(e)	--	--	(h)
Alpha BHC	(e)	--	--	(h)
Alpha endosulfan (Endosulfan I)	(e)	--	(f)	(h)
Alpha chlordane	110	--	--	(h)
Gamma chlordane	110	--	--	(h)
Dieldrin	(e)	--	--	(h)
Endosulfan sulfate	(e)	--	(f)	(h)
Endrin	(e)	--	(f)	(h)
Endrin aldehyde	(e)	--	(f)	(h)
Endrin ketone	(e)	--	(f)	(h)
Gamma BHC (Lindane)	(e)	--	--	(h)
Heptachlor	(e)	--	--	(h)
Heptachlor epoxide	60	--	--	(h)
4,4'-DDD	(e)	--	--	(h)
4,4'-DDE	(e)	--	--	(h)
4,4'-DDT	(e)	--	--	(h)
Pentachlorophenol	(e)	--	--	(h)
Toxaphene	(e)	--	--	(h)
PCB-1248 (Aroclor 1248)	570	(g)	--	(h)
PCB-1260 (Aroclor 1260)	(e)	(g)	--	(h)
Dioxin-like Compounds				
2,3,7,8-tetrachlorodibenzo-p-dioxin	(e)	(g)	--	(h)

TABLE 7-7
SITE-SPECIFIC RISK-BASED REMEDIATION GOALS FOR CHEMICALS OF CONCERN IN SOIL TO PROTECT OUTDOOR INDUSTRIAL WORKERS
Oakland Army Base, Oakland, California

Notes:

(a) Soil saturation concentration for COCs are calculated below using equation from U.S. EPA, 1 November 2000, *Region 9 Preliminary Remediation Goals (PRGs) 1999*, Memorandum from Stanford J. Smucker, Ph.D., Regional Toxicologist (SFD-8-B), Technical Support Team. Values of site-specific physical parameters used to calculate soil saturation concentrations are summarized in Table 7-2.

(b) Risk-based remediation goals in this table have been calculated through use of equations presented in Section 7 of the RAP. Human health toxicity values and physical and exposure parameters used in calculating remediation goals are summarized in Tables 7-1 through 7-4.

(c) Risk-based remediation goals assume a non-carcinogenic target risk level that corresponds to a hazard index of 1 and a carcinogenic target risk level of one-in-one million (i.e., 10^{-6}) incremental risk of an individual developing cancer over a lifetime from exposure to a single chemical.

(d) Unless otherwise noted, value cited is the lesser of the non-carcinogenic and carcinogenic risk-based remediation goals when both values could be calculated.

(e) No soil saturation concentrations were calculated for compounds that are solids under ambient temperature and pressure.

(f) U.S. EPA or OEHHA do not classify compound as a potential carcinogen, thus no published carcinogenic slope factor is available for this compound.

(g) No published chronic reference dose is available for this compound, and no suitable surrogate compound was identified.

(h) Vapor intrusion is the only potentially complete exposure pathway for this population. Consequently, risk-based remediation goals for this population are calculated only for those compounds considered to be volatile. Volatile compounds are defined to be chemicals that have Henry Law constants greater than 10^{-5} atm-m^3/mol and molecular weights less than 200 g/mol.

(i) Prefix "SAT" denotes risk -based value exceeds calculated soil saturation concentration, thus, the estimated saturation value is listed inside the parenthesis.

(j) No published human health toxicity values available for compound. Consequently, risk-based remediation goal could not be calculated for compound.

(k) No site-specific risk-based remediation goals were calculated for petroleum hydrocarbons. Fuel Storage Tank Sites Cleanup Levels derived by the Army are adopted as remediation goals for petroleum hydrocarbons. Refer to Table 7-11.

(l) Prefix "MAX" denotes that the calculated risk-based concentration is 100,000 mg/kg or greater. A non-risk based "ceiling limit" concentration for metals and certain SVOCs that are solids at ambient temperatures is given as 100,000 mg/kg, consistent with U.S. EPA Region IX Preliminary Remediation Goals (U.S. EPA, 2000).

TABLE 7-8
SITE-SPECIFIC RISK-BASED REMEDIATION GOALS FOR CHEMICALS OF CONCERN IN SOIL TO PROTECT MAINTENANCE PERSONNEL
Oakland Army Base, Oakland, California

Chemical of Concern	Estimated Soil Saturation Concentration (mg/kg); (a)	RG_{nc} Non-carcinogenic Remediation Goal at HI = 1 (mg/kg); (b); (c)	RG_c Carcinogenic Remediation Goal at Risk = 10^{-6} (mg/kg); (b); (c)	Lowest Remediation Goal to Protect Maintenance Personnel (mg/kg); (d)
Metals				
Antimony	(e)	7,600	(f)	7,600
Arsenic	(e)	4,800	30	30
Barium	(e)	1,100,000	(f)	MAX(100,000); (m)
Beryllium	(e)	34,000	16,000	16,000
Cadmium	(e)	11,000	150	150
Chromium (III)	(e)	15,000,000	(f)	MAX(100,000)
Chromium (VI)	(e)	38,000	87	87
Chromium, Total	(e)	260,000 (l)	610 (l)	610
Cobalt	(e)	1,100,000	(f)	MAX(100,000)
Copper	(e)	710,000	(f)	MAX(100,000)
Lead	--	--	--	77,000 (h)
Manganese	(e)	560,000	(f)	MAX(100,000)
Mercury	(e)	1,600	(f)	1,600
Molybdenum	(e)	96,000	(f)	96,000
Nickel	(e)	380,000	150,000	MAX(100,000)
Selenium	(e)	96,000	(f)	96,000
Silver	(e)	96,000	(f)	96,000
Thallium	(e)	1,300	(f)	1,300
Vanadium	(e)	130,000	(f)	MAX(100,000)
Zinc	(e)	5,700,000	(f)	MAX(100,000)
Volatile Organic Compounds				
1,1,2,2-tetrachloroethane	7,000	280,000	56	56
1,1,2-trichloroethane	9,300	21,000	140	140
1,1-dichloroethane	5,900	170,000	610	610
1,1-dichloroethene	710	6,300	(f)	SAT(710); (i)
1,2,3-trichloropropane	3,600	32,000	2.1	2.1
1,2,4-trimethylbenzene	5,400	17,000	(f)	SAT(5,400)
1,2-dichloroethane	8,100	2,800	71	71
1,2-dichloropropane	3,600	2,300	160	160
1,3,5-trimethylbenzene	1,300	9,000	(f)	SAT(1,300)
Acetone	130,000	120,000	(f)	120,000
Benzene	3,000	2,100	34	34
Bromodichloromethane	7,900	41,000	40	40
Carbon disulfide	1,600	120,000	(f)	SAT(1,600)
Carbon tetrachloride	1,100	460	12	12
Chloroform	14,000	18,000	230	230

TABLE 7-8
SITE-SPECIFIC RISK-BASED REMEDIATION GOALS FOR CHEMICALS OF CONCERN IN SOIL TO PROTECT MAINTENANCE PERSONNEL
Oakland Army Base, Oakland, California

Chemical of Concern	Estimated Soil Saturation Concentration (mg/kg); (a)	RG_{nc} Non-carcinogenic Remediation Goal at HI = 1 (mg/kg); (b); (c)	RG_c Carcinogenic Remediation Goal at Risk = 10^{-6} (mg/kg); (b); (c)	Lowest Remediation Goal to Protect Maintenance Personnel (mg/kg); (d)
Volatile Organic Compounds				
Dibromochloromethane	4,100	74,000	110	110
cis-1,2-dichloroethene	3,700	14,000	(f)	SAT(3,700)
trans-1,2-dichloroethene	7,100	19,000	(f)	SAT(7,100)
Ethylbenzene	1,200	490,000	(f)	SAT(1,200)
Isopropylbenzene (Cumene)	3,800	550,000	(f)	SAT(3,800)
Methyl ethyl ketone	49,000	1,100,000	(f)	SAT(49,000)
Methyl isobutyl ketone	5,500	150,000	(f)	SAT(5,500)
Methyl tertiary butyl ether	21,000	1,800,000	3,200	3,200
Methylene chloride	5,800	380,000	650	650
n-butylbenzene	3,300	45,000	(f)	SAT(3,300)
n-propylbenzene	1,200	31,000	(f)	SAT(1,200)
p-cymene (p-isopropyltoluene)	3,700	550,000	(f)	SAT(3,700)
sec-butylbenzene	4,000	29000	(f)	SAT(4,000)
tert-butylbenzene	530	26,000	(f)	SAT(530)
Tetrachloroethene	2,200	22,000	220	220
Toluene	3,900	270,000	(f)	SAT(3,900)
Trichloroethene	3,000	9,000	390	390
Trichlorofluoromethane	4,300	480,000	(f)	SAT(4,300)
Vinyl chloride	670	5,800	2.5	2.5
Xylenes, Total	1,200	3,900,000	(f)	SAT(1,200)
Semi-volatile Organic Compounds				
Acenaphthene	(e)	460,000	(f)	MAX(100,000)
Acenaphthylene	(e)	(g)	(f)	(j)
Anthracene	(e)	2,300,000	(f)	MAX(100,000)
Benzidine	(e)	23,000	0.04	0.04
Benzo(a)anthracene	(e)	(g)	18	18
Benzo(a)pyrene	(e)	(g)	1.8	1.8
Benzo(b)fluoranthene	(e)	(g)	18	18
Benzo(b,k)fluoranthene	(e)	(g)	18	18
Benzo(g,h,i)perylene	(e)	(g)	(f)	(j)
Benzo(k)fluoranthene	(e)	(g)	18	18
Bis(2-ethylhexyl)phthalate	100	200,000	9,100	SAT(100)
Chrysene	(e)	(g)	200	200
Dibenz(a,h)anthracene	(e)	(g)	5	5
Fluoranthene	(e)	310,000	(f)	MAX(100,000)
Fluorene	(e)	310,000	(f)	MAX(100,000)

TABLE 7-8
SITE-SPECIFIC RISK-BASED REMEDIATION GOALS FOR CHEMICALS OF CONCERN IN SOIL TO PROTECT MAINTENANCE PERSONNEL
Oakland Army Base, Oakland, California

Chemical of Concern	Estimated Soil Saturation Concentration (mg/kg); (a)	RG_{nc} Non-carcinogenic Remediation Goal at HI = 1 (mg/kg); (b); (c)	RG_c Carcinogenic Remediation Goal at Risk = 10^{-6} (mg/kg); (b); (c)	Lowest Remediation Goal to Protect Maintenance Personnel (mg/kg); (d)
Semi-volatile Organic Compounds				
Hexachlorobutadiene	83,000	2,800	340	340
Indeno(1,2,3-c,d)pyrene	(e)	(g)	18	18
Naphthalene	(e)	15,000	(f)	15,000
Phenanthrene	(e)	2,300,000	(f)	MAX(100,000)
Pyrene	(e)	230,000	(f)	MAX(100,000)
Total Petroleum Hydrocarbons				
TPH Diesel	--	--	--	(k)
TPH Gasoline	--	--	--	(k)
TPH Motor Oil	--	--	--	(k)
TPH Recoverable	--	--	--	(k)
PCBs, Pesticides, and Herbicides				
Aldrin	(e)	400	2.1	2.1
Alpha BHC	(e)	3,800	13	13
Alpha endosulfan (Endosulfan I)	(e)	69,000	(f)	69,000
Alpha chlordane	110	6,500	29	29
Gamma chlordane	110	6,500	29	29
Dieldrin	(e)	700	2.3	2.3
Endosulfan sulfate	(e)	73,000	(f)	73,000
Endrin	(e)	4,000	(f)	4,000
Endrin aldehyde	(e)	4,000	(f)	4,000
Endrin ketone	(e)	4,000	(f)	4,000
Gamma BHC (Lindane)	(e)	3,800	32	32
Heptachlor	(e)	6,000	8.2	8.2
Heptachlor epoxide	60	170	6.8	6.8
4,4'-DDD	(e)	6,700	160	160
4,4'-DDE	(e)	6,300	100	100
4,4'-DDT	(e)	6,700	110	110
Pentachlorophenol	(e)	380,000	460	460
Toxaphene	(e)	(g)	5.3	5.3
PCB-1248 (Aroclor 1248)	570	(g)	4.4	4.4
PCB-1260 (Aroclor 1260)	(e)	(g)	4.4	4.4
Dioxin-like Compounds				
2,3,7,8-tetrachlorodibenzo-p-dioxin	(e)	(g)	0.0002	0.0002

Notes:

(a) Soil saturation concentration for COCs are calculated below using equation from U.S. EPA, 1 November 2000, *Region 9 Preliminary Remediation Goals (PRGs) 1999*, Memorandum from Stanford J. Smucker, Ph.D., Regional Toxicologist (SFD-8-B), Technical Support Team. Values of site-specific physical parameters used to calculate soil saturation concentrations are summarized in Table 7-2.

(b) Risk-based remediation goals in this table have been calculated through use of equations presented in Section 7 of the RAP. Human health toxicity values and physical and exposure parameters used in calculating remediation goals are summarized in Tables 7-1 through 7-4.

(c) Risk-based remediation goals assume a non-carcinogenic target risk level that corresponds to a hazard index of 1 and a carcinogenic target risk level of one-in-one million (i.e., 10^{-6}) incremental risk of an individual developing cancer over a lifetime from exposure to a single chemical.

(d) Unless otherwise noted, value cited is the lesser of the non-carcinogenic and carcinogenic risk-based remediation goals when both values could be calculated.

(e) No soil saturation concentrations were calculated for compounds that are solids under ambient temperature and pressure.

(f) U.S. EPA or OEHHA do not classify compound as a potential carcinogen, thus no published carcinogenic slope factor is available for this compound.

(g) No published chronic reference dose is available for this compound, and no suitable surrogate compound was identified.

(h) Risk-based remediation goal for lead calculated using DTSC Lead Spread Version 7.0 computer model (See Appendix B)

(i) Prefix "SAT" denotes risk -based value exceeds calculated soil saturation concentration, thus, the estimated saturation value is listed inside the parenthesis.

(j) No published human health toxicity values available for compound. Consequently, risk-based remediation goal could not be calculated for compound.

(k) No site-specific risk-based remediation goals were calculated for petroleum hydrocarbons. Fuel Storage Tank Sites Cleanup Levels derived by the Army are adopted as remediation goals for petroleum hydrocarbons. Refer to Table 7-11.

(l) The remediation goal for total chromium was calculated from the chromium (III) and chromium (IV) remediation goal assuming a 1:6 ratio of chromium(VI) to chromium(III), consistent with U.S. EPA Region IX Preliminary Remediation Goals (U.S. EPA, 2000).

(m Prefix "MAX" denotes that the calculated risk-based concentration is 100,000 mg/kg or greater. A non-risk based "ceiling limit" concentration for metals and certain SVOCs that are solids at ambient temperatures is given as 100,000 mg/kg, consistent with U.S. EPA Region IX Preliminary Remediation Goals (U.S. EPA, 2000).

TABLE 7-9
SITE-SPECIFIC RISK-BASED REMEDIATION GOALS FOR CHEMICALS OF CONCERN IN GROUNDWATER TO PROTECT INDOOR COMMERCIAL WORKERS
Oakland Army Base, Oakland, California

Chemical of Concern	RG_{nc} Non-carcinogenic Remediation Goal at HI = 1 (µg/L); (a); (b)	RG_c Carcinogenic Remediation Goal at Risk = 10^{-6} (µg/L); (a); (b)	Lowest Remediation Goal to Protect Indoor Commercial Worker (µg/L); (c)
Metals			
Antimony	--	(d)	(f)
Arsenic	--	--	(f)
Barium	--	(d)	(f)
Beryllium	--	--	(f)
Cadmium	--	--	(f)
Chromium (III)	--	(d)	(f)
Chromium (VI)	--	--	(f)
Chromium, Total	--	--	(f)
Cobalt	--	(d)	(f)
Copper	--	(d)	(f)
Lead	--	--	(f)
Manganese	--	(d)	(f)
Mercury	--	(d)	(f)
Molybdenum	--	(d)	(f)
Nickel	--	--	(f)
Selenium	--	(d)	(f)
Silver	--	(d)	(f)
Thallium	--	(d)	(f)
Vanadium	--	(d)	(f)
Zinc	--	(d)	(f)
Volatile Organic Compounds			
1,1,2,2-tetrachloroethane	8,300,000	1,900	1,900
1,1,2-trichloroethane	230,000	2,800	2,800
1,1-dichloroethane	1,900,000	6,700	6,700
1,1-dichloroethene	33,000	(d)	33,000
1,2,3-trichloropropane	1,500,000	100	100
1,2,4-trimethylbenzene	18,000	(d)	18,000
1,2-dichloroethane	67,000	1,900	1,900
1,2-dichloropropane	16,000	110	110
1,3,5-trimethylbenzene	25,000	(d)	25,000
Acetone	86,000,000	(d)	86,000,000
Benzene	25,000	420	420
Bromodichloromethane	790,000	850	850
Carbon disulfide	230,000	(d)	230,000
Carbon tetrachloride	2,700	72	72
Chloroform	170,000	2,500	2,500

TABLE 7-9
SITE-SPECIFIC RISK-BASED REMEDIATION GOALS FOR CHEMICALS OF CONCERN IN GROUNDWATER TO PROTECT INDOOR COMMERCIAL WORKERS
Oakland Army Base, Oakland, California

Chemical of Concern	RG_{nc} Non-carcinogenic Remediation Goal at HI = 1 (µg/L); (a); (b)	RG_c Carcinogenic Remediation Goal at Risk = 10^{-6} (µg/L); (a); (b)	Lowest Remediation Goal to Protect Indoor Commercial Worker (µg/L); (c)
Volatile Organic Compounds			
Dibromochloromethane	1,400,000	2,100	2,100
cis-1,2-dichloroethene	180,000	(d)	180,000
trans-1,2-dichloroethene	190,000	(d)	190,000
Ethylbenzene	4,200,000	(d)	4,200,000
Isopropylbenzene (Cumene)	1,800,000	(d)	1,800,000
Methyl ethyl ketone	160,000,000	(d)	160,000,000
Methyl isobutyl ketone	5,300,000	(d)	5,300,000
Methyl tertiary butyl ether	66,000,000	120,000	120,000
Methylene chloride	20,000,000	19,000	19,000
n-butylbenzene	95,000	(d)	95,000
n-propylbenzene	100,000	(d)	100,000
p-cymene (p-isopropyltoluene)	1,000,000	(d)	1,000,000
sec-butylbenzene	77,000	(d)	77,000
tert-butylbenzene	75,000	(d)	75,000
Tetrachloroethene	72,000	960	960
Toluene	1,600,000	(d)	1,600,000
Trichloroethene	61,000	2,800	2,800
Trichlorofluoromethane	2,800,000	(d)	2,800,000
Vinyl chloride	90,000	32	32
Xylenes, Total	28,000,000	(d)	28,000,000
Semi-volatile Organic Compounds			
Acenaphthene	25,000,000	(d)	25,000,000
Acenaphthylene	(e)	(d)	(g)
Anthracene	330,000,000	(d)	330,000,000
Benzidine	--	--	(f)
Benzo(a)anthracene	(e)	--	(f)
Benzo(a)pyrene	(e)	--	(f)
Benzo(b)fluoranthene	(e)	--	(f)
Benzo(b,k)fluoranthene	(e)	--	(f)
Benzo(g,h,i)perylene	(e)	(d)	(i)
Benzo(k)fluoranthene	(e)	--	(f)
Bis(2-ethylhexyl)phthalate	--	--	(f)
Chrysene	(e)	--	(f)
Dibenz(a,h)anthracene	(e)	--	(f)
Fluoranthene	--	(d)	(f)
Fluorene	38,000,000	(d)	38,000,000

TABLE 7-9
SITE-SPECIFIC RISK-BASED REMEDIATION GOALS FOR CHEMICALS OF CONCERN IN GROUNDWATER TO PROTECT INDOOR COMMERCIAL WORKERS
Oakland Army Base, Oakland, California

Chemical of Concern	RG_{nc} Non-carcinogenic Remediation Goal at HI = 1 (µg/L); (a); (b)	RG_c Carcinogenic Remediation Goal at Risk = 10^{-6} (µg/L); (a); (b)	Lowest Remediation Goal to Protect Indoor Commercial Worker (µg/L); (c)
Total Petroleum Hydrocarbons			
Hexachlorobutadiene	--	--	(f)
Indeno(1,2,3-c,d)pyrene	(e)	--	(f)
Naphthalene	100,000	(d)	100,000
Phenanthrene	520,000,000	(d)	520,000,000
Pyrene	200,000,000	(d)	200,000,000
Total Petroleum Hydrocarbons			
TPH Diesel	--	--	(h)
TPH Gasoline	--	--	(h)
TPH Motor Oil	--	--	(h)
TPH Recoverable	--	--	(h)
PCBs, Pesticides, and Herbicides			
Aldrin	--	--	(f)
Alpha BHC	--	--	(f)
Alpha endosulfan (Endosulfan I)	--	(d)	(f)
Alpha chlordane	--	--	(f)
Gamma chlordane	--	--	(f)
Dieldrin	--	--	(f)
Endosulfan sulfate	--	(d)	(f)
Endrin	--	(d)	(f)
Endrin aldehyde	--	(d)	(f)
Endrin ketone	--	(d)	(f)
Gamma BHC (Lindane)	--	--	(f)
Heptachlor	--	--	(f)
Heptachlor epoxide	--	--	(f)
4,4'-DDD	--	--	(f)
4,4'-DDE	--	--	(f)
4,4'-DDT	--	--	(f)
Pentachlorophenol	--	--	(f)
Toxaphene	--	--	(f)
PCB-1248 (Aroclor 1248)	(e)	--	(f)
PCB-1260 (Aroclor 1260)	(e)	--	(f)
Dioxin-like Compounds			
2,3,7,8-tetrachlorodibenzo-p-dioxin	(e)	--	(f)

TABLE 7-9
SITE-SPECIFIC RISK-BASED REMEDIATION GOALS FOR CHEMICALS OF CONCERN IN SOIL TO PROTECT INDOOR COMMERCIAL WORKERS
Oakland Army Base, Oakland, California

Notes:

(a) Risk-based remediation goals in this table have been calculated through use of U.S. EPA Johnson and Ettinger vapor intrusion computer model. Human health toxicity values and physical and exposure parameters used in calculating remediation goals are summarized in Tables 7-1 through 7-4.

(b) Risk-based remediation goals assume a non-carcinogenic target risk level that corresponds to a hazard index of 1 and a carcinogenic target risk level of one-in-one million (i.e., 10^{-6}) incremental risk of an individual developing cancer over a lifetime from exposure to a single chemical.

(c) Unless otherwise noted, value cited is the lesser of the non-carcinogenic and carcinogenic risk-based remediation goals when both values could be calculated.

(d) U.S. EPA or OEHHA do not classify compound as a potential carcinogen, thus no published carcinogenic slope factor is available for this compound.

(e) No published chronic reference dose is available for this compound, and no suitable surrogate compound was identified.

(f) Vapor intrusion is the only potentially complete exposure pathway for this population. Consequently, risk-based remediation goals for this population are calculated only for those compounds considered to be volatile. Volatile compounds are defined to be chemicals that have Henry Law constants greater than 10^{-5} atm-m^3/mol and molecular weights less than 200 g/mol.

(g) No published human health toxicity values available for compound. Consequently, risk-based remediation goal could not be calculated for compound.

(h) No site-specific risk-based remediation goals were calculated for petroleum hydrocarbons. Fuel Storage Tank Sites Cleanup Levels derived by the Army are adopted as remediation goals for petroleum hydrocarbons. Refer to Table 7-11.

TABLE 7-10
COMPARISON OF SITE-SPECIFIC RISK-BASED REMEDIATION GOALS FOR CHEMICALS OF CONCERN IN SOIL TO RWQCB SOIL LEACHING SCREENING LEVELS
Oakland Army Base, Oakland, California

Chemical of Concern	Lowest Remediation Goal to Protect Potentially Exposed Population (a); (b)				RWQCB Soil Leaching Screening Level (mg/kg); (c)	Lowest Goal Protecting Both Human Health and Environment (mg/kg); (d)
	Earthwork Construction Worker (mg/kg)	Indoor Commercial Worker (mg/kg)	Outdoor Industrial Worker (mg/kg)	Maintenance Personnel (mg/kg)		
Metals						
Antimony	280	(e)	(e)	7,600	(f)	280
Arsenic	20	(e)	(e)	30	(f)	20
Barium	43,000	(e)	(e)	MAX(100,000); (l)	(f)	43,000
Beryllium	1,300	(e)	(e)	16,000	(f)	1,300
Cadmium	180	(e)	(e)	150	(f)	150
Chromium (III)	MAX(100,000)	(e)	(e)	MAX(100,000)	(f)	MAX(100,000)
Chromium (VI)	86	(e)	(e)	87	(f)	86
Chromium, Total	600 (k)	(e)	(e)	610 (k)	(f)	600
Cobalt	42,000	(e)	(e)	MAX(100,000)	(f)	42,000
Copper	26,000	(e)	(e)	MAX(100,000)	(f)	26,000
Lead	3,500 (g)	(e)	(e)	77,000 (g)	(f)	3,500 (g)
Manganese	25,000	(e)	(e)	MAX(100,000)	(f)	25,000
Mercury	60	(e)	(e)	1,600	(f)	60
Molybdenum	3,500	(e)	(e)	96,000	(f)	3,500
Nickel	14,000	(e)	(e)	MAX(100,000)	(f)	14,000
Selenium	3,500	(e)	(e)	96,000	(f)	3,500
Silver	3,500	(e)	(e)	96,000	(f)	3,500
Thallium	49	(e)	(e)	1,300	(f)	49
Vanadium	4,900	(e)	(e)	MAX(100,000)	(f)	4,900
Zinc	MAX(100,000)	(e)	(e)	MAX(100,000)	(f)	MAX(100,000)
Volatile Organic Compounds						
1,1,2,2-tetrachloroethane	18	3.8	5.8	56	14	3.8
1,1,2-trichloroethane	42	2.7	11	140	17	2.7
1,1-dichloroethane	160	2.7	34	610	2.1	2.1
1,1-dichloroethene	63	43	330	SAT(710); (h)	1.7	1.7
1,2,3-trichloropropane	0.7	0.2	0.2	2.1	(f)	0.2
1,2,4-trimethylbenzene	170	470	850	SAT(5,400)	(f)	170
1,2-dichloroethane	18	0.8	3.9	71	6.2	0.8
1,2-dichloropropane	24	0.1	9.7	160	2.5	0.1
1,3,5-trimethylbenzene	87	130	440	SAT(1,300)	(f)	87
Acetone	2,700	10,000	16,000	120,000	0.5	0.5
Benzene	8.5	0.3	1.8	34	2.1	0.3
Bromodichloromethane	12	0.7	2.7	40	11	0.7
Carbon disulfide	1,200	950	SAT(1,600)	SAT(1,600)	(f)	950
Carbon tetrachloride	3	0.1	0.6	12	2.1	0.1
Chloroform	64	1.5	15	230	0.9	0.9

TABLE 7-10
COMPARISON OF SITE-SPECIFIC RISK-BASED REMEDIATION GOALS FOR CHEMICALS OF CONCERN IN SOIL TO RWQCB SOIL LEACHING SCREENING LEVELS
Oakland Army Base, Oakland, California

Chemical of Concern	Lowest Remediation Goal to Protect Potentially Exposed Population (a); (b)				RWQCB Soil Leaching Screening Level (mg/kg); (c)	Lowest Goal Protecting Both Human Health and Environment (mg/kg); (d)
	Earthwork Construction Worker (mg/kg)	Indoor Commercial Worker (mg/kg)	Outdoor Industrial Worker (mg/kg)	Maintenance Personnel (mg/kg)		
Volatile Organic Compounds						
Dibromochloromethane	32	2	8.4	110	530	2
cis-1,2-dichloroethene	140	83	750	SAT(3,700)	18	18
trans-1,2-dichloroethene	190	95	990	SAT(7,100)	38	38
Ethylbenzene	SAT(1,200)	SAT(1,200)	SAT(1,200)	SAT(1,200)	24	24
Isopropylbenzene (Cumene)	SAT(3,800)	SAT(3,800)	SAT(3,800)	SAT(3,800)	(f)	SAT(3,800)
Methyl ethyl ketone	12,000	32,000	SAT(49,000)	SAT(49,000)	13	13
Methyl isobutyl ketone	1,500	1,200	SAT(5,500)	SAT(5,500)	3.8	3.8
Methyl tertiary butyl ether	850	33	190	3,200	1	1
Methylene chloride	180	4.8	50	650	34	4.8
n-butylbenzene	550	1,600	SAT(3,300)	SAT(3,300)	(f)	550
n-propylbenzene	350	530	SAT(1,200)	SAT(1,200)	(f)	350
p-cymene (p-isopropyltoluene)	SAT(3,700)	SAT(3,700)	SAT(3,700)	SAT(3,700)	(f)	SAT(3,700)
sec-butylbenzene	320	200	2,000	SAT(4,000)	(f)	200
tert-butylbenzene	290	300	SAT(530)	SAT(530)	(f)	290
Tetrachloroethene	65	2.8	20	220	19	2.8
Toluene	2,700	3,900	SAT(3,900)	SAT(3,900)	8.4	8.4
Trichloroethene	93	2.5	20	390	29	2.5
Trichlorofluoromethane	SAT(4,300)	3,600	SAT(4,300)	SAT(4,300)	(f)	3,600
Vinyl chloride	0.6	0.05	0.1	2.5	0.8	0.05
Xylenes, Total	SAT(1,200)	SAT(1,200)	SAT(1,200)	SAT(1,200)	1	1
Semi-volatile Organic Compounds						
Acenaphthene	8,000	MAX(100,000)	MAX(100,000)	MAX(100,000)	16	16
Acenaphthylene	(i)	(i)	(i)	(i)	120	120
Anthracene	39,000	MAX(100,000)	MAX(100,000)	MAX(100,000)	2.9	2.9
Benzidine	0.02	(e)	(e)	0.04	(f)	0.02
Benzo(a)anthracene	7.6	(e)	(e)	18	12	7.6
Benzo(a)pyrene	0.8	(e)	(e)	1.8	130	0.8
Benzo(b)fluoranthene	7.6	(e)	(e)	18	640	7.6
Benzo(b,k)fluoranthene	7.6	(e)	(e)	18	(f)	7.6
Benzo(g,h,i)perylene	(i)	(i)	(i)	(i)	5.3	5.3
Benzo(k)fluoranthene	7.6	(e)	(e)	18	37	7.6
Bis(2-ethylhexyl)phthalate	SAT(100)	(e)	(e)	SAT(100)	530	SAT(100)
Chrysene	86	(e)	(e)	200	4.7	4.7
Dibenz(a,h)anthracene	2.2	(e)	(e)	5.4	140	2.2
Fluoranthene	5,100	(e)	(e)	MAX(100,000)	60	60
Fluorene	5,100	MAX(100,000)	MAX(100,000)	MAX(100,000)	5.1	5.1

TABLE 7-10
COMPARISON OF SITE-SPECIFIC RISK-BASED REMEDIATION GOALS FOR CHEMICALS OF CONCERN IN SOIL TO RWQCB SOIL LEACHING SCREENING LEVELS
Oakland Army Base, Oakland, California

Chemical of Concern	Lowest Remediation Goal to Protect Potentially Exposed Population (a); (b)				RWQCB Soil Leaching Screening Level (mg/kg); (c)	Lowest Goal Protecting Both Human Health and Environment (mg/kg); (d)
	Earthwork Construction Worker (mg/kg)	Indoor Commercial Worker (mg/kg)	Outdoor Industrial Worker (mg/kg)	Maintenance Personnel (mg/kg)		
Semi-volatile Organic Compounds						
Hexachlorobutadiene	49	(e)	(e)	340	46	46
Indeno(1,2,3-c,d)pyrene	7.6	(e)	(e)	18	72	7.6
Naphthalene	150	3,900	820	15,000	4.9	4.9
Phenanthrene	38,000	MAX(100,000)	MAX(100,000)	MAX(100,000)	11	11
Pyrene	3,900	MAX(100,000)	MAX(100,000)	MAX(100,000)	55	55
Total Petroleum Hydrocarbons						
TPH Diesel	--	--	--	--	--	(j)
TPH Gasoline	--	--	--	--	--	(j)
TPH Motor Oil	--	--	--	--	--	(j)
TPH Recoverable	--	--	--	--	--	(j)
PCBs, Pesticides, and Herbicides						
Aldrin	1.2	(e)	(e)	2.1	5	1.2
Alpha BHC	7.1	(e)	(e)	13	(f)	7.1
Alpha endosulfan (Endosulfan I)	1,300	(e)	(e)	69,000	(f)	1,300
Alpha chlordane	16	(e)	(e)	29	(f)	16
Gamma chlordane	16	(e)	(e)	29	(f)	16
Dieldrin	1.3	(e)	(e)	2.3	0.002	0.002
Endosulfan sulfate	1,500	(e)	(e)	73,000	(f)	1,500
Endrin	90	(e)	(e)	4,000	0.0006	0.0006
Endrin aldehyde	91	(e)	(e)	4,000	(f)	91
Endrin ketone	91	(e)	(e)	4,000	(f)	91
Gamma BHC (Lindane)	17	(e)	(e)	32	(f)	17
Heptachlor	4.1	(e)	(e)	8.2	0.013	0.013
Heptachlor epoxide	3.8	(e)	(e)	6.8	0.014	0.014
4,4'-DDD	89	(e)	(e)	160	750	89
4,4'-DDE	54	(e)	(e)	100	1,100	54
4,4'-DDT	63	(e)	(e)	110	4.3	4.3
Pentachlorophenol	260	(e)	(e)	460	42	42
Toxaphene	1.4	(e)	(e)	5.3	(f)	1.4
PCB-1248 (Aroclor 1248)	1.8	(e)	(e)	4.4	6.3	1.8
PCB-1260 (Aroclor 1260)	1.8	(e)	(e)	4.4	6.3	1.8
Dioxin-like Compounds						
2,3,7,8-tetrachlorodibenzo-p-dioxi	0.0001	(e)	(e)	0.0002	(f)	0.0001

TABLE 7-10
COMPARISON OF SITE-SPECIFIC RISK-BASED REMEDIATION GOALS FOR CHEMICALS OF CONCERN IN SOIL TO RWQCB SOIL LEACHING SCREENING LEVELS
Oakland Army Base, Oakland, California

Notes:

(a) Unless otherwise noted, values cited are the human health risk-based remediation goals that protect the potentially exposed population listed from non-carcinogenic effects and carcinogenic effects of chemicals of concern. Remediation goals for earthwork construction workers, indoor commercial workers, outdoor industrial workers, and maintenance personnel are summarized in Tables 7-5 through 7-8, respectively.

(b) Risk-based remediation goals assume a non-carcinogenic target risk level that corresponds to a hazard index of 1 and a carcinogenic target risk level of one-in-one million (i.e., 10^{-6}) incremental risk of an individual developing cancer over a lifetime from exposure to a single chemical.

(c) Soil Leaching Screening Levels listed are for the protection of groundwater that is not potential drinking water supply such as the brackish groundwater found beneath the OARB. Soil Leaching Screening Levels are compiled from RWQCB, December 2001, *Application of Risk-Based Screening Levels and Decision Making to Sites with Impacted Soil and Groundwater, Volume 2: Background Documentation for the Development of Tier 1 Soil and Groundwater Screening Levels*, Interim Final, San Francisco Bay Region.

(d) Unless otherwise noted, goals listed are the lowest values of the risk-based remediation goals that protect identified potentially exposed populations and the RWQCB Soil Leaching Screening Levels intended to minimize degradation of groundwater that is not potential drinking water supply.

(e) Vapor intrusion is the only potentially complete exposure pathway for this population. Consequently, risk-based remediation goals for this population are calculated only for those compounds considered to be volatile. Volatile compounds are defined to be chemicals that have Henry Law constants greater than 10^{-5} atm-m^3/mol and molecular weights less than 200 g/mol.

(f) No Soil Leaching Screening Level listed for this compound in RWQCB RBSL guidance (RWQCB, 2001).

(g) Risk-based remediation goal for lead calculated using DTSC Lead Spread Version 7.0 computer model (See Appendix B).

(h) Prefix "SAT" denotes risk-based value exceeds calculated soil saturation concentration, thus, the estimated saturation value is listed inside the parenthesis.

(i) No published human health toxicity values available for compound. Consequently, risk-based remediation goal could not be calculated for compound.

(j) No site-specific risk-based remediation goals were calculated for petroleum hydrocarbons. Fuel Storage Tank Sites Cleanup Levels derived by the Army are adopted as remediation goals for petroleum hydrocarbons. Refer to Table 7-11.

(k) The remediation goal for total chromium was calculated from the chromium (III) and chromium (IV) remediation goal assuming a 1:6 ratio of chromium(VI) to chromium(III), consistent with U.S. EPA Region IX Preliminary Remediation Goals (U.S. EPA, 2000).

(l) Prefix "MAX" denotes that the calculated risk-based concentration is 100,000 mg/kg or greater. A non-risk based "ceiling limit" concentration for metals and certain SVOCs that are solids at ambient temperatures is given as 100,000 mg/kg, consistent with U.S. EPA Region IX Preliminary Remediation Goals (U.S. EPA, 2000).

TABLE 7-11
REMEDIATION GOALS FOR CHEMICALS OF CONCERN
IN SOIL AND GROUNDWATER
Oakland Army Base, Oakland, California

Chemical of Concern	Soil Remediation Goal at HI=1 or Risk = 10^{-6} (mg/kg)	Population or Pathway Governing Soil Remediation Goal (see Table 7-10)	Groundwater Remediation Goal at HI=1 or Risk = 10^{-6} (µg/L)
Metals			
Antimony	280	Construction Worker	(a)
Arsenic	20	Construction Worker	(a)
Barium	43,000	Construction Worker	(a)
Beryllium	1,300	Construction Worker	(a)
Cadmium	150	Construction Worker	(a)
Chromium (III)	MAX(100,000); (f)	--	(a)
Chromium (VI)	86	Construction Worker	(a)
Chromium, Total	600 (e)	Construction Worker	(a)
Cobalt	42,000	Construction Worker	(a)
Copper	26,000	Construction Worker	(a)
Lead	750 (h)	See Note (h)	(a)
Manganese	25,000	Construction Worker	(a)
Mercury	60	Construction Worker	(a)
Molybdenum	3,500	Construction Worker	(a)
Nickel	14,000	Construction Worker	(a)
Selenium	3,500	Construction Worker	(a)
Silver	3,500	Construction Worker	(a)
Thallium	49	Construction Worker	(a)
Vanadium	4,900	Construction Worker	(a)
Zinc	MAX(100,000)	--	(a)
Volatile Organic Compounds			
1,1,2,2-tetrachloroethane	3.8	Leaching to Groundwater (b)	1,900
1,1,2-trichloroethane	2.7	Indoor Worker	2,800
1,1-dichloroethane	2.1	Leaching to Groundwater (b)	6,700
1,1-dichloroethene	1.7	Leaching to Groundwater (b)	33,000
1,2,3-trichloropropane	0.2	Indoor Worker	100
1,2,4-trimethylbenzene	170	Construction Worker	18,000
1,2-dichloroethane	0.8	Indoor Worker	1,900
1,2-dichloropropane	0.1	Indoor Worker	110
1,3,5-trimethylbenzene	87	Construction Worker	25,000
Acetone	0.5	Leaching to Groundwater (b)	86,000,000
Benzene	0.3	Indoor Worker	420
Bromodichloromethane	0.7	Indoor Worker	850
Carbon disulfide	950	Indoor Worker	230,000
Carbon tetrachloride	0.1	Indoor Worker	72
Chloroform	0.9	Leaching to Groundwater (b)	2,500

TABLE 7-11
REMEDIATION GOALS FOR CHEMICALS OF CONCERN
IN SOIL AND GROUNDWATER
Oakland Army Base, Oakland, California

Chemical of Concern	Soil Remediation Goal at HI=1 or Risk = 10^{-6} (mg/kg)	Population or Pathway Governing Soil Remediation Goal (see Table 7-10)	Groundwater Remediation Goal at HI=1 or Risk = 10^{-6} (µg/L)
Volatile Organic Compounds			
Dibromochloromethane	2.0	Leaching to Groundwater (b)	2,100
cis-1,2-dichloroethene	18	Leaching to Groundwater (b)	180,000
trans-1,2-dichloroethene	38	Leaching to Groundwater (b)	190,000
Ethylbenzene	24	Leaching to Groundwater (b)	4,200,000
Isopropylbenzene (Cumene)	SAT(3,800); (g)	--	1,800,000
Methyl ethyl ketone	13	Leaching to Groundwater (b)	160,000,000
Methyl isobutyl ketone	4	Leaching to Groundwater (b)	5,300,000
Methyl tertiary butyl ether	1	Leaching to Groundwater (b)	120,000
Methylene chloride	4.8	Leaching to Groundwater (b)	19,000
n-butylbenzene	550	Construction Worker	95,000
n-propylbenzene	350	Construction Worker	100,000
p-cymene (p-isopropyltoluene)	SAT(3,700)	--	1,000,000
sec-butylbenzene	200	Leaching to Groundwater (b)	77,000
tert-butylbenzene	290	Construction Worker	75,000
Tetrachloroethene	2.8	Leaching to Groundwater (b)	960
Toluene	8.4	Leaching to Groundwater (b)	1,600,000
Trichloroethene	2.5	Indoor Worker	2,800
Trichlorofluoromethane	3,600	Indoor Worker	2,800,000
Vinyl chloride	0.05	Indoor Worker	32
Xylenes, Total	1	Indoor Worker	28,000,000
Semi-volatile Organic Compounds			
Acenaphthene	16	Leaching to Groundwater (b)	25,000,000
Acenaphthylene	120	Leaching to Groundwater (b)	(a)
Anthracene	2.9	Leaching to Groundwater (b)	330,000,000
Benzidine	0.02	Construction Worker	(a)
Benzo(a)anthracene	7.6	Construction Worker	(a)
Benzo(a)pyrene	0.8	Construction Worker	(a)
Benzo(b)fluoranthene	7.6	Construction Worker	(a)
Benzo(b,k)fluoranthene	7.6	Construction Worker	(a)
Benzo(g,h,i)perylene	5.3	Leaching to Groundwater (b)	(a)
Benzo(k)fluoranthene	7.6	Construction Worker	(a)
Bis(2-ethylhexyl)phthalate	SAT(100)	--	(a)
Chrysene	4.7	Leaching to Groundwater (b)	(a)
Dibenz(a,h)anthracene	2.2	Construction Worker	(a)
Fluoranthene	60	Leaching to Groundwater (b)	(a)
Fluorene	5.1	Leaching to Groundwater (b)	38,000,000

TABLE 7-11
REMEDIATION GOALS FOR CHEMICALS OF CONCERN
IN SOIL AND GROUNDWATER
Oakland Army Base, Oakland, California

Chemical of Concern	Soil Remediation Goal at HI=1 or Risk = 10^{-6} (mg/kg)	Population or Pathway Governing Soil Remediation Goal (see Table 7-10)	Groundwater Remediation Goal at HI=1 or Risk = 10^{-6} (µg/L)
Semi-volatile Organic Compounds			
Hexachlorobutadiene	46	Leaching to Groundwater (b)	(a)
Indeno(1,2,3-c,d)pyrene	7.6	Construction Worker	(a)
Naphthalene	4.9	Leaching to Groundwater (b)	100,000
Phenanthrene	11	Leaching to Groundwater (b)	520,000,000
Pyrene	55	Leaching to Groundwater (b)	200,000,000
Total Petroleum Hydrocarbons			
TPH Diesel	8,000 (c)	See Note (c)	9,600 (c)
TPH Gasoline	2,400 (c)	See Note (c)	7,280 (c)
TPH Motor Oil	58,000 (c)	See Note (c)	(a)
TPH Recoverable	(d)	--	(a)
PCBs, Pesticides, and Herbicides			
Aldrin	1.2	Construction Worker	(a)
Alpha BHC	7.1	Construction Worker	(a)
Alpha endosulfan (Endosulfan I)	1,300	Construction Worker	(a)
Alpha chlordane	16	Construction Worker	(a)
Gamma chlordane	16	Construction Worker	(a)
Dieldrin	0.002	Leaching to Groundwater (b)	(a)
Endosulfan sulfate	1,500	Construction Worker	(a)
Endrin	0.001	Leaching to Groundwater (b)	(a)
Endrin aldehyde	91	Construction Worker	(a)
Endrin ketone	91	Construction Worker	(a)
Gamma BHC (Lindane)	17	Construction Worker	(a)
Heptachlor	0.013	Leaching to Groundwater (b)	(a)
Heptachlor epoxide	0.014	Leaching to Groundwater (b)	(a)
4,4'-DDD	89	Construction Worker	(a)
4,4'-DDE	54	Construction Worker	(a)
4,4'-DDT	4.3	Leaching to Groundwater (b)	(a)
Pentachlorophenol	42	Leaching to Groundwater (b)	(a)
Toxaphene	1.4	Construction Worker	(a)
PCB-1248 (Aroclor 1248)	1.8	Construction Worker	(a)
PCB-1260 (Aroclor 1260)	1.8	Construction Worker	(a)
Dioxin-like Compounds			
2,3,7,8-tetrachlorodibenzo-p-dioxin	0.0001	Construction Worker	(a)

TABLE 7-11
REMEDIATION GOALS FOR CHEMICALS OF CONCERN
IN SOIL AND GROUNDWATER
Oakland Army Base, Oakland, California

Notes:

(a) Vapor intrusion is the only potentially complete exposure pathway for COCs in groundwater. Consequently, as described in Table 7-9, risk-based remediation goals for non-volatile compounds in groundwater were not calculated. However, the narrative goal is to prevent further significant increases of metals and other non-volatile COC concentrations in groundwater.

(b) A more detailed evaluation should be considered if remediation goals based on leaching to groundwater govern the need for future remediation at RAP sites or RMP locations.

(c) The Army's Fuel Storage Tank Sites Cleanup Levels (IT, 2000n) have been adopted as the site-specific remediation goals for petroleum hydrocarbons in soil and groundwater at the OARB.

(d) No site-specific goal established for "TPH recoverable," which is general considered to be weathered, high molecular weight residual TPH. TPH recoverable is normally managed to control nuisance conditions (e.g., odor or deficiency of impacted soil for structural purposes).

(e) The remediation goal for total chromium was calculated from the chromium (III) and chromium (IV) remediation goal assuming a 1:6 ratio of chromium(VI) to chromium(III), consistent with U.S. EPA Region IX Preliminary Remediation Goals (U.S. EPA, 2000).

(f) Prefix "MAX" denotes that the calculated risk-based concentration is 100,000 mg/kg or greater. A non-risk based "ceiling limit" concentration for metals and certain SVOCs that are solids at ambient temperatures is given as 100,000 mg/kg, consistent with U.S. EPA Region IX Preliminary Remediation Goals (U.S. EPA, 2000).

(g) Prefix "SAT" denotes risk-based value exceeds calculated soil saturation concentration, thus, the estimated saturation value is listed inside the parenthesis.

(h) The U.S. EPA Region IX Preliminary Remediation Goal (U.S. EPA, 2000) has been adopted as the site-specific remediation goal for lead in soil.

TABLE 8-1
SCREENING SUMMARY OF GENERAL RESPONSE ACTIONS, TECHNOLOGIES, AND PROCESS OPTIONS FOR SOIL

Oakland Army Base, Oakland, California

General Response Action	Remedial Technology	Process Option	Description	Screening Status
No Action			No Action.	Required for consideration by NCP.
Institutional Controls			Oakland Army Base ("OARB") land use would be restricted or controlled by administrative procedures and/or requirements to follow a risk management plan.	Potentially applicable in conjunction with engineering controls.
Monitored Natural Attenuation			Routine inspections alone or in conjunction with ongoing groundwater sampling are performed to assess impacts on environmental conditions at the OARB.	Potentially applicable in conjunction with engineering controls.
Containment	Permeable Cover Systems		Applicable to soil with chemicals of concern ("COCs") that are not mobile or do not present a significant risk to groundwater. Clean soil or other suitable cover materials (e.g., asphalt, building slabs, concrete walk-ways) are used to minimize the potential for humans and ecological receptors to contact soil containing COCs.	Potentially applicable.
	Low Permeability Cover Systems	Vapor Barrier	Low permeability geomembrane is placed below building foundations to limit volatilization of COCs from soil or groundwater into buildings or to prevent leaching of potentially mobile COCs from soil to groundwater.	Potentially applicable.

TABLE 8-1
SCREENING SUMMARY OF GENERAL RESPONSE ACTIONS, TECHNOLOGIES, AND PROCESS OPTIONS FOR SOIL

Oakland Army Base, Oakland, California

General Response Action	Remedial Technology	Process Option	Description	Screening Status
In-situ Soil Treatment	Physical/Chemical Technology	Soil Flushing	Water, surfactant, or organic solvents are injected into soil to remove COCs. Technology requires extraction system to recover fluid used to flush soil.	Not retained. Not demonstrated. In-situ fluid recovery difficult to accomplish.
		Immobilization	Cement or other chemical agents are injected and mixed with soil to immobilize COCs. Includes stabilization and solidification technologies.	Retain for possible future use. In-situ mixing difficult to verify, residual chemicals not addressed.
		Soil Vapor Extraction	Vacuum is applied to soil to remove volatile COCs for subsequent treatment in most applications.	Retain for possible future use. No significant VOC source material currently identified in soil to date.
		Sub-slab Depressurization	A slight vacuum is maintained beneath the building to overcome pressure gradient pulling volatile chemicals into the building.	Potentially applicable.
		Electrokinetics	Conductive solution is injected into soil to mobilize COCs. Electrical current is applied across soil to cause COCs to migrate to the anodes or cathodes inserted into the subsurface. Technology requires extraction system to recover conductive solution injected into soil.	Not retained. Not demonstrated. In-situ fluid recovery difficult to accomplish.
	Thermal Technology	Vitrification	Heat or electric current is applied to melt soil and to incorporate metals into vitrified mass.	Not retained. Cost and availability of equipment limit implementation.
	Biological Technology	Phytoremediation	Plants established in soil uptake COCs and incorporate the chemicals in their plant structure. Plants are subsequently harvested for disposal at an off-site, permitted waste management facility, if needed.	Retain for possible future use. Plants not compatible with planned commercial/industrial land use.
		Bioremediation	Oxygen, water, and/or nutrients are supplied in-situ to soil to stimulate degradation of petroleum hydrocarbons or other organic chemicals by indigenous microorganisms.	Retain for possible future use. Multiple small sites are not cost-effectively addressed by this technology.

TABLE 8-1
SCREENING SUMMARY OF GENERAL RESPONSE ACTIONS, TECHNOLOGIES, AND PROCESS OPTIONS FOR SOIL

Oakland Army Base, Oakland, California

General Response Action	Remedial Technology	Process Option	Description	Screening Status
Soil Excavation			Soil is excavated using standard construction techniques.	Potentially applicable.

TABLE 8-1
SCREENING SUMMARY OF GENERAL RESPONSE ACTIONS, TECHNOLOGIES, AND PROCESS OPTIONS FOR SOIL

Oakland Army Base, Oakland, California

General Response Action	Remedial Technology	Process Option	Description	Screening Status
Ex-situ Soil Treatment	Physical/Chemical Technology	Soil Washing	Water, surfactant, or organic solvents are used to leach COCs from soil.	Retain for possible future use. Difficult to implement.
		Chemical Oxidation/ Reduction	Chemicals are mixed with soil to oxidize or reduce COCs to less toxic forms.	Not retained. Not demonstrated. Difficult to implement.
		Immobilization	Soil is screened to remove oversize wastes and debris. Cement or other chemical reagents are mixed with soil to solidify or stabilize COCs.	Potentially applicable.
	Thermal Technology	Thermal Desorption	Soil is heated to volatilize COCs for subsequent treatment in most applications.	Retain for possible future use. Expensive to implement.
		Vitrification	Heat or electric current is applied to melt soil and to incorporate metals into vitrified mass.	Not retained. Cost and availability of equipment limit implementation.
		Incineration	Soil is burned at high temperatures, destroying organic compounds. Metals volatilize or remain in ash.	Not retained. Expensive to implement.
	Biological Technology	Phytoremediation	Plants established in soil uptake COCs and incorporate the chemicals in their plant structure. Plants are subsequently harvested for disposal at an off-site, permitted waste management facility.	Not retained.
		Bioremediation	Oxygen, water, and/or nutrients are supplied ex-situ to soil to stimulate degradation of petroleum hydrocarbons or other organic chemicals by microorganisms.	Potentially applicable.

TABLE 8-1
SCREENING SUMMARY OF GENERAL RESPONSE ACTIONS, TECHNOLOGIES, AND PROCESS OPTIONS FOR SOIL

Oakland Army Base, Oakland, California

General Response Action	Remedial Technology	Process Option	Description	Screening Status
Excavated Soil Management	Disposal of Soil On-site		Soil is treated such that COCs are below site-specific remedial goals. Soil is reused on-site.	Potentially applicable.
	Disposal of Soil Off-site		Soil containing COCs is transported to and disposed at an off-site, permitted waste management facility.	Potentially applicable.

TABLE 8-2
SCREENING SUMMARY OF GENERAL RESPONSE ACTIONS, TECHNOLOGIES, AND PROCESS OPTIONS FOR GROUNDWATER

Oakland Army Base, Oakland, California

General Response Action	Remedial Technology	Process Option	Description	Screening Status
No Action			No Action.	Required for consideration by NCP.
Institutional Controls			Uses of Oakland Army Base ("OARB") sites and groundwater are restricted or controlled by administrative procedures and/or requirements to follow a risk management plan.	Potentially applicable in conjunction with monitoring or engineering controls.
Monitored Natural Attenuation			Routine inspections alone or in conjunction with ongoing groundwater sampling are performed to assess environmental conditions at the OARB and to enforce groundwater restrictions.	Potentially applicable.
Groundwater Diversion	Subsurface Barriers	Slurry Wall	Slurry walls or grout curtains are created by injecting or placing a soil-bentonite or cement-bentonite mixture into the subsurface. Slurry walls are used to divert groundwater flow.	Retain for possible future use. Slurry walls need competent foundation for bottom key and are expensive.
		Sheet Piling	Low permeability vertical barrier created by vibrating or otherwise installing sheet piling into the subsurface. Sheet piling is used to divert groundwater flow.	Not retained. Groundwater flow is minimal at OARB. May be used temporarily for construction dewatering.

TABLE 8-2
SCREENING SUMMARY OF GENERAL RESPONSE ACTIONS, TECHNOLOGIES, AND PROCESS OPTIONS FOR GROUNDWATER

Oakland Army Base, Oakland, California

General Response Action	Remedial Technology	Process Option	Description	Screening Status
In-situ Groundwater Treatment	Physical/Chemical Technology	Air Sparging	Air sparging, recirculating wells, or other means cause volatile chemicals of concern ("COCs") in groundwater to partition into an air stream that is collected through soil vapor extraction for subsequent treatment in most applications.	Potentially applicable.
		Permeable Reactive Walls	Groundwater is directed into subsurface units or "walls" that contain zero-valent iron or other reactive medium that converts COCs to less toxic forms.	Retain for possible future use. Groundwater gradient at OARB does not generate significant groundwater flow through wall, expensive pumping may be required.
		Chemical Oxidation/ Reduction	Chemicals are injected or otherwise introduced to groundwater to oxidize or reduce COCs to less toxic forms.	Potentially applicable.
	Biological Technology	Bioremediation	Enhanced bioremediation can be performed under both aerobic (i.e., presence of oxygen) and anaerobic (i.e., absence of oxygen) conditions. Under aerobic conditions, oxygen and nutrients are supplied in-situ to groundwater containing COCs to stimulate degradation of organic chemicals by indigenous microorganisms. Petroleum hydrocarbons and many other organic chemicals are amenable to aerobic bioremediation. Under anaerobic conditions, nutrients are supplied in-situ to groundwater containing COCs to stimulate degradation of organic chemicals by indigenous microorganisms. Some chlorinated organic solvents are amenable to anaerobic bioremediation.	Potentially applicable.

TABLE 8-2
SCREENING SUMMARY OF GENERAL RESPONSE ACTIONS, TECHNOLOGIES, AND PROCESS OPTIONS FOR GROUNDWATER

Oakland Army Base, Oakland, California

General Response Action	Remedial Technology	Process Option	Description	Screening Status
Groundwater Extraction	Wells		Migration of COCs in groundwater is controlled by extracting impacted groundwater. Groundwater is removed from the subsurface by mechanical pumps placed in vertical wells.	Potentially applicable.
	Trenches		Migration of COCs in groundwater is controlled by extracting impacted groundwater. Groundwater is collected as it flows into trenches. The water is pumped from sumps in the bottom of the trenches to the above grade collection point.	Potentially applicable.

TABLE 8-2
SCREENING SUMMARY OF GENERAL RESPONSE ACTIONS, TECHNOLOGIES, AND PROCESS OPTIONS FOR GROUNDWATER

Oakland Army Base, Oakland, California

General Response Action	Remedial Technology	Process Option	Description	Screening Status
Ex-situ Groundwater Treatment	Physical/Chemical Technologies	Air Stripping	Air stripping causes volatile COCs to partition from water to an air stream. Subsequent treatment of air stream may be required.	Potentially applicable.
		Adsorption	COCs are adsorbed onto granular activated carbon or resin beds.	Potentially applicable.
		Membrane Separation	Reverse osmosis, ultrafiltration, or electrodialysis employ membranes to separate COCs from water.	Not retained. Expensive, brine requires subsequent treatment and disposal.
		Precipitation/Coagulation	Chemicals are supplied to water to convert COCs to insoluble forms which are then filtered, settled, or otherwise removed from water.	Not retained for possible future use. Not all COCs at OARB can be removed by this process.
		Ion Exchange	Chemical treatment by ion exchange captures ionic COCs on a resin bed.	Not retained. Same limitations as for precipitation / coagulation.
		Advanced Oxidation	Ultraviolet light, hydrogen peroxide, or ozone alone or in combination are supplied to water to destroy or convert COCs to less toxic forms.	Potentially applicable.
	Biological Technologies	Bioremediation	Oxygen and/or nutrients are supplied to water containing COCs to stimulate degradation of petroleum hydrocarbons or organic chemicals by microorganisms.	Not retained. Not all COCs at OARB can be removed by this process.

TABLE 8-2
SCREENING SUMMARY OF GENERAL RESPONSE ACTIONS, TECHNOLOGIES, AND PROCESS OPTIONS FOR GROUNDWATER

Oakland Army Base, Oakland, California

General Response Action	Remedial Technology	Process Option	Description	Screening Status
Extracted Groundwater Management	Reclamation		Reuse water for irrigation, pond, or other use on site.	Not retained. No reuse opportunities exist at OARB.
	Discharge to Sanitary Sewer		Discharge of collected water to East Bay Municipal Utility District Publicly Owned Treatment Works ("POTW") under permit.	Not retained. Unlikely to be appropriate for discharge of water containing COCs, due to local restrictions limiting discharge of groundwater to sewers.
	Discharge to Storm Drain		Discharge of collected water to surface water under National Pollutant Discharge Elimination System ("NPDES") permit.	Potentially applicable.

TABLE 9-1
SCREENING OF OARB REMEDIAL ALTERNATIVES (a); (b)

Oakland Army Base, Oakland, California

Soil Process Option	Water Process Option	Effectiveness	Implementability	Cost	Status
No Action	No Action	Does not achieve remedial action objectives for sites with chemicals of concern ("COCs") in soil and groundwater above applicable remedial goals.	Easily implemented.	Negligible cost.	Retained. Required for consideration by NCP.
Institutional Controls	Institutional Controls	Effective to restrict land and groundwater use, and to follow Risk Managemetn Plan	Easily implemented.	Low capital cost, low to moderate annual cost.	Retained.
	Monitored Natural Attenuation	Monitoring is effective to demonstrate compliance with remedial goals.	Easily implemented.	Low capital cost, low to moderate annual cost.	Retained.
	In-situ Oxidation/ Reduction Monitoring	Likely to reduce concentrations of COCs in groundwater by oxidation or reduction. Monitoring is effective to evaluate performance of remedial actions.	Implementation is a function of accessibility to groundwater.	Low to moderate capital cost, low to moderate annual cost.	Retained.
	In-situ Bioremediation Monitoring	Likely to reduce concentrations of COCs in soil or groundwater by bioremediation. Monitoring is effective to evaluate performance of remedial actions.	Implementation is a function of accessibility to soil and groundwater.	Low to moderate capital cost, low to moderate annual cost.	Retained.

TABLE 9-1
SCREENING OF OARB REMEDIAL ALTERNATIVES (a); (b)
Oakland Army Base, Oakland, California

Soil Process Option	Water Process Option	Effectiveness	Implementability	Cost	Status
	Groundwater Extraction Ex-situ Groundwater Treatment Discharge to Storm Drain Monitor	Could maintain hydraulic containment of impacted groundwater.	Can be implemented with standard equipment. NPDES discharge permit required.	Moderate to high capital cost, moderate to high annual cost.	Retain for possible future use. Hydraulic control not necessary to control groundwater at OARB. These processes are more costly and may not be as effective as in-situ treatment alternatives.
	Air Sparging Monitor	Could volatize chemicals, off-gas treatment may be necessary.	Extensive equipment requirements could hinder redevelopment activities.	Moderate to high capital cost, moderate to high annual cost.	Retain for possible future use. These processes are more costly and may not be as effective as in-situ chemical addition alternatives.

TABLE 9-1
SCREENING OF OARB REMEDIAL ALTERNATIVES (a); (b)
Oakland Army Base, Oakland, California

Soil Process Option	Water Process Option	Effectiveness	Implementability	Cost	Status
Vapor Barrier	Monitoring	Likely to limit volatilization of COCs into buildings with intact barriers. Monitoring is effective to evaluate performance of remedial actions.	Can be easily implemented during building construction. Difficult to implement on existing buildings.	Low to moderate capital cost, low to moderate annual cost.	Retained.
Vapor Barrier Sub-slab Depressurization	Monitoring	Likely to limit volatilization of COCs into buildings by capture of soil gases to enhance effectiveness of barrier. Monitoring is effective to evaluate performance of remedial actions.	Can be easily implemented during building construction. Difficult to implement on existing buildings.	Moderate capital cost, moderate annual cost.	Retained.
Soil Excavation Ex-Situ Bioremediation Dispose of Soil On-site	Monitoring	Ex-situ biodegredation would effectively degrade petroleum hydrocarbons and fuel constituents, but small volumes cannot be treated cost-effectively .	Implementation requires extended time and area to treat soil. May limit redevelopment of areas used for treatment.	Low to moderate capital cost, low to moderate annual cost.	Retain for possible future use. No large volume of petroleum hydrocarbon impacted soil has been identified to date. Small treatment volumes over an extended time are not cost-effective.

TABLE 9-1

SCREENING OF OARB REMEDIAL ALTERNATIVES (a); (b)

Oakland Army Base, Oakland, California

Soil Process Option	Water Process Option	Effectiveness	Implementability	Cost	Status
Soil Excavation Dispose of Soil Off-site	Monitoring (As Needed)	Complete removal of soil is likely to achieve applicable remedial goals for soil. Groundwater monitoring would be included only if groundwater issues identified.	Readily implemented with standard construction equipment.	Low to high capital cost, depending on the volume of soil to be managed. Low annual cost.	Retained.
Soil Excavation Dispose of Soil Off-site	In-situ Groundwater Treatment Monitoring	Groundwater treatment of residuals after impacted soil removal is generally more effective. Monitoring is effective to evaluate performance of remedial actions.	Readily implemented with standard construction equipment.	Moderate to high capital cost, low to moderate annual cost.	Retained.
Soil Excavation Ex-situ Immobilization Disposal of Soil Off-site	Monitoring	Immobilization of soil may be effective to allow waste or soil containing oily residue to be transported for off-site disposal. Monitoring is effective to evaluate performance of remedial actions.	Implementation depends the nature and characteristics of the oily residue. A land disposal restriction variance is also likely to be required to implement this alternative.	High capital cost, low annual cost. On-site immobilization may be required for off-site disposal of some oily residue waste to minimize free liquids or pH extremes.	Retained.

Notes:

(a) Institutional controls such as restrictions on on-site groundwater use and land use are an inherent component of all alternatives for planned commercial and industrial redevelopment of OARB. Land use restrictions include construction or maintenance of the existing site-wide asphalt or concrete pavement, building slab, or other engineered structure that minimize direct contact of impacted soil by commercial and industrial workers, as well as, implementation of Risk Management Plan ("RMP") protocols.

(b) Additional investigation to confirm appropriateness and extent of remedial actions may also be included as part of design and implementation of a remedial alternative.

TABLE 9-2
SUMMARY OF POTENTIAL REMEDIAL ACTIONS
Oakland Army Base, Oakland, California

Site	Alternative	Remedial Alternatives for Detailed Analysis (a); (b)									
		No Action for Soil and Groundwater	Institutional Controls	Monitored Natural Attenuation	Perform In-situ Chemical Oxidation/ Reduction of COCs in Groundwater, and Monitor Groundwater	Perform In-situ Bioremediation of COCs in Groundwater, Monitor Groundwater	Install Vapor Barrier Beneath New Building and Monitor Groundwater	Install Vapor Barrier with Sub-slab Depressurization System Beneath New Building and Monitor Groundwater	Excavate and Dispose Soil Off-site, and Monitor Groundwater As Needed (c)	Excavate and Dispose Soil Off-site, In-situ Groundwater Treatment and Monitor Groundwater	Excavate, Conduct Ex-situ Immobilization, and Dispose of Soil Off-site, and Monitor Groundwater
RAP Sites											
• Former ORP/Building 1 Area (d)	1	●									
	2		●								●
• VOCs in Groundwater at the Eastern End of Building 807	1	●									
	2		●	●							
	3		●		●						
• VOCs in Groundwater Near Buildings 808 and 823	1	●									
	2		●	●							
	3		●			●					
	4		●				●				
	5		●					●			
• VOCs in Groundwater Near Building 99	1	●									
	2		●	●							
	3		●			●					
	4		●				●				
	5		●					●			
• Benzene and MTBE in Groundwater Near Former USTs 11A/12A/13A	1	●									
	2		●						●		
	3		●							●	

TABLE 9-2
SUMMARY OF POTENTIAL REMEDIAL ACTIONS
Oakland Army Base, Oakland, California

Site	Alternative	Remedial Alternatives for Detailed Analysis (a); (b)									
		No Action for Soil and Groundwater	Institutional Controls	Monitored Natural Attenuation	Perform In-situ Chemical Oxidation/ Reduction of COCs in Groundwater, and Monitor Groundwater	Perform In-situ Bioremediation of COCs in Groundwater, Monitor Groundwater	Install Vapor Barrier Beneath New Building and Monitor Groundwater	Install Vapor Barrier with Sub-slab Depressurization System Beneath New Building and Monitor Groundwater	Excavate and Dispose Soil Off-site, and Monitor Groundwater As Needed (c)	Excavate and Dispose Soil Off-site, In-situ Groundwater Treatment and Monitor Groundwater	Excavate, Conduct Ex-situ Immobilization, and Dispose of Soil Off-site, and Monitor Groundwater
RAP Sites											
• Building 991 Area	1	●									
	2		●						●		
	3		●							●	
• Building 99	1	●									
	2		●						●		
RMP Implementation Area											
• Washracks, Sumps, Oil/Water Separators, and Miscellaneous Operations	1	●									
	2		●						●		
• Tanks	1	●									
	2		●	●							
	3		●						●		
• Boiler Debris Near Building 99	1	●									
	2		●						●		
• Building 85	1	●									
	2		●						●		

TABLE 9-2
SUMMARY OF POTENTIAL REMEDIAL ACTIONS
Oakland Army Base, Oakland, California

Site	Alternative	Remedial Alternatives for Detailed Analysis (a); (b)									
		No Action for Soil and Groundwater	Institutional Controls	Monitored Natural Attenuation	Perform In-situ Chemical Oxidation/ Reduction of COCs in Groundwater, and Monitor Groundwater	Perform In-situ Bioremediation of COCs in Groundwater, Monitor Groundwater	Install Vapor Barrier Beneath New Building and Monitor Groundwater	Install Vapor Barrier with Sub-slab Depressurization System Beneath New Building and Monitor Groundwater	Excavate and Dispose Soil Off-site, and Monitor Groundwater As Needed (c)	Excavate and Dispose Soil Off-site, In-situ Groundwater Treatment and Monitor Groundwater	Excavate, Conduct Ex-situ Immobilization, and Dispose of Soil Off-site, and Monitor Groundwater
RMP Implementation Area											
• Building 812	1	●									
	2		●						●		
• Building 823	1	●									
	2		●						●		
• Potential Drum Drainage Area East of Buildings 805 and 806	1	●									
	2		●							●	
• Former Motor Pool and Salvage Operations at Building 640	1	●									
	2		●						●		
	3		●							●	
• Benzidine at Former Used Oil Tank 21	1	●									
	2		●						●		
• Historical Spills and Stains	1	●									
	2		●						●		
• Lead in Soil Around Buildings	1	●									
	2		●						●		

TABLE 9-2
SUMMARY OF POTENTIAL REMEDIAL ACTIONS
Oakland Army Base, Oakland, California

Site	Alternative	Remedial Alternatives for Detailed Analysis (a); (b)									
		No Action for Soil and Groundwater	Institutional Controls	Monitored Natural Attenuation	Perform In-situ Chemical Oxidation/ Reduction of COCs in Groundwater, and Monitor Groundwater	Perform In-situ Bioremediation of COCs in Groundwater, Monitor Groundwater	Install Vapor Barrier Beneath New Building and Monitor Groundwater	Install Vapor Barrier with Sub-slab Depressurization System Beneath New Building and Monitor Groundwater	Excavate and Dispose Soil Off-site, and Monitor Groundwater As Needed (c)	Excavate and Dispose Soil Off-site, In-situ Groundwater Treatment and Monitor Groundwater	Excavate, Conduct Ex-situ Immobilization, and Dispose of Soil Off-site, and Monitor Groundwater
RMP Implementation Area											
• Former PCB-Containing Transformers and Equipment Locations	1	●									
	2		●						●		
• Storm Drains and Sanitary Sewers (e)	1	●									
	2		●						●		
• Railroad Tracks (f)	1	●									
	2		●						●		
• Marine Sediments at Former Parcels 2 and 3 (g)	1	●									
	2		●								

TABLE 9-2
SUMMARY OF POTENTIAL REMEDIAL ACTIONS
Oakland Army Base, Oakland, California

Notes:

(a) The NCP at 40 CFR §300.430(e)(6) requires that the no action alternative be evaluated as a baseline for comparison of other alternatives developed. No action may be an appropriate remedial alternative for sites where concentrations of chemicals of concern ("COCs") are found to be not greater than cleanup levels for soil or groundwater.

(b) Institutional controls including on-site land and groundwater use restrictions are an inherent component of all alternatives, including maintaining existing cover or constructing new permeable cover. The existing site-wide permeable cover or new constructed cover includes asphalt or concrete pavement, building slab, or other engineered structure that minimizes contact of impacted soil by human receptors.

(c) Additional investigation is planned for many OARB sites. Remedial actions will be conducted only if impacted soil or groundwater is identified.

(d) ORP Area near Building 1 Alternative 2 includes subalternatives to potentially reuse of overburden. If the overburden cannot be reused, all materials will be disposed off-site.

(e) Storm Drain Alternative 2 includes flushing of the sediments within storm drains.

(f) Railroad Track Alternative 2 includes reusing existing ballast and covering impacted ballast identified in investigation.

(g) Remedial actions for Marine Sediments at Former Parcels 2 and 3 are essentially No Action. No action is proposed for Outfalls 5, 6, and 7. Filling as part of the Port's Berth 21 Project is planned to cover Outfalls 8 through 11. Marine sediments at Outfall 4 are designated as part of Parcel 1 and will be addressed with the Spit and Parcel 1 outfalls by separate RAP.

TABLE 9-3
SUMMARY OF KEY PARAMETERS FOR REMEDIAL ALTERNATIVES (a)
Oakland Army Base, Oakland, California

Location	Key Parameters
RAP Sites	
• Former ORP/Building 1 Area	**Common to Remedial Alternatives 2a and 2b** • Primary COCs: lead, PAHs, PCDDs, PCDFs, tarry residue • Demolition of Building 1 to be funded and completed by Army prior to transfer. No demolition costs included. • Excavate overburden soil (est. 8,700 cy) • Excavate soil with 1,2,3-trichloropropane (est. 1,800 cy) • Excavate and immobilize soil with oily residue (est. 6,000 cy) • Dispose of tarry residue off-site as RCRA hazardous waste with variance from land disposal restrictions • Monitor groundwater for 5 years **Specific to Alternative 2a** • Reuse overburden and soil with 1,2,3-trichloropropane on-site **Specific to Alternative 2b** • Dispose of overburden and soil with 1,2,3-trichloropropane off-site as non-hazardous waste
• VOCs in Groundwater at Eastern End of Building 807	**Common to Alternatives 2 and 3** • Primary COCs: VOCs, particularly vinyl chloride and TCE **Specific to Alternative 2** • Monitor groundwater for 15 years **Specific to Alternative 3** • Perform in-situ chemical oxidation/reduction of groundwater (est. 30,000 sf area of shallow groundwater impacted) • Monitor groundwater for 5 years
• VOCs in Groundwater Near Buildings 808 and 823	**Common to Alternatives 2, 3, 4, and 5** • Primary COCs: VOCs, particularly vinyl chloride **Specific to Alternative 2** • Monitor groundwater for 15 years **Specific to Alternative 3** • Perform in-situ bioremediation of groundwater (est. 40,000 sf area of shallow groundwater impacted) • Monitor groundwater for 5 years **Specific to Alternative 4** • Install vapor barrier under footprint of new building (40,000 sf) • Monitor groundwater for 15 years **Specific to Alternative 5** • Install sub-slab depressurization system with vapor barrier under footprint of new building (40,000 sf) • Monitor groundwater for 15 years

TABLE 9-3
SUMMARY OF KEY PARAMETERS FOR REMEDIAL ALTERNATIVES (a)
Oakland Army Base, Oakland, California

Location	Key Parameters
RAP Sites	
• VOCs in Groundwater Near Building 99	**Common to Alternatives 2, 3, 4, and 5** • Primary COCs: VOCs, particularly vinyl chloride and benzene **Specific to Alternative 3** • Monitor groundwater for 15 years **Specific to Alternative 3** • Perform in-situ bioremediation of groundwater (est. 22,000 sf area of shallow groundwater impacted) **Specific to Alternative 4** • Install vapor barrier under footprint of new building (40,000 sf) • Monitor groundwater for 15 years **Specific to Alternative 5** • Install sub-slab depressurization system with vapor barrier under footprint of new building (40,000 sf) • Monitor groundwater for 15 years
• Benzene and MTBE in Groundwater Near Former USTs 11A/12A/13A	**Common to Alternatives 2 and 3** • Primary COCs: petroleum hydrocarbons, benzene, MTBE **Specific to Alternative 2** • Excavate overburden (est. 170 cy) • Excavate and dispose of source soil (est. 110 cy) • Monitor groundwater for 15 years **Specific to Alternative 3** • Excavate overburden (est. 260 cy) • Excavate and dispose of source soil (est. 170 cy) • Perform in-situ bioremediation of groundwater (est. 6,300 sf area of shallow groundwater impacted) • Monitor groundwater for 5 years
• Building 991 Area	**Common to Alternatives 2 and 3** • Primary COCs: petroleum hydrocarbons and related constituents **Specific to Alternative 2** • Excavate and dispose of source soil (est. 250 cy) • Monitor groundwater for 5 years **Specific to Alternative 3** • Excavate and dispose impacted source soil (est. 500 cy) • Perform in-situ bioremediation of groundwater (est. 8,000 sf area of shallow groundwater impacted) • Monitor groundwater for 5 years
• Building 99	**Common to Alternatives 2 and 3** • Suspected COCs: petroleum hydrocarbons, metals, VOCs • Perform additional characterization **Specific to Alternative 2a** • No source soil identified **Specific to Alternative 2b** • Excavate and dispose of source soil (est. 400 cy)

TABLE 9-3
SUMMARY OF KEY PARAMETERS FOR REMEDIAL ALTERNATIVES (a)
Oakland Army Base, Oakland, California

Location	Key Parameters
RMP Implementation Area	
• Washracks, Sumps, Oil/Water Separators, and Miscellaneous Operations	**Common to Alternatives 2a and 2b** • Primary COCs: petroleum hydrocarbons and related constituents • Perform additional characterization as needed **Specific to Alternative 2a** • No impacted soil or groundwater discovered **Specific to Alternative 2b** • Perform additional characterization • Remove existing structures, if present • Excavate and dispose of source soil as encountered at each location (est. 50 cy each)
• Tanks	**Common to Alternatives 2a, 2b, and 2c** • Primary COCs: petroleum hydrocarbons and related constituents **Specific to Alternative 2a** • No impacted soil or groundwater discovered **Specific to Alternative 2b** • Remove existing tanks, if present • Excavate and dispose of source soil as encountered at each location (est. 50 cy each) **Specific to Alternative 2c** • Remove existing tanks, if present • Excavate and dispose of source soil as encountered at each location (est. 50 cy each) • Continue ongoing groundwater monitoring at selected locations for 5 years
• Debris Area Near Building 99	**Common to Alternatives 2a and 2b** • Suspected COCs: petroleum hydrocarbons, metals, VOCs, asbestos • Perform additional characterization **Specific to Alternative 2a** • No impacted soil or groundwater discovered **Specific to Alternative 2b** • Excavate and dispose of source soil as encountered (est. 200 cy)
• Building 85	**Common to Alternatives 2a and 2b** • Suspected COCs: petroleum hydrocarbons, metals, VOCs • Perform additional characterization **Specific to Alternative 2a** • No impacted soil or groundwater discovered **Specific to Alternative 2b** • Excavate and dispose of source soil as encountered (est. 100 cy)
• Building 812	**Common to Alternatives 2a and 2b** • Suspected COCs: petroleum hydrocarbons, metals, VOCs • Perform additional characterization **Specific to Alternative 2a** • No impacted soil or groundwater discovered **Specific to Alternative 2b** • Excavate and dispose of source soil as encountered (est. 100 cy)

TABLE 9-3
SUMMARY OF KEY PARAMETERS FOR REMEDIAL ALTERNATIVES (a)
Oakland Army Base, Oakland, California

Location	Key Parameters
RMP Implementation Area	
• Building 823	**Common to Alternatives 2a and 2b** • Suspected COCs: petroleum hydrocarbons, metals, VOCs • Perform additional characterization **Specific to Alternative 2a** • No impacted soil or groundwater discovered **Specific to Alternative 2b** • Excavate and dispose of source soil as encountered (est. 200 cy)
• Potential Drum Drainage Area East of Buildings 805 and 806	**Common to Alternatives 2a and 2b** • Suspected COCs: metals, VOCs, pesticides • Perform additional characterization **Specific to Alternative 2a** • No impacted soil or groundwater discovered **Specific to Alternative 2b** • Excavate and dispose of impacted soil as encountered (est. 250 cy) • Perform in-situ treatment of groundwater (est. 6,300 sf area of shallow impacted groundwater) • Monitor groundwater for 5 years
• Former Motor Pool and Salvage Building 640	**Common to Alternatives 2 and 3** • Suspected COCs: petroleum hydrocarbons, metals, VOCs • Perform additional characterization **Specific to Alternative 2** • No impacted soil or groundwater discovered **Specific to Alternative 3** • Excavate and dispose of source soil as encountered (est. 250 cy) • Perform in-situ treatment of groundwater (est. 8,000 sf area of shallow impacted groundwater) • Monitor groundwater for 5 years
• Benzidine at Former Used Oil Tank 21	**Common to Alternatives 2a and 2b** • Suspected COCs: Petroleum hydrocarbons, metals, VOCs • Perform additional characterization **Specific to Alternative 2a** • No impacted soil or groundwater discovered **Specific to Alternative 2b** • Excavate and dispose impacted soil as encountered (est. 50 cy)
• Historical Spills and Stains	**Common to Alternatives 2a and 2b** • Suspected COCs: petroleum hydrocarbons, metals, VOCs • Estimated stained area is 100,000 sf • Perform additional characterization **Specific to Alternative 2a** • No impacted soil or groundwater discovered **Specific to Alternative 2b** • Excavate and dispose of source soil as encountered (est. 1,900 cy)

TABLE 9-3
SUMMARY OF KEY PARAMETERS FOR REMEDIAL ALTERNATIVES (a)
Oakland Army Base, Oakland, California

Location	Key Parameters
RMP Implementation Area	
• Lead in Soil Around Buildings	**Common to Alternatives 2a and 2b** • Suspected COCs: lead • Perform additional characterization **Specific to Alternative 2a** • No impacted shallow soil discovered **Specific to Alternative 2b** • Excavate and dispose of impacted shallow soil as encountered (est. 1,500 cy)
• Former PCB-Containing Transformers and Equipment Locations	**Alternative 2** • Suspected COCs: PCBs • Perform additional characterization • Inventory and track equipment potentially containing PCBs (est. 110 pieces of equipment) • Dispose of PCB-containing oil (est. 2,500 gal) • Dispose of PCB-containing equipment (est. 44 tons)
• Storm Drains and Sanitary Sewers Locations	**Common to Alternatives 2a and 2b** • Suspected COCs: petroleum hydrocarbons, metals, pesticides, PCBs • Perform additional characterization of sediments inside storm drains • Flush storm drain lines (est. 35,000 lf) **Specific to Alternative 2a** • No impacted soil or groundwater discovered **Specific to Alternative 2b** • Collect soil samples adjacent to storm drain lines in areas of encountered breakages or contaminant release • Excavate and dispose impacted soil as encountered (est. 22,500 cy)
• Railroad Tracks	**Common to Alternatives 2a and 2b** • Suspected COCs: petroleum hydrocarbons, metals, pesticides, PCBs, VOCs, PAHs • Investigate railroad track areas (est. 26 miles) • Manage railroad ties (est. 99,000 ties that weigh a total of 7,500 tons) **Specific to Alternative 2a** • No impacted soil or groundwater discovered **Specific to Alternative 2b** • Reuse all ballast on-site at no incremental environmental cost • Excavate and dispose subballast as RCRA or non-RCRA hazardous waste as encountered (est. 2,000 cy which is equivalent to 1% of total subballast volume) • Import gravel to maintain site cover (est. 13,000 cy) • Salvage 50% of railroad ties at no cost • Dispose of 50% of railroad ties as special waste (est. 3,800 tons)
• Marine Sediments at Former Parcels 2 and 3	**Alternative 2** • Suspected COCs: metals, pesticides, PCBs, PAHs • No remedial action required to implement Port of Oakland's Berth 21 Project • Marine sediments at Outfall 4 are designated as part of former Parcel 1

TABLE 9-3
SUMMARY OF KEY PARAMETERS FOR REMEDIAL ALTERNATIVES (a)
Oakland Army Base, Oakland, California

Notes:

(a) Abbreviations used in this table are as follows:

COC	chemical of concern
cy	cubic yard
est.	estimated
gal	gallons
lf	linear feet
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PCDD	polychlorinated dibenzodioxin
PCDF	polychlorinated dibenzofuran
RCRA	Resource Conservation and Recovery Act
sf	square foot or square feet
TCE	trichloroethene
VOC	volatile organic compound

TABLE 10-1
DETAILED ANALYSIS OF REMEDIAL ALTERNATIVE:
NO ACTION FOR SOIL AND GROUNDWATER
Oakland Army Base, Oakland, California

	Evaluation Criteria	Conditions Under Which Alternative May Be Applicable
Threshold Criteria	• Overall Protection of Human Health and the Environment	Alternative may be protective of human health and the environment if no chemicals of concern ("COCs") are present above screening levels for unrestricted use. No institutional controls are included in this alternative.
	• Compliance with ARARs	ARARs require institutional controls to meet unrestricted land use. No institutional controls are included.
Balancing Criteria	• Long-term Effectiveness and Permanence	Alternative may offer long-term protection against exposure of humans and ecological receptors if no COCs are present above screening levels for unrestricted use.
	• Reduction of Toxicity, Mobility, Volume through Treatment	Alternative will not reduce toxicity, mobility, or volume of COCs.
	• Short-term Effectiveness	Alternative is not anticipated to result in any short-term disruptions or risks to workers and the community.
	• Implementability	Alternative can be readily implemented.
	• Cost	Alternative has negligible costs associated with implementation.
Modifying Criteria	• State Acceptance	State of California Environmental Protection Agency, Department of Toxic Substances Control is not anticipated to accept alternative at any site without institutional controls.
	• Community Acceptance	Community members of the Restoration Advisory Board and the community at large are not anticipated to accept alternative at any site without institutional controls.
• State of California Health and Safety Code Criteria		Alternative does not comply with State of California Health and Safety Code Criteria.
• Summary of Evaluation Criteria		**Alternative is not selected at any sites.** **The no action alternative is included to comply with NCP requirements** and to provide a baseline for evaluating other remedial alternatives.

TABLE 10-2
DETAILED ANALYSIS OF REMEDIAL ALTERNATIVE:
INSTITUTIONAL CONTROLS
Oakland Army Base, Oakland, California

	Evaluation Criteria	Conditions Under Which Alternative May Be Applicable
Threshold Criteria	• Overall Protection of Human Health and the Environment	Alternative may be protective of human health and the environment, when used in combination with other alternatives, by restricting land use, groundwater use, or requiring implementation of the Risk Management Plan.
	• Compliance with ARARs	Alternative expected to comply with ARARs, when used in combination with other alternatives, by restricting land use, groundwater use, or requiring implementation of the Risk Management Plan.
Balancing Criteria	• Long-term Effectiveness and Permanence	Alternative may offer long-term protection against exposure of humans if implemented and periodically verified, e.g., in accordance with the RMP protocols.
	• Reduction of Toxicity, Mobility, or Volume through Treatment	Alternative will not reduce toxicity, mobility, or volume of COCs, although these actions may not be required if COC concentrations are less that applicable site-specific remedial goals.
	• Short-term Effectiveness	Alternative is not anticipated to result in any short-term disruptions or risks to workers and the community.
	• Implementability	Alternative can be readily implemented.
	• Cost	Alternative has low costs associated with implementation.
Modifying Criteria	• State Acceptance	State of California Environmental Protection Agency, Department of Toxic Substances Control may accept alternative if it is protective of human health and the environment and complies with ARARs.
	• Community Acceptance	Community members of the Restoration Advisory Board and the community at large may accept alternative if it is protective of human health and the environment and complies with ARARs.
• State of California Health and Safety Code Criteria		Alternative may comply with State of California Health and Safety Code Criteria.
• Summary of Evaluation Criteria		**Alternative will be included** with selected remedial alternatives for RAP sites or RMP locations.

TABLE 10-3
DETAILED ANALYSIS OF REMEDIAL ALTERNATIVE:
MONITORED NATURAL ATTENUATION
Oakland Army Base, Oakland, California

	Evaluation Criteria	Conditions Under Which Alternative May Be Applicable
Threshold Criteria	• Overall Protection of Human Health and the Environment	Alternative may be protective of human health and the environment if chemicals of concern ("COCs") are present above applicable site-specific remedial goals, and the soil is not expected to be an ongoing source of groundwater contamination.
	• Compliance with ARARs	Alternative expected to comply with ARARs at sites where COC concentrations do not pose unacceptable risks to human health and the environment.
Balancing Criteria	• Long-term Effectiveness and Permanence	Alternative may offer long-term protection against exposure of humans if COCs are ammenable to attenuation mechanisms.
	• Reduction of Toxicity, Mobility, or Volume through Treatment	Alternative may reduce toxicity, mobility, or volume of COCs over time.
	• Short-term Effectiveness	Alternative is not anticipated to result in any short-term disruptions or risks to workers and the community.
	• Implementability	Alternative is readily implemented for certain COCs.
	• Cost	Alternative has low costs associated with implementation.
Modifying Criteria	• State Acceptance	State of California Environmental Protection Agency, Department of Toxic Substances Control may accept alternative if it is protective of human health and the environment and complies with ARARs.
	• Community Acceptance	Community members of the Restoration Advisory Board and the community at large may accept alternative if it is protective of human health and the environment and complies with ARARs.
• State of California Health and Safety Code Criteria		Alternative may comply with State of California Health and Safety Code Criteria.
• Summary of Evaluation Criteria		**Alternative may be selected** for RAP sites or RMP locations where COC concentrations in groundwater are greater than applicable remedial goals and natural processes are likely to degrade or attenuate the COCs over time.

TABLE 10-4
DETAILED ANALYSIS OF REMEDIAL ALTERNATIVE:
PERFORM IN-SITU CHEMICAL OXIDATION/REDUCTION OF CHEMICALS OF CONCERN IN GROUNDWATER, AND MONITOR GROUNDWATER

Oakland Army Base, Oakland, California

	Evaluation Criteria	Conditions Under Which Alternative May Be Applicable
Threshold Criteria	• Overall Protection of Human Health and the Environment	Alternative may be protective of human health and the environment if chemicals of concern ("COCs") in groundwater can be effectively treated by in-situ chemical oxidation/reduction to bring concentrations of COCs below applicable site-specific remedial goals.
	• Compliance with ARARs	Alternative expected to comply with ARARs at sites where COC concentrations are treated to be less than applicable remedial goals.
Balancing Criteria	• Long-term Effectiveness and Permanence	Alternative offers long-term effectiveness and permanence because the COCs are oxidized or reduced, and no longer present in the subsurface.
	• Reduction of Toxicity, Mobility, or Volume through Treatment	Alternative will reduce toxicity, mobility, and volume of COCs by in-situ treatment.
	• Short-term Effectiveness	Alternative is not anticipated to result in any short-term disruptions or risks to workers and the community.
	• Implementability	Alternative can be readily implemented with standard chemical injection technologies.
	• Cost	Alternative has low to moderate capital and annual costs associated with implementation.
Modifying Criteria	• State Acceptance	State of California Environmental Protection Agency, Department of Toxic Substances Control is anticipated to accept alternative as it is protective of human health and complies with ARARs.
	• Community Acceptance	Community members of the Restoration Advisory Board and the community at large are anticipated to accept alternative as it is protective of human health and complies with ARARs.
• State of California Health and Safety Code Criteria		Alternative is anticipated to comply with State of California Health and Safety Code Criteria.
• Summary of Evaluation Criteria		**Alternative may be selected** for RAP sites or RMP locations where COC concentrations in groundwater are greater than applicable remedial goals, and in-situ chemical oxidation/reduction is an effective means of treating the COCs. Groundwater monitoring is included to confirm effectiveness of treatment.

TABLE 10-5
DETAILED ANALYSIS OF REMEDIAL ALTERNATIVE: PERFORM IN-SITU BIOREMEDIATION OF CHEMICALS OF CONCERN IN GROUNDWATER, AND MONITOR GROUNDWATER

Oakland Army Base, Oakland, California

	Evaluation Criteria	Conditions Under Which Alternative May Be Applicable
Threshold Criteria	• Overall Protection of Human Health and the Environment	Alternative may be protective of human health and the environment if chemicals of concern ("COCs") in groundwater can be effectively treated by in-situ bioremediation to bring concentrations of COCs below applicable site-specific remedial goals.
Threshold Criteria	• Compliance with ARARs	Alternative expected to comply with ARARs at sites where COC concentrations are treated to be less than applicable remedial goals.
Balancing Criteria	• Long-term Effectiveness and Permanence	Alternative offers long-term effectiveness and permanence because the COCs are biologically degraded, and no longer present in the subsurface.
Balancing Criteria	• Reduction of Toxicity, Mobility, or Volume through Treatment	Alternative will reduce toxicity, mobility, and volume of COCs by in-situ treatment.
Balancing Criteria	• Short-term Effectiveness	Alternative is not anticipated to result in any short-term disruptions or risks to workers and the community.
Balancing Criteria	• Implementability	Alternative can be readily implemented with standard chemical injection technologies.
Balancing Criteria	• Cost	Alternative has low to moderate capital and annual costs associated with implementation.
Modifying Criteria	• State Acceptance	State of California Environmental Protection Agency, Department of Toxic Substances Control is anticipated to accept alternative as it is protective of human health and complies with ARARs.
Modifying Criteria	• Community Acceptance	Community members of the Restoration Advisory Board and the community at large are anticipated to accept alternative as it is protective of human health and complies with ARARs.
• State of California Health and Safety Code Criteria		Alternative is anticipated to comply with State of California Health and Safety Code Criteria.
• Summary of Evaluation Criteria		**Alternative may be selected** for RAP sites or RMP locations where COC concentrations in groundwater are greater than applicable remedial goals, and in-situ bioremediation is an effective means of treating the COCs. Groundwater monitoring is included to confirm effectiveness of treatment.

TABLE 10-6
DETAILED ANALYSIS OF REMEDIAL ALTERNATIVE:
INSTALL VAPOR BARRIER BENEATH NEW BUILDING AND MONITOR GROUNDWATER
Oakland Army Base, Oakland, California

	Evaluation Criteria	Conditions Under Which Alternative May Be Applicable
Threshold Criteria	• Overall Protection of Human Health and the Environment	Alternative may be protective of human health and the environment if chemicals of concern ("COCs") in groundwater are volatile and can be effectively isolated from human inhalation pathways by vapor barriers beneath buildings.
	• Compliance with ARARs	Alternative expected to comply with ARARs at sites where volatile COC concentrations could migrate into buildings and exceed inhalation exposure criteria for commercial/industrial workers.
Balancing Criteria	• Long-term Effectiveness and Permanence	Alternative offers long-term effectiveness and permanence because vapor barrier is an integral part of the building.
	• Reduction of Toxicity, Mobility, or Volume through Treatment	Alternative will not reduce toxicity, mobility, and volume of COCs by treatment, though it will reduce mobility into buildings.
	• Short-term Effectiveness	Alternative is not anticipated to result in any short-term disruptions or risks to workers and the community.
	• Implementability	Alternative can be implemented during building construction.
	• Cost	Alternative has low to moderate capital and annual costs associated with implementation.
Modifying Criteria	• State Acceptance	State of California Environmental Protection Agency, Department of Toxic Substances Control is anticipated to accept alternative as it is protective of human health and complies with ARARs.
	• Community Acceptance	Community members of the Restoration Advisory Board and the community at large are anticipated to accept alternative as it is protective of human health and complies with ARARs.
• State of California Health and Safety Code Criteria		Alternative is anticipated to comply with State of California Health and Safety Code Criteria.
• Summary of Evaluation Criteria		**Alternative may be selected** for RAP sites or RMP locations where COC concentrations in groundwater are greater than applicable remedial goals, and positioning a vapor barrier beneath a building can reduce the potential for the migration of vapors into the building. Groundwater monitoring is included to monitor COC concentrations in groundwater.

TABLE 10-7
DETAILED ANALYSIS OF REMEDIAL ALTERNATIVE:
INSTALL VAPOR BARRIER WITH SUB-SLAB DEPRESSURIZATION SYSTEM
BENEATH NEW BUILDING AND MONITOR GROUNDWATER
Oakland Army Base, Oakland, California

	Evaluation Criteria	Conditions Under Which Alternative May Be Applicable
Threshold Criteria	• Overall Protection of Human Health and the Environment	Alternative may be protective of human health and the environment if chemicals of concern ("COCs") in groundwater are volatile and can be effectively isolated from human inhalation pathways by vapor barriers and a sub-slab depressurization system ("SSD") beneath buildings.
	• Compliance with ARARs	Alternative expected to comply with ARARs at sites where volatile COC concentrations could migrate into buildings and exceed inhalation exposure criteria for commercial/industrial workers.
Balancing Criteria	• Long-term Effectiveness and Permanence	Alternative offers long-term effectiveness and permanence because vapor barrier with SSD is an integral part of the building.
	• Reduction of Toxicity, Mobility, or Volume through Treatment	Alternative will not reduce toxicity, mobility, and volume of COCs by treatment, though it will increase mobility of volatiles out of the soil gas into the atmosphere (no off-gas treatment is assumed).
	• Short-term Effectiveness	Alternative is not anticipated to result in any short-term disruptions or risks to workers and the community.
	• Implementability	Alternative can be implemented during building construction.
	• Cost	Alternative has moderate capital and annual costs associated with implementation.
Modifying Criteria	• State Acceptance	State of California Environmental Protection Agency, Department of Toxic Substances Control is anticipated to accept alternative as it is protective of human health and complies with ARARs.
	• Community Acceptance	Community members of the Restoration Advisory Board and the community at large are anticipated to accept alternative as it is protective of human health and complies with ARARs.
• State of California Health and Safety Code Criteria		Alternative is anticipated to comply with State of California Health and Safety Code Criteria.
• Summary of Evaluation Criteria		**Alternative may be selected** for RAP sites or RMP locations where COC concentrations in groundwater are greater than applicable remedial goals, and likely positioning a vapor barrier with an SSD system beneath a building can reduce the potential for the migration of vapors into the building. Groundwater monitoring is included to monitor COC concentrations in groundwater.

TABLE 10-8
DETAILED ANALYSIS OF REMEDIAL ALTERNATIVE:
EXCAVATE AND DISPOSE SOIL OFF-SITE, AND MONITOR GROUNDWATER AS NEEDED
Oakland Army Base, Oakland, California

	Evaluation Criteria	Conditions Under Which Alternative May Be Applicable
Threshold Criteria	• Overall Protection of Human Health and the Environment	Alternative may be protective of human health and the environment if chemicals of concern ("COCs") in soil exceed site-specific remedial goals, and groundwater impacts may or may not be present.
	• Compliance with ARARs	Alternative expected to comply with ARARs at sites where soil with COC concentrations above remedial goals has been identified, and no groundwater remedial action is required.
Balancing Criteria	• Long-term Effectiveness and Permanence	Alternative offers long-term effectiveness and permanence because impacted soil is removed from the site.
	• Reduction of Toxicity, Mobility, or Volume through Treatment	Alternative will not reduce toxicity of COCs in soil, if present, but will decrease on-site volume and mobility of COCs in soil by removal to a permitted off-site disposal facility.
	• Short-term Effectiveness	Alternative is not anticipated to result in any short-term disruptions or risks to workers and the community, other than minor soil removal activities.
	• Implementability	Alternative is readily implemented with standard excavation procedures.
	• Cost	Alternative has low to high capital cost, depending on the volume of soil to be managed, and low annual costs.
Modifying Criteria	• State Acceptance	State of California Environmental Protection Agency, Department of Toxic Substances Control is anticipated to accept alternative as it is protective of human health and complies with ARARs.
	• Community Acceptance	Community members of the Restoration Advisory Board and the community at large are anticipated to accept alternative as it is protective of human health and complies with ARARs.
• State of California Health and Safety Code Criteria		Alternative is anticipated to comply with State of California Health and Safety Code Criteria.
• Summary of Evaluation Criteria		**Alternative may be selected** for RAP sites or RMP locations where COC concentrations in soil are identified to be greater than applicable remedial goals, and excavation and disposal of soil efficiently removes the COCs. Groundwater monitoring may be included if COCs have impacted groundwater.

TABLE 10-9
DETAILED ANALYSIS OF REMEDIAL ALTERNATIVE:
EXCAVATE AND DISPOSE SOIL OFF-SITE, IN-SITU
GROUNDWATER TREATMENT, AND MONITOR GROUNDWATER
Oakland Army Base, Oakland, California

	Evaluation Criteria	Conditions Under Which Alternative May Be Applicable
Threshold Criteria	• Overall Protection of Human Health and the Environment	Alternative may be protective of human health and the environment if chemicals of concern ("COCs") in soil and groundwater exceed site-specific remedial goals, impacted soils can be removed, and groundwater treatment technologies effectively treat residual COCs.
	• Compliance with ARARs	Alternative expected to comply with ARARs at sites where soil with COC concentrations above remedial goals has been identified in soil and groundwater, and groundwater remedial action is required.
Balancing Criteria	• Long-term Effectiveness and Permanence	Alternative offers long-term effectiveness and permanence because impacted soil is removed from the site and residual COCs in groundwater are treated in-situ..
	• Reduction of Toxicity, Mobility, or Volume through Treatment	Alternative will reduce toxicity, mobility, and volume of COCs in the subsurface by a combination of removal and in-situ treatment of groundwater.
	• Short-term Effectiveness	Alternative is not anticipated to result in any short-term disruptions or risks to workers and the community, other than minor soil removal activities.
	• Implementability	Alternative is readily implemented with standard excavation procedures, and chemical injection procedures.
	• Cost	Alternative has moderate to high capital cost, and low to moderate annual costs.
Modifying Criteria	• State Acceptance	State of California Environmental Protection Agency, Department of Toxic Substances Control is anticipated to accept alternative as it is protective of human health and complies with ARARs.
	• Community Acceptance	Community members of the Restoration Advisory Board and the community at large are anticipated to accept alternative as it is protective of human health and complies with ARARs.
• State of California Health and Safety Code Criteria		Alternative is anticipated to comply with State of California Health and Safety Code Criteria.
• Summary of Evaluation Criteria		**Alternative may be selected for RAP sites or RMP locations where** COC concentrations in soil and groundwater are elevated and concentrated in an identifiable area, such that excavation removes a significant volume of COCs. In-situ treatment addresses residual concentrations in groundwater. Groundwater monitoring is included.

TABLE 10-10
DETAILED ANALYSIS OF REMEDIAL ALTERNATIVE:
EXCAVATE, CONDUCT EX-SITU IMMOBILIZATION,
AND DISPOSE SOIL OFF-SITE, AND MONITOR GROUNDWATER
Oakland Army Base, Oakland, California

	Evaluation Criteria	Conditions Under Which Alternative May Be Applicable
Threshold Criteria	• Overall Protection of Human Health and the Environment	Alternative may be protective of human health and the environment if chemicals of concern ("COCs") in soil and groundwater exceed site-specific remedial goals, and soils must be treated prior to off-site disposal.
Threshold Criteria	• Compliance with ARARs	Alternative expected to comply with ARARs at Former ORP where soil with COC concentrations above remedial goals is anticipated to require treatment to meet disposal regulations.
Balancing Criteria	• Long-term Effectiveness and Permanence	Alternative offers long-term effectiveness and permanence because impacted soil is removed from the site.
Balancing Criteria	• Reduction of Toxicity, Mobility, or Volume through Treatment	Alternative will reduce toxicity and mobility of COCs in soil by treatment, and will also decrease on-site volume and mobility of COCs in soil by removal to a permitted off-site disposal facility.
Balancing Criteria	• Short-term Effectiveness	Alternative is not anticipated to result in any short-term disruptions or risks to workers and the community, other than soil removal activities.
Balancing Criteria	• Implementability	Alternative can be implemented with standard excavation procedures, and immobilization is a function of the characteristics of the waste.
Balancing Criteria	• Cost	Alternative has high capital cost, and low annual costs.
Modifying Criteria	• State Acceptance	State of California Environmental Protection Agency, Department of Toxic Substances Control is anticipated to accept alternative as it is protective of human health and complies with ARARs.
Modifying Criteria	• Community Acceptance	Community members of the Restoration Advisory Board and the community at large are anticipated to accept alternative as it is protective of human health and complies with ARARs.
	• State of California Health and Safety Code Criteria	Alternative is anticipated to comply with State of California Health and Safety Code Criteria.
	• Summary of Evaluation Criteria	**Alternative may be selected** for the Former ORP Area only, where COC concentrations soil are elevated and may require immobilization for disposal of some oily residue waste to minimize free liquids or pH extremes. Groundwater monitoring is included.

TABLE 10-11
COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES:
FORMER ORP / BUILDING 1 AREA
Oakland Army Base, Oakland, California

	Evaluation Criteria	Alternative 1 No Action for Soil and Groundwater	Alternative 2 Excavate, Immobilize Soil, and Dispose of Soil Off-Site and Monitor Groundwater 2a. Reuse Some Overburden On-site	Alternative 2 Excavate, Immobilize Soil, and Dispose of Soil Off-Site and Monitor Groundwater 2b. Disposal All Soil Off-Site
Threshold Criteria	• Overall Protection of Human Health and the Environment	Alternative is not anticipated to be protective of human health and the environment.	Alternative is anticipated to be protective of human health and the environment.	Alternative is anticipated to be protective of human health and the environment.
Threshold Criteria	• Compliance with ARARs	Alternative is not anticipated to comply with ARARs.	Alternative is anticipated to comply with ARARs, provided a Land Disposal Restrictions ("LDRs") variance is received from regulatory agencies if waste is subject to LDRs.	Alternative is anticipated to comply with ARARs, provided a LDRs variance is received from regulatory agencies if waste is subject to LDRs.
Balancing Criteria	• Long-term Effectiveness and Permanence	Alternative will not offer long-term protection against exposure of humans receptors to chemicals of concern ("COCs") in soil or groundwater.	Alternative is anticipated to offer long-term effectiveness as impacted soil will be removed. Groundwater monitoring will verify long-term effectiveness.	Alternative is anticipated to offer long-term effectiveness as impacted soil will be removed. Groundwater monitoring will verify long-term effectiveness.
Balancing Criteria	• Reduction of Toxicity, Mobility, or Volume through Treatment	Alternative will not reduce toxicity, mobility, or volume of soil or waste.	Alternative may reduce toxicity of COCs in soil by treatment, but will increase volume of waste by the addition of chemicals. Alternative will decrease on-site volume and mobility of COCs in soil by removal to a permitted off-site disposal facility.	Alternative will reduce toxicity of COCs in soil by stabilization, but will increase volume of waste by the addition of chemicals. Alternative will decrease on-site volume and mobility of COCs in soil by removal to a permitted off-site disposal facility.

TABLE 10-11
COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES:
FORMER ORP / BUILDING 1 AREA
Oakland Army Base, Oakland, California

	Evaluation Criteria	Alternative 1 No Action for Soil and Groundwater	Alternative 2 Excavate, Immobilize Soil, and Dispose of Soil Off-Site and Monitor Groundwater 2a. Reuse Some Overburden On-site	Alternative 2 Excavate, Immobilize Soil, and Dispose of Soil Off-Site and Monitor Groundwater 2b. Disposal All Soil Off-Site
Balancing Criteria	• Short-term Effectiveness	Alternative is not anticipated to result in any short-term disruptions or risks to workers and the community.	Alternative involves excavation and treatment of impacted soil. Normal construction health and safety practices and OSHA standards would be employed to protect remedial construction workers and the general public. Dust, vapor, and odor control would also be implemented to protect the public.	Alternative involves excavation and treatment of impacted soil. Normal construction health and safety practices and OSHA standards would be employed to protect remedial construction workers and the general public. Dust, vapor, and odor control would also be implemented to protect the public.
Balancing Criteria	• Implementability	Alternative is easily implemented.	Alternative requires a LDR variance; segregation and testing of overburden may be difficult to implement.	Alternative requires a LDR variance, but earthwork is easily implemented.
Balancing Criteria	• Cost Estimated Capital Cost: Estimated Annual Cost: Estimated Present Worth:	Alternative has negligible costs associated with implementation.	$6,400,000 $39,000 $6,600,000	$7,600,000 $39,000 $7,800,000
Modifying Criteria	• State Acceptance	State of California Environmental Protection Agency, Department of Toxic Substances Control ("DTSC") is not anticipated to accept alternative.	DTSC is anticipated to accept remedial action because alternative is protective of human health and the environment, and complies with ARARs.	DTSC is anticipated to accept remedial action because alternative is protective of human health and the environment, and complies with ARARs.
Modifying Criteria	• Community Acceptance	Alternative is not likely to be accepted by community members of the Restoration Advisory Board ("RAB") or the community at large.	Alternative is anticipated to be accepted by the RAB and the community at large.	Alternative is anticipated to be accepted by the RAB and the community at large.

TABLE 10-11
COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES:
FORMER ORP / BUILDING 1 AREA
Oakland Army Base, Oakland, California

Evaluation Criteria	Alternative 1 No Action for Soil and Groundwater	Alternative 2 Excavate, Immobilize Soil, and Dispose of Soil Off-Site and Monitor Groundwater	
		2a. Reuse Some Overburden On-site	2b. Disposal All Soil Off-Site
• Six Factors from State of California Health and Safety Code Section 25356.1	Alternative does not comply with State of California Health and Safety Code Criteria.	Alternative is believed to comply with State of California Health and Safety Code Criteria.	Alternative is believed to comply with State of California Health and Safety Code Criteria.
• Summary of Evaluation Criteria	**Alternative is Not Selected.** COC concentrations in soil are greater than applicable site-specific remedial goals and pose unacceptable risks to human health and the environment. Alternative does not meet ARARs for unrestricted use.	**Alternative is Not Selected.** Soil and waste with COC concentrations greater than applicable site-specific remedial goals will be removed. However, stockpile and reuse of existing site soils is not anticipated to be feasible due to potential chemical impacts, difficulties segregating soil during excavation activities, and geotechnical requirements for backfill.	**Selected Alternative.** Soil and waste with COC concentrations greater than applicable site-specific remedial goals will be removed, treated, and disposed off-site in a permitted facility. Groundwater monitoring will be implemented to verify remedial action effectiveness.

TABLE 10-12
COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES:
VOCs IN GROUNDWATER AT THE EASTERN END OF BUILDING 807
Oakland Army Base, Oakland, California

	Evaluation Criteria	Alternative 1 No Action for Soil and Groundwater	Alternative 2 Monitor Groundwater	Alternative 3 Perform In-situ Chemical Oxidation/ Reduction and Monitor Groundwater
Threshold Criteria	• Overall Protection of Human Health and the Environment	Alternative is not anticipated to be protective of human health and the environment.	Alternative is anticipated to be protective of human health and the environment.	Alternative is anticipated to be protective of human health and the environment.
	• Compliance with ARARs	Alternative is not anticipated to comply with ARARs.	Alternative may comply with ARARs.	Alternative is anticipated to comply with ARARs.
Balancing Criteria	• Long-term Effectiveness and Permanence	Alternative will not offer long-term protection against exposure of humans to chemicals of concern ("COCs") in soil or groundwater.	Alternative does not offer long-term effectiveness as chemical concentrations may continue to remain elevated or increase over time. Alternative assumes 15 years of groundwater monitoring.	Alternative is anticipated to offer long-term effectiveness as COCs will be chemically oxidized in the subsurface. Five years of groundwater monitoring will verify long-term effectiveness.
	• Reduction of Toxicity, Mobility, or Volume through Treatment	Alternative will not reduce toxicity, mobility, or volume of impacted groundwater.	Alternative will not reduce toxicity, mobility, or volume of impacted groundwater.	Alternative will likely reduce toxicity, mobility, and volume of impacted groundwater through treatment.
	• Short-term Effectiveness	Alternative is not anticipated to result in any short-term disruptions or risks to workers and the community.	Alternative is not anticipated to result in any short-term disruptions or risks to workers and the community.	Alternative is not anticipated to result in significant short-term disruptions or risks to workers and the community.

TABLE 10-12
COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES:
VOCs IN GROUNDWATER AT THE EASTERN END OF BUILDING 807
Oakland Army Base, Oakland, California

	Evaluation Criteria	Alternative 1 No Action for Soil and Groundwater	Alternative 2 Monitor Groundwater	Alternative 3 Perform In-situ Chemical Oxidation/ Reduction and Monitor Groundwater
Balancing Criteria	• Implementability	Alternative is easily implemented.	Alternative can be implemented, as it involves standard well installation and monitoring procedures.	Alternative can be implemented, as it involves standard well installation and chemical injection procedures.
Balancing Criteria	• Cost Estimated Capital Cost: Estimated Annual Cost: Estimated Present Worth:	Alternative has negligible costs associated with implementation.	 $82,000 $46,000 $620,000	 $220,000 $46,000 $430,000
Modifying Criteria	• State Acceptance	State of California Environmental Protection Agency, Department of Toxic Substances Control ("DTSC") is not anticipated to accept alternative.	DTSC may accept remedial action because alternative is protective of human health and the environment, may comply with ARARs.	DTSC is anticipated to accept remedial action because alternative is protective of human health and the environment, and complies with ARARs.
Modifying Criteria	• Community Acceptance	Alternative is not likely to be accepted by community members of the Restoration Advisory Board ("RAB") and the community at large.	Alternative is anticipated to be accepted by the RAB and the community at large.	Alternative is anticipated to be accepted by the RAB and the community at large.
• Six Factors from State of California Health and Safety Code Section 25356.1		Alternative does not comply with State of California Health and Safety Code Criteria.	Alternative may comply with State of California Health and Safety Code Criteria.	Alternative is believed to comply with State of California Health and Safety Code Criteria.
• Summary of Evaluation Criteria		**Alternative is Not Selected.** COC concentrations in groundwater are greater than screening levels for unrestricted use; no institutional controls are included in this alternative.	**Alternative is Not Selected.** Ongoing monitoring for groundwater with elevated concentrations of COCs that may continue to rise does not provide a long-term solution.	**Selected Alternative.** Elevated COCs in groundwater will be treated. Groundwater monitoring will demonstrate effectiveness.

TABLE 10-13

COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES:

VOCs IN GROUNDWATER NEAR BUILDINGS 808 AND 823

Oakland Army Base, Oakland, California

	Evaluation Criteria	Alternative 1 No Action for Soil and Groundwater	Alternative 2 Monitor Groundwater	Alternative 3 Perform In-situ Biodegradation and Monitor Groundwater
Threshold Criteria	• Overall Protection of Human Health and the Environment	Alternative is not anticipated to be protective of human health or the environment.	Alternative may be protective of human health and environment.	Alternative is anticipated to be protective of human health and environment.
	• Compliance with ARARs	Alternative is not anticipated to comply with ARARs.	Alternative is expected to comply with ARARs.	Alternative is expected to comply with ARARs.
Balancing Criteria	• Long-term Effectiveness and Permanence	Alternative will not offer long-term protection against exposure of humans and ecological receptors to chemicals of concern ("COCs") in groundwater.	Alternative does not offer long-term effectiveness as chemical concentrations may continue to remain elevated or increase over time. Alternative assumes 15 years of groundwater monitoring.	Alternative is anticipated to offer long-term effectiveness as COCs will be biologically degraded in the subsurface. Five years of groundwater monitoring will verify long-term effectiveness.
	• Reduction of Toxicity, Mobility, or Volume through Treatment	Alternative will not reduce toxicity, mobility, or volume of COCs.	Alternative will not reduce toxicity, mobility, or volume of COCs.	Alternative could reduce toxicity, mobility, and volume of COCs by treatment that degrades COCs in groundwater.

TABLE 10-13

COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES:

VOCs IN GROUNDWATER NEAR BUILDINGS 808 AND 823

Oakland Army Base, Oakland, California

	Evaluation Criteria	Alternative 4 Install Vapor Barrier Beneath Building and Monitor Groundwater	Alternative 5 Install Vapor Barrier with Sub-slab Depressurization System, Monitor Groundwater
Threshold Criteria	• Overall Protection of Human Health and the Environment	Alternative is anticipated to be protective of human health and environment.	Alternative is anticipated to be protective of human health and environment.
Threshold Criteria	• Compliance with ARARs	Alternative is expected to comply with ARARs.	Alternative is expected to comply with ARARs.
Balancing Criteria	• Long-term Effectiveness and Permanence	Long-term effectiveness is a function of the effectiveness of the barrier beneath the building. Impacted groundwater remains in the subsurface and could potentially migrate. Fifteen years of groundwater monitoring will verify long-term effectiveness.	Long-term effectiveness is a function of the effectiveness of the barrier beneath the building and the ability of the depressurization system to limit migration into buildings. Impacted groundwater remains in the subsurface and could potentially migrate. Fifteen years of groundwater monitoring will verify long-term effectiveness.
Balancing Criteria	• Reduction of Toxicity, Mobility, or Volume through Treatment	Alternative will not reduce toxicity or volume of COCs in groundwater, but it may decrease mobility by volatilization pathways by providing subsurface containment.	Alternative will not reduce toxicity or volume of COCs in groundwater. Mobility of COCs is increased by transferring COCs from groundwater to air. Exhaust air treatment system is not anticipated to be required.

TABLE 10-13

COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES:

VOCs IN GROUNDWATER NEAR BUILDINGS 808 AND 823

Oakland Army Base, Oakland, California

	Evaluation Criteria	Alternative 1 No Action for Soil and Groundwater	Alternative 2 Monitor Groundwater	Alternative 3 Perform In-situ Biodegradation and Monitor Groundwater
Balancing Criteria	• Short-term Effectiveness	Alternative is not anticipated to result in any short-term disruptions or risks to workers and the community.	Alternative is not anticipated to result in any short-term disruptions or risks to workers and the community.	Alternative is not anticipated to result in significant short-term disruptions or risks to workers and the community.
	• Implementability	Alternative can be easily implemented.	Alternative can be implemented, as it involves standard groundwater monitoring procedures.	Alternative can be implemented, as it involves standard chemical injection procedures and monitoring.
	• Cost Estimated Capital Cost: Estimated Annual Cost: Estimated Present Worth:	Alternative has negligible costs associated with implementation.	 $83,000 $39,000 $540,000	 $340,000 $39,000 $520,000
Modifying Criteria	• State Acceptance	State of California Environmental Protection Agency, Department of Toxic Substances Control ("DTSC") is not anticipated to accept alternative.	DTSC may not accept remedial action if exposure to volatile COCs could potentially occur in future land use scenarios.	It is expected that DTSC will consider this alternative to be acceptable.
	• Community Acceptance	Alternative is not anticipated to be accepted by community members of the Restoration Advisory Board ("RAB") and the community at large.	RAB and community may not accept remedial action if exposure to volatile COCs could potentially occur in future land use scenarios.	Alternative is likely to be an acceptable alternative to the RAB and community.

TABLE 10-13

COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES:

VOCs IN GROUNDWATER NEAR BUILDINGS 808 AND 823

Oakland Army Base, Oakland, California

	Evaluation Criteria	Alternative 4 Install Vapor Barrier Beneath Building and Monitor Groundwater	Alternative 5 Install Vapor Barrier with Sub-slab Depressurization System, Monitor Groundwater
Balancing Criteria	• Short-term Effectiveness	Alternative is not anticipated to result in any short-term disruptions or risks to workers and the community. Vapor barrier would be installed during building construction.	Alternative is not anticipated to result in any short-term disruptions or risks to workers and the community. Sub-slab depressurization system would be installed during building construction.
	• Implementability	This alternative can be easily implemented during building construction. Implementation post construction is difficult.	This alternative can be easily implemented during building construction. Implementation post construction is difficult.
	• Cost Estimated Capital Cost: Estimated Annual Cost: Estimated Present Worth:	 $240,000 $39,000 $700,000	 $540,000 $56,000 $1,200,000
Modifying Criteria	• State Acceptance	It is expected that DTSC will consider this alternative to be acceptable.	It is expected that DTSC will consider this alternative to be acceptable.
	• Community Acceptance	Alternative is likely to be an acceptable alternative to the RAB and community.	Alternative is likely to be an acceptable alternative to the RAB and community.

TABLE 10-13

COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES:

VOCs IN GROUNDWATER NEAR BUILDINGS 808 AND 823

Oakland Army Base, Oakland, California

Evaluation Criteria	Alternative 1 No Action for Soil and Groundwater	Alternative 2 Monitor Groundwater	Alternative 3 Perform In-situ Biodegradation and Monitor Groundwater
• Six Factors from State of California Health and Safety Code Section 25356.1	Alternative does not comply with State of California Health and Safety Code Criteria.	Alternative is believed to comply with State of California Health and Safety Code Criteria.	Alternative is believed to comply with State of California Health and Safety Code Criteria.
• Summary of Evaluation Criteria	**Alternative is Not Selected.** Alternative is not protective of human health and the environment, and does not comply with ARARs.	**Alternative is Not Selected.** Alternative does not limit potential exposure to volatile COCs in potential future land use.	**Selected Alternative.** COCs in groundwater are actively remediated. Groundwater treatment could effectively reduce potential human health impacts. Remedial action is anticipated to be complete in 5 years.

TABLE 10-13

COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES:

VOCs IN GROUNDWATER NEAR BUILDINGS 808 AND 823

Oakland Army Base, Oakland, California

Evaluation Criteria	Alternative 4 Install Vapor Barrier Beneath Building and Monitor Groundwater	Alternative 5 Install Vapor Barrier with Sub-slab Depressurization System, Monitor Groundwater
• Six Factors from State of California Health and Safety Code Section 25356.1	Alternative is believed to comply with State of California Health and Safety Code Criteria.	Alternative is believed to comply with State of California Health and Safety Code Criteria.
• Summary of Evaluation Criteria	**Alternative is Not Selected.** Although alternative is likely to be protective of human health and the environment and may be acceptable to DTSC and the community, it is not the most cost-effective alternative. The COCs remain in place, and ongoing monitoring to verify protection of human health is estimated to extend 15 years.	**Alternative is Not Selected.** Although alternative is likely to be protective of human health and the environment and may be acceptable to DTSC and the community, it is not the most cost-effective alternative. The COCs remain in place, and ongoing monitoring to verify protection of human health is estimated to extend 15 years.

TABLE 10-14

COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES:

VOCs IN GROUNDWATER NEAR BUILDING 99

Oakland Army Base, Oakland, California

	Evaluation Criteria	Alternative 1 No Action for Soil and Groundwater	Alternative 2 Monitor Groundwater	Alternative 3 Perform In-situ Biodegradation and Monitor Groundwater
Threshold Criteria	• Overall Protection of Human Health and the Environment	Alternative is not anticipated to be protective of human health or the environment.	Alternative may be protective of human health and environment.	Alternative is anticipated to be protective of human health and environment.
Threshold Criteria	• Compliance with ARARs	Alternative is not anticipated to comply with ARARs.	Alternative is expected to comply with ARARs.	Alternative is expected to comply with ARARs.
Balancing Criteria	• Long-term Effectiveness and Permanence	Alternative will not offer long-term protection against exposure of humans and ecological receptors to chemicals of concern ("COCs") in groundwater.	Alternative does not offer long-term effectiveness as chemical concentrations may continue to remain elevated or increase over time. Alternative assumes 15 years of groundwater monitoring.	Alternative is anticipated to offer long-term effectiveness as COCs will be biologically degraded in the subsurface. Five years of groundwater monitoring will verify long-term effectiveness.
Balancing Criteria	• Reduction of Toxicity, Mobility, or Volume through Treatment	Alternative will not reduce toxicity, mobility, or volume of COCs.	Alternative will not reduce toxicity, mobility, or volume of COCs.	Alternative could reduce toxicity, mobility, and volume of COCs by treatment that degrades COCs in groundwater.

TABLE 10-14

COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES:

VOCs IN GROUNDWATER NEAR BUILDING 99

Oakland Army Base, Oakland, California

	Evaluation Criteria	Alternative 4 Install Vapor Barrier Beneath Building and Monitor Groundwater	Alternative 5 Install Vapor Barrier with Sub-slab Depressurization System, Monitor Groundwater
Threshold Criteria	• Overall Protection of Human Health and the Environment	Alternative is anticipated to be protective of human health and environment.	Alternative is anticipated to be protective of human health and environment.
Threshold Criteria	• Compliance with ARARs	Alternative is expected to comply with ARARs.	Alternative is expected to comply with ARARs.
Balancing Criteria	• Long-term Effectiveness and Permanence	Long-term effectiveness is a function of the effectiveness of the barrier beneath the building. Impacted groundwater remains in the subsurface and could potentially migrate. Fifteen years of groundwater monitoring will verify long-term effectiveness.	Long-term effectiveness is a function of the effectiveness of the barrier beneath the building and the ability of the depressurization system to limit migration into buildings. Impacted groundwater remains in the subsurface and could potentially migrate. Fifteen years of groundwater monitoring will verify long-term effectiveness.
Balancing Criteria	• Reduction of Toxicity, Mobility, or Volume through Treatment	Alternative will not reduce toxicity or volume of COCs in groundwater, but it may decrease mobility by volatilization pathways by providing subsurface containment.	Alternative will not reduce toxicity or volume of COCs in groundwater. Mobility of COCs is increased by transferring COCs from groundwater to air. Exhaust air treatment system is not anticipated to be required.

TABLE 10-14

COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES:

VOCs IN GROUNDWATER NEAR BUILDING 99

Oakland Army Base, Oakland, California

	Evaluation Criteria	Alternative 1 No Action for Soil and Groundwater	Alternative 2 Monitor Groundwater	Alternative 3 Perform In-situ Biodegradation and Monitor Groundwater
Balancing Criteria	• Short-term Effectiveness	Alternative is not anticipated to result in any short-term disruptions or risks to workers and the community.	Alternative is not anticipated to result in any short-term disruptions or risks to workers and the community.	Alternative is not anticipated to result in significant short-term disruptions or risks to workers and the community.
	• Implementability	Alternative can be easily implemented.	Alternative can be implemented, as it involves standard groundwater monitoring procedures.	Alternative can be implemented, as it involves standard chemical injection procedures and monitoring.
	• Cost Estimated Capital Cost: Estimated Annual Cost: Estimated Present Worth:	Alternative has negligible costs associated with implementation.	$82,000 $39,000 $540,000	$320,000 $39,000 $500,000
Modifying Criteria	• State Acceptance	State of California Environmental Protection Agency, Department of Toxic Substances Control ("DTSC") is not anticipated to accept alternative.	DTSC may not accept remedial action if exposure to volatile COCs could potentially occur in future land use scenarios.	It is expected that DTSC will consider this alternative to be acceptable.
	• Community Acceptance	Alternative is not anticipated to be accepted by community members of the Restoration Advisory Board ("RAB") and the community at large.	RAB and community may not accept remedial action if exposure to volatile COCs could potentially occur in future land use scenarios.	Alternative is likely to be an acceptable alternative to the RAB and community.

TABLE 10-14

COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES:

VOCs IN GROUNDWATER NEAR BUILDING 99

Oakland Army Base, Oakland, California

	Evaluation Criteria	Alternative 4 Install Vapor Barrier Beneath Building and Monitor Groundwater	Alternative 5 Install Vapor Barrier with Sub-slab Depressurization System, Monitor Groundwater
Balancing Criteria	• Short-term Effectiveness	Alternative is not anticipated to result in any short-term disruptions or risks to workers and the community. Vapor barrier would be installed during building construction.	Alternative is not anticipated to result in any short-term disruptions or risks to workers and the community. Sub-slab depressurization system would be installed during building construction.
	• Implementability	This alternative can be easily implemented during building construction. Implementation post construction is difficult.	This alternative can be easily implemented during building construction. Implementation post construction is difficult.
	• Cost Estimated Capital Cost: Estimated Annual Cost: Estimated Present Worth:	 $230,000 $39,000 $690,000	 $480,000 $43,000 $1,000,000
Modifying Criteria	• State Acceptance	It is expected that DTSC will consider this alternative to be acceptable.	It is expected that DTSC will consider this alternative to be acceptable.
	• Community Acceptance	Alternative is likely to be an acceptable alternative to the RAB and community.	Alternative is likely to be an acceptable alternative to the RAB and community.

TABLE 10-14

COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES:

VOCs IN GROUNDWATER NEAR BUILDING 99

Oakland Army Base, Oakland, California

Evaluation Criteria	Alternative 1 No Action for Soil and Groundwater	Alternative 2 Monitor Groundwater	Alternative 3 Perform In-situ Biodegradation and Monitor Groundwater
• Six Factors from State of California Health and Safety Code Section 25356.1	Alternative does not comply with State of California Health and Safety Code Criteria.	Alternative is believed to comply with State of California Health and Safety Code Criteria.	Alternative is believed to comply with State of California Health and Safety Code Criteria.
• Summary of Evaluation Criteria	**Alternative is Not Selected.** Alternative is not protective of human health and the environment, and does not comply with ARARs.	**Alternative is Not Selected.** Alternative does not limit potential exposure to volatile COCs in potential future land use.	**Selected Alternative.** COCs in groundwater are actively remediated. Groundwater treatment could effectively reduce potential human health impacts. Remedial action is anticipated to be complete in 5 years.

TABLE 10-14

COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES:

VOCs IN GROUNDWATER NEAR BUILDING 99

Oakland Army Base, Oakland, California

Evaluation Criteria	Alternative 4 Install Vapor Barrier Beneath Building and Monitor Groundwater	Alternative 5 Install Vapor Barrier with Sub-slab Depressurization System, Monitor Groundwater
• Six Factors from State of California Health and Safety Code Section 25356.1	Alternative is believed to comply with State of California Health and Safety Code Criteria.	Alternative is believed to comply with State of California Health and Safety Code Criteria.
• Summary of Evaluation Criteria	**Alternative is Not Selected.** Although alternative is likely to be protective of human health and the environment and is acceptable to DTSC and the community, it is not the most cost-effective alternative. The COCs remain in place, and ongoing monitoring to verify protection of human health is estimated to extend 15 years.	**Alternative is Not Selected.** Although alternative is likely to be protective of human health and the environment and is acceptable to DTSC and the community, it is not the most cost-effective alternative. The COCs remain in place, and ongoing monitoring to verify protection of human health is estimated to extend 15 years.

TABLE 10-15
COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES:
BENZENE AND MTBE IN GROUNDWATER NEAR FORMER USTs 11A/12A/13A
Oakland Army Base, Oakland, California

	Evaluation Criteria	Alternative 1 No Action for Soil and Groundwater	Alternative 2 Excavate and Dispose Soil Off-site, and Monitor Groundwater	Alternative 3 Excavate and Dispose Soil Off-site, In-situ Groundwater Treatment, and Monitor Groundwater
Threshold Criteria	• Overall Protection of Human Health and the Environment	Alternative is not anticipated to be protective of human health and the environment.	Alternative is anticipated to be protective of human health and the environment.	Alternative is anticipated to be protective of human health and the environment.
	• Compliance with ARARs	Alternative is not anticipated to comply with ARARs.	Alternative is anticipated to comply with ARARs.	Alternative is anticipated to comply with ARARs.
Balancing Criteria	• Long-term Effectiveness and Permanence	Alternative will not offer long-term protection against exposure of humans to chemicals of concern ("COCs") in soil or groundwater.	Alternative offers long-term effectiveness as soil with elevated concentrations of COCs will be disposed off-site. Alternative assumes 5 years of groundwater monitoring.	Alternative offers long-term effectiveness as soil with elevated concentrations of COCs will be removed, and residual COCs will be biologically degraded. subsurface. Alternative assumes 5 years of groundwater monitoring.
	• Reduction of Toxicity, Mobility, or Volume through Treatment	Alternative will not reduce toxicity, mobility, or volume of impacted soil or groundwater.	Alternative will not reduce toxicity of COCs in subsurface, but will reduce volume and mobility by removal to off-site permitted disposal facility.	Alternative will likely reduce toxicity, mobility, and volume of impacted soil and groundwater through removal and in-situ treatment.
	• Short-term Effectiveness	Alternative is not anticipated to result in any short-term disruptions or risks to workers and the community.	Alternative is not anticipated to result in significant short-term disruptions or risks to workers and the community, other than minor soil excavation activities.	Alternative is not anticipated to result in significant short-term disruptions or risks to workers and the community, other than minor soil excavation activities.

TABLE 10-15
COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES:
BENZENE AND MTBE IN GROUNDWATER NEAR FORMER USTs 11A/12A/13A
Oakland Army Base, Oakland, California

	Evaluation Criteria	Alternative 1 No Action for Soil and Groundwater	Alternative 2 Excavate and Dispose Soil Off-site, and Monitor Groundwater	Alternative 3 Excavate and Dispose Soil Off-site, In-situ Groundwater Treatment, and Monitor Groundwater
Balancing Criteria	• Implementability	Alternative is easily implemented.	Alternative can be implemented, as it involves standard soil excavation procedures.	Alternative can be implemented, as it involves standard soil excavation and chemical injection procedures.
	• Cost Estimated Capital Cost: Estimated Annual Cost: Estimated Present Worth:	Alternative has negligible costs associated with implementation.	$220,000 $42,000 $410,000	$270,000 $42,000 $460,000
Modifying Criteria	• State Acceptance	State of California Environmental Protection Agency, Department of Toxic Substances Control ("DTSC") is not anticipated to accept alternative.	DTSC is anticipated to accept remedial action because alternative is protective of human health and complies with ARARs.	DTSC is anticipated to accept remedial action because alternative is protective of human health and complies with ARARs.
	• Community Acceptance	Alternative is not likely to be accepted by community members of the Restoration Advisory Board ("RAB") and the community at large.	Alternative is anticipated to be accepted by the RAB and the community at large.	Alternative is anticipated to be accepted by the RAB and the community at large.
• Six Factors from State of California Health and Safety Code Section 25356.1		Alternative does not comply with State of California Health and Safety Code Criteria.	Alternative is believed to comply with State of California Health and Safety Code Criteria.	Alternative is believed to comply with State of California Health and Safety Code Criteria.
• Summary of Evaluation Criteria		**Alternative is Not Selected.** Alternative is not protective of human health and the environment, and does not comply with ARARs.	**Alternative is Not Selected.** Although excavation will remove COCs i removed, COCs would likely remain in groundwater.	**Selected Alternative.** COCs in soil and groundwater greater than applicable site-specific remedial goals will be removed or treated.

TABLE 10-16
COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES:
BUILDING 991 AREA
Oakland Army Base, Oakland, California

	Evaluation Criteria	Alternative 1 No Action for Soil and Groundwater	Alternative 2 Excavate and Dispose Soil Off-site, and Monitor Groundwater	Alternative 3 Excavate and Dispose Soil Off-site, In-situ Groundwater Treatment, and Monitor Groundwater
Threshold Criteria	• Overall Protection of Human Health and the Environment	Alternative is not anticipated to be protective of human health and the environment.	Alternative is anticipated to be protective of human health and the environment.	Alternative is anticipated to be protective of human health and the environment.
	• Compliance with ARARs	Alternative is not anticipated to comply with ARARs.	Alternative is anticipated to comply with ARARs.	Alternative is anticipated to comply with ARARs.
Balancing Criteria	• Long-term Effectiveness and Permanence	Alternative will not offer long-term protection against exposure of humans to chemicals of concern ("COCs") in soil or groundwater.	Alternative offers long-term effectiveness as soil with elevated concentrations of COCs will be disposed off-site. Alternative assumes 5 years of groundwater monitoring.	Alternative offers long-term effectiveness as soil with elevated concentrations of COCs will be removed, and residual COCs will be biologically degraded. subsurface. Alternative assumes 5 years of groundwater monitoring.
	• Reduction of Toxicity, Mobility, or Volume through Treatment	Alternative will not reduce toxicity, mobility, or volume of impacted soil or groundwater.	Alternative will not reduce toxicity of COCs in subsurface, but will reduce volume and mobility by removal to off-site permitted disposal facility.	Alternative will likely reduce toxicity, mobility, and volume of impacted soil and groundwater through removal and in-situ treatment.
	• Short-term Effectiveness	Alternative is not anticipated to result in any short-term disruptions or risks to workers and the community.	Alternative is not anticipated to result in significant short-term disruptions or risks to workers and the community, other than minor soil excavation activities.	Alternative is not anticipated to result in significant short-term disruptions or risks to workers and the community, other than minor soil excavation activities.

TABLE 10-16
COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES:
BUILDING 991 AREA
Oakland Army Base, Oakland, California

	Evaluation Criteria	Alternative 1 No Action for Soil and Groundwater	Alternative 2 Excavate and Dispose Soil Off-site, and Monitor Groundwater	Alternative 3 Excavate and Dispose Soil Off-site, In-situ Groundwater Treatment, and Monitor Groundwater
Balancing Criteria	• Implementability	Alternative is easily implemented.	Alternative can be implemented, as it involves standard soil excavation procedures.	Alternative can be implemented, as it involves standard soil excavation and chemical injection procedures.
Balancing Criteria	• Cost Estimated Capital Cost: Estimated Annual Cost: Estimated Present Worth:	Alternative has negligible costs associated with implementation.	$270,000 $38,000 $440,000	$470,000 $47,000 $680,000
Modifying Criteria	• State Acceptance	State of California Environmental Protection Agency, Department of Toxic Substances Control ("DTSC") is not anticipated to accept alternative.	DTSC is anticipated to accept remedial action because alternative is protective of human health and complies with ARARs.	DTSC is anticipated to accept remedial action because alternative is protective of human health and complies with ARARs.
Modifying Criteria	• Community Acceptance	Alternative is not likely to be accepted by community members of the Restoration Advisory Board ("RAB") and the community at large.	Alternative is anticipated to be accepted by the RAB and the community at large.	Alternative is anticipated to be accepted by the RAB and the community at large.
• Six Factors from State of California Health and Safety Code Section 25356.1		Alternative does not comply with State of California Health and Safety Code Criteria.	Alternative is believed to comply with State of California Health and Safety Code Criteria.	Alternative is believed to comply with State of California Health and Safety Code Criteria.
• Summary of Evaluation Criteria		**Alternative is Not Selected.** Alternative is not protective of human health and the environment, and does not comply with ARARs.	**Alternative is Not Selected.** Although excavation will remove COCs i removed, COCs would likely remain in groundwater.	**Selected Alternative.** COCs in soil and groundwater greater than applicable site-specific remedial goals will be removed or treated.

TABLE 10-17
COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES:
BUILDING 99
Oakland Army Base, Oakland, California

	Evaluation Criteria	Alternative 1 No Action for Soil and Groundwater	Alternative 2 Excavate and Dispose Soil Off-site, and Monitor Groundwater As Needed	
			2a. No Impacted Soil or Groundwater Identified	2b. Excavate and Dispose Impacted Soil Off-site
Threshold Criteria	• Overall Protection of Human Health and the Environment	Alternative is not protective of human health and the environment.	Alternative is anticipated to be protective of human health and the environment.	Alternative is anticipated to be protective of human health and the environment.
	• Compliance with ARARs	Alternative is not anticipated to comply with ARARs.	Alternative is anticipated to comply with ARARs.	Alternative is anticipated to comply with ARARs.
Balancing Criteria	• Long-term Effectiveness and Permanence	Alternative will not offer long-term protection against exposure of humans to chemicals of concern ("COCs") in soil.	Alternative may offer long-term effectiveness.	Alternative offers long-term effectiveness as impacted soil will be excavated and disposed off-site. Removal also reduces potential for future groundwater impact.
	• Reduction of Toxicity, Mobility, or Volume through Treatment	Alternative will not reduce toxicity, mobility, or volume of impacted soil.	Alternative assumes no COCs greater than applicable remedial goals remain in the subsurface.	Alternative will not reduce toxicity of COCs in soil, if present, but will decrease on-site volume and mobility of COCs in soil by removal to a permitted off-site disposal facility.
	• Short-term Effectiveness	Alternative is not anticipated to result in any short-term disruptions or risks to workers and the community.	Alternative is not anticipated to result in any short-term disruptions or risks to workers and the community.	Alternative is not anticipated to result in significant short-term disruptions or risks to workers and the community, other than minor soil excavation activities.

TABLE 10-17
COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES:
BUILDING 99
Oakland Army Base, Oakland, California

	Evaluation Criteria	Alternative 1 No Action for Soil and Groundwater	Alternative 2 Excavate and Dispose Soil Off-site, and Monitor Groundwater As Needed 2a. No Impacted Soil or Groundwater Identified	Alternative 2 Excavate and Dispose Soil Off-site, and Monitor Groundwater As Needed 2b. Excavate and Dispose Impacted Soil Off-site
Balancing Criteria	• Implementability	Alternative is easily implemented.	Alternative is easily implemented.	Alternative can be implemented, as it involves standard soil excavation procedures.
Balancing Criteria	• Cost Estimated Capital Cost: Estimated Annual Cost: Estimated Present Worth:	Alternative has negligible costs associated with implementation.	$70,000 $0 $70,000	$230,000 $0 $230,000
Modifying Criteria	• State Acceptance	State of California Environmental Protection Agency, Department of Toxic Substances Control ("DTSC") is not anticipated to accept alternative.	DTSC is anticipated to accept remedial action because alternative is protective of human health and complies with ARARs.	DTSC is anticipated to accept remedial action because alternative is protective of human health and complies with ARARs.
Modifying Criteria	• Community Acceptance	Alternative is not likely to be accepted by community members of the Restoration Advisory Board ("RAB") and the community at large.	Alternative is anticipated to be accepted by the RAB and the community at large.	Alternative is anticipated to be accepted by the RAB and the community at large.
	• Six Factors from State of California Health and Safety Code Section 25356.1	Alternative does not comply with State of California Health and Safety Code Criteria.	Alternative is believed to comply with State of California Health and Safety Code Criteria.	Alternative is believed to comply with State of California Health and Safety Code Criteria.
	• Summary of Evaluation Criteria	**Alternative is Not Selected.** Alternative is not protective of human health and the environment, and does not comply with ARARs.	**Alternative is Not Selected.** If no COCs are detected at concentrations greater than site-specific remedial goals, this alternative may be appropriate.	**Selected Alternative.** COCs identified above site-specific remedial goals soil would be removed.

TABLE 10-18
COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES:
WASHRACKS, SUMPS, OIL/WATER SEPARATORS, AND MISCELLANEOUS OPERATIONS
Oakland Army Base, Oakland, California

	Evaluation Criteria	Alternative 1 No Action for Soil and Groundwater	Alternative 2 Excavate and Dispose Soil Off-site, and Monitor Groundwater As Needed 2a. No Impacted Soil or Groundwater Identified	Alternative 2 Excavate and Dispose Soil Off-site, and Monitor Groundwater As Needed 2b. Excavate and Dispose Impacted Soil Off-site
Threshold Criteria	• Overall Protection of Human Health and the Environment	Alternative is not protective of human health and the environment.	Alternative is anticipated to be protective of human health and the environment.	Alternative is anticipated to be protective of human health and the environment.
Threshold Criteria	• Compliance with ARARs	Alternative is not anticipated to comply with ARARs.	Alternative is anticipated to comply with ARARs.	Alternative is anticipated to comply with ARARs.
Balancing Criteria	• Long-term Effectiveness and Permanence	Alternative may not offer long-term protection against exposure of humans to chemicals of concern ("COCs") in soil, if present.	Alternative may offer long-term effectiveness.	Alternative offers long-term effectiveness as impacted soil will be excavated and disposed off-site. Removal also reduces potential for future groundwater impact.
Balancing Criteria	• Reduction of Toxicity, Mobility, or Volume through Treatment	Alternative will not reduce toxicity, mobility, or volume of impacted soil, if present.	Alternative assumes no COCs greater than applicable remedial goals remain in the subsurface.	Alternative will not reduce toxicity of COCs in soil, if present, but will decrease on-site volume and mobility of COCs in soil by removal to a permitted off-site disposal facility.
Balancing Criteria	• Short-term Effectiveness	Alternative is not anticipated to result in any short-term disruptions or risks to workers and the community.	Alternative is not anticipated to result in any short-term disruptions or risks to workers and the community.	Alternative is not anticipated to result in significant short-term disruptions or risks to workers and the community, other than minor soil excavation activities.

TABLE 10-18
COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES:
WASHRACKS, SUMPS, OIL/WATER SEPARATORS, AND MISCELLANEOUS OPERATIONS
Oakland Army Base, Oakland, California

	Evaluation Criteria	Alternative 1 No Action for Soil and Groundwater	Alternative 2 Excavate and Dispose Soil Off-site, and Monitor Groundwater As Needed	
			2a. No Impacted Soil or Groundwater Identified	2b. Excavate and Dispose Impacted Soil Off-site
Balancing Criteria	• Implementability	Alternative is easily implemented.	Alternative is easily implemented.	Alternative is easily implemented with standard excavation procedures.
Balancing Criteria	• Cost (a) Estimated Capital Cost: Estimated Annual Cost: Estimated Present Worth:	Alternative has negligible costs associated with implementation.	$890,000 $0 $890,000	$2,300,000 $0 $2,300,000
Modifying Criteria	• State Acceptance	State of California Environmental Protection Agency, Department of Toxic Substances Control ("DTSC") is not anticipated to accept alternative.	DTSC is anticipated to accept remedial action because alternative is protective of human health and complies with ARARs.	DTSC is anticipated to accept remedial action because alternative is protective of human health and complies with ARARs.
Modifying Criteria	• Community Acceptance	Alternative is not likely to be accepted by community members of the Restoration Advisory Board ("RAB") and the community at large.	Alternative is anticipated to be accepted by the RAB and the community at large.	Alternative is anticipated to be accepted by the RAB and the community at large.
	• Six Factors from State of California Health and Safety Code Section 25356.1	Alternative does not comply with State of California Health and Safety Code Criteria.	Alternative is believed to comply with State of California Health and Safety Code Criteria.	Alternative is believed to comply with State of California Health and Safety Code Criteria.
	• Summary of Evaluation Criteria	**Alternative is Not Selected.** Alternative is not protective of human health and the environment, and does not comply with ARARs.	**Alternative is Not Selected.** If no COCs are detected at concentrations greater than site-specific remedial goals, this alternative may be appropriate.	**Selected Alternative.** COCs identified above site-specific remedial goals soil would be removed.

Notes:

(a) Costs listed are cumulative expenditures to address approximately 82 washracks, sumps, oil/water separators, and miscellaneous items at approximately 55 locations on the OARB.

TABLE 10-19
COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES:
TANKS
Oakland Army Base, Oakland, California

	Evaluation Criteria	Alternative 1 No Action for Soil and Groundwater	Alternative 2 Excavate and Dispose Soil Off-site, and Monitor Groundwater As Needed 2a. No Impacted Soil or Groundwater Identified	2b. Excavate and Dispose Soil Off-site	2c. Excavate and Dispose Soil Off-site, and Monitor Groundwater
Threshold Criteria	● Overall Protection of Human Health and the Environment	Alternative is not protective of human health and the environment.	Alternative is anticipated to be protective of human health and the environment.	Alternative is anticipated to be protective of human health and the environment.	Alternative is anticipated to be protective of human health and the environment.
	● Compliance with ARARs	Alternative is not anticipated to comply with ARARs.	Alternative is anticipated to comply with ARARs.	Alternative is anticipated to comply with ARARs.	Alternative is anticipated to comply with ARARs.
Balancing Criteria	● Long-term Effectiveness and Permanence	Alternative will not offer long-term protection against exposure of humans to chemicals of concern ("COCs") in soil.	Alternative may offer long-term effectiveness.	Alternative offers long-term effectiveness as impacted soil will be excavated and disposed off-site. Removal also reduces potential for future groundwater impact.	Alternative offers long-term effectiveness as impacted soil will be excavated and disposed off-site. Removal also reduces potential for future groundwater impact. Alternative assumes 5 years of groundwater monitoring for some sites.
	● Reduction of Toxicity, Mobility, or Volume through Treatment	Alternative will not reduce toxicity, mobility, or volume of impacted soil, if present.	Alternative assumes no COCs greater than applicable remedial goals remain in the subsurface.	Alternative will not reduce toxicity of COCs in soil, if present, but will decrease on-site volume and mobility of COCs in soil by removal to a permitted off-site disposal facility.	Alternative will not reduce toxicity of COCs in soil, if present, but will decrease on-site volume and mobility of COCs in soil by removal to a permitted off-site disposal facility.
	● Short-term Effectiveness	Alternative is not anticipated to result in any short-term disruptions or risks to workers and the community.	Alternative is not anticipated to result in any short-term disruptions or risks to workers and the community.	Alternative is not anticipated to result in significant short-term disruptions or risks to workers and the community, other than minor soil excavation activities.	Alternative is not anticipated to result in significant short-term disruptions or risks to workers and the community, other than minor soil excavation activities.

TABLE 10-19
COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES:
TANKS

Oakland Army Base, Oakland, California

	Evaluation Criteria	Alternative 1 No Action for Soil and Groundwater	Alternative 2 Excavate and Dispose Soil Off-site, and Monitor Groundwater As Needed		
			2a. No Impacted Soil or Groundwater Identified	2b. Excavate and Dispose Soil Off-site	2c. Excavate and Dispose Soil Off-site, and Monitor Groundwater
Balancing Criteria	• Implementability	Alternative is easily implemented.	Alternative is easily implemented.	Alternative can be implemented, as it involves standard soil excavation procedures.	Alternative can be implemented, as it involves standard soil excavation procedures.
Balancing Criteria	• Cost (a) Estimated Capital Cost: Estimated Annual Cost: Estimated Present Worth:	Alternative has negligible costs associated with implementation.	$740,000 $0 $740,000	$1,580,000 $0 $1,600,000	$1,620,000 $115,000 $2,100,000
Modifying Criteria	• State Acceptance	State of California Environmental Protection Agency, Department of Toxic Substances Control ("DTSC") is not anticipated to accept alternative.	DTSC is anticipated to accept remedial action because alternative is protective of human health and complies with ARARs.	DTSC is anticipated to accept remedial action because alternative is protective of human health and complies with ARARs.	DTSC is anticipated to accept remedial action because alternative is protective of human health and complies with ARARs.
Modifying Criteria	• Community Acceptance	Alternative is not likely to be accepted by community members of the Restoration Advisory Board ("RAB") and the community at large.	Alternative is anticipated to be accepted by the RAB and the community at large.	Alternative is anticipated to be accepted by the RAB and the community at large.	Alternative is anticipated to be accepted by the RAB and the community at large.
• Six Factors from State of California Health and Safety Code Section 25356.1		Alternative does not comply with State of California Health and Safety Code Criteria.	Alternative is believed to comply with State of California Health and Safety Code Criteria.	Alternative is believed to comply with State of California Health and Safety Code Criteria.	Alternative is believed to comply with State of California Health and Safety Code Criteria.
• Summary of Evaluation Criteria		**Alternative is Not Selected.** Alternative is not protective of human health and the environment, and does not comply with ARARs.	**Alternative is Not Selected.** If no COCs are detected at concentrations greater than site-specific remedial goals, this alternative may be appropriate at some locations.	**Alternative is Not Selected.** COCs identified above site-specific remedial goals soil would be removed. Groundwater monitoring is anticipated to be required at some sites.	**Selected Alternative.** COCs identified above site-specific remedial goals soil would be removed. Groundwater monitoring will be conducted at some sites to verify remedial objectives attained.

Notes:

(a) Costs listed are cumulative expenditures to address approximately 93 underground storage tanks and aboveground storage tanks at approximately 73 locations on the OARB.

TABLE 10-20
COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES:
DEBRIS AREA NEAR BUILDING 99
Oakland Army Base, Oakland, California

	Evaluation Criteria	Alternative 1 No Action for Soil and Groundwater	Alternative 2 Excavate and Dispose Soil Off-site, and Monitor Groundwater As Needed 2a. No Impacted Soil or Groundwater Identified	Alternative 2 Excavate and Dispose Soil Off-site, and Monitor Groundwater As Needed 2b. Excavate and Dispose Impacted Soil Off-site
Threshold Criteria	• Overall Protection of Human Health and the Environment	Alternative is not anticipated to be protective of human health and the environment.	Alternative is anticipated to be protective of human health and the environment.	Alternative is anticipated to be protective of human health and the environment.
Threshold Criteria	• Compliance with ARARs	Alternative is not anticipated to comply with ARARs.	Alternative is anticipated to comply with ARARs.	Alternative is anticipated to comply with ARARs.
Balancing Criteria	• Long-term Effectiveness and Permanence	Alternative will not offer long-term protection against exposure of humans to chemicals of concern ("COCs") in soil.	Alternative may offer long-term effectiveness.	Alternative offers long-term effectiveness as impacted soil will be excavated and disposed off-site.
Balancing Criteria	• Reduction of Toxicity, Mobility, or Volume through Treatment	Alternative will not reduce toxicity, mobility, or volume of impacted soil.	Alternative assumes no COCs greater than applicable remedial goals remain in the subsurface.	Alternative will not reduce toxicity of COCs in soil, if present, but will decrease on-site volume and mobility of COCs in soil by removal to a permitted off-site disposal facility.
Balancing Criteria	• Short-term Effectiveness	Alternative is not anticipated to result in any short-term disruptions or risks to workers and the community.	Alternative is not anticipated to result in any short-term disruptions or risks to workers and the community.	Alternative is not anticipated to result in significant short-term disruptions or risks to workers and the community, other than minor soil excavation activities.

TABLE 10-20
COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES:
DEBRIS AREA NEAR BUILDING 99
Oakland Army Base, Oakland, California

	Evaluation Criteria	Alternative 1 No Action for Soil and Groundwater	Alternative 2 Excavate and Dispose Soil Off-site, and Monitor Groundwater As Needed 2a. No Impacted Soil or Groundwater Identified	Alternative 2 Excavate and Dispose Soil Off-site, and Monitor Groundwater As Needed 2b. Excavate and Dispose Impacted Soil Off-site
Balancing Criteria	• Implementability	Alternative is easily implemented.	Alternative is easily implemented.	Alternative is easily implemented with standard excavation procedures.
Balancing Criteria	• Cost Estimated Capital Cost: Estimated Annual Cost: Estimated Present Worth:	Alternative has negligible costs associated with implementation.	$56,000 $0 $56,000	$170,000 $0 $170,000
Modifying Criteria	• State Acceptance	State of California Environmental Protection Agency, Department of Toxic Substances Control ("DTSC") is not anticipated to accept alternative.	DTSC is anticipated to accept remedial action because alternative is protective of human health and complies with ARARs.	DTSC is anticipated to accept remedial action because alternative is protective of human health and complies with ARARs.
Modifying Criteria	• Community Acceptance	Alternative is not likely to be accepted by community members of the Restoration Advisory Board ("RAB") and the community at large.	Alternative is anticipated to be accepted by the RAB and the community at large.	Alternative is anticipated to be accepted by the RAB and the community at large.
	• Six Factors from State of California Health and Safety Code Section 25356.1	Alternative does not comply with State of California Health and Safety Code Criteria.	Alternative is believed to comply with State of California Health and Safety Code Criteria.	Alternative is believed to comply with State of California Health and Safety Code Criteria.
	• Summary of Evaluation Criteria	**Alternative is Not Selected.** Alternative is not protective of human health and the environment, and does not comply with ARARs.	**Alternative is Not Selected.** If no COCs are detected at concentrations greater than site-specific remedial goals, this alternative may be appropriate.	**Selected Alternative.** COCs identified above site-specific remedial goals soil would be removed.

TABLE 10-21
COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES:
BUILDING 85
Oakland Army Base, Oakland, California

	Evaluation Criteria	Alternative 1 No Action for Soil and Groundwater	Alternative 2 Excavate and Dispose Soil Off-site, and Monitor Groundwater As Needed	
			2a. No Impacted Soil or Groundwater Identified	2b. Excavate and Dispose Impacted Soil Off-site
Threshold Criteria	• Overall Protection of Human Health and the Environment	Alternative is not anticipated to be protective of human health and the environment.	Alternative is anticipated to be protective of human health and the environment.	Alternative is anticipated to be protective of human health and the environment.
	• Compliance with ARARs	Alternative is not anticipated to comply with ARARs.	Alternative is anticipated to comply with ARARs.	Alternative is anticipated to comply with ARARs.
Balancing Criteria	• Long-term Effectiveness and Permanence	Alternative will not offer long-term protection against exposure of humans to chemicals of concern ("COCs") in soil.	Alternative may offer long-term effectiveness.	Alternative offers long-term effectiveness as impacted soil will be excavated and disposed off-site.
	• Reduction of Toxicity, Mobility, or Volume through Treatment	Alternative will not reduce toxicity, mobility, or volume of impacted soil.	Alternative assumes no COCs greater than applicable remedial goals remain in the subsurface.	Alternative will not reduce toxicity of COCs in soil, if present, but will decrease on-site volume and mobility of COCs in soil by removal to a permitted off-site disposal facility.
	• Short-term Effectiveness	Alternative is not anticipated to result in any short-term disruptions or risks to workers and the community.	Alternative is not anticipated to result in any short-term disruptions or risks to workers and the community.	Alternative is not anticipated to result in significant short-term disruptions or risks to workers and the community, other than minor soil excavation activities.

TABLE 10-21
COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES:
BUILDING 85
Oakland Army Base, Oakland, California

	Evaluation Criteria	Alternative 1 No Action for Soil and Groundwater	Alternative 2 Excavate and Dispose Soil Off-site, and Monitor Groundwater As Needed 2a. No Impacted Soil or Groundwater Identified	2b. Excavate and Dispose Impacted Soil Off-site
Balancing Criteria	• Implementability	Alternative is easily implemented.	Alternative is easily implemented.	Alternative is easily implemented with standard excavation procedures.
Balancing Criteria	• Cost Estimated Capital Cost: Estimated Annual Cost: Estimated Present Worth:	Alternative has negligible costs associated with implementation.	$56,000 $0 $56,000	$140,000 $0 $140,000
Modifying Criteria	• State Acceptance	State of California Environmental Protection Agency, Department of Toxic Substances Control ("DTSC") is not anticipated to accept alternative.	DTSC is anticipated to accept remedial action because alternative is protective of human health and complies with ARARs.	DTSC is anticipated to accept remedial action because alternative is protective of human health and complies with ARARs.
Modifying Criteria	• Community Acceptance	Alternative is not likely to be accepted by community members of the Restoration Advisory Board ("RAB") and the community at large.	Alternative is anticipated to be accepted by the RAB and the community at large.	Alternative is anticipated to be accepted by the RAB and the community at large.
	• Six Factors from State of California Health and Safety Code Section 25356.1	Alternative does not comply with State of California Health and Safety Code Criteria.	Alternative is believed to comply with State of California Health and Safety Code Criteria.	Alternative is believed to comply with State of California Health and Safety Code Criteria.
	• Summary of Evaluation Criteria	**Alternative is Not Selected.** Alternative is not protective of human health and the environment, and does not comply with ARARs.	**Alternative is Not Selected.** If no COCs are detected at concentrations greater than site-specific remedial goals, this alternative may be appropriate.	**Selected Alternative.** COCs identified above site-specific remedial goals soil would be removed.

TABLE 10-22
COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES:
BUILDING 812
Oakland Army Base, Oakland, California

	Evaluation Criteria	Alternative 1 No Action for Soil and Groundwater	Alternative 2 Excavate and Dispose Soil Off-site, and Monitor Groundwater As Needed 2a. No Impacted Soil or Groundwater Identified	Alternative 2 Excavate and Dispose Soil Off-site, and Monitor Groundwater As Needed 2b. Excavate and Dispose Impacted Soil Off-site
Threshold Criteria	• Overall Protection of Human Health and the Environment	Alternative is not anticipated to be protective of human health and the environment.	Alternative is anticipated to be protective of human health and the environment.	Alternative is anticipated to be protective of human health and the environment.
Threshold Criteria	• Compliance with ARARs	Alternative is not anticipated to comply with ARARs.	Alternative is anticipated to comply with ARARs.	Alternative is anticipated to comply with ARARs.
Balancing Criteria	• Long-term Effectiveness and Permanence	Alternative will not offer long-term protection against exposure of humans to chemicals of concern ("COCs") in soil.	Alternative may offer long-term effectiveness.	Alternative offers long-term effectiveness as impacted soil will be excavated and disposed off-site.
Balancing Criteria	• Reduction of Toxicity, Mobility, or Volume through Treatment	Alternative will not reduce toxicity, mobility, or volume of impacted soil.	Alternative assumes no COCs greater than applicable remedial goals remain in the subsurface.	Alternative will not reduce toxicity of COCs in soil, if present, but will decrease on-site volume and mobility of COCs in soil by removal to a permitted off-site disposal facility.
Balancing Criteria	• Short-term Effectiveness	Alternative is not anticipated to result in any short-term disruptions or risks to workers and the community.	Alternative is not anticipated to result in any short-term disruptions or risks to workers and the community.	Alternative is not anticipated to result in significant short-term disruptions or risks to workers and the community, other than minor soil excavation activities.

TABLE 10-22
COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES:
BUILDING 812
Oakland Army Base, Oakland, California

	Evaluation Criteria	Alternative 1 No Action for Soil and Groundwater	Alternative 2 Excavate and Dispose Soil Off-site, and Monitor Groundwater As Needed 2a. No Impacted Soil or Groundwater Identified	Alternative 2 Excavate and Dispose Soil Off-site, and Monitor Groundwater As Needed 2b. Excavate and Dispose Impacted Soil Off-site
Balancing Criteria	• Implementability	Alternative is easily implemented.	Alternative is easily implemented.	Alternative is easily implemented with standard excavation procedures.
Balancing Criteria	• Cost Estimated Capital Cost: Estimated Annual Cost: Estimated Present Worth:	Alternative has negligible costs associated with implementation.	$60,000 $0 $60,000	$150,000 $0 $150,000
Modifying Criteria	• State Acceptance	State of California Environmental Protection Agency, Department of Toxic Substances Control ("DTSC") is not anticipated to accept alternative.	DTSC is anticipated to accept remedial action because alternative is protective of human health and complies with ARARs.	DTSC is anticipated to accept remedial action because alternative is protective of human health and complies with ARARs.
Modifying Criteria	• Community Acceptance	Alternative is not likely to be accepted by community members of the Restoration Advisory Board ("RAB") and the community at large.	Alternative is anticipated to be accepted by the RAB and the community at large.	Alternative is anticipated to be accepted by the RAB and the community at large.
	• Six Factors from State of California Health and Safety Code Section 25356.1	Alternative does not comply with State of California Health and Safety Code Criteria.	Alternative is believed to comply with State of California Health and Safety Code Criteria.	Alternative is believed to comply with State of California Health and Safety Code Criteria.
	• Summary of Evaluation Criteria	**Alternative is Not Selected.** Alternative is not protective of human health and the environment, and does not comply with ARARs.	**Alternative is Not Selected.** If no COCs are detected at concentrations greater than site-specific remedial goals, this alternative may be appropriate.	**Selected Alternative.** COCs identified above site-specific remedial goals soil would be removed.

TABLE 10-23
COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES:
BUILDING 823
Oakland Army Base, Oakland, California

	Evaluation Criteria	Alternative 1 No Action for Soil and Groundwater	Alternative 2 Excavate and Dispose Soil Off-site, and Monitor Groundwater As Needed	
			2a. No Impacted Soil or Groundwater Identified	2b. Excavate and Dispose Impacted Soil Off-site
Threshold Criteria	• Overall Protection of Human Health and the Environment	Alternative is not anticipated to be protective of human health and the environment.	Alternative is anticipated to be protective of human health and the environment.	Alternative is anticipated to be protective of human health and the environment.
	• Compliance with ARARs	Alternative is not anticipated to comply with ARARs.	Alternative is anticipated to comply with ARARs.	Alternative is anticipated to comply with ARARs.
Balancing Criteria	• Long-term Effectiveness and Permanence	Alternative will not offer long-term protection against exposure of humans to chemicals of concern ("COCs") in soil.	Alternative may offer long-term effectiveness.	Alternative offers long-term effectiveness as impacted soil will be excavated and disposed off-site.
	• Reduction of Toxicity, Mobility, or Volume through Treatment	Alternative will not reduce toxicity, mobility, or volume of impacted soil.	Alternative assumes no COCs greater than applicable remedial goals remain in the subsurface.	Alternative will not reduce toxicity of COCs in soil, if present, but will decrease on-site volume and mobility of COCs in soil by removal to a permitted off-site disposal facility.
	• Short-term Effectiveness	Alternative is not anticipated to result in any short-term disruptions or risks to workers and the community.	Alternative is not anticipated to result in any short-term disruptions or risks to workers and the community.	Alternative is not anticipated to result in significant short-term disruptions or risks to workers and the community, other than minor soil excavation activities.

TABLE 10-23
COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES:
BUILDING 823
Oakland Army Base, Oakland, California

	Evaluation Criteria	Alternative 1 No Action for Soil and Groundwater	Alternative 2 Excavate and Dispose Soil Off-site, and Monitor Groundwater As Needed 2a. No Impacted Soil or Groundwater Identified	Alternative 2 Excavate and Dispose Soil Off-site, and Monitor Groundwater As Needed 2b. Excavate and Dispose Impacted Soil Off-site
Balancing Criteria	• Implementability	Alternative is easily implemented.	Alternative is easily implemented.	Alternative is easily implemented with standard excavation procedures.
Balancing Criteria	• Cost Estimated Capital Cost: Estimated Annual Cost: Estimated Present Worth:	Alternative has negligible costs associated with implementation.	$60,000 $0 $60,000	$170,000 $0 $170,000
Modifying Criteria	• State Acceptance	State of California Environmental Protection Agency, Department of Toxic Substances Control ("DTSC") is not anticipated to accept alternative.	DTSC is anticipated to accept remedial action because alternative is protective of human health and complies with ARARs.	DTSC is anticipated to accept remedial action because alternative is protective of human health and complies with ARARs.
Modifying Criteria	• Community Acceptance	Alternative is not likely to be accepted by community members of the Restoration Advisory Board ("RAB") and the community at large.	Alternative is anticipated to be accepted by the RAB and the community at large.	Alternative is anticipated to be accepted by the RAB and the community at large.
	• Six Factors from State of California Health and Safety Code Section 25356.1	Alternative does not comply with State of California Health and Safety Code Criteria.	Alternative is believed to comply with State of California Health and Safety Code Criteria.	Alternative is believed to comply with State of California Health and Safety Code Criteria.
	• Summary of Evaluation Criteria	**Alternative is Not Selected.** Alternative is not protective of human health and the environment, and does not comply with ARARs.	**Alternative is Not Selected.** If no COCs are detected at concentrations greater than site-specific remedial goals, this alternative may be appropriate.	**Selected Alternative.** COCs identified above site-specific remedial goals soil would be removed.

TABLE 10-24
COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES:
POTENTIAL DRUM DRAINAGE AREA EAST OF BUILDINGS 805 AND 806
Oakland Army Base, Oakland, California

	Evaluation Criteria	Alternative 1 No Action for Soil and Groundwater	Alternative 2 Excavate and Dispose Soil Off-site, In-Situ Groundwater Treatment, and Monitor Groundwater As Needed 2a. No Impacted Soil or Groundwater Identified	Alternative 2 2b. Excavate and Dispose Impacted Soil Off-site, Groundwater Treatment
Threshold Criteria	• Overall Protection of Human Health and the Environment	Alternative is not anticipated to be protective of human health and the environment.	Alternative is anticipated to be protective of human health and the environment.	Alternative is anticipated to be protective of human health and the environment.
Threshold Criteria	• Compliance with ARARs	Alternative is not anticipated to comply with ARARs.	Alternative is anticipated to comply with ARARs.	Alternative is anticipated to comply with ARARs.
Balancing Criteria	• Long-term Effectiveness and Permanence	Alternative will not offer long-term protection against exposure of humans to chemicals of concern ("COCs") in soil or groundwater.	Alternative offers long-term effectiveness as no impacted soil is identified.	Alternative offers long-term effectiveness as soil with elevated concentrations of COCs will be removed, and residual COCs will be treated in-situ. Alternative assumes 5 years of groundwater monitoring.
Balancing Criteria	• Reduction of Toxicity, Mobility, or Volume through Treatment	Alternative will not reduce toxicity, mobility, or volume of impacted soil.	Alternative assumes no COCs greater than applicable remedial goals remain in the subsurface.	Alternative will likely reduce toxicity, mobility, and volume of impacted soil and groundwater through removal and in-situ treatment.
Balancing Criteria	• Short-term Effectiveness	Alternative is not anticipated to result in any short-term disruptions or risks to workers and the community.	Alternative is not anticipated to result in any short-term disruptions or risks to workers and the community.	Alternative is not anticipated to result in significant short-term disruptions or risks to workers and the community, other than minor soil excavation activities.

TABLE 10-24
COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES:
POTENTIAL DRUM DRAINAGE AREA EAST OF BUILDINGS 805 AND 806
Oakland Army Base, Oakland, California

	Evaluation Criteria	Alternative 1 No Action for Soil and Groundwater	Alternative 2 Excavate and Dispose Soil Off-site, In-Situ Groundwater Treatment, and Monitor Groundwater As Needed 2a. No Impacted Soil or Groundwater Identified	 2b. Excavate and Dispose Impacted Soil Off-site, Groundwater Treatment
Balancing Criteria	• Implementability	Alternative is easily implemented.	Alternative is easily implemented.	Alternative can be implemented, as it involves standard soil excavation and chemical injection procedures.
Balancing Criteria	• Cost Estimated Capital Cost: Estimated Annual Cost: Estimated Present Worth:	Alternative has negligible costs associated with implementation.	$69,000 $0 $69,000	$300,000 $17,000 $380,000
Modifying Criteria	• State Acceptance	State of California Environmental Protection Agency, Department of Toxic Substances Control ("DTSC") is not anticipated to accept alternative.	DTSC is anticipated to accept remedial action because alternative is protective of human health and complies with ARARs.	DTSC is anticipated to accept remedial action because alternative is protective of human health and complies with ARARs.
Modifying Criteria	• Community Acceptance	Alternative is not likely to be accepted by community members of the Restoration Advisory Board ("RAB") and the community at large.	Alternative is anticipated to be accepted by the RAB and the community at large.	Alternative is anticipated to be accepted by the RAB and the community at large.
	• Six Factors from State of California Health and Safety Code Section 25356.1	Alternative does not comply with State of California Health and Safety Code Criteria.	Alternative is believed to comply with State of California Health and Safety Code Criteria.	Alternative is believed to comply with State of California Health and Safety Code Criteria.
	• Summary of Evaluation Criteria	**Alternative is Not Selected.** Alternative is not protective of human health and the environment, and does not comply with ARARs.	**Alternative is Not Selected.** If no COCs are detected at concentrations above remedial goals, this alternative may be appropriate.	**Selected Alternative.** COCs in soil and groundwater greater than applicable site-specific remedial goals will be removed or treated.

TABLE 10-25
COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES:
FORMER MOTOR POOL AND SALVAGE OPERATIONS AT BUILDING 640
Oakland Army Base, Oakland, California

	Evaluation Criteria	Alternative 1 No Action for Soil and Groundwater	Alternative 2 Excavate and Dispose Soil Off-site, and Monitor Groundwater As Needed	Alternative 3 Excavate and Dispose Soil Off-site, In-situ Groundwater Treatment, and Monitor Groundwater
Threshold Criteria	• Overall Protection of Human Health and the Environment	Alternative is not anticipated to be protective of human health and the environment.	Alternative is anticipated to be protective of human health and the environment.	Alternative is anticipated to be protective of human health and the environment.
	• Compliance with ARARs	Alternative is not anticipated to comply with ARARs.	Alternative is anticipated to comply with ARARs.	Alternative is anticipated to comply with ARARs.
Balancing Criteria	• Long-term Effectiveness and Permanence	Alternative will not offer long-term protection against exposure of humans to chemicals of concern ("COCs") in soil or groundwater.	Alternative offers long-term effectiveness as impacted soil, if present, will be excavated and disposed off-site.	Alternative offers long-term effectiveness as soil with elevated concentrations of COCs will be removed, and residual COCs will be treated in-situ. Alternative assumes 5 years of groundwater monitoring.
	• Reduction of Toxicity, Mobility, or Volume through Treatment	Alternative will not reduce toxicity, mobility, or volume of impacted soil.	Alternative will not reduce toxicity of COCs in soil, if present, but will decrease on-site volume and mobility of COCs in soil by removal to a permitted off-site disposal facility.	Alternative will likely reduce toxicity, mobility, and volume of impacted soil and groundwater through removal and in-situ treatment.
	• Short-term Effectiveness	Alternative is not anticipated to result in any short-term disruptions or risks to workers and the community.	Alternative is not anticipated to result in any short-term disruptions or risks to workers and the community.	Alternative is not anticipated to result in significant short-term disruptions or risks to workers and the community, other than minor soil excavation activities.

TABLE 10-25
COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES:
FORMER MOTOR POOL AND SALVAGE OPERATIONS AT BUILDING 640
Oakland Army Base, Oakland, California

	Evaluation Criteria	Alternative 1 No Action for Soil and Groundwater	Alternative 2 Excavate and Dispose Soil Off-site, and Monitor Groundwater As Needed	Alternative 3 Excavate and Dispose Soil Off-site, In-situ Groundwater Treatment, and Monitor Groundwater
Balancing Criteria	• Implementability	Alternative is easily implemented.	Alternative is easily implemented.	Alternative can be implemented, as it involves standard soil excavation and chemical injection procedures.
Balancing Criteria	• Cost Estimated Capital Cost: Estimated Annual Cost: Estimated Present Worth:	Alternative has negligible costs associated with implementation.	$170,000 $0 $170,000	$430,000 $16,000 $500,000
Modifying Criteria	• State Acceptance	State of California Environmental Protection Agency, Department of Toxic Substances Control ("DTSC") is not anticipated to accept alternative.	DTSC is anticipated to accept remedial action because alternative is protective of human health and complies with ARARs.	DTSC is anticipated to accept remedial action because alternative is protective of human health and complies with ARARs.
Modifying Criteria	• Community Acceptance	Alternative is not likely to be accepted by community members of the Restoration Advisory Board ("RAB") and the community at large.	Alternative is anticipated to be accepted by the RAB and the community at large.	Alternative is anticipated to be accepted by the RAB and the community at large.
• Six Factors from State of California Health and Safety Code Section 25356.1		Alternative does not comply with State of California Health and Safety Code Criteria.	Alternative is believed to comply with State of California Health and Safety Code Criteria.	Alternative is believed to comply with State of California Health and Safety Code Criteria.
• Summary of Evaluation Criteria		**Alternative is Not Selected.** Alternative is not protective of human health and the environment, and does not comply with ARARs.	**Alternative is Not Selected.** COCs identified above site-specific remedial goals soil would be removed. If no impacts are found, this alternative may be appropriate.	**Selected Alternative.** COCs in soil and groundwater greater than applicable site-specific remedial goals will be removed or treated.

TABLE 10-26
COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES:
BENZIDINE AT FORMER USED OIL TANK 21
Oakland Army Base, Oakland, California

	Evaluation Criteria	Alternative 1 No Action for Soil and Groundwater	Alternative 2 Excavate and Dispose Soil Off-site, and Monitor Groundwater As Needed 2a. No Impacted Soil or Groundwater Identified	Alternative 2 Excavate and Dispose Soil Off-site, and Monitor Groundwater As Needed 2b. Excavate and Dispose Impacted Soil Off-site
Threshold Criteria	• Overall Protection of Human Health and the Environment	Alternative is not anticipated to be protective of human health and the environment.	Alternative is anticipated to be protective of human health and the environment.	Alternative is anticipated to be protective of human health and the environment.
Threshold Criteria	• Compliance with ARARs	Alternative is not anticipated to comply with ARARs.	Alternative is anticipated to comply with ARARs.	Alternative is anticipated to comply with ARARs.
Balancing Criteria	• Long-term Effectiveness and Permanence	Alternative will not offer long-term protection against exposure of humans to chemicals of concern ("COCs") in soil.	Alternative may offer long-term effectiveness.	Alternative offers long-term effectiveness as impacted soil will be excavated and disposed off-site.
Balancing Criteria	• Reduction of Toxicity, Mobility, or Volume through Treatment	Alternative will not reduce toxicity, mobility, or volume of impacted soil.	Alternative assumes no COCs greater than applicable remedial goals remain in the subsurface.	Alternative will not reduce toxicity of COCs in soil, if present, but will decrease on-site volume and mobility of COCs in soil by removal to a permitted off-site disposal facility.
Balancing Criteria	• Short-term Effectiveness	Alternative is not anticipated to result in any short-term disruptions or risks to workers and the community.	Alternative is not anticipated to result in any short-term disruptions or risks to workers and the community.	Alternative is not anticipated to result in significant short-term disruptions or risks to workers and the community, other than minor soil excavation activities.

TABLE 10-26
COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES:
BENZIDINE AT FORMER USED OIL TANK 21
Oakland Army Base, Oakland, California

	Evaluation Criteria	Alternative 1 No Action for Soil and Groundwater	Alternative 2 Excavate and Dispose Soil Off-site, and Monitor Groundwater As Needed 2a. No Impacted Soil or Groundwater Identified	 2b. Excavate and Dispose Impacted Soil Off-site
Balancing Criteria	• Implementability	Alternative is easily implemented.	Alternative is easily implemented.	Alternative is easily implemented with standard excavation procedures.
Balancing Criteria	• Cost Estimated Capital Cost: Estimated Annual Cost: Estimated Present Worth:	Alternative has negligible costs associated with implementation.	 $40,000 $0 $40,000	 $130,000 $0 $130,000
Modifying Criteria	• State Acceptance	State of California Environmental Protection Agency, Department of Toxic Substances Control ("DTSC") is not anticipated to accept alternative.	DTSC is anticipated to accept remedial action because alternative is protective of human health and complies with ARARs.	DTSC is anticipated to accept remedial action because alternative is protective of human health and complies with ARARs.
Modifying Criteria	• Community Acceptance	Alternative is not likely to be accepted by community members of the Restoration Advisory Board ("RAB") and the community at large.	Alternative is anticipated to be accepted by the RAB and the community at large.	Alternative is anticipated to be accepted by the RAB and the community at large.
• Six Factors from State of California Health and Safety Code Section 25356.1		Alternative does not comply with State of California Health and Safety Code Criteria.	Alternative is believed to comply with State of California Health and Safety Code Criteria.	Alternative is believed to comply with State of California Health and Safety Code Criteria.
• Summary of Evaluation Criteria		**Alternative is Not Selected.** Alternative is not protective of human health and the environment, and does not comply with ARARs.	**Alternative is Not Selected.** If no COCs are detected at concentrations greater than site-specific remedial goals, this alternative may be appropriate.	**Selected Alternative.** COCs identified above site-specific remedial goals soil would be removed.

TABLE 10-27
COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES:
HISTORIC SPILLS AND STAINS
Oakland Army Base, Oakland, California

	Evaluation Criteria	Alternative 1 No Action for Soil and Groundwater	Alternative 2 Excavate and Dispose Soil Off-site, and Monitor Groundwater As Needed 2a. No Impacted Soil or Groundwater Identified	Alternative 2 Excavate and Dispose Soil Off-site, and Monitor Groundwater As Needed 2b. Excavate and Dispose Impacted Soil Off-site
Threshold Criteria	• Overall Protection of Human Health and the Environment	Alternative is not anticipated to be protective of human health and the environment.	Alternative is anticipated to be protective of human health and the environment.	Alternative is anticipated to be protective of human health and the environment.
Threshold Criteria	• Compliance with ARARs	Alternative is not anticipated to comply with ARARs.	Alternative is anticipated to comply with ARARs.	Alternative is anticipated to comply with ARARs.
Balancing Criteria	• Long-term Effectiveness and Permanence	Alternative will not offer long-term protection against exposure of humans to chemicals of concern ("COCs") in soil.	Alternative may offer long-term effectiveness.	Alternative offers long-term effectiveness as impacted soil will be excavated and disposed off-site.
Balancing Criteria	• Reduction of Toxicity, Mobility, or Volume through Treatment	Alternative will not reduce toxicity, mobility, or volume of impacted soil.	Alternative assumes no COCs greater than applicable remedial goals remain in the subsurface.	Alternative will not reduce toxicity of COCs in soil, if present, but will decrease on-site volume and mobility of COCs in soil by removal to a permitted off-site disposal facility.
Balancing Criteria	• Short-term Effectiveness	Alternative is not anticipated to result in any short-term disruptions or risks to workers and the community.	Alternative is not anticipated to result in any short-term disruptions or risks to workers and the community.	Alternative is not anticipated to result in significant short-term disruptions or risks to workers and the community, other than minor soil excavation activities.

TABLE 10-27
COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES:
HISTORIC SPILLS AND STAINS
Oakland Army Base, Oakland, California

	Evaluation Criteria	Alternative 1 No Action for Soil and Groundwater	Alternative 2 Excavate and Dispose Soil Off-site, and Monitor Groundwater As Needed 2a. No Impacted Soil or Groundwater Identified	Alternative 2 Excavate and Dispose Soil Off-site, and Monitor Groundwater As Needed 2b. Excavate and Dispose Impacted Soil Off-site
Balancing Criteria	• Implementability	Alternative is easily implemented.	Alternative is easily implemented.	Alternative is easily implemented with standard excavation procedures.
Balancing Criteria	• Cost Estimated Capital Cost: Estimated Annual Cost: Estimated Present Worth:	Alternative has negligible costs associated with implementation.	$140,000 $0 $140,000	$560,000 $0 $560,000
Modifying Criteria	• State Acceptance	State of California Environmental Protection Agency, Department of Toxic Substances Control ("DTSC") is not anticipated to accept alternative.	DTSC is anticipated to accept remedial action because alternative is protective of human health and complies with ARARs.	DTSC is anticipated to accept remedial action because alternative is protective of human health and complies with ARARs.
Modifying Criteria	• Community Acceptance	Alternative is not likely to be accepted by community members of the Restoration Advisory Board ("RAB") and the community at large.	Alternative is anticipated to be accepted by the RAB and the community at large.	Alternative is anticipated to be accepted by the RAB and the community at large.
	• Six Factors from State of California Health and Safety Code Section 25356.1	Alternative does not comply with State of California Health and Safety Code Criteria.	Alternative is believed to comply with State of California Health and Safety Code Criteria.	Alternative is believed to comply with State of California Health and Safety Code Criteria.
	• Summary of Evaluation Criteria	**Alternative is Not Selected.** Alternative is not protective of human health and the environment, and does not comply with ARARs.	**Alternative is Not Selected.** If no COCs are detected at concentrations greater than site-specific remedial goals, this alternative may be appropriate.	**Selected Alternative.** COCs identified above site-specific remedial goals soil would be removed.

TABLE 10-28
COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES:
LEAD IN SOIL AROUND BUILDINGS
Oakland Army Base, Oakland, California

	Evaluation Criteria	Alternative 1 No Action for Soil and Groundwater	Alternative 2 Excavate and Dispose Soil Off-site, and Monitor Groundwater As Needed 2a. No Impacted Soil or Groundwater Identified	Alternative 2 Excavate and Dispose Soil Off-site, and Monitor Groundwater As Needed 2b. Excavate and Dispose Impacted Soil Off-site
Threshold Criteria	• Overall Protection of Human Health and the Environment	Alternative is not anticipated to be protective of human health and the environment.	Alternative is anticipated to be protective of human health and the environment.	Alternative is anticipated to be protective of human health and the environment.
Threshold Criteria	• Compliance with ARARs	Alternative is not anticipated to comply with ARARs.	Alternative is anticipated to comply with ARARs.	Alternative is anticipated to comply with ARARs.
Balancing Criteria	• Long-term Effectiveness and Permanence	Alternative will not offer long-term protection against exposure of humans to lead in soil.	Alternative may offer long-term effectiveness.	Alternative offers long-term effectiveness as impacted soil will be excavated and disposed off-site.
Balancing Criteria	• Reduction of Toxicity, Mobility, or Volume through Treatment	Alternative will not reduce toxicity, mobility, or volume of impacted soil.	Alternative assumes no lead greater than applicable remedial goals remain in the subsurface.	Alternative will not reduce toxicity of lead in soil, if present, but will decrease on-site volume and mobility of lead in soil by removal to a permitted off-site disposal facility.
Balancing Criteria	• Short-term Effectiveness	Alternative is not anticipated to result in any short-term disruptions or risks to workers and the community.	Alternative is not anticipated to result in any short-term disruptions or risks to workers and the community.	Alternative is not anticipated to result in significant short-term disruptions or risks to workers and the community, other than minor soil excavation activities.

TABLE 10-28
COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES:
LEAD IN SOIL AROUND BUILDINGS
Oakland Army Base, Oakland, California

	Evaluation Criteria	Alternative 1 No Action for Soil and Groundwater	Alternative 2 Excavate and Dispose Soil Off-site, and Monitor Groundwater As Needed 2a. No Impacted Soil or Groundwater Identified	Alternative 2 Excavate and Dispose Soil Off-site, and Monitor Groundwater As Needed 2b. Excavate and Dispose Impacted Soil Off-site
Balancing Criteria	• Implementability	Alternative is easily implemented.	Alternative is easily implemented.	Alternative is easily implemented with standard excavation procedures.
Balancing Criteria	• Cost Estimated Capital Cost: Estimated Annual Cost: Estimated Present Worth:	Alternative has negligible costs associated with implementation.	 $47,000 $0 $47,000	 $460,000 $0 $460,000
Modifying Criteria	• State Acceptance	State of California Environmental Protection Agency, Department of Toxic Substances Control ("DTSC") is not anticipated to accept alternative.	DTSC is anticipated to accept remedial action because alternative is protective of human health and complies with ARARs.	DTSC is anticipated to accept remedial action because alternative is protective of human health and complies with ARARs.
Modifying Criteria	• Community Acceptance	Alternative is not likely to be accepted by community members of the Restoration Advisory Board ("RAB") and the community at large.	Alternative is anticipated to be accepted by the RAB and the community at large.	Alternative is anticipated to be accepted by the RAB and the community at large.
• Six Factors from State of California Health and Safety Code Section 25356.1		Alternative does not comply with State of California Health and Safety Code Criteria.	Alternative is believed to comply with State of California Health and Safety Code Criteria.	Alternative is believed to comply with State of California Health and Safety Code Criteria.
• Summary of Evaluation Criteria		**Alternative is Not Selected.** Alternative is not protective of human health and the environment, and does not comply with ARARs.	**Alternative is Not Selected.** If lead is not detected at concentrations greater than site- specific remedial goals, this alternative may be appropriate.	**Selected Alternative.** Lead identified above site-specific remedial goals soil would be removed.

TABLE 10-29

COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES:

FORMER PCB-CONTAINING TRANSFORMERS AND EQUIPMENT LOCATIONS

Oakland Army Base, Oakland, California

	Evaluation Criteria	Alternative 1 No Action for Equipment, Soil, or Groundwater	Alternative 2 Remove and Dispose of Waste Off-site, and Monitor Groundwater As Needed
Threshold Criteria	• Overall Protection of Human Health and the Environment	Alternative is not anticipated to be protective of human health and the environment.	Alternative is anticipated to be protective of human health and the environment.
	• Compliance with ARARs	Alternative is not anticipated to comply with ARARs.	Alternative is anticipated to comply with ARARs.
Balancing Criteria	• Long-term Effectiveness and Permanence	Alternative will not offer long-term protection against exposure of humans to polychlorinated biphenyls ("PCBs") in equipment, soil, or groundwater.	Alternative offers long-term effectiveness as PCB-containing equipment will be removed and properly disposed. No groundwater monitoring is anticipated.
	• Reduction of Toxicity, Mobility, or Volume through Treatment	Alternative will not reduce toxicity, mobility, or volume of PCBs in equipment, soil, or groundwater.	Alternative will not reduce toxicity of PCBs in electrical components or soil, if present, but will decrease on-site volume and mobility of PCBs by removal and disposal at a permitted off-site disposal facility.
	• Short-term Effectiveness	Alternative is not anticipated to result in any short-term disruptions or risks to workers and the community.	Alternative is not anticipated to result in significant short-term disruptions or risks to workers and the community, other than minor equipment removal activities.

TABLE 10-29

COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES:

FORMER PCB-CONTAINING TRANSFORMERS AND EQUIPMENT LOCATIONS

Oakland Army Base, Oakland, California

	Evaluation Criteria	Alternative 1 No Action for Equipment, Soil, or Groundwater	Alternative 2 Remove and Dispose of Waste Off-site, and Monitor Groundwater As Needed
Balancing Criteria	• Implementability	Alternative is easily implemented.	Alternative can be implemented, as it involves standard equipment replacement procedures.
Balancing Criteria	• Cost Estimated Capital Cost: Estimated Annual Cost: Estimated Present Worth:	Alternative has negligible costs associated with implementation.	 $260,000 $0 $260,000
Modifying Criteria	• State Acceptance	State of California Environmental Protection Agency, Department of Toxic Substances Control ("DTSC") is not anticipated to accept alternative.	DTSC is anticipated to accept remedial action because alternative is protective of human health and complies with ARARs.
Modifying Criteria	• Community Acceptance	Alternative is not likely to be accepted by community members of the Restoration Advisory Board ("RAB") and the community at large.	Alternative is anticipated to be accepted by the RAB and the community at large.
	• Six Factors from State of California Health and Safety Code Section 25356.1	Alternative does not comply with State of California Health and Safety Code Criteria.	Alternative is believed to comply with State of California Health and Safety Code Criteria.
	• Summary of Evaluation Criteria	**Alternative is Not Selected.** Alternative is not protective of human health and the environment, and does not comply with ARARs.	**Selected Alternative.** PCBs identified in electrical equipment and other materials would be removed and disposed of at a permitted off-site disposal facility.

TABLE 10-30
COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES:
STORM DRAINS AND SANITARY SEWERS
Oakland Army Base, Oakland, California

	Evaluation Criteria	Alternative 1 No Action for Soil and Groundwater	Alternative 2 Excavate and Dispose Soil Off-site, and Monitor Groundwater As Needed 2a. No Impacted Soil or Groundwater Identified	 2b. Excavate and Dispose Impacted Soil Off-site
Threshold Criteria	• Overall Protection of Human Health and the Environment	Alternative is not anticipated to be protective of human health and the environment.	Alternative is anticipated to be protective of human health and the environment.	Alternative is anticipated to be protective of human health and the environment.
	• Compliance with ARARs	Alternative is not anticipated to comply with ARARs.	Alternative is anticipated to comply with ARARs.	Alternative is anticipated to comply with ARARs.
Balancing Criteria	• Long-term Effectiveness and Permanence	Alternative will not offer long-term protection against exposure of humans to chemicals of concern ("COCs") in soil.	Alternative may offer long-term effectiveness.	Alternative offers long-term effectiveness as impacted soil will be excavated and disposed off-site.
	• Reduction of Toxicity, Mobility, or Volume through Treatment	Alternative will not reduce toxicity, mobility, or volume of impacted soil.	Alternative assumes no COCs greater than applicable remedial goals remain in the subsurface.	Alternative will not reduce toxicity of COCs in soil, if present, but will decrease on-site volume and mobility of COCs in soil by removal to a permitted off-site disposal facility.
	• Short-term Effectiveness	Alternative is not anticipated to result in any short-term disruptions or risks to workers and the community.	Alternative will have minor disruptions to the community as the flushing and inspection activities will likely be in public rights of way.	Alternative will have minor disruptions to the community as the flushing, inspection, investigation, and source removal activities will likely be in public rights of way.

TABLE 10-30
COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES:
STORM DRAINS AND SANITARY SEWERS
Oakland Army Base, Oakland, California

			Alternative 2 Excavate and Dispose Soil Off-site, and Monitor Groundwater As Needed	
Evaluation Criteria		Alternative 1 No Action for Soil and Groundwater	2a. No Impacted Soil or Groundwater Identified	2b. Excavate and Dispose Impacted Soil Off-site
Balancing Criteria	• Implementability	Alternative is easily implemented.	Alternative can be implemented using standard drain inspection procedures.	Alternative can be implemented, as it involves standard drain inspection and soil excavation procedures.
Balancing Criteria	• Cost Estimated Capital Cost: Estimated Annual Cost: Estimated Present Worth:	Alternative has negligible costs associated with implementation.	 $990,000 $0 $990,000	 $3,600,000 $0 $3,600,000
Modifying Criteria	• State Acceptance	State of California Environmental Protection Agency, Department of Toxic Substances Control ("DTSC") is not anticipated to accept alternative.	DTSC is anticipated to accept remedial action because alternative is protective of human health and complies with ARARs.	DTSC is anticipated to accept remedial action because alternative is protective of human health and complies with ARARs.
Modifying Criteria	• Community Acceptance	Alternative is not likely to be accepted by community members of the Restoration Advisory Board ("RAB") and the community at large.	Alternative is anticipated to be accepted by the RAB and the community at large.	Alternative is anticipated to be accepted by the RAB and the community at large.
• Six Factors from State of California Health and Safety Code Section 25356.1		Alternative does not comply with State of California Health and Safety Code Criteria.	Alternative is believed to comply with State of California Health and Safety Code Criteria.	Alternative is believed to comply with State of California Health and Safety Code Criteria.
• Summary of Evaluation Criteria		**Alternative is Not Selected.** Alternative is not protective of human health and the environment, and does not comply with ARARs.	**Alternative is Not Selected.** If no structural defects are identified in the pipes which could transport COCs in the subsurface, this alternative may be appropriate.	**Selected Alternative.** COCs identified above site-specific remedial goals soil would be removed.

TABLE 10-31
COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES:
RAILROAD TRACKS
Oakland Army Base, Oakland, California

	Evaluation Criteria	Alternative 1 No Action for Soil and Groundwater	Alternative 2 Excavate and Dispose Soil Off-site, and Monitor Groundwater As Needed 2a. No Impacted Soil or Groundwater Identified	Alternative 2 Excavate and Dispose Soil Off-site, and Monitor Groundwater As Needed 2b. Excavate and Dispose Impacted Soil Off-site
Threshold Criteria	• Overall Protection of Human Health and the Environment	Alternative is not anticipated to be protective of human health and the environment.	Alternative is anticipated to be protective of human health and the environment.	Alternative is anticipated to be protective of human health and the environment.
Threshold Criteria	• Compliance with ARARs	Alternative is not anticipated to comply with ARARs.	Alternative is anticipated to comply with ARARs.	Alternative is anticipated to comply with ARARs.
Balancing Criteria	• Long-term Effectiveness and Permanence	Alternative will not offer long-term protection against exposure of humans to chemicals of concern ("COCs") in soil.	Alternative may offer long-term effectiveness.	Alternative offers long-term effectiveness as impacted subballast will be excavated and disposed off-site.
Balancing Criteria	• Reduction of Toxicity, Mobility, or Volume through Treatment	Alternative will not reduce toxicity, mobility, or volume of impacted soil.	Alternative assumes no COCs greater than applicable remedial goals remain in the subsurface.	Alternative will not reduce toxicity of COCs in soil, if present, but will decrease on-site volume and mobility of COCs in soil by removal to a permitted off-site disposal facility.
Balancing Criteria	• Short-term Effectiveness	Alternative is not anticipated to result in any short-term disruptions or risks to workers and the community.	Alternative is not anticipated to result in any short-term disruptions or risks to workers and the community.	Alternative is not anticipated to result in significant short-term disruptions or risks to workers and the community, other than minor soil excavation activities.

TABLE 10-31
COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES:
RAILROAD TRACKS
Oakland Army Base, Oakland, California

	Evaluation Criteria	Alternative 1 No Action for Soil and Groundwater	Alternative 2 Excavate and Dispose Soil Off-site, and Monitor Groundwater As Needed 2a. No Impacted Soil or Groundwater Identified	Alternative 2 Excavate and Dispose Soil Off-site, and Monitor Groundwater As Needed 2b. Excavate and Dispose Impacted Soil Off-site
Balancing Criteria	• Implementability	Alternative is easily implemented.	Alternative is easily implemented.	Alternative is easily implemented with standard excavation procedures.
Balancing Criteria	• Cost Estimated Capital Cost: Estimated Annual Cost: Estimated Present Worth:	Alternative has negligible costs associated with implementation.	$430,000 $0 $430,000	$1,700,000 $0 $1,700,000
Modifying Criteria	• State Acceptance	State of California Environmental Protection Agency, Department of Toxic Substances Control ("DTSC") is not anticipated to accept alternative.	DTSC is anticipated to accept remedial action because alternative is protective of human health and complies with ARARs.	DTSC is anticipated to accept remedial action because alternative is protective of human health and complies with ARARs.
Modifying Criteria	• Community Acceptance	Alternative is not likely to be accepted by community members of the Restoration Advisory Board ("RAB") and the community at large.	Alternative is anticipated to be accepted by the RAB and the community at large.	Alternative is anticipated to be accepted by the RAB and the community at large.
	• Six Factors from State of California Health and Safety Code Section 25356.1	Alternative does not comply with State of California Health and Safety Code Criteria.	Alternative is believed to comply with State of California Health and Safety Code Criteria.	Alternative is believed to comply with State of California Health and Safety Code Criteria.
	• Summary of Evaluation Criteria	**Alternative is Not Selected.** Alternative is not protective of human health and the environment, and does not comply with ARARs.	**Alternative is Not Selected.** If no COCs are detected at concentrations greater than site-specific remedial goals, this alternative may be appropriate.	**Selected Alternative.** COCs identified above site-specific remedial goals soil would be removed.

TABLE 10-32
SUMMARY OF COST ASSOCIATED WITH POTENTIAL REMEDIAL ACTIONS (a), (b)
Oakland Army Base, Oakland, California

Remedial Alternative	Assumed Project Duration (years)	Remedial Alternative Estimated Cost (2001 dollars)			Preferred Remedy Estimated Cost (2001 dollars)		
		Estimated Capital Costs	Estimated Annual Costs	Present Worth of Total Estimated Costs	Estimated Capital Costs	Estimated Annual Costs	Present Worth of Total Estimated Costs
RAP Sites							
● Former ORP/Building 1 Area							
1 *No Action for Soil and Groundwater*	*0*	$0	$0	$0	--	--	--
2 *Excavate and Immobilize Tarry Residue, with Off-Site Disposal and Monitor Groundwater (c);(d)*							
2a *Reuse Overburden and Soil with TCP On-Site*	*5*	$6,400,000	$39,000	$6,600,000	--	--	--
2b *Dispose of Overburden and Soil with TCP Off-Site*	*5*	$7,600,000	$39,000	$7,800,000	**$7,600,000**	**$39,000**	**$7,800,000**
● VOCs in Groundwater at Eastern End of Building 807							
1 *No Action for Soil and Groundwater*	*0*	$0	$0	$0	--	--	--
2 *Monitor Groundwater*	*15*	$82,000	$46,000	$620,000	--	--	--
3 *Perform In-Situ Chemical Oxidation/Reduction and Monitor Groundwater*	*5*	$220,000	$46,000	$430,000	**$220,000**	**$46,000**	**$430,000**
● VOCs in Groundwater Near Buildings 808 and 823							
1 *No Action for Soil and Groundwater*	*0*	$0	$0	$0	--	--	--
2 *Monitor Groundwater*	*15*	$83,000	$39,000	$540,000	--	--	--
3 *Perform In-Situ Bioremediation and Monitor Groundwater*	*5*	$340,000	$39,000	$520,000	**$340,000**	**$39,000**	**$520,000**
4 *Install Vapor Barrier Beneath Building and Monitor Groundwater*	*15*	$240,000	$39,000	$700,000	--	--	--
5 *Install Vapor Barrier with Sub-Slab Depressurization System ("SSD") Beneath Building and Monitor Groundwater*	*15*	$540,000	$56,000	$1,200,000	--	--	--

TABLE 10-32
SUMMARY OF COST ASSOCIATED WITH POTENTIAL REMEDIAL ACTIONS (a), (b)
Oakland Army Base, Oakland, California

Remedial Alternative	Assumed Project Duration (years)	Remedial Alternative Estimated Cost (2001 dollars)			Preferred Remedy Estimated Cost (2001 dollars)		
		Estimated Capital Costs	Estimated Annual Costs	Present Worth of Total Estimated Costs	Estimated Capital Costs	Estimated Annual Costs	Present Worth of Total Estimated Costs
RAP Sites (contd)							
● VOCs in Groundwater Near Building 99							
1 *No Action for Soil and Groundwater*	*0*	$0	$0	$0	--	--	--
2 *Monitor Groundwater*	*15*	$82,000	$39,000	$540,000	--	--	--
3 *Perform In-Situ Bioremediation and Monitor Groundwater*	*5*	$320,000	$39,000	$500,000	**$320,000**	**$39,000**	**$500,000**
4 *Install Vapor Barrier Beneath Building and Monitor Groundwater*	*15*	$230,000	$39,000	$690,000	--	--	--
5 *Install Vapor Barrier & SSD Beneath Building, Monitor Groundwater*	*15*	$480,000	$43,000	$1,000,000	--	--	--
● Benzene and MTBE in Groundwater Near Former USTs 11A/12A/13A							
1 *No Action for Soil and Groundwater*	*0*	$0	$0	$0	--	--	--
2 *Excavate and Dispose Soil Off-site, Monitor Groundwater As Needed*	*5*	$220,000	$42,000	$410,000	--	--	--
3 *Excavate and Dispose Soil Off-site, In-situ Groundwater Treatment and Monitor Groundwater*	*5*	$270,000	$42,000	$460,000	**$270,000**	**$42,000**	**$460,000**
● Building 991 Area							
1 *No Action for Soil and Groundwater*	*0*	$0	$0	$0	--	--	--
2 *Excavate and Dispose Soil Off-site, Monitor Groundwater As Needed*	*5*	$270,000	$38,000	$440,000	--	--	--
3 *Excavate and Dispose Soil Off-site, In-Situ Bioremediation, and Monitor Groundwater*	*5*	$470,000	$47,000	$680,000	**$470,000**	**$47,000**	**$680,000**
● Building 99							
1 *No Action for Soil and Groundwater*	*0*	$0	$0	$0	--	--	--
2 *Excavate and Dispose Soil Off-site, Monitor Groundwater As Needed*							
2a *No Impacted Soil or Groundwater Identified*	*0*	$70,000	$0	$70,000	--	--	--
2b *Impacted Soil Excavated and Disposed Off-site*	*0*	$230,000	$0	$230,000	**$230,000**	**$0**	**$230,000**

TABLE 10-32
SUMMARY OF COST ASSOCIATED WITH POTENTIAL REMEDIAL ACTIONS (a), (b)

Oakland Army Base, Oakland, California

Remedial Alternative	Assumed Project Duration (years)	Remedial Alternative Estimated Cost (2001 dollars)			Preferred Remedy Estimated Cost (2001 dollars)		
		Estimated Capital Costs	Estimated Annual Costs	Present Worth of Total Estimated Costs	Estimated Capital Costs	Estimated Annual Costs	Present Worth of Total Estimated Costs
RMP Implementation Area							
● Washracks, Sumps, Oil/Water Separators, and Miscellaneous Operations							
1 *No Action for Soil and Groundwater*	*0*	$0	$0	$0	--	--	--
2 *Excavate and Dispose Soil Off-site, Monitor Groundwater As Needed*							
2a *No Impacted Soil or Groundwater Identified*	*0*	$890,000	$0	$890,000	--	--	--
2b *Impacted Soil Excavated and Disposed Off-site*	*0*	$2,300,000	$0	$2,300,000	**$2,300,000**	**$0**	**$2,300,000**
● Tanks							
1 *No Action for Soil and Groundwater*	*0*	$0	$0	$0	--	--	--
2 *Excavate and Dispose Soil Off-site, Monitor Groundwater As Needed*							
2a *No Impacted Soil or Groundwater Identified*	*0*	$740,000	$0	$740,000	--	--	--
2b *Impacted Soil Excavated and Disposed Off-site*	*0*	$1,580,000	$0	$1,600,000	--	--	--
2c *Impacted Soil Excavated and Disposed Off-site, Monitor Groundwater*	*5*	$1,620,000	$115,000	$2,100,000	**$1,600,000**	**$120,000**	**$2,100,000**
● Debris Area Near Building 99							
1 *No Action for Soil and Groundwater*	*0*	$0	$0	$0	--	--	--
2 *Excavate and Dispose Soil Off-site, Monitor Groundwater As Needed*							
2a *No Impacted Soil or Groundwater Identified*	*0*	$56,000	$0	$56,000	--	--	--
2b *Impacted Soil Excavated and Disposed Off-site*	*0*	$170,000	$0	$170,000	**$170,000**	**$0**	**$170,000**
● Building 85							
1 *No Action for Soil and Groundwater*	*0*	$0	$0	$0	--	--	--
2 *Excavate and Dispose Soil Off-site, Monitor Groundwater As Needed*							
2a *No Impacted Soil or Groundwater Identified*	*0*	$56,000	$0	$56,000	--	--	--
2b *Impacted Soil Excavated and Disposed Off-site*	*0*	$140,000	$0	$140,000	**$140,000**	**$0**	**$140,000**

TABLE 10-32
SUMMARY OF COST ASSOCIATED WITH POTENTIAL REMEDIAL ACTIONS (a), (b)
Oakland Army Base, Oakland, California

Remedial Alternative	Assumed Project Duration (years)	Remedial Alternative Estimated Cost (2001 dollars)			Preferred Remedy Estimated Cost (2001 dollars)		
		Estimated Capital Costs	Estimated Annual Costs	Present Worth of Total Estimated Costs	Estimated Capital Costs	Estimated Annual Costs	Present Worth of Total Estimated Costs
RMP Implementation Area (contd)							
● Building 812							
1 *No Action for Soil and Groundwater*	*0*	$0	$0	$0	--	--	--
2 *Excavate and Dispose Soil Off-site, Monitor Groundwater As Needed*							
2a *No Impacted Soil or Groundwater Identified*	*0*	$60,000	$0	$60,000	--	--	--
2b *Impacted Soil Excavated and Disposed Off-site*	*0*	$150,000	$0	$150,000	**$150,000**	**$0**	**$150,000**
● Building 823							
1 *No Action for Soil and Groundwater*	*0*	$0	$0	$0	--	--	--
2 *Excavate and Dispose Soil Off-site, Monitor Groundwater As Needed*							
2a *No Impacted Soil or Groundwater Identified*	*0*	$60,000	$0	$60,000	--	--	--
2b *Impacted Soil Excavated and Disposed Off-site*	*0*	$170,000	$0	$170,000	**$170,000**	**$0**	**$170,000**
● Potential Drum Drainage Area East of Buildings 805 and 806							
1 *No Action for Soil and Groundwater*	*0*	$0	$0	$0	--	--	--
2 *Excavate and Dispose Soil Off-site, In-Situ Groundwater Treatment, and Monitor Groundwater As Needed*							
2a *No Impacted Soil or Groundwater Identified*	*0*	$69,000	$0	$69,000	--	--	--
2b *Impacted Soil Excavated and Disposed Off-site, In-Situ Groundwater Treatment, and Monitor Groundwater*	*5*	$300,000	$17,000	$380,000	**$300,000**	**$17,000**	**$380,000**
● Former Motor Pool and Salvage Operations at Building 640							
1 *No Action for Soil and Groundwater*	*0*	$0	$0	$0	--	--	--
2 *Excavate and Dispose Soil Off-site, Monitor Groundwater As Needed*	*0*	$170,000	$0	$170,000	--	--	--
3 *Excavate and Dispose Soil Off-site, In-Situ Groundwater Treatment, and Monitor Groundwater*	*5*	$430,000	$16,000	$500,000	**$430,000**	**$16,000**	**$500,000**

TABLE 10-32
SUMMARY OF COST ASSOCIATED WITH POTENTIAL REMEDIAL ACTIONS (a), (b)
Oakland Army Base, Oakland, California

Remedial Alternative	Assumed Project Duration (years)	Remedial Alternative Estimated Cost (2001 dollars)			Preferred Remedy Estimated Cost (2001 dollars)		
		Estimated Capital Costs	Estimated Annual Costs	Present Worth of Total Estimated Costs	Estimated Capital Costs	Estimated Annual Costs	Present Worth of Total Estimated Costs
RMP Implementation Area (contd)							
● Benzidine at Former Used Oil Tank 21							
1 *No Action for Soil and Groundwater*	*0*	$0	$0	$0	--	--	--
2 *Excavate and Dispose Soil Off-site, Monitor Groundwater As Needed*							
2a *No Impacted Soil or Groundwater Identified*	*0*	$40,000	$0	$40,000	--	--	--
2b *Impacted Soil Excavated and Disposed Off-site*	*0*	$130,000	$0	$130,000	**$130,000**	**$0**	**$130,000**
● Historical Spills and Stains							
1 *No Action for Soil and Groundwater*	*0*	$0	$0	$0	--	--	--
2 *Excavate and Dispose Soil Off-site, Monitor Groundwater As Needed*							
2a *No Impacted Soil or Groundwater Identified*	*0*	$140,000	$0	$140,000	--	--	--
2b *Impacted Soil Excavated and Disposed Off-site*	*0*	$560,000	$0	$560,000	**$560,000**	**$0**	**$560,000**
● Lead in Soil Around Buildings							
1 *No Action for Soil and Groundwater*	*0*	$0	$0	$0	--	--	--
2 *Excavate and Dispose Soil Off-site, Monitor Groundwater As Needed*							
2a *No Impacted Soil or Groundwater Identified*	*0*	$47,000	$0	$47,000	--	--	--
2b *Impacted Soil Excavated and Disposed Off-site*	*0*	$460,000	$0	$460,000	**$460,000**	**$0**	**$460,000**
● Former PCB-Containing Transformers and Equipment Locations							
1 *No Action for Soil and Groundwater*	*0*	$0	$0	$0	--	--	--
2 *Excavate and Dispose Soil Off-site, Monitor Groundwater As Needed*	*0*	$260,000	$0	$260,000	**$260,000**	**$0**	**$260,000**

TABLE 10-32
SUMMARY OF COST ASSOCIATED WITH POTENTIAL REMEDIAL ACTIONS (a), (b)
Oakland Army Base, Oakland, California

Remedial Alternative	Assumed Project Duration (years)	Remedial Alternative Estimated Cost (2001 dollars)			Preferred Remedy Estimated Cost (2001 dollars)		
		Estimated Capital Costs	Estimated Annual Costs	Present Worth of Total Estimated Costs	Estimated Capital Costs	Estimated Annual Costs	Present Worth of Total Estimated Costs
RMP Implementation Area (contd)							
● Storm Drains and Sanitary Sewers							
1 *No Action for Soil and Groundwater*	*0*	$0	$0	$0	--	--	--
2 *Excavate and Dispose Soil Off-site, Monitor Groundwater As Needed*							
2a *No Impacted Soil or Groundwater Identified*	*0*	$990,000	$0	$990,000	--	--	--
2b *Impacted Soil Excavated and Disposed Off-site*	*0*	$3,600,000	$0	$3,600,000	**$3,600,000**	**$0**	**$3,600,000**
● Railroad Tracks							
1 *No Action for Soil and Groundwater*	*0*	$0	$0	$0	--	--	--
2 *Excavate and Dispose Soil Off-site, Monitor Groundwater As Needed*							
2a *No Impacted Soil or Groundwater Identified*	*0*	$430,000	$0	$430,000	--	--	--
2b *Impacted Soil Excavated and Disposed Off-site*	*0*	$1,700,000	$0	$1,700,000	**$1,700,000**	**$0**	**$1,700,000**
● Marine Sediments at Former Parcels 2 and 3							
1 *No Action for Sediments*	*0*	$0	$0	$0	--	--	--
2 *No Further Action/Containment by Filling for Port's Berth 21 Project*	*10*	$0	$22,000	$190,000	**$0**	**$22,000**	**$190,000**

TABLE 10-32
SUMMARY OF COST ASSOCIATED WITH POTENTIAL REMEDIAL ACTIONS (a), (b)
Oakland Army Base, Oakland, California

Remedial Alternative	Assumed Project Duration (years)	Remedial Alternative Estimated Cost (2001 dollars)			Preferred Remedy Estimated Cost (2001 dollars)		
		Estimated Capital Costs	Estimated Annual Costs	Present Worth of Total Estimated Costs	Estimated Capital Costs	Estimated Annual Costs	Present Worth of Total Estimated Costs
Indirect Costs to Coordinate Implementation of Remedial Actions							
● Basewide Regulatory Agency Compliance							
1 *Best-case Scenario*	*5*	$410,000	$500,000	$2,700,000	--	--	--
2 *Expected Scenario*	*5*	$590,000	$710,000	$3,800,000	**$590,000**	**$710,000**	**$3,800,000**
● Operations and Maintenance/5 Year Reviews/Reporting							
1 *Best-case Scenario*	*30*	$0	$30,000	$570,000	--	--	--
2 *Expected Scenario*	*30*	$0	$43,000	$820,000	**$0**	**$43,000**	**$820,000**
● Implementation of Risk Management Plan							
1 *Best-case Scenario*	*30*	$0	$36,000	$690,000	--	--	--
2 *Expected Scenario*	*30*	$0	$51,000	$970,000	**$0**	**$51,000**	**$970,000**
				TOTAL (e)	**$22,000,000**	**$1,230,000**	**$29,000,000**

TABLE 10-32
SUMMARY OF COST ASSOCIATED WITH POTENTIAL REMEDIAL ACTIONS (a), (b)
Oakland Army Base, Oakland, California

Notes:

(a) Consistent with U.S. EPA *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study,* dated July 2000, present worth of total estimated costs have been calculated assuming a real discount rate of 3.2 percent. The real discount rate is assumed to be equivalent to the nominal interest rate on 30-year federal treasury notes and bonds upon adjustment to remove the effect of expected inflation. The real discount rate has been estimated following guidelines in Circular No. A-94 published by the Federal Office of Management and Budget, Appendix C, revised January 2001.

(b) Annual costs, if any, are a function of the specific alternative.

(c) For Building 1, Alternatives 2a and 2b assume that oily residue to be excavated and successfully neutralized and stabilized for metals at the site prior to acceptance at an off-site, permitted disposal facility. These alternatives also assume U.S. EPA and DTSC grant a variance from Land Disposal Restrictions for Underlying Hazardous Constituents above their respective Universal Treatment Standards, if required by waste characteristics. These alternatives also assume an off-site, permitted disposal facility will accept the waste with the regulatory variance. In addition, Alternatives 2a and 2b assume demolition of Building 1 is funded and conducted by the Army prior to property transfer. No Building 1 demolition costs are included in this estimate.

(d) Alternative 2a assumes that overburden and some soil can be reused to fill the excavation at the site. Alternative 2b assumes that all overburden and some soil must be disposed as non-hazardous waste. Odor control is assumed to be required for Alternative 2b as well.

(e) Total does not include (a) reimbursement of regulatory agency oversight fees, and (b) environmental insurance premiums.

APPENDICES

A

APPENDIX A

Electronic Database for Chemicals of Concern
Detected in Soil and Groundwater

Erler & Kalinowski, Inc.

Consulting Engineers and Scientists

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27 September 2002

To Potential Users of Electronic Files:

Erler & Kalinowski, Inc. ("EKI") has provided our CLIENT, the Oakland Base Reuse Authority ("OBRA"), with paper copies of the *Final Remedial Action Plan, Oakland Army Base, Oakland, California,* that includes the *Final Risk Management Plan as Appendix E*, dated 27 September 2002, prepared by EKI. An electronic copy of the chemical information database (Appendix A to the RAP, i.e., the COC Database) used to prepare these documents is provided on this compact disk. Information contained in the database was received from the Army contractor and others and has not been verified for completeness or accuracy by EKI.

These electronic files are being provided at the request of our CLIENT and for the convenience of our CLIENT. The delivery of electronic media does not constitute the delivery of our professional work product or provide rights of reliance by third parties. Only the original paper prints provided to, and for the sole benefit of, our CLIENT constitute our professional work product. Because the electronic media may be damaged during transfer or altered, the paper prints shall control where there are any differences between the paper prints and the electronic media. EKI makes no warranties, either express or implied, of the merchantability, applicability, compatibility with the recipients' computer equipment or software; of the fitness for any particular purpose for the documents and electronic media; or that the electronic media contain no defects or are virus free.

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If you have any questions or require additional information, please call me at (650) 292-9100.

Very truly yours,

ERLER & KALINOWSKI, INC.

Thomas W. Kalinowski

Thomas W. Kalinowski, Sc.D.
Vice President

A10063.00

B

APPENDIX B

Sample Calculations and Model Outputs Supporting Determination of Remediation Goals

LeadSpread Version 7.0
Computer Spreadsheets

BLOOD LEAD CONCENTRATION FOR EXPOSURE OF CONSTRUCTION/INDUSTRIAL WORKERS TO LEAD IN SOIL AT PROPOSED CLEANUP LEVEL

CALIFORNIA DEPARTMENT OF TOXIC SUBSTANCES CONTROL

USER'S GUIDE to version 7

INPUT	
MEDIUM	LEVEL
Lead in Air (ug/m^3)	0.028
Lead in Soil/Dust (ug/g)	**3,500**
Lead in Water (ug/l)	15.0
% Home-grown Produce	0%
Respirable Dust (ug/m^3)	1.5

OUTPUT	Percentile Estimate of Blood Pb (ug/dl)					PRG-99	PRG-95
	50th	90th	95th	98th	99th	(ug/g)	(ug/g)
BLOOD Pb, ADULT	4.3	7.9	9.4	11.4	13.0	2417	3809
BLOOD Pb, CHILD	26.4	48.2	57.0	69.3	78.9	255	435
BLOOD Pb, PICA CHILD	51.0	93.2	110.3	134.0	152.5	128	219
BLOOD Pb, OCCUPATIONAL	3.4	6.1	7.3	8.8	**10.0**	3475	5464

EXPOSURE PARAMETERS	units	adults	children
Days per week	days/wk	7	
Days per week, occupational		**5**	
Geometric Standard Deviation		1.6	
Blood lead level of concern (ug/dl)		10	
Skin area, residential	cm^2	5700	2900
Skin area occupational	cm^2	2900	
Soil adherence	ug/cm^2	70	200
Dermal uptake constant	(ug/dl)/(ug/day)	0.0001	
Soil ingestion	mg/day	50	100
Soil ingestion, pica	mg/day		200
Ingestion constant	(ug/dl)/(ug/day)	0.04	0.16
Bioavailability	unitless	0.44	
Breathing rate	m^3/day	20	6.8
Inhalation constant	(ug/dl)/(ug/day)	0.08	0.192
Water ingestion	l/day	1.4	0.4
Food ingestion	kg/day	1.9	1.1
Lead in market basket	ug/kg	3.1	
Lead in home-grown produce	ug/kg	1575.0	

Click here for REFERENCES

PATHWAYS — ADULTS	Residential			Occupational		
	Pathway contribution			Pathway contribution		
Pathway	PEF	ug/dl	percent	PEF	ug/dl	percent
Soil Contact	3.8E-5	0.13	3%	1.4E-5	0.05	1%
Soil Ingestion	8.8E-4	3.08	71%	6.3E-4	2.20	65%
Inhalation, bkgrnd		0.05	1%		0.03	1%
Inhalation	2.5E-6	0.01	0%	1.8E-6	0.01	0%
Water Ingestion		0.84	19%		0.84	25%
Food Ingestion, bkgrnd		0.23	5%		0.23	7%
Food Ingestion	0.0E+0	0.00	0%			0%

CHILDREN	typical			with pica		
	Pathway contribution			Pathway contribution		
Pathway	PEF	ug/dl	percent	PEF	ug/dl	percent
Soil Contact	5.6E-5	0.19	1%		0.19	0%
Soil Ingestion	7.0E-3	24.64	93%	1.4E-2	49.28	97%
Inhalation	2.0E-6	0.01	0%		0.01	0%
Inhalation, bkgrnd		0.04	0%		0.04	0%
Water Ingestion		0.96	4%		0.96	2%
Food Ingestion, bkgrnd		0.54	2%		0.54	1%
Food Ingestion	0.0E+0	0.00	0%		0.00	0%

BLOOD LEAD CONCENTRATION FOR EXPOSURE OF MAINTENANCE WORKERS TO LEAD IN SOIL AT PROPOSED CLEANUP LEVEL

CALIFORNIA DEPARTMENT OF TOXIC SUBSTANCES CONTROL

USER'S GUIDE to version 7

INPUT	
MEDIUM	LEVEL
Lead in Air (ug/m^3)	0.028
Lead in Soil/Dust (ug/g)	**77,000**
Lead in Water (ug/l)	15.0
% Home-grown Produce	0%
Respirable Dust (ug/m^3)	1.5

OUTPUT	Percentile Estimate of Blood Pb (ug/dl)					PRG-99	PRG-95
	50th	90th	95th	98th	99th	(ug/g)	(ug/g)
BLOOD Pb, ADULT	72.0	131.6	155.7	189.2	215.3	2417	3809
BLOOD Pb, CHILD	548.1	1001.2	1184.6	1439.8	1638.4	255	435
BLOOD Pb, PICA CHILD	1090.1	1991.4	2356.3	2863.8	3259.0	128	219
BLOOD Pb, OCCUPATIONAL	3.4	6.1	7.3	8.8	**10.0**	76604	119842

EXPOSURE PARAMETERS	units	adults	children
Days per week	days/wk	7	
Days per week, occupational *		**0.23**	
Geometric Standard Deviation		1.6	
Blood lead level of concern (ug/dl)		10	
Skin area, residential	cm^2	5700	2900
Skin area occupational	cm^2	2900	
Soil adherence	ug/cm^2	70	200
Dermal uptake constant	(ug/dl)/(ug/day)	0.0001	
Soil ingestion	mg/day	50	100
Soil ingestion, pica	mg/day		200
Ingestion constant	(ug/dl)/(ug/day)	0.04	0.16
Bioavailability	unitless	0.44	
Breathing rate	m^3/day	20	6.8
Inhalation constant	(ug/dl)/(ug/day)	0.082	0.192
Water ingestion	l/day	1.4	0.4
Food ingestion	kg/day	1.9	1.1
Lead in market basket	ug/kg	3.1	
Lead in home-grown produce	ug/kg	34650.0	

Click here for REFERENCES

PATHWAYS						
ADULTS	Residential			Occupational		
	Pathway contribution			Pathway contribution		
Pathway	PEF	ug/dl	percent	PEF	ug/dl	percent
Soil Contact	3.8E-5	2.95	4%	6.4E-7	0.05	1%
Soil Ingestion	8.8E-4	67.76	94%	2.9E-5	2.23	66%
Inhalation, bkgrnd		0.05	0%		0.00	0%
Inhalation	2.5E-6	0.19	0%	8.1E-8	0.01	0%
Water Ingestion		0.84	1%		0.84	25%
Food Ingestion, bkgrnd		0.23	0%		0.23	7%
Food Ingestion	0.0E+0	0.00	0%			0%

CHILDREN	typical			with pica		
	Pathway contribution			Pathway contribution		
Pathway	PEF	ug/dl	percent	PEF	ug/dl	percent
Soil Contact	5.6E-5	4.29	1%		4.29	0%
Soil Ingestion	7.0E-3	542.08	99%	1.4E-2	1084.16	99%
Inhalation	2.0E-6	0.15	0%		0.15	0%
Inhalation, bkgrnd		0.04	0%		0.04	0%
Water Ingestion		0.96	0%		0.96	0%
Food Ingestion, bkgrnd		0.54	0%		0.54	0%
Food Ingestion	0.0E+0	0.00	0%		0.00	0%

* Equivalent to 12 days per year

Johnson and Ettinger Model Version 2.3
Computer Spreadsheets

Soil Remedial Goals for Indoor Worker

DATA ENTRY SHEET FOR J&E MODEL

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

SL-ADV
Version 2.3; 03/01

YES: X

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES:

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (µg/kg)	Chemical
75014		Vinyl chloride (chloroethene)

ENTER Average soil temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_b (cm)	ENTER Thickness of soil stratum A, h_A (cm) (Totals must add up to value of L_t (cell D28))	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
15	15	15	150	15	0	0			1.00E-08

ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)	ENTER Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
1.704	0.357	0.196	0.026	0	0	0	0	0	0	0	0

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP ($g/cm \cdot s^2$)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)
15	40	6000	6000	488	0.1	1

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	25	25	250	1.0E-06	1

Used to calculate risk-based soil concentration.

Soil Remedial Goals for Indoor Worker

CHEMICAL PROPERTIES SHEET

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H (atm-m^3/mol)	Henry's law constant reference temperature, T_R (°C)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (°K)	Critical temperature, T_C (°K)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF ($\mu g/m^3$)$^{-1}$	Reference conc., RfC (mg/m^3)	Physical state at soil temperature, (S,L,G)
1.04E-01	9.80E-06	2.71E-02	25	5,250	259.25	432.00	2.45E+00	2.76E+03	3.9E-05	2.0E-01	G

END

Soil Remedial Goals for Indoor Worker

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Floor-wall seam perimeter, X_{crack} (cm)	**Initial soil concentration used, C_R (μg/kg)**	Bldg. ventilation rate, $Q_{building}$ (cm^3/s)
7.88E+08	1	0.161	0.000	0.000	#N/A	#N/A	#N/A	1.00E-08	24,000	**1.00E+00**	4.88E+06

Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. soil temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. soil temperature, H_{TS} $(atm\text{-}m^3/mol)$	Henry's law constant at ave. soil temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)	Convection path length, L_p (cm)
3.60E+07	6.67E-05	15	4,944	2.03E-02	8.58E-01	1.77E-04	1.86E-03	0.00E+00	0.00E+00	1.86E-03	1	15

Soil-water partition coefficient, K_d (cm^3/g)	Source vapor conc., C_{source} $(\mu g/m^3)$	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ $(\mu g/m^3)$	**Finite source β term (unitless)**	**Finite source ψ term $(sec)^{-1}$**	Time for source depletion, τ_D (sec)	Exposure duration > time for source depletion (YES/NO)
6.38E-02	3.30E+03	0.10	5.98E+01	1.86E-03	2.40E+03	1.02E+87	NA	NA	**1.12E+03**	**3.61E-03**	**4.45E+07**	**YES**

Finite source indoor attenuation coefficient, $\langle\alpha\rangle$ (unitless)	**Mass limit** bldg. conc., $C_{building}$ $(\mu g/m^3)$	Finite source bldg. conc., $C_{building}$ $(\mu g/m^3)$	Final finite source bldg. conc., $C_{building}$ $(\mu g/m^3)$	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
NA	2.15E-03	NA	2.15E-03	3.9E-05	2.0E-01

END

Soil Remedial Goals for Indoor Worker
RESULTS SHEET

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

Indoor exposure soil conc., carcinogen (µg/kg)	Indoor exposure soil conc., noncarcinogen (µg/kg)	Risk-based indoor exposure soil conc., (µg/kg)	Soil saturation conc., C_{sat} (µg/kg)	Final indoor exposure soil conc., (µg/kg)
4.92E+01	1.38E+05	4.92E+01	7.17E+05	4.92E+01

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

SCROLL DOWN TO "END"

END

DATA ENTRY SHEET

GW-ADV
Version 2.3; 03/01

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES: X

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES:

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (μg/L)	Chemical
75014		Vinyl chloride (chloroethene)

MORE ↓

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm²)
			Totals must add up to value of L_{WT} (cell D28)							
15	15	150	150	0	0	A	S			1.00E-08

MORE ↓

ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm³)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm³/cm³)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm³)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm³/cm³)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm³)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm³/cm³)
1.704	0.357	0.196	0	0	0	0	0	0

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s²)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)
15	40	6000	6000	488	0.1	1

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	25	25	250	1.0E-06	1

Used to calculate risk-based groundwater concentration.

END

CHEMICAL PROPERTIES SHEET

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H ($atm \cdot m^3/mol$)	Henry's law constant reference temperature, T_R (°C)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (°K)	Critical temperature, T_C (°K)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF ($(\mu g/m^3)^{-1}$)	Reference conc., RfC (mg/m^3)
1.04E-01	9.80E-06	2.71E-02	25	5,250	259.25	432.00	2.45E+00	2.67E+03	3.9E-05	1.0E-01

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm³/cm³)	Stratum B soil air-filled porosity, θ_a^B (cm³/cm³)	Stratum C soil air-filled porosity, θ_a^C (cm³/cm³)	Stratum A effective total fluid saturation, S_{te} (cm³/cm³)	Stratum A soil intrinsic permeability, k_i (cm²)	Stratum A soil relative air permeability, k_{rg} (cm²)	Stratum A soil effective vapor permeability, k_v (cm²)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm³/cm³)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm³/cm³)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm³/cm³)	Floor-wall seam perimeter, X_{crack} (cm)
7.88E+08	135	0.161	0.000	0.000	#N/A	#N/A	#N/A	1.00E-08	17.05	0.357	0.035	0.322	24,000

Bldg. ventilation rate, $Q_{building}$ (cm³/s)	Area of enclosed space below grade, A_B (cm²)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m³/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm²/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm²/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm²/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm²/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm²/s)	Diffusion path length, L_d (cm)
4.88E+06	3.60E+07	6.67E-05	15	4,944	2.03E-02	8.58E-01	1.77E-04	1.86E-03	0.00E+00	0.00E+00	1.36E-05	1.03E-04	135

Convection path length, L_p (cm)	Source vapor conc., C_{source} (μg/m³)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm³/s)	Crack effective diffusion coefficient, D^{crack} (cm²/s)	Area of crack, A_{crack} (cm²)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ (μg/m³)	Unit risk factor, URF (μg/m³)⁻¹	Reference conc., RfC (mg/m³)
15	8.58E+02	0.10	5.98E+01	1.86E-03	2.40E+03	1.02E+87	3.85E-06	3.30E-03	3.9E-05	1.0E-01

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (μg/L)	Indoor exposure groundwater conc., noncarcinogen (μg/L)	Risk-based indoor exposure groundwater conc., (μg/L)	Pure component water solubility, S (μg/L)	Final indoor exposure groundwater conc., (μg/L)
3.17E+01	4.42E+04	3.17E+01	2.67E+06	3.17E+01

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

SCROLL DOWN TO "END"

END

C

APPENDIX C

Sensitivity Analysis of Risk-Based Remediation Goal Calculations

C-1. BARE DIRT INDUSTRIAL WORKER EXPOSURE SCENARIO

This appendix presents a sensitivity analysis of risk calculations for a hypothetical exposure pathway of an outdoor industrial worker scenario where no cover materials are assumed to exist on soils at the OARB (i.e., the "bare dirt" outdoor industrial worker scenario). The "bare dirt" outdoor industrial worker scenario assumes that workers are present for 25 years on the OARB with exposed surface soil and no cover materials, i.e., paving, foundations, imported landscaping soils, or gravel, to provide a barrier to direct contact or wind erosion of existing soil. This bare dirt scenario is not currently the case nor will be the case in the future at OARB under the planned commercial and industrial redevelopment, and is presented herein for informational purposes only.

Table C-1.1 presents individual COC remediation goals calculated as a sensitivity evaluation for the outdoor industrial worker for the hypothetical 25-year "bare dirt" exposure scenario. Table C-1.2 lists several key input parameters and assumptions used in the calculation of goals listed in Table C-1.1.

Under the hypothetical bare dirt scenario, all typical dirt contact, ingestion, and inhalation pathways are assumed to be complete. As shown in Table C-1.1, the resultant, calculated health-protective concentrations for many COCs under the bare dirt outdoor industrial worker scenario are more stringent than the remediation goals for the OARB described in Section 7.4 of the RAP, e.g., approximately one-third of the COCs are calculated to have lower goals in the bare dirt scenario and the calculated goals for remaining COCs are controlled by other exposure pathways addressed in Section 7 of the RAP. Risk-based numerical remediation goals calculated for the bare dirt industrial worker scenario are, thus, illustrative of the protective effects of incorporating required cover materials as part of all remedial actions for the OARB considered in this RAP. These hypothetical risk calculations also provide a gauge of the sensitivity of these risk evaluations to potential failures in the permanence or long-term effectiveness in a barrier-type remedy.

TABLE C-1.1

HYPOTHETICAL SITE-SPECIFIC RISK-BASED REMEDIATION GOALS CALCULATED FOR CHEMICALS OF CONCERN IN SOIL TO PROTECT OUTDOOR INDUSTRIAL WORKERS EXPOSED TO BARE DIRT FOR 25 YEARS (a)

Oakland Army Base, Oakland, California

Chemical of Concern	Estimated Soil Saturation Concentration (mg/kg) (b)	RG_{nc} Non-carcinogenic Remediation Goal at HI = 1 (mg/kg); (c)	RG_c Carcinogenic Remediation Goal at Risk = 10^{-6} (mg/kg); (c)	Lowest Remediation Goal to Protect Outdoor Commercial Worker (mg/kg); (d)
Metals				
Antimony	(e)	670	(f)	670
Arsenic	(e)	360	2.3	2.3
Barium	(e)	86,000	(f)	86,000
Beryllium	(e)	2,700	790	790
Cadmium	(e)	1,000	14	14
Chromium (III)	(e)	930,000	(f)	MAX(100,000); (m)
Chromium (VI)	(e)	2,600	6	6
Chromium, Total	(e)	18,000 (g)	42 (g)	42
Cobalt	(e)	100,000	(f)	100,000
Copper	(e)	62,000	(f)	62,000
Lead	--	--	--	3,500 (j)
Manganese	(e)	30,000	(f)	30,000
Mercury	(e)	140	(f)	140
Molybdenum	(e)	8,300	(f)	8,300
Nickel	(e)	33,000	7,300	7,300
Selenium	(e)	8,300	(f)	8,300
Silver	(e)	8,300	(f)	8,300
Thallium	(e)	120	(f)	120
Vanadium	(e)	12,000	(f)	12,000
Zinc	(e)	500,000	(f)	MAX(100,000)
Volatile Organic Compounds				
1,1,2,2-tetrachloroethane	7,000	15,000	3.1	3.1
1,1,2-trichloroethane	9,400	650	7.5	7.5
1,1-dichloroethane	5,900	8,300	30	30
1,1-dichloroethene	710	310	(f)	310
1,2,3-trichloropropane	3,600	1,700	(f)	1,700
1,2,4-trimethylbenzene	5,400	820	(f)	820
1,2-dichloroethane	8,100	140	3.5	3.5
1,3,5-trimethylbenzene	1,300	430	(f)	430
Benzene	3,000	100	1.7	1.7
Bromodichloromethane	7,900	2,100	2.2	2.2
Carbon tetrachloride	1,100	22	0.6	0.6
Chloroform	14,000	890	12	12
Dibromochloromethane	4,100	3,900	5.8	5.8
cis-1,2-dichloroethene	3,700	670	(f)	670
trans-1,2-dichloroethene	7,100	920	(f)	920

TABLE C-1.1
HYPOTHETICAL SITE-SPECIFIC RISK-BASED REMEDIATION GOALS CALCULATED FOR CHEMICALS OF CONCERN IN SOIL TO PROTECT OUTDOOR INDUSTRIAL WORKERS EXPOSED TO BARE DIRT FOR 25 YEARS (a)

Oakland Army Base, Oakland, California

Chemical of Concern	Estimated Soil Saturation Concentration (mg/kg) (b)	RG_{nc} Non-carcinogenic Remediation Goal at HI = 1 (mg/kg); (c)	RG_c Carcinogenic Remediation Goal at Risk = 10^{-6} (mg/kg); (c)	Lowest Remediation Goal to Protect Outdoor Commercial Worker (mg/kg); (d)
Volatile Organic Compounds				
Ethylbenzene	1,200	27,000	(f)	SAT(1,200); (i)
Isopropylbenzene (Cumene)	3,800	30,000	(f)	SAT(3,800)
Methyl tertiary butyl ether	21,000	89,000	160	160
Methylene chloride	5,800	21,000	34	34
n-propylbenzene	1,200	1,600	(f)	SAT(1,200)
p-cymene (p-isopropyltoluene)	3,700	30,000	(f)	SAT(3,700)
sec-butylbenzene	4,000	1,500	(f)	1,500
tert-butylbenzene	530	1,300	(f)	SAT(530)
Tetrachloroethene	2,200	1,100	12	12
Toluene	3,900	13,000	(f)	SAT(3,900)
Trichloroethene	3,000	450	20	20
Trichlorofluoromethane	4,300	24,000	(f)	SAT(4,300)
Vinyl chloride	670	290	0.1	0.1
Xylenes, Total	1,200	200,000	(f)	SAT(1,200)
Semi-volatile Organic Compounds				
Acenaphthene	(e)	30,000	(f)	30,000
Acenaphthylene	(e)	(i)	(f)	(k)
Anthracene	(e)	140,000	(f)	MAX(100,000)
Benzidine	(e)	1,400	0.003	0.003
Benzo(a)anthracene	(e)	(i)	1.1	1.1
Benzo(a)pyrene	(e)	(i)	0.1	0.1
Benzo(b)fluoranthene	(e)	(i)	1.1	1.1
Benzo(b,k)fluoranthene	(e)	(i)	1.1	1.1
Benzo(g,h,i)perylene	(e)	(i)	(f)	(k)
Benzo(l)fluoranthene	(e)	(i)	1.1	1.1
Bis(2-ethylhexyl)phthalate	100	12,000	568	SAT(100)
Chrysene	(e)	(i)	12	12
Dibenz(a,h)anthracene	(e)	(i)	0.3	0.3
Fluoranthene	(e)	18,000	(f)	18,000
Fluorene	(e)	18,000	(f)	18,000
Hexachlorobutadiene	83,000	170	21	21
Indeno(1,2,3-c,d)pyrene	(e)	(i)	1.1	1.1
Naphthalene	(e)	750	(f)	750
Phenanthrene	(e)	140,000	(f)	MAX(100,000)
Pyrene	(e)	14,000	(f)	14,000

TABLE C-1.1

HYPOTHETICAL SITE-SPECIFIC RISK-BASED REMEDIATION GOALS CALCULATED FOR CHEMICALS OF CONCERN IN SOIL TO PROTECT OUTDOOR INDUSTRIAL WORKERS EXPOSED TO BARE DIRT FOR 25 YEARS (a)

Oakland Army Base, Oakland, California

Chemical of Concern	Estimated Soil Saturation Concentration (mg/kg) (b)	RG_{nc} Non-carcinogenic Remediation Goal at HI = 1 (mg/kg); (c)	RG_c Carcinogenic Remediation Goal at Risk = 10^{-6} (mg/kg); (c)	Lowest Remediation Goal to Protect Outdoor Commercial Worker (mg/kg); (d)
Total Petroleum Hydrocarbons				
TPH Diesel`	--	--	--	(l)
TPH Gasoline	--	--	--	(l)
TPH Motor Oil	--	--	--	(l)
TPH Recoverable	--	--	--	(l)
PCBs, Pesticides, and Herbicides				
Aldrin	(e)	27	0.2	0.2
Alpha BHC	(e)	260	0.9	0.9
Alpha endosulfan (Endosulfan I)	(e)	4,500	(f)	4,500
Alpha chlordane	110	450	2	2
Gamma chlordane	110	450	2	2
Dieldrin	(e)	46	0.2	0.2
Endosulfan sulfate	(e)	4,900	(f)	4,900
Endrin	(e)	280	(f)	280
Endrin aldehyde	(e)	280	(f)	280
Endrin ketone	(e)	280	(f)	280
Gamma BHC (Lindane)	(e)	260	2.2	2.2
Heptachlor	(e)	400	0.6	0.6
Heptachlor epoxide	60	12	0.5	0.5
4,4'-DDD	(e)	470	11	11
4,4'-DDE	(e)	430	7	7
4,4'-DDT	(e)	470	8	8
PCB-1248 (Aroclor 1248)	570	(i)	0.3	0.3
PCB-1260 (Aroclor 1260)	(e)	(i)	0.3	0.3
Dioxins				
2,3,7,8-tetrachlorodibenzo-p-dioxin	(e)	(i)	0.00001	0.00001

TABLE C-1.1

HYPOTHETICAL SITE-SPECIFIC RISK-BASED REMEDIATION GOALS CALCULATED FOR CHEMICALS OF CONCERN IN SOIL TO PROTECT OUTDOOR INDUSTRIAL WORKERS EXPOSED TO BARE DIRT FOR 25 YEARS (a)

Oakland Army Base, Oakland, California

Notes:

(a) This table presents individual risk-based remediation goals calculated as a sensitivity evaluation for the outdoor industrial worker for the hypothetical 25-year "bare dirt" exposure scenario; other exposure scenarios may result in more stringent remeidation goals as listed in Table 7-11 in the main body of the RAP. See Table C-1.2 for a summary of key input values and exposure assumptions for the hypothetical 25-year "bare dirt" exposure scenario.

(b) Soil saturation concentration for COCs are calculated below using equation from U.S. EPA, 1 November 2000, *Region 9 Preliminary Remediation Goals (PRGs) 1999*, Memorandum from Stanford J. Smucker, Ph.D., Regional Toxicologist (SFD-8-B), Technical Support Team.

(c) Risk-based remediation goals assume a non-carcinogenic target risk level that corresponds to a hazard index of 1 and a carcinogenic target risk level of one-in-one million (i.e., 10^{-6}) incremental risk of an individual developing cancer over a lifetime from exposure to a single chemical.

(d) Unless otherwise noted, value cited is the lesser of the non-carcinogenic and carcinogenic risk-based remediation goals when both values could be calculated.

(e) No soil saturation concentrations were calculated for compounds that are solids under ambient temperature and pressure.

(f) U.S. EPA or OEHHA do not classify compound as a potential carcinogen, thus no published carcinogenic slope factor is available for this compound.

(g) Consistent with U.S. EPA Region IX Preliminary Remediation Goals (U.S. EPA, 2000), the remediation goal for total chromium was calculated from the chromium (III) and chromium (VI) remediation goal assuming a 1:6 ratio of chromium (VI) to chromium (III).

(h) Prefix "SAT" denotes risk -based value exceeds calculated soil saturation concentration, thus, the estimated saturation value is listed.

(i) No published chronic reference dose is available for this compound, and no suitable surrogate compound was identified.

(j) Risk-based remediation goal for lead calculated using DTSC Lead Spread Version 7.0 computer model (See Appendix B).

(k) No published human health toxicity values available for compound. Consequently, risk-based remediation goal could not be calculated for this compound.

(l) No site-specific risk-based remediation goals were calculated for petroleum hydrocarbons. Fuel Storage Tank Sites Cleanup Levels derived by the Army are adopted as remediation goals for petroleum hydrocarbons. Refer to Table 7-11.

(m) Prefix "MAX" denotes that the calculated risk-based concentration is 100,000 mg/kg or greater. A non-risk based "ceiling limit" concentration for metals and certain SVOCs that are solids at ambient temperatures is given as 100,000 mg/kg, consistent with U.S. EPA Region IX Preliminary Remediation Goals (U.S. EPA, 2000).

TABLE C-1.2
EXPOSURE PARAMETERS USED TO CALCULATE HUMAN HEALTH RISK-BASED REMEDIATION GOALS FOR THE HYPOTHETICAL "BARE DIRT" EXPOSURE SCENARIO

Oakland Army Base, Oakland, California

Parameter	Symbol	Unit	Value	Note/Reference
Averaging Time	AT			
Carcinogens		year	70	Default value (a)
Non-carcinogens		year	ED	Default value (a)
Body Weight	BW			
Outdoor industrial worker		kg	70	Default value (a)
Dermal Absorption Factor	ABS			
Arsenic			0.03	Default value (b)
Cadmium			0.001	Default value (b)
Other metals			0.01	Default value (c)
Chlordane			0.05	Specified by DTSC HERD
DDT			0.05	Specified by DTSC HERD
Other chlorinated pesticides			0.05	Specified by DTSC HERD
Benzo(a)pyrene			0.15	Specified by DTSC HERD
Other polycyclic aromatic hydrocarbons			0.15	Specified by DTSC HERD
Semi-volatile organic compounds			0.1	Default value (b)
Polychlorinated biphenyls			0.15	Specified by DTSC HERD
Volatile organic compounds			0.1	Default value (c)
Exposure Duration	ED			
Outdoor industrial worker		year	25	Default value (a)
Exposure Frequency	EF			
Outdoor industrial worker		day/year	250	Default value (a)
Exposure Interval	T			
Outdoor industrial worker		s	7.9×10^8	Calculated as 3.16×10^7*ED
Ingestion Rate for Soil	IR_{soil}			
Outdoor industrial worker		mg/day	50	Specified by DTSC HERD
Inhalation Rate for Air	IR_{air}			
Outdoor industrial worker		m^3/day	20	Default value (a)
Particulate Emission Factor	PEF			
Outdoor industrial worker		m^3/kg	4.63×10^9	Default value (a)

TABLE C-1.2
EXPOSURE PARAMETERS USED TO CALCULATE HUMAN HEALTH RISK-BASED REMEDIATION GOALS FOR THE HYPOTHETICAL "BARE DIRT" EXPOSURE SCENARIO

Oakland Army Base, Oakland, California

Parameter	Symbol	Unit	Value	Note/Reference
Skin Surface Area Exposed to Soil	SA			
Outdoor industrial worker		cm^2/day	5,700	(d)
Soil-to-Air Volatilization Factor	VF			
Outdoor industrial worker		m^3/kg		Chemical-specific value (g)
Soil-to-Skin Adherence Factor	AF			
Outdoor industrial worker		mg/cm^2	0.2	Default value for industrial worker (b)

Notes:

(a) U.S. EPA. 1991. *Risk Assessment Guidance for Superfund: Volume 1 – Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals), Interim.* Office of Solid Waste and Emergency Response. Publication: 9285.7-01B.

(b) U.S. EPA. September 2001. *Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual – Part E (Supplemental Guidance for Dermal Risk Assessment), Interim*. Office of Solid Waste and Emergency Response.

(c) Cal-EPA. July 1992 (corrected and reprinted August 1996). *Supplemental Guidance for Human Health Multimedia Risk Assessments of Hazardous Waste Sites and Permitted Facilities.*

(d) DTSC. 7 January 2000. Memorandum to Human and Ecological Risk Division. *Guidance for the Dermal Exposure Pathway*.

(g) Soil-to-air volatilization factor is chemical-specific. Volatilization factors were calculated using the equation in Section 3.3.1 in U.S. EPA's Risk Assessment Guidance for Superfund, Part B, dated December 1991, and input parameters listed in Table 7-4 of this RAP.

C-2. DERMAL CONTACT WITH COCs IN GROUNDWATER

This appendix presents a sensitivity analysis of risk calculations for hypothetical dermal contact with COCs in groundwater. Under planned redevelopment, future on-site commercial and industrial workers will have no contact with groundwater; however, such contact may occur on a short-term basis and intermittently during dewatering or trenching activities by earthwork construction workers and future maintenance personnel, e.g., when penetrating cover materials and digging deeper than approximately 5-feet, bgs. Hypothetical remediation goals that would be protective for earthwork construction workers and maintenance personnel from dermal exposure to vinyl chloride, benzo(a)pyrene, or arsenic in shallow groundwater were calculated using the equations and exposure factors in *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) – Interim* (U.S. EPA, 2001). These three exemplar COCs were selected because they represent three broad classes of COCs possibly occurring on-site at OARB (VOCs, SVOCs, and metals) and their relatively high potency as possible carcinogens. The assumed exposure duration for these sensitivity calculations was 1-year with an exposure frequency of 10 days per year, an event frequency of 1 per day, and an event duration of 8 hours.

Hypothetical exposures by contact with COCs in groundwater are judged to be insignificant for the following reasons: (a) the OBRA COC analytical data base and the recent Phase II data collected by the Army and OBRA indicate that chemical impacts to groundwater are limited to only a few well-defined areas of the shallow water-bearing zone (i.e., identified groundwater RAP sites) that will be remediated as part of the RAP, and (b) workers will not be exposed to COCs in groundwater because appropriate health and safety requirements will be incorporated into on-site activities that may involve incidental contact with contaminated groundwater, consistent with protocols in Section 6.1 of the RMP.

VINYL CHLORIDE IN GROUNDWATER

Vinyl chloride is present in groundwater at the OARB in three well-defined areas, as described in Section 4 of the main body of the RAP. As shown on the attached calculation worksheet, the hypothetical remediation goal to protect the earthwork construction worker from dermal exposure to vinyl chloride in groundwater at a cancer risk of 10^{-6} is estimated to be 5,400 µg/L. This indicates that the hypothetical risk to earthwork construction workers from dermal contact with vinyl chloride in groundwater is insignificant when this concentration is compared to the remediation goal, as presented in Section 7.4 of the RAP, to protect indoor commercial workers from inhalation of vapors (32 μg/L), which will govern future remediation of vinyl chloride impacts to shallow groundwater at the OARB. Thus, hypothetical, incidental dermal contact to vinyl chloride in groundwater is judged to be insignificant and unlikely, particularly in the vast majority of the OARB outside of the groundwater RAP sites.

BENZO(A)PYRENE IN GROUNDWATER

Similarly, as shown on the attached calculation worksheet, the hypothetical remediation goal to protect the earthwork construction worker from dermal exposure to benzo(a)pyrene in groundwater at a cancer risk of 10^{-6} is estimated to be 0.3 μg/L. This concentration of benzo(a)pyrene compared to concentrations measured in a few samples of groundwater at the OARB indicates that the hypothetical risk to earthwork construction workers could be significant if earthwork construction workers contacted benzo(a)pyrene impacted groundwater at the OARB. However, contact with benzo(a)pyrene in groundwater is unlikely as it was detected in groundwater in only 11 of the 418 groundwater samples collected at the OARB, and the majority of these benzo(a)pyrene detections were groundwater samples collected during underground storage tank removal actions. Additionally, these reported concentrations of benzo(a)pyrene at the OARB were close to, or even greater than, the solubility of benzo(a)pyrene in groundwater, which is approximately 1.6 μg/L. This indicates that such groundwater samples were likely turbid or contained petroleum residuals, and the benzo(a)pyrene was actually present on the soil particles or in the petroleum residual, and not dissolved in groundwater. Thus, risks of dermal contact with benzo(a)pyrene in groundwater is judged to be insignificant and unlikely, particularly in the vast majority of the OARB outside of the former tank locations.

ARSENIC IN GROUNDWATER

Similarly, as shown on the attached calculation worksheet, the hypothetical remediation goal to protect the earthwork construction worker from dermal exposure to arsenic in groundwater at a cancer risk of 10^{-6} is estimated to be 2,600 μg/L. The maximum concentration of arsenic measured in groundwater at the OARB during the recent Phase II investigations was 43 μg/L, indicating that the hypothetical risk to earthwork construction workers from dermal contact to arsenic in groundwater is insignificant.

Vinyl chloride

Cancer Risk = Slope Factor ("SF") x Dermal Absorbed Dose ("DAD")

Cancer Risk = 1.8E-10 for 1 ug/L in groundwater - see calculations below

Remediation goal to protect against dermal exposure at 10-6

5,400	ug/L

SF = 0.27 (mg/kg-day)-1

equation (1) from U.S. EPA (2001)
DAD = (Daevent x EV x ED x EF x SA)/ (BW x AT)

DAD = 6.8E-10 mg/kg - day (see inputs below)

where:

BW	70	body weight (kg)
SA	5,700	exposed skin surface area (cm2)
ED	1	exposure duration (years)
EV	1	event frequency (events/day)
EF	10	exposure frequency (days/year) - best professional judgement
ATnc	365	averaging time for non-carcinogens (days)
ATc	25550	averaging time for carcinogens (days)
DAevent	2.1E-08	dermal absorbed dose per event (chemical specific -see equation 2)

equation (2) from U.S. EPA (2001)

DAevent = 2 x FA x Kp x CW x sqrt (6 tauevent x tevent/pi)

DAevent = 2.1E-08 mg/cm2- event (see inputs below)

where:

FA	1	fraction absorbed water - from Appendix B of U.S. EPA, 2001
Kp	5.60E-03	permeability coefficient (cm/hr) - from Appendix B of U.S. EPA, 2001)
Cw	0.000001	concentration in water (mg/cm3) (= 1 ug/L)
τevent	0.24	lag time per event (hours/event) - from Appendix B
tevent	8	event duration (hours/event) - best professional judgement
t*	0.57	time to reach steady state (hours) - from Appendix B
B	0	dimensionless ratio for permeability - from Appendix B

Benzo(a)pyrene

Cancer Risk = Slope Factor ("SF") x Dermal Absorbed Dose ("DAD")

Cancer Risk = 3.4E-06 for 1 ug/L in groundwater - see calculations below

Remediation goal to protect against dermal exposure at 10-6

0.3	ug/L

SF = 12 (mg/kg-day)-1

equation (1) from U.S. EPA (2001)
DAD = (Daevent x EV x ED x EF x SA)/ (BW x AT)

DAD = 2.9E-07 mg/kg - day (see inputs below)

where:

BW	70	body weight (kg)
SA	5,700	exposed skin surface area (cm2)
ED	1	exposure duration (years)
EV	1	event frequency (events/day)
EF	10	exposure frequency (days/year) - best professional judgement
ATnc	365	averaging time for non-carcinogens (days)
ATc	25550	averaging time for carcinogens (days)
DAevent	9.0E-06	dermal absorbed dose per event (chemical specific -see equation 2)

equation (2) from U.S. EPA (2001)

DAevent = 2 x FA x Kp x CW x sqrt (6 tauevent x tevent/pi)

DAevent = 9.0E-06 mg/cm2- event (see inputs below)

where:

FA	1	fraction absorbed water - from Appendix B of U.S. EPA, 2001
Kp	7.00E-01	permeability coefficient (cm/hr) - from Appendix B of U.S. EPA, 2001)
Cw	0.000001	concentration in water (mg/cm3) (= 1 ug/L)
τevent	2.69	lag time per event (hours/event) - from Appendix B
tevent	8	event duration (hours/event) - best professional judgement
t*	11.67	time to reach steady state (hours) - from Appendix B
B	4.3	dimensionless ratio for permeability - from Appendix B

eKI

Arsenic

Cancer Risk = Slope Factor ("SF") x Dermal Absorbed Dose ("DAD")

Cancer Risk = 3.8E-10 for 1 ug/L in groundwater - see calculations below

Remediation goal to protect against dermal exposure at 10-6

2,600	ug/L

SF = 1.5 (mg/kg-day)-1

equation (1) from U.S. EPA (2001)

DAD = (Daevent x EV x ED x EF x SA)/ (BW x AT)

DAD = 2.5E-10 mg/kg - day (see inputs below)

where:

BW	70	body weight (kg)
SA	5,700	exposed skin surface area (cm2)
ED	1	exposure duration (years)
EV	1	event frequency (events/day)
EF	10	exposure frequency (days/year) - best professional judgement
ATnc	365	averaging time for non-carcinogens (days)
ATc	25550	averaging time for carcinogens (days)
DAevent	8.0E-09	dermal absorbed dose per event (chemical specific -see equation 2)

equation (2) from U.S. EPA (2001)

DAevent = Kp x CW x tevent

DAevent = 8.0E-09 mg/cm2- event (see inputs below)

where:

Kp	1.00E-03	permeability coefficient (cm/hr) - from Appendix B of U.S. EPA, 2001)
Cw	0.000001	concentration in water (mg/cm3) (= 1 ug/L)
tevent	8	event duration (hours/event) - best professional judgement

C-3. JOHNSON AND ETTINGER CALCULATIONS FOR LOW VOLATILITY COCs

This appendix presents a sensitivity risk analysis of hypothetical remediation goal calculations for relatively low or non-volatile COCs using the advanced U.S. EPA version of the Johnson and Ettinger Model (U.S. EPA, 2001). This analysis was conducted for polychlorinated biphenyls ("PCBs"), aldrin, alpha BHC, and gamma BHC (lindane). The calculations of risk-based remediation goals for these compounds in soil were performed using the same exposure pathway parameters and inputs listed in Section 7.4 of the RAP. The results of these calculations are shown below.

The hypothetical remediation goals for these low volatility compounds in soil, as determined using the Johnson and Ettinger and input parameters specific to the OARB are as follows:

PCBs: 3,460 mg/kg (greater than solubility)

Aldrin: 4,240 mg/kg

Alpha-BHC: 212 mg/kg (greater than solubility)

Gamma-BHC: 343 mg/kg (greater than solubility)

The corresponding goals calculated for these same COCs in Table 7-11 are at least two orders of magnitude lower than the hypothetical goals above, indicating that for these non-volatile compounds, the indoor air exposure pathway is insignificant compared to other exposure pathways when remediated to the goals in Table 7-11 or found at concentrations below those goals. Thus, such calculations were not routinely performed for other low volatility organics. As discussed in the main text the RAP, when such organic COCs are found at elevated concentrations or as free phase products, it will be appropriate to consider the volatilization pathway in determining potential health risks, although other remediation goals are likely to control final remediation objectives.

D

APPENDIX D

Interim Use Sites

D. INTERIM USE SITES

Brief descriptions of buildings at the OARB that have current, interim uses for temporary residential, school or childcare uses are provided in this appendix. These four interim use sites or buildings are located in the area of OARB south of 14th Street. As shown on historical aerial photographs of the OARB just prior to development by the Army in 1941, this area of the OARB was bare ground still reflecting the apparent contouring of the hydraulic filling or other filling operations. Thus, there is no apparent prior industrial use of these interim use sites at OARB before the Army development after 1941. Figures are provided in this appendix for each interim use building described below. Current tenants at the four interim use sites or buildings may continue to occupy the sites and buildings for five years post-transfer upon DTSC's issuance of waivers for such specified sensitive reuses.

Analytical data from investigations conducted at or near these interim use sites, e.g., for sample locations indicated on the figures in this appendix, are available in the electronic database in Appendix A of this RAP, as well as data obtained from OBRA's Phase II report entitled *OBRA Phase II Investigation Data Report, Oakland, California* (EKI, 2002), and the Army's Phase II report entitled *Draft Phase II Supplemental Investigation Report, Oakland, California* (IT, 2002). The results of Phase II investigations conducted at or near these interim use sites are briefly summarized below where relevant.

BUILDING 796

Building 796 is a former Army barracks and administration building, which is now used as part of the OAKLAND MILITARY INSTITUTE (NATIONAL GUARD COLLEGE PREPARATORY ACADEMY). The school includes several temporary classroom units located on asphalt on the adjacent parking area. The OMI is a Charter School facility established in partnership with the California National Guard and the Mayor of Oakland for students in grades 7-12. There are currently 160 7th-grade students enrolled in the 2001-2002 school year, and plans are to enroll 160 additional 8th-grade students in the school year beginning September 2002. The school is supported by a total of 25 to 40 teachers and administrators.

As part of its Phase II investigation, OBRA collected three surface soil samples around Building 796 and analyzed the samples for lead. Lead concentrations in these samples varied from 57 mg/kg to 140 mg/kg. As reported in the PA/SI, there is one pad-mounted or vaulted dry transformer at Building 796 (Kleinfelder, 1998b).

BUILDING 740

Building 740, a former bowling alley, is home to OPERATION DIGNITY, a 100-bed winter emergency relief shelter for homeless men and women. The site is leased to the City of Oakland Community and Economic Development Agency, who funds the program. The program operates from January 15 through the end of April, and is open from 6:00 p.m. until 8:00 a.m. the following morning. Clients are transported to the shelter by a free van, which picks up and drops off from designated sites in Berkeley and Oakland.

Building 740 was constructed in 1968. No surface soil sample was collected to assess the potential of lead contamination from exterior surfaces painted with lead-based paint.

As reported in the PA / SI, one pad-mounted PCB-containing transformer at Building 740 was tested by the Army, and PCBs were not detected above analytical laboratory reporting limits (Kleinfelder, 1998b).

Tank D site is located adjacent to the west side of Building 740. Tank D was a 1,000-gallon fuel oil UST. The Army removed Tank D in 1990, removed floating product in 1994 and 1995, and excavated contaminated soil in 1994 and 2000. RWQCB requires periodic groundwater monitoring for TPH-d, TPH-mo, and PAHs at existing wells to confirm that floating product has been removed.

BUILDING 655

Building 655, built in 1987, is a former Army childcare center, which is still used as such. Known formally as the CITY OF OAKLAND LIFE ENRICHMENT AGENCY, AGING, HEALTH & HUMAN SERVICES HEAD START PROGRAM, the Child Development Program provides education, nutrition, health, and mental services to low-income children and families throughout Oakland. The program operates Monday through Friday, from 7:00 a.m. to 6:00 p.m., and is staffed by 10-12 full-time employees serving 85 to 91 children (60 families).

Former Building T-661, located in the footprint of Building 655, was designated as "hostess house" (Post Map, Oakland Army Base, dated 28 May 1943 (Revised 16 December 1947), Office of the Post Engineer), and later converted into a "bachelor officers' quarters" and a "transient quarters" (General Site and Building Use Map, 5 August 1960). Former Building T-661 was constructed in 1942 and was demolished sometime after 1960. No surface soil sample was collected at the former Building T-661 perimeter to assess the potential of lead contamination. The building perimeter coincides with the childcare center's playground area.

According to a property card for Building T-661 on file at the Oakland Army Base, dated 29 June 1948, Building T-661 was heated with an oil-fired furnace. A drawing entitled "General Heating Plan", sheet 9 of 16, dated 14 May 1963 shows a 1,000-gallon underground heating oil storage tank located near former Building T-661. No records were reviewed by EKI or the Port indicating that the tank was removed.

The Army did not investigate the possible location of the heating tank near former Building T-661. The possible tank location is directly beneath Building 655, which apparently was not easily accessible to a drill rig or geophysical investigation by the Army.

BUILDING 650

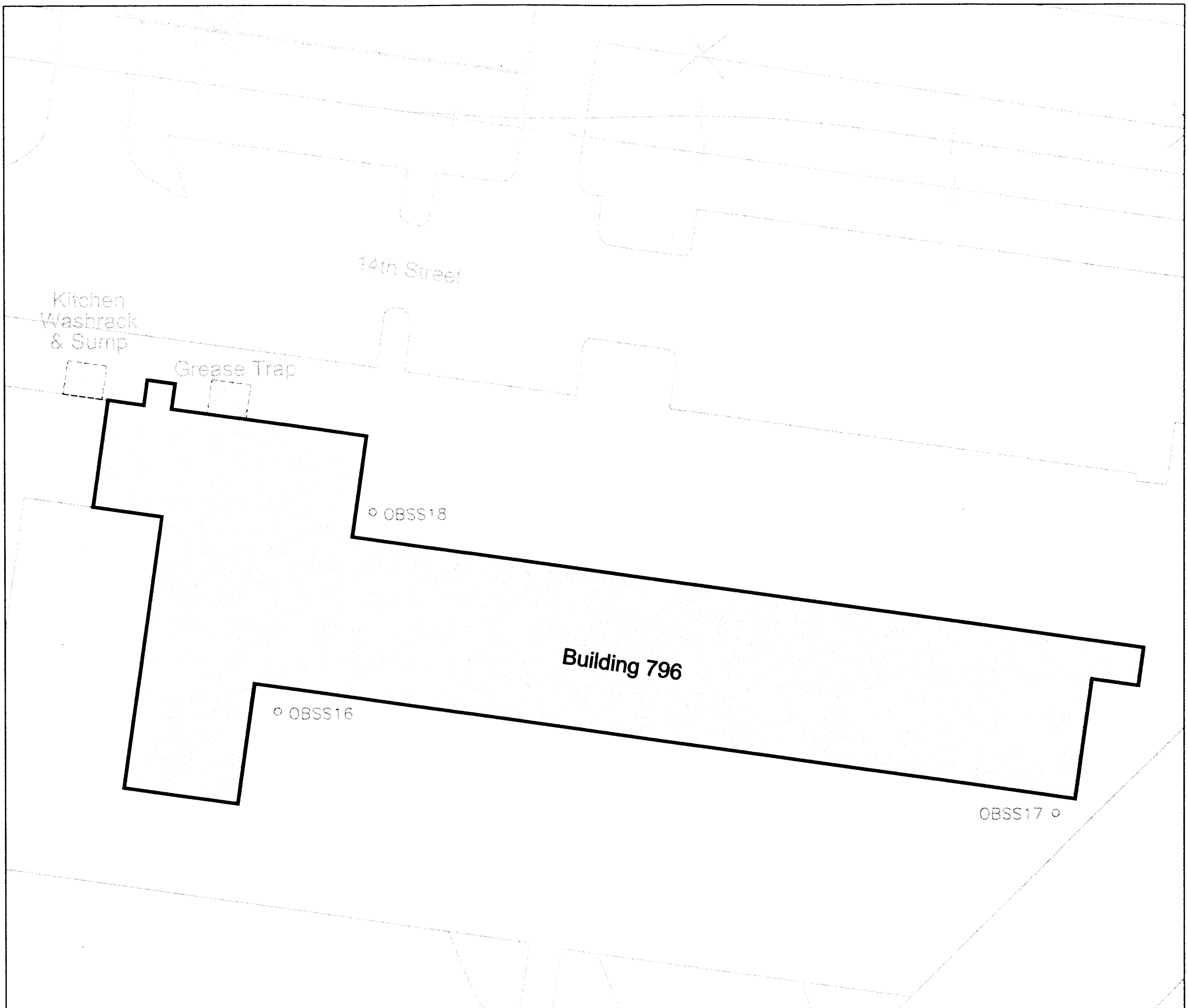
Building 650 is a former Army guest house in which MILESTONES HUMAN SERVICES, INC., through its Milestones-East Bay Center program, operates a licensed residential drug and alcohol treatment facility for homeless men and women in Building 650 under a contract the California Department of Corrections. Occupying the first floor of Building 650 (also known as Jacobs Guest House), the program offers a comprehensive set of services ranging from substance abuse treatment, literacy and education, life skills, employment preparation, placement, counseling, and aftercare services. There are nine full-time staff members for a resident population of 25. The program operates 24 hours per day, 7 days a week.

Former Buildings S-651 and S-654, located in the footprint of Building 650, were designated by the Office of the Post Engineer at Oakland Army Base as "bachelor officers' quarters" and "post office", respectively (Post Map, Oakland Army Base, dated 28 May 1943 (Revised 16 December 1947), Office of the Post Engineer; General Site and Building Use Map, 5 August 1960). Former Buildings S-651 and S-654 were constructed in 1942 and were demolished sometime after 1966.

According to the property card for Building S-651 on file at the Oakland Army Base, dated 21 April 1948, Building S-651 was heated with an oil-fired furnace. A drawing entitled "General Heating Plan", sheet 9 of 16, dated 14 May 1963 shows a 500-gallon underground heating oil storage tank located near former Building S-651. No records were reviewed by EKI or the Port indicating that the tank was removed.

As part of its Phase II Investigation, the Army advanced two soil borings in the possible location of the 500-gallon former heating oil tank near former Building S-651. No petroleum hydrocarbons or volatile organic compounds were detected in soil above analytical method reporting limits. Low concentrations of 1,2,4-trimethylbenzene (0.26 µg/L), ethylbenzene (0.31 µg/L), xylenes (0.31 µg/L), toluene (0.21 µg/L), and diesel (130 µg/L) were detected in a grab groundwater sample from one of the borings. The Army also constructed monitoring well ITMW249 near Building 650 to the West. No organic COCs were detected in soil sampled from this well boring above analytical method reporting limits. No metals were detected in soil at concentrations above residential PRGs. Low concentrations of ethylbenzene (0.46 µg/L), xylenes (0.52 µg/L), toluene (0.25 µg/L) and diesel (200µg/L) were detected in groundwater collected from the monitoring well.

As part of its Phase II Investigation, OBRA collected four surface soil samples around Building 650 and analyzed the samples for lead. Lead concentrations in these samples ranged from 22 mg/kg to 460 mg/kg.



N

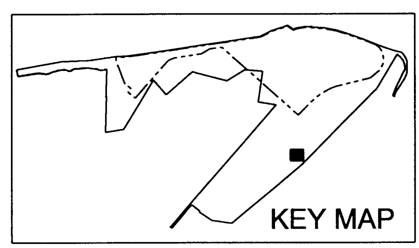
0 50 100

(Approximate Scale in Feet)

EXPLANATION:

Footprint of Former Building or Feature

Soil Sample



Erler & Kalinowski, Inc.

Building 796 Area

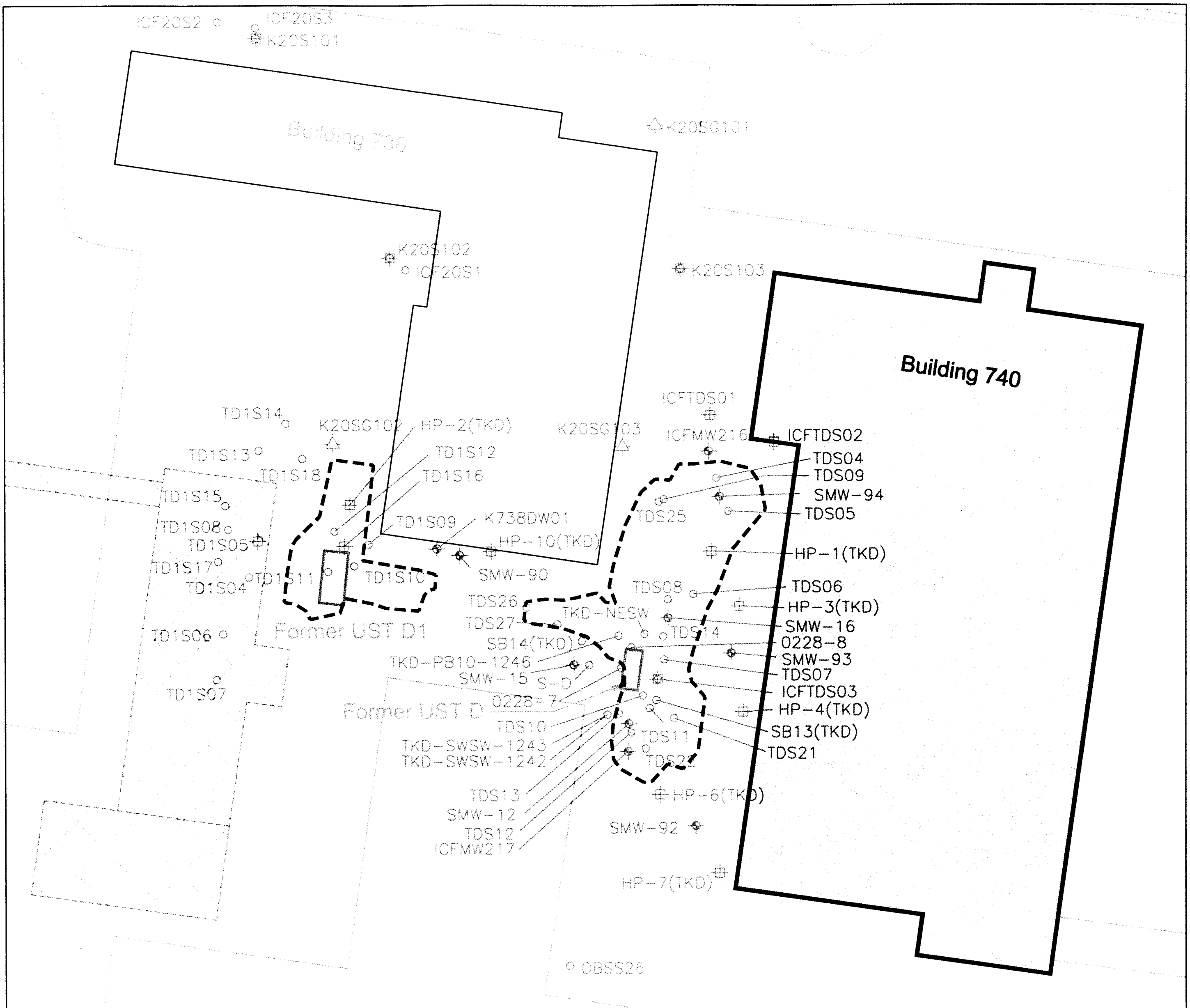
Oakland Army Base
Oakland, CA

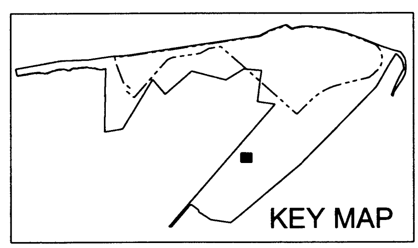
September 2002
EKI A10063.00

Figure D-1

Notes:

1. All locations are approximate.
2. Basemap taken from IT Corporation "OARB Site Map", dated 17 February 1999.





EXPLANATION:

- Footprint of Former Building or Feature
- Approximate Limit of Excavation Boundary
- Monitoring Well
- Grab Groundwater Sample
- Soil Sample
- Soil and Grab Groundwater Sample

Notes:

1. All locations are approximate.
2. Basemap taken from IT Corporation "OARB Site Map", dated 17 February 1999.

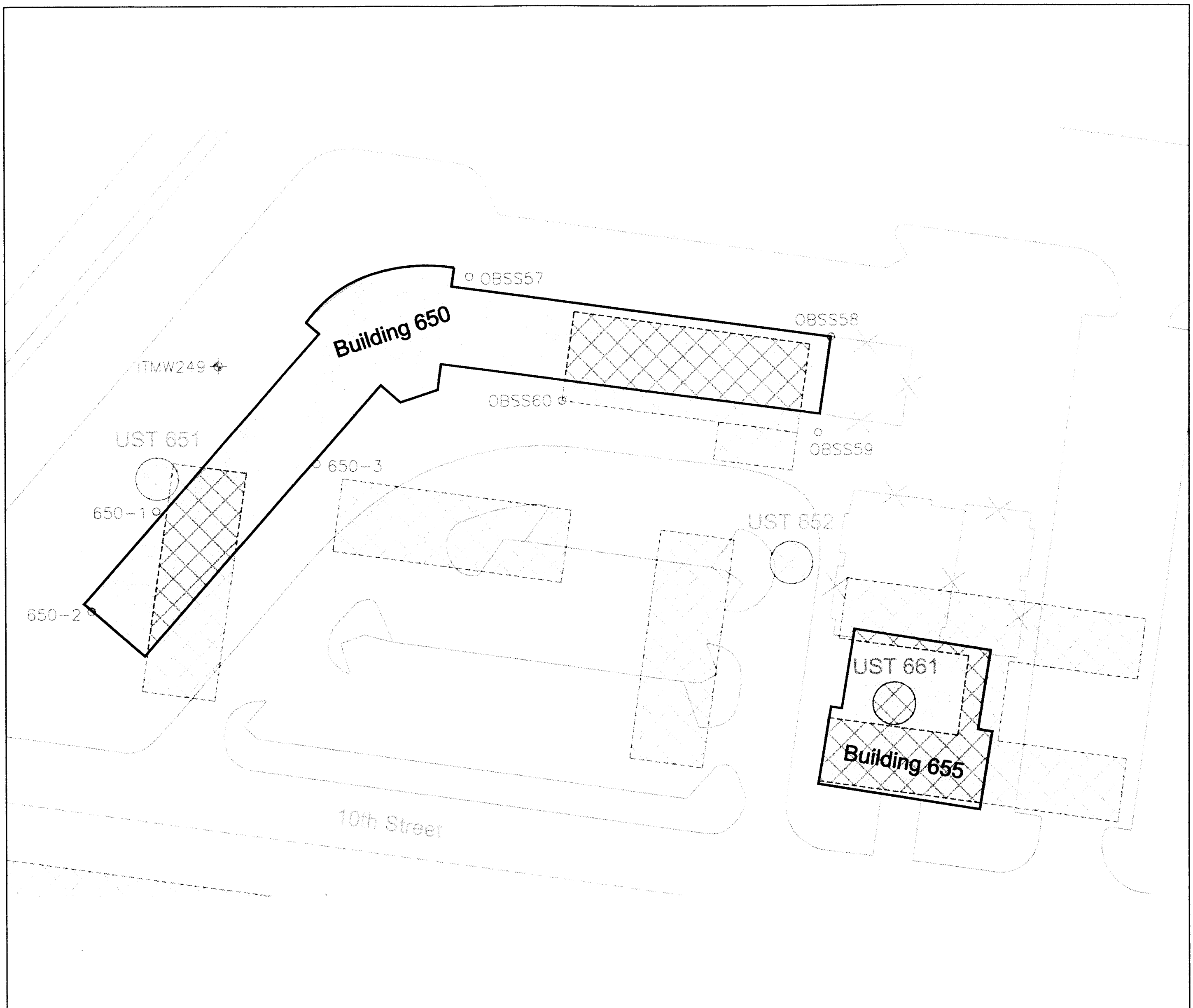
Erler & Kalinowski, Inc.

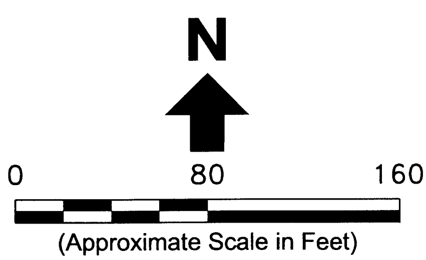
Building 740 Area

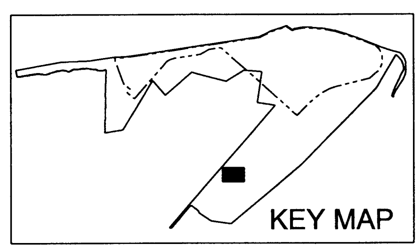
Oakland Army Base
Oakland, CA

September 2002
EKI A10063.00

Figure D-2







EXPLANATION:

- Footprint of Former Building or Feature
- Monitoring Well
- Soil Sample

Notes:

1. All locations are approximate.
2. Basemap taken from IT Corporation "OARB Site Map", dated 17 February 1999.

Erler & Kalinowski, Inc.

Building 650 and 655 Area

Oakland Army Base
Oakland, CA

September 2002
EKI A10063.00

Figure D-3

E

APPENDIX E

Risk Management Plan
(Under Separate Cover)

F

APPENDIX F

Responsiveness Summary

F. RESPONSIVENESS SUMMARY

The Department of Toxic Substances Control (DTSC) issued a public notice on July 22, 2002 to invite the public to comment on the Remedial Action Plan (RAP) and Risk Management Plan (RMP). A public notice and a fact sheet were mailed to approximately 730 individuals, government agencies, and other parties. The public notice was also published on the Oakland Tribune and the San Francisco Chronicle on July 22, 2002 announcing the 30-day public comment period. DTSC held a public meeting on August 6, 2002 at the West Oakland Multipurpose Senior Center to provide information and answer questions about the proposed remedies. The comment period ended on August 21, 2002. DTSC received four written comments and one verbal comment during the public meeting. This Responsiveness Summary contains restatement of the public comments, DTSC's responses, and copies of the actual comment letters and transcripts of verbal comments.

<u>Comments from Mr. William R. Kirkpatrick, East Bay Municipal Utility District, Letter Dated August 12, 2002</u>

Comment 1: *The practice of the District is to not install pipelines or services in soil with contamination levels which would expose workers to dermal or respiratory impacts that cannot be mitigated by Level D personal protective equipment or which would generate soil or groundwater that requires disposal as a hazardous waste. If the District is requested to construct water pipelines and services, wastewater interceptors or pump stations within areas of contamination, depending on the level and type of contamination, the location may not be feasible due to the potential for unacceptable exposure to District personnel when performing installation, repairs, or maintenance.*

Response: Construction activities will be performed within the entire RMP Implementation Area with selected levels of personal protective equipment specified in site-specific health and safety plans that are required by the RMP. The RAP and RMP further require that contamination encountered during repair or replacement of infrastructure including subsurface utilities will be remediated consistent with the remediation goals established in the RAP. Excavated soils will be tested and managed for use on-site or for off-site disposal in accordance with the protocols in the RMP. Responsibilities for remediation and management of waste soils will be retained by the City of Oakland or its designated contractors or agents as provided in its project plans and specifications. Thus, it is envisioned that known or encountered areas of contamination, e.g., where personal protective equipment levels higher than Level D may be required, would be remediated prior to installation or repair of utilities by East Bay Municipal Utility District or that utilities will be placed in suitable corridors established by the City or its designees.

Comments from Ms. Diane Heinze, Port of Oakland, Letter Dated August 21, 2002

Comment 1: *Section 8.3.2 of the RMP requires after the construction of permanent improvements, annual physical inspections of the property to confirm adequate cover so that COC impacted soils are not exposed, groundwater is not being used for any purpose, and to confirm that other requirements of the Land Use Covenant are being followed. The text further states that the covered materials will be inspected for breaches, gaps, breaks, depressions, etc. Descriptions of the observed condition of the covered areas will be noted in the inspection reports, and necessary repairs performed. The Port suggests that the inspection of cover materials be limited to observation of areas where breaks in cover materials result in the exposure of native material, not to document cracks where no exposure exists.*

Response: The text in Section 8.3.2 of the RMP on page 8-4 has been revised to state that the routine inspection of cover materials will be for purposes of identifying areas where exposures to on-site personnel may be greater than assumed in the development of remediation goals in the RAP. Inasmuch as the cover requirements are primarily to preclude direct human contact with the underlying soils, and not to provide an impermeable barrier, the RMP does not intend documentation of minor cracking of cover materials. Cracking that may indicate, or be expected to result in, significant deterioration of cover materials will be identified and repaired in accordance with the RMP.

Comment 2: *Section 2.4 of the RAP specifies that any property that is not being transferred via the Economic Development Conveyance (EDC) is not considered in this RAP/RMP. For clarification, note that any off-site property adjacent to the EDC area which may be contaminated from Army activities in the EDC area is an Army-Retained Condition such as off-site pesticides described in Section 4.4.3.6 of the RAP.*

Response: The Army remains responsible for all contaminants located outside the EDC area, including for example the off-site pesticide wetland remediation area, Parcel 1, and the area near Building 991. The term "Army-Retained Condition" actually refers to certain types of contaminants on the EDC area that, if discovered, remain the responsibility of the Army to remediate in accordance with applicable legal requirements.

Comment 3: *Page 1-1 of the RMP states that the RMP will become an appendix to, and enforceable, as part of, the Land Use Covenant ("LUC"). The RMP should not be an appendix to the LUC (which runs with the land) because changes to the RMP will occur. For example, portions of the RMP that describe sampling of known RMP locations (7.4 Soil Management Protocols), and reporting results to DTSC (5.1.4 Completion Reports) will be excluded from the RMP after DTSC approval of the completion report to eliminate possible future redundant sampling. The RMP should only appear as a citation in the LUC with the understanding that the RMP will be modified over time with DTSC concurrence as already anticipated in the RMP, e.g., see Section 5.2.*

There are assurances outside the deed (and LUC) that future site owners and developers will be aware of, and required to implement, the requirements of the then-current RMP. This assurance is provided by the City of Oakland's permit tracking program via the issuance of building permits.

Response: Agreed. The text on page 1-1 of the RMP has been modified to explain that the RMP, or the most current version of the RMP as it may be amended from time to time with approval of the DTSC, will be cited in the land use covenants as a specified requirement; however, the RMP will not be appended to the land use covenants.

Comment 4: *Section 3.2 of the RAP and 2.1 of the RMP state that: "During the first half of 1900s, the Army Corps of Engineers ("ACE") and Port of Oakland placed over 6.5 million cubic yards ("cy") of dredged sand and imported soil to create the land subsequently acquired by the Army." This is incorrect. The Port of Oakland did not place imported soil as fill. The following provides suggested modified language:*

"Prior to the Army's occupancy of the Oakland Army Base in January 1941, most of the property was partially filled with dredge spoils placed by the Army Corps of Engineers ("ACE"), the City and subsequently the Port of Oakland (Annual Reports of the ACE; City of Oakland, 1918, Lease to the Union Construction Company and W.W. Johnson and H.G. Peake doing business under the firm name and style of Union Construction Company, 4 April; Minor Woodruff, 2000. Pacific Gateway: An Illustrated History of the Port of Oakland). The only land area was around the Union Construction Company's buildings. During 1941, the ACE and the Army (referred to at the time as the S.F. Port of Embarkation) placed over 6.5 million cubic yards ("cy") of dredged sand and imported soil to create the remainder of the land area (Army Port Contractors, 1941, Progress report to August 31, 1941 dated 4 September; Bechtel-McCone-Parsons Corporation, 1941, Plot Plan Oakland Port and General Depot, 22 July; Labarre, R.V., 1941, Report on Foundation Investigation and Studies of Proposed Oakland Port and General Depot for Bechtel-McCone-Parsons Corporation, May-June; Army Port Contractors, 1942, Completion Report; and Rogers, David and Sands Figuers, 1991, Engineering Geologic Site Characterization of the Greater Oakland-Alameda Area, Alameda and San Francisco Counties, California. Final Report to National Science Foundation).

Response: The text in these two sections has been revised in response to the above comment, and the additional reference documents have been added to the RAP and RMP reference lists.

Comments from Ms. Lea Loizos, ARC Ecology, Letter Dated August 21, 2002

Comment 1: *Writing a RAP prior to full characterization of the site is contradictory to the CERCLA process and undermines the quality of the report. Without full characterization of the majority of the RMP sites, the possibility remains for the extent of contamination to be greater than what was originally expected and it is difficult to accept that the proposed remedies will be protective of human health. Relying on base use history as a guide to the remaining contamination in the RMP sites is an insufficient method of characterization.*

Response: Under the National Oil and Hazardous Substances Pollution Contingency Plan, included in both CERCLA and the California Health and Safety Code, Chapter 6.8, characterization of a site is intended to be sufficient so that appropriate remedial actions can be selected. U.S. EPA makes this point clear when its identifies time and cost as the two primary constraints in developing and implementing a sampling strategy to characterize a site under CERCLA. In the *Risk Assessment Guidance for Superfund, Volume I - Human Health Evaluation Manual (Part A)*, dated December 1989, U.S. EPA states the following:

"In general, it is important to remember when developing the sampling strategy that detailed sampling must be balanced against the time and cost involved. The goal of RI/FS sampling is not exhaustive site characterization, but rather to provide sufficient information to form the basis for site remediation."

Characterization of the OARB, including identification of RAP sites and RMP locations, was developed through a process equivalent to an adequate Preliminary Endangerment Assessment. As such, all sites for which historical records, photographs, interviews with past employees, and preliminary sampling have been identified. DTSC believes that characterization to date is sufficient to select remedies or suites of remedies to be applied to contamination. Further sampling of known sites to aid in design of remedies is contemplated. The RMP further provides for a specific process to be followed in the event that a site is discovered for which no previous evidence existed.

Thus, the RMP provides a level of environmental response action beyond what is typically obtained in cleanup of specific CERCLA sites. The RMP provides protocols for managing redevelopment work in all areas of the base, including areas of no known chemical use history or just suspected potential release locations. All RMP locations as identified in the RMP will be sampled during redevelopment, and protocols obligating the construction contractors to report and manage unknown release locations, if and when encountered, are contained in the RMP.

Comment 2: *More importantly, the RMP only addresses how unknown contamination will be addressed if discovered. There is no mention of who will cover the costs of unexpected remediation. What protections are in place to insure that the contamination will be remediated and not left in place due to lack of funding?*

Response: The City of Oakland is identified as the party responsible for remediation of the OARB through a Consent Agreement with DTSC. The City of Oakland in turn has secured some funding from the Army, has committed the City's funds, and has purchased environmental remediation insurance that will provide funds in the event that new release locations are discovered or the planned remediation, e.g., at identified RAP sites, becomes more costly than now estimated.

Comment 3: *Furthermore, how can it be assumed that contamination will be discovered during redevelopment if no prior sampling is required of the area? It is inappropriate to assume that a visual inspection of soils will identify contamination.*

Response: There is no basis on which to specify sampling points or analytes to consider at locations not already identified as RAP sites or RMP locations. As would typically be the case at a construction site, not otherwise identified as contaminated, visual or olfactory clues serve to suggest that the site requires further evaluation. In addition to visual inspection of soils, the RMP requires that at least two soil samples be collected within ten feet of each RMP location (Section 7.4 of the RMP). The RMP specifies that environmental sampling for a wide range of chemicals of concern will be conducted at all RMP locations as identified in the RMP, unless available data are determined to be adequate.

Comment 4: *Section 2.2.2, page 2-3 of the RMP states that RMP [locations] include former industrial and chemical handling locations with little or no subsurface environmental data. If little or no sampling has been conducted in these areas, how can one be certain that the contamination is minimal?*

Response: Soil and groundwater sampling was conducted at six of the seven "Former Industrial and Chemical Handling Locations" RMP locations during the Army and the Oakland Base Reuse Authority (OBRA) Phase II Investigations in May 2002. The results are summarized in Section 4.4.4.3 in the RAP. The words "with little or no subsurface environmental data" have been deleted in the subject text. See also responses to Comments 1 and 3 above.

Comment 5: *The RMP makes the assumption that buildings, asphalt roadways, concrete pavement, and other cover types existing and planned at OARB may adequately protect human health against contact with petroleum hydrocarbons and other COCs most frequently identified at RMP sites. (Section 1.1, page 1-4) Again, not knowing the full extent of contamination, it is impossible to assume that this type of cover will be protective of all remaining, undiscovered contamination.*

Response: As discussed in the response to Comment 1, much is known about the chemicals of concern ("COCs") at the base. This information has been used in accordance with state and federal guidance to establish risk-based remediation goals and to select appropriate remedies as documented in the RAP. In general, there are few areas on the base with COCs that cannot be contained by simple cover materials. Areas with elevated concentrations of VOCs, for example, are targeted for active remediation as RAP sites. Further, any RMP locations that are determined to be poor candidates for RMP type remedies will be reevaluated for other remedies as defined in the RAP.

Comment 6: *Page 4-2 (40) RMP: The RMP mentions the possibility of contaminated ground water migrating to San Francisco Bay through the gravel or sand beddings that surround storm drains. This potential problem is not mentioned anywhere else in the document.*

Response: The comment relates to a potential condition, not one that is now documented to be occurring. Section 10.2.2.7 of the RAP describes the selected remedial alternative for storm drains and sanitary sewers. Remediation of contaminated media near storm drains and sewers in accordance with the remediation goals established in the RAP is required. Removing contaminated soil when found along existing storm drains and sanitary sewers, as well as other RMP locations, will serve to remediate localized impacts to groundwater by eliminating possible sources of COCs to the shallow water-bearing zone. Further, as stated in Section 6.1.1 of RMP, repair and replacement of subsurface utilities will incorporate design features such as grout collars and the like, where necessary.

Comment 7: *Who will pay for the costs of implementing the required engineering controls and routine groundwater monitoring discussed in Section 7 of the RMP?*

Response: The City of Oakland is obligated under the Consent Agreement to ensure implementation of applicable long-term maintenance and monitoring requirements of the RMP.

Comment 8: *Rather, it should be assumed that all previously unsampled RMP sites are contaminated until proven otherwise. Sampling should be required at all RMP sites before redevelopment activities begin.*

Response: See response to Comment 1. Most RMP locations were sampled during the Army's various remedial investigations or the Army's and OBRA's Phase II Investigations in May 2002. Tables 1 and 2 in the RMP summarize the investigations at each RMP location and have been updated to reflect which locations were investigated during the Army and OBRA Phase II environmental sampling activities.

Comments from Ms. Louise J. Belle, Letter Dated August 3, 2002

Comment 1: *I think it is a waste of energy, plastic, and other resources to send out CDs unless specifically on request.*

Response: The CD was used in an effort to minimize the volume of paper and number of binders that would be required to provide the public with copies of the environmental data. Access to the data is necessary for many reviewers of the documents. Without use of the CD, a huge amount of paper would have been needed. In the future, the CDs will be provided to selected agencies and parties. The CDs will also be sent to individuals whom have requested copies.

Comments from Ms. Elaine Wyrick-Parkinson during Public Meeting on August 6, 2002
(Summarized Generally from Public Meeting Transcript)

Comment 1: *Why did the Army only recently find that Building 1 was toxic? The "ooze" was known about a long time ago.*

Response: The concerns about the characteristics and need for remediation of the tarry residue beneath and near Building 1 have evolved over the past few years as additional information has been obtained from observations of the "ooze", reviews of records and historical aerial photographs, and completion of subsurface environmental investigations in areas where access is possible. This information is summarized below.

According to Army's records, the Army constructed Building 1 in 1941 during the early stages of World War II when the OARB began operations. An oil reclaiming plant ("ORP") reportedly operated on the site from the 1920s through the 1930s. The Army removed the aboveground ORP facilities prior to constructing Building 1.

At the time of the operation of the former ORP, tidal mudflats were present immediately to the north and northwest beyond a bulkhead. From historical aerial photographs, the area of staining indicates that the waste from the ORP was likely deposited onto the mudflats (1939 aerial photograph from University of California at Berkeley Photo Archives and 1941 aerial photograph, Army records). This area was later covered by dredged fill and dry fill during the construction of the Army facilities in 1941 and 1942; however, a thick, tarry layer under this fill area remains (*Draft Feasibility Study for Operable Unit 1, Oakland Army Base, Oakland*, California, Revision B, dated 26 January 2001 ("Draft Feasibility Study") at pp.1-6 to 1-7).

Building 1, made up of four wings, was built on the filled land just north of the former ORP and is supported by green wooden pilings, driven 45 to 70 feet deep. The pilings would have penetrated the fill, the tarry layer, and mud, finally stopping in the underlying Merritt Sand layer. Creosoted pilings, approximately 20 feet long, were attached to the top of the green pilings, and these in turn support the main beams in the building crawl space (Draft Feasibility Study at p.1-7).

In the Army's Draft Feasibility Study, IT Corporation indicates that early oil recycling processes included the addition of concentrated sulfuric acid to the oil as a pretreatment step. The sulfuric acid would act as an oxidizer to remove unsaturated hydrocarbons, sulfur, nitrogen and oxygen compounds as well as resinous and asphaltic compounds. The separated oil would then undergo distillation or fractionation to produce the useful components such as various oils. The residuals from this process would consist of a heavy mixture of undistillable hydrocarbons and sulfuric acid sludge left in the bottom of the tanks. The waste was too acidic and unprofitable to neutralize. Therefore, it is likely that it was simply dumped on-site, as there were no environmental laws prohibiting such actions at the time (Draft Feasibility Study at pp.1-6 to 1-7).

The thick, tarry residue, sometimes referred to as "ooze," has been observed on several occasions to surface in and around Building 1. In 1994, the Army removed and replaced a section of pavement in the eastern parking lot between Wings 1 and 2, where buckled asphalt and a tar-like substance were observed. In 1998, the Army excavated a broader area in the same parking lot to remove a tar-like substance. The excavation continued toward Wing 2 of the building, but excavation efforts ceased approximately 15 feet from the building foundation due to utility and structural concerns.

In 2000, the Army found a tarry substance extruding through the joints of the sanitary sewer line during a video camera examination of the pipes. The presence of the tarry material prevented examination beyond 80 feet due to slipping drive wheels on the video camera. Also in 2000, City of Oakland employees discovered a tar-like substance in the crawl space of Wing 1, some 120 feet to the southeast of the previous parking lot excavation. The substance was extruding from the subsurface through a small gap between the wooden piling and the concrete vermin-protection slab. The substance had a black skin that was stiff and slightly resilient, appearing to be an oxidized layer over a softer interior. When the outer layer was penetrated, a clear watery liquid welled up and squirted out as if under pressure. The liquid reacted with the concrete slab, producing a faint hissing and bubbling. A test with pH paper indicated a very strong acid and faint traces of sulfurous and nitrous gases were noticed (Draft Feasibility Study at p.1-7).

As recently as March 2002, Army investigators again found that the tarry material had surfaced in the crawl space of Building 1 at a piling.

Laboratory analysis of the oily residue has confirmed its acidic nature. Lead has been measured at a concentration as high as 11,800 mg/kg in the oily residue.

The material also contains polycyclic aromatic hydrocarbons ("PAHs"), polychlorinated biphenyls ("PCBs"), polychlorinated dibenzodioxins ("PCDDs"), and polychlorinated dibenzofurans ("PCDFs") at concentrations of concern. PAHs were the contaminants in the tarry residue that contributed to the Army's finding of an unacceptable human health hazard requiring remediation (Draft Feasibility Study at pp. 1-8, 2-9 to 2-10). Available laboratory analytical results indicate, at a minimum, that the tarry material when excavated or removed would probably meet the State of California and Federal definitions of a hazardous waste.

The Army noted that the presence of the ooze in the crawl space of Building 1 indicates that changes can and are occurring in the subsurface under Building 1. Analysis confirmed that free liquid present within the ooze exhibits a pH of 1, likely due to pockets of sulfuric acid. In its draft Feasibility Study in January 2001, the Army concluded that remediation of contaminants in the soil at the former ORP area, including under and around Building 1, is warranted due to its potential mobility and the unacceptable health risks from exposure to the tarry residue (Draft Feasibility Study at p. 2-9). Similarly, the RAP identifies the ORP/Building 1 area as one of seven RAP Sites planned for active remediation in advance of any redevelopment activities.

Comment 2: *Building 1 can be saved if we want to save it.*

Response: Tarry residue beneath Building 1 cannot be removed with the structure present. To provide sufficient clearance for excavators and other heavy equipment to access the tarry residue, Building 1 must be demolished because it is not feasible to relocate it. Building 1 is a large, multi-winged structure, and Wings 1 and 2 of Building 1 comprise approximately one-half of the building, or about 80,000 square feet. Temporary relocation of Building 1 during remediation would involve separating Wings 1 and 2 and utilities from the remaining wings, stabilizing both segments, placing the structure to be removed on a dolly, raising the structure, and cutting the existing wood pilings after the building has been lifted. After remediation (which would involve excavation with heavy equipment), new pilings would be constructed and the building would be returned to the site and reconnected. The Army concluded that based on the "inherent risk and uncertainties involved with the temporary relocation of Wings 1 and 2, demolition, was selected" (see pages 2-12 through 2-13 of Draft Feasibility Study). This conclusion is also consistent with the findings in the Draft Historic Building Reuse Alternatives Report, which concludes; "Building 1, though modular in plan, was considered excessively large to consider relocating. Additionally, its historic significance and prominence on the Base would be compromised by relocation. For these reasons, relocation of Building 1 has not been included in the cost estimates presented in this report".

Public Comments

1. Mr. William R. Kirkpatrick
   East Bay Municipal Utility District, Letter Dated August 12, 2002

2. Ms. Diane Heinze
   Port of Oakland, Letter Dated August 21, 2002

3. Ms. Lea Loizos
   ARC Ecology, Letter Dated August 21, 2002

4. Ms. Louise J. Belle
   Community Member, Letter Dated August 3, 2002

5. Ms. Elaine Wyrick-Parkinson
   Community Member, Verbal Comments during Public Meeting on August 6, 2002

EAST BAY
MUNICIPAL UTILITY DISTRICT

August 15, 2002

DEPARTMENT OF TOXIC SUBSTANCES CONTROL
SITE MITIGATION BRANCH
BERKELEY
AUG 19 2002
STATE OF CALIFORNIA EPA
RECEIVED

Mr. Henry Wong, Remedial Project Manager
Department of Toxic Substances Control
700 Heinz Avenue, Suite 200
Berkeley, CA 94112

Dear Mr. Wong:

Re: Draft Remedial Action Plan/Draft Risk Management Plan -
Oakland Army Base, Oakland

East Bay Municipal Utility District (District) appreciates the opportunity to comment on the Draft Remedial Action Plan/Draft Risk Management Plan for Oakland Army Base. The District has the following comments regarding water and wastewater services at the project site.

The subject document discusses at length the presence of a variety of contaminants in the soil and the groundwater, each with various levels of contamination depending upon location. The District is concerned about the presence of heavy metals, particularly lead from old paint on the buildings, volatile organics, solvents, MBTE, and Benzene.

The practice of the District is to not install pipelines or services in soil with contamination levels which would expose workers to dermal or respiratory impacts that cannot be mitigated by Level D personal protective equipment or which would generate soil or groundwater that requires disposal as a hazardous waste. If the District is requested to construct water pipelines and services, wastewater interceptors or pump stations within areas of contamination, depending on the level and type of contamination, the location may not be feasible due to the potential for unacceptable exposure to District personnel when performing installation, repairs, or maintenance.

If you have any questions or if the District can be of further assistance, please contact Marie A. Valmores, Senior Civil Engineer, Water Service Planning, at (510) 287-1084.

Sincerely,

WILLIAM R. KIRKPATRICK
Manager of Water Distribution Planning

WRK:WWMcG:sb
sb02_288.doc

cc: Ms. Aliza Gallo, Executive Director

375 ELEVENTH STREET . OAKLAND . CA 94607-4240 . (510) 835-3000

PORT OF OAKLAND

August 21, 2002

Mr. Henry Wong
Remedial Project Manager
Department of Toxic Substances Control
700 Heinz Avenue, Suite 200
Berkeley, CA 94112

Subject : Oakland Army Base – Port of Oakland's Comments on the Draft Remedial Action Plan/Risk Management Plan

Dear Henry:

This letter contains the Port of Oakland's (Port) comments on the "Draft Remedial Action Plan" and "Draft Risk Management Plan" ("RAP/RMP") dated 19 July 2002 prepared by Erler & Kalinoswki, Inc., for the Oakland Base Reuse Authority ("OBRA") and the Department of Toxic Substances Control ("DTSC"). As a future Site Owner and Developer of the Port Development Area ("PDA") as documented in OBRA's Final Reuse Plan, the Port trusts you will consider the following comments when preparing and approving the final RAP/RMP.

1. Section 8.3.2 Periodic Inspection of Site Capping Materials

This section requires after the construction of permanent improvements, annual physical inspections of the property to confirm adequate cover so that COC impacted soils are not exposed, groundwater is not being used for any purpose, and to confirm that other requirements of the Land Use Covenant are being followed. The text further states that the covered materials will be inspected for breaches, gaps, breaks, depressions, etc. Descriptions of the observed condition of the covered areas will be noted in the inspection reports, and necessary repairs performed. The Port suggests that the inspection of cover materials be limited to observation of areas where breaks in cover materials result in the exposure of native material, not to document cracks where no exposure exists.

2. Off-site Contamination

Section 2.4 of the RAP specifies that any property that is not being transferred via the EDC is not considered in this RAP/RMP. For clarification, note that any off-site property adjacent to the EDC area which may be contaminated from Army activities in the EDC area is an Army Retained Condition such as off-site pesticides described in Section 4.4.3.6 of the RAP.

3. Request for Elimination of the RMP as an Appendix to the Land Use Covenant

Page 1-1 of the RMP states that the RMP will become an appendix to, and enforceable, as part of, the Land Use Covenant ("LUC"). The RMP should not be an appendix to the LUC (which runs with the land) because changes to the RMP will occur. For example, portions of the RMP that describe sampling of known RMP locations (7.4 Soil Management Protocols), and reporting results to DTSC (5.1.4 Completion Reports) will be excluded from the RMP after DTSC approval of the completion report to eliminate possible future redundant sampling. The RMP should only appear as a citation in the LUC with the understanding that the RMP will be modified over time with DTSC concurrence as already anticipated in the RMP, e.g., see Section 5.2.

There are assurances outside the deed (and LUC) that future site owners and developers will be aware of, and required to implement, the requirements of the then-current RMP. This assurance is provided by the City of Oakland's permit tracking program via the issuance of building permits.

4. Placement of Imported Soil as Fill

Section 3.2 of the RAP and 2.1 of the RMP state that: "During the first half of 1900s, the Army Corps of Engineers ("ACE") and Port of Oakland placed over 6.5 million cubic yards ("cy") of dredged sand and imported soil to create the land subsequently acquired by the Army." This is incorrect. The Port of Oakland did not place imported soil as fill. The following provides suggested modified language:

> "Prior to the Army's occupancy of the Oakland Army Base in January 1941, most of the property was partially filled with dredge spoils placed by the Army Corps of Engineers (" ACE"), the City and subsequently the Port of Oakland (Annual Reports of the ACE; City of Oakland, 1918, Lease to the Union Construction Company and W.W. Johnson and H.G. Peake doing business under the firm name and style of Union Construction Company, 4 April; Minor Woodruff, 2000. Pacific Gateway: An Illustrated History of the Port of Oakland). The only land area was around the Union Construction Company's buildings. During 1941, the ACE and the Army (referred to at the time as the S.F. Port of Embarkation) placed over 6.5 million cubic yards ("cy") of dredged sand and imported soil to create the remainder of the land area (Army Port Contractors, 1941, Progress report to August 31, 1941 dated 4 September; Betchtel-McCone-Parsons Corporation, 1941, Plot Plan Oakland Port and General Depot, 22 July; Labarre, R.V., 1941, Report on Foundation Investigation and Studies of Proposed Oakland Port and General Depot for Bechtel-McCone-Parsons Corporation, May-June; Army Port Contractors, 1942, Completion Report; and Rogers, David and Sands Figuers, 1991, Engineering Geologic Site Characterization of the Greater Oakland-Alameda Area, Alameda and San Francisco Couties, California. Final Report to National Science Foundation).

If you have any questions, please contact me at 510-627-1467.

Sincerely,

Diane Heinze, P.E.
Associate Port Environmental Scientist

Cc : Michele Heffes, Port of Oakland
Jon Amdur, Port of Oakland
Roger Caswell, OARB
Joshua Bloom, Bingham McCutcheon
Yane Nordhav, BASELINE
Tom Kalinowski, EKI
Jennifer Hernandez, Beveridge & Diamond

Arc Ecology

Environment, Economy, Society, & Peace

August 21, 2002

Henry Wong
Remedial Project Manager
Department of Toxic Substances Control
700 Heinz Ave., Suite 200
Berkeley, CA 94112

BY FAX: 510-849-5285

RE: Draft Remedial Action Plan (RAP)/Risk Management Plan (RMP) for Oakland Army Base, Oakland, CA

Dear Mr. Wong:

Arc Ecology has reviewed the above-mentioned document. I am pleased to see that active remediation has been chosen for all of the RAP sites. I am, however, concerned with the assumptions being made in the RAP/RMP about sites that have yet to be fully characterized. Writing a RAP prior to full characterization of the site is contradictory to the CERCLA process and undermines the quality of the report.

Without full characterization of the majority of the RMP sites, the possibility remains for the extent of contamination to be greater than what was originally expected and it is difficult to accept that the proposed remedies will be protective of human health. Relying on base use history as a guide to the remaining contamination in the RMP sites in an insufficient method of characterization.

More importantly, the RMP only addresses how unknown contamination will be addressed if discovered. There is no mention of who will cover the costs of unexpected remediation. What protections are in place to insure that the contamination will be remediated and not left in place due to a lack of funding? Furthermore, how can it be assumed that contamination will be discovered during redevelopment if no prior sampling is required of the area? It is inappropriate to assume that a visual inspection of soils will identify contamination.

Specifically:

- Section 2.2.2, page 2-3 of the RMP states that RMP include former industrial and chemical handling locations with little or no subsurface environmental data. If little or no sampling has been conducted in these areas, how can one be certain that the contamination is minimal?

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- The RMP makes the assumption that buildings, asphalt roadways, concrete pavement, and other cover types existing and planned at OARB **may** adequately protect human health against contact with petroleum hydrocarbons and other COCs most frequently identified at RMP sites. (Section 1.1, page 1-4) Again, not knowing the full extent of contamination, it is impossible to assume that this type of cover will be protective of all remaining, undiscovered contamination.

- Page 4-2 (40) RMP: The RMP mentions the possibility of contaminated ground water migrating to San Francisco Bay through the gravel or sand beddings that surround storm drains. This potential problem is not mentioned anywhere else in the document.

- Who will pay for the costs of implementing the required engineering controls and routine groundwater monitoring discussed in Section 7 of the RMP?

In order to create remedies that are truly protective of human health, it is preferred that further characterization of the site be completed prior to redevelopment of OARB. Given my experience at other military installations, it is dangerous to make assumptions about undiscovered contamination. Rather, it should be assumed that all previously unsampled RMP sites are contaminated until proven otherwise. Sampling should be required at all RMP sites before redevelopment activities begin.

I appreciate the opportunity to review this document. If you have any questions, please contact me at 415-495-1786.

Sincerely,

Lea Loizos
Staff Scientist

Louise J. Belle

08/03/02

To DTSC – California EPA:

Thank you for the materials on the Oakland Army Base reuse proposal. – But one thing I do not need is the CD. I think it is a waste of energy, plastic, & other resources & materials to send out CDs unless specifically on request.

Please send the CD (enclosed) to someone else, or reuse/recycle it. (You could also package the CDs in paper sleeves instead of hard plastic.)

Thank you,

L.J. Belle

L. Belle
P.O. Box 5271
Berkeley, CA 94705

PUBLIC MEETING

STATE OF CALIFORNIA

DEPARTMENT OF TOXIC SUBSTANCES CONTROL

OAKLAND ARMY BASE

DRAFT REMEDIAL ACTION PLAN

RISK MANAGEMENT PLAN

WEST OAKLAND MULTIPURPOSE SENIOR CENTER

1724 ADELINE STREET, SECOND FLOOR

OAKLAND, CALIFORNIA

TUESDAY, AUGUST 6, 2002
6:30 P.M.

Reported by:
Peter Petty

ORIGINAL

Comments from Ms. Wyrick-Parkinson during the public meeting on 8/6/02

Base. And consistent with Mike's first RAP site, Building 1 Oil Reprocessing Plant residue, the Army has applied for a Land Disposal Restriction variance from USEPA, so that the material can be stabilized onsite and then buried in a California landfill. This meets protection of the environment, an effective use, and a cost effective way to do it.

There are -- I brought a notice along, a public notice, which will be mailed out in a general mailing shortly, that sketches the LDR variance process and what we're intending to apply it to.

Thank you.

PUBLIC PARTICIPATION SPECIALIST RYAN: Thank you very much.

At this point we'd like to open the floor, open the meeting to questions from -- we have representatives from the Army, from the Department of Toxic Substances Control, from EKI, and from OBRA, present, who can answer questions relative to the presentations that just were presented, or any other questions you may have regarding the Oakland Army Base.

So is there anyone who would like to have a question at this time?

MS. WYRICK-PARKINSON: I'm late coming, I know. I have a million, but that's all right. I need to look at the materials first. Thank you.

Where are you on the agenda?

PUBLIC PARTICIPATION SPECIALIST RYAN: We are just about at the Formal Comment period, which will be Number 4.

MS. WYRICK-PARKINSON: Oh, you're all over. So I can't ask any questions.

PUBLIC PARTICIPATION SPECIALIST RYAN: Yes, you can. That's -- this is your opportunity to ask any questions, if you'd like, prior to the comment segment of the meeting.

MS. WYRICK-PARKINSON: Yeah. Well, can I -- through the Chair, I'd like to address -- one of the things I was concerned about was I -- oh, yes. My name is Elaine Wyrick-Parkinson, and I am with the -- as well as the RAP.

And I, in the comments, I notice where Mr. Rogers had written a letter, and in the letter he said how poisonous Building 1 was. And I wonder why he didn't mention all the other things that's supposed to be left out there at the Army base that's still there. And that was a concern of mine.

And the other concern that we have worked, I started working on the RAP with Mr. Keller, and that was one of the cleanest spots on the Army base, was Building 1. And here, when we get way down the road, Building 1 is so poisonous until you can't even go near it, and I just can't imagine how Mr. Caswell could write such a letter, because I was really surprised to read it. And because we had said that we knew when Mr. Keller was there, there was a ooze in the back of the building. And we had wondered where it came from. They had done a lot of research on it, so they say. And so now I'm wondering about what did the RAP really do. What did we really do out there?

It seems like to me that we spent millions of dollars, and we didn't do what we were supposed to do, because I can't see in the last couple of months that a building could become so poisonous where people have worked there for years, and there are no symptoms. And I just wonder and question the letter. And I guess I always will, because working on the RAP and going to the Army base, at one time I went to the Army base once every month to meet with the environmentalists. And each one said that that building was one of the cleanest building, except for I think -- well, they said it was very little lead, very little asbestos at that particular building. So it was almost toxic free.

And I just can't imagine overnight that these things happened. And I question what did we really do. Now, when I say we, I mean the RAP, what did we really clean up at the Army base. I bet if we went out there and started all over again with new environmental people, we would find either it's -- it's, what is that, leaking clean, whatever that little saying is, or it's filthy. One or the other. And so, because it's, you know, the building became hot when the port decided they wanted the other side of the Army base. Then this building began to be questioned, and little by little we were finding things wrong with it. And then all of a sudden, it exploded, and we found everything wrong with it. It's the dirtiest building on the entire Army base.

And I find that very questionable. And so, you know, I really plan to write some letters to find out, or do some calling to find out what is really wrong with that building, because I just can't believe it. And so -- and I know, I have worked, and I know what you do as an employee. I know those kind of things, they become very political. And being political, things do happen.

And so -- and the rest of the Army base, it's all in question because we spent so many years and the community came out on the short end of the stick. And so I guess that's why very few of us are sitting at the table today, due to the fact, or even in the audience, of us coming out on the short end of the stick. And so I still say we can save Building 1 if we want to, because there isn't anything you can't save, just like the two little girls they separated their little heads today. Took them 20 hours, but they're still breathing. So you can do anything you want to do. All you have to do is set your mind for it, and go ahead and do it.

We talk about money, but money was here when many years ago they had some means of money, or exchange. So it can be done, and we can find money. There's grants and everything to save historical buildings. And so we realize this, but we've gone along with the story, and it has been a very interesting story and a very educational story, for me.

Thank you.

PUBLIC PARTICIPATION SPECIALIST RYAN: Would you like a response from the Army?

MS. WYRICK-PARKINSON: There's no response. I already know what it is. So I don't need one, because I'm on the RAP. And I was at the meeting Thursday night, so I know what the answer is. It can't be any different, because Thursday night was the hearing downtown. So if it has changed, I'm sure downtown would be very interested in the change. So I don't need an answer.

PUBLIC PARTICIPATION SPECIALIST RYAN: Is there anyone else who would like to pose a question or comment to the panel at this time, before we actually solicit formal comment?

If not, then we would like to invite you to present any formal comments you might have for the record regarding the presentation you heard tonight. If there is any, you could please present them at this time.

Well, apparently there is not. Again, this is the opportunity to have your comments on the record, and they would be responded to in writing. So once more, I'd like to ask if there is anyone present who would like to do this at this time.

If not, our meeting would be adjourned. Thank you very much for attending.

(Thereupon, the public meeting was concluded at 7:04 p.m.)

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