FINAL RECORD OF DECISION, NEBO SOUTH GROUNDWATER – OPERABLE UNIT 2 MARINE CORPS LOGISTICS BASE BARSTOW, CALIFORNIA

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ABBREVIATIONS AND ACRONYMS

°F	degrees Fahrenheit
µg/L	micrograms per liter
1,1-DCA	1,1-dichoroethane
1,1-DCE	1,1-dichloroethene
1,2-DCA	1,2-dichloroethane
AQMD	Air Quality Management District
ARAR	applicable or relevant and appropriate requirement
AS/SVE	air sparging/soil vapor extraction
bgs	below ground surface
BLRA	baseline risk assessment
BMP	Base Master Plan
BNSF	Burlington Northern Santa Fe
Cal.	California
Cal/EPA	California Environmental Protection Agency
Cal. Water Code	California Water Code
CAOC	CERCLA Area of Concern
Cal. Code Regs.	California Code of Regulations
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
C.F.R.	Code of Federal Regulations
ch.	Chapter
COC	chemical of concern
CSM	conceptual site model
div.	Division
DON	Department of the Navy
DTSC	Department of Toxic Substances Control
EPA	U.S. Environmental Protection Agency
Fed. Reg.	Federal Register
FFA	Federal Facilities Agreement
FS	Feasibility Study
ft/ft	feet per foot

ABBREVIATIONS AND ACRONYMS

(Continued)

FWENC	Foster Wheeler Environmental Corporation
GAC	granular activated carbon
GEW	groundwater extraction well
gpd	gallons per day
gpm	gallons per minute
GWMR	Groundwater Monitoring Report
HRS	hazard ranking system
IAS	initial assessment study
IC	institutional control
ILCR	incremental lifetime cancer risk
IR	Installation Restoration
IWTP	Industrial Wastewater Treatment Plant
kg	kilogram
J	estimated value
JEG	Jacobs Engineering Group, Inc.
LUC	Land Use Control
MCL	Maximum Contaminant Level
MCLB	Marine Corps Logistics Base
MCLG	Maximum Contaminant Level Goal
mg/L	milligrams per liter
mph	miles per hour
NACIP	Navy Assessment and Control of Installation Pollutants
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NEESA	Naval Energy and Environmental Support Activity
NPL	National Priorities List
OHM	OHM Remediation Services, Inc.
OU	Operable Unit
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
Porter-Cologne Act	Porter-Cologne Water Quality Control Act

ABBREVIATIONS AND ACRONYMS

(Continued)

RA	relevant and appropriate
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RI	Remedial Investigation
ROD	Record of Decision
ROI	radius of influence
RWQCB	Regional Water Quality Control Board
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
SMCL	Secondary Maximum Contaminant Level
SWRCB	State Water Resources Control Board
SVOC	semivolatile organic compound
TBC	to be considered
TCE	trichloroethene
TCLP	Toxicity Characteristic Leaching Procedure
TEF	technical and economical feasibility
tit.	Title
TtEC	Tetra Tech EC, Inc.
TtFW	Tetra Tech FW, Inc.
U	below reporting limits
U.S.C.	United States Code
USGS	United States Geological Survey
VOC	volatile organic compound
Water Board	California Regional Water Quality Control Board
WESTDIV	Western Division Naval Facilities Engineering Command
WQO	water quality objective

PART I – DECLARATION

1.0 DECLARATION STATEMENT FOR RECORD OF DECISION

This Record of Decision (ROD) documents the selected remedial action for the Nebo South Plume at the Marine Corps Logistics Base (MCLB), Barstow, California. The ROD serves as a legal document that certifies that the remedy selection process was carried out in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA) and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). It also provides a substantive summary of the technical rationale and background information contained in the Administrative Record. The ROD provides information necessary for identifying the engineering components of the remedy It also outlines the remedial action objectives (RAOs) and cleanup levels for the selected remedy and is a key tool for communication with the public.

1.1 SITE NAME AND LOCATION

MCLB Barstow is located in San Bernardino County, California, within the central Mojave Desert approximately 135 miles northeast of Los Angeles. MCLB consists of two areas: the Nebo Main Base, which includes the Rifle Range, is 3.5 miles east of Barstow and intersected by Interstate 40; and the Yermo Annex, which is 7 miles east of Barstow between Interstates 15 and 40 (Figure 1-1). Groundwater underlying the Yermo Annex and Nebo Main Base is designated as Operable Units (OUs) 1 and 2, respectively. OUs 1 and 2 are comprised of two major groundwater regions separated by the Harper Lake - Camp Rock Fault: Yermo Annex groundwater lies within the Yermo Sub-basin; and the Nebo Main Base groundwater within the Barstow Sub-basin This ROD addresses the cleanup of groundwater contamination at OU 2 Nebo South groundwater plume and CERCLA Area of Concern (CAOC) 6, considered to be the source area for the OU 2 Nebo South groundwater plume, located on Nebo Main Base. The areal extent of interconnected groundwater where the contamination occurs in each OU is designated an aquifer, whereas the areal extent of similarly contaminated groundwater within the aquifer is designated a plume.

The U.S. Environmental Protection Agency (EPA) Identification Number for MCLB Barstow is CA8170024261.

1.2 STATEMENT OF BASIS AND PURPOSE

In November 1989, MCLB was placed on the CERCLA National Priorities List (NPL) due to the presence of soil and groundwater contamination on MCLB. Three distinct plumes of groundwater contaminated with volatile organic compounds (VOCs) were identified at MCLB: one at OU 1 referred to as the Yermo Annex plume, and two at OU 2 referred to as the Nebo Main Base North (Nebo North) and Nebo South groundwater plumes, respectively. The recent

extent of the Nebo North and the Nebo South groundwater plumes, based on the 2004 analytical data, is illustrated on Figure 1-2. VOCs are the only confirmed class of groundwater contaminants in the Nebo South groundwater plume area. The groundwater contamination plume at Nebo South appears to be the result of historical releases and disposal practices for solvents at CAOC 6 between 1946 and 1952. These practices included disposing of waste liquids in revetments once located in that area of MCLB.

Based on detailed field investigations, engineering reports, and public input, a ROD was signed in April 1998 detailing the specific remedial alternatives to be implemented at OUs 1 and 2: *Operable Units 1 and 2, Final Record of Decision Report, Marine Corps Logistics Base, Barstow, California* (OUs 1 and 2 ROD; DON, 1998a). The remedial alternatives proposed for the Yermo Annex groundwater plume under OU 1 and the Nebo Main Base North groundwater plume under OU 2 were both deemed final under the OUs 1 and 2 ROD, (DON, 1998a). However, an interim remedial alternative was selected for the Nebo South groundwater plume because the remedial pilot test was not conclusive at the time that the ROD was signed. This decision document presents the final remedy for the Nebo South groundwater plume based on the success of subsequent pilot tests.

The selected remedy for the Nebo South groundwater plume was chosen in accordance with CERCLA requirements, as amended by SARA and, to the extent practicable, with those under the NCP. The decisions are supported by information contained in the administrative record for the Nebo South groundwater plume. The EPA and the State of California (through the California Environmental Protection Agency [Cal/EPA] Department of Toxic Substances Control [DTSC], and the California Regional Water Quality Control Board (Water Board [formerly known as RWQCB]), Lahontan Region, provide support to the Department of the Navy (DON) in evaluating and selecting remedial alternatives. These decisions are based on the Administrative Record for the sites.

1.3 ASSESSMENT OF OU 2

Actual or threatened releases of hazardous substances into the groundwater under OU 2 Nebo South groundwater plume, if not addressed by implementing the remedial action selected in this ROD, may present a current or potential threat to public health and welfare or to the environment. The response actions selected in this ROD for OU 2 Nebo South groundwater plume are necessary to protect the public health or welfare or the environment from those threats.

The DON has concluded that remedial action is required for groundwater to protect public health and the environment based on the following:

- Site history;
- Field investigations;

- Laboratory analytical results;
- Evaluation of potential ecological and human health risks;
- Current and reasonable anticipated future land use.

1.4 DESCRIPTION OF THE SELECTED REMEDY

This ROD addresses the OU 2 Nebo South groundwater plume portion of OU 2 and its related vadose zone contamination. The primary risk driver in the OU 2 Nebo South groundwater plume is trichloroethene (TCE). The chosen remedial approach to groundwater reduces the chemical of concern (COC) in groundwater to or below federal and state Maximum Contaminant Levels (MCLs) for drinking water. This ROD establishes RAOs for the groundwater contaminants as the most stringent of the federal and state MCLs. The ROD also establishes RAOs for vadose zone cleanup for Nebo South as the removal of contaminant mass in the subsurface soils to the degree necessary to prevent further degradation of the groundwater above groundwater cleanup standards and minimize the aquifer cleanup time. The major components of the selected remedy are described below.

The selected remedy consists of an air sparging/soil vapor extraction (AS/SVE) system for VOC mass removal in both groundwater and the vadose zone at CAOC 6, the source area for the Nebo South groundwater plume. The major components of the selected remedy include the following:

- An AS/SVE system to remove VOCs from Nebo South groundwater and the vadose zone at CAOC 6.
- Institutional controls (ICs) including access restrictions to prevent the use of untreated groundwater for drinking water in the area of the plume above MCLs.
- Vadose zone monitoring at CAOC 6 for effectiveness during AS/SVE system operation. The criteria to shut down the AS/SVE system will be evaluated prior to the actual shutdown of the system. These criteria are based on Sections 2.8.3 through 2.8.6 of the OUs 1 and 2 ROD (DON, 1998a) for the other AS/SVE systems at MCLB. In addition, periodic monitoring of the vadose zone for 5 years following the shutdown of the AS/SVE system will take place to test for rebound of VOC vapor concentrations in the vadose zone.
- Groundwater monitoring during the AS/SVE system operational period. As stated above, the criteria to shut down the AS/SVE system will be evaluated prior to the actual shut down of the system. In addition, periodic monitoring of groundwater for 5 years following the shutdown of the AS/SVE remedial action will take place to test for rebound of VOC concentrations in groundwater.
- Evaluations of treatment and cost effectiveness at 5-year intervals until RAOs are met. When RAOs are met, ICs will be lifted and 5-year reviews will no longer be required.

1.5 STATUTORY DETERMINATIONS

The selected remedy for the OU 2 Nebo South groundwater plume is protective of human health and the environment, complies with federal and state requirements that are legally applicable or relevant and appropriate to the remedial actions, and is cost-effective. The remedy uses permanent solutions and alternative treatment technologies to the maximum extent practicable and satisfies the statutory preference for remedies that reduce toxicity, mobility, or volume as a principal element.

Under CERCLA Sec. 121(e)(1), remedial actions conducted by the United States are exempt from permitting requirements. CERCLA requires compliance with substantive applicable or relevant and appropriate requirements (ARARs) that otherwise would have been addressed in such permits. The DON analyzed ARARs as applied to the selected remedy for OU 2.

The effectiveness of the remedial actions for the Nebo South groundwater plume will be reviewed at a minimum of 5-year intervals until RAOs are achieved. The purpose of the 5-year review is to verify that the remedy continues to adequately protect human health and the environment and is achieving cleanup goals while the contaminants are present at OU 2 Nebo South. Once the RAOs are achieved, the ICs will be lifted, allowing for unrestricted use of the Nebo South area and 5-year reviews will not be required. The first 5-year review for the OUs 1-6 remedial actions was performed in 2002.

1.6 ROD DATA CERTIFICATION CHECKLIST

The following information is included in the Decision Summary (Section 2.0) of this ROD:

- COCs and their respective concentrations (Section 2.5 – Site Characteristics);
- Risk assessments are representative of the COCs (Section 2.6 – Risk Characterization/Management);
- Remedial levels established for COCs and the basis for these levels (Section 2.7 – Remedial Action Objectives);
- How source materials constituting principle threats are addressed (Section 2.11 – *Principal Threat Wastes*);
- Current and reasonably anticipated future land-use assumptions and current and potential future beneficial uses of groundwater (Section 2.10.1.2 – Current and Future Land Use for Nebo South);
- Potential land and groundwater use that will be available at the site as a result of the selected remedy (Section 2.10.1.2 – Current and Future Land Use for Nebo South);
- Estimated capital, annual operation and maintenance, and total present worth costs, discount rate, and the number of years over which the remedy cost estimates are projected (Section 2.10.3 – Summary of Estimated Costs for the Selected Remedy);

- Key factors that led to selecting the remedy (Section 2.10 – Selected Remedy and the Rationale - Nebo South Groundwater Plume)

Additional information can be found in the Administrative Record file for Nebo South.

1.7 AUTHORIZING SIGNATURES

Kenneth D. Enzor
Colonel, U.S. Marine Corps
Commanding

260906
Date

Kathleen Johnson
Chief, Federal Facilities and Site Cleanup Branch
U.S. Environmental Protection Agency, Region IX

9/28/06
Date

1.8 CONCURRING SIGNATURES

This ROD presents the final remedy selected by the DON and EPA, in concurrence with the State of California, for the OU 2 Nebo South groundwater plume at MCLB. The selected remedy was chosen in accordance with CERCLA requirements, as amended by the SARA of 1986 and, to the extent practicable, NCP requirements.

John Scandura
Chief, Southern California Operations
Office of Military Facilities
California Environmental Protection Agency
Department of Toxic Substances Control

10/26/06
Date

Harold J. Singer, P.E.
Executive Officer
California Regional Water Quality Control Board
Lahontan Region

Nov 8, 2006
Date

PART II – DECISION SUMMARY

2.0 DECISION SUMMARY FOR RECORD OF DECISION

The decision summary provides an overview of the site characteristics and remedial alternatives that were evaluated. This section also presents a summary of information available in the Administrative Record pertinent to Nebo South; the *Draft Final Remedial Investigation Report, Marine Corps Logistics Base Barstow, Barstow, California (Draft Final Remedial Investigation Report)* (Jacobs Engineering Group (JEG), 1995), the *Draft Final Feasibility Study Report, Operable Units 1 and 2, Marine Corps Logistics Base Barstow, Barstow, California (Draft Final Feasibility Study Report)* (JEG, 1996), the OUs 1 and 2 ROD (DON, 1998a), the *Final Interim Remedial Action Construction Report* (Tetra Tech FW, Inc. [TtFW], 2004a), *Annual Groundwater Monitoring Report for 2004* (TtFW, 2005a), and the *Draft Final Technical Memorandum – Evaluation of Off-Base Extraction Wells* (TtFW, 2005b). The ROD preparation follows the guidelines provided in Chapter 6 of *A Guide to Preparing Superfund Proposed Plans, Record of Decision, and Other Remedy Selection Decision Documents* (EPA, 1999).

2.1 SITE NAME AND LOCATION

MCLB Barstow is located in San Bernardino County, California, within the central Mojave Desert approximately 135 miles northeast of Los Angeles. MCLB consists of two areas: the Nebo Main Base, which includes the Rifle Range, is 3.5 miles east of Barstow and intersected by Interstate 40; and the Yermo Annex, which is 7 miles east of Barstow between Interstates 15 and 40 (Figure 1-1). Groundwater underlying the Yermo Annex and Nebo Main Base is designated as OUs 1 and 2, respectively. OUs 1 and 2 are comprised of two major groundwater regions separated by the Harper Lake - Camp Rock Fault: Yermo Annex groundwater lies within the Yermo Sub-basin; and the Nebo Main Base groundwater within the Barstow Sub-basin. This ROD addresses the cleanup of groundwater contamination at OU 2 Nebo South groundwater plume and CAOC 6, considered to be the source area for the OU 2 Nebo South groundwater plume, located on Nebo Main Base The areal extent of interconnected groundwater where the contamination occurs in each OU is designated an aquifer, whereas the areal extent of similarly contaminated groundwater within the aquifer is designated a plume.

The EPA Identification Number for MCLB is CA8170024261.

2.2 SITE HISTORY

MCLB Barstow was established in 1942 at the Nebo Main Base (see Figure 1-1) as a Marine Corps Depot of Supplies, a staging area for supplies and equipment for Marine Corps forces deployed in the Pacific during World War II. By 1943, the Marine Corps Depot of Supplies began providing logistical support to Marine Corps commands throughout the western United States and the Pacific.

Yermo Annex (see Figure 1-1) was acquired in 1946 because Nebo Main Base operations outgrew escalating mission requirements. The Rifle Range (refer to Figure 1-1) was acquired in the mid-1950s for shooting practice. Until the early 1960s, MCLB Barstow's major industrial operations were conducted at Nebo Main Base; in the early 1960s, the major industrial operations were moved to the Yermo Annex.

Operations at MCLB Barstow have included maintaining, issuing, and shipping materials held in the Marine Corps Stores Distribution System. During its 50 years of operation through 1992, MCLB Barstow has generated industrial waste such as waste oil; fuel; solvent; paint residue; grease; hydraulic fluid; battery acid; various gases; and other components, including some that are sources of low-level radiation. Additional waste generated included pesticides, herbicides, polychlorinated biphenyls (PCBs), calcium hypochlorite, and sodium hypochlorite. In the early years, some of these wastes were disposed of in landfills, burn trenches, and other areas located throughout the Nebo Main Base and the Yermo Annex.

After the passage of CERCLA in 1980, the DON began the Installation Restoration (IR) Program to identify, investigate, and clean up past hazardous waste disposal sites. MCLB Barstow and the DON have been actively involved in this program since the early 1980s as described in the following sections.

2.2.1 Site Assessment

Site assessment activities have been conducted since 1983 to determine the nature and extent of contamination and the hydrogeological conditions underlying MCLB. In 1988, chlorinated solvents, including TCE, were found in groundwater production wells at the Yermo Annex. The wells were then connected to a granular activated carbon treatment system to treat the contamination at the wellhead. Several groundwater production wells at the Nebo Main Base were abandoned due to groundwater degradation (there was no groundwater production after 1975). In 1977, the Nebo Main Base was connected to the Southern California Water Company system for its potable water supply.

The DON conducted a series of studies as part of the Navy Assessment and Control of Installation Pollutants (NACIP) program to determine the presence of contamination in soil and groundwater at MCLB.

Under the NACIP program, an initial assessment study (IAS) (Naval Energy and Environmental Support Activity [NEESA], 1983) was conducted to evaluate past practices of hazardous waste handling, storage, and disposal and to identify areas representing a potential threat to the environment or human health. The IAS identified 33 potential sites of contamination through record searches, employee interviews, and site surveys. Other sources of information and further review of the IAS research findings led to the identification of three additional sites.

Of the 36 sites identified, the following five posed a potential threat to the environment and were recommended for further evaluation through a confirmation study:

- Site 2 — Pesticide Storage and Washout Area;
- Site 3 — Wastewater Disposal Area;
- Site 5 — Chemical Storage Area;
- Site 18 — Sludge Waste Disposal Area;
- Site 19 — First Hazardous and Low-level Radiological Storage Area.

Six more sites were included in the confirmation study based on additional evidence of potential contamination. The additional sites are as follows:

- Site 9 — Fuel Disposal Area;
- Site 11 — Fuel Burn Area;
- Site 17 — Industrial Waste Treatment Area;
- Site 21 — Industrial Waste Disposal Area;
- Site 23 — Landfill Area;
- Site 34 — PCB Storage Area.

Confirmation studies were completed for Sites 2, 5, 9, and 11 at the Nebo Main Base and Sites 18, 19, 21, 23, and 34 at the Yermo Annex documented in the *Confirmation Study Marine Corps Logistics Base* (Western Division Naval Facilities Engineering Command [WESTDIV], 1985; 1986). The studies detected chlorinated hydrocarbons, PCBs, pesticides, and metals in soils at concentrations warranting potential concern. Chlorinated hydrocarbons were also detected in groundwater.

The EPA prepared a hazard ranking system (HRS) document for MCLB that included results from the confirmation studies and from United States Geological Survey (USGS) water sampling reports to the Southern California Water Company. These reports provided the documentation required for the decision to place MCLB Barstow on the NPL.

Low levels of VOC contamination have been reported in the Yermo Annex groundwater since 1984. These data are found in monthly monitoring reports for the domestic wastewater oxidation ponds. VOC concentrations exceeding state action levels were detected in samples taken in June 1985. Up to 7 micrograms per liter (µg/L) of tetrachloroethene (PCE) and 3 µg/L of 1,1-dichloroethene (1,1-DCE) were detected in groundwater beneath the sludge waste disposal area southeast of the Industrial Wastewater Treatment Plant (IWTP). Up to 11 µg/L of 1,1-dichloroethane (1,1-DCA) were detected in groundwater beneath the industrial waste disposal area south of the effluent ponds at the Sanitary Wastewater Treatment Plant. In March 1988, TCE was detected at 5.7 µg/L in Yermo Water Supply Well No. 3. Subsequent samples taken from Supply Well No. 3 contained TCE concentrations of 14 µg/L (on September 16, 1988) and

26 µg/L (on November 3, 1988). Monitoring wells near the Yermo Annex IWTP contained TCE and PCE concentrations up to 440 µg/L, which were detected on November 3, 1988. State action levels are 5 µg/L for both TCE and PCE.

On July 27, 1989, the Water Board issued Cleanup and Abatement Order No. 6-89-178, requiring MCLB to clean up and abate the effects of waste discharges and threatened waste discharges to the groundwater of the Mojave Hydrologic Unit

Based on the EPA HRS score and the fact that, at the time, groundwater was the sole source of drinking water for MCLB and the surrounding areas, the EPA placed MCLB on the NPL on November 15, 1989.

2.2.2 Federal Facilities Agreement for Site Cleanup

In November 1989, MCLB was placed on the NPL due to the presence of soil and groundwater contamination. In October 1990, MCLB entered into a Federal Facilities Agreement (FFA) with the EPA, DTSC, and Water Board. The FFA constitutes a legally binding agreement between the Marine Corps and these regulatory agencies.

The FFA specifies a schedule for completing the CERCLA investigation and remediation activities and defines seven OUs at MCLB. OU 1 and OU 2 address the groundwater contamination at the Yermo Annex and the Nebo Main Base, respectively. OU 3, OU 4, OU 5, and OU 6 address soil contamination at 36 CAOCs. OU 7 was created to include any additional CAOCs that may be identified from the ongoing Resource Conservation and Recovery Act (RCRA) Facility Assessment at MCLB.

2.2.3 OUs 1 and 2 Remedial Investigation, 1995

Remedial Investigation (RI) activities for OU 1 and OU 2 were conducted within the framework of the FFA to define regional hydrogeologic conditions and to assess the nature and extent of groundwater contamination at MCLB. Phase 1 RI activities were conducted between February and December 1992. The Phase 1 RI identified the presence of VOCs exceeding MCLs in the groundwater both at the Yermo Annex and the Nebo Main Base. In 1992, a CERCLA emergency removal action was conducted as TCE concentrations above drinking water standards were detected in groundwater samples from an off-base private residence well. The well was removed from service and the residence was connected to MCLB water supply system, as stated in the OUs 1 and 2 ROD.

Phase 2 RI activities, conducted between June and September 1994, focused on defining the vertical and lateral extent of the groundwater contamination detected in Phase 1. The investigative approach and results of the groundwater RI are presented in the Draft Final Remedial Investigation Report (JEG, 1995).

2.2.4 OUs 1 and 2 Feasibility Study, 1996

Based on site conditions, the primary RAO for the Nebo South groundwater plume was to prevent any further migration of the VOC contamination at the leading edge of the plume. This strategy involved the capture of the VOC mass estimated to exist in the aquifer. The following remediation strategies were evaluated in the Feasibility Study (FS), as documented in the *Draft Final Feasibility Study Report, Operable Units 1 and 2, MCLB Barstow, Barstow, California* (JEG, 1996).

1. Containment of groundwater contamination at the leading edge of the VOC plume by active extraction and treatment. This process option was evaluated to determine if extraction and treatment could be a cost-effective remedy to prevent further plume migration and provide a permanent solution. Due to the significant limitations posed on extraction and treatment technology by the extremely low permeability of the aquifer (maximum well yields of 5 gallons per minute [gpm]), a limited containment system was determined to be more cost-effective than a more aggressive full-scale system.
2. Removal of the VOC contaminant source by AS/SVE at CAOC 6. This process option was evaluated to determine if AS/SVE could be a cost-effective remedy to remove VOC contamination from the vadose zone and groundwater in the source area and reduce the time required to clean up the aquifer with the extraction and treatment containment system. A pilot study consisting of two nested sets of two AS wells (one shallow and one deep) and six SVE wells was conducted in 1998 to analyze the effectiveness of AS/SVE in removing VOC mass from the vadose zone and groundwater. The pilot study yielded inconclusive results. Average radius of influence, mass removal rates, vacuum levels and flow rates for both AS and SVE wells were greater than expected, suggesting that coverage of the entire site could be achieved with about half as many wells as originally anticipated. However, the results also indicated significant variability from well to well for some of the parameters, suggesting that localized subsurface conditions could significantly affect the performance of a full-scale system. In addition, many data gaps in the study made it difficult to fully assess the results.

The following remedial action alternatives were evaluated during the OUs 1 and 2 FS (JEG, 1996) and ROD (DON, 1998a):

- Alternative 1 – No Action;
- Alternative 2 – ICs/Groundwater Monitoring;
- Alternative 3 – Vadose Zone Source Reduction (AS/SVE at CAOC 6) with ICs and Groundwater Monitoring;
- Alternative 4 – Groundwater Removal (Extraction Wells at MCL Boundary), Source Reduction at CAOC 6, Ex Situ Treatment, and Discharge with ICs and Groundwater Monitoring;
- Alternative 5 – Groundwater Containment and Removal (Extraction Wells at MCL Boundary), Ex Situ Treatment, and Discharge with ICs and Groundwater Monitoring.

2.2.5 Removal Action – Nebo South

In 1992, TCE concentrations above drinking water standards were detected in groundwater samples from an off-base private residence well within the 1996 off-base plume boundary. A CERCLA emergency removal action was conducted to remove the well from service and connect the residence to MCLB water supply system as stated in the OUs 1 and 2 ROD and the *Action Memorandum (Notification of Removal Action at the Private Property Well Contaminated with Trichloroethene [TCE] Adjacent to the Nebo Annex of the Marine Corps Logistics Base [MCLB] in Barstow, CA [DON, 1993]*).

2.2.6 Interim Remedy – Nebo South Groundwater Plume (OU 2 ROD)

The OUs 1 and 2 ROD addressed the groundwater contaminant plumes in the OU 1 and OU 2 aquifers and related vadose zone contamination. The selected alternative in the OUs 1 and 2 ROD (DON, 1998a) for addressing the groundwater contamination at the Nebo South was Alternative 5 from the FS: Groundwater Containment and Removal (Extraction Wells at the MCL Boundary), Ex Situ Treatment and Discharge. This alternative was selected as an interim remedy. Implementation of the Phase 2 AS/SVE pilot system was also a major component of the interim remedial action. As discussed in Section 2.2.7, AS/SVE was implemented on a pilot basis to test for effectiveness.

The remedial goal chosen at OU 2 was to reduce the contaminant mass in groundwater and the vadose zone to levels that would result in groundwater concentrations at or below the federal and state MCLs. The Nebo South groundwater is impacted primarily by TCE and to a lesser extent, other VOCs. The OUs 1 and 2 ROD set aquifer cleanup levels for TCE, PCE, 1,1-DCE, and 1,2-dichloroethane (1,2-DCA) as the most stringent of the federal and state MCLs.

As described above, the remedy originally selected for Nebo South in 1998 was an interim remedy consisting of containment and removal of the groundwater contaminant plume from the aquifer, followed by ex situ treatment and recharge of treated groundwater back into the aquifer. This containment measure was deemed necessary to stop any further migration of the VOC plume.

The major components of the selected interim remedy, as specified in the OU 1 and OU 2 ROD (DON, 1998a), included the following:

- Capture the contaminant plume above MCLs through five groundwater extraction wells (GEWs) at the leading edge of the plume (see Figure 2-1 for the previously proposed well locations);
- Treat extracted groundwater by aboveground activated carbon units;
- Recharge treated groundwater back into the aquifer via percolation ponds located on the northeast corner of the Nebo Main Base, downgradient of the plume;
- Continue to evaluate the AS/SVE technology as a remedy to reduce cleanup time and overall remediation costs;

- Implement ICs;
- Select the final remedy at a later date with an accompanying Proposed Plan and ROD.

The implementation details of such a remedy were provided in the *Draft Operable Units 1 and 2 Remedial Action Work Plan and Preliminary Remedial Design* (OHM Remediation Services, Inc. [OHM], 1998), which was submitted to the FFA signatories.

After further consideration, the groundwater extraction system component of the interim remedy for the Nebo South groundwater plume, as described above, was not implemented. For the most part, the extent of the Nebo South groundwater plume has been limited to a small area (approximately 2.28 acres) on-base near MCLB's southeast boundary, and if implemented, groundwater extraction by off-base wells could have potentially resulted in the VOC contamination migrating off-base.

At the time of signing the OUs 1 and 2 ROD (DON, 1998a), the AS/SVE pilot test was underway at Nebo South, and the results were noted to be inconclusive. Therefore, the OUs 1 and 2 ROD (DON, 1998a) proposed that the final remedy for the Nebo South groundwater plume be selected and that the final Proposed Plan and ROD be completed following collection and evaluation of the AS/SVE pilot test data. Further evaluation and analysis of the AS/SVE pilot test results indicated that the AS/SVE technology would be the most effective technology to clean up groundwater contamination in the Nebo South groundwater plume.

2.2.7 AS/SVE at Nebo South

An initial AS/SVE pilot test at CAOC 6 (conducted in 1998, and termed "Phase 1 testing") had provided inconclusive results as to its effectiveness, which resulted in the containment strategy by extraction as the only viable option during the development of the OUs 1 and 2 ROD (DON, 1998a). However, re-evaluation of the Phase 1 AS/SVE test data indicated that AS/SVE was potentially feasible. This was followed by implementation of additional AS/SVE testing (termed Phase 2 testing). The Phase 2 testing confirmed that AS/SVE was in fact feasible, as discussed in detail in the *Draft Final Phase 2 AS/SVE Pilot Test Report* (Foster Wheeler Environmental Corporation [FWENC], 2003a). Implementation of the Phase 2 AS/SVE resulted in significant reduction of the Nebo South groundwater plume extent. Groundwater monitoring data from 2004 indicate that TCE is the only contaminant that continues to be detected above its respective MCL at Nebo South.

As stated in Section 5.3.1 (Groundwater Cleanup) and 5.3.2 (Source Reduction) of the OUs 1 and 2 ROD (DON, 1998a), the continued operation and additional evaluation of the AS/SVE pilot test were expected to indicate whether or not AS/SVE technology would be effective at Nebo South for both groundwater cleanup and source reduction. Based on promising results from the Phase 2 testing, DON and agencies expanded the pilot study to further evaluate the potential for AS/SVE to fully remediate the OU 2 VOC plume and achieve source reduction in the vadose zone (*Draft Final Interim Remedial Design/Remedial Action Work Plan* [FWENC, 2003b]).

These AS/SVE wells are currently in operation. The pilot testing results were used in conjunction with findings of the OUs 1 and 2 FS (JEG, 1996) to evaluate an expanded version of the AS/SVE remedial approach (Alternative 3) evaluated in the OUs 1 and 2 FS. This evaluation was used to support the remedy selection described in this ROD.

2.3 COMMUNITY PARTICIPATION

A public meeting in the form of an open house meeting was conducted on June 28, 2006 to present the Final Proposed Plan for the OU 2 Nebo South Groundwater (DON, 2006a) to the public. Prior to the meeting, a fact sheet (Tetra Tech EC, Inc. [TtEC], 2006) summarizing the Final Proposed Plan was prepared and mailed to the public and other entities on the updated mailing lists referenced in the Community Relations Plan. In addition, advertisements were placed in the local newspapers regarding the open house meeting. Representatives of the DON, EPA, DTSC, and Water Board were available at the public meeting to answer questions about the site and the proposed final remedy. Two people from the community attended the open house and discussed the remedy with DON and the Agencies. There were no comments on the Final Proposed Plan at the open house meeting. In addition, no comments were received during the public comment period, which ended on July 21, 2006.

The Final Proposed Plan for OU 2 Nebo South groundwater plume, incorporating the agency comments on the Draft version of the Final Proposed Plan (DON, 2006a) was submitted on August 11, 2006. These activities fulfill the requirements of CERCLA Sections 113(k)(2)(B)(i-v) and 117(a)(2). Documents for the OU 2 Nebo South groundwater plume and OU 1 can be found in the Administrative Record file.

2.4 SCOPE AND ROLE OF THE ONGOING ACTION AT THE NEBO SOUTH GROUNDWATER PLUME

The FFA specifies a schedule for completing the CERCLA investigation and remediation activities and defines seven OUs at MCLB. OU 1 and OU 2 address the groundwater contamination at the Yermo Annex and the Nebo Main Base, respectively. OU 3, OU 4, OU 5, and OU 6 address soil contamination at 36 CAOCs. OU 7 was created to include any additional CAOCs that may be identified from the ongoing RCRA Facility Assessment at MCLB. RODs have been signed for OUs 1 through 6, as follows:

1. OUs 1 and 2 ROD (DON, 1998a). An interim remedy was selected and documented for the OU 2 Nebo South plume, and this new ROD documents the final remedy. This Final ROD presents the final remedy for the Nebo South groundwater plume portion of OU 2;
2. OUs 3 and 4: *Operable Units 3 and 4, Final Record of Decision Report, Marine Corps Logistics Base, Barstow, California* (OUs 3 and 4 ROD, [DON, 1997]);
3. OUs 5 and 6: *Operable Units 5 and 6, Final Record of Decision Report, Marine Corps Logistics Base, Barstow, California* (OUs 5 and 6 ROD; [DON, 1998b]).

2.5 SITE CHARACTERISTICS

2.5.1 General Site Conditions

The Nebo Main Base is located near the Mojave River where the topography is relatively flat. The topographic surface slopes gently north to the river at the Nebo Main Base and the Rifle Range.

The Mojave River is the dominant surface water feature in the Mojave Desert. The Mojave River originates as a series of interconnecting drainages along the northeast front of the San Bernardino Mountains, extends east-northeast from the mountain front, passes through MCLB, and terminates at Soda Lake about 70 miles east of MCLB. Because the river is primarily fed by mountain front drainages, the riverbed is generally dry much of the year; flows in the Barstow area are limited to periods of heavy rainfall. Surficial flow is also evident near areas of bedrock highs and intermittently along the Harper Lake-Camp Rock Fault near the Nebo Main Base.

On average, about 90 percent of the flow of the Mojave River is retained within the Mojave River Drainage Basin to recharge several groundwater basins, including the Yermo and Barstow sub-basins (DON, 1998a). MCLB lies partly within the 100-year floodplain of the Mojave River, which passes through the northern portion of Nebo Main Base and the southern portion of the Yermo Annex. On-site flooding at the Nebo Main Base is rare. The surface water drainage systems at Nebo Main Base have been designed to intercept and convey runoff water to the Mojave River.

The Barstow area is characterized by intense summer heat, minimal rainfall and low humidity, strong winds, periodic thunderstorms, and flash floods. Factors that tend to moderate the weather in other areas of California are absent in the Mojave Desert, resulting in an extreme climate. Temperature ranges from 12 degrees Fahrenheit (°F) to 114°F annually (DON, 1998a). Winds near Barstow are primarily from the west at an average annual speed of about 11 miles per hour (mph). Wind gusts of up to 65 mph have been recorded.

Annual average precipitation in the Barstow area is about 4 inches per year; however, considerable year-to-year variability occurs, which results in the variable discharge conditions of the Mojave River. Precipitation in the Mojave Desert occurs primarily with the passing of weakened winter fronts from the north and the periodic development of brief, localized thunderstorms during the summer. Periodic episodes of intense rainfall create flash flood conditions (referred to as floodflows) in the Mojave and in the intermittent washes near MCLB and Barstow.

2.5.2 Geology

MCLB is within the Mojave Desert Province (JEG, 1995). This province is a wedge-shaped unit bounded by the Garlock Fault on the north and the San Andreas Fault on the southwest. The approximate eastern boundary is the Bristol-Granite Mountains fault zone in the eastern Mojave

Desert. At this diffuse boundary, the Mojave Desert merges with the Basin and Range Geomorphic Province.

The Mojave Desert Province is characterized by a series of low-lying, northwest-trending, fault-block mountain ranges with intermontane basins and local playas (dry lakes). The ranges are composed primarily of Pre-cambrian granitic and metamorphic rocks, Paleozoic sedimentary rocks, Mesozoic granitic and volcanic rocks, and late Tertiary sedimentary and volcanic rocks. The intermontane basins are largely filled with late Tertiary and Quaternary alluvium. The tectonic grain is essentially defined by a series of closely spaced northwest-trending faults. East-trending faults are more common near the Garlock Fault.

MCLB is located along the west-northwest-trending Barstow Basin, roughly bounded by the Blackwater/Calico faults to the northeast and the Lenwood Fault to the southwest (Figure 2-2). The Barstow Basin slopes sharply to the southeast. Bedrock beneath MCLB reaches depths of 3,500 feet below ground surface (bgs) (DON, 1998a). Exposed local bedrock consists primarily of Tertiary sedimentary and volcanic rocks. The basin is filled by a sequence of late Tertiary to early Quaternary alluvial deposits. The surface is mantled by windblown sand deposits and young alluvial deposits derived from either the Mojave River or shed from adjacent highlands. The southern portion of the facility is underlain by coarse alluvial fan debris containing abundant gravel and cobbles.

2.5.3 Hydrogeology

MCLB is located within the Mojave River Drainage Basin, which covers about 3,700 square miles within the south-central Mojave Desert (JEG, 1995).

The Mojave River Drainage Basin consists of a series of sub-basins separated by largely impermeable bedrock. MCLB is within the Lower Mojave sub-unit. The Lower Mojave sub-unit is further divided into several sub-basins. The Nebo Main Base is in the Barstow sub-basin. Water-bearing sediments within this sub-basin are composed primarily of late Pleistocene to Holocene alluvial deposits shed from adjacent highlands. These deposits are unconsolidated to partially consolidated and consist primarily of sand, silt, and gravel with lenses of clay.

The Barstow sub-basin extends over approximately 20 square miles and is delineated by various hydraulic boundaries. The projection of the Harper Lake-Camp Rock Fault to the east, consolidated rocks to the west, and the terminus of unconsolidated sediments to the north and south delineate the Barstow sub-basin (DON, 1998a).

Aquifer testing was conducted during the course of the RI at CAOC 6. As discussed in Section 7.4.2 of the Draft Final Remedial Investigation Report (JEG, 1995), aquifer testing was conducted on eight wells (NEP-5, NS6-3, NS6-4, NS6-6, NS6-7, NS6-8, NS6-A1, and NS6-A2). The results of the aquifer testing revealed that the soil conditions beneath the water table at CAOC 6 are variable and are not uniformly conducive to groundwater extraction. For example,

pumping could not be performed on four wells (NS6-4, NS6-8, NS6-6, and NS6-7) as they had specific capacities that were too low to support step-drawdown tests. The specific capacities determined from all the wells at CAOC 6 ranged from 0.02 to 4.76 gpm per foot. Typically, specific capacities below approximately 0.1 gpm per foot would indicate that continuous pumping, even at a low-flow rate, may not be sustainable.

2.5.4 Groundwater Flow Directions and Gradients

Groundwater conditions at the Nebo Main Base are monitored by an extensive network of groundwater monitoring wells. Groundwater elevation contours interpreted from the November 2004 Nebo Main Base data are illustrated in Figure 2-3. Groundwater flow patterns (see Figure 2-3) indicate significant influence from the Harper Lake-Camp Rock Fault. East of the fault, the groundwater flow was generally to the southeast with a relatively uniform hydraulic gradient of 0.004 feet per foot (ft/ft). West of the Harper Lake-Camp Rock Fault, a more complex groundwater flow pattern was observed. Flow west of the fault was generally to the east-northeast, with a hydraulic gradient ranging from 0.0017 ft/ft to 0.025 ft/ft and averaging approximately 0.01 ft/ft overall. The hydraulic gradient is relatively steep in the southwest corner of the site and flattens out toward the Harper Lake-Camp Rock Fault.

A gradual overall decrease in groundwater elevations has been noted at wells located in the Nebo South area. The lowering of the water table can be attributed to regional groundwater withdrawal due primarily to agricultural wells, with minor influences from private and public production wells. However, a slight increase in groundwater elevations has been noted during the 2004-2005 rainy season as a result of unusually heavy precipitation. Groundwater production wells at Nebo Main Base have been inactive since 1975 (DON, 1998a).

2.5.5 Chemicals of Concern

The results of the groundwater RI for the Nebo Main Base indicate that VOCs are the primary class of chemicals affecting the groundwater in the Nebo South groundwater plume area. During the RI, TCE, PCE, and 1,2-DCA were detected at concentrations exceeding their federal and/or state drinking water standards. Other VOCs detected at levels not exceeding federal or state standards include 1,1-DCE, chloroform, bromoform, dibromochloromethane, and bromodichloromethane. Provided in Table 2-1 are the maximum concentrations of these contaminants based on the RI/FS data, as well as the 2004 annual groundwater monitoring data, including the respective MCLs. Groundwater monitoring data from 2004 indicate that TCE is the only COC that continues to be detected above its respective MCL at Nebo South.

TCE was noted to be the predominant contaminant in the groundwater at the Nebo South groundwater plume and was detected in all seven groundwater monitoring wells investigated as part of the groundwater RI for the Nebo South (DON, 1998a). Evaluation of the nature and extent of metals concentrations at the Nebo South groundwater plume indicates that metals are not present in the groundwater plume at levels above their expected naturally occurring

concentrations. The RI concluded that there is no evidence that the discharge of wastes from MCLB has resulted in elevated metals concentrations in the groundwater at the Nebo South area.

It was also concluded that VOCs are the only confirmed class of groundwater contaminants in the Nebo South groundwater plume area. The groundwater contamination plume at Nebo South appears to be the result of historical releases and disposal practices for solvents at CAOC 6 between 1946 and 1952. These practices included disposing of waste liquids in revetments once located in that area of MCLB.

2.5.6 Current Status of VOC Plume at Nebo South

Figures 2-4 through 2-8 show the interpreted extents of the Nebo South groundwater plume for 1996, 1998, 2000, 2002, and 2003, respectively. These plume extents were originally submitted in the *Annual Groundwater Monitoring Report [GWMR] for 2003* (Annual 2003 GWMR) (TtFW, 2004b), but were subsequently revised after EPA input and resubmitted in August 2004. The areal extent of the Nebo South groundwater plume based on the annual monitoring event of 2004 (November/December 2004) data is shown on Figure 2-9. The Phase 2 AS/SVE has resulted in significant reduction of the Nebo South groundwater plume extent. Groundwater monitoring data from 2004 indicate that TCE is the only contaminant that continues to be detected above its respective MCL at Nebo South.

As stated in the OUs 1 and 2 ROD (DON, 1998a), continued operation and additional evaluation of the AS/SVE pilot test were expected to indicate whether or not AS/SVE technology would likely be effective at Nebo South for groundwater cleanup as well as source reduction. As discussed in Section 2.2.7, Phase 1 and Phase 2 AS/SVE pilot testing conducted at Nebo South indicated that AS/SVE was a feasible technology for remediating dissolved VOCs. This, coupled with the decrease in the extent of the MCL plume boundary, led to the implementation of AS/SVE as an interim remedial action at Nebo South. This strategy is documented in the *Draft Final Interim Remedial Design/Remedial Action Work Plan* (FWENC, 2003b), which describes the installation of 15 new AS/SVE wells at Nebo South. These AS/SVE wells are currently in operation (August 2006).

Shown on Figure 2-10 are TCE concentrations versus time trend plots for selected wells at Nebo South. These plots indicate, in general, a decreasing trend in dissolved concentrations in the vicinity of the pilot test (in particular, after the start of the post-ROD AS/SVE pilot test). Based on a review of Figures 2-4 through 2-9, the areal extent of the dissolved TCE plume at Nebo South has reduced over the years. Continued operation of the AS/SVE system is expected to result in further reduction of TCE at Nebo South to levels below the MCL.

2.5.7 Vadose Zone Contamination

Although VOCs were not detected in soil samples at CAOC 6 during the RI, VLEACH modeling conducted on soil gas data collected from several vertical profile borings indicated that organic vapors in the vadose zone soils could pose a continuing, long-term source of VOCs to

groundwater. Therefore, the vadose zone at CAOC 6 has been targeted for remedial action under OU 2 on the basis of these results.

As discussed in the *Final Interim Remedial Action Construction Report* (TtFW, 2004a), the results of soil gas sampling (Figure 2-11) indicate that TCE in soil gas lies predominantly in the western portion of CAOC 6. It is likely that TCE was present in soil gas to the east, but was extracted by SVE operations conducted thus far.

2.5.8 Conceptual Site Model

Based on the information obtained from the installation of the 15 new AS/SVE wells, a conceptual site model (CSM) was developed for the site, as discussed in *Final Interim Remedial Action Construction Report* (TtFW, 2004a). This CSM is shown on Figure 2-12 and is described below.

2.5.8.1 Potential Source(s) of Contamination

Based on the low levels of VOCs in soil and relatively low levels of VOCs in soil gas, it is unlikely that solvents were spilled at CAOC 6 in product form. It is more likely that washwater (or similar) containing VOCs was spilled in at least three discrete areas (possibly the revetments). Of these three areas, two areas are likely defined by the limits of the two western groundwater plumes that exceed 10 µg/L of TCE in groundwater. The third area (eastern) encompasses the area of the Phase 1 and 2 AS/SVE wells and extends up to MCLB property line, in the vicinity of NEP-4.

2.5.8.2 Transport/Extent of VOCs

As the VOC-impacted washwater migrated downwards, some VOCs were transferred into the vadose zone, as evidenced by their presence in soil gas. Given that TCE in gas phase is heavier than air, some amount of downward migration of soil gas VOCs may also have occurred. Upon reaching groundwater, dissolved VOCs entered the groundwater. Some off-gassing of VOCs may have also occurred due to equilibrium shifts over time, causing VOCs (in gas phase) to re-enter the vadose zone.

The dissolved VOCs migrated with groundwater at a low rate (low-groundwater velocity coupled with retardation and other processes), creating the plume as interpreted in the RI. In particular, the relatively high impacts at the NEP-4 area are likely a result of this migration. VOCs in groundwater have migrated off MCLB property, as evidenced by the detection of TCE in off-base HydroPunch samples from NH-2 and NH-4. Specifically, TCE was detected at 15 µg/L at 25 feet below the groundwater table at NH-2. This prompted the advancement of NH-5 and NH-6 downgradient, with sampling locations as deep as 60 feet below the groundwater table (see Figure 2-6). TCE was detected at 2 µg/L at 4.4 feet below the groundwater table in NH-5, decreasing to 0.8 µg/L and eventually non-detectable levels at lower sampling depths. At NH-6, TCE was reported at estimated concentrations of 0.6 µg/L at 61.5 feet below the groundwater

table (with six samples above it showing non-detectable levels). The presence of the Fault B (see Section 2.5.4) may also have had an impact on VOC migration.

Gradual lowering of the groundwater may also have caused a reduction in the amount of dissolved VOCs in groundwater, with a portion transferring into the vadose zone. This is evident from Figure 2-6, which indicates that in certain wells, VOC levels have decreased over time, despite their significant distance from Phase 1 and 2 AS/SVE activities (groundwater levels at Nebo South have gradually dropped over the years as discussed in Section 2.5.4).

2.5.8.3 Impact of Previous Remedial Activities

The success of the Phase 1 and 2 AS/SVE testing activities is evidenced by decreases in dissolved VOCs in groundwater at NS6-7, NS6-6, and NS6-3 (see Figure 2-10). Decreases were also observed in NEP-4, NS6-4, and NS6-5; although, these may not be directly attributable to the influence of the AS/SVE, as some decreases were apparent prior to commencement of AS/SVE activities. Decreases in soil gas in the area of Phase 1 and 2 AS/SVE operation are also evident, based on Figure 2-11.

2.5.9 Comparison of 1995 RI Plume with 2004 Plume

TCE plumes based on the data from the 1995 RI and the results from the annual monitoring event of 2004 (November/December 2004) are illustrated on Figure 2-13. TCE concentrations observed during the annual monitoring event of 2004 (November/December 2004) in the Nebo South off-base area have been reduced to levels below the MCLs. As such, the Nebo South off-base plume (based on TCE concentrations in excess of 5 µg/L) can no longer be interpreted to exist. When compared to the extent of the 1995 RI plume, the 2004 TCE plume has shrunk in both size and magnitude at Nebo South (see Figure 2-13). Groundwater samples from Well NEP-4 have historically contained TCE concentrations of over 200 µg/L, but these concentrations have steadily decreased to below MCL during the most recent sampling event (see Figures 2-13 and 2-10). These observed decreases are likely the result of the AS/SVE pilot test operations in this area.

Figure 2-13 also indicates the locations of the groundwater extraction wells previously proposed in the *Draft Operable Units 1 and 2 Remedial Action Work Plan and Preliminary Remedial Design* (OHM, 1998). As can be seen from Figure 2-13, these locations lie outside the boundary of the MCL plume as it is currently interpreted. Given the relatively flat groundwater gradient at Nebo South, implementation of off-base groundwater extraction would cause migration of VOCs from on-base to off-base locations before being extracted.

2.6 RISK CHARACTERIZATION/MANAGEMENT

2.6.1 Assessment of Risk

The *Draft Final Remedial Investigation Report, Marine Corps Logistics Base Barstow, Barstow, California (JEG 1995),* documents a baseline risk assessment (BLRA) that was conducted to determine whether soil and groundwater found at MCLB posed a current or potential threat to human health and the environment. The BLRA provides the basis for defining acceptable risk ranges to determine if either no action or a selected remedy will be protective of human health and the environment. The BLRA results, as presented in the OUs 1 and 2 ROD (DON, 1998a), are summarized below.

Cancer risk is expressed in terms of the chance of contracting cancer over a human's lifetime due to exposure to site chemicals and is called the incremental lifetime cancer risk (ILCR). A risk of 1 out of 1 million means that one additional person out of a group of 1 million may develop cancer as a result of exposure to a chemical. EPA considers a risk of less than 1×10^{-6} (1 in a million) to be protective of human health, and uses this value as the point of departure. The EPA also has developed a risk management range represented as 10^{-6} to 10^{-4} as the target range for managing cancer risks. An ILCR above 10^{-4} (e.g., 10^{-3}) generally requires remedial action.

Non-cancer health effects are evaluated in terms of a hazard index (the ratio of the actual or potential level of exposure to an acceptable level of exposure). EPA uses a hazard index level of less than 1 to be acceptable for non-cancer health effects. Non-cancer hazards significantly above 1 indicate a potential for adverse effects.

2.6.2 Summary of Human Exposure Assumptions

The BLRA presented in the OUs 1 and 2 ROD (DON, 1998a) used a future resident exposure scenario with the following exposure assumptions for the identified pathways:

- A 70-kilogram (kg) adult on-site resident exposed 350 days per year for 30 years
- A 15-kg child on-site resident exposed 350 days per year for 6 years
- Adult and child ingest 2 and 1 liters of water per day, respectively, for the exposure frequency and duration stated above
- A resident showers daily with site groundwater
- The contaminated groundwater is used as a drinking water source without treatment
- Users are exposed to the maximum concentrations detected in the plume

2.6.3 Summary of Nebo South Groundwater Plume Risks

The major risk currently associated with the Nebo South groundwater plume is the ingestion of the contaminated groundwater underlying the affected on- and off-base areas. Actual or threatened releases of hazardous substances from the Nebo South groundwater plume, if not

addressed by implementing the response action selected in the ROD, may present a threat to public health and the environment.

2.6.3.1 *COCs*

The majority of the waste and residues generated by mission operations at the Nebo Main Base have been managed, treated, and disposed of on site throughout MCLB history. By applying screening criteria, the chemicals detected in the vadose zone and groundwater during the RI were evaluated for inclusion as COCs in the risk assessment.

COCs identified in groundwater during the RI groundwater sampling activities, as well as the annual groundwater monitoring conducted during 2004 at Nebo South, include mainly TCE and PCE; however, other compounds have been identified as COCs. COCs are listed in Table 2-1.

2.6.3.2 Summary of Toxicity Values

Summaries of the carcinogenic and noncarcinogenic toxicity values for COCs in groundwater at the Nebo South groundwater plume area are provided in Tables 2-2 and 2-3, respectively.

2.6.3.3 Human Health Risk

For groundwater at the Nebo South groundwater plume under OU 2, the BLRA evaluated a future hypothetical residential scenario as discussed in the OUs 1 and 2 ROD (DON, 1998a).

The BLRA showed that under this scenario for cancer risk, as many as 10 persons in 10,000 (1×10^{-3}) have the potential to develop cancer during their lifetimes. Excluding the contribution from naturally occurring metals and laboratory contaminants, the incremental cancer risk was approximately 4×10^{-4}. This particular estimate was above the EPA's target risk management range of 10^{-4} to 10^{-6}. The primary contributor to this risk is TCE.

These estimates were developed by taking into account the conservative assumptions about the likelihood of a person being exposed to groundwater contamination (see Section 2.6.2). For example, it assumes that the maximum detected contamination concentrations persist for the entire 30-year exposure duration. As detailed in the BLRA, pre-remedial action risks exceeded EPA's target risk range, chiefly due to TCE concentration in groundwater. The interim remedial actions significantly decreased these groundwater TCE concentrations. Therefore, with continued remediation, current and future risks are expected to remain well within EPA's target risk management range.

Evaluations were also performed for hypothetical receptors assuming exposure at the MCL and background levels (analytical quantitation limit). At the MCL, the incremental risk from both PCE and TCE was estimated to be approximately 1×10^{-5}. The corresponding incremental risk at

the background level is approximately 5 x 10^{-6}. The noncarcinogenic hazard index is less than 1.0 for both chemicals.

2.6.3.4 Ecological Risk

EPA Region IX independently conducted an ecological risk assessment to evaluate potential effects on plants and animals from groundwater contaminants at MCLB. At Nebo South, the groundwater in most areas is found at depths ranging from 60 to 100 feet bgs and no surface water exists. Exposure of potential ecological receptors to VOCs in groundwater is unlikely because groundwater does not discharge to local surface water and is therefore not accessible to plants and animals. Thus, there is no complete exposure pathway to impact ecological receptors at Nebo South.

2.7 REMEDIAL ACTION OBJECTIVES

The RAOs for the Nebo South groundwater plume (OU 2) are listed below.

- The RAO for groundwater at CAOC 6 is to restore the groundwater quality within and downgradient of the CAOC 6 area to levels at or below MCLs for COCs. The MCLs for COCs are shown on Table 2-1. A technical and economic feasibility (TEF) evaluation that supports achieving certain cleanup levels that are not technically or economically feasible was included in the Draft Final Feasibility Study Report (JEG, 1996). Based on the TEF evaluation analysis and risk assessment results, the DON concluded that achieving background levels of constituents in the groundwater is not technically or economically feasible. The DON established MCLs as the cleanup levels for groundwater remedial actions, consistent with the requirements of California Code of Regulations (Cal. Code Regs.) tit. 22, § 66264.94, Cal. Code Regs. tit. 23 § 2550.4, and State Water Resources Control Board (SWRCB) Resolution Nos. 68-16 (SWRCB, 1994) and 92-49 (SWRCB, 1992). Therefore, the selection of MCL as the cleanup levels for groundwater is consistent with the procedure described in SWRCB Resolution 92-49.

  A detailed discussion on the applicability of MCLs for groundwater cleanup can be found in Section 2.8 of the OUs 1 and 2 ROD (DON, 1998a). Cleanup of groundwater to MCLs would reduce baseline risk estimated based on maximum concentrations detected during RI/FS by 98 percent resulting in a residual risk of 1 x 10^{-5}, which is within the risk management range.

  In the event that the groundwater concentrations for the COCs reach asymptotic levels (i.e., do not indicate statistically increasing or decreasing trends) that are above MCLs, additional remedial technologies and/or system optimization will be evaluated.

- Reduce or eliminate further contamination of groundwater by addressing the vadose zone contamination. The RAO for vadose zone cleanup at the CAOC 6, is to remove contaminant mass in the subsurface soils to the degree necessary to prevent further degradation of the groundwater above groundwater cleanup standards and minimize the aquifer cleanup time. Vadose zone modeling and site-specific data will be used as part of future optimization studies to determine when to discontinue operation of the

AS/SVE system. Vadose zone cleanup standards and criteria for the shutdown of vadose zone remediation systems are included in Sections 2.10.7.1 and 2.10.7.2.

2.8 DESCRIPTION OF ALTERNATIVES

To address the remediation of the groundwater and vadose zone in the Nebo South groundwater plume area, five alternatives were developed and retained for detailed analysis and evaluation in the Draft Final Feasibility Study Report (JEG, 1996). These alternatives were:

- Alternative 1 – No Action
- Alternative 2 – ICs/Groundwater Monitoring
- Alternative 3 – Vadose Zone Source Reduction (AS/SVE at CAOC 6)
- Alternative 4 – Groundwater Removal (Extraction Wells at MCL Boundary), Source Reduction at CAOC 6, Ex Situ Treatment, and Discharge
- Alternative 5 – Groundwater Containment and Removal (Extraction Wells at MCL Boundary), Ex Situ Treatment, and Discharge

As part of the Phase 2 AS/SVE testing, Alternative 3 was expanded beyond the wells used in the Phase 1 pilot test (only the wells associated with the Phase 1 test were included in the OUs 1 and 2 FS [JEG, 1996] evaluation of alternatives). In conjunction with the Phase 2 pilot testing, the AS/SVE system was expanded to cover more of CAOC 6 and to address groundwater contamination. This section compares this expanded AS/SVE alternative with the other alternatives from the OUs 1 and 2 FS (JEG 1996). This expanded version of Alternative 3 is referred to as Alternative 3-expanded throughout the rest of this ROD.

Brief descriptions of each of the alternatives are presented below. A detailed discussion of these alternatives can be found in the OUs 1 and 2 ROD (DON, 1998a) as well as the Draft Final Feasibility Study Report (JEG, 1996).

2.8.1 Alternative 1 – No Action

Under this alternative, MCLB would not take any action to clean up groundwater or limit contaminant migration, and existing site conditions would not change.

2.8.2 Alternative 2 – Institutional Controls/Groundwater Monitoring

For Alternative 2, access restrictions would be imposed to prevent the use of untreated groundwater in the area of the plume for drinking water purposes. Periodic long-term groundwater monitoring would be conducted to track movement of the VOC plume, monitor progress of the VOC plume, monitor progress of VOC mass reduction, and provide advanced warning to potentially affected downgradient users.

2.8.3 Alternative 3-expanded – Groundwater and Vadose Zone Source Reduction (AS/SVE at CAOC 6) with Institutional Controls and Groundwater Monitoring

As discussed in Section 2.2.6, an interim remedy for the Nebo South Plume was selected in the OUs 1 and 2 ROD (DON, 1998a) based on Alternative 5. The interim remedial alternative for the Nebo South groundwater plume called for off-base groundwater extraction and treatment and continued pilot testing of AS/SVE. The groundwater extraction portion of the interim remedy was not implemented when it was recognized that groundwater extraction by off-base wells could potentially increase the VOC contamination migrating beyond MCLB property lines. However, the Institutional Controls and the Phase 2 AS/SVE pilot testing selected in the OUs 1 and 2 ROD for the Nebo South plume were implemented. Alternative 3-expanded involves continued operation of the AS/SVE system installed as part of the Phase 2 testing with potential expansion and optimization of the AS/SVE system as necessary to remediate the Nebo South plume and CAOC 6 source area, continued operation and maintenance of ICs that restrict groundwater use, and groundwater monitoring.

The institutional control component of Alternative 3-expanded is similar to Alternative 2. The AS/SVE component of the remedy is described below. AS involves the injection of air through a contaminated aquifer; the injected air helps to flush the contaminants into the unsaturated zone. Injected air travels through the saturated zone, creating conditions that allow VOCs and semivolatile organic compounds (SVOCs) to volatilize from groundwater into the air bubbles. The bubbles then rise to the unsaturated zone, where the VOCs and SVOCs can be removed by SVE. SVE works by applying a vacuum to the soil above the water table to remove the contaminated air from the subsurface environment. The extracted air will only contain low concentrations of VOCs that are expected to be discharged directly to the atmosphere. Air concentrations will be monitored to ensure that concentrations remain below discharge limits established by the Air Quality Management District (AQMD) ARARs. The VOCs that contaminate the groundwater at Barstow are rapidly degraded in the atmosphere; therefore, these low level emissions will not pose a risk to human health or the environment.

2.8.4 Alternative 4 – Groundwater Removal (Extraction Wells at MCL/Background Boundary), Source Reduction at CAOC 6, Ex Situ Treatment, and Discharge with Institutional Controls and Groundwater Monitoring

Alternative 4 includes expanding AS/SVE system to a full-scale AS/SVE treatment system to address source removal at the Nebo South plume source area, CAOC 6; continued operation and maintenance of ICs; subsequent semiannual and annual groundwater monitoring; and adding a groundwater pump and treat system to contain the leading edge of the plume.

The institutional controls and the AS/SVE components of Alternative 4 are similar to those described for Alternatives 2 and 3-expanded, respectively. The groundwater pump and treat component of Alternative 4 is described below.

Groundwater pump and treat consists of extraction wells placed strategically within and at the edges of a plume. These extraction wells remove contaminants through pumping contaminated groundwater from the affected aquifer. The contaminated groundwater then is routed through various cleanup technologies to prepare it for re-injection. There are many cleanup technologies that can be implemented in a pump and treat system; therefore, each system is customized based on the COC, geology, and other particular characteristics of the OU. For example, at OU 1 Yermo Annex, the cleanup technologies implemented include granular activated carbon (GAC), with four tanks containing re-activated carbon (for chlorinated solvents) and two tanks containing virgin coconut shells, for polishing. After the contaminated water passes through the treatment technologies, the groundwater is then routed to an area designated for re-injection, such as an infiltration galleries or ponds.

2.8.5 Alternative 5 – Groundwater Removal (Extraction Wells at MCL/Background Boundary), Ex Situ Treatment, and Discharge with Institutional Controls and Groundwater Monitoring

Alternative 5 consists of a groundwater extraction system at the leading edge of the Nebo South plume, continued operation and maintenance of ICs, and subsequent semiannual and annual groundwater monitoring. All of the components of this alternative have been previously described.

2.9 SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

As discussed in Section 2.8.3, the existing interim remedial action in the form of Phase 1 and Phase 2 AS/SVE has demonstrated the ability to substantially decrease the concentrations and extent of TCE in the Nebo South groundwater plume. This section summarizes the evaluation conducted to determine which of the alternatives provide the best balance with respect to statutory balancing criteria in Section 121 of CERCLA and Section 300.430 of the NCP. The NCP categorizes the nine evaluation criteria into three groups, as discussed in this section. The following analysis summarizes the evaluation of remedial alternatives under the three categories.

This section compares the relative performance of each alternative against the others with respect to the nine criteria of the NCP. The nine criteria are identified in EPA guidance for RI and FS and include the threshold criteria (1 and 2), which must be satisfied by the proposed remedy, the balancing criteria (3, 4, 5, 6, and 7), and the modifying criteria (8 and 9), as summarized in the table below.

2.9.1 Threshold Criteria

2.9.1.1 Overall Protection of Human Health and the Environment

Alternative 1, the no action alternative, is rated poor because it does not adequately protect human health and the environment. It does not reduce COCs in the groundwater or vadose zone or prevent potential human exposure if the groundwater were to be used as a future drinking

water source. Also, it does not include any components that would prevent the spread of contamination.

EVALUATION CRITERIA FOR SUPERFUND REMEDIAL ALTERNATIVES

1. ***Overall Protectiveness of Human Health and the Environment*** determines whether an alternative eliminates, reduces, or controls threats to public health and the environment through ICs, engineering controls, or treatment.

2. ***Compliance with ARARs*** evaluates whether the alternative meets federal and state environmental statutes, regulations, and other requirements that pertain to the site, or whether a waiver is justified.

3. ***Long-term Effectiveness and Permanence*** considers the ability of an alternative to maintain protection of human health and the environment over time.

4. ***Reduction of Toxicity, Mobility, or Volume of Contaminants through Treatment*** evaluates an alternative's use of treatment to reduce the harmful effects of principal contaminants, their ability to move in the environment, and the amount of contamination present.

5. ***Short-term Effectiveness*** considers the length of time needed to implement an alternative and the risks the alternative poses to workers, residents, and the environment during implementation.

6. ***Implementability*** considers the technical and administrative feasibility of implementing the alternative, including factors such as the relative availability of goods and services.

7. ***Cost*** includes estimated capital and annual operations and maintenance costs, as well as present worth cost. Present worth cost is the total cost of an alternative over time in terms of today's dollar value. Cost estimates are expected to be accurate within a range of +50 to -30 percent.

8. ***State/Support Agency Acceptance*** considers whether the state agrees with the DON's analyses and recommendations.

9. ***Community Acceptance*** considers whether the local community agrees with DON's analyses and preferred alternative. Comments received on the Proposed Plan are an important indicator of community acceptance.

Alternative 2, ICs and groundwater monitoring, was rated good for protecting human health because the ICs would prevent extraction and use of groundwater. Groundwater is relatively deep at MCLB, therefore the likelihood of human or ecological receptors contacting contaminated groundwater is low. However, Alternative 2 does not include any components that would prevent the spread of contamination; therefore it was rated poor for protecting the environment.

Alternative 3-expanded was rated good for protecting human health and the environment because it employs a cost effective and timely remediation technology to decrease COCs to or below MCLs for groundwater while reducing the potential for further migration from the vadose zone. AS/SVE implementation, in conjunction with ICs and groundwater monitoring, has successfully decreased VOC contamination during pilot testing.

Although AS/SVE combined with groundwater extraction, ICs, and groundwater monitoring has been successful at OU 1 Yermo Annex, Alternative 4 was rated poor for protecting human health and the environment because, as noted earlier in this ROD, as well as the *Draft Final Technical Memorandum – Evaluation of Off-Base Wells* (TtFW, 2005b), the off-base groundwater extraction wells proposed in this alternative could potentially result in off-base migration of the Nebo South groundwater plume.

Alternative 5 utilizes a pump and treat system, which may not be effective in achieving the groundwater RAOs because of the low permeability soils at the site. This alternative does not provide adequate overall protection of human health and the environment, and as noted earlier in this ROD, as well as the *Draft Final Technical Memorandum – Evaluation of Off-Base Wells* (TtFW, 2005b), the off-base groundwater extraction wells proposed in this alternative could potentially result in off-base migration of the Nebo South groundwater plume. Therefore, Alternative 5 was rated poor for protecting human health and the environment.

2.9.1.2 Compliance with ARARs

The OUs 1 and 2 ROD (DON, 1998a) presents a detailed discussion of the ARARs. A summary of the ARARs for groundwater protection at Nebo South is provided in Tables 2-4 through 2-9. Compliance with location-specific, action-specific, and chemical-specific ARARs is described in the following subsections.

2.9.1.2.1 Compliance with Location-specific ARARs

Location-specific ARARs are restrictions on the concentrations of hazardous substances or on conducting activities solely because they are in specific locations that can potentially impact humans and/or ecological life. Archaeological and biological resources are the resource categories relating to location-specific requirements potentially affected by the Nebo South remedial activities. No potential cultural resources, wetlands protection, floodplain management, or geologic characteristics ARARs were identified for the site. Desert tortoise mitigation measures will continue to be followed during the implementation of remedial actions in order to comply with the Endangered Species Act of 1973. Federal and state location-specific ARARs are presented in Tables 2-6 and 2-7.

Because of this, all alternatives, with the exception of Alternative 1, comply with location-specific ARARs if the existing tortoise protection measures are followed for alternatives requiring active remediation. Alternative 1, the no action alternative, is not subject to ARARs.

2.9.1.2.2 Compliance with Action-specific ARARs

Action-specific ARARs are technology- or activity-based requirements or limitations for remedial activities. These requirements are triggered by the particular remedial activities conducted at the site. Federal and state action-specific ARARs for the selected remedy are presented in Tables 2-8 and 2-9. The selected remedy complies with action-specific ARARs.

Alternative 1, the no action alternative, is not subject to ARARs. All other alternatives comply with action-specific ARARs. Section 2.12.2.3 describes each action-specific ARAR in detail.

2.9.1.2.3 Compliance with Chemical-specific ARARs

Chemical-specific ARARs are health- or risk-based numerical values or methodologies that, when applied to site-specific conditions, establish the acceptable amount or concentration of a chemical that may be found in, or discharged to, the ambient environment. The selected remedy complies with all chemical-specific ARARs. Federal and state chemical-specific ARARs for the selected remedy are presented in Tables 2-4 and 2-5.

All alternatives, except Alternative 1 and in a special case, Alternative 2, comply with federal and state drinking water standards (see Section 2.12.2.1, Federal and State Chemical-specific ARARs, for a full discussion of federal and state chemical-specific ARARs involving drinking water standards). Alternative 1, the no action alternative, is not subject to ARARs. With the implementation of ICs, Alternative 2 complies with federal and state drinking water standards.

2.9.2 Primary Balancing Criteria

2.9.2.1 Long-term Effectiveness and Permanence

Alternative 1 is rated as a poor alternative for long-term effectiveness and permanence because it does not include any treatment and is therefore ineffective in reducing contamination at or below RAOs for this site

As stated in the OUs 1 and 2 ROD (DON, 1998a) based on the RI/FS data, Alternative 2, because it utilizes natural attenuation as its cleanup strategy, while maintaining ICs and groundwater monitoring as protective measures, may require a significantly longer timeframe to achieve RAOs when compared to the remaining alternatives. This Alternative would be considered good for long-term effectiveness and permanence if the goal was to restrict groundwater use from humans and ecological life indefinitely. However, the goal is to restore the groundwater to beneficial use, and natural attenuation is not reliably effective for effectiveness and permanence in a reasonable timeframe. Therefore, Alternative 2 is considered a poor alternative.

Alternative 3-expanded and Alternative 4 equally offer long-term effectiveness and both are considered to be good alternatives. Alternative 3-expanded and Alternative 4 achieve good long-term effectiveness and permanence because they both employ AS/SVE which has been shown to be effective at permanently reducing groundwater and vadose zone contamination at CAOC 6. Both Alternative 3 and 4 are expected to be capable of achieving the RAOs in a reasonable time-frame. Remediation technologies reduce the amount of contamination in the aquifer and therefore contribute to long-term effectiveness of the remedy to reduce contamination to levels at or below the RAOs and permanence for the aquifer, once the RAO is met, to once again be beneficial waters of the State.

Alternative 5 is a fair alternative because the stand alone pump and treat system is better suited to containment rather than treatment, and it does not reduce contamination in the vadose zone

Thus the vadose zone could continue to act as a source of VOCs. Because of the pump and treat's inability to reduce contamination in all affected stratas, its effectiveness is lower than that of Alternative 3 and Alternative 4. Thus Alternative 5 would require a longer timeframe to achieve a permanent reduction in COCs.

2.9.2.2 Short-term Effectiveness

Alternative 1 is a poor alternative for short-term effectiveness because it is not effective in reducing contamination at or below the RAOs for this site.

Alternatives 2, 3-expanded, 4, and 5 are good alternatives because they rely on ICs for short-term effectiveness. ICs are easily implemented, and in this case, they have already been implemented in conjunction with the OUs 1 and 2 ROD (DON 1998). ICs provide short-term effectiveness because they keep humans and ecological life from contact with contaminated water. ICs are most effective on MCLB property. If off-MCLB controls cannot be maintained, short-term effectiveness would be compromised. Because groundwater cleanup actions require relatively long timeframes to restore the aquifer, short-term risks are the same as current risks.

2.9.2.3 Reduction of Toxicity, Mobility, and Volume through Treatment

Alternatives 1 and 2 are poor alternatives for reduction of toxicity, mobility, and volume through treatment because they do not include treatment. Therefore, these two alternatives do not satisfy the statutory preference for treatment, as stated in the OUs 1 and 2 ROD (DON, 1998a), based on the RI/FS data.

Alternatives 3-expanded and 4 are good alternatives because they have the ability to reduce toxicity, mobility, or volume of contamination in the aquifer and vadose zone through active pump and treat and/or AS/SVE groundwater. Alternative 5 is a fair alternative compared to Alternatives 3-expanded and Alternative 4 because it does not treat vadose zone contamination through the implementation of AS/SVE.

2.9.2.4 Implementability

Alternative 1, the no action alternative, was rated excellent for implementability because there is nothing to be implemented.

Alternative 2 was rated excellent for implementability based on the assumption that ICs are limited to those already in place on MCLB property. There is also a groundwater monitoring well array in place, so implementing groundwater monitoring is also easy. By imposing ICs off-base, additional actions would be required through regulatory agencies and property owners. Therefore, Alternative 2 that includes ICs on and off MCLB property would be considered a fair alternative.

Alternatives 3-expanded was rated excellent for implementability because the AS/SVE system, associated ICs, and groundwater monitoring are already in place.

Alternatives 4 and 5 were only rated fair for implementability because groundwater pump and treat systems would need to be implemented. Alternative 5 would also require the decommissioning of the AS/SVE system. Additional ICs and groundwater monitoring for these systems would need to be added as part of the post-ROD remedial action because the off-base extraction wells could potentially increase off-base migration of COCs. ICs specifically required for off-base properties would require coordination with the regulatory agencies and property owners.

2.9.2.5 Cost

Alternative 1 was rated excellent for cost because there is no cost associated with Alternative 1.

Alternative 2 was only rated good on the basis of cost. Although ICs and groundwater monitoring wells are already in place, this alternative would require long term monitoring and management, which would increase costs.

Alternative 3-expanded was rated good based on cost because the AS/SVE system is already in place from the previous pilot studies. No additional cost for installing AS/SVE is required. The remaining capital required for implementing Alternative 3-expanded is estimated to be $670,000 and is associated with operation and maintenance of the AS/SVE system, as well as subsequent groundwater monitoring. This cost estimate is based on an estimated 3 years of AS/SVE operation and 5 years of subsequent groundwater monitoring after AS/SVE shutdown.

Alternative 4 was rated fair on the basis of cost because the estimated present worth cost is $15.1 million (OUs 1 and 2 ROD [DON, 1998a]). Although this system can satisfactorily achieve the goals set forth in other Criteria for Superfund, it is the highest cost of all the alternatives and is not preferable.

Alternative 5's associated cost, as stated in the OUs 1 and 2 ROD (DON, 1998a) is approximately $5.5 million. This was rated fair because the cost is high, and does not address the vadose zone contamination through AS/SVE. Best value for overall cleanup lies with alternatives containing AS/SVE.

2.9.3 Modifying Criteria

2.9.3.1 State Acceptance

As agreed by DON, EPA, and Cal/EPA in the FFA for MCLB, the State of California, through the Water Board and DTSC, reviews and approves DON documents pertaining to CERCLA. Comments from the State pertaining to this ROD, as well as documentation preceding this ROD, have been noted, incorporated, and documented.

Alternatives 1 and 2 were not acceptable to Cal/EPA because they are not adequately protective of human health and the environment; therefore, these alternatives were rated poor.

Alternative 3-expanded is acceptable to Cal/EPA because of its ability to treat the COCs in a timely and cost effective manner. Alternatives 4 and 5 are not acceptable to Cal/EPA because of the possibility of plume migration off-base due to off-base extraction wells, and the low contaminant capture rate of pump and treat systems in other systems at MCLB. Therefore, Alternatives 4 and 5 were rated poor for state acceptance.

2.9.3.2 Community Acceptance

The community discussed here includes the City of Barstow, cities and towns adjacent to Barstow where employees of MCLB and other local businesses live and commute from, and state and local agencies and politicians. In compliance with the FFA, DON notifies the community of CERCLA actions planned and executed at MCLB.

Alternatives 1 and 2 were not acceptable to EPA and Cal/EPA, as they are insufficient for protection of human health and the environment, and therefore were not presented as options to the community. Alternatives 3-expanded, 4, and 5 are considered acceptable to the community as no comments were received regarding these alternatives. The selected remedy was chosen based on other CERCLA criteria discussed previously.

Public notice for the release of the Draft Final Proposed Plan (DON, 2006c) was published in the local newspapers and advertised on the local radio stations, as well as documented in a mailout sent via US Mail to the community. Representatives of the DON, EPA, DTSC, and Water Board were available at the public meeting to answer questions about the site and the proposed remedy. The public meeting presenting the Proposed Plan was held on June 28, 2006. Two people from the community attended and asked questions regarding the OU 2 Nebo South project. No comments on the Final Proposed Plan were received during the public meeting, as well as during the public comment period. These activities fulfill the requirements of CERCLA Sections 113(k)(2)(B)(i-v) and 117(a)(2).

2.10 SELECTED REMEDY AND THE RATIONALE – NEBO SOUTH GROUNDWATER PLUME

This section describes the selected remedy, the rationale, associated costs, and expected outcome.

The selected remedy to remediate the Nebo South groundwater plume is an expanded version of Alternative 3 – Groundwater and Vadose Zone Source Reduction (AS/SVE at CAOC 6).

2.10.1 Selected Final Remedy Description

This Final ROD recommends using AS/SVE, continued operation and maintenance of institutional controls, and subsequent semiannual and annual groundwater monitoring as the final action for addressing the Nebo South groundwater plume as an alternative to implementing the off-base groundwater extraction and treatment previously selected in the interim remedy in the OUs 1 and 2 ROD (DON, 1998a). The AS/SVE remedy has demonstrated its effectiveness through successive pilot tests at the site. The extent of the TCE plume has been decreasing in recent years following the issue of the OUs 1 and 2 ROD (DON, 1998a). The need for containment of the off-base plume by extraction and treatment has diminished further with time. It has been proven through recent data that the ongoing AS/SVE action could reduce the toxicity, mobility, and volume of the VOC plume associated with Nebo South that constitutes the principal risk driver at the site.

The planned sequence of actions for ongoing operation and maintenance at Nebo South (OU 2) included:

- Continued operation and optimization of the AS/SVE system. It is expected that the system will be in operation until the shutdown criteria for the AS/SVE system are met;
- Continued use of ICs, until RAOs are achieved, as specified in the Interim ROD for Nebo South (OUs 1 and 2 ROD [DON, 1998a]), MCLB Master Plan (BMP) (*OUs 1,2,3,4,5,6 Institutional Controls Section, for MCLB Base Master Plan,* [MCLB Barstow, 1999]), and the Land Use Control (LUC) Remedial Design (RD) deliverable, as described in Section 2.10.1.1;
- Periodic groundwater monitoring during active operation of the AS/SVE system followed by periodic groundwater monitoring for 5 additional years;
- Periodic AS/SVE system extracted-vapor monitoring on an annual basis during the operation of the AS/SVE system.

Sections 2.10.7 through 2.10.7.2 describing the shutoff criteria for the AS/SVE systems were extracted from OUs 1 and 2 ROD (DON, 1998a). A reference to groundwater pump and treat in Section 2.10.7 was deleted, as a groundwater pump and treat system is not a part of the proposed Nebo South final groundwater remedy.

2.10.1.1 Land Use Controls (Institutional Controls) Description

LUCs (or ICs as specified in the 1998 OU 1 and OU 2 ROD and subsequently referenced in this ROD) are established at the Nebo South remediation area to ensure contaminants do not pose an unacceptable risk to human health and the environment. LUCs are established to ensure long-term protectiveness and are required as part of the remedy when contamination remains in place at a site. LUCs do not eliminate the risk associated with contamination at a site, but reduce contaminant exposure by preventing a complete exposure pathway and therefore reduce unacceptable risk to human health and the environment.

LUCs are already in place at Nebo South. By themselves, LUCs will not likely achieve RAOs; however, such controls implemented along with the proposed remedy will ensure that contaminants contained on site will remain isolated from possible human and ecological receptors. Therefore, the LUCs are an integral part of the selected remedy for this site. DON has responsibility for implementing, maintaining, reporting, and enforcing LUCs. Implementation and enforcement of LUCs is a statutory requirement of DON as part of its CERCLA activities and authority.

The following are the LUC objectives to be achieved through land-use restrictions for this site.

- LUCs will prevent access and use of groundwater at Nebo South until RAOs are achieved;
- LUCs will maintain the integrity of current and future remediation or monitoring systems;
- LUCs will be implemented, maintained, reported, and enforced by DON in a cost-effective manner to ensure continued long-term protectiveness of the remedy;
- LUCs will be monitored and enforced by the Agencies to ensure continued long-term protectiveness of the remedy;
- LUCs will be maintained until the concentrations of hazardous substances in the soil and groundwater are at such levels to allow for unrestricted use and exposure;
- LUCs will ensure no residential use or residential development of the property.

DON shall prepare and submit to EPA and the State for review and approval a LUC RD primary document that shall contain implementation and maintenance actions, including periodic inspections. The LUC RD will describe LUC implementation actions including:

- Requirements for CERCLA 5-year remedy review;
- Frequency and requirements for periodic monitoring or visual inspection;
- Notification procedures to the regulators for planned property conveyance, corrective action required, and/or response to actions inconsistent with LUCs for the remedy;
- Providing a list of LUCs with the expected duration;
- Maps identifying where the LUCs are to be implemented.

In compliance with Section 8 2 (Deadlines) of the FFA for MCLB, DON shall prepare within 21 days of issuance of the ROD for Nebo South proposed deadlines for completion of all subsequent primary documents, including the LUC RD. Agreements to the schedule of the subsequent primary documents shall follow the stipulations cited in the FFA.

Figure 2-14, a map of Nebo South with a LUC boundary, depicts areas subject to the controls. Specific implementation actions for the controls will be identified and described in a LUC RD. The LUC RD will include specific restrictions required at the site, a statement that the restrictions are required because of the presence of pollutants or contaminants, the current land

use and anticipated future land use, the geographic control boundaries, and the objectives of the land use restrictions.

DON will provide annual information reports that detail operation and maintenance of the LUCs DON will conduct annual inspections and maintenance of the LUCs, with reviews at 5-year intervals, to ensure that the selected remedy continues to be protective of human health and the environment. Annual inspections and maintenance will continue until the risk associated with the waste at the site no longer exists; subsequently, LUCs will be lifted, and the 5-year review requirement will cease.

LUCs are already discussed in the OUs 1, 2, 3, 4, 5, 6 IC Section of the MCLB BMP (MCLB Barstow, 1999), which is currently used internally at MCLB to implement and maintain LUCs. The BMP includes language regarding access restrictions and notification instructions for any amendments to LUCs at Nebo South. If any future projects are proposed for Nebo South, conformance with the LUCs associated with this site shall be reviewed as part of the MCLB Site Approval and Project Review Process. The controls described in the LUC RD will ensure that no actions involving LUCs will occur without prior concurrence by EPA and the State.

The remedy selected in this ROD, including the LUCs objectives, will not be modified or terminated except in accordance with NCP, EPA, and State regulatory concurrence.

If control of Nebo South is transferred to another federal agency, DON shall advise the recipient federal agency of all obligations agreed to in the ROD and will require the recipient federal agency to enforce LUC objectives contained in this ROD DON will further advise the recipient agency that an obligation exists to execute and record a State Land Use Covenant, pursuant to 22 Cal. Code Regs. tit. 22, § 67391.1, in the event the federal agency transfers the property to a non-federal entity

If DON transfers control of Nebo South to a non-federal entity, DON will provide information to that entity regarding the LUCs contained in this ROD and the obligation exists to record a State Land Use Covenant pursuant to Cal. Code Regs. tit. 22, § 67391.1. The deed transferring Nebo South property to a non-federal entity will include LUCs and resource restrictions equivalent to those contained in the State Land Use Covenant and this ROD.

2.10.1.2 Current and Future Land Use for Nebo South

The Lower Mojave hydrologic sub-unit, which includes the Barstow sub-basin, is classified as a source of drinking water (i.e., Class I Aquifer) in the *Water Quality Control Plan for the Lahontan Region (Basin Plan)* (RWQCB, 1995). Groundwater is the sole source of drinking water in this area and its quality may have been impacted since at least 1952. Both the Yermo Annex and Nebo Main Base have evidence of solvent-contaminated groundwater.

The Nebo Main Base currently receives its drinking water through a pipeline from the City of Barstow, which obtains water from groundwater wells in the Mojave River Drainage Basin, upgradient from MCLB.

Currently, the Nebo South groundwater plume area is vacant with exception of a small covered area used to house the AS/SVE system-related components.

The areas immediately surrounding MCLB are basically undeveloped except for some small-scale, older commercial developments along Highway 66 west of the main entrance to the Nebo Main Base. Future plans in the immediate vicinity indicate five main land uses:

- Rural-urban (low-density residential);
- Open space/recreation;
- Agricultural;
- Industrial;
- Commercial.

The area west of the main entrance to the Nebo Main Base where Interstate 40, Route 66, and the Burlington Northern Santa Fe (BNSF) railroad lines converge is slated for industrial development per the City of Barstow and San Bernardino County. Other than this, MCLB has no plans in the near future for any development other than to further Marine Corps mission.

2.10.2 Rationale

The selected remedy was selected over the other alternatives because it is expected to achieve substantial and long-term risk reduction in a cost-effective and timely manner. Based on the pilot test results, the selected remedy is expected to reduce the overall risk within a reasonable timeframe and at a lower cost ($670,000) than the other remedial alternatives. In addition, hydrogeological conditions at the site may pose significant limitations to other aquifer restoration alternatives due to the extremely low permeability of the aquifer (i.e., maximum well yields of 5 gpm), making Alternative 3-expanded the most technically effective remedy.

Based on the information available at this time, the DON believes that the selected remedy would be protective of human health and the environment, would comply with ARARs, would be cost-effective, and would use permanent solutions and alternative treatment technologies to the maximum extent practicable. The basis for the decision included the comparative evaluation of alternatives against the Nine Criteria for Superfund, as summarized in the following table.

Comparative Evaluation of the Remedial Alternatives

Evaluation Criteria	Alternative 1 No Action	Alternative 2 Institutional Controls and Groundwater Monitoring	Alternative 3-Expanded Existing Phase 1 and Phase 2 AS/SVE Pilot System	Alternative 4 Groundwater Extraction at MCL/Background Boundary, Source Reduction, Ex Situ Treatment, and Discharge	Alternative 5 Groundwater Extraction at MCL/Background Boundary, Ex Situ Treatment, and Discharge
1 - Overall Protection of Human Health and the Environment	Poor	Good for preventing human use Poor for COC in the environment	Good	Poor	Poor when using pump and treat systems alone due to the low permeability soils at the site
2 - Compliance with ARARs	Not Applicable	Good	Good	Good	Good
3 - Long-term Effectiveness and Permanence	Poor	Poor	Good	Good	Fair
4 - Short-term Effectiveness	Poor	Good	Good	Good	Good
5 - Reduction of Toxicity, Mobility, and Volume Through Treatment	Poor	Poor	Good	Good	Fair
6 - Implementability	Excellent	Excellent (LUCs and groundwater monitoring program already in place)	Excellent (system in place)	Fair	Fair
7 - Cost	Excellent (no additional)	Good	Good $670,000	Fair $15.1 Million	Fair $5.5 Million
8 - State and Supporting Agency Acceptance	Poor	Poor	Good	Poor	Poor
9 - Community Acceptance	Poor to agencies, therefore not presented to the community	Poor to agencies, therefore not presented to the community	Good	Good	Good

Abbreviations and Acronyms:

ARAR – applicable or relevant and appropriate requirement
AS/SVE – air sparge/soil vapor extraction
COC – chemical of concern
LUC – Land Use Control
MCL – Maximum Contaminant Level

As discussed in Section 2.5.7, for the Nebo South groundwater plume, COCs were not detected in the vadose zone soils. However, predictive modeling of vapor concentrations in the vadose zone indicated potential groundwater contamination resulting from the COC concentrations in vapor. Depth to groundwater is approximately 100 feet bgs. The COC-laden vapors are not expected to be present near the surface. Accordingly, the vadose zone vapors and groundwater at

Nebo South are considered to be non-principal threat wastes. As required, the DON may evaluate other alternatives in the future through system optimization to expedite the cleanup of the Nebo South groundwater plume. Any changes to the selected remedy established in this ROD will be documented by preparing an Explanation of Significant Differences

To ensure that human health and the environment are protected in the future, ICs are in place as required by the OUs 1 and 2 ROD (DON, 1998a) and as documented in the BMP (MCLB, 1999).

The major components of the selected remedy consist of:

- Continued operation of ICs until RAOs are achieved;
- Continued operation of the Phase 1 and 2 AS/SVE system until the shutoff criteria are met;
- Periodic groundwater monitoring during the remedial action period followed by periodic monitoring for an additional 5 years after active remedial activities have been completed;
- Periodic soil vapor monitoring during the remedial action period.

The selected final groundwater remedy for the Nebo South groundwater plume (OU 2) is consistent with the requirements of Section 121 of CERCLA and the NCP. The final remedy for the Nebo South groundwater plume is consistent with previous and projected removal actions at Nebo South. Based on the information available at this time, the selected remedy represents the best balance among the criteria used to evaluate remedies.

2.10.3 Summary of Estimated Costs for the Selected Remedy

The cost of the selected remedy is estimated at $670,000. A summary of the cost estimate is provided in Table 2-10. Because the selected remedy does not require any additional significant capital, the costs to implement the remedy are primarily related to operation and maintenance of the AS/SVE system, continued implementation and maintenance of ICs, and groundwater and soil vapor monitoring.

During the remedial action period, periodic groundwater monitoring and soil vapor monitoring will be conducted to verify that the remedy is progressing and the RAOs are achieved. Thereafter, for the next 5 years, periodic groundwater monitoring will be conducted to document the long-term achievement of RAOs. The order-of-magnitude engineering cost estimate presented in Table 2-10 is expected to be within +50 to -30 percent of the actual project cost.

2.10.4 Expected Outcomes of the Selected Remedy

Potential risk to possible future human receptors will be further reduced by the selected remedy at Nebo South. The potential for mobilization and migration of VOCs from soils to groundwater will be reduced as the AS/SVE system continues to operate. For as long as remedial actions at Nebo South continue, human contact with contaminants will be limited by ICs. Once RAOs are

achieved, ICs will be lifted, and 5-year reviews will no longer be required. It is a goal of DON to restore the aquifer to a state when beneficial groundwater use can resume.

2.10.5 Performance Standards for Groundwater

Groundwater from the aquifer shall be monitored until the RAOs, as discussed in Section 2.7, are achieved. See Section 2.7 for a discussion of the source reduction performance standards.

2.10.6 Groundwater and Vadose Zone Monitoring

During the remedial action period, periodic groundwater monitoring and soil vapor monitoring will be conducted to verify that performance objectives are being achieved. Thereafter, for an additional 5 years after the remedial activities have ceased, groundwater and vapor monitoring will be conducted to document the long-term achievement of RAOs.

2.10.7 Criteria for Shutoff of AS/SVE Systems

AS/SVE systems used to remove VOCs from vadose zone and groundwater at MCLB will be operated until one of the following two conditions is reached:

1. (a) Remaining vadose zone VOC concentrations no longer cause modeled groundwater concentrations to exceed the groundwater cleanup standards (based on interpretation of soil gas data using appropriate vadose zone fate and transport and groundwater mixing zone models), and (b) representative groundwater concentrations measured within the AS/SVE system radius of influence (ROI) have achieved groundwater cleanup standards, or;
2. VOCs in the vadose zone and groundwater within the ROI of the AS/SVE system have been removed to the extent technically and economically feasible. That is, the incremental benefit of attaining further reduction in the concentration of VOCs is exceeded by the incremental cost of achieving those reductions through AS/SVE.

The DON will demonstrate that vadose zone cleanup standards have been achieved for Part (a) of Condition 1 through an examination of the current effects of remaining vadose zone contamination on groundwater based on an interpretation of soil gas data using appropriate vadose zone fate and transport and groundwater mixing zone model(s) by using a mixing zone extending to a depth of 10 feet below the water table. If it is demonstrated that soil gas concentrations of COCs in the vadose zone no longer cause modeled groundwater concentrations to exceed the cleanup standards, the parties agree that the demonstration for Part (a) of Condition 1 has been made.

It is the Water Board's position that the purpose of soil remediation as specified in state law and policy is to remove VOCs so that they no longer cause or threaten to cause pollution in the groundwater, that is, that VOCs are no longer migrating into the groundwater at greater than, in this case, the groundwater cleanup standards. The Water Board asserts that the DON's proposed methodology for determining shutoff of the AS/SVE system does not provide information to

evaluate whether VOCs are no longer migrating into the groundwater at concentrations greater than the cleanup standard. A model using a 10-foot mixing zone may not be appropriate in predicting whether VOCs in the vadose zone will enter groundwater at levels that are greater than the groundwater cleanup standards. However, the Water Board will not dispute the proposed shutoff criteria if the facility agrees to provide detailed results of both the vadose zone model and associated groundwater model including all model parameters.

The DON will demonstrate that groundwater cleanup standards have been achieved for Part (b) of Condition 1 through collection of groundwater samples from monitoring wells agreed upon by all parties. If it is demonstrated that the representative groundwater concentrations of COCs meet the groundwater cleanup standards, the parties agree that the demonstration for Part (b) of Condition 1 has been made.

If it is determined that the cleanup standards in Condition 1 cannot be achieved, the DON will demonstrate that VOCs in the vadose zone and groundwater within the ROI of the AS/SVE have been removed by AS/SVE to the extent technically and economically feasible as set forth in Condition 2, by analyzing the following five factors:

1. Whether the mass removal rate is approaching asymptotic levels after temporary shutdown periods and appropriate optimization of the AS/SVE system:
2. The additional cost of continuing to operate the AS/SVE system when mass removal reaches asymptotic levels.
3. The predicted effectiveness and cost of further enhancements of the AS/SVE system (e.g., additional vapor extraction wells, air injection) beyond optimization of the existing system.
4. Whether discontinuing the AS/SVE will significantly prolong the time to attain the groundwater cleanup standard.
5. Historic data that present the AS/SVE system operating costs per unit of VOC mass removed from the vadose zone and groundwater and the concurrent soil gas and groundwater VOC concentrations, both as a function of time.

The signatory parties agree that the AS/SVE system may be cycled on and off in order to optimize the operation and/or evaluate the factors listed above. The DON will submit a primary document under the FFA providing the appropriate demonstrations. The signatory parties to this ROD will jointly make the decision that the AS/SVE system may be shut off permanently based on the criteria set forth in this ROD.

2.10.7.1 Vadose Zone and Groundwater Modeling to Determine AS/SVE System Shutoff

Two separate models will be used to determine when to shut off an AS/SVE system: a vadose zone contaminant fate and transport model to simulate contaminant migration into groundwater, and a groundwater mixing zone model to calculate groundwater concentrations from the contaminant mass fluxes supplied by the vadose zone model. Under Part (a) of Condition 1,

performance parameters for vadose zone modeling will be measured by using vapor probes located at representative depths in the vadose zone. The vapor probe monitoring results will provide an indication of the VOC mass removal in the vadose zone. The DON proposes a 10-foot mixing zone be used to calculate groundwater concentrations from the mass flux supplied by the vadose zone model because the 10-foot mixing zone is representative of a typical monitoring well screen interval at MCLB.

2.10.7.2 Determination of Asymptotic Conditions for Shutoff of AS/SVE Component of Groundwater Remedy

The DON will track the cumulative mass of VOCs removed by the AS/SVE system, and plot the data as function of time, to help determine how quickly the cumulative mass removed approaches asymptotic levels. It is expected that the resulting graph of cumulative VOC mass removed versus time will follow the general curve defined by the following exponential decay equation:

$$M(t) = \text{Sum}(M_i) = K_I \left(1 - e^{(-t/T)}\right)$$

Where:

$M(t)$ = Total cumulative mass removed at time t.

M_i = Total mass removed from vapor extraction well "i".

K_I = Maximum cumulative total mass, which the AS/SVE system approaches asymptotically.

T = Time constant, or resident time equal to the amount of time at which the AS/SVE system removes approximately 63 percent of K_I (theoretically, T is equivalent to V/Q, or the volume of soil gas in the vadose zone being remediated [V] divided by the volumetric flowrate of the AS/SVE system [Q]).

t = Anytime during system operation at which cumulative mass removed is calculated.

i = Any vapor extraction well for which total mass removed is calculated.

The above equation will be used as a guide to help determine when asymptotic conditions have been reached. The 'asymptote' to the mass removal curve is that total/cumulative maximum mass (K_I - defined above), which the AS/SVE system attempts to remove but approaches with ever decreasing speed. Asymptotic conditions will have been reached when the upper limb of this curve is substantially linear and the slope of the curve approaches zero. The specific procedures used to evaluate if data are asymptotic will be defined during the remedial design phase of work. However, it is not expected that field data will match the theoretical equation exactly. Therefore, it will be necessary to use best professional judgment based on field data to conclude that asymptotic conditions have been reached.

In order to assess if there are zones where the AS/SVE system has not removed VOCs, cycling will be used to allow residual vadose zone contamination to re-equilibrate. The treatment system will be shut down temporarily for a suitable period of time after asymptotic conditions are reached. This will allow for VOC concentrations to re-establish in the soil gas. After cycling, soil gas monitoring probes will be sampled to determine the remaining VOC concentrations in the soil gas. If the resulting VOC levels are not characteristic of the pre-cycling conditions or indicate a spike increase in soil gas concentration, then additional treatment may be warranted. The decision to shut off or restart any part of the remediation system will be made jointly by all FFA signatories according to the criteria set forth in Section 2.10.7 of this ROD.

2.11 PRINCIPAL THREAT WASTES

The NCP establishes an expectation that treatment will be used to address the principal threats posed by a site wherever practicable (NCP, 40 Code of Federal Regulations [C.F.R.], Part 300.430[a][1][ii][A]). Principal threat wastes are the source materials considered highly toxic or highly mobile and that cannot be reliably contained or that would present a significant risk to human health and the environment should exposure occur (EPA, 1999). Principal threat wastes include liquid source material, mobile source material, or highly toxic source material. Non-principal threat wastes are the source materials that generally can be reliably contained and that would present only a low risk in the event of exposure. It should be noted that for the Nebo South groundwater plume, COCs were not detected in the vadose zone soils. However, predictive modeling of vapor concentrations in the vadose zone indicated potential groundwater contamination resulting from the COC concentrations in vapor. Accordingly, the COCs present in the vadose zone vapors and groundwater are considered to be non-principal threat wastes. Operation of the AS/SVE system (the selected remedy) is expected to minimize the migration of contaminants to off-site sources while reducing further groundwater contamination via the VOC vapors in the vadose zone.

2.12 STATUTORY DETERMINATION

Under CERCLA, the DON's primary responsibility is to undertake remedial actions that achieve adequate protection of human health and the environment. Section 121 of CERCLA establishes several additional statutory requirements and preferences specifying that, when complete, the selected remedial action must comply with ARARs established under federal and state laws unless a statutory waiver is justified. The selected remedy also must be cost-effective and use permanent solutions and alternative treatment technologies to the maximum extent practicable. The statute also includes a preference for remedies that include treatment as a principal element to permanently and significantly reduce the volume, toxicity, or mobility of hazardous waste.

Complete discussions of statutory requirements are found in the OU 1 and OU 2 FS. Statutory determinations are provided to (1) describe how the selected remedy satisfies the statutory requirements of CERCLA, Section 121 (as required by NCP, 40 C.F.R., Part 300.430[f][5][ii]), and (2) explain the 5-year review requirements for the selected remedy.

2.12.1 Protection of Human Health and the Environment

The selected remedy, Alternative 3-expanded, provides protection to human health and the environment by eliminating, reducing, and controlling risk through anticipated mass and contaminant reduction of the plume via AS/SVE and operation and maintenance of ICs.

2.12.2 Compliance with ARARs

Section 121(d) of CERCLA (42 United States Code [U.S.C.] § 9621[d]), as amended, states that remedial actions on CERCLA sites must attain (or the decision document must justify the waiver of) any federal or more stringent state environmental standards, requirements, criteria, or limitations that are determined to be legally applicable or relevant and appropriate.

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

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

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

- the purpose of the requirement and the purpose of the CERCLA action;
- the medium regulated or affected by the requirement and the medium contaminated or affected at the CERCLA site;
- the substances regulated by the requirement and the substances found at the CERCLA site;
- the actions or activities regulated by the requirement and the response action contemplated at the CERCLA site;
- any variances, waivers, or exemptions of the requirement and their availability for the circumstances at the CERCLA site;
- the type of place regulated and the type of place affected by the release or CERCLA action;

- the type and size of structure or facility regulated and the type and size of structure or facility affected by the release or contemplated by the CERCLA action; and
- any consideration of use or potential use of affected resources in the requirement and the use or potential use of the affected resources at the CERCLA site.

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

Tables 2-4 through 2-9 present each potential ARAR with an initial determination of ARAR status (i.e., applicable, relevant and appropriate, or not an ARAR). For the determination of relevance and appropriateness, the pertinent criteria were examined to determine whether the requirements addressed problems or situations sufficiently similar to the circumstances of the release or response action contemplated, and whether the requirement was well suited to the site. A negative determination of relevance and appropriateness indicates that the requirement did not meet the pertinent criteria. Negative determinations are documented in the tables and are discussed in the text only for specific cases.

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

- a state law or regulation;
- an environmental or facility siting law or regulation;
- promulgated (of general applicability and legally enforceable);
- substantive (not procedural or administrative);
- more stringent than federal requirements;
- identified in a timely manner;
- consistently applied.

To constitute an ARAR, a requirement must be substantive. Therefore, only the substantive provisions of requirements identified as ARARs in this analysis are considered to be ARARs. Permits are considered to be procedural or administrative requirements. Provisions of generally relevant federal and state statutes and regulations that were determined to be procedural or non-environmental, including permit requirements, are not considered to be ARARs. CERCLA Section 121(e)(1), 42 U.S.C. § 9621(e)(1), states that "No Federal, State, or local permit shall be required for the portion of any removal or remedial action conducted entirely on-site, where such remedial action is selected and carried out in compliance with this section." The term on-site is

defined for purposes of this ARARs discussion as "the areal extent of contamination and all suitable areas in very close proximity to the contamination necessary for implementation of the response action" (40 C.F.R., Part 300.5).

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

Pursuant to EPA guidance (EPA, 1988), ARARs are generally divided into three categories: chemical-specific, location-specific, and action-specific requirements. This classification was developed to aid in the identification of ARARs; some ARARs do not fall precisely into one group or another. ARARs are identified on a site basis for remedial actions where CERCLA authority is the basis for cleanup.

As the lead federal agency, the DON has primary responsibility for identifying federal ARARs at MCLB. The OUs 1 and 2 ROD (DON, 1998a) presents a detailed discussion of the ARARs. A summary of the ARARs for groundwater protection at Nebo South is provided in Tables 2-4 through 2-9. Compliance with location-specific, action-specific, and chemical-specific ARARs is described in the following subsections.

Identification of potential state ARARs was initiated through DON requests that the Cal/EPA DTSC identify potential state ARARs; this action was initiated during the OU 1 and OU 2 ROD and is described in more detail there. Potential state ARARs that have been identified for OU 2 Nebo South groundwater plume are discussed below.

As stated in Section 2.10, remedial action performed under CERCLA must comply with all ARARs. The selected remedy was found to comply with all ARARs, as presented in Tables 2-4 through 2-9.

2.12.2.1 Federal and State Chemical-specific ARARs

Chemical-specific ARARs are health- or risk-based numerical values or methodologies that, when applied to site-specific conditions, establish the acceptable amount or concentration of a chemical that may be found in, or discharged to, the ambient environment. Many ARARs associated with the selected alternative (such as closure or discharge) can be characterized as action-specific but include numerical values or methodologies to establish them so they fit in both categories (chemical- and action-specific). To simplify the comparison of numerical values, most action-specific requirements that include numerical values are included in this chemical-specific section, and if such requirements are repeated in the action-specific section, the discussion refers back to this section.

The selected remedy complies with all chemical-specific ARARs. Federal and state chemical-specific ARARs for the selected remedy are presented in Tables 2-4 and 2-5.

The substantive provisions of the following requirements are the most stringent of the potential federal and state chemical-specific ARARs and TBCs for remediation of Nebo South groundwater.

Safe Drinking Water Act

Federal MCLs and Maximum Contaminant Level Goals (MCLGs) developed by EPA under the Safe Drinking Water Act (SDWA) are potentially relevant and appropriate requirements for aquifers with Class I and Class II characteristics and therefore are potential federal ARARs. The point of compliance for MCLGs and MCLs under the SDWA is at the tap. Therefore, the MCLs and MCLGs are not "applicable" ARARs for DON sites. However, MCLs and MCLGs are generally considered relevant and appropriate as remediation goals for current or potential drinking water sources and thus are commonly identified as potential ARARs for groundwater response actions under CERCLA.

MCLs for the action at OU 2 Nebo South groundwater plume are found at 40 C.F.R., Part 141.61(a) and (c). Although MCLs are developed using cost and technical considerations, EPA considers them to be protective of human health as well.

EPA has also developed MCLGs to serve as guidance for establishing MCLs. MCLGs for organic contaminants are promulgated at 40 C.F.R., Part 141.50. An MCLG is set at a level at which no adverse health effects may arise, with a margin of safety. An MCL is required to be set as close as possible to its corresponding MCLG, taking into consideration the best technology, treatment techniques, and other factors, including cost. For noncarcinogens, MCLs generally are set equal to MCLGs. MCLGs for carcinogens are set at the zero level.

The NCP states that MCLGs that are set at levels above zero should be considered to be relevant and appropriate requirements for groundwaters that are potential sources of drinking water (40 C.F.R., Part 300.430(e)(2)(i)(B) and 55 Federal Register (Fed. Reg.) 8666, 8750–8754 [1990]). Some chemicals of concern at Nebo South have nonzero MCLGs. MCLGs for these COCs are considered to be relevant and appropriate requirements.

Secondary MCLs (SMCLs) are nonenforceable federal contaminant levels intended as guidelines for the states. Because they are nonenforceable, federal SMCLs are not ARARs.

Although the point of compliance for MCLGs and MCLs under the SDWA is at the tap, EPA has determined that for CERCLA remedies, nonzero MCLGs or MCLs should be obtained throughout the contaminated plume or at and beyond the edge of the waste management area, when waste is left in place (55 Fed. Reg. 8666, 8753 [1990]). For the OU2 NEBO South groundwater plume, MCLs and MCLGs are relevant and appropriate throughout the contaminated plume.

Primary State MCLs

The DON has determined that the substantive provisions of the standards in Cal. Code Regs. tit. 22, §§ 64431 and 64444 constitute potential "relevant and appropriate" state ARARs.

RCRA Groundwater Protection Standards

Groundwater concentration limits for RCRA-regulated units are promulgated in Cal. Code Regs. tit. 22, § 66264.94. For corrective action programs, Cal. Code Regs. tit. 22, § 66264.94(c) states that the concentrations of compounds must not exceed the background level of that constituent in groundwater or, if achieving background is shown to be technologically or economically infeasible, some higher concentration limit that is set as part of the corrective action program. In no event shall a concentration limit greater than background exceed MCLs established under the federal SDWA (Cal. Code Regs. tit. 22, §§ 64431 and 64444).

These standards are not "applicable" because Nebo South does not contain a RCRA waste management unit, and the wastes being addressed are not classified as RCRA hazardous wastes.

However, substantive provisions of Cal. Code Regs. tit. 22, § 66264.94(a)(1), (a)(3), (c), (d), and (e) are "relevant and appropriate" federal ARARs for groundwater at Nebo South because the wastes at the site are similar or identical to RCRA hazardous wastes

Porter-Cologne Water Quality Control Act

The Porter-Cologne Water Quality Control Act (Porter-Cologne Act) became Division 7 of the California Water Code in 1969. The Porter-Cologne Act requires each regional board to formulate and adopt a Comprehensive Water Quality Control Plan (Basin Plan) for all areas within the region (California Water Code [Cal. Water Code] § 13240). It also requires each regional board to establish water quality objectives (WQOs) that will protect the beneficial uses of the water basin (Cal. Water Code § 13241) and to prescribe waste discharge requirements that would implement the Basin Plan for any discharge of waste to the waters of the state (Cal. Water Code § 13263[a]).

Other sections of the Porter-Cologne Act include Cal. Water Code § 13243, which allows regional boards to specify conditions or areas where waste discharge is not permitted. Cal. Water Code § 13269 provides the boards authority for waivers for reports or compliance with requirements as long as it is not against the public interest. Cal. Water Code § 13360 specifies circumstances for regional boards to order compliance in a specific manner.

The DON accepts the substantive provisions of Cal. Water Code §§ 13241, 13243, 13263(a), 13269, and 13360 of the Porter-Cologne Act as enabling legislation as implemented through the beneficial uses, WQOs, waste discharge requirements, promulgated policies of the Basin Plan for the Lahontan Region, SWRCB Res. 68-16 and Res. 88-63, and state primary MCLs as potential state ARARs. Where waste discharge requirements are specified in general permits, the substantive requirements in the permits, but not the permits themselves, are potential ARARs.

Cal. Water Code § 13304 sets forth enforcement authority and an enforcement process (orders issued by the state) and is procedural in nature. It does not constitute an ARAR because it does not itself establish or contain substantive environmental "standards, requirements, criteria, or limitations" (CERCLA Section 121 [42 U.S.C. § 9621]) and is not in itself directive in intent. Through its enforcement authority and procedures, substantive state environmental standards set forth in other statutes, regulations, plans, and orders are enforced. In addition, Cal. Water Code § 13304 is no more stringent than the substantive requirements of the potential state ARARs identified in the above paragraphs or potential federal ARARs for groundwater.

Lahontan Region Basin Plan

The DON accepts the substantive provisions in Chapters 2, 3, and 4 of the Basin Plan for Lahontan Region, including beneficial uses, WQOs, and waste discharge requirements, as ARARs.

The Basin Plan for the Lahontan Region was prepared and implemented by the Water Board to protect and enhance the quality of the waters. The Basin Plan establishes location-specific beneficial uses and WQOs for the surface water and groundwater of the region and is the basis of the Water Board's regulatory programs. The Basin Plan includes both numeric and narrative WQOs for specific groundwater subbasins. The WQOs are intended to protect the beneficial uses of the waters of the region and to prevent nuisance.

SWRCB Resolution 88-63

SWRCB Res. 88-63 states that water sources that contain total dissolved solids exceeding 3,000 milligrams per liter (mg/L) (or having electrical conductivity of greater than 5,000 micro-siemens per centimeter) or a yield of less than 200 gallons per day (gpd) are not reasonably expected by the Water Board to supply a public water system (SWRCB, 1988). The substantive provisions of SWRCB Res. 88-63 are applicable to the remedial action conducted at Nebo South.

The DON's Position Regarding SWRCB Resolutions 92-49 and 68-16

The DON and the state of California have not agreed whether the SWRCB Res. 92-49 and Res. 68-16 are ARARs for the remedial action at Nebo South. Therefore, this ROD documents each party's position, but does not attempt to resolve the issue.

The DON recognizes that the key substantive requirements of Cal. Code Regs. tit. 22, § 66264.94 (and the identical requirements of Cal. Code Regs. tit. 23, § 2550.4 and Section III.G of SWRCB Res. 92-49) require cleanup of constituents to background levels, unless such restoration proves to be technologically or economically infeasible and an alternative cleanup level will not pose a substantial present or potential hazard to human health or the environment. In addition, the DON recognizes that these provisions are more stringent than the corresponding provisions of 40 C.F.R., Part 264.94, and that although federally enforceable via the RCRA

program authorization, they are also independently based on state law to the extent that they are more stringent than the federal regulations

The DON has also determined that SWRCB Res. 68-16 is not a chemical-specific ARAR for determining remedial action goals. However, SWRCB Res. 68-16 is an action-specific ARAR for regulating discharged treated groundwater back into the aquifer. The DON has determined that further migration of already-contaminated groundwater is not a discharge governed by the language in Res. 68-16. More specifically, the language of SWRCB Res. 68-16 indicates that it is prospective in intent, applying to new discharges in order to maintain existing high-quality waters. It is not intended to apply to restoration of waters that are already degraded.

The DON's position is that SWRCB Res. 68-16 and Res. 92-49 and Cal. Code Regs. tit. 23, § 2550.4 do not constitute chemical-specific ARARs for this remedial action because they are state requirements and are not more stringent than the federal ARAR provisions of Cal. Code Regs. tit. 22, § 66264.94. The NCP set forth in 40 C.F.R., Part 300.400(g) provides that only state standards more stringent than federal standards may be ARARs (see also CERCLA Section 121[d][2][A][ii] [42 U.S.C. § 9621(d)(2)(A)(ii)]).

The substantive technical standard in the equivalent state requirements (i.e., Cal. Code Regs. tit. 23, Division (div.) 3, Chapter (ch.) 15 and SWRCB Res. 92-49 and Res. 68-16) is identical to the substantive technical standard in Cal. Code Regs. tit. 22, § 66264.94. This section of Cal. Code Regs. tit. 22 will likely be applied in a manner consistent with equivalent provisions of other regulations, including SWRCB Res. 92-49 and Res. 68-16.

State of California's Position Regarding SWRCB Resolutions 92-49 and 68-16

The state does not agree with the DON determination that SWRCB Res. 92-49 and Res. 68-16 and certain provisions Cal. Code Regs. tit. 23, div. 3, ch. 15 are not ARARs for this response action. SWRCB has interpreted the term "discharges" in the Cal. Water Code to include the movement of waste from soils to groundwater and from contaminated to uncontaminated water (SWRCB, 1994). However, the state agrees that the proposed action would comply with SWRCB Res. 92-49 and Res. 68-16, and compliance with Cal. Code Regs. tit. 22 provisions should result in compliance with Cal. Code Regs. tit. 23 provisions. The state does not intend to dispute the ROD, but reserves its rights if implementation of the Cal. Code Regs. tit. 22 provisions is not as stringent as state implementation of Cal. Code Regs. tit. 23 provisions. Because the Cal. Code Regs. tit. 22 regulation is part of the state's authorized hazardous waste control program, it is also the state's position that Cal. Code Regs. tit. 22, § 66264.94 is a state ARAR and not a federal ARAR (*United States v. State of Colorado*, 990 F.2d 1565 [1993]).

Whereas the DON and the state of California have not agreed on whether SWRCB Res. 92-49 and Res. 68-16 and Cal. Code Regs. tit. 23, § 2550.4 are ARARs for this response action, this ROD documents each of the parties' positions on the resolutions but does not attempt to resolve the issue.

Hazardous Waste

The federal RCRA requirements at 40 C.F.R., Part 261 do not apply in California because the state RCRA program is authorized. The authorized state RCRA requirements are therefore considered potential federal ARARs. The applicability of RCRA requirements depends on whether the waste is a RCRA hazardous waste, whether the waste was initially treated, stored, or disposed after the effective date of the particular RCRA requirement, and whether the activity at the site constitutes treatment, storage, or disposal as defined by RCRA. However, RCRA requirements may be relevant and appropriate even if they are not applicable. Examples include activities that are similar to the definition of RCRA treatment, storage, or disposal for waste that is similar to RCRA hazardous waste.

The determination of whether a waste is a RCRA hazardous waste can be made by comparing the site waste to the definition of RCRA hazardous waste. The RCRA requirements at Cal. Code Regs., tit. 22, § 66261.21, 66261.22(a)(1), 66261.23, 66261.24(a)(1), and 66261.100 are potential ARARs because they define RCRA hazardous waste. A waste can meet the definition of hazardous waste if it has the toxicity characteristic of hazardous waste. This determination is made by using the Toxicity Characteristic Leaching Procedure (TCLP). The maximum concentrations allowable for the TCLP listed in § 66261.24(a)(1)(B) are potential federal ARARs for determining whether the site has hazardous waste. If the site waste has concentrations exceeding these values, it is determined to be a characteristic RCRA hazardous waste.

State RCRA requirements included within the EPA-authorized RCRA program for California are considered to be potential federal ARARs and are discussed above. When state regulations are broader in scope than their federal counterparts, they are considered potential state ARARs. State requirements such as the non-RCRA, state-regulated hazardous waste requirements may be potential state ARARs because they are not within the scope of the federal ARARs (57 Fed. Reg. 32726 [1992]). The Cal. Code Regs., tit. 22, div. 4.5 requirements that are part of the state-approved RCRA program would be potential state ARARs for non-RCRA, state-regulated hazardous wastes.

The site waste characteristics need to be compared to the definition of non-RCRA, state-regulated hazardous waste. Under the California RCRA Program, waste can be classified as non-RCRA state-only hazardous waste if it meets specified conditions, as defined in Cal. Code Regs., tit. 22, §§ 66261.22(a)(3) and (4), 66261.24(a)(2) through (a)(8), 66261.101, and 66261.3(a)(2)(C) or 66261.3(a)(2)(F). These requirements have been identified as potentially applicable because a determination will be made as to whether wastes generated may be classified as non-RCRA wastes.

2.12.2.2 Federal and State Location-specific ARARs

Location-specific ARARs are restrictions on the concentrations of hazardous substances or on conducting activities solely because they are in specific locations. The selected remedial action can be implemented to comply with location-specific ARARs.

Archaeological and biological resources are the resource categories relating to location-specific requirements potentially affected by the Nebo South remedial activities. No potential cultural resources, wetlands protection, floodplain management, or geologic characteristics ARARs were identified for the site. Desert tortoise mitigation measures will continue to be followed during the implementation of remedial actions in order to comply with the Endangered Species Act of 1973. Federal and state location-specific ARARs are presented in Tables 2-6 and 2-7.

2.12.2.3 Federal and State Action-specific ARARs

Action-specific ARARs are technology- or activity-based requirements or limitations for remedial activities. These requirements are triggered by the particular remedial activities conducted at the site. Federal and state action-specific ARARs for the selected remedy are presented in Tables 2-8 and 2-9. The selected remedy complies with action-specific ARARs.

Hazardous Waste

The potential exists for hazardous wastes to be generated as a result of remedial actions at Nebo South. Generators of hazardous waste are subject to the requirements in Cal. Code Regs. tit 22, §§ 66262.10(a) and 66262.11, which require generators of hazardous waste to make a hazardous waste determination. The substantive requirements of these regulations are applicable to Nebo South remedial activities.

Although the remedial action conducted at Nebo South is not being conducted within a RCRA treatment, storage, and disposal facility, and is therefore not applicable, groundwater protection standards under RCRA in Cal. Code Regs. tit 22, §§ 66264.91(a)(1), (2), (3), (4), (b) and (c); 66264.93, 66264.97(b)(1), (b)(1)(D), (b)(4), (b)(5), (b)(6), (b)(7),)(d)(1), (d)(2)(D), (e), and 66264.100 (b), (c) and (g)(1) are considered relevant and appropriate for remedial actions for groundwater and the vadose zone since the hazardous constituents being addressed are similar or identical to those found in RCRA hazardous waste.

Clean Air Act

Mojave Desert AQMD Rule 442 requires a reduction of air emissions by 65 percent for facilities that discharge organic materials into the atmosphere from equipment in which organic materials are extracted. Historical data from the Nebo South AS/SVE system indicate that the maximum potential emissions are below set limits for solvents. Because the AS/SVE system discharges VOCs into the air, this rule is considered applicable to Nebo South.

Mojave Desert AQMD Rule 1300 requires a pre-construction review of new or modified facilities to ensure that attainment and maintenance of ambient air quality standards are not impeded. This rule is considered applicable because MCLB emissions exceed the offset threshold for reactive organic compounds of 25 tons per year.

Mojave Desert AQMD Rule 212 requires that equipment be designed, controlled, or equipped with air pollution control equipment so that it will operate without emitting air contaminants in violation of Section 41700 or 41701 of the State Health and Safety Code or of the Mojave Desert AQMD rules. Only the substantive portions of this rule are applicable.

State Water Resources Control Board

Article 5, Section 2550.7 (e)(12)(B) contains the monitoring standards for groundwater and the vadose zone at classified waste management units. Although Nebo South is not considered a waste management unit, the presence of contaminants in the groundwater and vadose zone are similar to what might be present within a waste management unit. Therefore, the substantive portions of this regulation are considered relevant and appropriate.

California Fish and Game Code

The California Endangered Species Act is codified in the California Fish and Game Code (Cal. Fish & Game Code) §§ 2050–2116. It is the DON's position that the requisite federal sovereign immunity waiver does not exist to authorize applicability of the California Endangered Species Act. Nevertheless, this act will be evaluated as a potentially relevant and appropriate requirement for the DON's CERCLA response actions. Cal. Fish & Game Code § 2080 prohibits the take of endangered species. Sections 1900 and 2053 are considered relevant and appropriate for the site. Desert tortoise mitigation measures will continue to be followed during the implementation of remedial actions in order to comply with the Endangered Species Act of 1973

2.12.3 Cost Effectiveness

Cost effectiveness is determined by comparing the cost of all alternatives considered with their overall effectiveness to determine whether the costs are proportional to the effectiveness achieved. The DON evaluates the incremental cost of each alternative as compared to the increased effectiveness of the remedy. Based on current information, the selected remedy will provide the best balance of trade-offs among the alternatives, with respect to the Nine Criteria for Superfund, provided by the NCP, to evaluate the alternatives.

The selected remedy is cost effective and represents a reasonable value for the money to be spent. The selected remedy is expected to effectively protect human health and the environment and is significantly less costly than Alternatives 4 and 5. In making this determination, the following definition was used: "A remedy shall be cost effective if its costs are proportional to overall effectiveness" (NCP, 40 C.F.R., Part 300.430[f][1][ii][D]). The estimated present-worth

cost of the selected remedy is $670,000. The DON has concluded that these costs are appropriate and that the selected remedy is a cost-effective approach for minimizing potential future risks.

2.12.4 Use of Permanent Solutions to the Maximum Extent Practicable and Long-term Effectiveness

Implementation of the selected remedy will provide a permanent solution to the groundwater contamination in a relatively short timeframe. It is also considered effective in the long-term, as it involves removing the contaminant source.

The DON has concluded that the selected remedy (Alternative 3-expanded) represents the maximum extent practicable to which groundwater remediation and vadose zone source reduction can be achieved in a cost-effective manner. Alternative 3-expanded is protective of human health and the environment and complies with ARARs. The DON has also determined that this selected remedy provides the best balance among the criteria of short-term effectiveness, long-term effectiveness and permanence, implementability, and cost. Furthermore, the selected remedy is expected to be permanent and effective over the long term. ICs will be maintained until RAOs are achieved. The remedy will be subject to 5-year reviews.

2.12.5 Preference for Treatment as a Principal Element

The statutory preference for treatment at the Nebo South plume will be met through treatment of contaminated soil and groundwater to remove the VOCs.

2.12.6 Summary of Five-Year Review Requirements for the Selected Remedy

The 5-year review is intended to answer three questions: (1) Is the remedy functioning as intended by the decision document? (2) Are the assumptions used at the time of the remedy still valid? (3) Has any other information come to light that could call into question the protectiveness of the remedy?

The effectiveness of the remedy must be evaluated every 5 years until RAOs are achieved and the site becomes suitable for unrestricted use. In the case of the selected remedy, the evaluation would include a review of available groundwater and/or soil-vapor monitoring data as well as other system information to ensure that contaminant levels remained below MCLs. Costs for each of the 5-year reviews for Nebo South groundwater are estimated to be approximately $45,000.

2.13 DOCUMENTATION OF SIGNIFICANT CHANGE FROM PREFERRED ALTERNATIVE OF PROPOSED PLAN

The Proposed Plan was released for public comment on June 28, 2006. It identified AS/SVE (as Alternative 3-expanded) as the preferred alternative for OU 2 Nebo South groundwater remediation. Although there are no changes to the preferred remedy, it was not clear that the preferred alternative included institutional controls and groundwater monitoring. The pilot

studies implemented at OU 2 Nebo South already had ICs in place and groundwater monitoring in progress. As this ROD is the documentation of the agreement between DON and the Agencies regarding the preferred alternative, ICs and groundwater monitoring must be documented as existing and acknowledged as part of the preferred remedy. A LUC RD will be prepared following the ROD finalization.

PART III – RESPONSIVENESS SUMMARY

3.0 RESPONSIVENESS SUMMARY

There were no comments received during the public meeting or the public comment period on the Final Proposed Plan for Nebo South (DON, 2006a).

4.0 REFERENCES

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TABLES

TABLE 2-1

MAXIMUM CONCENTRATIONS OF VOCS IN GROUNDWATER INCLUDING ASSOCIATED MCLS - OPERABLE UNIT 2, NEBO SOUTH GROUNDWATER PLUME

VOC	Maximum Groundwater Concentrations Listed in the OUs 1 and 2 ROD* (µg/L)	Maximum Groundwater Concentration as of November/December 2004 (µg/L)	Federal MCL (µg/L)	California MCL (µg/L)
1,2-Dichloroethane	4	0.7 J	5	0.5
Tetrachloroethene	17	2	5	5
Trichloroethene	422	46	5	5
Contaminants Not Exceeding Drinking Water Standards (MCLs)				
Acetone[1]	3	5 J	5500[3]	NE
Chloroform[2]	5	3	80	NE
Dibromochloromethane[2]	3	0.3 J	80	NE
Bromodichloromethane[2]	4	2	80	NE
Bromoform[2]	1.3 J	1 U	80	NE
Methylene Chloride[1]	0.4	0.9 J	4.3 [3]	NE

Notes:

* -Source: OUs 1 and 2 ROD (DON, 1998a)

[1] This chemical is a suspected laboratory contaminant and is not considered representative of plume conditions

[2] MCL is for trihalomethanes

[3] This chemical does not have a federal or state primary MCL. Therefore, the PRG is used

Abbreviations and Acronyms:

µg/L - micrograms per liter
DON - Department of the Navy
J - estimated value
MCL - Maximum Contaminant Level
NE - not established
OU - Operable Unit
PRG - Preliminary Remediation Goal
ROD - Record of Decision
U - below reporting limits
VOC - volatile organic compound

TABLE 2-2

CARCINOGENIC TOXICITY VALUES FOR CHEMICALS OF CONCERN – OPERABLE UNIT 2, NEBO SOUTH GROUNDWATER PLUME

Contaminant	Ingestion Slope Factor* (mg/kg-day)	Inhalation Slope Factor* (mg/kg-day)	Dermal Slope Factor* (mg/kg-day)
Bromoform	0.0079	0.0039	0.0079
Chloroform	0.0061	0.081	0.0061
Dibromochloromethane	0.084	0.084	0.084
Tetrachloroethene	0.052	0.002	0.052
Trichloroethene	0.011	0.006	0.011

Notes:

*Source: *OUs 1 and 2 ROD (DON, 1998a)*

Abbreviations and Acronyms:

DON - Department of the Navy
mg/kg-day - milligrams per kilogram per day
OU - Operable Unit
ROD - Record of Decision

TABLE 2-3

NONCARCINOGENIC TOXICITY VALUES FOR CHEMICALS OF CONCERN – OPERABLE UNIT 2, NEBO SOUTH GROUNDWATER PLUME

Contaminant	Ingestion Reference Dose* (mg/kg-day)	Inhalation Reference Dose* (mg/kg-day)	Dermal Reference Dose* (mg/kg-day)
1,2-Dichloroethane	NA	NA	NA
Bromoform	0.02	0.02	0.02
Chloroform	0.01	0.01	0.01
Dibromochloromethane	0.02	0.02	0.02
Tetrachloroethene	0.01	0.01	0.01
Trichloroethene	0.006	0.006	0.006

Notes:

*Source: OUs 1 and 2 ROD (DON, 1998a)

Abbreviations and Acronyms:

DON - Department of the Navy
mg/kg-day - milligrams per kilogram per day
NA - not available
OU - Operable Unit
ROD - Record of Decision

TABLE 2-4

FEDERAL CHEMICAL-SPECIFIC ARARS
OPERABLE UNIT 2, NEBO SOUTH GROUNDWATER PLUME
MCLB BARSTOW, CALIFORNIA

Requirement	Prerequisite	Citation	ARAR Determination	Comments
Safe Drinking Water Act, 42 U.S.C. 300				
National primary drinking water standards are health-based standards for public water systems (MCLs).	Public water system	40 C.F.R., Part 141.61(a) and (c)	Relevant and appropriate for groundwater	The NCP defines MCLs as relevant and appropriate for groundwater determined to be a current or potential source of drinking water in cases where MCLGs are not ARARs. Groundwater in the vicinity of MCLB Barstow has been designated for drinking water use.
MCLGs pertain to known or anticipated adverse health effects (also known as recommended MCLs).	Pubic water system	40 C.F.R., Part 141.50	Relevant and appropriate for groundwater	MCLGs that have non-zero values are relevant and appropriate for groundwater determined to be a current or potential source of drinking water (40 C.F.R., Parts 300.430[e][2][i][B] through [D]). Groundwater in the vicinity of the MCLB Barstow has been designated for drinking water use. Non-zero MCLGs exist for some of the COCs for Nebo South groundwater (OU 2).
Definition of RCRA hazardous waste; TCLP regulatory levels.	Waste generation	Cal Code Regs. tit. 22, §§ 66261.21, 66261.22(a)(1), 66261.23, 66261.24(a)(1), and 66261.100	Applicable	Applicable for determining whether waste is hazardous. These regulations are needed for potential generation of condensate that may form in the knockout pot during SVE system operation.

TABLE 2-4

FEDERAL CHEMICAL-SPECIFIC ARARS
OPERABLE UNIT 2, NEBO SOUTH GROUNDWATER PLUME
MCLB BARSTOW, CALIFORNIA

Requirement	Prerequisite	Citation	ARAR Determination	Comments
Groundwater protection standards: owners/operators of RCRA treatment, storage, or disposal facilities must comply with conditions in this section that are designed to ensure that hazardous constituents entering groundwater from a regulated unit do not exceed the concentration limits set forth under Section 66264.94 for contaminants of concern in the uppermost aquifer underlying the waste management area beyond the point of compliance.	A regulated unit that receives or has received hazardous waste before July 26, 1982, or regulated units that ceased receiving hazardous waste prior to July 26, 1982, where constituents in or derived from the waste may pose a threat to human health or the environment.	Cal Code Regs. tit. 22, §§ 66264.94, except 66264.94(a)(2) and 94(b)	Relevant and appropriate	These standards are not applicable because the groundwater contamination being addressed by Nebo South groundwater (OU 2) did not result from releases from RCRA-regulated units. However, substantive provisions of these requirements may be considered relevant and appropriate for groundwater because the hazardous constituents being addressed by this action are similar or identical to those found in RCRA hazardous wastes.

Notes:

Statutes and policies, and their citations, are provided as headings to identify general categories of potential ARARs for the convenience of the reader. Listing the statutes and policies does not indicate that the DON accepts the entire statute or policy as an ARAR. Specific ARARs are addressed in the table below each general heading; only substantive requirements of the specific citations are considered ARARs.

Abbreviations and Acronyms:

§ - section
ARAR – applicable or relevant and appropriate requirement
Cal Code Regs. – California Code of Regulations
C.F.R. – Code of Federal Regulations
COC – chemical of concern
MCL – Maximum Contaminant Level
MCLB – Marine Corps Logistics Base
MCLG – Maximum Contaminant Level Goal
NCP – National Oil and Hazardous Substances Pollution Contingency Plan
OU – Operable Unit
RCRA – Resource Conversation and Recovery Act
SVE – soil vapor extraction
TCLP – Toxicity Characteristic Leaching Procedure
tit. – Title
U.S.C. – United States Code

TABLE 2-5

STATE CHEMICAL-SPECIFIC ARARS
OPERABLE UNIT 2, NEBO SOUTH GROUNDWATER PLUME
MCLB BARSTOW, CALIFORNIA

Requirement	Prerequisite	Citation	ARAR Determination	Comments
California Environmental Protection Agency Department of Toxic Substances Control				
Definition of "Non-RCRA hazardous waste"; persistent and bioaccumulative toxic substances; TTLCs and STLCs.	Waste generation	Cal. Code Regs. tit. 22, §§ 66261.22(a)(3) and (4),66261.24(a)(2) to (a)(8), 66261.101,66261.3(a)(2)(C), or 66261.3(a)(2)(F)	Applicable	Hazardous waste determination for generation of condensate that may form in the knockout pot during SVE system operation, soil cutting generated from the installation of extraction, conveyance and treatment systems (should additional system components be required in the future), and spent carbon from off-gas treatment (should treatment become necessary during future operation to meet air standards) will be made at the time the wastes are generated.
State MCL list.		Cal. Code Regs. tit. 22, §§ 64431 and 64444	Relevant and appropriate for groundwater	Like federal MCLs, state MCLs are tap standards that are relevant and appropriate for the drinking water aquifers at MCLB Barstow.
State Water Resources Control Board and California Regional Water Quality Control Board				
Describes the water basins in the Lahontan Region, establishes beneficial uses of groundwater and surface water, establishes WQOs, including narrative and numerical standards, establishes implementation plans to meet WQOs and protect beneficial uses, and incorporates statewide water quality control plans and policies.		Comprehensive Water *Quality Control Plan for the* Lahontan Region (Water Code §13240)	Applicable	Substantive requirements pertaining to beneficial uses, WQOs, and certain statewide water quality control plans are state ARARs for the groundwater components of this response action.

TABLE 2-5

STATE CHEMICAL-SPECIFIC ARARS
OPERABLE UNIT 2, NEBO SOUTH GROUNDWATER PLUME
MCLB BARSTOW, CALIFORNIA

Requirement	Prerequisite	Citation	ARAR Determination	Comments
Authorizes the state and regional Water Boards to establish in Water Quality Control Plan beneficial uses and numerical and narrative standards to protect both surface and groundwater quality. Authorizes regional Water Boards to issue permits for discharges to land, surface, water, or groundwater that could affect water quality, including NPDES permits, and to take enforcement actions to protect water quality.		California Water Code, div. 7, §§ 13241, 13243, 13360, and 13263(a), 13269 (Porter-Cologne Water Quality Control Act)	Applicable	The DON accepts the substantive provisions of §§ 13241, 13243, 13263(a), 13269, and 13360 of the Porter-Cologne Act enabling legislation, as implemented through the beneficial uses, WQOs, waste discharge requirements, and promulgated policies of the Basin Plan for the Lahontan Region, as ARARs.
Incorporated into all Regional Board Basin Plans. Designates all ground and surface waters of the State as drinking water, except where the TDS is greater than 3,000 ppm, the well yield is less than 200 gpd from a single well, the water is a geothermal resource or in a water conveyance facility, or the water cannot reasonably be treated for domestic use using either Best Management Practices or Best Economically Achievable Treatment Practices.		SWRCB Resolution No. 88-63 (Sources of Drinking Water Policy)	Applicable	This resolution provides the basis for drinking water determinations in California. Substantive provisions are ARARs. The groundwater at MCLB Barstow has been identified as a source of drinking water.

TABLE 2-5

STATE CHEMICAL-SPECIFIC ARARS
OPERABLE UNIT 2, NEBO SOUTH GROUNDWATER PLUME
MCLB BARSTOW, CALIFORNIA

Requirement	Prerequisite	Citation	ARAR Determination	Comments
Incorporated into all Regional Board Basin Plans. Requires that quality of waters of the state that is better than needed to protect all beneficial uses be maintained unless certain findings are made. Discharges to high-quality waters must be treated using best practicable treatment or control necessary to prevent pollution or nuisance and to maintain the highest quality water. Beneficial uses must, at least, be protected.		SWRCB Resolution No. 68-16 (Policy with Respect to Maintaining High Quality Waters in California) (Water Code §13140, Clean Water Act regulations 40 C.F.R., §131.12)	Not an ARAR	The DON's position is that SWRCB Resolutions 68-16 and Resolutions 92-49 and Cal. Code Regs. tit. 23, § 2550.4 do not constitute chemical-specific ARARs for this remedial action because they are state requirements and are not more stringent than the federal ARAR provisions of Cal. Code Regs. tit. 22, § 66264.94. The substantive technical standard in the equivalent state requirements (i.e., Cal. Code Regs. tit. 23, div. 3, ch. 15 and SWRCB Resolutions 92-49 and Resolutions 68-16) is identical to the substantive technical standard in Cal. Code Regs. tit. 22, § 66264.94. This section of Cal. Code Regs. tit. 22 will likely be applied in a manner consistent with equivalent provisions of other regulations, including SWRCB Resolutions 92-49 and Resolutions 68-16. Please refer to section 2.12.2 of the main text for further discussion. SWRCB Res. 68-16 is an ARAR for reinjection only. The OU2 NEBO South groundwater action does not include reinjection of groundwater.

TABLE 2-5

STATE CHEMICAL-SPECIFIC ARARS
OPERABLE UNIT 2, NEBO SOUTH GROUNDWATER PLUME
MCLB BARSTOW, CALIFORNIA

Requirement	Prerequisite	Citation	ARAR Determination	Comments
Establishes policies and procedures for the oversight of investigations and cleanup and abatement activities resulting from discharge of hazardous substances that affect or threaten water quality. It authorizes the Regional Boards to require cleanup of all waste discharged and restoration of affected water to background conditions. Requires actions for cleanup and abatement to conform to Resolution 68-16 and applicable provisions of Cal Code Regs. tit. 23, div. 3, ch. 15, as feasible.	Discharge affecting water.	SWRCB Resolution 92-49 (Policies and Procedures for Investigation and Cleanup and Abatement of Discharges Under Water Code Section 13304)	Not an ARAR	The DON has determined that SWRCB Resolution 92-49 does not constitute an ARAR for the OU 2, Nebo South groundwater plume remedial actions because its pertinent requirements are not more stringent than the ARAR provisions of Cal. Code Regs. tit. 22, § 66264.94. The State does not agree with the determination that SWRCB Resolution 92-49 is not ARAR for this ROD. However, the State agrees that actions proposed in this ROD would comply with Resolution 92-49 and compliance with the Cal. Code Regs. tit. 22 provisions should result in compliance with Resolution 92-49. The State does not intend to dispute the ROD, but reserves its rights if implementation of the Cal. Code Regs. tit. 22 provisions is not as stringent as State implementation of Resolution 92-49.
Provides general waste discharge requirements for land disposal of treated groundwater. The order contains discharge specifications that include 30-day median and daily maximum values. Discharge monitoring program requirements are also specified.	Discharges of treated groundwater in the Lahontan Region.	Lahontan Water Board Resolution 6-93-106 (General Waste Discharge Requirements for Land Disposal of Treated Groundwater)	Not an ARAR	The selected remedy does not include discharges of treated or extracted groundwater.

Notes:

Statutes and policies, and their citations, are provided as headings to identify general categories of potential ARARs for the convenience of the reader. Listing the statutes and policies does not indicate that the DON accepts the entire statute or policy as an ARAR. Specific potential ARARs are addressed in the table below each general heading; only substantive requirements of specific citations are considered ARARs.

Chemical-specific concentrations used for remedial action alternative evaluation may not be ARARs indicated in this table, but may be concentrations based upon other factors. Such factors may include the following:

Human health risk-based concentrations (Risk-based PRGs) (40 C.F.R, Parts 300.430[e][A][1] and [2]).
Ecological risk-based concentrations (40 C.F.R., Part 300.430[e][G]).
Practical quantitation limits of contaminants (40 C.F.R., Part 300.430[e][A][3]).

TABLE 2-5

STATE CHEMICAL-SPECIFIC ARARS
OPERABLE UNIT 2, NEBO SOUTH GROUNDWATER PLUME
MCLB BARSTOW, CALIFORNIA

Abbreviations and Acronyms:

§ - section
ARAR – applicable or relevant and appropriate requirement
Cal. Code. Regs. – California Code of Regulations
C.F.R. – Code of Federal Regulations
ch. – Chapter
div. – Division
DON – Department of the Navy
gpd – gallons per day
ppm – parts per million
MCL – Maximum Contaminant Level
MCLB – Marine Corps Logistics Base
NPDES – National Pollutant Discharge Elimination System
OU – Operable Unit
PRG – Preliminary Remediation Goal
RCRA – Resource Conservation and Recovery Act
ROD – Record of Decision
STLC – Soluble Threshold Limit Concentration
SVE – soil vapor extraction
SWRCB – State Water Resources Control Board
TDS – total dissolved solids
tit. – Title
TTLC – Total Threshold Limit Concentration
Water Board – California Regional Water Quality Control Board
WQO – water quality objective

TABLE 2-6

FEDERAL LOCATION-SPECIFIC ARARS
OPERABLE UNIT 2, NEBO SOUTH GROUNDWATER PLUME
MCLB BARSTOW, CALIFORNIA

Location	Requirement	Prerequisite	Citation	ARAR Determination	Comments
National Archaeological and Historical Preservation Act					
Within area where action may cause irreparable harm, loss, or destruction of significant artifacts	Construction on previously undisturbed land would require an archaeological survey of the area.	Alteration of terrain that threatens significant scientific, prehistoric, historic, or archaeological data.	Substantive requirements of 16 U.S.C. § 469–469c-1 40 C.F.R., Part 6.301(c)	Applicable	Phase I archaeological surveys would need to be conducted if remedial action activities take place in areas that have not been surveyed for cultural resources.
Endangered Species Act of 1973					
Critical habitat upon which endangered species or threatened species depend	Federal agencies may not jeopardize the continued existence of any listed species or cause the destruction or adverse modification of critical habitat. The Endangered Species Committee may grant an exemption for agency action if reasonable mitigation and enhancement measures such as propagation, transplantation, and habitat acquisition and improvement are implemented.	Determination of effect upon endangered or threatened species or its habitat.	16 U.S.C. § 1536(a), (h)(1)(B)	Applicable	Substantive provisions are ARARs for this response action. Desert tortoise mitigation measures will be followed during the implementation of remedial actions.

TABLE 2-6

FEDERAL LOCATION-SPECIFIC ARARS
OPERABLE UNIT 2, NEBO SOUTH GROUNDWATER PLUME
MCLB BARSTOW, CALIFORNIA

Location	Requirement	Prerequisite	Citation	ARAR Determination	Comments
Migratory Bird Treaty Act of 1972					
Migratory bird area	Protects almost all aspects of native birds in the U.S. from unregulated "take," which can include poisoning at hazard waste sites.	Presence of migratory birds.	16 U.S.C. § 703	Relevant and appropriate	Migratory birds and nesting activities have been documented on MCLB Barstow, particularly in the riparian edge zone on the northern boundary of Nebo. Action to be taken as part of OU 2 Nebo South groundwater plume remedial alternatives is not expected to impact migratory bird activities.

Notes:

Statutes and policies and their citations, are provided as headings to identify general categories of potential ARARs for the convenience of the reader. Listing the statutes and policies does not indicate that the DON accepts the entire statute or policy as an ARAR. Specific ARARs are addressed in the table below each general heading; only substantive requirements of the specific citations are considered ARARs.

Abbreviations and Acronyms:

§ - section
ARAR – Applicable or relevant and appropriate requirement
C.F.R. – Code of Federal Regulations
DON – Department of the Navy
MCLB – Marine Corps Logistics Base
OU – Operable Unit
U.S.C. – United States Code

TABLE 2-7

STATE LOCATION-SPECIFIC ARARS
OPERABLE UNIT 2, NEBO SOUTH GROUNDWATER PLUME
MCLB BARSTOW, CALIFORNIA

Location	Requirement	Prerequisite	Citation	ARAR Determination	Comments
Fish and Game Code					
Endangered Species	No person shall import, export, take, possess, or sell any endangered or threatened species or part or product thereof.	Threatened or endangered species determination on or before January 1, 1985, or a candidate species with proper notification.	Cal. Fish and Game Code § 2080	Relevant and appropriate	Actions to be taken as part of OU 2 Nebo South groundwater plume remedial alternatives are not expected to have any long-term impacts on threatened or endangered species. Desert tortoise mitigation measures will be followed during the implementation of remedial actions.

Notes:

Statutes and policies, and their citations, are provided as headings to identify general categories of potential ARARs for the convenience of the reader. Listing the statutes and policies does not indicate that the DON accepts the entire statute or policy as an ARAR. Specific potential ARARs follow each general heading; only substantive requirements of the specific citations are considered ARARs.

Abbreviations and Acronyms:

§ - section
ARAR – applicable or relevant and appropriate requirement
Cal. – California
MCLB – Marine Corps Logistics Base
OU – Operable Unit

TABLE 2-8

FEDERAL ACTION-SPECIFIC ARARS
OPERABLE UNIT 2, NEBO SOUTH GROUNDWATER PLUME
MCLB BARSTOW, CALIFORNIA

Action	Requirement	Prerequisites	Citation	ARAR Determination	Comments
Resource Conservation and Recovery Act 42 U.S.C. 6901 et seq.					
On-site waste generation	Person who generates waste shall determine if that waste is a hazardous waste.	Generator of hazardous waste in California.	Cal. Code Regs. tit. 22, §§ 66262.10(a), 66262.11	Applicable	Applicable for any operations where hazardous waste is generated. There is a potential for groundwater from the knockout pot to contain hazardous waste due to treatment system operation. Wastes, such as treatment residues and potential soil cuttings from well installation, generated during remedial activities will be determined to be hazardous or non-hazardous at the time the wastes are generated.
Monitoring	Owners/operators of RCRA surface impoundment, waste pile, land treatment unit, or landfill shall conduct a monitoring and response program for each regulated unit.	Surface impoundment, waste pile, land treatment unit, or landfill for which constituents in or derived from waste in the unit may pose a threat to human health or the environment.	Cal. Code Regs. tit. 22, § 66264.91(a)(1), (2), (3), (4), (b), and (c), except as it cross-references permit requirements	Relevant and Appropriate	The groundwater standards under RCRA are considered relevant and appropriate for remedial actions for groundwater and the vadose zone since the hazardous constituents being addressed are similar or identical to those found in RCRA hazardous waste.

TABLE 2-8

FEDERAL ACTION-SPECIFIC ARARS
OPERABLE UNIT 2, NEBO-SOUTH GROUNDWATER PLUME
MCLB BARSTOW, CALIFORNIA

Action	Requirement	Prerequisites	Citation	ARAR Determination	Comments
Groundwater protection standards: Owners/operators of RCRA treatment, storage, or disposal facilities must comply with conditions in this section that are designed to ensure that hazardous constituents entering groundwater from a regulated unit do not exceed the concentration limits set forth under Section 66264.94 for contaminants of concern in the uppermost aquifer underlying the waste management area beyond the point of compliance.	COCs		Cal. Code Regs. tit. 22, § 66264.93	Relevant and appropriate	The groundwater standards under RCRA are considered relevant and appropriate for remedial actions for groundwater and the vadose zone since the hazardous constituents being addressed are similar or identical to those found in RCRA hazardous waste.
Groundwater Monitoring	Requirements for monitoring groundwater, surface water, and the vadose zone.	Hazardous waste treatment, storage, or disposal facility.	Cal Code Regs. tit. 22, §66264.97(b)(1), (b)(1)(D), (b)(4), (b)(5), (b)(6), (b)(7	Relevant and appropriate	RCRA are considered relevant and appropriate for remedial actions for groundwater and the vadose zone since the hazardous constituents being addressed are similar or identical to those found in RCRA hazardous waste.

TABLE 2-8

FEDERAL ACTION-SPECIFIC ARARS
OPERABLE UNIT 2, NEBO SOUTH GROUNDWATER PLUME
MCLB BARSTOW, CALIFORNIA

Action	Requirement	Prerequisites	Citation	ARAR Determination	Comments
Unsaturated zone monitoring	Requirements for monitoring groundwater, surface water, and the vadose zone.	Hazardous waste treatment, storage, or disposal facility.	Cal Code Regs. tit. 22, §66264.97)(d)(1), (d)(2)(D), (e)	Relevant and appropriate	RCRA is considered relevant and appropriate for remedial actions for groundwater and the vadose zone since the hazardous constituents being addressed are similar or identical to those found in RCRA hazardous waste. COCs detected in the vadose zone may affect concentration in the groundwater.
Corrective action monitoring	Requirements for monitoring groundwater, surface water, and the vadose zone.	Hazardous waste treatment, storage, or disposal facility	Cal Code Regs. tit. 22, 66264.100 (b) , (c); (g)(1)	Relevant and appropriate	RCRA are considered relevant and appropriate for remedial actions for groundwater and the vadose zone since the hazardous constituents being addressed are similar or identical to those found in RCRA hazardous waste. COCs detected in the groundwater are being remediated.
Clean Air Act 40 U.S.C. 7401 et seq.					
Discharge of organic solvents to the atmosphere	Emissions reduction by at least 65 percent. Exemptions are provided for emissions of photochemically reactive solvents that do not exceed 39.6 lbs/day and for non-photochemically reactive solvents that do not exceed 2,970 lbs/day.	Discharge of organic materials into the atmosphere from equipment in which organic solvents or materials containing organic solvents are used or extracted.	Mojave Desert AQMD Rule 442	Applicable	Historical data from the Nebo South AS/SVE system indicate that the maximum potential emissions are below the limits set for solvents. Risk- based analysis indicates that the VOC concentrations in the AS/SVE system extracted vapors would result in human health risks that are within the EPA-specified acceptable range.

TABLE 2-8

FEDERAL ACTION-SPECIFIC ARARS
OPERABLE UNIT 2, NEBO SOUTH GROUNDWATER PLUME
MCLB BARSTOW, CALIFORNIA

Action	Requirement	Prerequisites	Citation	ARAR Determination	Comments
Discharge to air	Requirements for the pre-construction review of new or modified facilities to ensure that construction or modification of such facilities does not interfere with the attainment and maintenance of ambient air quality standards. This regulation provides for no net increase in the emission of any affected air pollutant from new major facilities or any modification to an existing major facility.	Applies to all new or modified facilities which are required, under District rules, to obtain an authority to construct.	Mojave Desert AQMD Rule 1300	Applicable	The new source review requirement is applicable for new sources of volatile organic air emissions at the Base since Base emissions exceed the offset threshold for reactive organic compounds of 25 tons/year. According to Mojave Desert AQMD, MCLB Barstow (Yermo Annex and Nebo Main Base) must either emit less than 39.6 lbs/day of photochemically reactive compounds and 600 lbs/day of non-photochemically reactive compounds, or control emissions with an air pollution control treatment system that reduces the emissions by at least 80 percent. Mojave Desert AQMD stated that if the emissions are below the above stated limits, use of any air pollution control system would not be necessary. The average calculated emission rate for CAOC 6 is less than 1.0 lbs/day of photochemically reactive compounds, with no emission of non-photochemically reactive compounds.

TABLE 2-8

FEDERAL ACTION-SPECIFIC ARARS
OPERABLE UNIT 2, NEBO SOUTH GROUNDWATER PLUME
MCLB BARSTOW, CALIFORNIA

Action	Requirement	Prerequisites	Citation	ARAR Determination	Comments
Discharge to the air	Standard for approving permits requires that equipment be designed, controlled, or equipped with air pollution control equipment so that it may be expected to operate without emitting air contaminants in violation of Section 41700 or 41701 of the State Health and Safety Code or of the Mojave Desert AQMD Rules.	Equipment with the potential to cause issuance of air contaminants.	Mojave Desert AQMD Rule 212	Applicable	The AS/SVE systems have the potential to cause issuance of air contaminants. On-site actions under CERCLA are exempt from procedural requirements such as permitting. However, notification of and concurrence by the Mojave Desert AQMD will take place as part of the remedial action review process should additional wells or equipment be required.

Notes:

Statutes and policies, and their citations, are provided as headings to identify general categories of potential ARARs. Listing the statutes and policies does not indicate that the DON accepts the entire statute or policy as an ARAR. Specific ARARs are addressed in the table below each general heading; only substantive requirements of the specific actions are considered ARARs.

Abbreviations and Acronyms:

§ - section
AQMD – Air Quality Management District
ARAR – applicable or relevant and appropriate requirement
AS/SVE – air sparging/soil vapor extraction
CAOC – CERCLA Area of Concern
Cal. Code Regs. – California Code of Regulations
CERCLA – Comprehensive Environmental Response, Compensation, and Liability Act
COC – Chemical of Concern
et seq. – and following
EPA – U.S. Environmental Protection Agency
lbs/day – pounds per day
MCLB – Marine Corps Logistics Base
RCRA – Resource Conservation and Recovery Act
tit. – Title
U.S.C. – United States Code
VOC – volatile organic compound

TABLE 2-9

STATE ACTION-SPECIFIC ARARS
OPERABLE UNIT 2, NEBO SOUTH GROUNDWATER PLUME
MCLB BARSTOW, CALIFORNIA

Action	Requirement	Prerequisites	Citation	ARAR Determination	Comments
State Water Resources Control Board and California Regional Water Quality Control Board					
Discharges of waste to land	Monitoring requirements for waste management units establishes water quality protection standards for corrective action including concentration limits for constituents of concern at background levels unless infeasible to achieve. Cleanup levels greater than background must meet all applicable water quality standards, must be the lowest levels technologically or economically feasible, must consider exposure via other media, and must consider combined toxicological effects of pollutants. A detection monitoring program must be maintained except during any periods when an agency-approved corrective action program is underway.		Cal. Code Regs. tit. 23, div. 3, ch. 15, Article 5, §§ 2550.0(a), 2550.1(a)(1), 2550.4(d), (e),(f)	Not an ARAR	Not an ARAR; no more stringent than Cal. Code Regs. tit. 22, § 66264.94(a)(1), (a)(3), (c), (d), and (e). The State agrees that actions proposed in this ROD would comply with this ARAR and that compliance with the Cal. Code Regs. tit. 22 provisions should result in compliance with this ARAR. The State does not intend to dispute the ROD, but reserves its rights if implementation of the Cal. Code Regs. tit. 22 provisions is not as stringent as State implementation of this ARAR.

TABLE 2-9

STATE ACTION-SPECIFIC ARARS
OPERABLE UNIT 2, NEBO SOUTH GROUNDWATER PLUME
MCLB BARSTOW, CALIFORNIA

Action	Requirement	Prerequisites	Citation	ARAR Determination	Comments
Discharges of waste to land	Water Quality Monitoring Program. Owners or operators of facilities that treat, store, or dispose of waste at waste management units must implement a water quality monitoring program to monitor the potential for releases from the unit or to demonstrate the effectiveness of a corrective action.	Cal. Code Regs. tit. 23 requirements are only applicable to waste discharges to land after 27 November 1984.	Cal. Code Regs. tit. 23, div. 3, ch. 15, Article 5, §§ 2550.3, 2550.4, 2550.5, 25501(e) except (e)(12)(B), 2550.8, 2550.10	Not an ARAR	Not ARARs; not more stringent than Cal. Code Regs. tit. 22, § 66264.93, 66264.94, 66264.95, 66264.97(e), 66264.98, 662264.100. The State agrees that actions proposed in this ROD would comply with this ARAR and compliance with the Cal. Code Regs. tit. 22 provisions should result in compliance with this ARAR. The State does not intend to dispute the ROD, but reserves its rights if implementation of the Cal. Code Regs. tit. 22 provisions is not as stringent as State implementation of this ARAR.
Water quality monitoring for classified waste management units	Establishes general water quality monitoring and system requirements for groundwater and vadose zone.	Contamination present within the groundwater and/or vadose zone at a classified waste management unit	Cal. Code Regs. tit. 23, div. 3, ch. 15, Article 5, § 2550.7 (e)(12)(B).	Relevant and appropriate	The monitoring standards are considered relevant and appropriate for remedial actions conducted within the groundwater and vadose zone since the actions are similar to those that might be conducted within a waste management unit.

TABLE 2-9

STATE ACTION-SPECIFIC ARARS
OPERABLE UNIT 2, NEBO SOUTH GROUNDWATER PLUME
MCLB BARSTOW, CALIFORNIA

Action	Requirement	Prerequisites	Citation	ARAR Determination	Comments
Fish and Game Code					
Actions impacting endangered species	Projects within the state shall not jeopardize the existence of any endangered or threatened species or result in the destruction or adverse modification of habitat essential to the species, if there are reasonable and prudent alternatives available consistent with preserving the species that or its habitat which would prevent jeopardy.	Threatened or endangered species	Cal. Fish and Game Code §§ 1900, 2053	Relevant and appropriate	Actions to be taken as part of OU 2 Nebo South groundwater plume remedial alternatives are not expected to have any long-term impacts on threatened or endangered species. Desert tortoise mitigation measures will be followed during the implementation of remedial actions.

Notes:

Statutes and policies, and their citations, are provided as headings to identify general categories of potential ARARs. Listing the statutes and policies does not indicate that the DON accepts the entire statute or policy as an ARAR. Specific ARARs are addressed in the table below each general heading; only substantive requirements of the specific actions are considered ARARs.

Abbreviations and Acronyms:

§ - section
ARAR – applicable or relevant and appropriate requirement
Cal. Code Regs. – California Code of Regulations
ch. – Chapter
div. – Division
DON – Department of the Navy
MCLB – Marine Corps Logistics Base
OU – Operable Unit
ROD – Record of Decision
tit. – Title

TABLE 2-10

COST ESTIMATE SUMMARY FOR THE SELECTED REMEDY – OPERABLE UNIT 2, NEBO SOUTH PLUME

Capital Costs: No capital costs anticipated at this time as the existing AS/SVE system is expected to achieve the RAOs.

Annual Operation and Maintenance Costs (Years 1 to 3)

DESCRIPTION	QUANTITY	UNIT	UNIT COST ($)	COMMENTS
O&M Costs - Semiannual Groundwater Monitoring, Laboratory Analysis, and Reporting (Years 1 to 3)	6	6 Months	$ 30,200.00	40 samples per event (includes QA/QC samples). Includes cost for the disposal of purged water.
O&M Costs - Vapor Monitoring, Analysis, and Reporting (Years 1 to 3)	3	1 Year	$ 26,400.00	60 samples per year (influent and effluent samples collected monthly, vapor probes sampled annually; includes QA/QC samples).
O&M Costs - AS/SVE System-Related Inspections, and Maintenance (Years 1 to 3)	3	1 Year	$ 42,400.00	Includes electricity utilty cost, annual capital replacement cost of $5,000, and miscellaneous parts and fittings cost.
O&M Costs - AS/SVE System Annual Servicng (Years 1 to 3)	3	1 Year	$ 5,000.00	
O&M Costs - AS/SVE System Vapor Treatment System Carbon Replacement (if required) (Years 1 to 3)	As required	Each	$ 6,600.00	
Subtotal			**$ 110,600.00**	
Contingency Allowances (25%)			$ 27,650	
Project Management and Support (15%)			$ 16,590	
		Total	**$ 154,840.00**	

TABLE 2-10

COST ESTIMATE SUMMARY FOR THE SELECTED REMEDY – OPERABLE UNIT 2, NEBO SOUTH PLUME

Annual Operation and Maintenance Costs (Years 4 to 8)

DESCRIPTION	QUANTITY	UNIT	UNIT COST ($)	COMMENTS
O&M Costs - Annual Groundwater Monitoring, Laboratory Analysis, and Reporting (Years 4 to 8)	5	1 Year	$ 30,200.00	40 samples per event (includes QA/QC samples). Includes cost for the disposal of purged water.
O&M Costs - Vapor Monitoring, Analysis, and Reporting (Years 4 to 8)	5	1 Year	$ 9,000.00	35 samples per year (vapor probes sampled annually; includes QA/QC samples).
Subtotal			**$ 39,200.00**	
Contingency Allowances (25%)			$ 9,800	
Project Management and Support (15%)			$ 5,880	
		Total	**$ 54,880.00**	

Summary of Present Worth Analysis

Year	Capital Cost	Annual O&M Cost Assuming Annual Inflation Rate of 3%	Total Cost	Present Worth (Assuming Annual Interest Rate of 5%)
1 (2006)	$ -	$ 154,840	$ 154,840	$ 147,467
2	$ -	$ 159,485	$ 159,485	
3	$ -	$ 164,270	$ 164,270	$ 434,027
4	$ -	$ 59,969	$ 59,969	
5 (2010)	$ -	$ 61,768	$ 61,768	$ 531,760
6	$ -	$ 63,621	$ 63,621	
7	$ -	$ 65,530	$ 65,530	
8 (2013)	$ -	$ 67,495	$ 67,495	$ 670,000

Total Present Woth Cost **$ 670,000**

Abbreviations and Acronyms:

AS/SVE - air sparging/soil vapor extraction
O&M - operation and maintenance
RAO - remedial action objective
QA - quality assurance
QC -quality control

FIGURES

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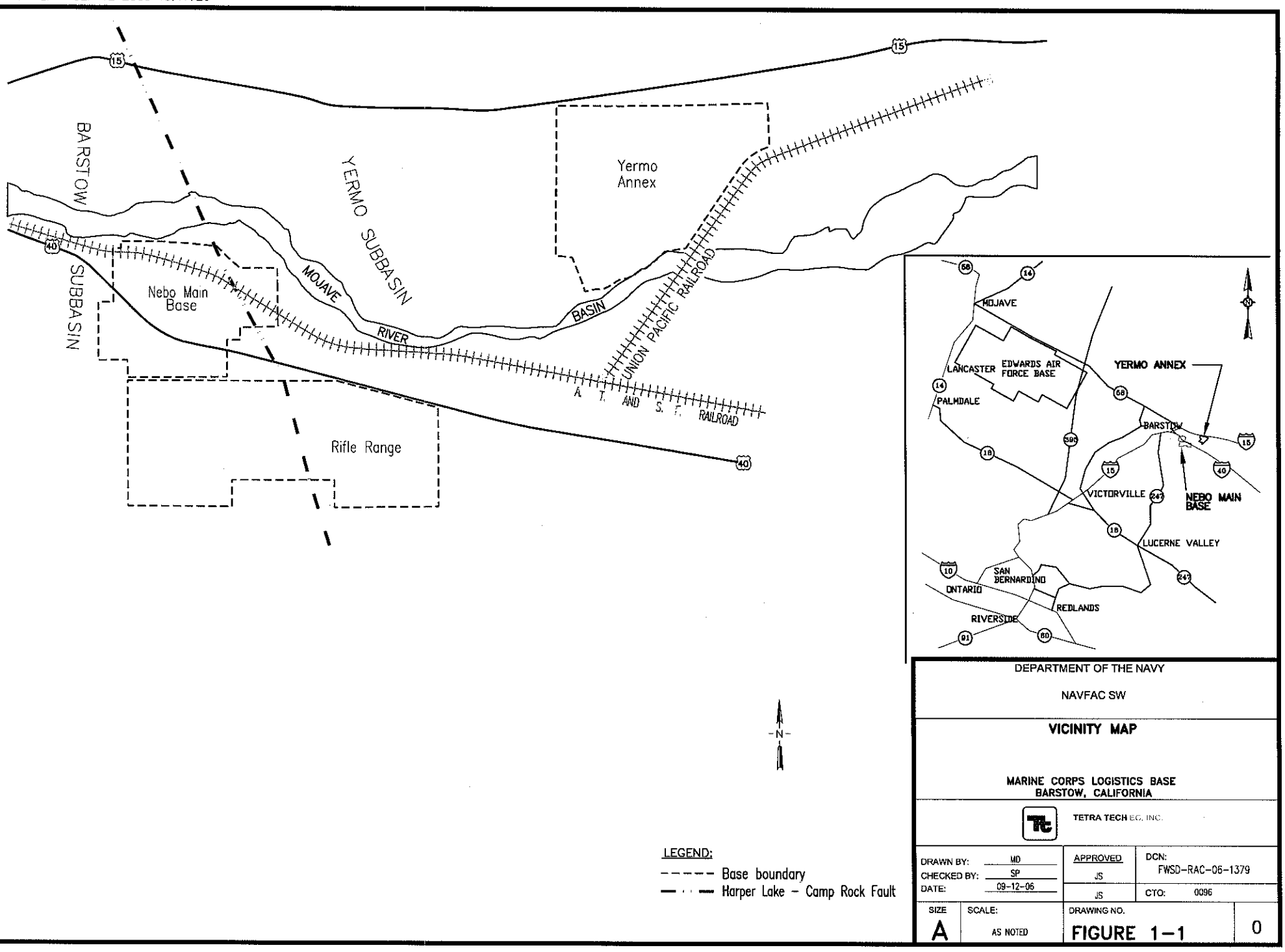

LEGEND:

- - - - - - Base boundary

— · · — Harper Lake - Camp Rock Fault

DEPARTMENT OF THE NAVY

NAVFAC SW

VICINITY MAP

MARINE CORPS LOGISTICS BASE
BARSTOW, CALIFORNIA

TETRA TECH EC, INC.

DRAWN BY: MD		APPROVED	DCN: FWSD-RAC-06-1379
CHECKED BY: SP		JS	
DATE: 09-12-06		JS	CTO: 0096
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NO	DATE	REVISION	BY	CH	APPROVED

MOJAVE RIVERBED

HARPER LAKE-CAMP ROCK FAULT

MOJAVE RIVERBED

FAULT E

FAULT D

FAULT C

FAULT B

FAULT A

**NEBO NORTH PLUME (2004)
(REMEDIAL ACTION ALTERNATIVE
DEEMED FINAL)**

**FINAL ROD
FOCUS AREA**

**NEBO SOUTH
PLUME (2004)**

**CAOC 6
(NEBO SOUTH
PLUME SOURCE
AREA)**

LEGEND:

- —(5)— APPROXIMATE LOCATION OF 2004 PCE CONCENTRATION ISOPLETH (µg/L)
- —(5)— APPROXIMATE LOCATION OF 2004 TCE CONCENTRATION ISOPLETH (µg/L)
- BASE BOUNDARY
- GENERALIZED GROUNDWATER FLOW DIRECTION
- ? INFERRED
- FAULTS (BASED ON OU1 AND 2 RI REPORT JEG 1995)

ABBREVIATIONS:

CAOC	CERCLA AREA OF CONCERN
TCE	TRICHLOROETHENE
PCE	TETRACHLOROETHENE
µg/L	MICROGRAMS PER LITER
JEG	JACOBS ENGINEERING GROUP
RI	REMEDIAL INVESTIGATION
OU	OPERABLE UNIT

N

0 500 1000

FEET

SOURCES: DEPARTMENT OF THE NAVY MARINE CORPS LOGISTICS BASE BARSTOW, CA. GENERAL DEVELOPMENT MAP, OCTOBER 1989 BECHTEL, 1999 (1998 RFA WORKPLAN) OHM, 1999 (ANNUAL GROUNDWATER MONITORING REPORT, 1998) LOCATIONS OF MONITORING WELLS ARE UPDATED BASED ON THE SURVEY PERFORMED DURING 2001 BY MERRELL-JOHNSON ENGINEERING, INC

DEPARTMENT OF THE NAVY

NAVFAC SW

LOCATION OF NEBO NORTH AND NEBO SOUTH GROUNDWATER PLUMES – OU 2

NEBO MAIN BASE – MARINE CORPS LOGISTICS BASE BARSTOW, CALIFORNIA

TETRA TECH EC, INC

DRAWN BY: MD	APPROVED JS	DCN: FWSD-RAC-06-1379	
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MOJAVE RIVERBED

HARPER LAKE-CAMP ROCK FAULT

NEBO NORTH GROUNDWATER EXTRACTION WELLS

NEBO NORTH

2004 (5)

EW-E EW-H EW-G EW-F EW-A EW-B EW-C EW-D

MOJAVE RIVERBED

R-3

R-4

TCE MCL (5 µg/L) PLUME BOUNDARY - 2004

NEBO SOUTH

GEW1 GEW2 GEW3 GEW4 GEW5 R-2 R-1

TCE MCL (5 µg/L) PLUME BOUNDARY - 1996

PHASE 1 AND 2 AS/SVE SYSTEM

NS6-AV8 NS6-AV15 NS6-AV14 NS6-AV3 NS6-AV2 NS6-AV1 NS6-A2 NS6-AV5 NS6-AV11 NS6-A5 NS6-A4 NS6-A3 NS6-A1 NS6-AV12 NS6-AV4 NS6-A7 NS6-AV6 NS6-AV9 NS6-AV13 NS6-AV10

LEGEND:

- (1) LANDFILL NORTH OF THE GOLF COURSE
- (3) GOLF COURSE WASTEWATER DISPOSAL AREA
- (6) ORIGINAL TRASH LANDFILL
- —(5)— APPROXIMATE LOCATION OF 2004 PCE CONCENTRATION ISOPLETH (µg/L)
- APPROXIMATE LOCATION OF 2004 TCE CONCENTRATION ISOPLETH (µg/L)
- APPROXIMATE LOCATION OF 1996 TCE CONCENTRATION ISOPLETH (µg/L)
- BASE BOUNDARY
- CAOC BOUNDARY
- GENERALIZED GROUNDWATER FLOW DIRECTION
- GROUNDWATER EXTRACTION WELL
- RESIDENTIAL WATER SUPPLY WELL
- ? INFERRED
- OFF-SITE GROUNDWATER EXTRACTION WELL PREVIOUSLY PROPOSED BY OHM
- NS6-AV15 SPARGE/EXTRACTION/MONITORING
- NS6-V4 VAPOR EXTRACTION WELL
- NS6-A5 AIR SPARGE WELL

ABBREVIATIONS:

AS/SVE	AIR SPARGING/SOIL VAPOR EXTRACTION
µg/L	MICROGRAMS PER LITER
CAOC	CERCLA AREA OF CONCERN
MCL	MAXIMUM CONTAMINANT LEVEL
TCE	TRICHLOROETHENE
PCE	TETRACHLOROETHENE

N

0 500 1000

FEET

SOURCES: DEPARTMENT OF THE NAVY MARINE CORPS LOGISTICS BASE BARSTOW, CA. GENERAL DEVELOPMENT MAP, OCTOBER 198 BECHTEL, 1999 (1998 RFA WORK OHM, 1999 (ANNUAL GROUNDWATE MONITORING REPORT, 1998). LOC OF MONITORING WELLS ARE UPD BASED ON THE SURVEY PERFOR DURING 2001 BY MERRELL-JOH ENGINEERING, INC

DEPARTMENT OF THE NAVY

NAVFAC SW

OU 2 REMEDIAL ACTIONS

NEBO MAIN BASE – MARINE CORPS LOGISTICS BA BARSTOW, CALIFORNIA

TETRA TECH EC INC

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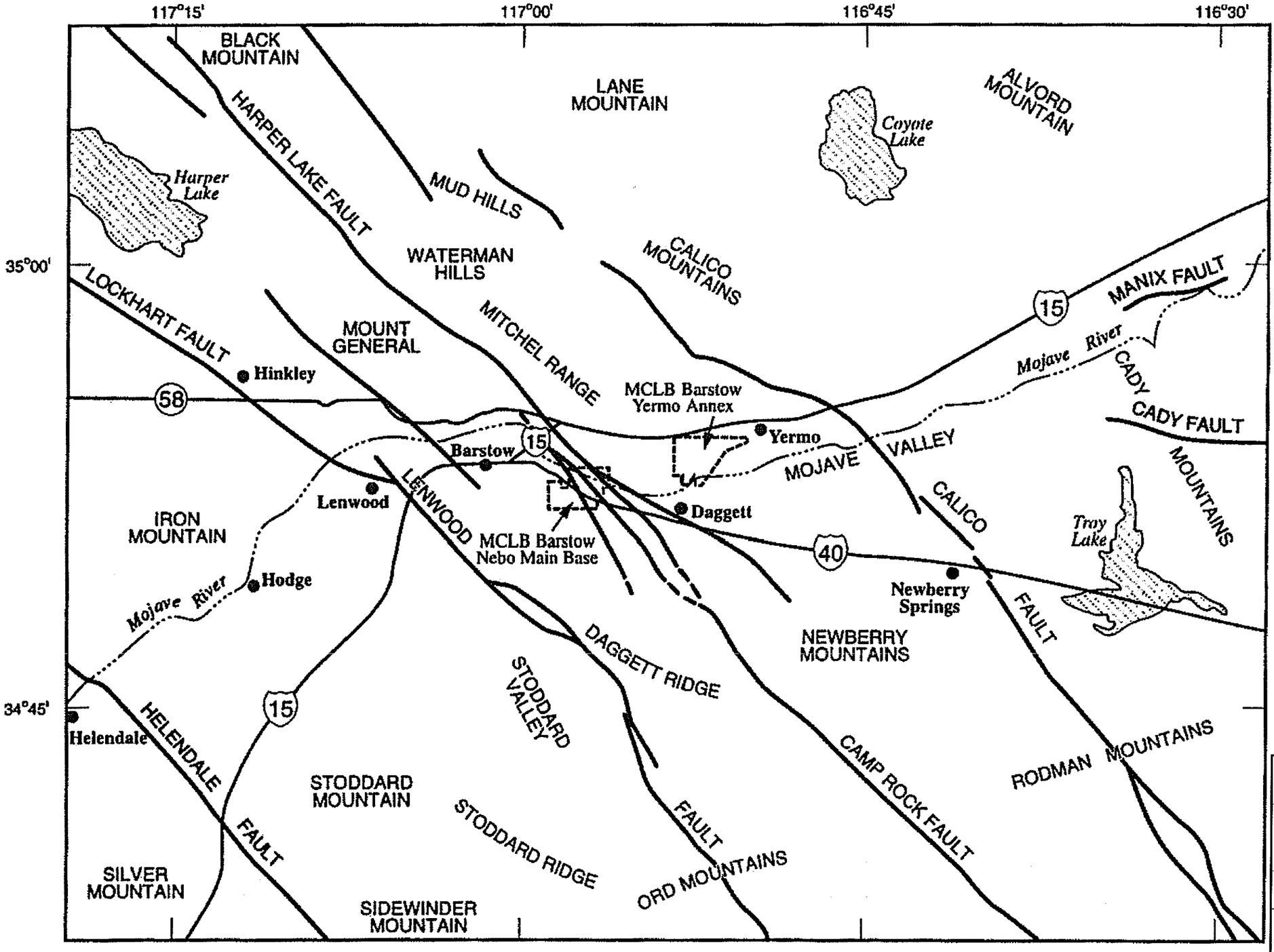

REFERENCE:
OU2 LEVEL 2 ROD (JEG 1998)

DEPARTMENT OF THE NAVY
NAVFAC SW

MOJAVE RIVER REGIONAL MAP
AND MAJOR TOPOGRAPHIC FEATURES

NEBO MAIN BASE – MARINE CORPS LOGISTICS BASE
BARSTOW, CALIFORNIA

TETRA TECH EC INC

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LEGEND:

- STRUCTURE
- PAVED ROAD OR AREA
- UNIMPROVED ROAD
- BRIDGE
- RAILROAD TRACKS
- FENCE
- TANKS
- UST LOCATION
- GROUNDWATER MONITORING WELL
- GROUNDWATER EXTRACTION WELL
- RESIDENTIAL WATER SUPPLY WELL
- VAPOR EXTRACTION WELL
- FAULTS (BASED ON OU1 AND 2 RI REPORT, JEG 1995)
- BASE BOUNDARY
- APPROXIMATE LIMITS OF MOJAVE RIVER BED
- 2010 — GROUNDWATER ELEVATION CONTOUR (ELEVATION IN FEET AMSL)
- GENERALIZED GROUNDWATER FLOW DIRECTION
- (0.008) HYDRAULIC GRADIENT IN FEET PER FOOT

ABBREVIATIONS:

DWTF	DOMESTIC WASTEWATER TREATMENT FACILITY
AMSL	ABOVE MEAN SEA LEVEL
GW	GROUNDWATER
FT	FEET

NEBO

GROUNDWATER ELEVATION IN SELECTED WELLS, NOVEMBER 2004

WELL	GW ELEVATION (FT AMSL)
NGWO3	1974.68
NGWO4	1970.62
NGWO6	1969.14
NNP-3	1980.15
NSI-1	2009.24
NSI-9	2007.42

N

0 500 1000

FEET

DEPARTMENT OF THE NAVY

NAVFAC SW

GROUNDWATER LEVEL MAP
(NOVEMBER 2004)

NEBO MAIN BASE – MARINE CORPS LOGISTICS BASE
BARSTOW, CALIFORNIA

TETRA TECH EC INC.

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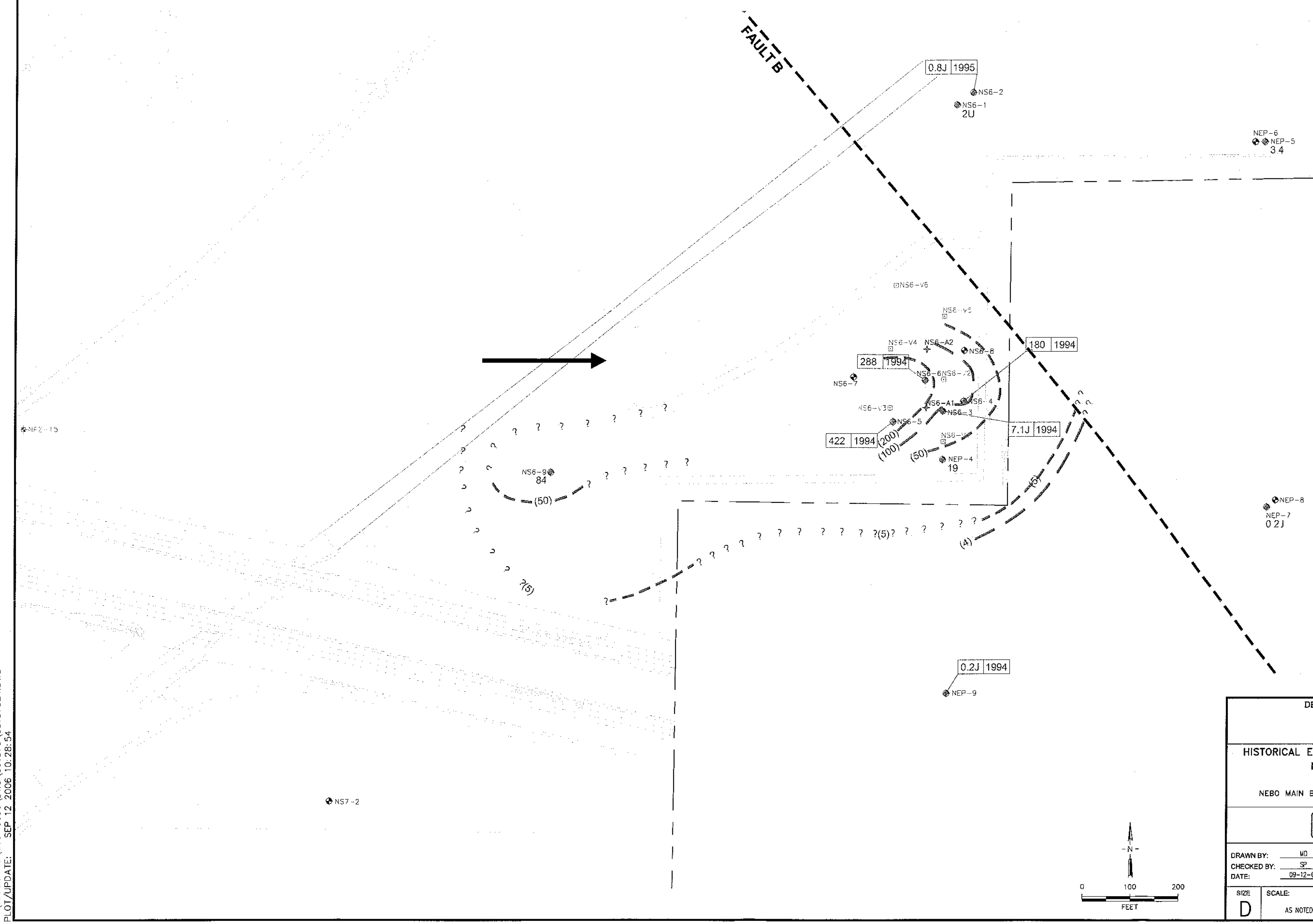

NO	DATE	REVISION	BY	CH	APPROVED

LEGEND:

- STRUCTURE
- PAVED ROAD OR AREA
- UNIMPROVED ROAD
- BRIDGE
- RAILROAD TRACKS
- FENCE
- TANKS
- UST LOCATION
- NS6-8 GROUNDWATER MONITORING WELL
- NFZ-15 PIEZOMETER
- NS6-V4 VAPOR EXTRACTION WELL
- NS6-A5 AIR SPARGE WELL
- BASE BOUNDARY
- 7.1J 1994 TCE CONCENTRATION AND DATE OF DETECTION
- (5) APPROXIMATE LOCATION OF 1996 TCE CONCENTRATION ISOPLETH (µg/L)
- FAULTS (BASED ON OU1 AND 2 RI REPORT JEG 1995)
- WELL WITH TCE RESULT
- 65 TCE (µg/L)
- GENERALIZED GROUNDWATER FLOW DIRECTION

ABBREVIATIONS:

µg/L	MICROGRAMS PER LITER
JEG	JACOBS ENGINEERING GROUP
J	ESTIMATED VALUE
MCL	MAXIMUM CONTAMINANT LEVEL
RI	REMEDIAL INVESTIGATION
TCE	TRICHLOROETHENE
U	NOT DETECTED AT OR ABOVE THE REPORTING LIMIT
OU	OPERABLE UNIT

DEPARTMENT OF THE NAVY

NAVFAC SW

HISTORICAL EXTENT OF TCE IN GROUNDWATER NEBO SOUTH (1996)

NEBO MAIN BASE – MARINE CORPS LOGISTICS BASE BARSTOW, CALIFORNIA

TETRA TECH EC, INC.

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LEGEND:

- STRUCTURE
- PAVED ROAD OR AREA
- UNIMPROVED ROAD
- BRIDGE
- RAILROAD TRACKS
- FENCE
- TANKS
- UST LOCATION
- NS6-8 GROUNDWATER MONITORING WELL
- NP1-15 PIEZOMETER
- NS6-V4 VAPOR EXTRACTION WELL
- NS6-A5 AIR SPARGE WELL
- BASE BOUNDARY
- (5) APPROXIMATE LOCATION OF 1998 TCE CONCENTRATION ISOPLETH (µg/L)
- FAULTS (BASED ON OU1 AND 2 RI REPORT, JEG, 1996)
- WELL WITH TCE RESULT
- 65 TCE (µg/L)
- GENERALIZED GROUNDWATER FLOW DIRECTION

ABBREVIATIONS:

µg/L	MICROGRAMS PER LITER
J	ESTIMATED VALUE
JEG	JACOBS ENGINEERING GROUP
MCL	MAXIMUM CONTAMINANT LEVEL
RI	REMEDIAL INVESTIGATION
TCE	TRICHLOROETHENE
U	NOT DETECTED AT OR ABOVE THE REPORTING LIMIT
OU	OPERABLE UNIT

NS6-2
NS6-1
1U
0.5J
NEP-6
NEP-5
2
NS6-V6
NS6-V3
NS6-V4
NS6-A2
NS6-8
16
NS6-6
NS6-10
NS6-7
NS6-A1
NS6-4
NS6-V5
NS6-3
NS6-5
NS6-V1
(50)
NEP-4
15
NS6-9
62
(50)
(10)
(5)
(4)
NS6-15
1U
NEP-8
NEP-7
1U
NEP-9
3
NS7-2
1U

0 100 200
FEET

DEPARTMENT OF THE NAVY

NAVFAC SW

HISTORICAL EXTENT OF TCE IN GROUNDWATER NEBO SOUTH (1998)

NEBO MAIN BASE – MARINE CORPS LOGISTICS BASE BARSTOW, CALIFORNIA

TETRA TECH EC INC

DRAWN BY: MD	APPROVED	DCN:	
CHECKED BY: SP	JS	FWSD-RAC-06-1379	
DATE: 09-12-06	JS	CTO: 0096	
SIZE: D	SCALE: AS NOTED	DRAWING NO. FIGURE 2-5	0

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PLOT/UPDATE: SEP 12 2006 10:32:17

NO	DATE	REVISION	BY	CH	APPROVED

LEGEND:

- STRUCTURE
- PAVED ROAD OR AREA
- UNIMPROVED ROAD
- BRIDGE
- RAILROAD TRACKS
- FENCE
- TANKS
- UST LOCATION
- NS6-8 GROUNDWATER MONITORING WELL
- NFZ-15 PIEZOMETER
- 10 38V13 ERFA BORING (SEE NOTE 1)
- NH-8 HYDROPUNCH
- NS6-V4 VAPOR EXTRACTION WELL
- NS6-A5 AIR SPARGE WELL
- BASE BOUNDARY
- 1U | 12-99 TCE CONCENTRATION AND DATE OF DETECTION
- (5) APPROXIMATE LOCATION OF 2000 TCE CONCENTRATION ISOPLETH (µg/L)
- FAULTS (BASED ON OU1 AND 2 RI REPORT, JEG, 1996)
- WELL WITH TCE RESULT
- 65 TCE (µg/L)
- GENERALIZED GROUNDWATER FLOW DIRECTION

ABBREVIATIONS:

µg/L	MICROGRAMS PER LITER
J	ESTIMATED VALUE
JEG	JACOBS ENGINEERING GROUP
MCL	MAXIMUM CONTAMINANT LEVEL
RI	REMEDIAL INVESTIGATION
TCE	TRICHLOROETHENE
U	NOT DETECTED AT OR ABOVE THE REPORTING LIMIT
OU	OPERABLE UNIT

NOTES:

1. BASED ON REVISED DRAFT ERFA REPORT (SOTA 1999)

1U | 08-99 — 10 38V11

1U — NS6-2

1U — NS6-1

2 — NEP-6 — NEP-5 — 1U

NH-1 | 1U | 04-99

6.7 | 12-00 — (5) — 10 38V12

NH-8 | 1U | 12-99

(50) — NS6-V4 48 — NS6-A2 42 — NS6-A3 9 — NS6-V2 5 — NS6-7 210 — NS6-V3 25J — NS6-A1 7 — NS6-4 — NS6-3 — NS6-5 5 — NS6-V1 1J — 17 — NS6-6

NH-4 | 3 | 12-99

NH-7 | 1U | 12-99

(10) — NS6-9 41 — 10 38V13 — 8.7 | 08-99

1U — NEP-8 — NEP-7 0.8J

NH-2 | 15 | 04-99

NH-6 | 1U | 12-99

NH-5 | 2 | 12-99

(10) — (4) — (5) — 5.7 | 08-99 — 10 38V14

(5)

NFZ-15 1U

NH-3 | 1U | 04-99

(5) — NEP-9 6

NS7-2

N

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DEPARTMENT OF THE NAVY			
NAVFAC SW			
HISTORICAL EXTENT OF TCE IN GROUNWATER NEBO SOUTH (2000)			
NEBO MAIN BASE – MARINE CORPS LOGISTICS BASE BARSTOW, CALIFORNIA			
TETRA TECH EC INC			
DRAWN BY: MD CHECKED BY: SP DATE: 09-12-06	APPROVED JS JS	DCN: FWSD-RAC-06-1379 CTO: 0096	
SIZE: D	SCALE: AS NOTED	DRAWING NO: FIGURE 2-6	0

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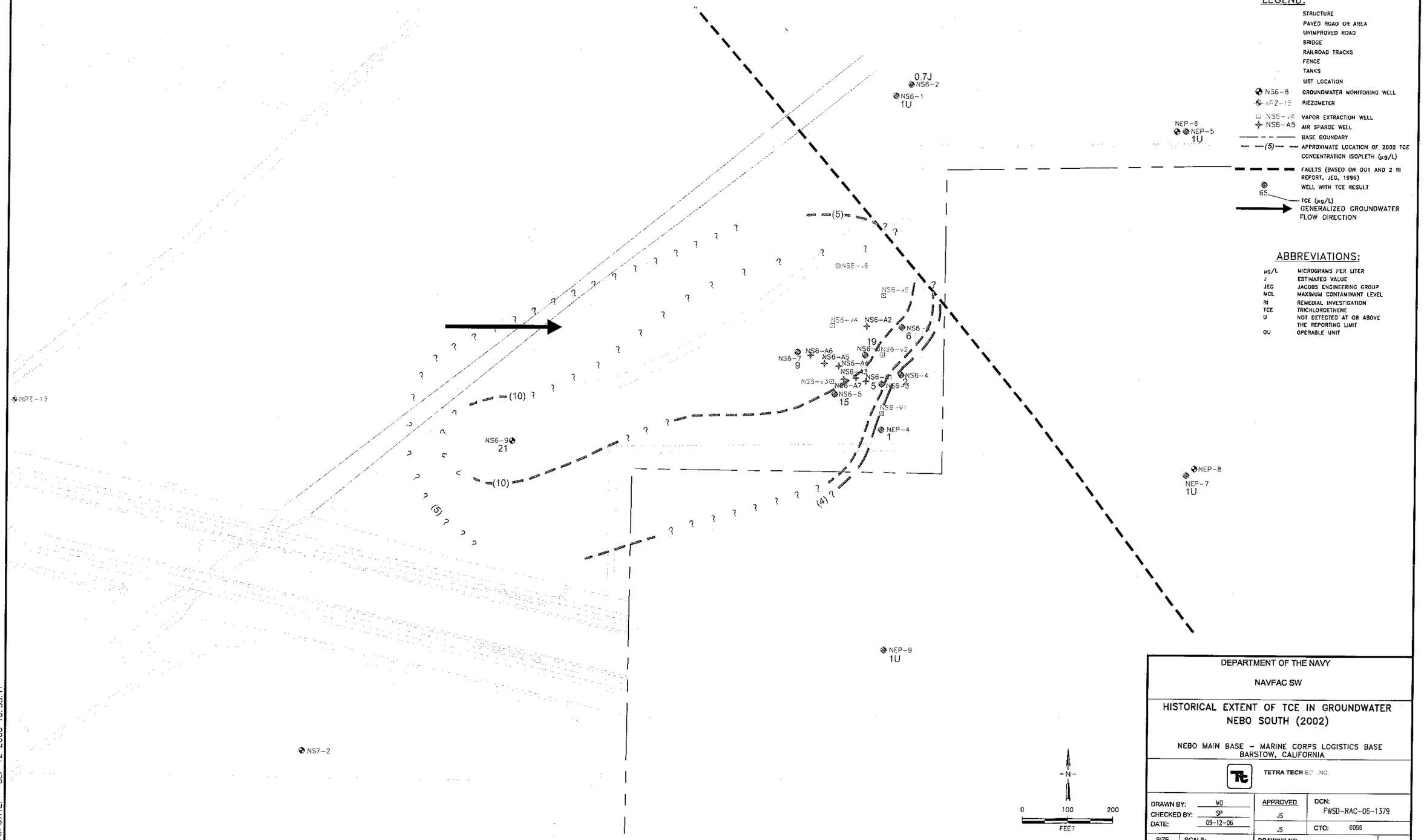

LEGEND:

- STRUCTURE
- PAVED ROAD OR AREA
- UNIMPROVED ROAD
- BRIDGE
- RAILROAD TRACKS
- FENCE
- TANKS
- UST LOCATION
- NS6-8 GROUNDWATER MONITORING WELL
- NPZ-15 PIEZOMETER
- NS6-V4 VAPOR EXTRACTION WELL
- NS6-A5 AIR SPARGE WELL
- BASE BOUNDARY
- (5) APPROXIMATE LOCATION OF 2002 TCE CONCENTRATION ISOPLETH (µg/L)
- FAULTS (BASED ON OU1 AND 2 RI REPORT, JEG, 1996)
- WELL WITH TCE RESULT
- 65 TCE (µg/L)
- GENERALIZED GROUNDWATER FLOW DIRECTION

ABBREVIATIONS:

µg/L	MICROGRAMS PER LITER
J	ESTIMATED VALUE
JEG	JACOBS ENGINEERING GROUP
MCL	MAXIMUM CONTAMINANT LEVEL
RI	REMEDIAL INVESTIGATION
TCE	TRICHLOROETHENE
U	NOT DETECTED AT OR ABOVE THE REPORTING LIMIT
OU	OPERABLE UNIT

DEPARTMENT OF THE NAVY

NAVFAC SW

HISTORICAL EXTENT OF TCE IN GROUNDWATER NEBO SOUTH (2002)

NEBO MAIN BASE – MARINE CORPS LOGISTICS BASE BARSTOW, CALIFORNIA

TETRA TECH EC, INC.

DRAWN BY: MD	APPROVED	DCN:	
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DATE: 09-12-06	JS	CTO: 0096	
SIZE: D	SCALE: AS NOTED	DRAWING NO: FIGURE 2-7	0

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PLOT/UPDATE: SEP 12 2006 10:35:11

NO	DATE	REVISION	BY	CH	APPROVED

LEGEND:

- STRUCTURE
- PAVED ROAD OR AREA
- UNIMPROVED ROAD
- BRIDGE
- RAILROAD TRACKS
- FENCE
- TANKS
- UST LOCATION
- NS6-8 GROUNDWATER MONITORING WELL
- PIEZOMETER
- DS17-2 SOIL BORING WITH SOIL GAS AND DISCRETE GROUNDWATER SAMPLING
- NS6-V4 VAPOR EXTRACTION WELL
- NS6-A5 AIR SPARGE WELL
- NS6-AV15 SPARGE/EXTRACTION/MONITORING
- BASE BOUNDARY
- (5) APPROXIMATE LOCATION OF 2003 TCE CONCENTRATION ISOPLETH (µg/L)
- FAULTS (BASED ON OU1 AND 2 RI REPORT JEG, 1996)
- 4J / 1U SHALLOW SCREEN(SPARGE WELL) / DEEP SCREEN (SPARGE WELL)
- GENERALIZED GROUNDWATER FLOW DIRECTION

ABBREVIATIONS:

µg/L	MICROGRAMS PER LITER
J	ESTIMATED VALUE
JEG	JACOBS ENGINEERING GROUP
MCL	MAXIMUM CONTAMINANT LEVEL
RI	REMEDIAL INVESTIGATION
TCE	TRICHLOROETHENE
U	NOT DETECTED AT OR ABOVE THE REPORTING LIMIT
OU	OPERABLE UNIT

DS17-2
DS17-3
NS6-1 0.3J
0.9J NS6-2
1 NEP-6 NEP-5 1U
0.5J 1U NS6-AV7
4 0.3J NS6-AV8
(4)
(5)
NS6-AV15 48 1U
0.2 NS6-V6
NS6-V5
0.3J 1U
(10)
1U 0.6J NS6-AV2
NS6-V4
NS6-A2
NS6-8
4
0.4J 1U NS6-AV3
NS6-AV
NS6-A6
NS6-A5
NS6-A4
NS6-A3
NS6-A1
NS6-4
NS6-3
4
NS6-A7
NS6-5
9
NS6-V1
2
NEP-4
2
4 1U NS6-AV14
1U 1U NS6-AV5
0.9 1U NS6-AV11
(10)
(50)
66 0.4J NS6-AV12
1U 1U NS6-AV4
(10)
NP2-10
0.9J 1U NS6-AV6
(50) 64
0.5J
NS6-9 31
NS6-AV13
17 1U NS6-AV9
(5)
(4)
1U 0.6J NS6-AV10
NEP-9
2
1U NEP-8
NEP-7 1U

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FEET

DEPARTMENT OF THE NAVY

NAVFAC SW

HISTORICAL EXTENT OF TCE IN GROUNDWATER NEBO SOUTH (2003)

NEBO MAIN BASE – MARINE CORPS LOGISTICS BASE BARSTOW, CALIFORNIA

TETRA TECH EC INC

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CHECKED BY: SP	JS	FWSD-RAC-06-1379	
DATE: 09-12-06	JS	CTO: 0096	
SIZE: D	SCALE: AS NOTED	DRAWING NO: FIGURE 2-8	0

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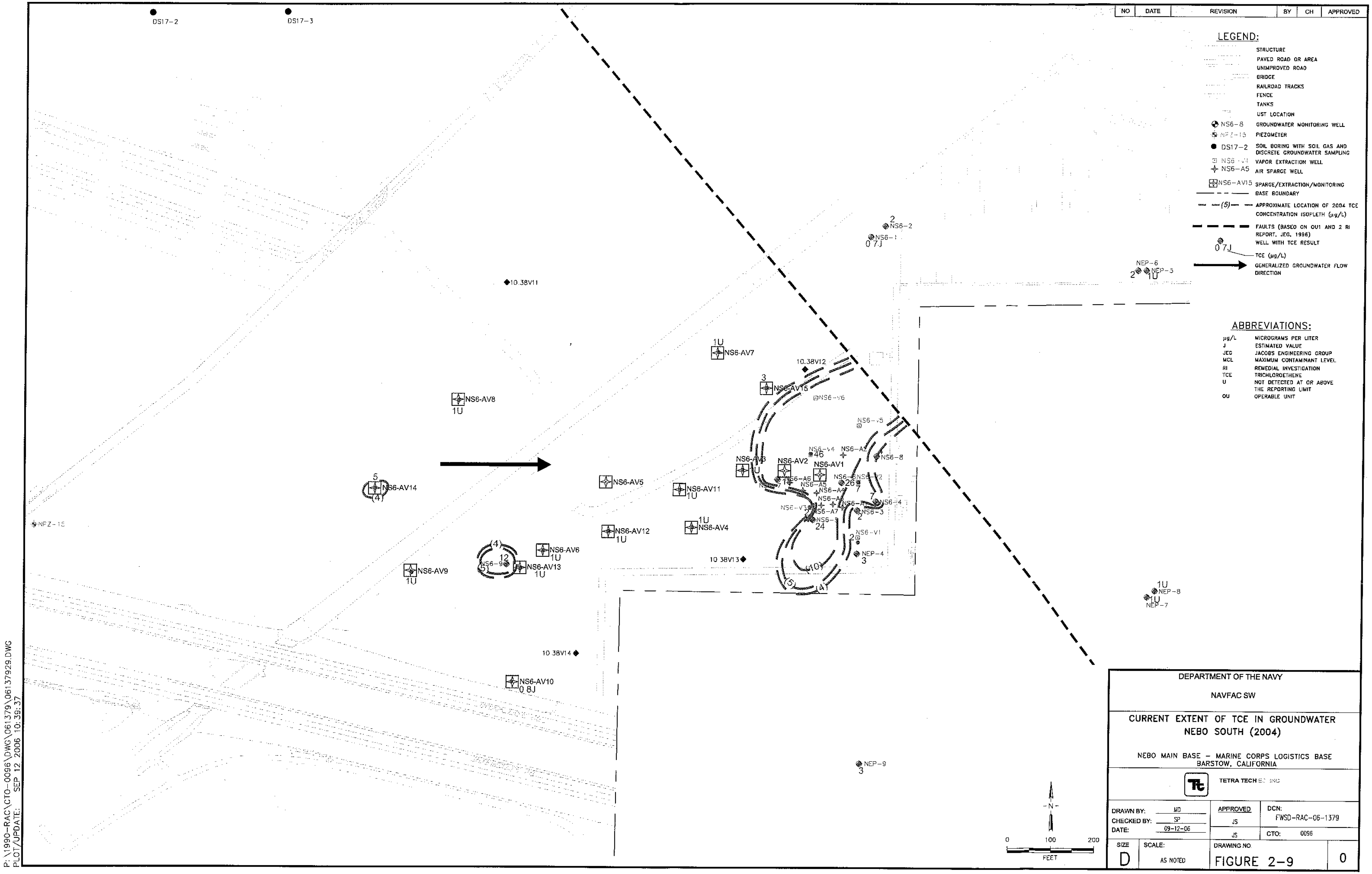

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LEGEND:
STRUCTURE
PAVED ROAD OR AREA
UNIMPROVED ROAD
BRIDGE
RAILROAD TRACKS
FENCE
TANKS
UST LOCATION
NS6-8 GROUNDWATER MONITORING WELL
PIEZOMETER
DS17-2 SOIL BORING WITH SOIL GAS AND DISCRETE GROUNDWATER SAMPLING
VAPOR EXTRACTION WELL
NS6-A5 AIR SPARGE WELL
NS6-AV15 SPARGE/EXTRACTION/MONITORING
BASE BOUNDARY
(5) APPROXIMATE LOCATION OF 2004 TCE CONCENTRATION ISOPLETH (μg/L)
FAULTS (BASED ON OU1 AND 2 RI REPORT, JEG, 1996)
WELL WITH TCE RESULT
0 7J
TCE (μg/L)
GENERALIZED GROUNDWATER FLOW DIRECTION
ABBREVIATIONS:
μg/L MICROGRAMS PER LITER
J ESTIMATED VALUE
JEG JACOBS ENGINEERING GROUP
MCL MAXIMUM CONTAMINANT LEVEL
RI REMEDIAL INVESTIGATION
TCE TRICHLOROETHENE
U NOT DETECTED AT OR ABOVE THE REPORTING LIMIT
OU OPERABLE UNIT
DS17-2
DS17-3
10 38V11
10 38V12
10 38V13
10 38V14
NS6-AV7
NS6-AV8
NS6-AV15
NS6-AV14
NS6-AV5
NS6-AV11
NS6-AV12
NS6-AV4
NS6-AV6
NS6-AV9
NS6-AV13
NS6-AV10
NS6-AV3
NS6-AV2
NS6-AV1
NS6-2
NS6-8
NS6-4
NS6-3
NEP-4
NEP-5
NEP-6
NEP-7
NEP-8
NEP-9
1U
0 8J
0 7J
46
26
24
12
(4)
(5)
(10)
0
100
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DEPARTMENT OF THE NAVY
NAVFAC SW
CURRENT EXTENT OF TCE IN GROUNDWATER
NEBO SOUTH (2004)
NEBO MAIN BASE – MARINE CORPS LOGISTICS BASE
BARSTOW, CALIFORNIA
TETRA TECH
DRAWN BY: MD
CHECKED BY: SP
DATE: 09-12-06
APPROVED JS
JS
DCN: FWSD-RAC-06-1379
CTO: 0096
SIZE D
SCALE: AS NOTED
DRAWING NO
FIGURE 2-9
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PLOT/UPDATE: SEP 12 2006 10:39:37

NO	DATE	REVISION	BY	CH	APPROVED

LEGEND:

- STRUCTURE
- PAVED ROAD OR AREA
- UNIMPROVED ROAD
- BRIDGE
- RAILROAD TRACKS
- FENCE
- TANKS
- UST LOCATION
- NS6-8 GROUNDWATER MONITORING WELL
- NPZ-15 PIEZOMETER
- DS17-2 SOIL BORING WITH SOIL GAS AND DISCRETE GROUNDWATER SAMPLING
- NS6-V4 VAPOR EXTRACTION WELL
- NS6-A5 AIR SPARGE WELL
- NS6-AV15 SPARGE/EXTRACTION/MONITORING
- BASE BOUNDARY
- (5) APPROXIMATE LOCATION OF 2004 TCE CONCENTRATION ISOPLETH (µg/L)
- FAULTS (BASED ON OU1 AND 2 RI REPORT, JEG, 1998)
- 4 / 1U WELL WITH TCE RESULT TCE CONCENTRATION (µg/L) SHALLOW/DEEP SCREEN
- GENERALIZED GROUNDWATER FLOW DIRECTION

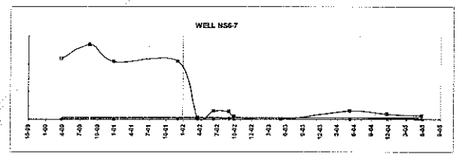
ABBREVIATIONS:

µg/L	MICROGRAMS PER LITER
J	ESTIMATED VALUE
JEG	JACOBS ENGINEERING GROUP
MCL	MAXIMUM CONTAMINANT LEVEL
RI	REMEDIAL INVESTIGATION
TCE	TRICHLOROETHENE
U	NOT DETECTED AT OR ABOVE THE REPORTING LIMIT
OU	OPERABLE UNIT

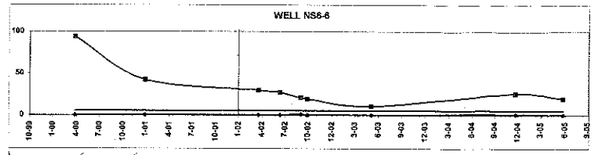
DS17-2 DS17-3 NPZ-15

NS6-AV1 26 7
NS6-AV2 46
NS6-AV3 U
NS6-AV4 1U
NS6-AV5
NS6-AV6 1U
NS6-AV7 1U
NS6-AV8 1U
NS6-AV9 1U
NS6-AV10 0.8J
NS6-AV11 1U
NS6-AV12 1U
NS6-AV13 1U
NS6-AV14 (4)
NS6-AV15 3
NS6-1 0.7J
NS6-2 2
NS6-3 2
NS6-4 1U
NS6-5 1U
NS6-8
NEP-4 3
NEP-5 1U
NEP-6 2
NEP-7
NEP-8 1U

WELL NS6-7



WELL NS6-6



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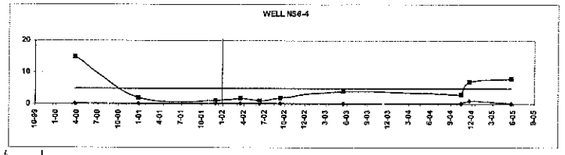
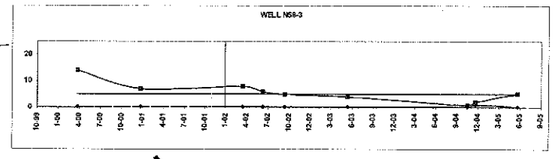
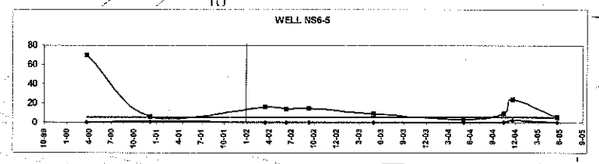


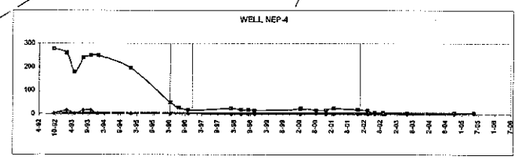
WELL NS6-3



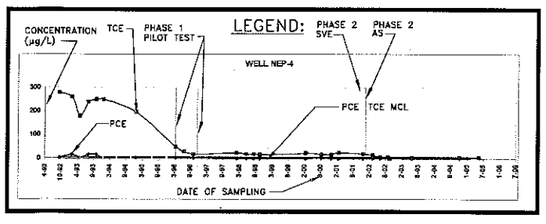
WELL NS6-5



WELL NEP-4



CONCENTRATION (µg/L) TCE PHASE 1 PILOT TEST LEGEND: PHASE 2 SVE PHASE 2 AS



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DEPARTMENT OF THE NAVY

NAVFAC SW

TCE TRENDS IN GROUNDWATER AT CAOC 6 – NEBO SOUTH

NEBO MAIN BASE – MARINE CORPS LOGISTICS BASE BARSTOW, CALIFORNIA

TETRA TECH EC INC

DRAWN BY: MD		APPROVED	DCN: FWSD-RAC-06-1379
CHECKED BY: SP		JS	
DATE: 09-12-06		JS	CTO: 0096
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PLOT/UPDATE: SEP 12 2006 10:41:35

NO	DATE	REVISION	BY	CH	APPROVED

LEGEND:

- STRUCTURE
- PAVED ROAD OR AREA
- UNIMPROVED ROAD
- BRIDGE
- RAILROAD TRACKS
- FENCE
- TANKS
- UST LOCATION
- NS6-8 GROUNDWATER MONITORING WELL
- NEP-15 PIEZOMETER
- NS6-V4 VAPOR EXTRACTION WELL
- NS6-A5 AIR SPARGE WELL
- NS6-AV15 PROPOSED SPARGE/EXTRACTION/ MONITORING WELL
- BASE BOUNDARY
- 180 TCE DETECTS
- ZONE OF SVE INFLUENCE–PHASE 1/2
- APPROXIMATE EXTENT OF VOCs IN SOIL GAS
- FORMER REVETMENT
- CAOC 6 BOUNDARY
- PROJECTED EXTENT OF VOCs IN SOIL GAS IN 1996

ABBREVIATIONS:

µg/m³	MICROGRAMS PER CUBIC METER
CAOC	CERCLA AREA OF CONCERN
TCE	TRICHLOROETHENE
PCE	TETRACHLOROETHENE
SVE	SOIL VAPOR EXTRACTION
U	NOT DETECTED AT OR ABOVE DETECTION LIMIT
VOCs	VOLATILE ORGANIC COMPOUNDS

NPZ-15		01-04
	TCE	PCE
SOIL-GAS µg/m³	79 U	100U

NS6-AV14		12-03
SOIL-GAS µg/m³	TCE	PCE
SHALLOW	74 U	27 U
DEEP	89	27 U

NS6-AV9		12-03
SOIL-GAS µg/m³	TCE	PCE
SHALLOW	180	28 U
DEEP	74 U	27 U

NS6-AV8		12-03
SOIL-GAS µg/m³	TCE	PCE
SHALLOW	75 U	28 U
DEEP	84 U	31 U

NS6-AV6		12-03
SOIL-GAS µg/m³	TCE	PCE
SHALLOW	640	27 U
DEEP	1300	28 U

NS6-AV5		12-03
SOIL-GAS µg/m³	TCE	PCE
SHALLOW	74 U	27 U
DEEP	74 U	27 U

NS6-AV12		12-03
SOIL-GAS µg/m³	TCE	PCE
SHALLOW	200	27 U
DEEP	210	28 U

NS6-AV11		12-03
SOIL-GAS µg/m³	TCE	PCE
SHALLOW	75 U	28 U
DEEP	77	28 U

NS6-AV3		12-03
SOIL-GAS µg/m³	TCE	PCE
SHALLOW	77 U	28 U
DEEP	73 U	27 U

NS6-AV2		12-03
SOIL-GAS µg/m³	TCE	PCE
SHALLOW	75 U	28 U
DEEP	72 U	27 U

NS6-A6		12-03
SOIL-GAS µg/m³	TCE	PCE
SHALLOW	68 U	25 U
MIDDLE	77 U	29 U
DEEP	75 U	28 U

NS6-AV7		12-03
SOIL-GAS µg/m³	TCE	PCE
SHALLOW	76 U	28 U
DEEP	75 U	28 U

NS6-AV15		12-03
SOIL-GAS µg/m³	TCE	PCE
SHALLOW	74 U	27 U
DEEP	74 U	27 U

NS6-V4		12-03
SOIL-GAS µg/m³	TCE	PCE
	74 U	27 U

NS6-V6		12-03
SOIL-GAS µg/m³	TCE	PCE
	74 U	27 U

NS6-V5		12-03
SOIL-GAS µg/m³	TCE	PCE
	74 U	27 U

NS6-8		12-03
SOIL-GAS µg/m³	TCE	PCE
	76 U	28 U

NS6-V2		12-03
SOIL-GAS µg/m³	TCE	PCE
	74 U	27 U

NS6-3		12-03
SOIL-GAS µg/m³	TCE	PCE
	76 U	28 U

NS6-6		12-03
SOIL-GAS µg/m³	TCE	PCE
	75 U	28 U

NS6-A7		12-03
SOIL-GAS µg/m³	TCE	PCE
SHALLOW	77 U	28 U
MIDDLE	77 U	28 U
DEEP	77 U	28 U

NS6-A3		12-03
SOIL-GAS µg/m³	TCE	PCE
SHALLOW	77 U	29 U
MIDDLE	75 U	28 U
DEEP	79 U	29 U

NS6-V1		12-03
SOIL-GAS µg/m³	TCE	PCE
	75 U	28 U

NEP-4		12-03
SOIL-GAS µg/m³	TCE	PCE
	74 U	27 U

NS6-5		12-03
SOIL-GAS µg/m³	TCE	PCE
	75 U	28 U

NS6-V3		12-03
SOIL-GAS µg/m³	TCE	PCE
	71 U	26 U

NS6-7		12-03
SOIL-GAS µg/m³	TCE	PCE
	77U	23U

NS6-AV4		12-03
SOIL-GAS µg/m³	TCE	PCE
SHALLOW	76 U	28 U
DEEP	430	27 U

NS6-A4		12-03
SOIL-GAS µg/m³	TCE	PCE
SHALLOW	77 U	23 U
MIDDLE	76 U	28 U
DEEP	76 U	28 U

NS6-A5		12-03
SOIL-GAS µg/m³	TCE	PCE
SHALLOW	150 U	54 U
MIDDLE	78 U	29 U
DEEP	77 U	29 U

NS6-AV10		12-03
SOIL-GAS µg/m³	TCE	PCE
SHALLOW	5800	230
DEEP	190	250

NS6-9		12-03
	TCE	PCE
SOIL-GAS µg/m³	75 U	28 U

NS6-AV13		12-03
SOIL-GAS µg/m³	TCE	PCE
SHALLOW	1200	39
DEEP	1800	50

NS6-1, NS6-2, NS6-AV7, NS6-AV15, NS6-V6, NS6-V5, NS6-AV8, NS6-AV6, NS6-AV5, NS6-AV14, NS6-AV12, NS6-AV11, NS6-AV3, NS6-AV2, NS6-A6, NS6-V4, NS6-8, NS6-V2, NS6-3, NS6-AV4, NS6-AV9, NS6-9, NS6-AV13, NS6-AV10, NS6-7, NS6-A4, NS6-A5, NS6-6, NS6-A7, NS6-A3, NS6-V1, NS6-4, NS6-5, NS6-V3, NEP-4, NEP-5, NEP-6, NEP-7, NEP-8, NEP-9, NS7-2

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DEPARTMENT OF THE NAVY

NAVFAC SW

TCE/PCE RESULTS FROM INITIAL SOIL GAS (2003) SAMPLING, AS/SVE WELLS, CAOC 6

NEBO MAIN BASE – MARINE CORPS LOGISTICS BASE BARSTOW, CALIFORNIA

TETRA TECH EC INC.

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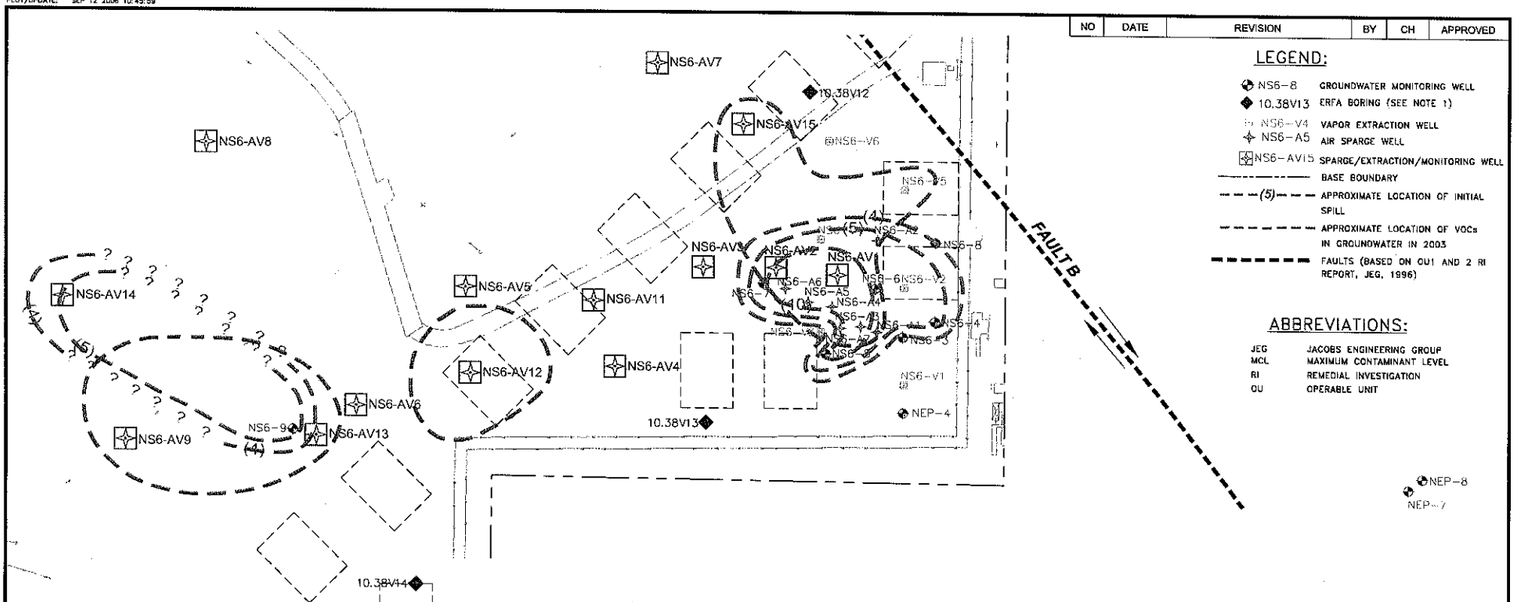
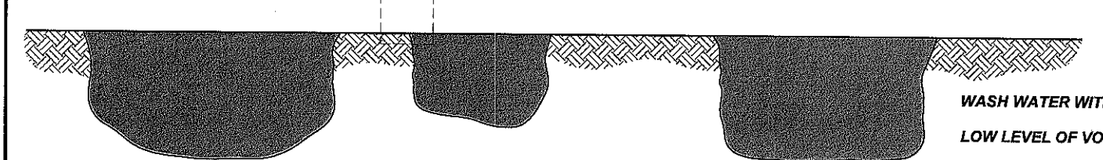


LEGEND:

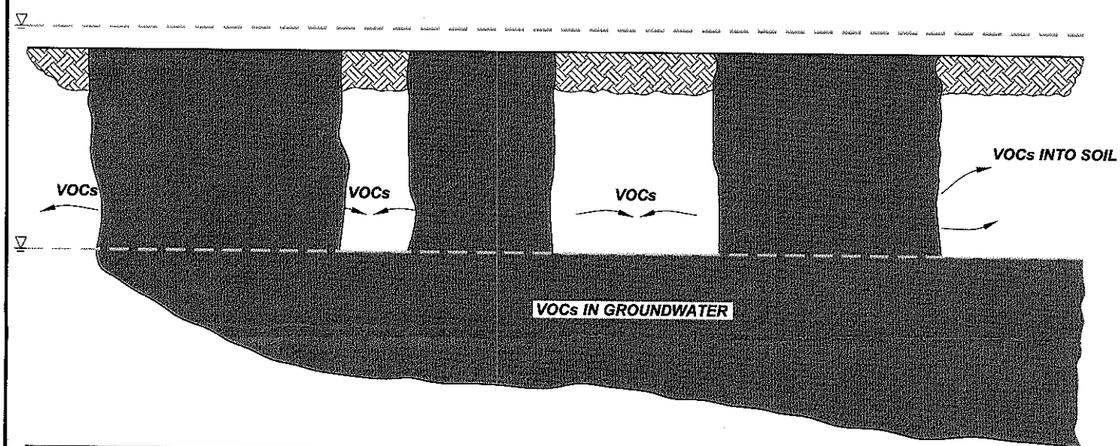
- NS6-8 GROUNDWATER MONITORING WELL
- 10.38V13 ERFA BORING (SEE NOTE 1)
- NS6-V4 VAPOR EXTRACTION WELL
- NS6-A5 AIR SPARGE WELL
- NS6-AV15 SPARGE/EXTRACTION/MONITORING WELL
- BASE BOUNDARY
- (5) APPROXIMATE LOCATION OF INITIAL SPILL
- APPROXIMATE LOCATION OF VOCs IN GROUNDWATER IN 2003
- FAULTS (BASED ON OU1 AND 2 RI REPORT, JEG, 1996)

ABBREVIATIONS:

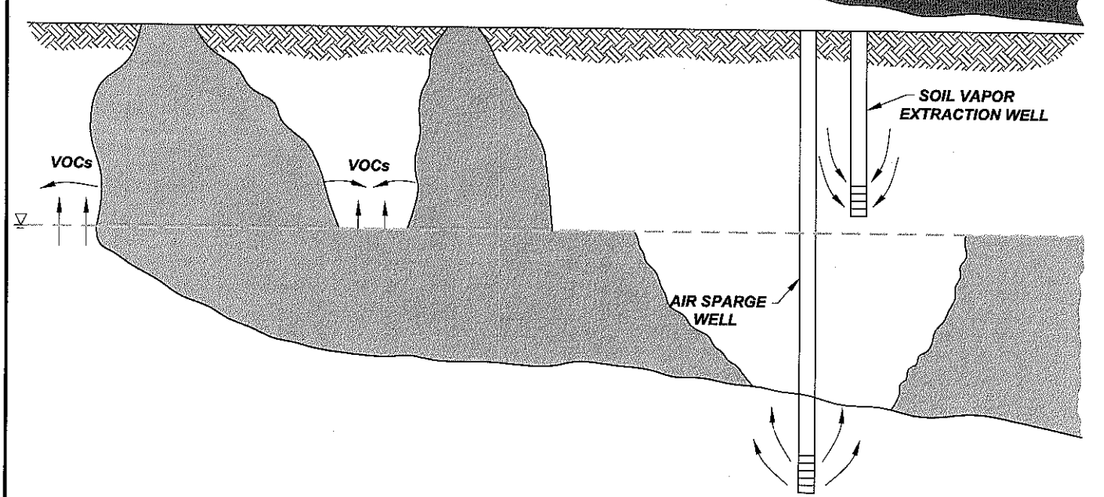
JEG	JACOBS ENGINEERING GROUP
MCL	MAXIMUM CONTAMINANT LEVEL
RI	REMEDIAL INVESTIGATION
OU	OPERABLE UNIT



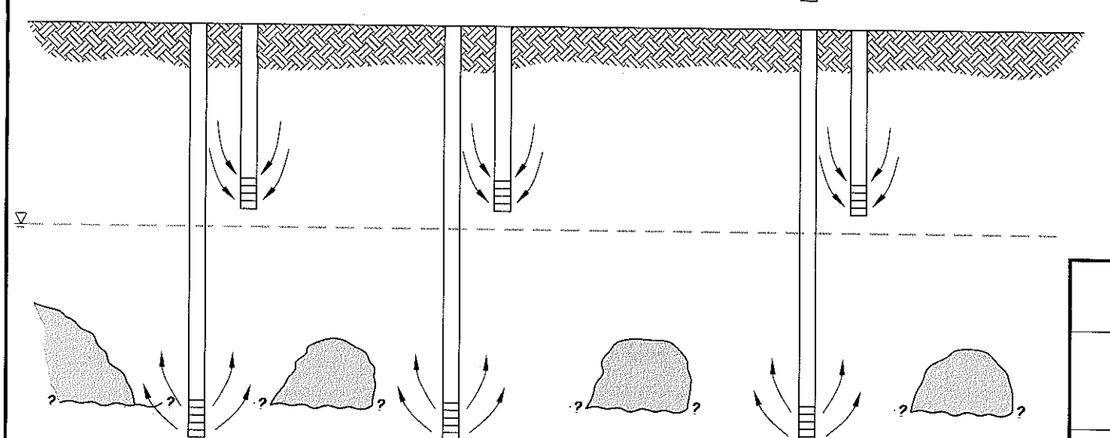
INITIAL SPILL CROSS SECTION



TRANSPORT TO VADOSE ZONE AND GROUNDWATER



PHASE 1 AS/SVE



INTERIM REMEDIAL ACTION

DEPARTMENT OF THE NAVY

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CONCEPTUAL SITE MODEL
CAOC 6

NEBO MAIN BASE – MARINE CORPS LOGISTICS BASE
BARSTOW, CALIFORNIA

TETRA TECH EC INC

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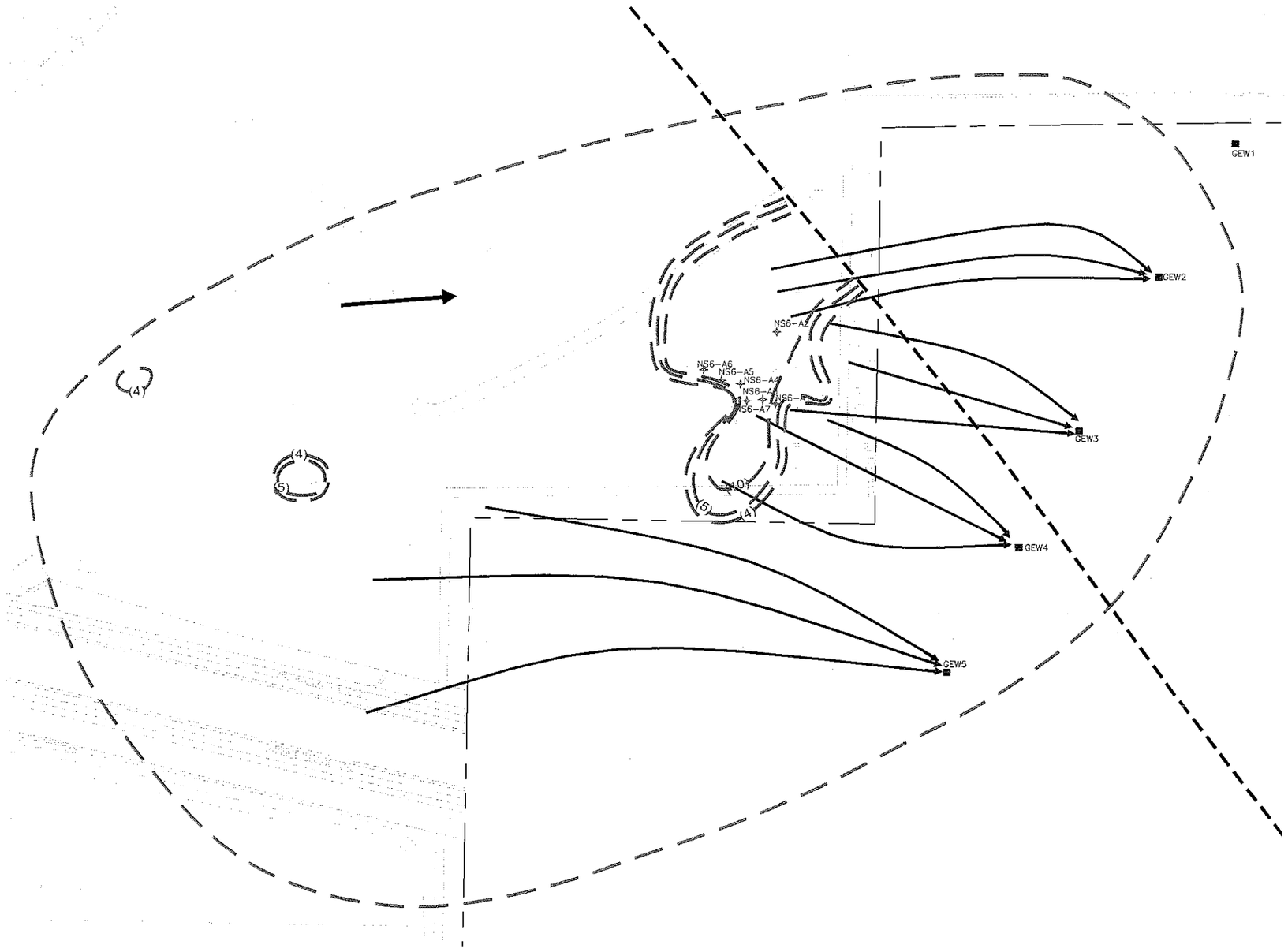

LEGEND:

- STRUCTURE
- PAVED ROAD OR AREA
- UNIMPROVED ROAD
- BRIDGE
- RAILROAD TRACKS
- FENCE
- TANKS
- UST LOCATION
- BASE BOUNDARY
- (5) TCE CONCENTRATION CONTOUR (µg/L)
- 1995 TCE CONCENTRATION CONTOUR (µg/L)
- ESTIMATED GROUNDWATER PATHWAY
- GENERALIZED GROUNDWATER FLOW DIRECTION
- AIR SPARGE/SOIL VAPOR WELL/MONITORING WELL
- OFF-SITE GROUNDWATER EXTRACTION PREVIOUSLY PROPOSED BY OHM

ABBREVIATIONS:

AS/SVE	AIR SPARGE/SOIL VAPOR EXTRACTION
MCL	MAXIMUM CONTAMINANT LEVEL
TCE	TRICHLOROETHENE
µg/L	MICROGRAMS PER LITER

N

0 100 200
FEET

SOURCES: DEPARTMENT OF THE NAVY MARINE CORPS LOGISTICS BASE BARSTOW, CA. GENERAL DEVELOPMENT MAP, OCTOBER 1989 BECHTEL, 1999 (1998 RFA WORKPLAN) OHM, 1999 (ANNUAL GROUNDWATER MONITORING REPORT, 1998). LOCATIONS OF MONITORING WELLS ARE UPDATED BASED ON THE SURVEY PERFORMED DURING 2001 BY MERRELL-JOHNSON ENGINEERING, INC.

DEPARTMENT OF THE NAVY

NAVFAC SW

EXPECTED FATE OF NEBO SOUTH GROUNDWATER PLUME UNDER INFLUENCE OF PREVIOUSLY PROPOSED OFF-BASE GROUNDWATER EXTRACTION WELLS

NEBO MAIN BASE – MARINE CORPS LOGISTICS BASE
BARSTOW, CALIFORNIA

TETRA TECH EC INC

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TCE MCL (5 µg/L)
PLUME BOUNDARY 2004

LAND USE
CONTROL
BOUNDARY

NS6-AV8
NS6-AV14
NS6-AV9
NS6-AV10
NS6-AV7
NS6-AV15
NS6-AV5
NS6-AV11
NS6-AV12
NS6-AV4
NS6-AV6
NS6-AV13
NS6-AV3
NS6-AV2
NS6-AV1
NS6-2
NS6-1
NEP-6
NEP-5
NS6-V6
NS6-V5
NS6-V4
NS6-A2
NS6-8
NS6-A6
NS6-V2
NS6-A5
NS6-A4
NS6-A3
NS6-7
NS6-V3
NS6-A7
NS6-3
NS6-5
NS6-V1
NEP-4
NEP-8
NEP-7
NEP-9

LEGEND:

- STRUCTURE
- PAVED ROAD OR AREA
- UNIMPROVED ROAD
- BRIDGE
- RAILROAD TRACKS
- FENCE
- TANKS
- UST LOCATION
- NS6-8 GROUNDWATER MONITORING WELL
- NEP-15 PIEZOMETER
- NS6-74 VAPOR EXTRACTION WELL
- NS6-A5 AIR SPARGE WELL
- NS6-AV15 SPARGE/EXTRACTION/MONITORING
- BASE BOUNDARY
- (5) APPROXIMATE LOCATION OF 2004 TCE CONCENTRATION ISOFLETH (µg/L)
- FAULTS (BASED ON OU1 AND 2 RI REPORT, JEG 1996)
- GENERALIZED GROUNDWATER FLOW DIRECTION
- LAND USE CONTROL BOUNDARY
- CAOC 6 BOUNDARY

ABBREVIATIONS:

µg/L	MICROGRAMS PER LITER
JEG	JACOBS ENGINEERING GROUP
MCL	MAXIMUM CONTAMINANT LEVEL
RI	REMEDIAL INVESTIGATION
TCE	TRICHLOROETHENE
OU	OPERABLE UNIT
CAOC	CERCLA AREA OF CONCERN

-N-

0 100 200
FEET

DEPARTMENT OF THE NAVY

NAVFAC SW

NEBO SOUTH MAP
WITH LUC BOUNDARY

NEBO MAIN BASE – MARINE CORPS LOGISTICS BASE
BARSTOW, CALIFORNIA

TETRA TECH EC, INC.

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