N68311.000731
NAVSTA LONG BEACH
SSIC #5090.3

LONG BEACH NAVAL COMPLEX RESTORATION ADVISORY BOARD MEETING NOTICE

To All RAB Members and interested parties:

The next LBNC RAB Meeting will be held on Tuesday, 21 May 1996 at 7:00 P.M. at the Long Beach Naval Shipyard, Building 300, 1st Floor (entering through Gate 5).

The Agenda for this RAB meeting will include:

- Finalize Response to Comments on Draft RI for IRP Site 7
- Debrief - 7 May 1996 Technical Workshop on IR Site 7
- The Signing of the new 1996-1997 Rules of Operation
- Workshop - Draft RI for IR Sites 8-13 (Long Beach Naval Shipyard)

RAB Members are requested to review the enclosed 16 April 1996 Minutes, and provide any corrections at the 21 May 1996 meeting.

If you have any questions or comments about the LBNC RAB, please feel free to contact:

Alan K. Lee
BRAC Environmental Coordinator, Naval Station
619-532-1250
or
Anna Ulaszewski
BRAC Environmental Coordinator, Naval Shipyard
(310) 547-7868
or
Ernie McBride
LBNSY Public Affairs Officer
(310) 547-7798

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ENCLOSURE

RESTORATION ADVISORY BOARD MEETING MINUTES

DATED 16 APRIL 1996

IS ENTERED IN THE DATABASE AND FILED AT ADMINISTRATIVE RECORD NO. **N68311.000728**

RESTORATION ADVISORY BOARD (RAB) MEETING
Long Beach Naval Shipyard, Building 300, 1st Floor
21 May 1996

AGENDA

7:00 P.M. Administrative Issues - Chair: Alan Lee

- Approval of 16 April 1996 Meeting Minutes
- Signing of the new Rules of Operation
- Announcement = Jennifer Rich, DTSC Public Participation Specialist

7:15P.M. Finalize Response to Comments on Draft RI for IRP Site 7 (Long Beach Harbor, West Basin)

The RAB will discuss the 7 May 1996 Technical Workshop and associated response to comments.

7:45 P.M. WORKSHOP - Draft RI for IRP Sites 8-13 (Long Beach Naval Shipyard)

Susan Livenick, CTO Leader for BNI, will present the work scope and findings of the draft Remedial Investigation report for IR Sites 8-13 (Long Beach Naval Shipyard).

8:30 P.M. Open Meeting to RAB members and members of the audience

9:00 P.M. Adjourn

sent out 4/19 in prep for the 5/21/96 mtg).

ENCLOSED PLEASE FIND THE EXECUTIVE SUMMARY, CHAPTER 1 AND CHAPTER 8 FROM THE LBNSY DRAFT RI FOR YOUR REVIEW. IF YOU WOULD LIKE TO REVIEW THE DOCUMENT IN ITS ENTIRETY, THE FULL 8 VOLUME SET IS IN THE LONG BEACH PUBLIC LIBRARY, OR ANY DOCUMENT REVIEW GROUP MAY REQUEST A COPY FOR THEIR REVIEW.

IF YOU HAVE ANY QUESTIONS, PLEASE FEEL FREE TO CONTACT EITHER ALAN LEE AT 619-532-1250 OR ANNA ULASZEWSKI AT 310-547-7868.

THE WORKSHOP ON THE DRAFT RI DOCUMENT IS SCHEDULED FOR THE MAY ~~20~~ 21, 1996 RAB MEETING.

EXECUTIVE SUMMARY

This Remedial Investigation (RI) Report presents the findings, conclusions, and recommendations of sampling conducted at Long Beach Naval Shipyard (LBNSY) as part of the Department of the Navy (DON) Installation Restoration (IR) Program. The objectives of this report were outlined in a Work Plan (Jacobs Engineering Group Inc. [JEG] 1993a), approved by DON and regulatory agencies. The Work Plan included a program for moving the identified potentially contaminated sites at LBNSY through the Remedial Investigation and Feasibility Study (RI/FS) process to a Record of Decision (ROD). The RI Report has been prepared by Bechtel National, Inc. (BNI) in accordance with the IR Program, and Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) guidance.

This RI Report addresses Operable Units (OUs) 4 and 5 at the Long Beach Naval Complex (LBNC), which consist of six IR Program sites identified on LBNSY in the Initial Assessment Study (Naval Energy and Environmental Support Activity [NEESA] 1983) and/or the Resource Conservation and Recovery Act (RCRA) Facility Assessment (State of California Department of Health Services). Sampling was conducted at IR Program Sites 8, 9, 10, 11, 12, and 13 from August 1994 to June 1995, in two phases, Planned and Conditional. Data collection activities were performed in compliance with the approved Work Plan and the Sampling and Analysis Plan (SAP) prepared by JEG (1993b) (Comprehensive Long-Term Environmental Action Navy [CLEAN] I contractor) and Technical Memoranda Numbers 1 and 2 prepared by BNI. Naval Station (NAVSTA) Long Beach IR Sites 1 through 6 are addressed in a separate report (BNI 1995b). IR Site 7 (the harbor sediments), which is shared by LBNSY and NAVSTA, is also addressed in a separate report (BNI 1996).

The six sites included in this RI Report have been investigated previously, and an effort has been made to make maximum use of existing data to attempt to establish site conditions and characterize potential risks. The data quality objectives established in the Work Plan were modified during the Conditional Phase. These modifications were needed to (1) identify data gaps, and (2) adjust a small portion of the field sampling for field conditions not anticipated during the Work Plan preparation.

The field investigation was conducted in two phases. After the first phase of the investigation which was conducted consistent with the sampling requirements of the SAP (JEG. 1996b) and Technical Memorandum Number 1 (BNI 1994b), Technical Memorandum Number 2 was prepared. It provided sampling detail for the second phase of the field investigation.

During the second phase of investigation, it became apparent that, although soil contamination at each IR site could be characterized, neither the groundwater contamination on Sites 9, 12, and 13 nor the groundwater regime in the two OUs could be characterized based on the approaches presented in the Work Plan, the SAP, and the two Technical Memoranda. For that reason, this RI Report presents an evaluation of the extent of contamination of soils at IR Sites 8 through 13, and presents all data collected on groundwater during the RI field investigation. IR Sites 9, 12, and 13 require further investigation of the hydrogeologic conditions and groundwater

A brief discussion of each of LBNSY IR Sites is included below.

- IR Site 8 – Building 210, Trichloroethylene (TCE) Disposal Site. This site is located in a parking lot and access road Gate 3 along the northern boundary fence of LBNSY and was identified because of the TCE suspected to have been disposed there.
- IR Site 9 – Building 129, Ground Floor Spills. This site is located in a Controlled Industrial Access (CIA) area of LBNSY and includes the following areas: the ground surface beneath Building 129 and the area north of Building 129, referred to as the "former Quonset Hut" site. From 1940 to 1973, many of the electrical and weapons shops operated on the first floor of Building 129, generating waste oils, greases, and solvents associated with degreasing and paint removal operations. These industrial wastes were reportedly disposed of into two concrete trenches, which were reported to have periodically overflowed. Also, spillage reportedly occurred from process tanks during daily operations. In addition, a spill of TCE reportedly occurred in 1974 or 1975 on the paved area immediately north of Building 129, in the former Quonset Hut area. The spill reportedly involved approximately 15 drums of TCE and caused the asphalt pavement to be "rolled up. "
- IR Site 10 – Lot H Past Operations. This site is located primarily in Parking Lot H near Gate 5 in the northeastern portion of LBNSY. From about 1952 to 1957, an unpaved scrap yard was situated on the site. The hazardous materials reportedly stored there included batteries, waste oil, equipment containing mercury, and spent sandblast material. During semiannual auctions of the batteries for reclamation, the battery acid was reportedly disposed of by pouring it on the ground. It was estimated that 1,700 to 2,400 gallons of battery acid per year may have been disposed of in this manner. Infrequent, unintentional releases of mercury may have occurred from radar equipment stored in the scrap yard.
- IR Site 11 – Hillside East of Drydock Number 1. The site is a north-south strip of land approximately 1,700 feet long, located in the eastern part of LBNSY. In 1975, spent black sandblast grit containing paint residues was reportedly used to fill in low areas within the site and to extend the edge of the embankment westward. No records were found to document the quantity of spent sandblast abrasives ultimately disposed of at the site. Sandblast material was reportedly removed in 1977 from the southern hillside. In January and February 1994, approximately 1,400 cubic yards of additional sandblast contaminated soil were removed from the southern hillside and placed in the level area to the south. The source of potential contamination at the site (spent sandblast grit) has been identified, and is still present on-site.
- IR Site 12 – Lot X Toxic Sandblast Grit Disposal. The site is located in the central portion of Pier Echo, east of Skipjack Road on LBNSY. Between 1971 and 1975, 72 to 100 tons of spent sandblast grit containing paint chips, which may have contained metals and organotins, were reportedly disposed of at a location in Lot X; the disposal volume was estimated to have been 15 feet by 15 feet by 10 feet deep. Another potential waste disposal area in IR Site 12 involved drum-crushing operations in Lot X that took place between 1986 and 1988. Drum contents reportedly had included epoxy-based paints, cleaning solvents such as TCE, lubricating oils, and other petroleum-based products.

EXECUTIVE SUMMARY (continued)

- IR Site 13 – Tank Farm Area near Building 303. The site is contiguous with the southern boundary of IR Site 12, in the eastern section of LBNSY. The site is a hazardous waste storage area (tank farm) that has been operated from the early 1970s until the present. There have been no reports of any large spills or leaks, but some areas of the asphalt are stained, probably indicating leakage from drums or releases from tank-flushing operations conducted on-site.

The RI field investigation included collecting 455 soil samples; drilling 31 soil borings and 7 hand-auger locations; installing 61 HydroPunch® groundwater sampling locations; pushing 30 Strataprobe™ and 3 Geoprobe® locations; performing soil gas sampling at 2 locations; installing and/or sampling 21 groundwater monitoring wells; installing 7 piezometers; and performing aquifer slug tests on 14 groundwater monitoring wells. Samples were collected and analyzed as outlined in the approved SAP (JEG 1993b).

Chemicals that were identified during the RI were further evaluated to identify potential human health risk under industrial land use scenarios at IR Sites 8, 9, 10, 11, 12, and 13 (IR Sites 12 and 13 have been combined for risk assessment since the chemicals of potential concern [COPCs] are similar). Analytical results for these chemicals are summarized below:

- IR Site 8 – Chemicals including Contract Laboratory Program (CLP) Target Compound List (TCL) volatile organic compounds (VOCs) and Target Analyte List (TAL) metals were detected in the soil. Solvents including acetone and methyl ethyl ketone (MEK) and TAL metals were detected in the groundwater.
- IR Site 9 – Chemicals including CLP TCL VOCs, TCL semivolatile organic compounds (SVOCs), TAL metals, total petroleum hydrocarbons (TPHs), and total recoverable petroleum hydrocarbons (TRPHs) were detected in the soil. VOCs including 1,1,1-trichloroethane (1,1,1-TCA), 1,1-dichloroethane (1,1-DCA), 1,1-dichloroethylene (1,1-DCE), 1,2-dichloroethylene (1,2-DCE), acetone, benzene, carbon disulfide, chloroform, ethylbenzene, MEK, tetrachloroethylene (PCE), toluene, TCE, vinyl chloride, and xylenes; and TAL metals were detected in the groundwater.
- IR Site 10 – Chemicals including CLP TCL VOCs, TCL SVOCs, TAL metals, and polynuclear aromatic hydrocarbons (PAHs) were detected in the soil. Analytes detected in the groundwater consisted of CLP TCL VOCs, including carbon disulfide, 1,1-DCA, 1,2-DCE, and TCE; TCL SVOCs, including acenaphthene, pyrene, and 1,2,4-trichlorobenzene; and TAL metals.
- IR Site 11 – Chemicals including PAHs, SVOCs, organotins, and TAL metals were detected in the soil and sandblast grit. TAL metals were detected below background concentrations in the groundwater.
- IR Site 12 – Chemicals including VOCs, PAHs, SVOCs, pesticides, polychlorinated biphenyls (PCBs), organotins, and TAL metals were detected in the soil. VOCs, PAHs, SVOCs, and TAL metals were detected in the groundwater.

- IR Site 13 – Chemicals including VOCs, PAHs, SVOCs, pesticides, PCBs, organotins, and TAL metals were detected in the soil. VOCs, PAHs, SVOCs, and TAL metals were detected in the groundwater.

Physical data were evaluated and compiled into geologic cross sections and physical conceptual models. These figures, in combination with soil and groundwater chemistry and geotechnical data, were used to compile the extent of contamination and to evaluate the fate and transport of constituents in soil and groundwater and assess the general quality of the groundwater below LBNSY. Based on the water quality data collected, the first-encountered (shallow) groundwater below is primarily saline (TDS concentrations of 10,000 to 100,000 mg/L).

Background threshold values were established for 19 select metals in soil and groundwater. Background concentrations are identified in order to distinguish between naturally occurring and site-related metals. A geochemical and statistical approach was used to establish background threshold values for metals in soil. The geochemical approach examines the tendency for a metal to adsorb onto iron, manganese, or aluminum oxides to estimate the background levels for metals in soils. A geochemical background is selected when available, otherwise a statistical background level is used. The statistical method used is determined by the distribution of each background dataset. Both parametric and nonparametric statistical methods were utilized to estimate the background for metals in soil and groundwater. The data used for establishing background were from locations across LBNC and Port of Los Angeles. The detected concentration for each metal was compared with the corresponding background threshold value to delineate the nature and extent of impact at each site.

A vadose zone leaching analysis was performed to assess the potential for COPCs in the soil to impact the groundwater. The computer modeling programs Vadose Zone Leaching Model and Analytical Transient One-, Two-, Three-Dimensional (Simulation) were used to assess the leaching and migration of the chemicals in soil from the vadose zone to the shallow water-bearing zone, and then to the Southern California Edison (SCE) Long Beach Generating Station dewatering system. As a means of environmental screening, the model results were compared to the California Enclosed Bays and Estuaries Plan criteria, California Ocean Plan criteria, and the Federal Water Quality criteria for receiving waters. The results of these comparisons suggest that the concentrations of the vadose zone chemicals found during field activities would not exceed the screening criteria or the level of detection in the SCE discharge water.

Concentrations of organic contaminants in the soil and groundwater at the IR Sites in LBNSY were evaluated using U.S. Environmental Protection Agency (U.S. EPA) Industrial Preliminary Remediation Goals (PRGs) only (U.S. EPA 1995a). Residential PRGs or the use of them were not evaluated. Concentrations of inorganic contaminants in soil and groundwater at the IR Sites in LBNSY were compared to background values.

Areas of potential concern (AOPCs) were defined based on similar mechanisms and types of potential contamination, similar types of potential exposure, or potential remedial actions (JEG 1993a). The AOPCs defined in the Work Plan were modified based on the RI results, and address only the soil. Groundwater AOPCs were not defined in the RI Work Plan, and are introduced in this report.

EXECUTIVE SUMMARY (continued)

Analytical data were evaluated and COPCs were identified. Analytic data were reviewed for usability under Risk Assessment Guidance for Superfund and the Work Plan. The COPC database was then statistically evaluated to calculate the 95 percent upper confidence limit (UCL) concentrations for all remaining analytes; these UCL concentrations were used as input to the Baseline Human Health Risk Assessment calculations. The incremental lifetime cancer risk and the chronic hazard index were calculated for industrial and maintenance/utility worker scenarios, which have been deemed the most likely exposure scenarios for current and future land use. Chemicals of concern (COCs) and corresponding areas of concern (AOCs) were identified based on the results of the industrial and maintenance/utility scenarios.

The estimated incremental lifetime cancer risks for both the industrial worker and maintenance/ utility worker scenarios were within or below the NCP-defined generally acceptable range for all of the sites except IR Site 12, AOC 1. The cancer risk at IR Site 12, AOC 1, which has been evaluated as an unpaved site, was predominantly associated with exposures to the soil media. Figure ES-1 presents cancer risk estimates for the soil medium for the IR sites by receptor.

With the exception of IR Site 9, the concentrations of noncarcinogenic chemicals do not appear to be high enough to cause systemic toxicity in the industrial worker or the maintenance/utility worker on any of the sites. The risk at Site 9 was solely associated with exposures to the groundwater medium.

On IR Site 12, AOC 1, the estimated incremental lifetime cancer risk was approximately 4.1×10^{-5} for the maintenance/utility worker and 2.9×10^{-4} for the industrial worker. These estimates are within the NCP-defined generally acceptable range for the maintenance/utility worker, but exceed the acceptable range for the industrial worker. The carcinogenic risk is driven by elevated concentrations of PAHs, in particular, benzo(a)pyrene concentrations found within AOC 1, the Drum-Crushing Area. The concentrations of benzo(a)pyrene in the soil on IR Site 12, AOC 1 are significantly higher than the rest of IR Site 12. The in-place volume of soil within IR Site 12 with concentrations of COCs exceeding risk-based concentrations is approximately 9,375 cubic yards.

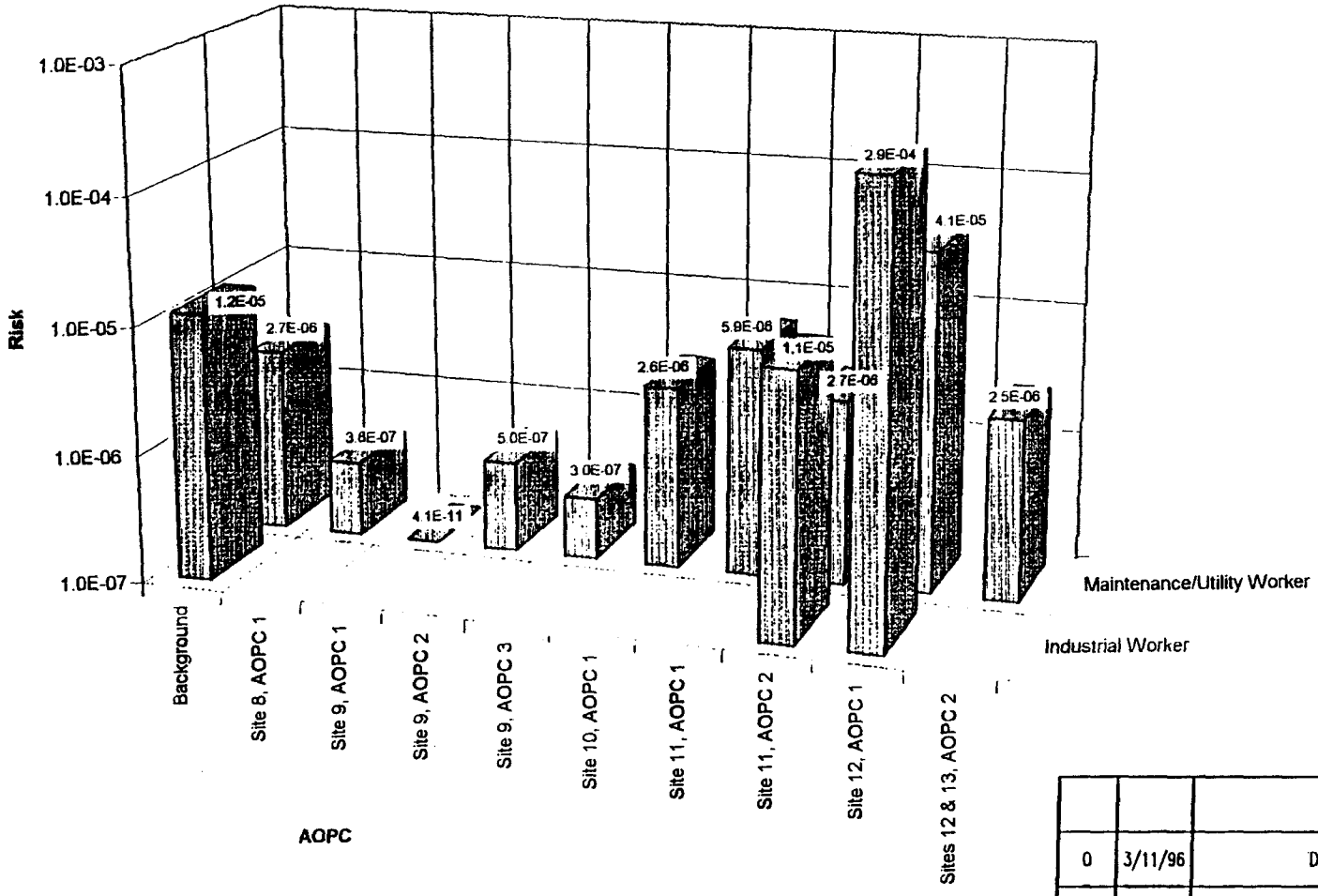
Table ES-1 lists the recommended future action at each of the IR sites and the rationale for these recommendations.

As discussed earlier in this section, this RI characterizes the vadose zone soil within each IR site. The groundwater investigation conducted under this RI did not define the extent of groundwater contamination in IR Sites 9, 12, and 13, and further groundwater investigation is recommended. The evaluations and conclusions in this report are based on currently available information that contains inherent uncertainties and could vary if further data concerning the site or its conditions or other information become available.

Table ES–1
Recommended Future Actions

IR Site	AOPC	Media	Proposed Action	Rationale
8	1	Soils	No further action	Risk is below NCP departure point.
9	1-3	Soils	No further action	Risk is below NCP departure point.
10	1	Soils	No further action	Risk is within NCP generally acceptable range.
11	1	Soils	No further action	Risk is within NCP generally acceptable range.
11	2	Soils	No further action	Risk is within NCP generally acceptable range.
12/13	1	Soils	Remedial action	Risk exceeds NCP generally acceptable range.
12/13	2	Soils	No further action	Risk is within NCP generally acceptable range.
8/10/11		Groundwater	No further action	Risk is below NCP departure point.
9		Groundwater	On/off-site plume delineation	On/off-site extent and sources unknown.
12/13		Groundwater	Source identification	On/off-site sources unknown.

Acronyms:
AOPC – area of potential concern
NCP – National (Oil and Hazardous Substances Pollution) Contingency Plan



Note: Risk to the industrial worker is only presented for AOPCs with identifiable COPCs.

REV	DATE	REASON FOR REVISION	BY	CHECK	APPROVAL
0	3/11/96	DRAFT RI	ECN	E.L.	

RI REPORT

FIGURE ES-1
SUMMARY OF TOTAL LIFETIME CANCER RISK FOR THE SOIL COPCs TO THE INDUSTRIAL AND MAINTENANCE/ UTILITY WORKER FOR THE UPPER-BOUND EVALUATION

NAVAL SHIPYARD, LONG BEACH, CALIFORNIA

Bechtel National, Inc
CLEAN II Program

DATE: 3/11/96
FILE NO.: NC786.DWG
JOB NO.: 22214-037

Section 1
INTRODUCTION

The Department of the Navy (DON), Southwest Division Naval Facilities Engineering Command (SWDIV) has contracted Bechtel National, Inc. (BNI), to conduct a Remedial Investigation/ Feasibility Study (RI/FS) at Long Beach Naval Shipyard (LBNSY) under SWDIV's Comprehensive Long-Term Environmental Action Navy (CLEAN) II Contract Number (No.) N68711-92D-4670. This RI Report was prepared by BNI for LBNSY in accordance with the "Guidance for Conducting Remedial Investigations and Feasibility Studies under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)" and the following planning documents:

- Final RI/FS Work Plan (Jacobs Engineering Group Inc. [JEG] 1993a). The Work Plan describes the rationale and proposed scope of RI/FS activities, and provides background on the RI/FS sites.
- Final Sampling and Analysis Plan (SAP) (JEG 1993b). The SAP provides information necessary to conduct the field investigation task including details for conducting field sampling during a Planned Phase of investigation and concepts for a Conditional Phase of investigation. The SAP also includes the Quality Assurance Project Plan (QAPP) and the Health and Safety Plan (HSP). The SAP describes field activities and rationale, specific field procedures, and quality assurance/quality control (QA/QC) protocol. The HSP describes procedures required to conduct field investigations safely and in conformance with Occupational Safety and Health Administration (OSHA) requirements and all applicable DON orders and directives. A HSP supplement was prepared to address site-specific health and safety issues and was issued in July 1994 (BNI 1994a).
- Final Community Relations Plan (CRP) (JEG 1993c). The CRP describes activities to keep the community informed and involved in the RI/FS process, as required by federal law.
- Final Technical Memorandum (Tech Memo) No. 1 (BNI 1994b). This memorandum proposes modifications to specific parts of the SAP for Installation Restoration (IR) Program Site 12; serves as an addendum to portions of this document and includes (1) an aerial photograph review conducted to determine if the reported pit or disposal areas identified in the SAP could be identified from photographs taken from 1971 to 1975 and, if found, to delineate the lateral extent of these disposal locations, and (2) proposed modifications of Planned Phase surface and subsurface soil and groundwater sampling strategies for IR Site 12.
- Final Tech Memo No. 2 (BNI 1995a). This memorandum proposes modifications to specific parts of the SAP; serves as an addendum to this document and includes (1) analytical results of the Planned Phase of sampling, and (2) proposed sampling locations and depth, media type, rationale, and analytical work for the Conditional Phase of sampling or the secondary phase of sampling.
- Final Data Management Plan (DMP) (BNI 1994c). The DMP describes the gathering, verifying, analyzing, reporting, and archiving of data gathered during the RI/FS.

- Final Investigation-Derived Waste (IDW) Management Plan (BNI 1994d). This plan describes the treatment and handling of IDW on-site, prior to disposal.
- Final Risk Assessment Work Plan (BNI 1994e). This document describes the scope and rationale for the Baseline Human Health Risk Assessment (BHHRA) using the data collected during the RI.
- Several telephone conference and meeting notes, documenting revision or addition to some of the above documents.

1.1 PURPOSES OF REMEDIAL INVESTIGATION

The purposes of this investigation are to attempt to characterize site conditions, assess the presence or absence, nature, and extent of contaminants, and assess the risk to human health as an industrial use facility at IR Program Sites 8 through 13 (hereafter referred to as IR Sites 8 through 13). The findings, recommendations, and professional opinions in this report have been developed within the limits prescribed by the government and are based on coordination with interested regulatory agencies. This report was prepared in accordance with generally accepted professional, environmental, and scientific principles and practices that exist in California today.

1.1.1 Data Quality Objectives

Data quality objectives (DQOs) are qualitative and quantitative statements that specify the quality of data required to support the decisions made during response activities. DQOs are based on the concept that different data users often require data of varying quality. DQOs for this RI report are identified in general planning documents including the Work Plan (JEG 1993a), the SAP (JEG 1993b) and Tech Memo #2 (BNI, 1995a). All the DQOs support the effort to collect data to be used for site characterization, risk assessment, and evaluation of remedial alternatives.

As detailed in the Final RI/FS Work Plan and SAP, prepared by the CLEAN I contractor, JEG, the general approach for these sites is to define areas of potential concern (AOPCs) based on similar migration mechanisms and types of potential contamination or similar remedial actions. These AOPCs would be handled as decision units within each site based on the sampling results and conditions at the site.

The DQOs, developed in the Work Plan and SAP for the Planned Phase were based on the concept that different data users require data of varying quality. The SAP did not develop specific DQOs for the Conditional Phase of sampling. The Conditional Phase was to be based on the results of the data collected during the Planned Phase.

During the Planned Phase of sampling, additional chemicals of potential concern (COPCs) were identified for which no DQOs had been developed in the SAP. Data gaps were identified after completion of the Planned Phase of sampling. A number of data gaps could not be resolved with the existing SAP-defined DQOs. Therefore, the seven-step DQO process was utilized in an effort to combine the data gaps and the additional

COPCs into the optimum sampling design. The United States Environmental Protection Agency (U.S. EPA) Quality Assurance Management Section (QAMS) seven-step DQO process (U.S. EPA 1994a) was used to define the conditional sampling program, as resolved in Tech Memo No. 2.

As specified in the SAP DQOs, a Conditional Phase of groundwater sampling was performed to evaluate the lateral and vertical extents of COPCs detected during the Planned Phase of sampling. The COPCs to be further evaluated, along with the number of samples and locations for the conditional sampling, were defined in the Tech Memo No. 2 (BNI 1995a).

The specific number of samples collected per medium per AOPC, the specific purpose of the sampling, the analytical QC levels, and uses for data collected during the RI are presented in the DQO summary tables (modified from JEG 1993b) in the site-specific sections of Section 5 in this report.

1.1.2 Site Characterization Objectives

Site characterization generally proceeds in three phases: review of existing information, site reconnaissance, and detailed investigations. The objectives of site characterization are:

- identify contaminants present,
- assess the extent of contamination,
- assess the quantities of contaminants present in the media being characterized, and
- assess the physical and chemical characteristics of the soil and/or groundwater for fate and transport analysis.

Site characterization information is essential to identify the need for remediation, to evaluate remedial technologies, and alternatives for each site.

The review of existing data includes evaluating present conditions at the six IR sites based on government-furnished data, previous studies and reports, and other documents as identified in this and subsequent sections of this report. This information has been reasonably relied on and has not been reverified by BNI, but has been supplemented by further investigation, including soil and groundwater sampling, as described in the following paragraphs and throughout this report.

The site reconnaissance and detailed investigation portions of the characterization for this RI were performed in Planned (primary) and Conditional (secondary) Phases of fieldwork. In addition to the overall sampling approach and sampling methods, specific prefield (i.e., aerial photograph review) and field activities for the Planned Phase were detailed in the SAP. The SAP specified the location, sample type and collection method, analytical method, and QC level for each sample collected during the Planned Phase. The SAP also specified a general number of additional samples on each site to be used in a

Conditional Phase of fieldwork based on the results of the Planned Phase. The additional fieldwork included a series of groundwater samples (from wellpoints or monitoring wells) on each site to delineate the extent of any plume detected during the Planned Phase. Only groundwater sampling was specified in the SAP for the Conditional Phase of fieldwork.

The data collected from the Planned Phase were evaluated to identify data gaps; this included the evaluation of analytical sampling results along with site-specific, facilitywide geologic and hydrogeologic data.

1.1.3 Operable Unit Designations

Operable Units (OUs) define an installation's remediation strategy. Contamination within a facility may be ultimately addressed as one or several OUs or portions of OUs. OUs represent discrete remedial response actions that manage migration, or eliminate or mitigate releases or pathways of exposure. Table 1-1 lists the OU designations and explanations for sites included in this RI.

OUs are typically defined as:

- areas with similar media or contaminated with similar waste materials,
- areas with similar geographic location (may equate with some designations),
- areas that may be remediated using similar techniques or within a similar time frame, and
- areas that are amenable to being managed in a single RI/FS.

Table 1-1
Operable Unit Designations for Naval Shipyard Long Beach RI/FS

Operable Unit	Sites	Rationale
OU 4	8, 9, 10, 12, and 13	Proximity of sites and similar hydrogeology conditions.
OU 5	11	Only site with reported confirmed surface contamination that may require a removal action (JEG 1993b).

1.1.4 Focus of the Remedial Investigation

This report presents the RI results for LBNSY IR Sites 8 through 13 (OUs 4 and 5). The field investigation and data evaluation process was performed in a similar manner at each of these six IR sites. Data from each of the sites were collected during two phases of field investigations (1994 and 1995), as specified in the Final RI/FS Work Plan, SAP, Tech Memo No. 1, and Tech Memo No. 2.

During the second phase of investigation, it became apparent that although soil contamination at each IR site could be characterized, neither the groundwater

contamination at IR Sites 9, 12 and 13 nor the groundwater regime could be characterized based on the approaches presented in the Final RI/FS Work Plan, SAP, and two Technical Memoranda. For that reason, this RI Report presents an evaluation of the extent of contamination of soils at IR Sites 8 through 13, and presents all data collected on groundwater during the RI field investigation. Characterization of the groundwater at IR sites 9, 12 and 13 will be the subject of a separate report.

1.2 FACILITY LOCATION AND DESCRIPTION

LBNSY is located in the eastern portion of Long Beach Naval Complex (LBNC). LBNC, which includes Naval Station (NAVSTA) Long Beach and LBNSY, lies on the southern side of Terminal Island within the Los Angeles and Long Beach Harbor districts, approximately 4 miles south of downtown Long Beach. LBNSY is bounded by Ocean Boulevard, and the Southern California Edison (SCE) Long Beach Generating Station (LBGS) to the north, Pier T and the Long Beach Harbor to the east, the Long Beach Harbor to the south, and NAVSTA to the west (Figure 1-1).

1.2.1 Long Beach Naval Shipyard Facilities

The LBNSY facilities are industrial in use:

- Pier Echo located south of Seaside Boulevard and west of Pier T Avenue;
- Drydock Nos. 1, 2, and 3 along the southern edge of the facility;
- Piers 1, 2, 3, and 6 along the southern edge, extending into the Long Beach Harbor West Basin; and
- Oil production easements within LBNSY property boundary, including one located to the east of Drydock No. 1, and another west of the Treatment, Storage, and Disposal unit on Pier Echo.

An oil production easement adjacent to a major transportation corridor bounds the property along the northern edge; the Long Beach Harbor West Basin is located along the southern property boundary; and the Long Beach Harbor lies to the north and east of LBNSY. On the west, LBNSY abuts NAVSTA Long Beach.

The majority of the land underlying the LBNSY facilities was reclaimed through hydraulic fill operations conducted between 1925 and the mid-1940s (Naval Energy and Environmental Support Activity [NEESA] 1983).

1.2.2 Demographics and Land Use

Land use in the vicinity of LBNSY is port-related, commercial, or industrial. On Terminal Island, the areas west and east of the facility are used for commercial shipping, liquid bulk handling, heavy industrial activities, and commercial fishing support activities. The area north of the facility (on Terminal Island) is used for oil production activities. Terminal Island consists of the western portion of the Port of Long Beach (POLB) and the eastern portion of the Port of Los Angeles (POLA).

Land use in the area of the POLB includes primary port uses, tank farms, automobile terminals, a cement terminal, cargo handling, and cargo terminals. The POLA has general cargo, liquid bulk, commercial fishing, industrial, container handling, as well as other commercial and recreational land use activities.

1.3 FACILITY HISTORY AND PREVIOUS INVESTIGATIONS

The following sections provide a summary of LBNSY history, including a brief description of modifications to Drydock Nos. 1, 2, and 3. Previous investigations are also discussed.

1.3.1 History

LBNSY is presently an industrial facility, and no use other than industrial for the facility has been identified by DON or the City of Long Beach. LBNSY records and historic aerial photographs indicate that prior to 1940, LBNSY Main Base property was and submerged land. In 1940, the Congress appropriated funds to build the Naval Shipyard. In August 1940, the Navy purchased 105 acres of coast land from the City of Long Beach (NEESA 1983), a portion of which became LBNSY. The following presents a summary of key events, for the LBNSY:

- Portions of submerged land adjoining this coast land were filled in the early 1940s during construction of the LBNC.
- In September 1942, Roosevelt Base was formally commissioned, and comprised the U.S. Navy Drydocks (LBNSY) and the present Naval Station.
- In March 1943, DON changed the facility name from Roosevelt Base to U.S. Naval Drydocks, Roosevelt Base (NEESA 1983).
- In July 1946, DON changed the facility name from Roosevelt Base to Navy Recreation Center.
- In March 1948, DON changed the facility name to LBNSY (NEESA 1983).
- In July 1950, LBNSY was placed on inactive status. In February 1951, the shipyard was reactivated.
- In 1970, DON initiated a short-range modernization program lasting through 1975.
- In 1974, DON initiated a long-range modernization program for improvements through 1980 (NEESA 1983).
- In 1974, the Secretary of Defense issued an order under the Shore Realignment and Disestablishment Program, in which LBNSY was designated as a Public Works Lead Activity (NEESA 1983).
- On June 1995, LBNSY was placed on the preliminary Base Realignment and Closure Act (BRAC IV) list of installations scheduled for closure.

The eastern portion of LBNSY consists of Pier Echo. Construction of Pier Echo began during the 1920s and was completed in the mid- to late 1950s. The pier was constructed in phases using hydraulic fill/dredging techniques. Cells were formed with rock jetties, concrete quay walls, or cellular bulkheading into which the dredged materials were hydraulically placed. In 1957, the DON leased 82.5 acres on Pier Echo, and, in 1964, the DON acquired the acreage which had been under lease (NEESA 1983).

The southern edge of the LBNSY consists of Drydock Nos. 1, 2, and 3. Drydock No. 1 was constructed from 1941 to 1942 and consists of a reinforced concrete structure, 1,092 feet long by 155 feet wide with a 48-foot depth of water at the sill. The elevation of the top of the drydock is 14 feet above mean lower low water (MLLW) (Woodward-Clyde Consultants [WCC] 1977). Between 1942 and 1967, when the Terminal Island area was subject to subsidence as discussed in Section 2, several remedial modifications to the drydock were initiated (see Section 2.1.4.2). These modifications included grouting of construction joints, placement of a steel sheet pile cutoff wall north of the outboard face of the drydock, and installation of hydrostatic relief wells and water pressure monitoring wells (WCC 1977). In the 1950s, several additional modifications were made to the drydock and included raising of the dike, quay, and sill walls, placement of concrete overlay along the floor of the drydock, and raising of the top of the drydock by 17 feet at the northern end and 11.6 feet at the southern end (WCC 1977). From the time it was constructed to 1954, the drydock had subsided an average of 16 feet (DON 1976). Drydock Nos. 2 and 3 were constructed in the early 1940s and were constructed with identical specification for length, depth, and width. The drydocks are 687 feet long, 104 feet wide, and 92 feet deep. From the time the docks were constructed to 1976, they subsided an average of 10 feet (DON 1976). No documentation of remedial modifications to Drydock Nos. 2 and 3 was located. No hydrostatic relief well system, as was constructed in Drydock No. 1, exists in Drydock Nos. 2 and 3 (DON 1976).

1.3.2 Previous Investigations

Between 1969 and 1992, several environmental investigations were completed at LBNC. A brief overview of the investigations relevant to the IR Program is provided in the following sections.

1.3.2.1 1969 INDUSTRIAL WASTE STUDY

In December 1969, an Industrial Waste Study at LBNC was completed by SWDIV. One of the objectives of this study was to "determine the nature and amount of all liquid and solid industrial wastes presently discharged into the storm drain system, directly into the harbor, or buried into the ground" (SWDIV 1969). This was the first known environmental investigation of "industrial" (now generally considered "hazardous") waste at LBNC. Estimates of quantities discharged were presented in the study.

1.3.2.2 1983 INITIAL ASSESSMENT STUDY

The Initial Assessment Study (IAS) for LBNC was completed in August 1983 (NEESA 1983). The purpose of the IAS was similar to that of the Preliminary Assessment (PA) under the CERCLA process. The IAS was conducted to identify and assess potential threats to human health or the environment caused by past hazardous materials storage, handling, or disposal practices at naval installations. As such, the IAS was the first comprehensive study by the DON to identify contaminated sites at the LBNC resulting from past operations. The study included information on waste-generating sources; waste handling, storage and transportation procedures; waste processing procedures; and descriptions of disposal sites and potentially contaminated areas.

Based on information from the available records, aerial photographs, surface and aerial surveys, and personnel interviews, the following five potentially contaminated sites were identified at LBNSY:

- IR Site 8, Building 210, Trichloroethylene Disposal Site;
- IR Site 9, Building 129, Ground Floor Spills;
- IR Site 10, Lot H Past Operations;
- IR Site 11, Hillside East of Drydock No. 1; and
- IR Site 12, Parking Lot X Toxic Sandblast Disposal.

The location of each site, as identified by the IAS and subsequent investigations, is shown on Figure 1-2.

Each site was assessed with regard to contamination characteristics, migration pathways, and potential receptors. The study concluded that none of the five sites found at LBNSY posed a significant threat to human health or the environment sufficient to warrant a confirmation study. The study, however, recommended various precautionary measures, such as use of protective clothing and equipment if excavating for construction at IR Sites 9, 11, and 12 (NEESA 1983).

1.3.2.3 1989 RCRA FACILITY ASSESSMENT

A Resource Conservation and Recovery Act (RCRA) Facility Assessment (RFA) of the LBNC, dated 30 November 1989, was prepared by the State of California Department of Health Services (DHS), later to become the State of California Environmental Protection Agency (Cal-EPA) Department of Toxic Substances Control (DTSC). The RFA was performed to identify and evaluate Solid Waste Management Units (SWMUs) and other areas of concern (AOCs) at LBNC. A records review, evaluation of existing data, personnel interviews, and a visual site inspection were conducted to evaluate the potential for releases of hazardous constituents from identified SWMUs.

The records review was based on information found in the RCRA and CERCLA files of the U.S. EPA Region IX, the files and inspection reports of the DHS (Long Beach Region), and the facility's RCRA Part B permit application. Other contacted agencies

included the South Coast Air Quality Management District (SCAQMD), the California Regional Water Quality Control Board (RWQCB) (Los Angeles Region), the City of Los Angeles, the County of Los Angeles, the Long Beach Fire Department, the California Fish and Game Department, the National Marine Fisheries Service (Department of Commerce), the U.S. Fish and Wildlife Service (Department of Interior), and the Federal OSHA.

The RFA recommended further action at the five SWMUs identified on LBNSY in the IAS and added one SWMU (IR Site 13, Tank Farm Area near Building 303).

1.3.2.4 1991/1992 SITE INSPECTION

A Site Inspection (SI) was conducted in 1991 at LBNSY; the SI Report was finalized in November 1992 (JEG 1992a). The SI follows the PA in the CERCLA process. The objectives of the SI were as follows:

- verify the presence of hazardous substances contamination at the six sites on LBNSY identified by the IAS and RFA,
- assess whether contamination at the sites exists at concentrations that warrant further action, and
- evaluate potential contaminant migration pathways and potential targets for scoring under the U.S. EPA Hazard Ranking System (HRS).

IR Sites 8 through 12 were addressed by the LBNSY SI. To accomplish the SI objectives, 49 soil samples and 17 groundwater samples were collected from IR Sites 8 through 12. The results of the laboratory analyses conducted on these samples were used to evaluate observed releases to groundwater, soil/sediment, surface, and air pathways in accordance with U.S. EPA guidance. Further investigation was recommended for each of the five sites.

1.3.2.5 1992 PHASE I RCRA FACILITY INVESTIGATION REPORT

A Phase I RCRA Facility Investigation (RFI) was conducted at LBNSY IR Site 13 (Tank Farm Area near Building 303) in December 1991. Twenty-eight soil samples and one groundwater sample were collected from the site and reporting was completed in December 1992 (JEG 1992b). The purpose of the RFI was to assess whether additional investigation or corrective measures are required (JEG 1992b). Releases were reportedly confirmed at the site and the area was recommended for further investigation (JEG 1992b).

1.3.2.6 OTHER INVESTIGATIONS

Other environmental investigations conducted at LBNC, not part of the IR Program, are summarized briefly below:

- Several investigations have been completed for underground storage tank (UST) locations at LBNC. Areas investigated include Building S-4 (JEG 1992c).

- A soils investigation was completed in 1989 in an area of IR Site 12 that had previously been used for drum-crushing operations (The EarthTechnology Corporation [Earth Tech] 1989).
- An interim removal action was conducted to remove and contain the exposed sandblast grit on in IR Site 11 (International Technology Corporation [IT] 1995).
- A subsurface investigation was conducted in the Hazardous Waste Storage Facility adjacent to Building 118 (SCS Engineers 1994).

1.4 COMMUNITY RELATIONS

As discussed in Section 1.3, DON has initiated an environmental investigation and cleanup effort at LBNC, the IR Program. A CRP was prepared in August 1993 to be implemented concurrently with the RI/FS phases of work performed under the IR Program. The plan describes the public participation program designed to ensure involvement by the local community.

In April 1992, a Technical Review Committee (TRC) was formed for the IR Program at LBNC. The TRC included DON and environmental regulatory agency representatives. The purpose of this TRC was to review IR Program documents and comment on the cleanup activities.

In April 1994, LBNC formed a Restoration Advisory Board (RAB) for both NAVSTA Long Beach and LBNSY IR Program activities. The RAB includes members of the public to facilitate public involvement in the environmental restoration program. The RAB expanded the TRC by adding members of the public to the existing committee of regulatory agency representatives and DON personnel.

Since April 1994, the 20-member RAB has met regularly and participated in site tours and educational workshops. The LBNC RAB will be invited to review and comment on this document.

1.5 REGULATORY STATUS

In September 1983, the DHS issued a RCRA hazardous waste facility permit to LBNSY (U.S. EPA ID No. CA6170023109) to operate a hazardous waste storage facility. The permit expired in August 1988 and LBNSY authorities applied for a RCRA Part B permit to modify its existing permit requirements. The permit authorized LBNSY to receive, handle, and store hazardous waste generated by LBNSY and NAVSTA and by the former Naval Hospital Long Beach (closed 31 March 1994). In 1993, LBNSY received the RCRA Part B modification for changes to the facility and changes to specific hazardous waste activities.

Although LBNSY is not listed on the U.S. EPA National Priority List (NPL), the DON's current policy is that response actions at both NPL and non-NPL sites be accomplished in accordance with the National Oil and Hazardous Substances Pollution Contingency Plan

NCP)/CERCLA. DTSC has agreed to accept CERCLA remedial action documents under the corrective action provisions of the LBNSY's RCRA permit (RCRA Corrective Action Program), since these provisions will be addressed in the environmental response actions taken at LBNSY. DON will serve as the lead federal agency for the implementation of these actions, and DTSC will be the lead state agency.

1.6 REMEDIAL INVESTIGATION GENERAL LIMITATIONS

The evaluations and conclusions in this report are based on currently available information which contains inherent uncertainties and could vary if further data concerning the site or its conditions or other information became available. The conclusions for each of the LBNSY IR sites are based on the industrial and maintenance/utility worker scenarios and are therefore dependent on the site remaining an industrial facility.

In conducting sampling, site conditions are evaluated from a limited number of data points, following accepted industry statistical and judgmental sampling practices in selecting the number and types of samples and tests to be performed. However, due to the sizes of the sites, the types and durations of industrial operations performed there, and the complexity of the underlying stratigraphy and hydrogeology, there is the potential that conditions away from the sampling points may differ.

It should be noted that there is a potential for local occurrence of constituents within soils and groundwater at concentrations higher than those detected at RI sample locations. Workers performing intrusive work based on this RI should be informed of this potential. Workers can be adequately protected from potential short-term exposure through engineering controls and by observing applicable OSHA (California and Federal) regulations. In addition, all local, state, and federal laws applicable to the excavation, storage, treatment and disposal of materials must be identified and observed if future intrusive activities occur at the sites.

1.7 REPORT ORGANIZATION

This RI Report includes Section 1 through 9 of text with supporting figures and tables and Appendices A through Q. The Executive Summary is presented at the beginning of this report. Section 1 provides the Introduction. Section 2 presents an overview of the regional setting, geology, and hydrogeology and a brief summary of the facilitywide (LBNC) investigation that includes:

- a presentation and interpretation of the geologic and hydrogeologic data collected across the facility,
- a presentation of chemical and physical data collected at facilitywide locations, with emphasis on LBNSY locations.
- a presentation and evaluation of the quality of the first-encountered groundwater below LBNC, with emphasis on LBNSY locations.

Data interpretation presented in the facilitywide section have been included throughout the document to support site-specific evaluations and to establish the rationale for the fate and transport of chemicals detected on individual IR sites.

Section 3 presents the preliminary screening criteria utilized to evaluate the analytical data prior to its use in risk assessment to identify COPCs. This section includes:

- statistical and geochemical evaluation of background threshold concentrations of specific analytes in soil,
- statistical evaluation of background threshold concentrations of specific analytes in groundwater, and
- industrial preliminary remediation goals (PRGs) for soil, and tap water PRGs for groundwater.

Section 4 presents a general overview of field procedures and sample analysis and validation.

Section 5 presents the investigations by site. This section includes:

- site history and summary of previous investigations,
- a summary of the site investigation field activities,
- a discussion of the site-specific sample analysis and validation,
- a discussion of site-specific characterization results,
- a discussion of the nature and extent of contamination, and
- a discussion of the fate and transport of chemicals identified in the previous subsection as those which may be of potential concern.

Physical and chemical data results from the RI were evaluated in this section to identify the AOPCs; these areas were subsequently used to characterize the sites in this section and in the BHHRA presented in Section 6. Following the AOPC definition, a preliminary screening that was performed to identify the COPCs at each site is described in this section. This preliminary screening compared site chemical data to (1) published risk-based criteria, (2) statistically calculated background threshold values for metals, or (3) established screening criteria, but it was not intended for remedial action decision-making purposes. However, the preliminary screening was used to indicate areas with chemicals that are present at elevated concentrations and as an indication of the completeness of the data collected. This evaluation was performed in parallel with the BHHRA, which provides the further information required to identify AOCs and chemicals of concern (COCs).

Section 6 presents the following topics:

- an overview of the BHHRA,

- the project-specific procedures, data evaluation (toxicity assessment, exposure assessment, and risk characterization),
- the site-specific results (source analysis, risk characterization, and higher-risk location analysis), and
- an analysis of the uncertainties.

Section 7 presents estimates of the volumes of potentially impacted media based on input from the background threshold assessment and the BHHRA calculations.

Section 8 presents the Summary and Conclusions, and Section 9 contains the References.

The following appendices are presented in support of this report:

A Field Investigation Methods and Procedures

B Slug Test Data and Calculation and Groundwater Monitoring Data

C Piper Diagrams

D Laboratory Results of Chemical Analysis

E Inorganic Background Data and Statistical Calculations

F Geochemical Assessment of Background Levels for Metals in Soil

G Statistical Calculations for Risk Assessment

H Health and Safety Close-out Report

I Geologic Borehole Logs

J Cone Penetration Test Data

K Land Surveyor's Reports

L Data Validation Reports

M Geotechnical Laboratory Data

N Historical Aerial Photograph and Map Review

O Fate and Transport Data and Calculations

P Risk Assessment

Q Geophysical Investigation Reports

Section 8
SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

This section summarizes the RI results for IR Sites 8, 9, 10, 12, and 13 (OU 4) and IR Site 11 (OU 5) at LBNSY. During this RI, data for each site were collected and analyzed as specified in the RI/FS Work Plan and SAP (JEG 1993a and 1993b) and in Tech Memo No. 1 (BNI 1994b) and Tech Memo No. 2 (BNI 1995a). Geologic and hydrogeologic data were interpreted to evaluate the subsurface characteristics of the facility and each site. Analytical chemical data were placed into a database and evaluated by (1) validating 100 percent of the Level D data packages (Appendix L), (2) reviewing the data for usability (see Appendix D), and (3) determining background threshold concentrations of metals by statistical calculation and geochemical evaluation (Appendices E and F, respectively). The usable metal data were compared to background threshold concentrations, and the usable organic data were compared to U.S. EPA Industrial Soil and Tapwater PRGs (Section 5), to assist in identification of AOPCs and COPCs, and assess lateral and vertical extent of detected COPCs. These data were also statistically evaluated to provide input to the risk assessment calculations (Appendix P). Based on the contaminant chemistry and hydrogeologic characteristics, the fate and transport of the COPCs were also evaluated on a site-by-site basis (Section 5.7).

A BHHRA was performed as part of the site characterization to assess potential impacts on human health from contaminants at the six IR sites if no remedial actions were taken (Section 6). The BHHRA involved selecting COPCs for the human health evaluation, identifying receptor scenarios and exposure pathways, estimating representative contaminant concentrations at receptor locations, collecting toxicity information, and estimating risks for each receptor. The BHHRA documents the hazards and provides information necessary for making risk management decisions concerning the necessity for or selecting the nature and extent of remedial alternatives.

8.1 SUMMARY OF SOIL RESULTS

The following sections discuss by site the nature and extent of the soil COPCs and AOPCs, summarize the fate and transport of site chemicals, summarize the BHHRA industrial scenario results, and provide conclusions regarding each IR site, where appropriate.

8.1.1 IR Site 8

8.1.1.1 SUMMARY

Nature and Extent of Contamination

- Analytes detected during the RI in soil at IR Site 8 included several metals, and VOCs.
- No soil COPCs were in excess of the background thresholds (metals) or PRGs (organics).

- Analytes detected in soil appeared randomly scattered, with no definable plume geometry.

Fate and Transport

- A vadose-zone leaching analysis was not performed for metals, because at IR Site 8, AOPC 1 the metals do not exceed the background thresholds.
- Results of a vadose-zone leaching screening analysis for methylene chloride indicate that vadose-zone soil is not a continuing source for groundwater contamination.

Risk Assessment

Figures 8-1 and 8-2 summarize IR Site 8's cancer risk and hazard index (HI), respectively.

- IR Site 8 presents a low, unquantified risk to the industrial worker (no VOC COPCs were detected in surface soils).
- For the maintenance/utility worker, total upper-bound and average lifetime cancer risks were estimated below the point of departure (10^{-6}) of the NCP's target risk range, at 3.8×10^{-7} and 1.2×10^{-8}, respectively.
- The HI associated with exposure to soils at IR Site 8 by a maintenance/utility worker does not exceed 1.0, which indicates that noncarcinogenic effects are unlikely to be associated with the soil.

Figure 8-3 summarizes the total lifetime cancer risk for soil COPCs of AOPC 1 for the maintenance/utility worker for the upper-bound evaluation.

8.1.1.2 CONCLUSIONS

- No AOCs or COCs were identified at IR Site 8.
- Remedial action at this site does not appear warranted.
- No further work at IR Site 8 is recommended.

8.1.2 IR Site 9

8.1.2.1 SUMMARY

Nature and Extent of Contamination

- Analytes detected during the RI in IR Site 9 soil included several metals; the VOCs 1,2-DCE (total), carbon disulfide, chloroform, MEK, PCE, and xylenes (total); and the SVOC dibutyl phthalate.

- There were no soil COPCs in excess of the background thresholds (metals) or industrial PRGs (organics).
- Except for MEK, contaminants in soil were detected in single samples only, and appear randomly scattered with no definable plume geometries. MEK was detected at three soil sample locations in an area northeast of Building 129, in the capillary fringe at depths of 7.5 to 9 feet bgs; extent is discussed in Section 8.2.2.
- COPCs were detected in groundwater of the upper coarse-grained, water-bearing interval. These COPCs associated with groundwater of IR Site 9 included 1,1-DCE, 1,2-DCE, benzene, chloroform, PCE, TCE, and vinyl chloride.

Fate and Transport

AOPC 1

- A vadose-zone leaching analysis was not performed for metals at IR Site 9, AOPC 1 because they do not exceed background thresholds.
- A leaching migration analysis for organic compounds in vadose-zone soil was not performed because Building 129 covers the entire AOPC, and under existing conditions its foundation prevents migration through the vadose-zone.

AOPC 2

- A vadose-zone leaching analysis was not performed for metals at IR Site 9, AOPC 2 because they do not exceed background thresholds.
- Results of a vadose-zone leaching screening analysis for organic compounds indicate that vadose-zone soil is not a continuing source for groundwater contamination.

AOPC 3

- A vadose-zone leaching analysis was not performed for metals at IR Site 9, AOPC 3 because they do not exceed background thresholds.
- Results of a vadose-zone leaching screening analysis for organic compounds indicate that vadose-zone soil is not a continuing source for groundwater contamination.

Risk Assessment

Figures 8-1 and 8-2 summarize the IR Site 9 AOPCs' cancer risks and HIs, respectively.

AOPC 1

- IR Site 9, AOPC 1 presents a low, unquantified risk to the industrial worker, as demonstrated by Building 129 soil gas and surface ambient air results for VOCs that were far below OSHA and NIOSH health protective standards.
- For the maintenance/utility worker, total upper-bound lifetime cancer risk for soil exposure was estimated below the NCP's point of departure (10^{-6}), at 4.1×10^{-11}. The vapors from groundwater increase the risk to the maintenance/utility worker. A summary of the groundwater results is presented in Section 8.2.2.
- The HI associated with exposure to soils by a maintenance/utility worker does not exceed 1.0, which indicates that noncarcinogenic effects are unlikely.

AOPC 2

- IR Site 9, AOPC 2 presents a low, unquantified risk to the industrial worker. Samples collected from this AOPC were analyzed only for the compounds of interest and for the analytical methods specified in the RI/FS Work Plan (JEG 1993a) and the SAP (JEG 1993b); consequently, an analysis of surface soil volatile COPCs was not performed.
- For the maintenance/utility worker, total upper-bound lifetime cancer risk for soil exposure were estimated below the NCP's point of departure (10^{-6}), at 5.0×10^{-7}. The vapors from groundwater increase the risk to the maintenance/utility worker. A summary of the groundwater results are presented in Section 8.2.2
- The HI for the maintenance/utility worker does not exceed 1.0.

AOPC 3

- IR Site 9, AOPC 3 presents a low, unquantified risk to the industrial worker, because surface soil volatile COPCs were not detected.
- For the maintenance/utility worker, total upper-bound lifetime cancer risk for soil exposure were estimated below the NCP's point of departure (10^{-6}), at 3.0×10^{-7}. The vapors from groundwater increase the risk to the maintenance/utility worker. A summary of the groundwater results is presented in Section 8.2.2

- The HI associated with exposure to soils by a maintenance/utility worker does not exceed 1.0, which indicates that noncarcinogenic effects are unlikely to be associated with the soil.

Figure 8-3 summarizes the total lifetime cancer risk for the soil COPCs of AOPCs 1 through 3 to the industrial and maintenance/utility worker for the upper-bound evaluation.

8.1.2.2 CONCLUSIONS

- For soils, no AOCs or COCs were identified at IR Site 9.
- Soils remedial action at this site does not appear warranted.

8.1.3 IR Site 10

8.1.3.1 SUMMARY

Nature and Extent of Contamination

- Analytes detected during the RI in vadose-zone soil at IR Site 10 include metals, VOCs, and SVOCs (including PAHs).
- The metal analytes cadmium, chromium, copper, iron, lead, manganese, nickel, and selenium were detected in soil above background thresholds and were considered COPCs.
- The organic COPCs detected above industrial PRGs in soil were the PAHs benzo(a)anthracene, benzo(a)pyrene, and dibenz(a,h)anthracene. All VOCs, phthalates, and the remaining PAHs were below their respective industrial PRGs.
- The former scrapyard operation at IR Site 10 is a likely source of the metals in soil detected above background thresholds; the source of the organic analytes detected in soil in the same area could also be the former scrapyard operation.

Fate and Transport

- The leaching analysis performed for metals above the background threshold in vadose-zone soils at IR Site 10, AOPC 1 indicates that concentrations of copper and nickel might exceed background thresholds in the groundwater beneath the AOPC. However, the modeling indicates that the concentrations of both metals would be lower than the surface water regulatory criteria upon reaching the SCE extraction system. An impact to the surface water receptor caused by the leaching of copper and nickel in the vadose zone would not be a concern.

- The leaching analysis performed for organic COPCs in soil indicated that concentrations of dibenzofuran, anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, fluorene, phenanthrene, and pyrene might impact groundwater beneath the AOPC. However, the concentrations of these organic COPCs reaching the SCE extraction system would be lower than the surface water regulatory criteria.
- IR Site 10 is covered by asphalt pavement, making significant leaching and transport of metal analytes and PAHs to the harbor unlikely. IR Site 10 is also separated from the harbor by a seawall along the southern edge of LBNSY, which, based on tidal monitoring, appears to limit communication between the groundwater beneath the site and the harbor. Therefore, an impact to the groundwater caused by the leaching of COPCs in the vadose-zone would not be a concern.

Risk Assessment

Figures 8-1 and 8-2 summarize IR Site 10's cancer risk and HI, respectively.

- Exposure of the industrial worker to COPCs in soil was performed assuming the asphalt cover remained in place; cancer risk to the industrial worker was not quantified, since the COPCs identified in the surface soil show no evidence of carcinogenicity.
- The HI associated with exposure to surface soils by an industrial worker does not exceed 1.0, indicating that noncarcinogenic effects associated with the soil are unlikely.
- For the maintenance/utility worker, the estimated upper-bound total lifetime cancer risk for this site was quantified at 2.6×10^{-6}. This risk estimate was predominantly associated with exposures to the soil media. Incremental (background deducted) cancer risks for soil slightly exceeded the NCP's point of departure (10^{-6}) at 1.8×10^{-6}. Risk from exposure to soil was attributable largely to benzo(a)pyrene.
- Total average lifetime cancer risks for soil exposures were estimated below the NCP's point of departure (10^{-6}).
- The HI for the maintenance/utility worker does not exceed 1.0.

8.1.3.2 CONCLUSIONS

- No AOCs or COCs were identified at IR Site 10.
- Remedial action at this site does not appear warranted.
- No further work at IR Site 10 is recommended.

Figure 8-3 summarizes the total lifetime cancer risk for the soil COPCs, AOPC 1, for the maintenance/utility worker for the upper-bound evaluation.

8.1.4 IR Site 11

8.1.4.1 SUMMARY

Nature and Extent of Contamination

- Analytes detected during the RI in sandblast grit and vadose-zone soil at IR Site 11 included metals, PAHs, phthalates, and organotins; VOCs were analyzed for in selected samples, but not detected.
- The metals in excess of background thresholds in soil or COPCs were aluminum, arsenic, barium, cadmium, chromium (total), cobalt, copper, iron, lead, manganese, nickel, selenium, thallium, vanadium, and zinc.
- The organics in excess of Industrial PRGs in soil or COPCs were benzo(a)pyrene and dibenz(a,h)anthracene.
- Sandblast grit was visually observed in two areas: under the shotcrete area (AOPC 1), and the southern hillside (AOPC 2). AOPC 1 is entirely covered with shotcrete, and has dimensions measuring approximately 60 by 350 feet; thickness of the sandblast grit beneath the shotcrete varies from approximately 0 to 8 feet. In AOPC 2, sandblast grit occurs in a patchy, relatively thin (maximum depth 2.5 feet) pattern covering the underlying soil.
- Trace amounts of possibly wind-blown sandblast grit appear to extend to the areas beneath the asphalt parking lot surfaces of Lot G west of the hillside, and Lot F east of the hillside, based on soil sample analytical results and visual observations.

Fate and Transport

The potential for leaching constituents present in the vadose-zone soils to groundwater is low, demonstrated by the fact that analytes that were present in soil were not detected in groundwater above background thresholds. This suggests that COPCs remain sorbed to the shallower soils and have not leached into groundwater. Fate and transport analyses at IR Site 11, AOPCs 1 and 2, are summarized below, by AOPC.

AOPC 1

- IR Site 11, AOPC 1 is entirely covered by shotcrete, making significant transport of chemicals to the harbor not possible.
- The vadose-zone screening analysis performed for metals above background thresholds in vadose-zone soils indicates that concentrations

of cobalt, copper, thallium, and zinc might exceed groundwater background thresholds.

- Modeling performed for cobalt, copper, thallium, and zinc to first calculate their leaching rates to the groundwater, and then assess groundwater transport, indicates that the incremental concentrations for the leached metals reaching the SCE extraction system would be lower than surface water regulatory criteria. An impact to the surface water receptor caused by the leaching of the metals from IR Site 11, AOPC 1 vadose-zone soil would not be a concern.
- The vadose-zone screening analysis performed for the organic COPCs indicates that the concentrations of phenanthrene and pyrene might impact groundwater.
- Modeling performed for phenanthrene and pyrene first to calculate their leaching rates to the groundwater, and then to assess groundwater transport, indicates that the concentrations of these COPCs reaching the SCE extraction system would be lower than the surface water regulatory criteria. An impact to the surface water receptor caused by the vadose-zone leaching and transport of phenanthrene and pyrene would not be a concern.

AOPC 2

- A vadose-zone screening analysis performed for metals above background thresholds in IR Site 11, AOPC 2 vadose-zone soils indicates that concentrations of arsenic, cadmium, cobalt, copper, lead, manganese, nickel, selenium, and zinc might exceed groundwater background thresholds.
- Modeling performed for these metals first to calculate their leaching rates to the groundwater, and then to assess groundwater transport, indicates that concentrations reaching the SCE extraction system would be lower than applicable surface water regulatory criteria. Cobalt, which has no applicable surface water criteria, has a potential to reach the nearest SCE extraction well at a level higher than the cobalt background threshold by a factor of about 2. Although the cobalt concentration will be higher than the background threshold at the time it reaches the closest SCE extraction wells, there are several hundred extraction wells within this dewatering system, and groundwater with elevated concentrations of cobalt would be mixed with other extracted groundwater prior to discharge to the harbor. The average cobalt concentration from all SCE wells would be below the background threshold. Therefore, an impact to the surface receptor

caused by the leaching of metals in the vadose-zone would not be a concern.

- The vadose-zone screening analysis performed for the organic COPCs indicates that the concentrations of benzo(a)anthracene, benzo(b)fluoranthene, benzo(g,h,i) perylene, benzo (k)fluoranthene, chrysene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, phenanthrene, and pyrene might impact groundwater. Except for phenanthrene, these PAHs are fairly persistent to very persistent in the environment.
- Modeling performed for the organic COPCs to first calculate their leaching rates to the groundwater, and then assess groundwater transport, indicates that the concentrations of these COPCs reaching the SCE extraction system would be lower than surface water regulatory criteria.
- IR Site 11, AOPC 2, although predominantly exposed soil, is separated from the harbor by a seawall. This limits communication between the groundwater beneath the site and the harbor, based on groundwater flow toward the SCE and discharge to the harbor through the SCE discharge system. Therefore, an impact to the groundwater caused by the leaching of the organic COPCs in the vadose-zone would not be a concern.

Risk Assessment

Figures 8-1 and 8-2 summarize the IR Site 11 AOPCs' cancer risks and HIs, respectively.

AOPC 1

- Exposure of the industrial worker at AOPC 1 to COPCs was estimated assuming that the shotcrete cover would remain in place. Because the industrial worker was assumed to be exposed to COPCs in soil beneath the pavement only via vapor inhalation, risk to the industrial worker is low but unquantified, since the COPCs identified in the surface soil show no evidence of carcinogenicity.
- The HI for the industrial worker does not exceed 1.0.
- For the maintenance/utility worker, total upper-bound lifetime cancer risk associated with exposures to soil was quantified at 5.9×10^{-6}. Incremental cancer risks for soil slightly exceeded the NCP's point of departure (10^{-6}) at 3.6×10^{-6}. The cancer risk from soil is attributable to arsenic, which is estimated to contribute 70 percent of the total lifetime cancer risk and 56 percent of the incremental lifetime cancer risk.
- Total average lifetime cancer risks for soil exposures were estimated below the NCP's point of departure (10^{-6}).
- The HI for the maintenance/utility worker does not exceed 1.0.

AOPC 2

- For the industrial worker, IR Site 11, AOPC 2 was evaluated as an unpaved area. Risks associated with an unpaved AOPC were quantified for incidental ingestion and dermal contact with surface soil and inhalation of dust and vapors. The total upper-bound lifetime cancer risk for this AOPC was estimated to be 1.1×10^{-5}; however, deduction of the background threshold risk for metals from the total carcinogenic risk resulted in an incremental cancer risk quantified below the NCP's point of departure (10^{-6}) at 2.3×10^{-8}.
- The HI for the industrial worker does not exceed 1.0.
- For the maintenance/utility worker, total lifetime upper-bound cancer risk for this site was quantified at 2.7×10^{-6}. This carcinogenic risk estimate was predominantly associated with exposures to the soil media. Deduction of the background threshold risk for metals results in an incremental cancer risk quantified at the NCP's point of departure (10^{-6}).
- Total average lifetime cancer risks for soil exposures were estimated below the NCP's point of departure (10^{-6}).
- The HI for a maintenance/utility worker does not exceed 1.0.

Figure 8-3 summarizes the total lifetime cancer risk for the soil COPCs of AOPCs 1 and 2, for the industrial and maintenance/utility worker for the upper-bound evaluation.

8.1.4.2 CONCLUSIONS

- No AOCs or COCs were identified at IR Site 11.
- Remedial action at this site does not appear warranted.
- No further work at IR Site 11 is recommended.

8.1.5 IR Site 12

8.1.5.1 SUMMARY

Nature and Extent of Contamination

- Analytes detected during the RI in vadose-zone soil at IR Site 12 were metals, VOCs, PAHs, phthalates, pesticides/PCBs, and organotins.
- The metal analytes detected above background concentration thresholds or COPCs were aluminum, arsenic, barium, chromium (total), cobalt, copper, iron, lead, manganese, mercury, nickel, vanadium, and zinc.
- The organics detected above industrial PRGs or COPCs were the PAHs anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene,

benzo(k) fluoranthene, chrysene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene. All VOCs, phthalates, pesticides/PCBs, and organotins were below their respective industrial PRGs.

- The source of metals detected above background thresholds in shallow soil in the vicinity of the former drum-crushing area appear to be sand blast grit; however, the former drum-crushing operation could also be a source. The source of the SVOCs detected in the same area could be the sandblast grit itself (if the materials cleaned with the grit were oily), waste oil used for dust suppression while placing the sandblast grit, and/or the former drum-crushing operation. Deeper 5-foot-bgs samples from these locations did not contain metals above background thresholds and contained organic analytes below detection limits or at concentrations below industrial PRGs, indicating that only soil shallower than 5 feet bgs is significantly impacted. Lateral extent is defined by soil results at locations to the northwest, northeast, southeast, southwest, and west.
- Metals above background thresholds, and PAHs were also detected in 2-foot-bgs samples from two other IR Site 12 locations, north (HP-12-29) and west (HP-12-22) of the western end of IR Site 13. The boring logs for the former location indicated evidence of fill (including paint chips, paper clips, and asphalt) at approximately 2 feet bgs, and at the latter location petroleum staining and odor in soil at approximately 4 feet bgs. Vertical extent was defined by deeper 5- and 6.5-foot-bgs samples. Lateral extent is defined to the northwest, but physical access constraints (Building 303) prevented assessment to nondetect to the southwest. Extent to the southeast onto IR Site 13 is discussed in Section 8.1.6.1.
- PAHs above industrial PRGs were detected off-site west of IR Site 12 in 2-feet-bgs soil samples at locations HP-12-26 and HP-12-32; HP-12-26 also contained metals (chromium, copper, lead, and zinc) above background thresholds. Deeper samples did not contain detectable PAHs, or contained PAHs below industrial PRGs; however, deeper samples from 5.0 to 6.5 and 15.0 to 16.5 feet bgs at HP-12-26 contained the same metals above background thresholds. The boring log for HP-12-32 indicates a black, oily, 3-inch-thick layer with an appearance consistent with an old road surface at a depth of approximately 1 foot bgs, which could be the source of the PAHs. The boring log for HP-12-26 does not indicate the presence of either sandblast grit or hydrocarbons; the source of the contaminants there is unknown. Lateral extent of PAHs and metals in the area of these two locations is defined by results for shallow soil samples from the north, northeast (PAHs), southeast, south (metals) and west (metals). Building 303 prevents assessment of PAHs to nondetect to

the south. The westward extent of PAHs was not defined, but an oil production easement is located directly west of this area.

- Elsewhere, SVOCs appear to be relatively evenly distributed in shallow soil on-site and off-site, with low concentrations throughout.

Fate and Transport

The potential for leaching many of the constituents present in the vadose-zone soils to groundwater is low, evidenced by the fact that analytes that were present in soil were not detected in groundwater above background thresholds. These data suggest that COPCs remain sorbed to the shallower soils and have not leached into groundwater.

AOPC 1

- A vadose-zone leaching analysis performed for metals above background thresholds in IR Site 12, AOPC 1 vadose-zone soils indicates that leached concentrations of aluminum, arsenic, barium, chromium, cobalt, copper, lead, manganese, nickel, vanadium, and zinc could exceed groundwater background thresholds.
- Modeling performed to first calculate leaching rates of the metals to groundwater, and then assess groundwater transport, indicated that only cobalt would exceed the groundwater background thresholds beneath the AOPC, and that no metals would exceed the groundwater background thresholds or applicable surface water criteria at the SCE dewatering facility.
- A vadose-zone leaching analysis performed for the organic COPCs indicated that concentrations of 2-methylnaphthalene, acenaphthene, naphthalene, xylenes, Aroclor 1248, Aroclor 1260, carbazole, dibenzofuran, dibutyltin, monobutyltin, fluoranthene, anthracene, benzo(a)anthracene, benzo(a) pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, dibenz(a,h)-anthracene, fluorene, indeno(1,2,3-cd)pyrene, phenanthrene, and pyrene might impact groundwater beneath the AOPC. The organic COPCs 2-methyl-naphthalene, acenaphthene, naphthalene, phenanthrene, and xylenes are not as persistent as the other COPCs; Aroclors and high-molecular-weight PAHs are very persistent.
- Modeling performed for the organic COPCs to first calculate their leaching rates to the groundwater, and then assess groundwater transport, indicated that only anthracene, fluorene, phenanthrene, and pyrene would impact the groundwater beneath the AOPC. These organic COPCs do not have the potential to reach the nearest SCE extraction well at detectable concentrations.

- IR Site 12, AOPC 1, although not entirely protected by surface pavement cover, is separated from the harbor by a seawall, which limits communication between the groundwater beneath the site and the harbor.

Fate and transport for Sites 12/13, AOPC 2 is discussed in Section 8.1.6.1.

Risk Assessment

Figures 8-1 and 8-2 summarize the IR Site 12, AOPC 1 cancer risk and HI, respectively. This AOPC presents the highest cancer risk of any site in LBNSY. The industrial scenario, where the industrial worker is exposed to surface soil COPCs, presented the higher risk of the two exposure scenarios at this site.

- For the industrial worker, IR Site 12, AOPC 1 was evaluated as an unpaved area. Total and incremental lifetime upper-bound cancer risks were quantified over the NCP's point for action (10^{-4}), at 2.9×10^{-4}. Several PAHs (benzo[a]pyrene, indeno[1,2,3-cd]pyrene, dibenz[a,h]anthracene, benzo[b]fluoranthene, benzo[k]fluoranthene, benzo[a]anthracene), a semivolatile (carbazole), and a metal (arsenic) are the major contributors to the total lifetime and incremental cancer risk; benzo(a)pyrene contributes over 50 percent of this risk. Dermal contact and incidental soil ingestion were the dominant risk pathways; the risk from inhalation was quantified significantly below 10^{-6}.
- For the average case, total lifetime carcinogenic risk exceeds the NCP's point of departure at 5.5×10^{-6}.
- The HI for the industrial worker does not exceed 1.0.
- For the maintenance/utility worker, total and incremental lifetime upper-bound cancer risks for the soil media were quantified over the NCP's point of departure (10^{-6}) at 4.1×10^{-5} and 3.9×10^{-5}, respectively. PAHs and arsenic are the major contributors to the total lifetime and incremental cancer risk, with benzo(a)pyrene contributing over 50 percent of the risk. Dermal contact and incidental soil ingestion were the dominant risk pathways.
- The HI for a maintenance/utility worker does not exceed 1.0.
- The analytes described above as presenting risk at IR Site 12 are present at concentrations greater than RBCs and are, therefore, considered COCs for IR Site 12. In addition to these analytes, a SVOC (chrysene) and two PCBs (Aroclor 1248 and Aroclor 1260) are present at concentrations greater than their respective RBCs, and are also considered COCs for IR Site 12.

Figure 8-3 summarizes the total lifetime cancer risk for the soil COPCs, of AOPC 1, for the industrial and maintenance/utility worker the upper-bound evaluation.

8.1.5.2 CONCLUSIONS

- IR Site 12, AOPC 1 is classified as an AOC.
- Benzo(a)pyrene is the COC (chemical at a concentration above the RBC of 10^{-6} and associated with a 10^{-4} lifetime cancer risk, or a HI greater than 1.0) that contributes the highest risk. In addition to benzo(a)pyrene, several other COCs (the PAHs benzo[a]anthracene, benzo[b]fluoranthene, benzo[k]fluoranthene, carbazole, chrysene, dibenz[a,h]anthracene, and indeno[1,2,3-cd]pyrene; PCB Aroclors 1248 and 1260; and the metals arsenic and chromium) contribute to the total lifetime cancer risk for an industrial worker for AOPC 1 of 2.9×10^{-4}; however, benzo(a)pyrene contributes over 50 percent of the risk.
- Fate and transport modeling indicate that the COCs detected within the soils of AOC 1 will reach the nearest SCE groundwater extraction well at concentrations below regulatory levels; thus, off-site movement of contaminants from the vadose-zone soils is not a concern.

8.1.6 IR Site 13

8.1.6.1 SUMMARY

Nature and Extent of Contamination

- Analytes detected during the RI in vadose-zone soil at IR Site 13 include metals, VOCs, PAHs, phthalates, and pesticides/PCBs; organotins were not detected.
- The metals detected above background thresholds or COPCs were arsenic, chromium (total), and nickel; the organic COPCs detected above industrial PRGs were the PAHs benzo(a)pyrene and dibenz(a,h)anthracene. All VOCs, phthalates, and pesticides/PCBs were below their respective industrial PRGs.
- Arsenic was detected at less than twice the background threshold in 2-foot-bgs samples at two locations, one (SB-13-08) in the southeastern corner of the site, and the other (SB-13-09) in the southcentral portion of the site. The SB-13-08 boring log indicates light olive-brown silty sand in the interval sampled, and the SB-13-09 boring log indicates olive-brown silty sand with a petroleum-like odor and trace of sandblast grit. Vertical extent at both locations was defined by arsenic results below the background threshold in 5-foot-bgs soil samples.

- Nickel was detected at 1.2 times the background threshold in a 9.5-foot-bgs soil sample from the southcentral portion of the site (SB-13-02).
- The highest PAH concentrations were in the 2-foot-bgs sample at SB-13-07, situated near the northeastern corner of IR Site 13; the boring log indicates black sand with sandblast grit and a petroleum-like odor from 1 to 4 feet bgs, which is a potential source of the detected PAH compounds. The 5-foot-bgs sample did not contain detectable PAHs, indicating their limited vertical extent. The next highest total PAH concentrations, and highest pesticide/PCB concentrations, were in the 2-foot-bgs sample at SB-13-03, situated near the northwestern corner of IR Site 13; its boring log did not indicate the presence of sandblast grit or petroleum hydrocarbons. Vertical extent was defined by the 5-foot-bgs sample, which did not contain detectable PAHs or pesticides/PCBs.
- Two-foot-bgs soil samples in the central portion of the site, and all deeper IR Site 13 soil samples, either did not contain detectable PAHs, or contained them at much lower concentrations, indicating that only the shallow soils at less than 5 feet bgs near the northeastern and northwestern corners of IR Site 13 are significantly impacted by PAHs. The organic COPCs extend off-site from the northwestern corner of IR Site 13 to the north and south, with concentrations decreasing in both directions; definition of westward extent was prevented by physical access constraints (Building 303). Concentrations of organic COPCs decrease from the northeastern corner of IR Site 13 toward the north, west, and south, based on results of shallow soil samples from adjacent locations.

Fate and Transport

AOPC 2 is situated in both IR Sites 12 and 13; the summary of chemical fate and transport for AOPC 2 is presented here.

AOPC 2

- A vadose-zone leaching analysis performed for the metals above background thresholds in IR Sites 12/13, AOPC 2 vadose-zone soils indicated that leached concentrations of arsenic, copper, nickel, and zinc might exceed groundwater background thresholds.
- Modeling performed to first calculate metal leaching rates to the groundwater, and then assess groundwater transport, indicated that leaching of metals would not exceed groundwater background threshold concentrations. Therefore, the metals would not impact the SCE extraction system.

- A vadose-zone leaching analysis performed for the organic COPCs indicated that leached SVOCs, PAHs, and pesticides might impact the groundwater beneath the AOPC.
- Modeling performed to calculate organic COPCs leaching rates to the groundwater, and then assess groundwater transport, indicated only butyl benzyl phthalate has the potential to impact groundwater, having the potential to reach the nearest SCE extraction well at concentrations above applicable surface criteria by a factor of 8.8. However, the average concentration after mixing with all SCE extraction wells would significantly reduce the exceedance factor, and the concentration during a 100-year period would be far less than applicable surface water criteria.
- Most of IR Site 13 is covered by asphalt pavement, which makes significant transport of metals in vadose-zone soils into groundwater and then to the harbor unlikely. IR Site 12/13, AOPC 2 is separated from the harbor by a seawall, and since groundwater flows toward the SCE dewatering system prior to its discharge to the harbor, this limits communication between the groundwater beneath the site and the harbor.

Risk Assessment

Figures 8-1 and 8-2 summarize the IR Sites 12/13, AOPC 2 cancer risk and HI, respectively.

- Exposure of the industrial worker to COPCs in surface soil was performed with the asphalt cover remaining in place. The industrial worker was assumed to be exposed to COPCs in soil beneath the pavement only via vapor inhalation: risk to the industrial worker is low, but not quantified since the volatile COPCs identified in the surface soil show no evidence of carcinogenicity.
- The HI for the industrial worker does not exceed 1.0.
- For the maintenance/utility worker, total and incremental upper-bound lifetime cancer risks were quantified slightly over the NCP's point of departure (10^{-6}) at 2.5×10^{-6} and 1.5×10^{-6}, respectively. These carcinogenic risk estimates were associated with exposures to the soil media where the cancer risk estimate for each of the carcinogenic COPCs was less than 10^{-6}.
- Total average lifetime cancer risk for the maintenance/utility worker was estimated below the NCP's point of departure.
- The HI for the maintenance/utility worker does not exceed 1.0.

Figure 8-3 summarizes the total lifetime cancer risk for the soil COPCs, of AOPC 2, to the maintenance/utility worker for the upper-bound evaluation.

8.1.6.2 CONCLUSIONS

- No AOCs or COCs were identified at IR Site 13.
- Remedial action at this site does not appear warranted.
- No further work at IR Site 13 is recommended.

8.2 SUMMARY OF GROUNDWATER RESULTS

This section provides the summary and conclusions for the groundwater investigation for IR Sites 8 through 13, and discusses the identified groundwater AOPCs by site.

8.2.1 IR Site 8

- Analytes detected in groundwater at IR Site 8 included several metals, and the VOCs acetone and MEK.
- The only contaminant in excess of background threshold concentration or PRGs (organics) was chromium, in groundwater from monitoring well MW-24. At 1.1 times the background threshold, chromium in this well is nearly equivalent to its background threshold concentration.
- Based on the data at IR Site 8, remedial goals for groundwater do not appear necessary and no further action appears warranted for groundwater.

8.2.2 IR Site 9

- COPCs detected in the IR Site 9 upper coarser-grained, water-bearing interval (depths less than approximately 40 feet bgs) included several metals, and the VOCs 1,1,1-TCA, 1,1-DCA, 1,1-DCE, 1,2-DCE (total), benzene, chloroform, ethylbenzene, MEK, PCE, toluene, TCE, vinyl chloride, and xylenes (total).
- COPCs detected in the fine-grained, water-bearing interval (depths of 40 and 60 feet bgs) included the VOCs benzene, carbon disulfide, and ethylbenzene.
- COPCs detected in the lower coarser-grained, water-bearing interval (deeper than 60 feet bgs) included the VOCs 1,1-DCA, acetone, benzene, carbon disulfide, ethylbenzene, and xylenes (total).
- There were no metal COPCs in excess of background thresholds in groundwater from any of these intervals.

The following organic COPCs in groundwater exceeded tapwater PRGs: upper coarser-grained, water-bearing interval – 1,1-DCE, 1,2-DCE (total), benzene, chloroform, PCE, TCE, and vinyl chloride; fine-grained, water-bearing interval – benzene; and lower coarser-grained, water-bearing interval – benzene.

- Based on the analytical results, six potential groundwater plumes have been detected in the three water-bearing intervals beneath IR Site 9, as summarized below.
- At least two, apparently commingled, chlorinated-VOC plumes exist in the upper coarser-grained, water-bearing interval beneath the entire IR Site 9 area and adjacent areas. The limits of these chlorinated-VOC plumes are poorly understood to the west and south of Building 129, but the lateral limits are defined by nondetects at sample locations in the areas to the north, northeast, and east of Building 129 (near the northwestern corner of Parking Lot J). The vertical extent was defined only in the area of the former Quonset hut, where the plumes do not extend below the upper portion of the upper coarser-grained, water-bearing interval. The chlorinated-VOC plume in the vicinity of the former Quonset hut is likely related to the reported TCE spill in the vicinity of the former Quonset hut.
- A BTEX plume and a MEK plume were each defined in the upper coarser-grained, water-bearing interval. The lateral extent of the BTEX plume appears to be confined to a limited portion of the upper coarser-grained, water-bearing interval in the area around locations SP-9-04 and HP-9-24 (approximately 300 feet northeast of Building 129), as BTEX were not detected in samples collected from surrounding locations. Analytical results of deeper HP-9-24 samples indicate vertical extent is limited to the upper portion of the upper coarser-grained, water-bearing interval. MEK was detected in groundwater from location HP-9-06 only, at a depth of 9 to 12 feet bgs; the extent of MEK-impacted groundwater is limited to this one area, and is confined to the upper portion of the upper coarser-grained, water-bearing interval. It is possible that the detected MEK is related to past activities in Building 216, or to a former 1,000-gallon, concrete-constructed, paint waste UST closed in place at Building 216.
- In the lower coarser-grained, water-bearing interval, and extending upward into the fine-grained, water-bearing interval above a contaminant plume consisting of benzene and lesser amounts of associated aromatic compounds (ethylbenzene and total xylene) was detected. The lateral and vertical extents of the benzene plume in this deeper water-bearing interval are not well understood. A portion of the limits of the benzene

plume was defined in the area to the northeast of Building 129, and an extreme southern limit for the benzene plume has been defined; however, the lateral limit of the benzene plume may extend past the area of Building 129. To the north and west of Building 129, the lateral extent of the benzene plume is not known. The vertical extent of the benzene plume was not defined by this investigation, as the deepest groundwater samples collected from this interval indicate the presence of benzene. The source of this benzene plume is unknown, but no data collected suggest that the source for this benzene plume is IR-related activities at IR Site 9. Based on the detected concentrations, the source of the plume appears to be located somewhere to the north of IR Site 9; however, without knowing the groundwater gradient and flow direction within the lower coarser-grained, water-bearing interval, predictions of the source and specific migration pathway are not possible.

- 1,1-DCA was detected in a groundwater sample collected from the lower coarser-grained, water-bearing interval at location HP-9-18. This 1,1-DCA-impacted groundwater is limited to this single sample location on the southern margin of IR Site 9. Because the groundwater gradient in the lower coarser-grained, water-bearing interval is unknown, the migration direction and potential source of 1,1-DCA are unknown. However, because TCE has been identified in the upper coarser-grained, water-bearing interval, it is possible that the 1,1-DCA may be related to a potential chlorinated-VOC source located south of Building 129.
- The lifetime cancer risk to the maintenance/utility worker at IR Site 9 for each AOPC is 9.4×10^{-5}. This risk value is driven by groundwater contamination, and soil does not contribute significantly to the risk at these AOPCs. The total HI for systemic toxicants for each AOPC at IR Site 9, also driven by groundwater contamination, was estimated at 5.0, indicating a potential for adverse health effects.
- Based on the risk associated with the on-site constituents of groundwater at IR Site 9 and the incomplete assessment of the groundwater at this IR site during this RI, additional evaluation of the groundwater will be necessary to better characterize risk.

8.2.3 IR Site 10

- Analytes detected at IR Site 10 in the shallow groundwater included metals, carbon disulfide, 1,1-DCA, 1,2-DCE, TCE, acenaphthene, pyrene, and 1,2,4-trichlorobenzene.
- The only metal in excess of groundwater background thresholds or COPC was barium, detected at a single location near the center of the western

boundary of the site. Barium was below background thresholds at locations to the north, east, and southeast, defining lateral extent in those directions. All other metals were below their respective background threshold concentrations at all locations.

- The only groundwater organic COPC above its respective tapwater PRG was TCE.
- 1,2,4-trichlorobenzene, and the PAHs acenaphthene and pyrene, were detected in groundwater at one location near the northeastern corner of IR Site 10.
- 1,1-DCA, 1,2-DCE, and/or TCE were detected at five locations in the central and northwestern portions of the site. The distribution of the detected concentrations is patchy and does not appear to indicate a well-definable dissolved solvent plume, but extent is defined by nondetect results for these analytes at locations to the northwest, northeast, and north (off-site).
- Carbon disulfide was detected in groundwater at a single location, off-site to the southeast of IR Site 10; none of the on-site samples contained carbon disulfide, and its extent to the east and north is defined.
- The risk associated with the on-site constituents of groundwater falls below the upper-bound lifetime cancer risk of 10^{-4} as defined by the NCP.
- Remedial goals for groundwater do not appear necessary, and no further action appears warranted.

8.2.4 IR Site 11

- The only analytes detected in IR Site 11 groundwater were metals; organotins were analyzed for, but not detected.
- There were no COPCs in groundwater above background thresholds (metals).
- Exposure to groundwater was not evaluated at IR Site 11, AOPC 1. The groundwater table is at depth greater than 11 feet at this location, and it is inaccessible to the maintenance/utility worker.
- Total cancer risks from groundwater exposures at AOPC 2 were estimated below the NCP's point of departure (10^{-6}). The HI for a maintenance/utility worker did not exceed 1.0.
- Remedial goals for groundwater do not appear necessary, and no further action appears warranted.

8.2.5 IR Site 12

- Analytes detected in shallow groundwater at IR Site 12 included metals, acetone, phthalates, and isophorone.
- The metals in excess of groundwater background thresholds or COPCs were arsenic, barium, cobalt, iron, manganese, nickel, selenium, thallium, and vanadium.
- There were no organic COPCs in groundwater above their respective tapwater PRGs.
- The source of the groundwater dissolved arsenic plume in the upper portion of the upper coarser-grained, water-bearing interval, west of IR Site 12, has not been determined. Its lateral extent is defined by shallow groundwater arsenic results below the background threshold at locations to the north, east, south, and west. Vertical extent is also defined at the location that had the maximum shallow (20- to 25-foot-bgs) groundwater arsenic concentration, where a deeper 30- to 35-foot-bgs groundwater sample did not contain detectable arsenic.
- The source of the dissolved manganese plume has also not been determined. Its lateral extent is defined by groundwater below-background threshold manganese results at locations to the north, east, southwest, and northwest.
- The distribution of the organic analytes and remaining metals detected in groundwater, and concentrations at which they were detected, do not appear to indicate the presence of additional dissolved groundwater plumes.
- Based on data for IR Site 12, including the depth to groundwater (approximately 20 feet bgs), groundwater does not contribute to industrial exposure risk at IR Site 12. However, the groundwater arsenic plume may warrant further investigation west of IR Site 12 and in adjacent areas, to identify a potential source and evaluate need for remedial action.

8.2.6 IR Site 13

- Analytes detected in IR Site 13 shallow groundwater included metals, carbon disulfide, diethylphthalate, benzo(g,h,i)perylene, and indeno(1,2,3-cd)pyrene.
- The metals in excess of groundwater background thresholds or COPCs were cobalt, manganese, and nickel.

- There were no groundwater organic COPCs above their respective tapwater PRGs.
- The IR Site 13 groundwater sample with above-background threshold cobalt, manganese, and nickel was from HP-13-01, located south of HP-12-21, which contained manganese in groundwater above the background threshold, and north of HP-12-22, which contained cobalt and manganese in groundwater above background. All metals in groundwater were below background thresholds at the remaining IR Site 13 locations; the extent of the dissolved metals plume is defined by below-background threshold metal results in groundwater at sample locations to the east, north, and west, and to the southwest beyond Building 303 by below-background threshold metal results in groundwater at MW-FW-10. The source of the dissolved metals plume is not known.
- The distribution of the organic analytes detected in groundwater, and concentrations at which they were detected, do not appear to indicate the presence of a dissolved organics groundwater plume.
- Based on data at IR Site 13, including the depth to groundwater (approximately 20 feet bgs), groundwater does not contribute to industrial exposure risk at IR Site 13. However, the occurrence of chemicals within groundwater may warrant further investigation for evaluation of remedial action.

8.3 GROUNDWATER AOPC IDENTIFICATION

The analytical results presented in Section 5.2.8.3 and summarized in Section 8.2.2 serve as the basis for identification of groundwater AOPCs at LBNSY. At IR Sites 8, 10, and 11, groundwater sampling results indicate either groundwater is not significantly impacted by metal and organic contaminants, or is impacted at levels that do not present unacceptable risk. However, at IR Site 9, the extents of dissolved organic groundwater plumes in the fine-grained and upper and lower coarser-grained, water-bearing intervals have not been sufficiently assessed. At IR Site 12, the sources have not been identified for the dissolved arsenic plume, and for the three locations with manganese above the groundwater background threshold near the IR Sites 12 and 13 boundary. For these reasons, groundwater AOPCs (GWAOPCs) are limited to IR Sites 9 and 12/13. Table 8-1 summarizes these GWAOPCs.

Table 8-1
GWAOPCs
IR Sites 9, 12, and 13

IR Site	Groundwater AOPC Number	COPCs	Comments
9	1	Chlorinated VOCs	Extent partially defined.
9	2	Vinyl chloride	Extent partially defined, and source unknown.
9	3	Benzene	Extent partially defined, and source unknown.
9	4	1,1-DCA	Extent not defined, and source unknown.
12	1	Arsenic	Extent defined, but source unknown.
12/13	2	Manganese, Cobalt, Nickel	Extent defined, but source unknown.

8.3.1 IR Site 9

8.3.1.1 UPPER COARSER-GRAINED, WATER-BEARING INTERVAL

The analytical results for groundwater samples collected from the upper coarser-grained, water-bearing interval are presented in Section 5.2.8.3. Based on the nature and distribution of the chemicals detected, the following GWAOPCs are defined for the upper coarser-grained, water-bearing interval:

GWAOPC 1 – Shallow Dissolved Chlorinated VOCs

Dissolved chlorinated VOCs appear to be widespread in the upper coarser-grained, water-bearing interval in the IR Site 9 vicinity. The lateral limits of this plume, in the area of the former Quonset huts, were defined only to the north, northeast, east and southeast of Building 129 (near the northwestern corner of Parking Lot J). Comparison of the analytical results to the subsurface stratigraphy indicates that the chlorinated hydrocarbon plume in this area is limited in vertical extent to the upper coarser-grained, water-bearing interval. The lateral and vertical limits were not defined in the area west of Building 129 (Building 128) and in the area to the south.

GWAOPC 2 – Shallow Dissolved Vinyl Chloride South of Building 129

The maximum vinyl chloride concentration of 28 µg/L was detected south of the site, with concentrations decreasing steadily northward. 1,1-DCE and 1,2-DCE showed similar decreases in concentration from south to north across the site, except in the general area of the former Quonset huts.

8.3.1.2 FINE-GRAINED, WATER-BEARING INTERVAL

Carbon disulfide and benzene were detected in the groundwater of the fine-grained, water-bearing interval at IR Site 9. These locations are north of LBNSY and are in an elevated fill area approximately 16 to 19 feet higher than the main portion of IR Site 9.

Carbon disulfide was detected at a concentration of 2 µg/L in a single groundwater sample. No industrial source for carbon disulfide has been identified, and the carbon disulfide detected in this RI sample may be related to naturally occurring reactions and is a common occurrence around this area. Benzene was detected in the lower portion of the fine-grained, water-bearing interval that separates the upper coarser-grained, water-bearing interval from the lower coarser-grained, water-bearing interval at concentrations between 190 and 150 µg/L. The southernmost limit of benzene-impacted groundwater in the fine-grained, water-bearing interval is defined by the sample points at the northern boundary of LBNSY along Avenue D. However, the lateral extent of benzene-impacted groundwater within the fine-grained, water-bearing interval is poorly defined.

Because the benzene was detected in the lower portion of the fine-grained, water-bearing interval, its source and extent are poorly understood, and there is a special association between the two plumes, it is being included in the deeper GWAOPC 3 below.

8.3.1.3 LOWER COARSER-GRAINED, WATER-BEARING INTERVAL

The analytical results for groundwater samples collected from the lower coarser-grained, water-bearing interval are presented in Section 5.2.8.3. Based on the nature and distribution of the chemicals detected, the following GWAOPCs are defined for the lower coarser-grained, water-bearing interval:

GWAOPC 3 – Deep Dissolved Benzene

The lateral and vertical extents of the benzene, ethylbenzene, and total xylene plume in the lower coarser-grained, water-bearing interval are not well understood. Based on the analytical data, the southern extent of the benzene (north of IR Site 9) is approximately defined to the northeast of Building 129, and to the southeast and south. Lateral limits are defined to nondetect. The lateral extent of the benzene, ethylbenzene, and xylene plume to the north-northwest of Building 129 is unknown. The detected concentrations increased north of Building 129, with the highest concentrations detected off-site of LBNSY, north of IR Site 9. No data collected suggest that the source for the benzene and associated compounds is IR Site 9. Based on the contaminant concentrations, the source of the plume in the lower coarser-grained, water-bearing interval appears to be located to the north of IR Site 9. However, without knowing the groundwater gradient and flow direction in the lower coarser-grained, water-bearing interval, it is not possible to predict the source or specific migration pathway.

GWAOPC 4 – Deep Dissolved 1,1-DCA

A single detect for 1,1-DCA was recorded for a groundwater sample collected from the lower coarser-grained, water-bearing interval south of IR Site 9. The lateral extent of 1,1-DCA-impacted groundwater interval is limited to this single location on the southern margin of the area investigated as part of this study. Because the groundwater gradient and flow direction in the lower coarser-grained, water-bearing interval are unknown, the migration direction and potential source of 1,1-DCA are unknown. However, because chlorinated hydrocarbons have been identified in the upper coarser-grained, water-bearing interval, it is possible that the 1,1-DCA may be related to the potential chlorinated-hydrocarbon source located somewhere to the south of Building 129, as previously described for the upper coarser-grained, water-bearing interval.

8.3.2 IR Sites 12 and 13

The occurrence of chemicals within the upper coarser-grained, water-bearing interval beneath IR Sites 12 and 13 may warrant further evaluation at two separate areas. The first is an area where several groundwater samples contained dissolved arsenic above the background threshold, and the other is an area with manganese above the background threshold.

GWAOPC 1 – Dissolved Arsenic

Dissolved arsenic was detected above the background threshold in the upper coarser-grained, water-bearing interval at five sample locations in the western portion of IR Site 12 and in Parking Lot E to the west. The maximum shallow (20- to 25-foot-bgs) groundwater arsenic concentration was 915 µg/L (33 times background threshold). The lateral extent of the dissolved arsenic plume is defined by shallow groundwater less-than-background threshold arsenic results at locations to the north, east, south, and west. Vertical extent is also defined at the location that had the maximum shallow dissolved arsenic concentration, where a deeper, 30- to 35-foot-bgs groundwater sample did not contain detectable arsenic. However, the source of the dissolved arsenic plume has not been determined.

GWAOPC 2 – Dissolved Manganese

A groundwater sample from the upper coarse-grained, water-bearing interval in southwestern portion of IR Site 12 contained an elevated concentration of manganese (9,820 µg/L [2.1 times background threshold], the highest concentration detected in this area) and elevated concentrations of cobalt (17.1 µg/L) and nickel (319 µg/L). Dissolved manganese was also detected above the background threshold at two locations near the southwestern corner of IR Site 12, and at a third location off-site to the west of IR Site 13; the latter location also contained cobalt (20.9 µg/L) at 2.9 times the background threshold. Lateral extent of the dissolved manganese is defined by groundwater less-than-background threshold manganese results at locations to the north, east, southwest,

and northwest. However, the source of the dissolved manganese, cobalt, and nickel has not been determined.

8.4 RECOMMENDATIONS

8.4.1 Remedial Action Objectives for Soils

The following presents remedial action objectives for soil and supporting rationale as a result of this RI. Table 8-2 summarizes the remedial action objectives for soil at each of the IR sites described below.

- IR Site 8 is recommended for no further remedial action because no COPCs were detected in soil samples.
- IR Site 9 is recommended for no further remedial action because no COCs or AOCs were identified in soil samples.
- No further action is recommended at IR Site 10 because no COCs or AOCs were identified in soils. Moreover, the overall site risk based on an industrial scenario (considering the background threshold contribution of metal) falls below the NCP-defined departure point for determining remediation goals. Remedial action at this site does not appear warranted.
- At IR Site 11, the overall site risks for both the industrial and maintenance/utility worker scenarios fall within the NCP's generally acceptable range for risk, and the potential for degradation of surface water by leaching of contaminants from the soil into the groundwater and then migrating to the harbor appears negligible, thus remedial action at IR Site 11 does not appear warranted. Therefore, no further action is recommended for this IR site.
- On IR Site 12 at AOC 1 further remedial action is recommended because of the COCs identified in soil samples. It is recommended that (1) the AOC boundary be limited to that of the AOPC 1, and (2) remedial action in the form of eliminating the exposure pathways for benzo(a) pyrene (specifically dermal contact, incidental ingestion, and dust inhalation) be performed. Modeling calculations indicate that COPCs detected beneath the site will not exceed regulatory levels at discharge to surface water.
- At IR Site 13, the overall site risk for an industrial and maintenance/utility worker scenario falls within the NCP-defined generally acceptable range and the potential for degradation of surface water by leaching of contaminants from the soil into the groundwater and migrating to the harbor appears negligible. Remedial action at IR Site 13

does not appear warranted. Therefore, no further action is recommended for this IR site.

Table 8-2
Recommended Future Actions for Soils

Site	AOPC	Media	Proposed Action	Rationale
8	1	Soils	No further action	Risk is below NCP departure point.
9	1-3	Soils	No further action	Risk is below NCP departure point.
10	1	Soils	No further action	Risk is within NCP generally acceptable range.
11	1	Soils	No further action	Risk is within NCP generally acceptable range.
11	2	Soils	No further action	Risk is within NCP generally acceptable range.
12	1	Soils	Remedial action	Risk exceeds NCP generally acceptable range.
12/13	2	Soils	No further action	Risk is within NCP generally acceptable range.

8.4.2 Remedial Action Objectives for Groundwater

The following presents remedial action objectives for groundwater and supporting rationale as a result of this RI. Table 8-3 summarizes the recommended remedial action objectives for groundwater at each of the IR sites described below.

- Because the overall site risk for groundwater falls below the NCP-defined generally acceptable range, and the potential for degradation of surface water by leaching of contaminants from the soil and migrating to the harbor appears negligible, remedial action for groundwater at IR Sites 8, 10, and 11 does not appear warranted. Therefore, no further action is recommended for these sites.

- Based on results of the BHHRA and the fact that groundwater was not completely evaluated at IR Site 9 during this RI, it is recommended that the groundwater at IR Site 9 and surrounding areas where plumes have been identified be further evaluated. This evaluation should include defining the lateral limits of the plumes, the vertical extent of the plumes where they have not already been defined by this investigation, and potential sources for the contamination when possible. To evaluate migration pathways, it is recommended that the potentially migration-limiting nature of the fine-grained, water-bearing interval be examined, and the flow direction of groundwater in the lower coarser-grained, water-bearing interval be determined, so that migration pathways for contaminants in groundwater may be analyzed. Upon completion of characterization of the groundwater, it is recommended that the risk posed from contaminants in the groundwater be reevaluated.

- Based on the analytical data, the sources of the arsenic plume at IR Site 12 and the manganese, cobalt, and nickel plume at IR Sites 12 and 13 in the upper coarser-grained, water-bearing interval are unknown. The recommended objective for IR Sites 12 and 13 is the identification of the source of the contaminant plumes detected in groundwater for both IR sites.

Table 8-3
Recommended Future Actions for Groundwater

Site	Media	Proposed Action	Rationale
8/10/11	Groundwater	No further action	Risk is below NCP departure point.
9	Groundwater	On/off-site plume delineation	On/off-site extent and sources unknown.
12/13	Groundwater	Source identification	On/off-site sources unknown.