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MARINE CORPS LOGISTICS BASE
BARSTOW, CALIFORNIA - CTO 298

FINAL

OPERABLE UNITS 1 AND 2

RECORD OF DECISION REPORT

CLE-J02-01F298-B7-0027

PREPARED BY:
Southwest Division Naval Facilities
Engineering Command
1220 Pacific Highway
San Diego, California 92132-5187

THROUGH:
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ACRONYMS AND ABBREVIATIONS

ARARs	applicable or relevant and appropriate requirements
AS/SVE	air sparging/soil vapor extraction
AT&SF	Atchison, Topeka, and Santa Fe Railway
bgs	below ground surface
BLRA	baseline risk assessment
Cal/EPA	California Environmental Protection Agency
Cal/OSHA	California Occupational Safety and Health Administration
CAOC	CERCLA area of concern
CAP	corrective action plan
CCR	California Code of Regulations
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cis-1,2-DCE	cis-1,2-dichloroethene
COC	chemical of concern
CRWQCB	California Regional Water Quality Control Board
DON	Department of the Navy
DTSC	Department of Toxic Substances Control
DWR	California Department of Water Resources
EDB	ethylene dibromide
EE/CA	engineering evaluation/cost analysis
EPA	U.S. Environmental Protection Agency
ESD	explanation of significant differences
F	Fahrenheit
FFA	Federal Facility Agreement
FS	feasibility study
ft/ft	foot per foot
gpm	gallons per minute
ILCR	incremental lifetime cancer risk
IR	Installation Restoration
IRIS	Integrated Risk Information System
IWTP	industrial wastewater treatment plant
Jacobs	Jacobs Engineering Group Inc.
kg	kilogram
MCB	Maintenance Center Base
MCL	maximum contaminant level
MCLB	Marine Corps Logistics Base
MCLG	maximum contaminant level goal
mg/kg-day	milligrams per kilogram per day

mph	miles per hour
MSL	mean sea level
MTBE	methyl tert butyl ether
Navy	U.S. Department of the Navy
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
NTCRA	non-time-critical removal action
OU	operable unit
O&M	operations and maintenance
PCBs	polychlorinated biphenyls
PCE	tetrachloroethene
ppb	parts per billion
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RD/RA	remedial design/remedial action
RFA	RCRA facility assessment
RG	remediation goal
RI/FS	remedial investigation/feasibility study
RME	reasonable maximum exposure
ROD	Record of Decision
ROI	radius of influence
RWQCB	Regional Water Quality Control Board
SARA	Superfund Amendments and Reauthorization Act (1986)
SOV	soil organic vapor
SVE	soil vapor extraction
SVOC	semivolatile organic compound
SWMU	solid waste management unit
SWRCB	State Water Resources Control Board (California)
TBC	to be considered
TCE	trichloroethene
TEF	technical and economical feasibility (analysis)
TPCA	Toxic Pit Closure Act
TPH-D	total petroleum hydrocarbons as diesel
USGS	United States Geological Survey
UST	underground storage tank
VLEACH	vadose zone leaching model
VOA	volatile organic analysis
VOC	volatile organic compound
WMA	waste management area
WMU	waste management unit
WQCP	water quality control plan
μg/L	micrograms per liter

1,1-DCA 1,1-dichloroethane
1,1-DCE 1,1-dichloroethene
1,1-TCA 1,1-trichloroethane

1,1,1-TCA 1,1,1-trichloroethane
1,1,2-TCA 1,1,2-trichloroethane

1,2-DCA 1,2-dichloroethane
1,2-DCE 1,2-dichloroethene

1.0 DECLARATION

1.1 Site Name and Location

The Marine Corps Logistics Base (MCLB) Barstow is in San Bernardino County, California, in the central Mojave Desert approximately 135 miles northeast of Los Angeles. The Base consists of two areas: the 4,006-acre Nebo Main Base, which includes the Rifle Range, is 3.5 miles east of Barstow and intersected by Interstate 40; and the 1,680-acre Yermo Annex, which is 7 miles east of Barstow between Interstates 15 and 40. Groundwater underlying the Yermo Annex and Nebo Main Base is designated as Operable Units (OUs) 1 and 2, respectively. OUs 1 and 2 comprise two major groundwater regions separated by the Harper Lake – Camp Rock Fault: Yermo Annex groundwater in the Yermo Subbasin; and Nebo Main Base groundwater in the Barstow Subbasin. This Record of Decision (ROD) addresses the cleanup of groundwater contamination at OUs 1 and 2 at MCLB Barstow. The areal extent of interconnected groundwater in which 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.

In November 1989, MCLB Barstow was placed on the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) National Priorities List (NPL) due to the presence of soil and groundwater contamination on the Base.

1.2 Statement of Basis and Purpose

This decision document presents the selected remedial actions for the three contaminant plumes identified in the OU 1 (Yermo Annex plume) and OU 2 (Nebo North and South plumes) aquifers at MCLB Barstow. The actions selected for these OUs were developed in accordance with the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) of 1980, as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986, and to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP).

The decisions for these OUs are based on the information contained in the Administrative Record for MCLB Barstow. The two primary documents used for the basis of the decisions are the Remedial Investigation (RI) Report for Operable Units 1 and 2 (Jacobs Engineering Group Inc. [Jacobs] 1995a) and the Feasibility Study (FS) Report for Operable Units 1 and 2 (Jacobs 1995b).

The U.S. Marine Corps, the U.S. Department of the Navy (Navy or DON), the U.S. Environmental Protection Agency (EPA), and the California Environmental Protection Agency's (Cal/EPA) Department of Toxic Substances Control (DTSC) and Lahontan Regional Water Quality Control Board (RWQCB) concur with the selected remedies for these OUs.

1.3 Assessment of OUs 1 and 2

Actual or threatened releases of hazardous substances from OUs 1 and 2 groundwater contaminant plumes may present a current or future threat to public health, welfare, or the environment if not addressed by implementing the response actions selected in this ROD.

1.4 Description of the Selected Remedy

This ROD addresses the groundwater contaminant plumes in the OUs 1 and 2 aquifers and related vadose zone contamination. The selected remedies for each groundwater contaminant plume are described in this section. The remedial approach to the groundwater and vadose zone contamination is to reduce the contaminant mass in groundwater and the vadose zone to levels at or below federal and state maximum contaminant levels (MCLs). The OUs 1 and 2 groundwater contaminant plumes are primarily characterized by tetrachloroethene (PCE) and trichloroethene (TCE) but also contain other volatile organic compounds (VOCs). This ROD sets aquifer cleanup levels for PCE, TCE, 1,1-dichloroethene (1,1-DCE), and 1,2-dichloroethane (1,2-DCA) as the more stringent of the federal and state MCLs. The major components of the selected remedies are described as follows.

Although, under CERCLA Sec. 121(e)(1), remedial actions 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.

1.4.1 OU 1 – Yermo Annex Plume

The selected remedy involves groundwater extraction, ex situ treatment and recharge of treated groundwater back into the aquifer, and air sparging/soil vapor extraction (AS/SVE) systems for groundwater and vadose zone VOC mass removal. Groundwater cleanup standards are based on removing constituents to levels at or below secondary and primary MCLs as measured by groundwater monitoring wells. Vadose zone cleanup standards are based on removal of VOCs from soils to levels that will not cause groundwater to exceed the groundwater cleanup standards, based on an interpretation of soil gas data using appropriate vadose zone fate and transport and groundwater mixing zone models. Monitoring will be conducted to verify adherence to groundwater cleanup standards. The major components of the selected remedy include the following.

- Remedy all the contaminant plume that exceeds the MCL, except directly beneath waste management areas/waste management units (see Section 2.8.2), by extracting groundwater at three locations: 1) four on-Base wells at the CERCLA area of concern (CAOC) 26 plume downgradient boundary; 2) eight wells at the Base eastern boundary; and 3) four off-Base wells at the MCL boundary.
- Treat extracted groundwater aboveground by activated carbon units.
- Operate existing AS/SVE systems for groundwater/vadose zone source removal at CAOC 26, and for groundwater VOC mass removal downgradient of CAOCs 16, 15/17, and 35.
- Recharge treated groundwater back into the aquifer via two infiltration galleries located at the upgradient edge of the plume.
- Monitor the vadose zone at CAOCs 16, 15/17, and 26 for the effectiveness of the AS/SVE systems.
- Monitor groundwater throughout the duration of the remedial action, which is estimated to take approximately 30 years, subject to evaluations of treatment effectiveness at 5-year intervals.

- Monitor groundwater at CAOCs 23 and 35 subject to landfill closure requirements.
- Sample groundwater quarterly for 1 year for five dissolved metals (nickel, chromium, antimony, thallium and aluminum) at selected wells in the area of CAOC 16 to ascertain if these metals are naturally occurring or the result of Base activities.
- Implement institutional controls as described in Section 1.4.2.

1.4.2 OU 2 – Nebo North Plume

The selected remedy involves an AS/SVE system for groundwater and vadose zone VOC mass removal at Warehouse 2 and natural attenuation (e.g., dispersion, degradation, sorption and volatilization) to reduce contamination in the groundwater plume to levels at or below MCLs. The remedy also includes fail-safe pump-and-treat as a backup in case natural attenuation fails to stop plume migration. The major components of the selected remedy include the following.

- Use AS/SVE system for groundwater/vadose zone source removal at Warehouse 2.
- Implement institutional controls including access restrictions to prevent the use of untreated groundwater for drinking water in the area of the plume above MCLs, and well head treatment of potentially impacted water supply wells.
- Design and implement sampling protocol to monitor and evaluate the progress of natural processes in achieving remediation goals.
- Activate an existing groundwater extraction and treatment pilot study system on a contingency basis to provide containment backup if natural processes fail to contain the plume. This ROD establishes "triggers" for turning the extraction and treatment system on and off, if required.
- Monitor vadose zone at Warehouse 2 for the effectiveness of the AS/SVE system.
- Monitor groundwater throughout the duration of the remedial action, which is estimated to take approximately 15 years, subject to evaluations of treatment and cost effectiveness at 5-year intervals.

1.4.3 OU 2 – Nebo South Plume

The selected remedy is 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. The containment measure is a necessary interim action designed to stop any further migration of the VOC plume. An AS/SVE pilot study is currently underway to evaluate the feasibility of this technology to reduce remediation time and thus enhance the cost-effectiveness of containment. The major components of the selected interim remedy include the following.

- Capture the contaminant plume above MCLs through five groundwater extraction wells at the leading edge of the plume.
- Treat extracted groundwater by activated carbon units aboveground.
- Recharge treated groundwater back into the aquifer via percolation ponds located on the northeast corner of the Nebo Main Base, downgradient of the plume.
- Implement institutional controls as described in Section 1.4.2.
- Select the final remedy at a later date with an accompanying Proposed Plan and ROD.

A major component of the selected interim remedy will also include conducting Phase II of the AS/SVE pilot study to further investigate the extent of vadose zone and groundwater contamination underlying CAOC 6, and evaluating the technical feasibility and effectiveness of AS/SVE at this CAOC.

1.5 Statutory Determinations

The selected remedies for the OUs 1 and 2 groundwater contaminant plumes are protective of human health and the environment, comply with federal and state requirements that are legally applicable or relevant and appropriate to the remedial actions, and are cost-effective. These remedies use permanent solutions and alternative treatment technologies to the maximum extent practicable and satisfy the statutory preference for remedies that employ treatment that reduce toxicity, mobility, or volume as a principal element.

The effectiveness of the remedial actions for each of the plumes will be reviewed at a minimum at 5-year intervals, or as otherwise prescribed in this ROD, during operation of the respective systems to ensure that the remedies continue to adequately protect human health and the environment and are achieving cleanup goals.

FOR THE UNITED STATES MARINE CORPS, MARINE CORPS LOGISTICS BASE, BARSTOW:

D.C. McBride
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Commanding

4/22/98.
Date

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April 8, 1998
Date

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2.0 SITE BACKGROUND

2.1 Facility Location and Description

MCLB Barstow (also referred to as the Base) is located within the central Mojave Desert in San Bernardino County, California (Figure 2-1). The Mojave River traverses the Base from west to east. The Base consists of two areas: Nebo Main Base, which includes the Rifle Range, and the Yermo Annex. The Nebo Main Base (1,568 acres) is 3.5 miles east of Barstow and is intersected by Interstate 40. The Rifle Range (2,438 acres) is south and adjacent to the Nebo Main Base. The Yermo Annex (1,680 acres) is 7 miles east of Barstow, adjacent to Interstate 15. Other surrounding communities include Yermo to the northeast and Daggett to the east.

2.2 Present Site Use

MCLB Barstow is a large-scale industrial facility. The primary mission of MCLB Barstow is to provide logistical support to Marine Corps commands throughout the western United States and the Pacific. The mission includes procuring, storing, and distributing military supplies and equipment and maintaining and repairing operational and combat equipment.

The Nebo Main Base is the center for most of the Base administration, Base housing, military and dependent support facilities, and covered storage for supplies and equipment. The Rifle Range is a secured area where Marines can practice and improve their marksmanship. The Yermo Annex is used mainly for maintenance and repair activities.

Workers and residents at the Nebo Main Base receive their domestic water from the Southern California Water Company. There are no active groundwater production wells at the Nebo Main Base.

Two active groundwater production wells at the Yermo Annex (YDW-4 and YDW-5) are within the Yermo contaminant plume. Both of these wells have carbon filtration treatment systems to remove VOCs to non-detectable levels. This water is used for various domestic and industrial uses at the Yermo Annex. The two active wells are operated in compliance with the State's drinking water program A third groundwater production well at the Yermo Annex is inactive.

The areas immediately surrounding MCLB Barstow are basically undeveloped except for some small-scale, older commercial development 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 Main Base where Interstate 40, Route 66, and the Atchison, Topeka, and Santa Fe (AT&SF) railroad lines converge is slated for industrial development per the City of Barstow and San Bernardino County.

2.3 Site History and Enforcement Activities

MCLB Barstow was established in 1942 at Nebo Main Base (Figure 2-1) as a Marine Corps Depot of Supplies; that is, 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 (Figure 2-1) was acquired in 1946 because Nebo Main Base operations outgrew escalating mission requirements. In 1961, a 10-acre central repair shop (Building 573) was built to provide additional vehicle repair and rebuilding capabilities. The Rifle Range (Figure 2-1) was acquired in the mid-1950s for shooting practice and continues to serve the same function today with minimal changes.

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. The hazardous waste generation and disposal operations associated with these industrial activities began at Yermo Annex at this same time.

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, 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, Yermo Annex, and the Rifle Range.

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

Site assessment activities have been conducted since 1983 to determine the nature and extent of contamination and hydrogeological conditions underlying the Base. In 1988, chlorinated solvents, including trichloroethene (TCE), were found in groundwater production wells at the Yermo Annex, and the wells were connected to a carbon filtration treatment system. Several groundwater production wells at the Nebo Main Base were abandoned due to groundwater degradation. In 1977, the Nebo Main Base was connected to the Southern California Water Company system for its potable water supply.

In November 1989, the Base was placed on the CERCLA National Priorities List (NPL) due to the presence of soil and groundwater contamination. In October 1990, MCLB Barstow entered into a Federal Facility Agreement (FFA) with the EPA, the DTSC, and the California Regional Water Quality Control Board (CRWQCB). The FFA constitutes a legally binding agreement between the Marine Corps and the regulatory agencies.

The FFA specified a schedule for completing the CERCLA investigation and remediation activities, and defined seven OUs at the Base. OUs 1 and 2 address the groundwater contamination at the Yermo Annex and the Nebo Main Base, respectively. OUs 3, 4, 5, and 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 (RFA) at the Base.

Groundwater RI activities for OUs 1 and 2 were conducted within the framework of the FFA to define regional hydrogeologic conditions and assess the nature and extent of groundwater contamination at the Base. Phase I RI activities were conducted between February and December 1992. The Phase I RI identified the presence of VOCs exceeding federal and state drinking water standards in the groundwater at both the Yermo Annex and the Nebo Main Base. Phase II RI activities, conducted between June and September 1994, focused on defining the vertical and lateral extent of the groundwater contamination detected in Phase I. The investigative approach and results of the groundwater RI are presented in the Draft Remedial Investigation Report, dated 15 June 1995 (Jacobs 1995a).

2.4 Scope and Role of OUs 1 and 2

For investigative purposes, the Federal Facility Agreement groups the inferred hazardous waste disposal sites (designated CAOCs) at MCLB Barstow into seven operable units as follows. CAOCs are grouped into OUs on the basis of similar characteristics to facilitate response actions.

- **OU 1**: Groundwater and vadose zone contamination underlying the Yermo Annex. The RI identified one large commingled VOC plume emanating from several sources including CAOCs 16, 15/17, 23, 26, and 35.

- **OU 2**: Groundwater and vadose zone contamination underlying the Nebo Main Base. The RI identified two discrete plumes: the Nebo north plume, believed to have originated from Warehouse 2; and the Nebo South plume, which originated from CAOC 6.

- **OU 3**: Shallow soil contamination at the Yermo Annex from five CAOCs (18, 20, 21, 23, and 34), for which analytical data existed prior to the RI.

- **OU 4**: Shallow soil contamination at the Nebo Main Base from four CAOCs (2, 5, 9, and 11), for which analytical data existed prior to the RI.

- **OU 5**: Shallow soil contamination at the Yermo Annex from 16 CAOCs (15/17, 16, 19, 22, 24 through 32, 35, and 36), for which analytical data did not exist prior to the RI.

- **OU 6**: Shallow soil contamination at the Nebo Main Base from 11 CAOCs (1, 3, 4, 6, 7, 8, 10, 12, 13, 14, and 33), for which analytical data did not exist prior to the RI.

- **OU 7**: Soil and groundwater contamination from any additional solid waste management units (SWMUs) that may be identified under the RFA process to have released hazardous materials into the soils.

This ROD provides information about the alternatives considered for groundwater and vadose zone remedial actions at OUs 1 and 2, and identifies the selected alternative with the rationale for its selection.

This information is based on detailed field investigation and engineering reports prepared for OUs 1 and 2. The three primary documents are the Remedial Investigation (RI) Report for OUs 1 and 2 (Jacobs 1995a), the Feasibility Study (FS) Report for OUs 1 and 2 (Jacobs 1996a) and the Proposed Plan for OUs 1 and 2 (Jacobs 1996b). The RI and FS reports are part of the MCLB Barstow Administrative Record. The Draft Final Proposed Plan is undergoing public comment.

2.5 Summary of Site Characteristics

2.5.1 General Site Conditions

In general, both the Nebo Main Base and the Yermo Annex, including those areas near potentially contaminated groundwater, are located near the Mojave River where topography is relatively flat. The topographic surface slopes gently north to the river at the Nebo Main Base and the Rifle Range, and gently slopes south-southeast to the river at the Yermo Annex.

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 the Base, and terminates at Soda Lake about 70 miles east of the Base. Because the river is primarily fed by mountain front drainages, the river bed is generally dry; 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 subbasins (California Department of Water Resources [DWR] 1967). MCLB Barstow is 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 and even less frequent at the Yermo Annex. The surface water drainage systems at both Yermo Annex and 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°

Fahrenheit (F) to 114° F annually. 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 the Base and Barstow.

2.5.2 Geology

MCLB Barstow is within the Mojave Desert Geomorphic Province (Jacobs 1994a). 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 Geomorphic 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 Precambrian 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 Barstow 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 the Base reaches depths of 3,500 feet below ground surface (bgs). 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 Barstow is within the Mojave River Drainage Basin, which covers about 3,700 square miles within the south-central Mojave Desert (Jacobs 1995a).

The Mojave River Drainage Basin consists of a series of subbasins separated by largely impermeable bedrock. MCLB Barstow is within the Lower Mojave subunit. The Lower Mojave subunit is further divided into several subbasins. The Nebo Main Base and the Yermo Annex are within the Barstow and Yermo subbasins, respectively. Water-bearing sediments within these subbasins 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 subbasin 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 subbasin (Miller 1969). The larger Yermo subbasin, similarly bounded by groundwater barriers, extends over 65 square miles. The Yermo subbasin shares a common boundary with the Barstow subbasin at the Harper Lake-Camp Rock Fault, but its northwest boundary is not well defined (United States Geological Study [USGS] 1969).

Groundwater conditions at MCLB Barstow are monitored by an extensive network of shallow, intermediate, and deep monitoring wells installed during prior and current environmental and engineering studies (Jacobs 1991; 1993b). The inventory of monitoring wells drilled under this investigation at the Yermo Annex and Nebo Main Base is provided in the Draft Final RI report. Figures 2-3 and 2-4 depict the location of monitoring wells and hydrogeologic cross section at the Yermo Annex, respectively. Figures 2-5 and 2-6 depict the location of monitoring wells and the hydrogeologic cross section at Nebo Main Base, respectively.

The Mojave River recharges regional groundwater. However, groundwater conditions at the Yermo Annex are significantly different from conditions at the Nebo Main Base. Monitoring well gauging results indicate that groundwater is encountered from between 133 and 147 feet bgs at the Yermo Annex. At the Nebo Main Base, groundwater is encountered between approximately 10 and 75 feet bgs in the central area of the Base and up to 175 feet bgs on the alluvial fan south of Interstate 40. In the bed of the Mojave River, groundwater has been encountered at depths of only 4 to 5 feet bgs (Jacobs 1993a).

The depth to the groundwater table has remained relatively stable at the Nebo Main Base but has been lowered about 70 feet at the Yermo Annex since the 1930s (Miller 1969). The lowering of the water table can be attributed to regional groundwater withdrawal due primarily to agricultural irrigation wells, with minor influences coming from private and public production wells. Two active groundwater production wells at the Yermo Annex are currently being operated in compliance with the State's drinking water program. Groundwater production wells at Nebo Main Base have been inactive since 1975 (Jacobs 1993a).

2.5.4 Groundwater Flow Directions and Gradients

The groundwater table surface beneath the Yermo Annex gently declines towards the east-southeast, with hydraulic gradients ranging typically from 0.0006 to 0.001 foot per foot (ft/ft).

Aquifer recharge from a Mojave River flood in April 1993 redirected groundwater flow at the Yermo Annex to the north-northeast and increased the hydraulic gradients to approximately 0.005 ft/ft. However, the regional flow direction and gradients returned to pre-flood flow conditions within 4 months after the recharge event. Figure 2-7 depicts the typical groundwater table contour map for the Yermo Annex based on groundwater depth measurements collected in January 1994.

The elevation of the groundwater table at the Yermo Annex is approximately 1,810 to 1,825 feet above mean sea level (MSL), and the groundwater table at Nebo Main Base lies between 1,980 and 2,085 feet above MSL. The average water table elevation difference between shallow wells (screened across the water table) and intermediate depth wells (screened at depths of 50 to 60 feet below the water table) is at or close to zero, and the absolute values of the maximum and minimum water table elevation differences are virtually equal. Therefore, no net vertical gradients have been determined to exist at the Yermo Annex.

At the Nebo Main Base, the groundwater gradient at the southwestern corner, which is the topographically high area, is directed radically towards the north, northeast, and east, at a slope of approximately 0.01 to 0.03 ft/ft (Figure 2-8). The groundwater flow gradient decreases to approximately 0.002 ft/ft near the central part of the Main Base, and the flow direction changes to predominantly northeast. The flow direction then changes to predominantly eastward underlying the Base golf course, located at the northern Main Base immediately south of the Mojave River channel. The change in groundwater flow direction along eastern Nebo Main Base is attributed to the presence of the Harper Lake-Camp Rock fault and shallow bedrock to the north.

Monitoring well clusters at the Nebo Main Base, consisting of intermediate and shallow depth wells, were measured for the presence of vertical flow gradients. Wells NSI-6/NSI-7 and NWP-1/NS10-1 displayed a net downward vertical gradient of 0.020 and 0.018 ft/ft, respectively. Monitoring wells NWP-3/NWP-7 and NS2-1/NS2-3 had a net upward vertical gradient of 0.093 and 0.013 ft/ft, respectively. Vertical gradients on all other wells at Nebo Main Base were less than 0.005 ft/ft.

2.5.5 Groundwater Use

The Lower Mojave subunit, which includes the Barstow and Yermo subbasins, is classified as a source of drinking water (i.e., Class I Aquifer) in the Comprehensive Water Quality Control Plan for the Lahontan Region. 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 Yermo Annex area relies on on-Base water supply wells to meet its domestic water needs. Groundwater at the Yermo Annex is extracted from the aquifer and treated through a carbon filtration system. The Nebo Main Base receives its drinking water through a pipeline from the City of Barstow, which gets its water supply from groundwater wells in the Mojave River Drainage Basin, upgradient from the Base.

2.6 Groundwater Removal Actions

As the lead agency, the Marine Corps has adopted the policy that removal actions will take priority over continued investigation when the removal action is deemed to be protective of human health and consistent with the final remedy. Two time-critical and one non-time-critical groundwater removal actions have been implemented at MCLB Barstow to address groundwater contamination at both the Yermo Annex and Nebo Main Base. These removal actions, described as follows, meet the requirements of CERCLA and have been fully incorporated into the remedial actions selected in this ROD.

In 1992, TCE concentrations above drinking water MCLs were detected in a private residence drinking water well located within the off-Base Nebo south plume boundary. A time-critical removal action was conducted to remove the well from service and connect the residence to the Base water supply system.

In 1994, levels above drinking water standards were detected off-Base about 2,000 feet downgradient of the Yermo Annex eastern boundary. Trace levels (less than 1 part per billion [ppb]) were detected in one of two private residence wells located downgradient of this area. The Base conducted a time-critical removal action to provide the two private residence wells with wellhead carbon treatment systems as a precautionary measure.

A non-time-critical removal action (NTCRA) for groundwater containment and cleanup is being conducted at the Yermo Annex and has been incorporated into this ROD. The purpose of the NTCRA is to prevent further migration of contaminants beyond the Base boundary and accelerate groundwater cleanup activities.

MCLB Barstow has also conducted removal actions for soils under OUs 3 and 5 at the Yermo Annex, and OU 4 at the Nebo Main Base. These removal actions are described in the respective RODs for these OUs, which are part of the MCLB Barstow Administrative Record.

2.7 Risk Characterization/Management

2.7.1 Assessment of Risk

The NCP directs the Marine Corps, as the lead agency for MCLB Barstow, to conduct a baseline risk assessment (BLRA) to determine whether the Base poses a current or potential threat to human health and the environment in the absence of any remedial action. 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.

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.

2.7.2 Summary of Human Exposure Assumptions

The BLRA for OUs 1 and 2 used a future resident exposure scenario with the following exposure assumptions for the identified pathways:

- A 70-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.

2.8 Remediation Goals

2.8.1 Groundwater Cleanup

Primary MCLs

Groundwater cleanup levels for VOCs are established to ensure that any persons exposed in the future will not be exposed to unsafe levels of chemicals of concern. These cleanup levels are based on a detailed analysis of chemical-specific applicable or relevant and appropriate requirements (ARARs) and health risk-based criteria that are consistent with the present and projected beneficial uses of the affected aquifers.

MCLB Barstow overlies the Lower Mojave subunit, which is classified as a source of drinking water (Class I aquifer) in the Comprehensive Water Quality Control Plan (WQCP) for the Lahontan Region. The Nebo Main Base receives its water supply from the Southern California Water District. The Yermo Annex obtains its water from the Yermo subbasin. The only two active water supply wells at the Yermo Annex have carbon filtration systems to meet drinking water standards.

Because the groundwater is a source of drinking water, federal MCLs, nonzero maximum contaminant level goals (MCLGs), and those state MCLs that are more stringent than federal MCLs are relevant and appropriate ARARs for the groundwater in the aquifer (EPA 1990). In addition to the Lahontan Region WQCP and the federal and state drinking water standards, the RCRA groundwater protection standards have also been determined to be relevant and appropriate for remedial actions for OUs 1 and 2 due to the nature of the chemicals of potential concern. The RCRA groundwater protection standards require cleanup to background levels (i.e., the water quality that existed before the discharge), unless background levels can be demonstrated to be technically and economically infeasible to attain. Concentration limits greater than background levels cannot exceed MCLs.

Pursuant to the RCRA Water Quality Protection Standard in Title 22 California Code of Regulations (CCR) Section 66264.94, the DON evaluated two sets of potential concentration limits for the purpose of establishing groundwater VOC cleanup levels (see Table 2-1).

1) The most stringent federal and state drinking water standards (i.e., MCLs), and

2) Background levels based on readily achievable detection limits (i.e., 0.5 µg/L).

The ILCRs for chemicals of concern within each plume calculated for both of these standards fall within the EPA risk management range of 10^{-6} to 10^{-4}. Both set of standards are considered to be protective of human health and the environment.

The technical and economic feasibility (TEF) of remedial alternatives to achieve both sets of cleanup standards (i.e., MCLs and background) was evaluated in the OUs 1 and 2 FS for each of the groundwater plumes at MCLB Barstow. The results of the TEF evaluation for the Yermo Annex, Nebo North and Nebo South contaminant plumes are summarized in Sections 3.3.1, 4.3.1, and 5.3.1 of this ROD, respectively. The complete TEF was provided to the agencies as Appendix J of the OUs 1 and 2 Draft Final FS Report (Jacobs 1997).

Based on the TEF analysis and risk assessment results, the DON concluded that achieving background levels of constituents in the groundwater is not technically or economically feasible, and established MCLs as the cleanup levels for groundwater remedial actions under this ROD consistent with the requirements of 22 CCR 66264.94, 23 CCR 2550.4, and SWRCB Resolution Nos. 68-16 and 92-49. MCLs will be attained throughout the contaminant plume, except directly beneath WMAs/WMUs. The FFA signatories agreed on and approved this conclusion in the Proposed Plan for OUs 1 and 2.

Secondary MCLs

The State asserts that the narrative taste and odor water quality objective specified in the WQCP for the Lahontan RWQCB, which incorporates State primary and secondary drinking water standards, is an ARAR that applies to the establishment of cleanup levels in these OUs. The DON and EPA agree that the negative taste and odor water quality objective is an ARAR, but do not agree that the secondary standard of three odor units is an ARAR because the measurement is subjective based upon the sensory determination of a panel. The DON agrees to implement the taste and odor objective for toluene and xylenes by using the numeric taste and odor standards proposed by EPA (see 56 Federal Register 3572, 3573, 30 January 1991), but not promulgated, as "to-be-considered" standards that will be identified as performance goals in this ROD. If the DON demonstrates compliance with the performance goals, the DON shall be deemed to be in compliance with the taste and odor water quality objectives and the secondary MCLs for xylene and toluene.

2.8.2 Points of Compliance with Groundwater Cleanup Standards

Background

The CERCLA NCP preamble provides that compliance with groundwater cleanup standards should be attained throughout the affected area of the aquifer or at and beyond the downgradient edge of the waste management area (WMA) when the waste is left in place (the "point of compliance"). See NCP preamble at 55 Federal Register 8753, 8 March 1990. Title 22 CCR Section 66264.95 contains similar provisions for RCRA "regulated units" and Title 23 CCR Section 2550.5 contains similar provisions for "point of compliance" for waste management units (WMU) regulated under Title 23 CCR Chapter 15.

It is the DON's position that the designation of "points of compliance" at the downgradient edge of all CAOCs addressed in this ROD would be appropriate and is supported by CERCLA, the NCP, and the administrative record for this ROD, and that the remedial action objective (RAO) of achieving the federal MCLs for PCE, TCE, and 1,1 DCE should apply throughout the contaminant plume downgradient from the points of compliance. The DON believes contamination upgradient of the points of compliance would be adequately contained by the remedial action to ensure compliance with this RAO and would adequately protect human health and the environment.

The NCP preamble states that there may be certain circumstances where a plume of groundwater contamination is caused by releases from several distinct sources that are in close geographical proximity. The NCP preamble provides that, in such cases, the most cost-effective groundwater cleanup strategy may be to address the problem as a whole rather than on a source-by-source basis, and to draw a common "point of compliance" that encompasses all the sources of release (55 Federal Register 8753, 8 March 1990).

See Appendix A for a more detailed explanation of the DON's position regarding the applicability of "point of compliance" regulatory provisions to the CAOCs addressed in this ROD.

Designation of Point of Compliance

EPA and DTSC agree that CAOCs 23, 35, and the majority of CAOC 15/17 are WMAs/WMUs and that the designation of a "point of compliance" at the downgradient edges of these units is appropriate. The DON hereby designates "points of compliance" at the downgradient edge of CAOC 23 and the common downgradient edge of CAOCs 35 and 15/17. Portions of CAOC 23 and 35 contain landfill WMUs that the DON will permanently close in-place. The WMUs at CAOC 15/17 encompass 14 evaporation ponds, four sludge drying beds, a temporary pond, three oxidation ponds, and the overflow area around the ponds. At CAOC 15/17, waste residues have been removed from the WMUs and disposed of at an appropriate off-Base facility. The DON is not proposing any further use of the WMUs at CAOC 15/17 for waste disposal and the WMUs are currently not permitted to receive waste. The WMUs cover the majority of CAOC 15/17, except for the wet well, and extend from near the upgradient boundary down to the downgradient edge of the CAOC.

The CRWQCB does not agree with DON's proposed use of the "point of compliance," but the CRWQCB is not contesting its use in this case, because DON has installed a groundwater monitoring network throughout the groundwater plume area and agrees to meet groundwater cleanup standards at all monitoring points within the network mutually agreed upon in the post-ROD groundwater monitoring plan. The DON has also agreed to install vadose zone monitoring networks in soils underlying CAOC 26 and Warehouse 2, and meet the vadose zone cleanup standard specified in Section 2.8.4

The DON is not designating "points of compliance" for CAOCs 6, 16, 26, and Warehouse 2 solely in the interest of obtaining the concurrence of EPA, DTSC, and the RWQCB on this ROD. The DON's agreement to comply with groundwater cleanup standards throughout the contaminant plume at these CAOCs is subject to the express reservation of its rights to propose the use of "points of compliance" for these areas in the future. The DON shall address such proposed "points of compliance" in explanation of significant differences (ESDs), ROD amendments, or new RODs that shall be submitted to the FFA signatories as a primary FFA deliverable. The FFA signatories agree that this decision will not set precedent for any other CAOCs or installations.

2.8.3 Vadose Zone Cleanup Standards

The DON and regulatory agencies have jointly determined the amount of vadose zone cleanup necessary to protect human health and environment. Unlike surface soil contamination, vadose zone contamination does not constitute a "walk-on" health risk (e.g., through direct soil contact) to a human receptor unless the contaminated soil becomes exposed by human activity (e.g., excavation). Surface soil contamination and the associated walk-on risk is addressed in the soil OUs (i.e., OUs 3 to 6).

The RAO for vadose zone cleanup at MCLB Barstow is to remove contaminant mass in the subsurface soils to the degree necessary to 1) prevent further degradation of the groundwater above groundwater cleanup standards and 2) minimize the aquifer cleanup time. Vadose zone soils cleanup goals are source-specific.

Vadose zone sources at the Yermo Annex include CAOCs 15/17, 16, 23, 26 and 35. Vadose zone remedial actions for these sources are discussed in detail in Section 3.3.2. Vadose zone sources at the Nebo Main Base include Warehouse 2 in the Nebo North area and CAOC 6 at the Nebo South area. Vadose zone remedial actions for these sources are discussed in detail in Sections 4.3.2. and 5.3.2 for Nebo North and Nebo South respectively.

Vadose zone cleanup using AS/SVE technology has been selected as part of the remedy for CAOC 26 and Warehouse 2. Criteria for assessing attainment of vadose zone cleanup goals at these sources are discussed in Sections 2.8.4 through 2.8.6 below.

2.8.4 Criteria for "Shut-off" of AS/SVE Systems

AS/SVE systems used to remove VOCs from vadose zone and groundwater at MCLB Barstow will be operated until one of the following two conditions are 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 pump and treat.

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) (using a mixing zone extending to a depth of 10 feet below the water table). If it is demonstrated that soil gas concentrations of chemicals of concern (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 CRWQCB'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 CRWQCB asserts that the Marine Corps' 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 CRWQCB 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 seven 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 the cost of groundwater pump and treat will be significantly more if AS/SVE is discontinued;

5. Whether discontinuing the AS/SVE will significantly prolong the time to attain the groundwater cleanup standard;

6. 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; and

7. Historic data that present the groundwater pump and treat system operating costs per unit of VOC mass removed from the groundwater and the concurrent 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.

2.8.5 Vadose Zone and Groundwater Modeling to Determine AS/SVE System "Shut Off"

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 Barstow.

2.8.6 Determination of Asymptotic Conditions for "Shut Off" 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:

$$M(t) = Sum(M_i) = K_T\,(1 - e^{(-t/T)})$$

Where:

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

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

K_T = 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% of KT (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 = Any time 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_T - 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 2.8.4 of this ROD.

2.8.7 Approach to Groundwater and Vadose Zone Cleanup at CAOC 16

CAOC 16 is a large active industrial facility (approximately 60 acres) with a high concentration of industrial activities, equipment and structures. The RAO for groundwater cleanup shall be to achieve and maintain compliance with the groundwater cleanup standards throughout the groundwater contaminant plume. The groundwater RAO will be achieved through continued operation of the Yermo Annex plume groundwater pump and treat system and the AS/SVE system downgradient of CAOC 16. These systems serve the dual purpose of treating the contaminated groundwater to achieve MCLs and containing the contaminated groundwater while the treatment is occurring. Institutional controls will also be implemented to prevent access to the contaminated groundwater until cleanup standards are achieved.

Vadose zone contamination beneath CAOC 16 has not been fully characterized because of the physical limitations posed by the structures and base operational activities covering the site. These limitations and logistical problems, partially demonstrated during construction and implementation of a small-scale AS/SVE pilot study system for Building 573 in 1994, are documented in the OUs 1 and 2 Feasibility Study for MCLB Barstow (Jacobs 1997) and include:

- High density of mission-critical operations (over 90% of CAOC area) with very limited free space available to construct and accommodate treatment system and equipment.
- Operational impacts, potential losses, and competitive consequences of down time.
- Numerous underground utilities (electrical, communication, sewer, water, gas) located throughout the building footprint.
- Inadequate access and vertical clearance inside Building 573 to accommodate large drilling equipment required.

Due to the above conditions, alternatives designed to address the vadose zone contamination directly under CAOC 16 (i.e., horizontal and vertical AS/SVE systems) were determined to be extremely costly and logistically difficult, yet limited in terms of the incremental risk reduction and protection to human health and the environment.

Despite the uncertainties at CAOC 16, the DON believes the selected remedy for the Yermo Annex outlined in Section 3.7 of this ROD will effectively achieve the groundwater cleanup goals. Therefore, the DON is willing to agree to achieve the groundwater cleanup standards throughout the contaminant plume solely in the interest of obtaining the concurrence of EPA, DTSC, and the RWQCB on this ROD, but reserves its right to propose a point of compliance (POC) for this CAOC at a later date as set forth in Section 2.8.2.

At EPA's request, the DON will install nested soil vapor monitoring probes beneath Building 573 at three locations agreed to with the regulatory agencies. The vapor probes will be installed at shallow, intermediate and deep depths. Data from the three soil vapor probe locations will be taken initially to establish a baseline, and on an annual basis thereafter. Data will be submitted on an annual basis as part of the groundwater monitoring report (see Section 2.8.12). The monitoring frequency may be modified as appropriate as determined by the FFA signatories.

Evaluation of the progress of the selected remedy in meeting groundwater cleanup standards shall occur every 5 years as an FFA deliverable attached to the CERCLA Section 121(c) 5-year review report. The 5-year progress evaluation shall specifically consider the CAOC 16 groundwater monitoring well and vapor probe data. The signatory parties to this ROD will jointly evaluate whether the groundwater monitoring well and vapor probe data demonstrate that adequate progress is being made towards meeting cleanup goals at CAOC 16. If the FFA signatories determine that the remedial action is not resulting in adequate progress, the DON shall prepare a follow-up FFA deliverable report to be submitted to the FFA signatories addressing the following subjects.

a) The potential need for additional remedial action at CAOC 16 (with supporting rationale, analysis, and documentation).

b) An evaluation of the technical and economic feasibility of further investigation and remediation beneath Building 573 and the Building 573 hardstand to meet the RAO. This feasibility analysis will identify and evaluate one or more approaches to adequately characterize and remediate CAOC 16. The analysis shall evaluate the approaches against the nine NCP criteria: overall protection of human health and the environment;

compliance with ARARs; long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; cost; state acceptance; and community acceptance. Evaluation of the implementability shall specifically include the impact of the approaches on Base operations, and any relevant technological advances. Discussion of the overall protection of human health criteria should include consideration of changes in land use. The evaluation of community acceptance shall specifically include social and economic impacts that the approaches may have on the surrounding community. Such impacts may include the consequences of any related degradation in the economic viability and competitiveness of MCLB Barstow.

c) Whether the basis for a CERCLA Section 121(d)(4)(C) "Technical Impracticability" waiver from attaining MCLs has been established (with supporting rationale, analysis, and documentation).

If appropriate, the agencies may request amendment of the OUs 1 and 2 ROD in accordance with paragraph 7.10 of the FFA.

2.8.8 Approach for Groundwater and Vadose Zone Cleanup at CAOC 26

CAOC 26 encompasses a packaging and maintenance shop and the area around it. Significant vadose zone and groundwater contamination was detected at this CAOC. Contamination at this CAOC has been contained, and source reduction via AS/SVE is ongoing as part of a NTCRA. Pump and treat remediation enhanced with AS/SVE has been selected as the final remedy which is already in place. The pump and treat and AS/SVE systems will be operated until RAOs for groundwater and vadose zone cleanup are achieved.

Achievement of the RAO for vadose zone cleanup will be demonstrated through sampling of the soil vapor probes already in place at this CAOC. The AS/SVE system will be operated until shut-off criteria set forth in Section 2.8.4 of this ROD are met. Achievement of the groundwater RAO will be demonstrated through sampling of compliance groundwater monitoring wells agreed upon by all parties. The DON will submit an FFA primary document to demonstrate that the RAOs have been achieved.

Despite agreeing to achieve the groundwater cleanup standards throughout the contaminant plume at CAOC 26, the DON reserves its right to propose a POC for this CAOC at a later date as set forth in Section 2.8.2.

2.8.9 Approach for Groundwater and Vadose Zone Cleanup at Warehouse 2 (Nebo North Plume)

Warehouse 2 is the Old Repair Facility where major industrial operations took place from 1942 to 1961. Residual vadose zone VOC contamination has been detected underlying the location of three former UST sites. Source reduction at Warehouse 2 using AS/SVE has been selected as part of the final remedial alternative for Nebo North, which also includes natural attenuation of the groundwater contaminant plume and fail-safe pump-and-treat in the event that natural attenuation fails to contain the plume.

Vadose zone contamination at Warehouse 2 will be characterized to adequately design the AS/SVE system. The AS/SVE system will be installed at appropriate locations. Achievement of the RAO for vadose zone cleanup will be demonstrated through sampling of soil vapor probes to be installed upon completion of the remedial design characterization phase. The AS/SVE system will be operated until both the vadose zone and groundwater RAOs have been achieved within the source area, according to the AS/SVE shut-off criteria set forth in Section 2.8.4 of this ROD.

Achievement of the groundwater RAO will be demonstrated through sampling of compliance groundwater monitoring wells agreed upon by all parties. Natural attenuation of the groundwater plume will be monitored until groundwater RAOs are achieved throughout the entire contaminant plume. In the event that natural attenuation fails to make adequate progress towards achieving the groundwater cleanup standards, the pump-and-treat system will be operated as a backup system to enhance the remediation time and contain the contaminant plume. The DON will submit an FFA primary document to demonstrate that the RAOs have been achieved.

Despite agreeing to achieve the groundwater cleanup standards throughout the contaminant plume at Warehouse 2, the DON reserves its right to propose a POC for this area at a later date as set forth in Section 2.8.2.

2.8.10 Approach for Groundwater and Vadose Zone Cleanup at CAOC 6 (Nebo South Plume)

At CAOC 6, documented releases and disposal of solvents to the ground surface took place dating back to 1943. Groundwater and vadose zone contamination has been detected at this CAOC. A pilot study conducted to assess the feasibility of AS/SVE for source reduction yielded inconclusive results. In addition, additional characterization of the extent of soil and groundwater contamination is needed to support remedial action decisions. Therefore, an interim remedy was selected for the Nebo South plume.

Groundwater contamination will be contained by five off-Base groundwater extraction wells as an interim remedy. During the interim remedy period, Phase II of the AS/SVE pilot study, including additional characterization, will be conducted at this CAOC. The DON will submit an FFA deliverable to document the results of these studies (see Section 2.8.12). Determination of RAOs will be deferred until the final ROD for the Nebo South Plume.

2.8.11 Remedial Approach for Groundwater at CAOCs 23, 35, and 15/17

At CAOCs 23 and 35 waste will be left in place and contained. The waste will be capped and monitored in accordance with ARARs and the presumptive remedy for CERCLA landfills. The majority of waste residues from the lined ponds at CAOC 15/17 have been removed and the ponds closed in conformance with RWQCB Toxic Pit Closure Act (TPCA) requirements. Vadose zone cleanup will not be conducted at these WMUs.

Groundwater RAOs for these WMUs will be achieved through continued operation of the Yermo Annex plume groundwater pump and treat system. When groundwater RAOs are attained at and beyond the point of compliance, remedial action will be considered complete. Evaluation of progress to attain the groundwater RAOs (i.e., MCLs at and downgradient of the point of compliance) shall occur every 5 years, as an FFA deliverable attached to the CERCLA Section 121(c) 5-year review report. The evaluation of progress will be measured at agreed upon monitoring wells located as close as practical to the downgradient edge of the WMUs. When MCLs are achieved at the downgradient edge of the WMUs, the remedial action for these CAOCs will be considered complete.

2.8.12 Initial Groundwater and Vadose Zone Primary FFA Deliverable

The DON will submit to the agencies, as the first primary FFA deliverable, a summary of all groundwater and vadose zone monitoring within 24 months of the signing of this ROD. This document will consolidate the vadose zone and groundwater data to be collected from the OUs 1 and 2 source areas (including CAOCs 16, 15/17 and 26 at the Yermo Annex and Warehouse 2 and CAOC 6 at the Nebo Main Base) during the initial ROD implementation period into a single deliverable. These data will be used to address the specific objectives of each CAOC, as follows:

CAOCs 16 (see Section 3.3.2):

- As requested by EPA, data collected from the soil vapor monitoring probes for use during the 5-year review evaluation.

CAOCs 15/17 (see Section 3.3.2):

- As requested by EPA, data collected from the wet well for use during the 5-year review evaluation.

CAOC 26 (see Section 3.3.2):

- Evaluate need for shallow vadose zone SVE wells to enhance the cost-effectiveness of the remediation system.

Warehouse 2 (see Section 4.3.2):

- Characterization of extent of vadose zone contamination underlying Warehouse 2, to be assessed during the AS/SVE remedial design phase for the Nebo North plume.
- Determination of cost effective AS/SVE system design requirements.
- Results of additional groundwater monitoring taken up to that time, designed to support that natural attenuation is occurring at the Nebo North plume.

CAOC 6 (See Section 5.3.2):

- Additional characterization of the extent of vadose zone and groundwater contamination underlying CAOC 6.
- Evaluation of the technical feasibility of AS/SVE to effectively cleanup contaminants in vadose zone and groundwater thereby reducing the cleanup time.
- Determination of radius of influence of AS/SVE system.
- Estimate of the amount of VOC mass in soil and groundwater, time for plume cleanup, and cost of full-scale AS/SVE system implementation.
- Recommendations regarding AS/SVE system capability, and other technologies which may be more effective if AS/SVE is deemed technically not feasible.

After this initial primary FFA deliverable, monitoring data from groundwater monitoring wells and soil vapor probes will be submitted on an annual basis as part of the annual groundwater monitoring report.

2.9 National Contingency Plan Statutory Balancing Criteria

Section 121 of CERCLA and Section 300.430 of the NCP requires that remedial alternatives be evaluated to determine which alternative provides the best balance with respect to criteria in Section 121 of CERCLA and Section 300.430 of the NCP.

The NCP categorized the nine evaluation criteria, discussed in detail in the Draft Final FS for OUs 5 and 6 (Jacobs 1996a), into three groups.

1) **Threshold Criteria** address overall protection of human health and the environment, compliance with ARARs (or invoking a waiver).

2) **Primary Balancing Criteria** address long-term effectiveness and performance; reduction of toxicity, mobility, or volume; short-term effectiveness; implementability, and cost. These primary balancing factors are used to weigh major trade-offs among alternative remediation strategies.

3) **Modifying Criteria** address state and community acceptance that are formally taken into account after public comment is received on the Proposed Plan and incorporated in the ROD.

The selected alternative must meet the threshold criteria of protection of human health and the environment and compliance with all ARARs. Any alternative that does not satisfy both of these requirements is not eligible for selection. The primary balancing criteria are the technical criteria upon which the detailed analysis is primarily based. The final two criteria, known as modifying criteria, assess the public's and the state agency's acceptance of the criteria. The Marine Corps may modify aspects of a specific alternative based upon these criteria.

2.10 Applicable and Relevant or Appropriate Requirements

The NCP states, "Overall protection of human health and the environment and compliance with ARARs (unless a specific ARAR is waived) are threshold requirements that each alternative must meet in order to be eligible for selection" (EPA 1990a).

Identification of ARARs is a site-specific determination. It involves determining whether a given requirement is applicable and if it is not applicable, then whether it is relevant and appropriate.

A requirement is deemed applicable if the specific terms of the law or regulation directly address the chemical of concern, the remedial action, or the location involved (e.g., cultural or environmental resources). If the jurisdictional prerequisites of the law or regulation are not met, a legal requirement may nonetheless be relevant and appropriate if the site's circumstances are sufficiently similar to circumstances in which the law otherwise applies, and if the requirement is well suited to the conditions of the site.

Where ARARs do not exist, the NCP also provides agency advisories, criteria, or guidance to be considered (TBC) useful in helping to determine what is protective at the site or how to carry out certain actions or requirements (EPA 1990a) (55 Federal Register 8745). The NCP preamble states, however, that provisions in the TBC category "should not be required as cleanup standards because they are, by definition, generally neither promulgated nor enforceable, so they do not have the same status under CERCLA as do ARARs."

As the lead federal agency, the Marine Corps has primary responsibility for identifying federal ARARs at MCLB Barstow. As the lead state agency, DTSC is primarily responsible for identifying state ARARs. MCLB Barstow initiated this process and the DTSC forwarded this request to several state agencies. Responses were received from the California Department of Health Services, the RWQCB, California Department of Fish and Game, and the California Integrated Waste Management Board. The ARARs presented in this response have been reviewed and included in the ARARs evaluation conducted in Appendix D of the FS Report for OUs 1 and 2 (Jacobs 1996a).

In addition, MCLB Barstow identified state ARARs in the Environmental Evaluation/Cost Analysis (EE/CA) for the OU 1 removal action (Jacobs 1995c). Comments were received from EPA Region IX and the California Regional Water Quality Control Board, Lahontan Region. These comments and additional state ARARs that were identified were also included in the ARARs evaluation in Appendix D of the FS Report for OUs 1 and 2.

Requirements of ARARs and TBCs are generally divided into three categories:

- **Chemical-specific ARARs** are health- or risk-based numerical values for various environmental media, specified in state or federal statutes or regulations. These numerical values establish the acceptable amount or concentration of a chemical that may be present in a specific medium at a site, or that may be discharged to the site or the ambient environment during remedial actions.
- **Location-specific ARARs** address the areas in which the remedial action takes place. Identified regulations that are potential ARARs may require actions to preserve or protect aspects of environmental or cultural resources that may be threatened by the remedial actions to be undertaken at the site.

- **Action-specific ARARs** are regulations that apply to specific activities or technologies used to remediate a site. They can include design criteria and performance standards.

Chemical-specific, location-specific, and action-specific ARARs driving the development of remedial actions objectives (RAOs) for groundwater and vadose zone soils at MCLB Barstow are discussed in the sections that follow and summarized in Tables 2-2 through 2-7. A detailed discussion of all the ARARs considered for groundwater remedy are included in the FS Report for OUs 1 and 2 (Jacobs 1996a).

2.10.1 Chemical-Specific ARARs Driving Remedial Action Objectives

Based on the above discussion and the evaluation presented in the FS for OUs 1 and 2, the substantive provisions of the following requirements have been identified as chemical-specific ARARs driving the development of remedial action objectives for the contaminant plumes in OUs 1 and 2:

- Water Quality Control Plan (WQCP) for the Lahontan Region, 1995 (water quality objectives, beneficial uses, waste discharge limitations).
- Federal maximum contaminant levels (MCLs) and nonzero maximum contaminant level goals (MCLGs).
- State primary MCLs in Title 22 CCR.
- Resource Conservation and Recovery Act (RCRA) groundwater protection standards in Title 22 CCR Sections 66264.94(a)(1), (a)(3), (c), (d), and (e).

Of these requirements, the most stringent are the requirements under the RCRA groundwater protection standards and Title 22 CCR Section 66264.94 to restore affected groundwater to background conditions or the best water quality that is reasonable if background levels of water quality cannot be achieved.

The Department of the Navy (DON) has determined that the substantive provisions of Title 22 CCR Section 66264.94(a)(1), (a)(3), (c), (d), and (e) constitute 'relevant and appropriate' federal ARARs for groundwater and vadose zone (i.e., the unsaturated zone) contamination associated with the Yermo groundwater plume (CAOCs 15/17,16,23,26 and 35) and the Nebo North (Warehouse 2) and South (CAOC 6) plumes. It is noted that the requirements at Title 23 CCR Division 3 Chapter 15 Article 5 are applicable for the inactive waste management units at CAOCs 23 and 35 (landfills) and the majority of CAOC 15/17 (surface impoundments). However, the Title 23 CCR requirements are not ARARs because they are no more stringent than relevant and appropriate federal ARARs at 22 CCR. The substantive provisions of Title 22 CCR 66264.94 are considered to be relevant and appropriate for this remedial action and are federal ARARs because they are federally enforceable (55 Federal Register 8765, March 8, 1990).

DON's Position Regarding SWRCB Resolution Nos. 92-49 and 68-16

The DON recognizes that the key substantive requirements of 22 CCR 66264.94 (and the identical requirements of 23 CCR 2550.4 and Section III.G of State Water Resources Control Board [SWRCB] Resolution 92-49) require cleanup to background levels of constituents unless such restoration proves to be technologically or economically infeasible and an alternative cleanup level of constituents 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 Code of Federal Regulations (CFR) 264.94 and, although they are 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 Resolution 68-16 is not a chemical-specific ARAR for determining remedial action goals. However, SWRCB Resolution 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 Resolution 68-16. More specifically, the language of Resolution 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 Resolutions 68-16 and 92-49 and 22 CCR 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 22 CCR 66264.94. The NCP set forth in 40 CFR 300.400(g) provides that only state standards more stringent than federal standards may be ARARs (see also Section 121(d)(2)(A)(ii) of CERCLA). The determination of which regulations constitute ARARs is documented in Appendix D of the FS Report for OUs 1 and 2 (Jacobs 1996a).

The substantive technical standard in the equivalent state ARARs (i.e., Title 23 CCR, Chapter 15, SWRCB Resolution 92-49, and SWRCB Resolution 68-16) is identical to the substantive technical standard in 22 CCR Section 66264.94. This section of Title 22 CCR will likely be applied in a manner consistent with equivalent provisions of other regulations, including SWRCB Resolutions 92-49 and 68-16.

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

The State does not agree with the Marine Corps' determination that SWRCB Resolutions 92-49 [and 68-16] and certain provisions of Title 23 CCR, Division 3, Chapter 15 are not ARARs for this ROD. However, the State agrees that actions proposed in this ROD would comply with Resolutions 92-49 [and 68-16] and compliance with the Title 22 provisions should result in compliance with the Title 23 provisions. The State does not intend to dispute the ROD, but reserves its rights if implementation of the Title 22 CCR provisions is not as stringent as State implementation of Title 23 CCR provisions. Because Title 22 CCR regulation is part of the State's authorized hazardous waste control program, it is also the State's position that Title 22 CCR 66264.94 is a State ARAR and not a federal ARAR (U.S. v. State of Colorado, 990 F.2d 1565, [1993]).

Whereas the DON and the State of California have not agreed on whether SWRCB Resolution Nos. 92-49 and 68-16 and Title 23 CCR Section 2550.4 are ARARs for the remedial action at the Yermo plume and the Nebo North and

South plumes, this ROD documents each of the parties' positions on the resolutions but does not attempt to resolve the issue.

2.10.2 Location-Specific ARARs

Location-specific requirements include those that involve restrictions on how remedial activities are to be conducted in particular locations. CAOC 6 is near a robust creosote community that is home to a significant population of desert tortoise. Because the desert tortoise is an endangered species, requirements pertaining to the protection of special-status species are ARARs as listed in Table 2-4.

2.10.3 Action-Specific ARARs

Action-specific requirements for OUs 1 and 2 were identified for waste generation, potential air emissions, discharge of treated water, and groundwater monitoring for RCRA landfill closure. These action-specific ARARs are listed in Tables 2-6 and 2-7. The following discussion expands on the groundwater monitoring requirements for CAOCs 23 and 35.

Landfill Closure Groundwater Monitoring Requirements

To promote efficiency in the implementation of groundwater monitoring requirements for MCLB remedial actions, this ROD addresses the groundwater monitoring component of the landfill closure requirements for CAOCs 23 and 35. Federal and State requirements that pertain to groundwater monitoring for RCRA corrective action programs are described below.

Federal

As discussed in Section 2.10.1, portions of the RCRA groundwater protection standards contained in Title 22 CCR are considered to be relevant and appropriate for the groundwater potentially impacted by releases from CAOCs 23 and 35 because the hazardous constituents being addressed by this action are similar or identical to those found in RCRA hazardous wastes. The substantive requirements of a corrective action program (CAP) is required for CAOCs 23 and 35 under 22 CCR 66264.100 and an evaluation monitoring program under 22 CCR 66264.99 is required to demonstrate effectiveness and compliance. Substantive provisions of the following requirements apply to the development and implementation of a groundwater monitoring program for CAOCs 23 and 35:

- Constituents of concern (22 CCR 66264.93)
- Concentration limits (22 CCR 66264.94)
- Monitoring points and points of compliance (22 CCR 66264.95)
- Detection monitoring program (22 CCR 66294.98)
- Statistical method for detecting a release (22 CCR 66264.97[e])
- Method for determining background (22 CCR 66264.97[e][11]).

State

The RWQCB Lahontan region identified the following requirements for the development of a CAP monitoring program for landfill closure:

- Constituents of concern (23 CCR 2550.3)
- Concentration limits (23 CCR 2550.4)
- Monitoring points and points of compliance (23 CCR 2550.5)
- Detection monitoring program (23 CCR 2550.8)
- Statistical method for detecting a release (23 CCR 2550.7[e])
- Method for determining background (23 CCR 2550.7[e][11]).

The Marine Corps has reviewed these provisions and has determined that they are identical to the corresponding Title 22 Federal ARARs, except for the more prescriptive sampling requirements found in 23 CCR 2550.7(e)(12)(B) and 23 CCR 2550.10(g)(2). The Marine Corps accepts the more prescriptive requirements of 23 CCR 2550.7(e)(12)(B) and 2550.10(g)(2) as State ARARs.

However, the other Title 23 requirements cited are not ARARs for OU 1 and OU 2 remedial actions because they are not more stringent than the Federal ARARs identified under Title 22.

Conclusions

The Federal requirements for CAP monitoring under Title 22 Article 6 are equivalent to the State requirements for CAP monitoring under Title 23 Article 5. Because State requirements would only be considered ARARs to the extent that they are more stringent than Federal requirements, the Title 22 requirements for CAP monitoring would be the controlling ARARs for remedial actions at CAOCs 23 and 35. The exceptions are the more prescriptive sampling requirements found in 23 CCR 2550.7(e)(12)(B) and 2550.10(g)(2). The Marine Corps accepts the more prescriptive requirements of 23 CCR 2550.7(e)(12)(B) and 2550.10(g)(2) as State ARARs.

2.11 Highlights of Community Relations and Participation

The community of Barstow is kept well informed about the MCLB Barstow remedial actions for soils and groundwater under the CERCLA program. The remedial investigation/feasibility study (RI/FS) and the Proposed Plan for MCLB Barstow OUs 1 and 2 were released to the public on November 3, 1997. The documents were made available to the public through the Administrative record (Appendix B) contained in the information repositories at the County of San Bernardino Public Library, Barstow Branch, and at MCLB Barstow Facilities and Services Division, Environmental Department, Warehouse 3. The notice of availability for the Proposed Plan the supporting documents were published in the *Barstow Desert Dispatch*, the *Sun* (San Bernardino), and the *Daily Press* (Victorville), on November 3, 1997. Also, the Proposed Plan was mailed to approximately 1,500 local and interested parties per the site mailing list. A public comment period was held from November 3 through December 3, 1997. A public meeting was held at the Barstow Holiday Inn on November 12, 1997. Several minor comments were received from the public during the public comment period. Transcripts from the meeting, which include the public comments are contained in Appendix C.

Table 2-1
Operable Units 1 & 2 Contaminants of Concern Groundwater Cleanup Levels (µg/L)

Contaminant	Basis for Goal		TBC RBCs[b]	
	Drinking Water Standard[a]	Reference	Cancer	Non-Cancer
1,1,1- Trichloroethane	200	1, 2		
1,1-Dichloroethane	5	2		
1,1-Dichloroethene (1,1-DCE)	6	2		
1,1,2-Trichloro-1,2,2-Trifluoroethane (Freon 113)	1200	2		
1,2-Dichloroethane (1,2-DCA)	0.5	2		
cis-1,2-Dichloroethene (cis-1,2-DCE)	6	2		
trans-1,2-Dichloroethene (trans-1,2-DCE)	10	2		
1,2-Dichloroethene, Total	6	2		
2-Butanone (MEK)	N	N	N	1,900
2-Hexanone	N	N	N	N
4-Methyl-2-Pentanone (Methyl Isobutyl Ketone)	N	N	N	160
Acetone	N	N	N	610
Benzene	1	2		
Bromodichloromethane	100	1		
Bromoform	100	1		
Carbon Disulfide	N	N	N	21
Carbon Tetrachloride	0.5	2		
Chloroform	100	1		
Chloromethane	N	N	1.5	
Dibromochloromethane	100	1		
1,2-Difluoro-1,1,2,2-Tetrachloroethane (Freon 112)	N	N	N	N
1,2-Dichloro-1,1,2,2-Tetrafluoroethane (Freon 114)	N	N	N	N
Methylene Chloride	5	1		
Tetrachloroethene (PCE)	5	1, 2		
Toluene[c]	42[c]	O		
Trichloroethene (TCE)	5	1, 2		
Trichlorofluoromethane (Freon 11)	150	2		
Xylenes (Total)[c]	17[c]	O		

Footnotes:
a Most stringent of federal and state MCL
b To be considered (TBC) risk-based criteria (RBC) where drinking water standard is not available. Source: EPA Region IX Preliminary Remediation Goals, August 1, 1996.
c DON agrees to implement taste and odor objectives for toluene and xylene proposed by EPA, but not promulgated, as "to-be-considered" standards (See Section 2.8.1)

References
1 - Federal MCL
2 - State MCL
N - None
O - Other

TABLE 2-2
Federal Chemical-Specific ARARs
Operable Units 1 and 2
MCLB Barstow, California

Requirement	Prerequisite	Citation	ARAR Determination	Comments
Safe Drinking Water Act (SDWA), 42 USC 300*				
National primary drinking water standards are health-based standards for public water systems (maximum contaminant levels [MCLs]).	Public water system.	40 CFR 141.11 - 141.16, excluding 141.11(d)(3); 40 CFR 141.60 -141.63	Relevant and appropriate for groundwater	The National Oil and Hazardous Substance Pollution Contingency Plan (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.
Maximum contaminant level goals (MCLGs) pertain to known or anticipated adverse health effects (also known as recommended maximum contaminant levels).	Public water system.	Public Law No. 99-339 100 Statute 642 (1986) 40 CFR 141 Subpart F	Relevant and appropriate for groundwater	MCLGs that have nonzero values are relevant and appropriate for groundwater determined to be a current or potential source of drinking water (40 CFR 300.430[e][2][i][B] through [D]). Groundwater in the vicinity of the MCLB Barstow has been designated for drinking water use. Nonzero MCLGs exist for some of the chemicals of potential concern for OUs 1 and 2.
Definition of RCRA hazardous waste; TCLP regulatory levels.	Waste generation.	22 CCR 66261.21, 66261.22(a)(1), 66261.23, 66261.24(a)(1), and 66261.100	Applicable	Hazardous waste determinations are needed for extracted groundwater being generated for storage, treatment, or disposal.
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 the 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.	Uppermost aquifer underlying a waste management unit beyond the point of compliance; RCRA hazardous waste, treatment, storage, or disposal.	22 CCR 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 the OUs 1 and 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.
Preliminary Remediation Goals (PRGs) for tap water.		U.S. EPA Region 9, August 1, 1996	To Be Considered	These PRGs are used for cleanup for the COCs that do not have MCLs.

TABLE 2-2
Federal Chemical-Specific ARARs
Operable Units 1 and 2
MCLB Barstow, California

* 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 Navy accepted the statutes or policies as potential ARARs. Specific potential ARARs are addressed in the table below each general heading; only substantive requirements of the specific citations are considered potential ARARs.

ARARs	Applicable or relevant and appropriate requirements	RCRA	Resource Conservation and Recovery Act
CCR	California Code of Regulations	SDWA	Safe Drinking Water Act
MCLs	Maximum contaminant levels	TCLP	Toxicity characteristics leaching procedure
MCLGs	Maximum contaminant level goals	USC	United States Code
NCP	National Oil and Hazardous Substance Pollution Contingency Plan		

Chemical-specific concentrations used for feasibility study (FS) 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 CFR 300.430[e][A][1] and [2]).
- Ecological risk-based concentrations (40 CFR 300.430[e][G]).
- Practical quantitation limits of contaminants (40 CFR 300.430[e][A][3]).

TABLE 2-3
State Chemical-Specific ARARs
Operable Units 1 and 2
MCLB Barstow, California

Requirement	Prerequisites	Citation	ARAR Determination	Comments
Cal/EPA Department of Toxic Substances Control (DTSC)*				
Definition of "Non-RCRA hazardous waste"; persistent and bioaccumulative toxic substances total threshold limit concentrations (TTLCs) and soluble threshold limit concentrations (STLCs).	Waste generation.	22 CCR 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	The chemical concentrations in all of the OU 1 and 2 monitoring wells are below the STLC limits; therefore the extracted groundwater would not be considered a characteristic hazardous waste. Hazardous waste determinations for soil cutting generated from the installation of extraction, conveyance and treatment systems and spent carbon from groundwater and off-gas treatment will be made at the time the wastes are generated.
State maximum contaminant level (MCL) list.		22 CCR 64435 and 64444.5	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 (SWRCB) and Regional Water Quality Control Board (RWQCB)*				
Describes the water basins in Lahontan region. Establishes beneficial uses of ground and surface waters. Establishes water quality objectives, including narrative and numerical standards. Establishes implementation plans to meet water quality objectives and protect beneficial uses, and incorporates statewide water quality control plans and policies.		Comprehensive Water Quality Control Plan for the Lahontan (Water Code 13240)	Applicable	Substantive provisions in Chapters 2, 4, and 5 of the plan are ARARs, including beneficial use designations, water quality objectives, and water discharge limits.

* 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 Navy accepts all the statutes or policies as potential ARARs. Specific potential ARARs are addressed in the table below each general heading; only substantive requirements of specific citations are considered potential ARARs.

TABLE 2-3
State Chemical-Specific ARARs
Operable Units 1 and 2
MCLB Barstow, California

Requirement	Prerequisites	Citation	ARAR Determination	Comments
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.
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 CFR 131.12)	Applicable	Action-specific ARAR for regulating discharges of treated groundwater back into aquifer. Discharges to groundwater that occur as part of the OUs 1 and 2 remedial actions must meet the substantive requirements of Resolution 68-16. This resolution is only applicable to the treated water discharges and not to the cleanup of the groundwater or the potential migration of contaminant plumes.

* 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 Navy accepts all the statutes or policies as potential ARARs. Specific potential ARARs are addressed in the table below each general heading; only substantive requirements of specific citations are considered potential ARARs.

TABLE 2-3
State Chemical-Specific ARARs
Operable Units 1 and 2
MCLB Barstow, California

Requirement	Prerequisites	Citation	ARAR Determination	Comments
Establishes policies and procedures for the oversight of investigations and cleanup and abatement activities resulting from discharges of waste 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 Title 23 CCR Division 3, Chapter 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	As Resolution 92-49 is no more stringent than 22 CCR 66264.94, a relevant and appropriate federal ARAR, the resolution does not qualify as a state ARAR under CERCLA. The State does not agree with the Maine Corps' determination that SWRCB Resolutions 92-49 and 68-16 and certain provisions of Title 23 CCR, Division 3, Chapter 15 are not ARARs for this ROD. However, the State agrees that actions proposed in this ROD would comply with Resolutions 92-49 and 6816 and compliance with the Title 22 CCR provisions should result in compliance with Title 23 CCR provisions. The State does not intend to dispute the ROD, but reserves its rights if implementation of the Title 22 CCR provisions is not as stringent as State implementation of Title 23 CCR provisions.
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 RWQCB Resolution 6-93-106 [General Waste Discharge Requirements for Land Disposal of Treated Groundwater]	TBC	Discharge of treated groundwater to oxidation ponds or infiltration galleries would need to meet these discharge and monitoring requirements. See Table 2-_ for the treated groundwater discharge limitations.

ARARs	Applicable or relevant and appropriate requirements
CAOC	CERCLA Area of Concern
CCR	California Code of Regulations
CFR	Code of Federal Regulations
gpd	gallons per day
MC	Marine Corps
ppm	parts per million
PRG	preliminary remediation goal
RCRA	Resource Conservation and Recovery Act
RWQCB	Regional Water Quality Control Board, Lahontan Region
STLC	soluble threshold limit concentration
SWRCB	California State Water Resources Control Board
TBC	To be considered
TDS	total dissolved solids
TTLC	total threshold limit concentration

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 CFR 300.430(e)(A)(1) and (2)].

- Ecological risk-based concentrations [40 CFR 300.430(e)(G)].
- Practical quantitation limits of contaminants [40 CFR 300.430(e)(A)(3)].

TABLE 2-4
Federal Location-Specific ARARs
Operable Units 1 and 2
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 archaeologic data.	Substantive requirements of 16 USC 469a-1 and 36 CFR 65	ARAR	Phase I archeological 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	Action to conserve endangered species or threatened species, including consultation with the Department of the Interior.	Determination of effect upon endangered or threatened species or its habitat.	16 USC 1536(a)	Applicable	Desert tortoise mitigation measures will be followed during the implementation of remedial actions.
Migratory Bird Treaty Act of 1972*					
Migratory bird area	Protects almost all species of native birds in the U.S. from unregulated "take," which can include poisoning at hazardous waste sites.	Presence of migratory birds.	16 USC Section 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. Actions to be taken as part of OU 1 and 2 remedial alternatives are not expected to impact migratory bird activities.

* 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 Navy accepts the entire statutes or policies as potential ARARs. Specific potential ARARs are addressed in the table below each general heading; only substantive requirements of the specific citations are considered potential ARARs.

ARARs Applicable or relevant and appropriate requirements.
CFR Code of Federal Regulations.
CCR California Code of Regulations.
USC United States Code.

TABLE 2-5
State Location-Specific ARARs
Operable Units 1 and 2
MCLB Barstow, California

Location	Requirement	Prerequisites	Citation	ARAR Determination	Comments
Fish and Game Code*					
Endangered Species Habitat	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. 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 1 January 1985 or a candidate species with proper notification.	Fish and Game Code Section 1900, 2053, 2080	Relevant and appropriate	Actions to be taken as part of OU 1 and 2 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.

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TABLE 2-6
Federal Action-Specific ARARs
Operable Units 1 and 2
MCLB Barstow, California

Action	Requirement	Prerequisites	Citation	ARAR Determination**			Comments
				A	RA	TBC	
Safe Drinking Water Act (SDWA), 42 USC 300*							
Underground injection of wastes and treated groundwater	The underground injection control (UIC) program prohibits injection activities that allow movement of contaminants into underground sources of drinking water which may result in violations of MCLs or adversely affect health. Five classifications of injection wells provided.	Regulates underground injection of wastes to protect aquifers that are, or may reasonably be expected to be, a source of drinking water if the contaminant(s) may cause a violation of any primary drinking water regulation or may adversely affect human health.	Substantive requirements of 40 CFR 144, 145, 146, and 147 under the conditions noted in the comment.		5		The infiltration galleries proposed as part of the OU 1 remedial alternatives would be Class V wells under this rule since the infiltrated groundwater would not be a hazardous waste. There are currently no requirements for injection into Class V wells. Substantive provisions of these requirements are relevant and appropriate only to the extent necessary to ensure that the injection activities would not cause the water in the receiving aquifer to violate primary drinking water regulations.
Resource Conservation and Recovery Act (RCRA) 42 USC 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.	22 CCR 66262.10(a), 66262.11	4,5			Applicable for any operations where hazardous waste is generated.

* 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 Navy accepts all the statutes or policies as potential ARARs. Specific potential ARARs are addressed in the table below each general heading; only substantive requirements of the specific actions are considered potential ARARs.

** Potential actions: 1) Monitoring and access restrictions. 2) Groundwater extraction and conveyance. 3) *Ex situ* groundwater treatment via carbon adsorption or ozone/carbon. 4) OU 2 discharge of treated groundwater to oxidation ponds. 5) OU 1 discharge of treated groundwater to infiltration galleries. 6) OU 1 vapor extraction and air sparging.

TABLE 2-6
Federal Action-Specific ARARs
Operable Units 1 and 2
MCLB Barstow, California

Action	Requirement	Prerequisites	Citation	ARAR Determination**			Comments
				A	RA	TBC	
Discharge to groundwater from a regulated unit	Water Quality Monitoring Program. Owners/operators of RCRA treatment, storage, and disposal facilities must develop and implement a water quality monitoring program to monitor the potential for releases from the facility or to demonstrate the effectiveness of a corrective action program (CAP).	Uppermost aquifer underlying a waste management unit beyond the point of compliance; RCRA hazardous waste, treatment, storage, or disposal.	22 CCR Sections 66264.93; 66264.94, 66264.95, 66264.97(e), 66264.98, 66264.100		1		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.
Post-closure care, use of property, and plant	Requires monitoring and maintenance for 30 years unless it is demonstrated that human health and the environment are protected.		22 CCR 66264.117		1		The substantive requirements of these provisions are relevant and appropriate for groundwater monitoring of CAOCs 35 and 23.
Clean Air Act (CAA) 40 USC 7401 *et seq.**							
Discharge of organic solvents to the atmosphere	Emissions reduction by at least 85 percent. Exemptions are provided for emissions of photochemically reactive solvents that do not exceed 39.6 lb/day and for non-photochemically reactive solvents that do not exceed 2970 lb/day.	Discharge of organic materials into the atmosphere from equipment in which organic solvents or materials containing organic solvents are used.	Mojave AQMD Rule 442	3, 6			The maximum potential emissions for the vapor extraction and air sparging systems are below the limits set for solvents. Also, the emissions controls planned for these systems achieve greater than 85 percent reduction of VOC emissions.

* 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 Navy accepts all the statutes or policies as potential ARARs. Specific potential ARARs are addressed in the table below each general heading; only substantive requirements of the specific actions are considered potential ARARs.

** Potential actions: 1) Monitoring and access restrictions. 2) Groundwater extraction and conveyance. 3) *Ex situ* groundwater treatment via carbon adsorption or ozone/carbon. 4) OU 2 discharge of treated groundwater to oxidation ponds. 5) OU 1 discharge of treated groundwater to infiltration galleries. 6) OU 1 vapor extraction and air sparging.

TABLE 2-6
Federal Action-Specific ARARs
Operable Units 1 and 2
MCLB Barstow, California

Action	Requirement	Prerequisites	Citation	ARAR Determination[*]			Comments
				A	RA	TBC	
New source of discharge to air	Requirements for the preconstruction 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; facilities for which offsets are required to be obtained pursuant to Rule 1307; or for which the use of BACT is required (e.g., the potential to emit 25 pounds per day or more of any affected pollutant).	Mojave AQMD Rule 1301	3, 6			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. See text in Section C4.1.1 for further discussion of the applicability of this requirement to emissions controls for the vapor extraction and air sparging systems.
	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 AQMD Rules.	Equipment with the potential to cause issuance of air contaminants.	Mojave AQMD Rule 212	3, 6			The vapor extraction and air sparging 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 AQMD will take place as part of the remedial action review process.

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** Potential actions: 1) Monitoring and access restrictions. 2) Groundwater extraction and conveyance. 3) *Ex situ* groundwater treatment via carbon adsorption or ozone/carbon. 4) OU 2 discharge of treated groundwater to oxidation ponds. 5) OU 1 discharge of treated groundwater to infiltration galleries. 6) OU 1 vapor extraction and air sparging.

TABLE 2-6
Federal Action-Specific ARARs
Operable Units 1 and 2
MCLB Barstow, California

A	Applicable	ppm	parts per million
AQMD	Air Quality Management District	RA	Relevant and appropriate
ARAR	Applicable or relevant and appropriate requirement	RCRA	Resource Conservation and Recovery Act
BACT	Best available control technology	RWQCB	California Regional Water Quality Control Board, San Diego Region
CAA	Clean Air Act	SWRCB	California State Water Resources Control Board
CCR	California Code of Regulations	SDWA	Safe Drinking Water Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act	TBC	To be considered
CFR	Code of Federal Regulations	UIC	Underground injection control
EPA	U.S. Environmental Protection Agency	USC	United States Code
LAER	Lowest achievable emission rate	VOC	volatile organic compound
lb/day	pounds per day	$\mu g/m^3$	micrograms per cubic meter
MCLs	Maximum contaminant levels		

TABLE 2-7
State Action-Specific ARARs
Operable Units 1 and 2
MCLB Barstow, California

Action	Requirement	Prerequisites	Citation	ARAR Determination**			Comments
				A	RA	TBC	
State Water Resources Control Board (SWRCB) and Regional Water Quality Control Board (RWQCB)*							
Actions affecting water quality in Lahontan Region	Describes the water basins in the Lahontan region. Establishes beneficial uses of ground and surface waters. Establishes water quality objectives, including narrative and numerical standards. Establishes implementation plans to meet water quality objectives 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)	4,5 1,2,3, 4,5,6			Substantive provisions are ARARs for discharges of treated groundwater. See Table 2-__ for the treated groundwater discharge limitations. The water quality objectives for groundwater are applicable to groundwater cleanup.
Discharges to land or surface or groundwater that could affect water quality	Authorize the State and regional water boards to establish in water quality control plans 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 or surface oar groundwater that could affect water quality, including NPDES permits, and to take enforcement actions to protect water quality.		California Water Code, Division 7, Section 13241, 13243, 13360, and 13263(a) (Porter-Cologne Water Quality Control Act)	1			Substantive provisions of sections cited, as implemented through the beneficial use, water quality objectives, and waste discharge requirements of the Comprehensive Water Quality Control Plan for the Lahontan Region are ARARs for discharges to groundwater from CAOCs 23 and 35. Minimization of those discharges is addressed by the CAOCs 23 and 35 proposed remedial actions; however, past and current discharges to groundwater from CAOCs 23 and 35 will be addressed by the removal action planned for OU 1 groundwater and subsequent remedial actions for groundwater at MCLB Barstow.

* 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 Navy accepts all the statutes or policies as potential ARARs. Specific potential ARARs are addressed in the table below each general heading; only substantive requirements of the specific actions are considered potential ARARs.

** Potential actions: 1) Monitoring and access restrictions. 2) Groundwater extraction and conveyance. 3) *Ex-situ* groundwater treatment via carbon adsorption or ozone/carbon. 4) OU 2 discharge of treated groundwater to oxidation ponds. 5) OU 1 discharge of treated groundwater to infiltration galleries. 6) OU 1 vapor extraction and air sparging. 7) Cap/cover of CAOC 35 landfill.

TABLE 2-7
State Action-Specific ARARs
Operable Units 1 and 2
MCLB Barstow, California

Action	Requirement	Prerequisites	Citation	ARAR Determination**			Comments
				A	RA	TBC	
Leachate control and monitoring requirements for landfill closure	Leachate control and monitoring shall cease only after the operator demonstrates that leachate is not longer being produced or the discharges of leachate will have no affect on water quality. The quantity and quality of leachate must be monitored at least quarterly or whenever groundwater samples are collected.		14 CCR 17781(b)(1)(2)	1			14 CCR 17781(c)(2) cross-references the requirements of 23 CCR 2559 for design requirements for vadose zone monitoring to detect the release of leachate. However, Section 2559 was repealed 7/91, so no specific regulatory requirements exist for the design of the vadose zone monitoring system.
Groundwater monitoring requirements for landfill closure.	Detection and verification monitoring in accordance with 23 CCR, Chapter 15, Article 5, must be conducted. Groundwater monitoring during postclosure must continue until leachate is no longer being produced or opposes no threat to water quality.		14 CCR 17782(a) b)(d)	1			23 CCR, Chapter 15, Article 5, outlines requirements for identification of water quality protection standards, constituents of concern, concentration limits, monitoring points and point of compliance, and compliance period. It also has specifications for water quality monitoring and system requirements.
Discharges to high quality waters	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 of Waters in California)(Water Code §13140, Clean Water Act regulations 40 CFR §131.12)	4,5			Action-specific ARAR for regulating discharges of treated groundwater back into aquifer. Discharges to groundwater that occur as part of the OUs 1 and 2 remedial actions must meet the substantive requirements of Resolution 68-16. This resolution is only applicable to the treated water discharges and not to the cleanup of the groundwater or the potential migration of contaminant plumes.

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TABLE 2-7
State Action-Specific ARARs
Operable Units 1 and 2
MCLB Barstow, California

Action	Requirement	Prerequisites	Citation	ARAR Determination**			Comments
				A	RA	TBC	
Cleanup and abatement of wastes that affect or threaten water quality	Establishes policies and procedures for the oversight of investigations and cleanup and abatement activities resulting from the discharges of waste that affect or threaten water quality. It requires cleanup of waste discharged in a manner that promotes either background water quality or the best water quality that is reasonable if background levels of water quality cannot be achieved. Requires actions for cleanup and abatement to conform to Resolution 68-16 and applicable provisions of Title 23 CCR, Division 3, Chapter 15, as feasible.		SWRCB Resolution 92-49 (Policies and Procedures for Investigation and Cleanup and Abatement of Discharges Under Water Code Section 13304)				The DON has determined that SWRCB Resolution 92-49 does not constitute an ARAR for the OUs 1 and 2 remedial actions because its pertinent requirements are not more stringent than the ARAR provisions of Title 22 Section 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 Title 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 Title 22 CCR provisions is not as stringent as State implementation of Resolution 92-49.
Discharges of treated groundwater in the Lahontan Region	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 requirements are also specified.		Lahontan RWQCB Resolution 6-93-106 [General Waste Discharge Requirements for Land Disposal of Treated Groundwater]	4,5		TBC	Discharge of treated groundwater to oxidation ponds or infiltration galleries would need to meet substantive discharge and limits monitoring requirements. See Table 2-__ for the treated groundwater discharge limitations.

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TABLE 2-7
State Action-Specific ARARs
Operable Units 1 and 2
MCLB Barstow, California

Action	Requirement	Prerequisites	Citation	ARAR Determination**			Comments
				A	RA	TBC	
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.		Title 23 CCR, Division 3, Chapter 15, Article 5, Sections 2550.0(a), 2550.1(a)(1), 2550.4(d), (e), (f)				Not an ARAR; no more stringent than Title 22 CCR 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 compliance with the Title 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 Title 22 CCR provisions is not as stringent as State implementation of this ARAR.

* 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 Navy accepts all the statutes or policies as potential ARARs. Specific potential ARARs are addressed in the table below each general heading; only substantive requirements of the specific actions are considered potential ARARs.

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TABLE 2-7
State Action-Specific ARARs
Operable Units 1 and 2
MCLB Barstow, California

Action	Requirement	Prerequisites	Citation	ARAR Determination**			Comments
				A	RA	TBC	
	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 program.		Article 5, Sections 2550.3, 2550.4, 2550.5, 2550.7(e) except (e)(12)(B), 2550.8, 2550.10				Not ARARs; not more stringent than 22 CCR Sections 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 Title 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 Title 22 CCR provisions is not as stringent as State implementation of this ARAR.
			Article 5, Section 255.7 (e)(12) (B).	1			More stringent than Federal ARARs and applicable for groundwater and vadose zone monitoring.

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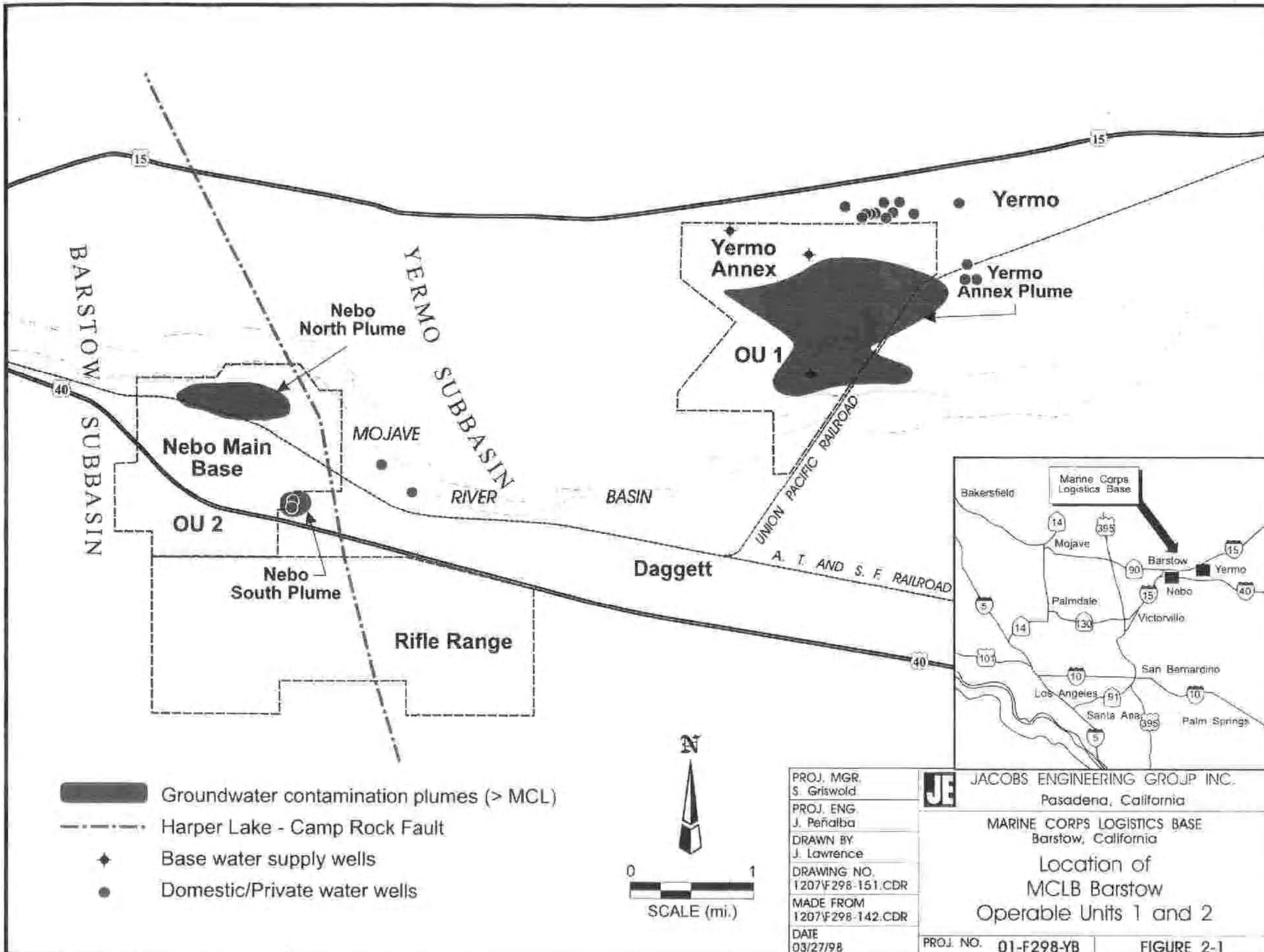
TABLE 2-7
State Action-Specific ARARs
Operable Units 1 and 2
MCLB Barstow, California

Action	Requirement	Prerequisites	Citation	ARAR Determination**			Comments
				A	RA	TBC	
California Water Code*							
Discharges to the waters of the state	Authorizes the regional board to prescribe the requirements under which a waste discharge may take place. These are referred to as Waste Discharge Requirements (WDRs).		California Water Code, Section 13263	4,5			CERCLA response actions taken entirely on site are exempt from permitting requirements. However, the OUs 1 and 2 remedial action design will incorporate valid ARARs derived from the substantive requirements of water quality control plans, taking into consideration the beneficial uses to be protected, the water quality objectives reasonably required for that purpose, other pertinent waste discharges, and the need to prevent.

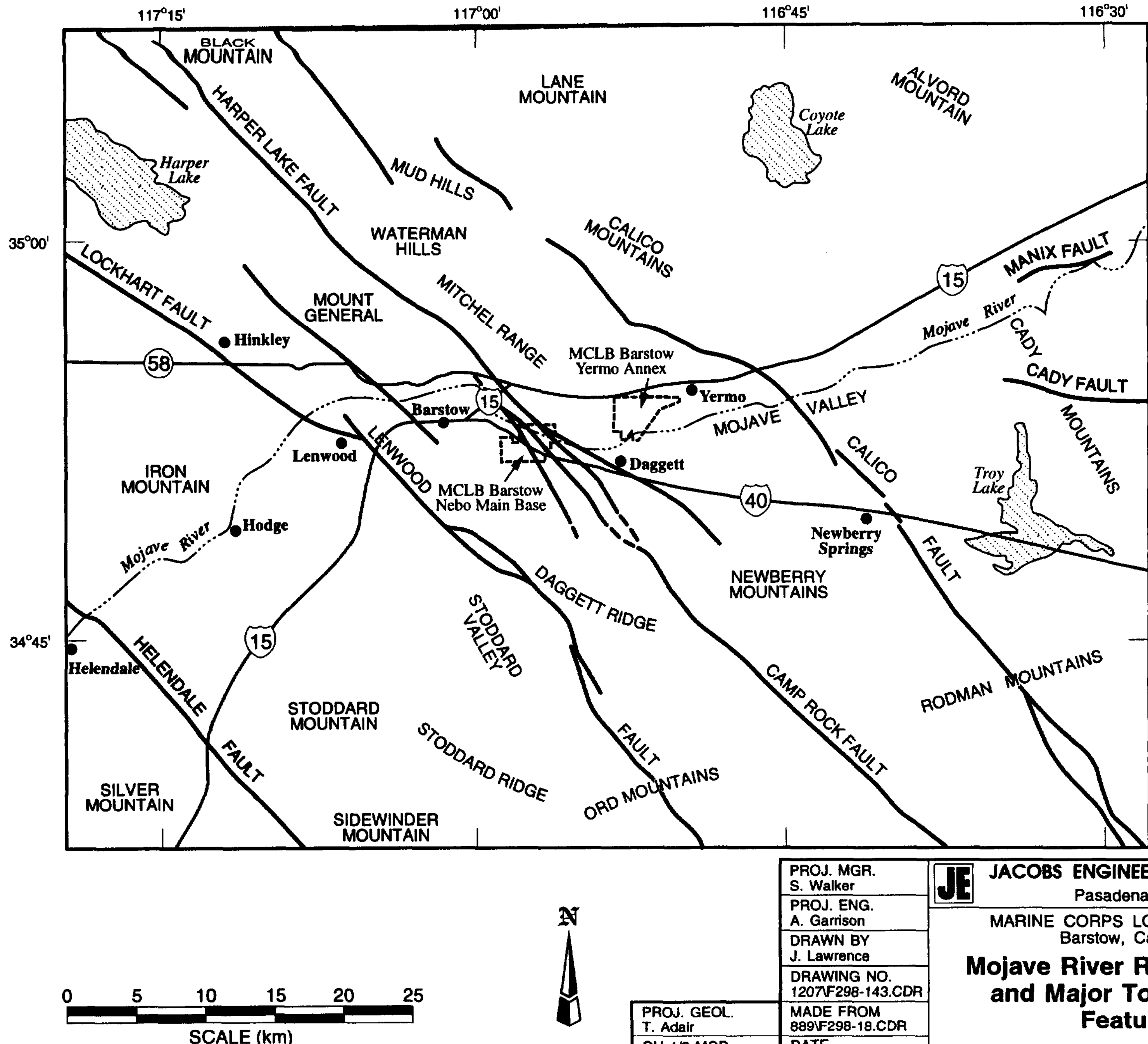
A — Applicable
ARAR — Applicable or relevant and appropriate requirement
CCR — California Code of Regulations
CERCLA — Comprehensive Environmental Response, Compensation, and Liability Act
CFR — Code of Federal Regulations
RA — Relevant and appropriate
RWQCB — California Regional Water Quality Control Board,
SWRCB — California State Water Resources Control Board, Lahontan Region
TBC — To be considered

* 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 Navy accepts all the statutes or policies as potential ARARs. Specific potential ARARs are addressed in the table below each general heading; only substantive requirements of the specific actions are considered potential ARARs.

** Potential actions: 1) Monitoring and access restrictions. 2) Groundwater extraction and conveyance. 3) *Ex-situ* groundwater treatment via carbon adsorption or ozone/carbon. 4) OU 2 discharge of treated groundwater to oxidation ponds. 5) OU 1 discharge of treated groundwater to infiltration galleries. 6) OU 1 vapor extraction and air sparging. 7) Cap/cover of CAOC 35 landfill.



BARSTOW SUBBASIN
YERMO SUBBASIN
Nebo North Plume
Nebo Main Base
OU 2
Nebo South Plume
Rifle Range
MOJAVE
RIVER
BASIN
Daggett
A. T. AND S. F. RAILROAD
UNION PACIFIC RAILROAD
Yermo
Yermo Annex
Yermo Annex Plume
OU 1
15
40
Marine Corps Logistics Base
Bakersfield
Mojave
Barstow
Yermo
Nebo
Palmdale
Victorville
San Bernardino
Los Angeles
Santa Ana
Palm Springs
Groundwater contamination plumes (> MCL)
Harper Lake - Camp Rock Fault
Base water supply wells
Domestic/Private water wells
SCALE (mi.)
PROJ. MGR. S. Griswold
PROJ. ENG. J. Peñalba
DRAWN BY J. Lawrence
DRAWING NO. 1207\F298-151.CDR
MADE FROM 1207\F298-142.CDR
DATE 03/27/98
JACOBS ENGINEERING GROUP INC.
Pasadena, California
MARINE CORPS LOGISTICS BASE
Barstow, California
Location of MCLB Barstow Operable Units 1 and 2
PROJ. NO. 01-F298-YB
FIGURE 2-1
CLE-J02-01F298-B7-0027



PROJ. GEOL. T. Adair	PROJ. MGR. S. Walker
OU 1/2 MGR. J. Peñalba	PROJ. ENG. A. Garrison
	DRAWN BY J. Lawrence
	DRAWING NO. 1207\F298-143.CDR
	MADE FROM 889\F298-18.CDR
	DATE 02/05/98

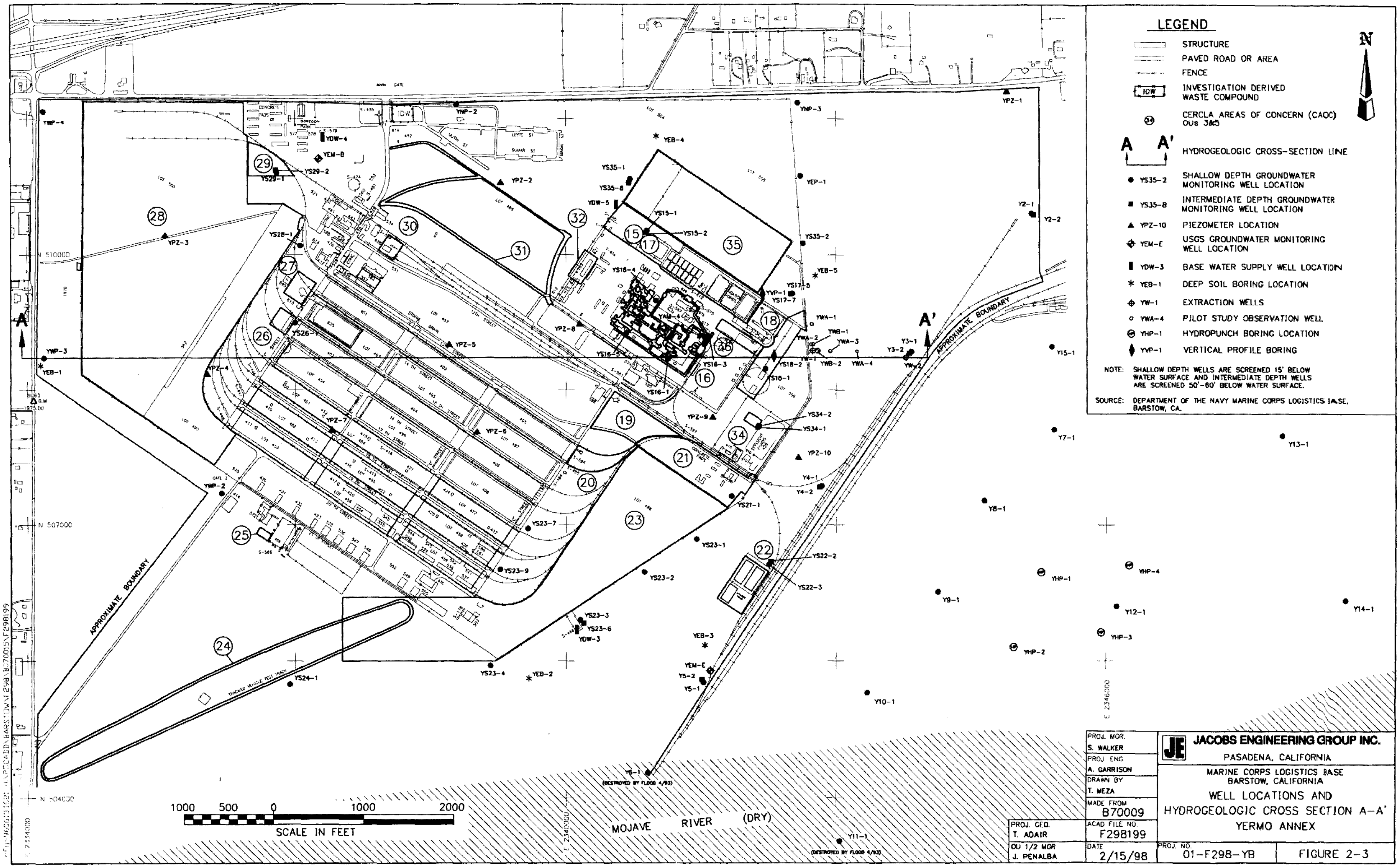
JE JACOBS ENGINEERING GROUP INC.
Pasadena, California

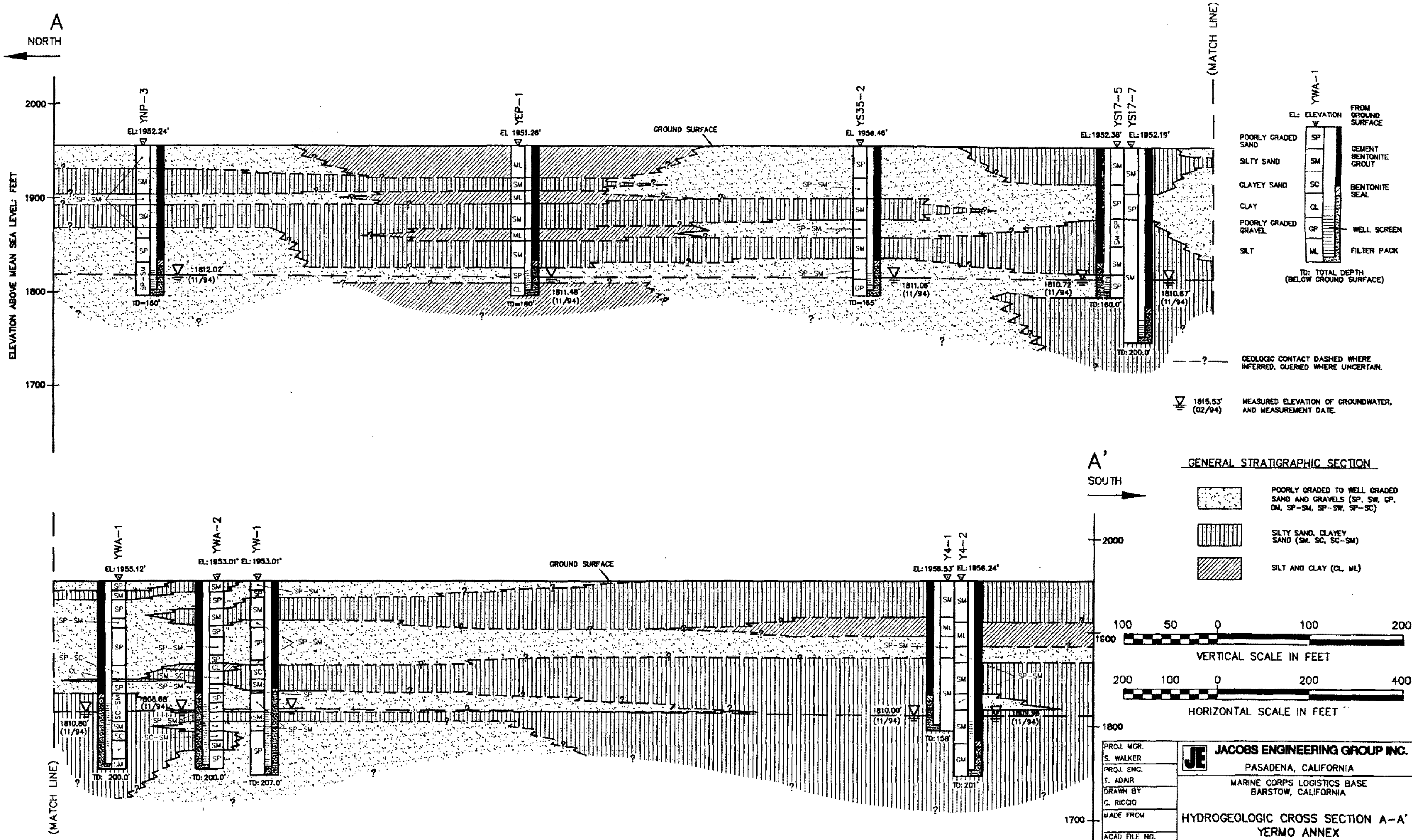
MARINE CORPS LOGISTICS BASE
Barstow, California

Mojave River Regional Map and Major Topographic Features

PROJ. NO. 01-F298-YB | FIGURE 2-2

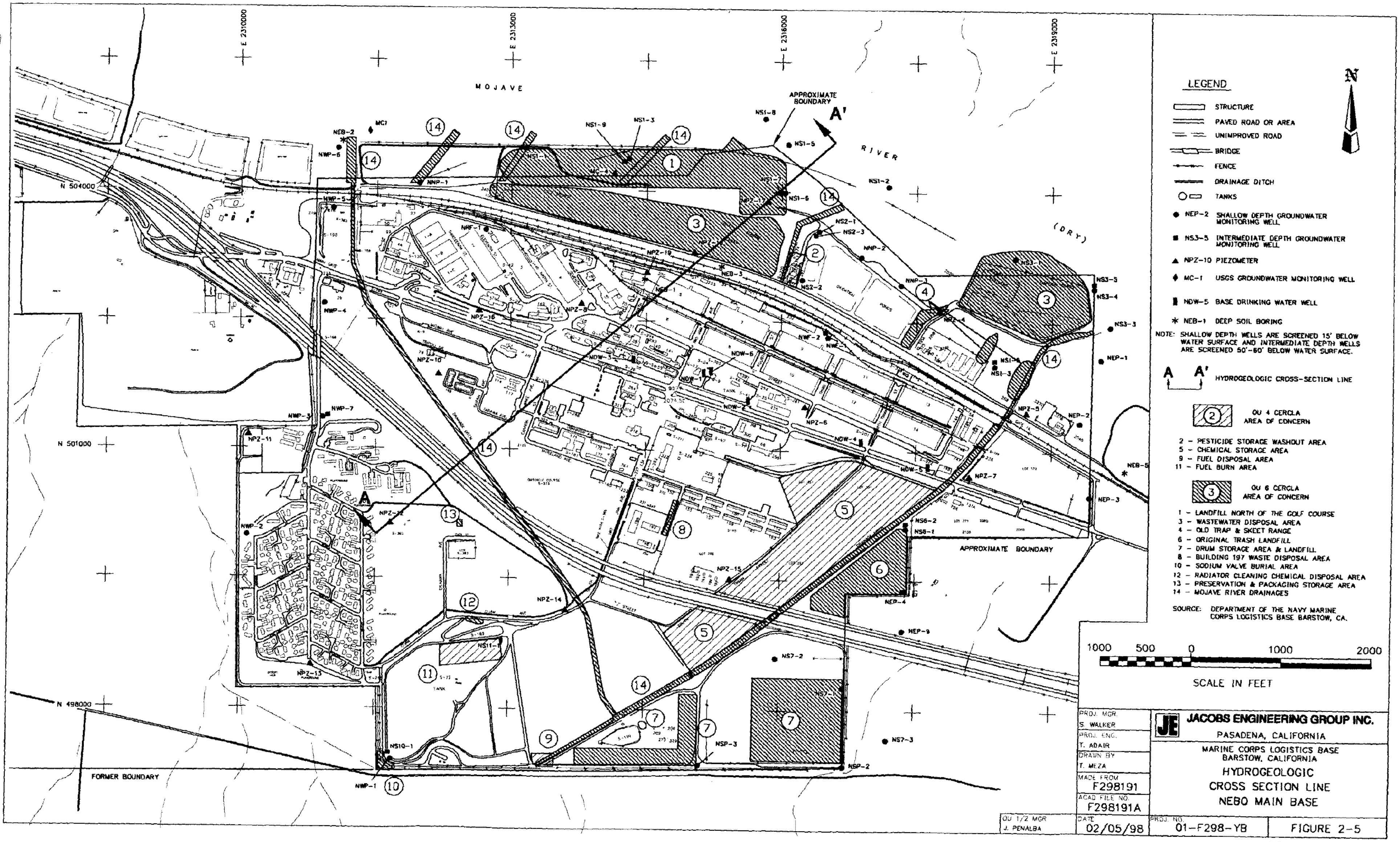
CLE-J02-01F298-B7-0021

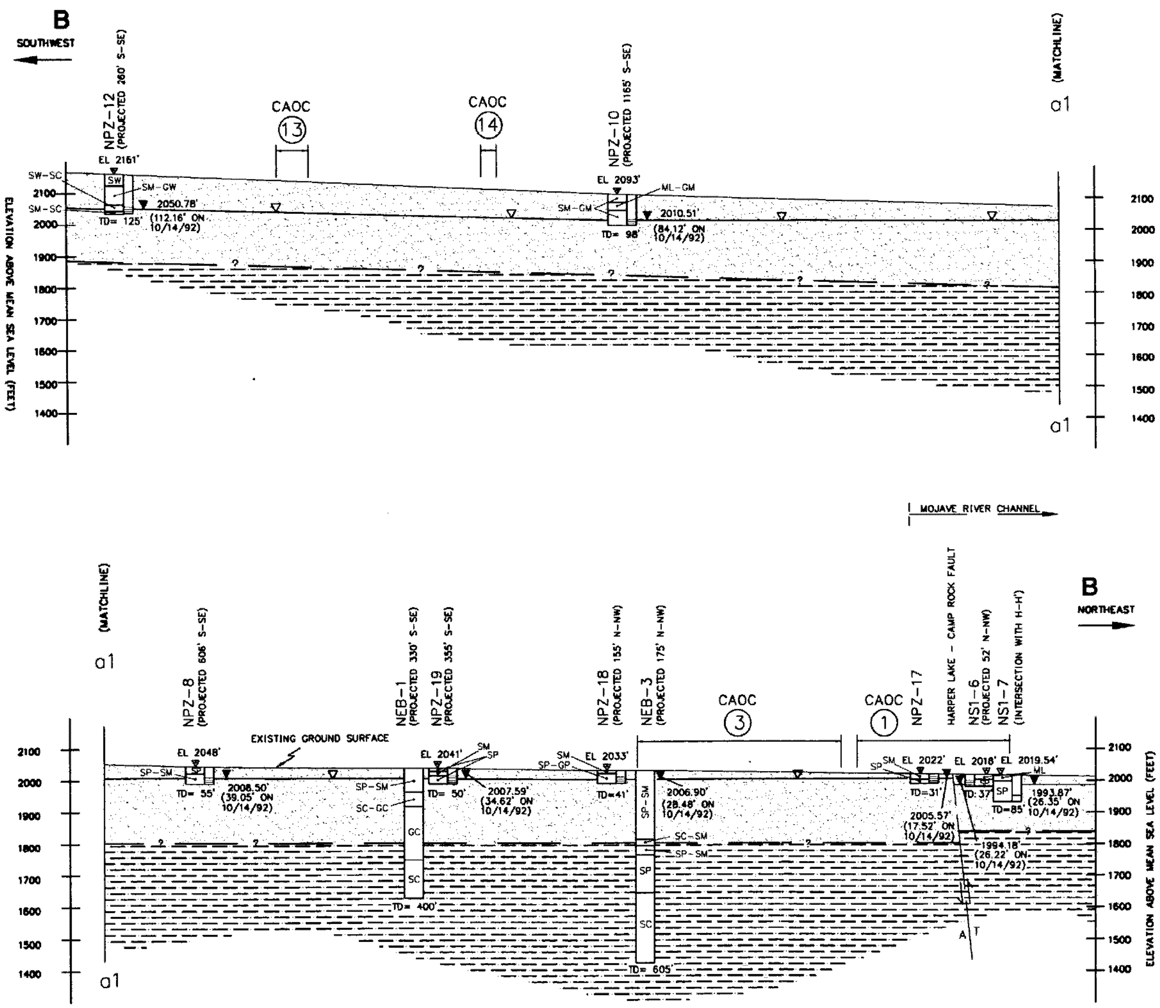

LEGEND
STRUCTURE
PAVED ROAD OR AREA
FENCE
IDW INVESTIGATION DERIVED WASTE COMPOUND
CERCLA AREAS OF CONCERN (CAOC) OUs 3&5
A A' HYDROGEOLOGIC CROSS-SECTION LINE
YS35-2 SHALLOW DEPTH GROUNDWATER MONITORING WELL LOCATION
YS35-8 INTERMEDIATE DEPTH GROUNDWATER MONITORING WELL LOCATION
YPZ-10 PIEZOMETER LOCATION
YEM-E USGS GROUNDWATER MONITORING WELL LOCATION
YDW-3 BASE WATER SUPPLY WELL LOCATION
YEB-1 DEEP SOIL BORING LOCATION
YW-1 EXTRACTION WELLS
YWA-4 PILOT STUDY OBSERVATION WELL
YHP-1 HYDROPUNCH BORING LOCATION
YVP-1 VERTICAL PROFILE BORING
NOTE: SHALLOW DEPTH WELLS ARE SCREENED 15' BELOW WATER SURFACE AND INTERMEDIATE DEPTH WELLS ARE SCREENED 50'-60' BELOW WATER SURFACE.
SOURCE: DEPARTMENT OF THE NAVY MARINE CORPS LOGISTICS BASE, BARSTOW, CA.
APPROXIMATE BOUNDARY
MOJAVE RIVER (DRY)
1000 500 0 1000 2000
SCALE IN FEET
PROJ. MGR. S. WALKER
PROJ. ENG. A. GARRISON
DRAWN BY T. MEZA
PROJ. GEO. T. ADAIR
OU 1/2 MGR J. PENALBA
MADE FROM B70009
ACAD FILE NO. F298199
DATE 2/15/98
JACOBS ENGINEERING GROUP INC.
PASADENA, CALIFORNIA
MARINE CORPS LOGISTICS BASE BARSTOW, CALIFORNIA
WELL LOCATIONS AND HYDROGEOLOGIC CROSS SECTION A-A' YERMO ANNEX
PROJ. NO. 01-F298-YB
FIGURE 2-3
CLE-J02-01F298-B7-0026



PROJ. MGR. S. WALKER PROJ. ENG. T. ADAIR DRAWN BY C. RICCIO MADE FROM ACAD FILE NO. F298160	JACOBS ENGINEERING GROUP INC. PASADENA, CALIFORNIA MARINE CORPS LOGISTICS BASE BARSTOW, CALIFORNIA HYDROGEOLOGIC CROSS SECTION A-A' YERMO ANNEX	
OU 1/2 MGR D. VAN HORSEN	DATE 06/09/95	PROJ. NO. 01-F298-YB
		FIGURE 2-4

CLE-J02-01F298-B7-0018


LEGEND
STRUCTURE
PAVED ROAD OR AREA
UNIMPROVED ROAD
BRIDGE
FENCE
DRAINAGE DITCH
TANKS
NEP-2 SHALLOW DEPTH GROUNDWATER MONITORING WELL
NS3-5 INTERMEDIATE DEPTH GROUNDWATER MONITORING WELL
NPZ-10 PIEZOMETER
MC-1 USGS GROUNDWATER MONITORING WELL
NDW-5 BASE DRINKING WATER WELL
NEB-1 DEEP SOIL BORING
NOTE: SHALLOW DEPTH WELLS ARE SCREENED 15' BELOW WATER SURFACE AND INTERMEDIATE DEPTH WELLS ARE SCREENED 50'-60' BELOW WATER SURFACE.
A A' HYDROGEOLOGIC CROSS-SECTION LINE
OU 4 CERCLA AREA OF CONCERN
2 - PESTICIDE STORAGE WASHOUT AREA
5 - CHEMICAL STORAGE AREA
9 - FUEL DISPOSAL AREA
11 - FUEL BURN AREA
OU 6 CERCLA AREA OF CONCERN
1 - LANDFILL NORTH OF THE GOLF COURSE
3 - WASTEWATER DISPOSAL AREA
4 - OLD TRAP & SKEET RANGE
6 - ORIGINAL TRASH LANDFILL
7 - DRUM STORAGE AREA & LANDFILL
8 - BUILDING 197 WASTE DISPOSAL AREA
10 - SODIUM VALVE BURIAL AREA
12 - RADIATOR CLEANING CHEMICAL DISPOSAL AREA
13 - PRESERVATION & PACKAGING STORAGE AREA
14 - MOJAVE RIVER DRAINAGES
SOURCE: DEPARTMENT OF THE NAVY MARINE CORPS LOGISTICS BASE BARSTOW, CA.
1000 500 0 1000 2000
SCALE IN FEET
MOJAVE
RIVER
(DRY)
APPROXIMATE BOUNDARY
FORMER BOUNDARY
E 2310000
E 2313000
E 2316000
E 2319000
N 504000
N 501000
N 498000
PROJ. MGR. S. WALKER
PROJ. ENG. T. ADAIR
DRAWN BY T. MEZA
MADE FROM F298191
ACAD FILE NO. F298191A
OU 1/2 MGR J. PENALBA
DATE 02/05/98
JACOBS ENGINEERING GROUP INC.
PASADENA, CALIFORNIA
MARINE CORPS LOGISTICS BASE BARSTOW, CALIFORNIA
HYDROGEOLOGIC CROSS SECTION LINE NEBO MAIN BASE
PROJ. NO. 01-F298-YB
FIGURE 2-5
CLE-J02-01F298-B7-0018



LEGEND

NS1 — GROUNDWATER MONITORING WELL DESIGNATION
NPZ — PIEZOMETER DESIGNATION
NEB — DEEP SOIL BORING
EL 2062' — GROUND SURFACE ELEVATION IN FEET

- GRAVELLY SAND OR POORLY GRADED SAND — SP
- WELL GRADED SAND — SW
- SANDY GRAVEL OR GRAVEL-SAND MIXTURE — GP
- SILTY SAND OR SANDY SILT — SM
- CLAYEY SAND — SC
- CLAYEY GRAVEL — GC
- SILT OR CLAYEY SILT — ML
- SILTY CLAY — CL

4" DIA. OR 2" DIA. SCHEDULE 40 PVC CASING. *

4" DIA. OR 2" DIA SCHEDULE 40 PVC SCREEN WITH .010" SLOT. *

DEPTH AND ELEVATION OF GROUNDWATER IN WELL (FROM TOP OF CASING) WITH DATE OF MEASUREMENT

TD = 400' — TOTAL DEPTH.

FAULT SHOWING SENSE OF DISPLACEMENT
A = AWAY FROM VIEWER
T = TOWARD VIEWER
ARROWS INDICATE RELATIVE VERTICAL SEPERATION

— — — ? — GEOLOGIC CONTACT DASHED WHERE INFERRED, QUERIED WHERE UNCERTAIN.

INFERRED DEPTH TO GROUNDWATER.

* 4" DIAMETER FOR GROUNDWATER MONITORING WELL AND 2" DIAMETER FOR PIEZOMETER.

CAOC (14) IDENTIFIED SITE WITH KNOWN OR POTENTIAL CONTAMINATION.

STRATIGRAPHIC SECTION

HOLOCENE TO PLEISTOCENE — YOUNGER ALLUVIUM: RIVER CHANNEL DEPOSITS AND YOUNGER FAN DEPOSITS CONSISTING OF GRAVELLY SAND, SANDY GRAVEL, AND OCCASIONAL LENSES OF SILTY OR CLAYEY SAND.

PLEISTOCENE — OLDER ALLUVIUM: OLDER FAN DEPOSITS -LITHOLOGICALLY DIVERSE CONSISTING OF CLAYEY GRAVEL, WELL GRADED SAND, AND SILTY TO CLAYEY SAND.

NOTES:

1. FOR LOCATION OF GEOLOGIC SECTION, SEE FIGURE 7-3. CROSS SECTION IS FACING EAST AND IS NORMAL TO GROUNDWATER FLOW, NORTH OF NPZ-10.
2. LOCATION OF HARPER LAKE-CAMP ROCK FAULT IS BASED ON GEOLOGIC, HYDROLOGIC AND GEOPHYSICAL EVIDENCE (FAULT C OF USGS, 1993).
3. DEPTH OF OLDER ALLUVIUM/YOUNGER ALLUVIUM CONTACT IS BASED ON LITHOLOGIC CONTRASTS AND ELECTRIC LOG RESULTS IN DEEP SOIL BORINGS. DIP OF HARPER LAKE-CAMP ROCK FAULT BASED ON FAULT ATTITUDES MEASURED ON SURFACE EXPOSURES NORTH OF MOJAVE RIVER BY USGS, 1993.

400 200 0 400 800

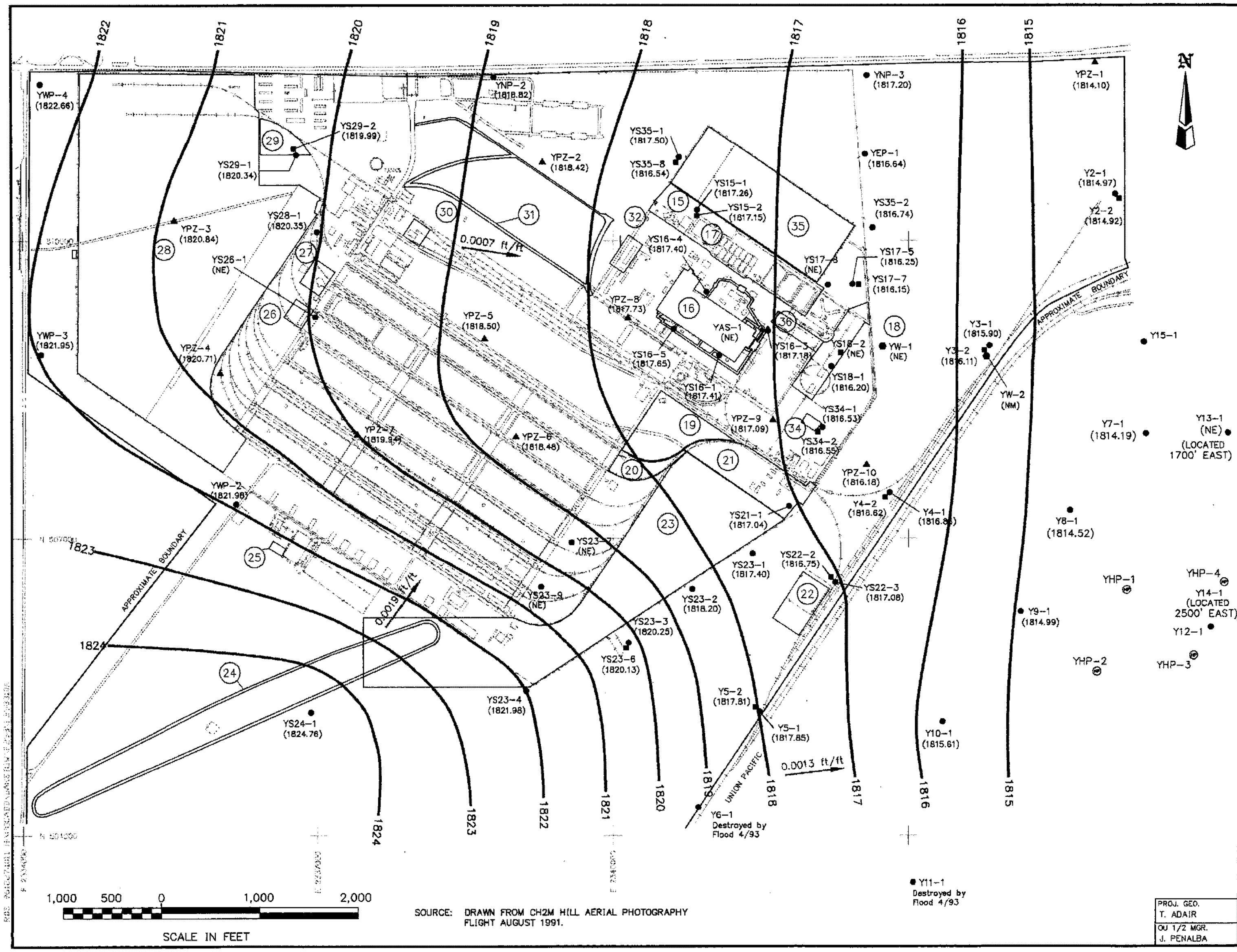
HORIZONTAL = VERTICAL: SCALE IN FEET

PROJ. MGR. S. WALKER	JACOBS ENGINEERING GROUP INC. PASADENA, CALIFORNIA	
PROJ. ENG. A. GARRISON	MARINE CORPS LOGISTICS BASE BARSTOW, CALIFORNIA	
DRAWN BY T. MEZA		
MADE FROM B70009	HYDROGEOLOGIC CROSS SECTION B-B' NEBO MAIN BASE	
ACAD FILE NO. F298178A		
DATE 02/05/98	PROJ. NO. 01-F298-YB	FIGURE 2-6

PROJ. GEO. T. ADAIR
OU 1/2 MGR J. PENALBA

CLE-J02-01F298-B7-0018

RDS-961227.0947 H:\PDCADD\BARSTOW\F298\F298178A



SOURCE: DRAWN FROM CH2M HILL AERIAL PHOTOGRAPHY FLIGHT AUGUST 1991.

LEGEND

- ● YS34-2 (1812.81) — SHALLOW DEPTH (15' BELOW WATER SURFACE) GROUNDWATER MONITORING WELL LOCATION WITH GROUNDWATER ELEVATION IN FEET ABOVE MEAN SEA LEVEL
- ■ YS35-8 (1813.88) — INTERMEDIATE DEPTH (50' BELOW WATER SURFACE) GROUNDWATER MONITORING WELL LOCATION WITH GROUNDWATER ELEVATION IN FEET ABOVE MEAN SEA LEVEL
- ▲ YPZ-10 (1811.81) — SHALLOW DEPTH (15' BELOW WATER SURFACE) PIEZOMETER LOCATION WITH GROUNDWATER ELEVATION IN FEET ABOVE MEAN SEA LEVEL
- ⊚ YAS-1 (1812.81) — AIR SPARGE WELL (>50' BELOW WATER SURFACE) WITH GROUNDWATER ELEVATION IN FEET ABOVE MEAN SEA LEVEL
- ● YW-2 (1812.81) — GROUNDWATER EXTRACTION WELL LOCATION (>50' BELOW WATER SURFACE) WITH GROUNDWATER ELEVATION IN FEET ABOVE MEAN SEA LEVEL
- —1820— GROUNDWATER ELEVATION CONTOURS IN 1' INTERVALS (FEET ABOVE MEAN SEA LEVEL)
- 0.0013 ft/ft → APPROXIMATE DIRECTION AND GRADIENT OF GROUNDWATER FLOW
- NE NOT EXISTING
- NM NOT MEASURED

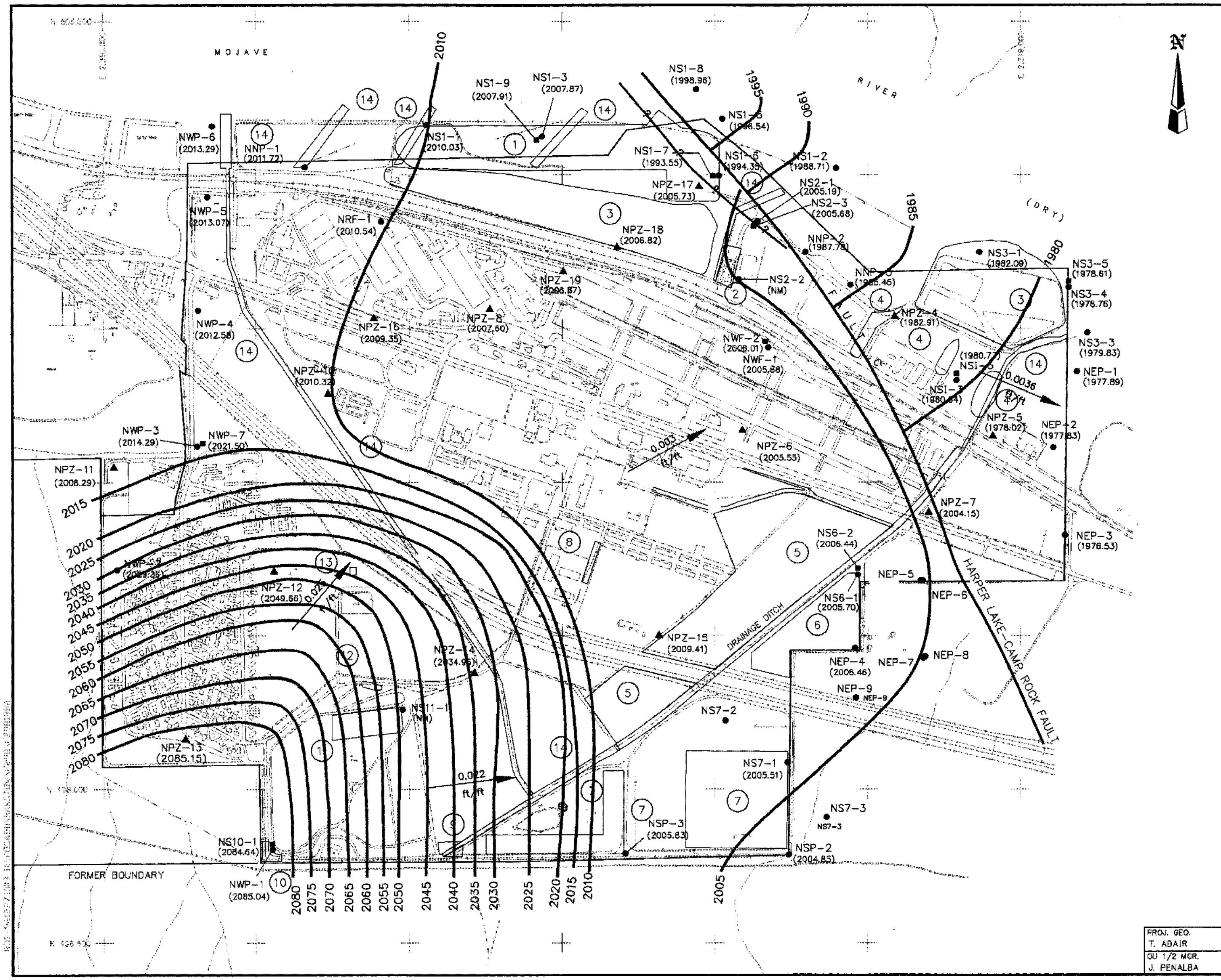
NOTE:
GROUNDWATER ELEVATION CONTOURS ARE DRAWN ACCORDING TO SHALLOW GROUNDWATER MONITORING WELL DATA.

OUs 3&5 CAOCs

- (15) — OIL STORAGE AND SPILLAGE AREA
- (16) — WASTEWATER PIPING BENEATH BUILDING 573 (MC[3])
- (17) — INDUSTRIAL WASTEWATER OVERFLOW AREA
- (18) — SLUDGE WASTE DISPOSAL AREA
- (19) — FIRST HAZARDOUS AND LOW-LEVEL RADIOLOGICAL AREA
- (20) — SECOND HAZARDOUS AND LOW-LEVEL RADIOLOGICAL AREA
- (21) — INDUSTRIAL WASTE DISPOSAL AREA
- (22) — DOMESTIC WASTEWATER DISPOSAL AREA
- (23) — LANDFILL AREA
- (24) — TRACKED VEHICLE TEST AREA
- (25) — WASTEWATER TREATMENT SLUDGE DISPOSAL AREA
- (26) — BUILDING 533 WASTE DISPOSAL AREA
- (27) — BUILDING 436 FUEL OIL STORAGE AREA
- (28) — WEST LOT DUST CONTROL AREA
- (29) — SLUDGE STORAGE AREA
- (30) — LOCOMOTIVE REPAIR SHOP DISPOSAL AREA
- (31) — NORTH VEHICLE TEST TRACK ROAD
- (32) — PRESERVATION & PACKAGING STORAGE AREA
- (34) — PREVIOUS PCB STORAGE AREA
- (35) — YERMO ANNEX SANITARY LANDFILL
- (36) — PROPOSED PAINT COMBAT VEHICLE MAINTENANCE SHOP MAINTENANCE SHOP

PROJ. GEO. T. ADAIR	PROJ. MGR. S. WALKER	JACOBS ENGINEERING GROUP INC. PASADENA, CALIFORNIA
OU 1/2 MGR. J. PENALBA	PROJ. ENG. A. GARRISON	MARINE CORPS LOGISTICS BASE BARSTOW, CALIFORNIA
	DRAWN BY T. MEZA	YERMO ANNEX
	MADE FROM B70009	GROUNDWATER TABLE CONTOUR MAP
	ACAD FILE NO. F298310A	JANUARY 1994
	DATE 02/05/98	PROJ. NO. 01-F298-YB — FIGURE 2-7

CLE-J02-01F298-B7-0026



LEGEND

● NEP-2 (1996.18) — SHALLOW DEPTH (15' BELOW WATER SURFACE) GROUNDWATER MONITORING WELL LOCATION WITH GROUNDWATER ELEVATION IN FEET ABOVE MEAN SEA LEVEL

■ NWF-2 (2011.58) — INTERMEDIATE DEPTH (50' BELOW WATER SURFACE) GROUNDWATER MONITORING WELL LOCATION WITH GROUNDWATER ELEVATION IN FEET ABOVE MEAN SEA LEVEL

▲ NPZ-10 (2018.79) — SHALLOW DEPTH (15' BELOW WATER SURFACE) PIEZOMETER LOCATION WITH GROUNDWATER ELEVATION IN FEET ABOVE MEAN SEA LEVEL

—2010— GROUNDWATER ELEVATION FOR SHALLOW DEPTH WELLS CONTOURS IN 2' AND 5' INTERVALS (FEET ABOVE MEAN SEA LEVEL)

FAULT LINE

POSSIBLE SECONDARY FAULT STRAND

0.021 ft/ft → APPROXIMATE DIRECTION AND GRADIENT OF GROUNDWATER FLOW

NM NOT MEASURED

NOTES:

1. GROUNDWATER ELEVATION CONTOURS ARE DRAWN ACCORDING TO SHALLOW GROUNDWATER MONITORING WELL DATA.
2. FAULT LOCATION BASED UPON COX AND WILSHIRE (USGS,1993)

OUs 4&6 CAOCs

(1) — LANDFILL NORTH OF THE GOLF COURSE
(2) — PESTICIDE STORAGE AND WASHOUT AREA
(3) — WASTEWATER DISPOSAL AREA AND GOLF COURSE
(4) — OLD TRAP & SKEET RANGE
(5) — CHEMICAL STORAGE AREA
(6) — ORIGINAL TRASH LANDFILL
(7) — DRUM STORAGE AREA & LANDFILL
(8) — BUILDING 197 WASTE DISPOSAL AREA
(9) — FUEL DISPOSAL AREA
(10) — SODIUM VALVE BURIAL AREA
(11) — FUEL BURN AREA
(12) — RADIATOR CLEANING CHEMICAL DISPOSAL AREA
(13) — PRESERVATION & PACKAGING STORAGE AREA
(14) — DRAINAGE CHANNELS AND OUTFALLS TO MOJAVE RIVER

SOURCE: DEPARTMENT OF THE NAVY MARINE CORPS LOGISTICS BASE BARSTOW, CA.

1,000 500 0 1,000 2,000

SCALE IN FEET

PROJ. GEO. T. ADAIR	
OU 1/2 MGR. J. PENALBA	
PROJ. MGR. S. WALKER	JACOBS ENGINEERING GROUP INC. PASADENA, CALIFORNIA
PROJ. ENG. A. GARRISON	MARINE CORPS LOGISTICS BASE BARSTOW, CALIFORNIA
DRAWN BY T. MEZA	NEBO MAIN BASE
MADE FROM B70009	GROUNDWATER TABLE CONTOUR MAP
ACAD FILE NO. F298188A	JANUARY 1993
DATE 02/05/98	PROJ. NO. 01-F298-YB — FIGURE 2-8

CLE-J02-01F298-B7-0026

3.0 YERMO ANNEX PLUME (OU 1) DECISION SUMMARY

3.1 Summary of Plume Characteristics

3.1.1 Contaminants of Concern

3.1.1.1 Organics

The results of the groundwater RI at MCLB Barstow indicate that VOCs are the primary class of chemicals affecting underlying groundwater at the Yermo Annex. VOC contamination may have reached groundwater in the Yermo subbasin as long ago as 1961 when major industrial operations were moved from the Nebo Main Base to the Yermo Annex. The most prevalent contaminants are the solvents TCE and PCE, which have been used at the Base primarily in cold cleaning, vapor degreasing, chemical paint stripping, and painting operations. TCE and PCE have been detected at concentrations exceeding federal and state drinking water standards in over a dozen groundwater monitoring wells in the Yermo Annex area. Other VOCs detected above federal or state standards include 1,1-dichloroethene (1,1-DCE), benzene, and 1,2-dichloroethene (1,2-DCA).

Tables 3-1 and 3-2 show the maximum concentrations of VOCs detected in on- and off-Base groundwater monitoring wells, respectively, along with their associated MCLs. Contaminants exceeding drinking water standards are shown at the top of the tables. The most commonly detected VOCs are TCE and PCE that were found in 21 and 20 wells respectively, and 1,1-DCE that was detected in seven wells. Other VOCs including 1,1-dichloroethane (1,1-DCA), 1,2-dichoroethane (1,2-DCA), 1,2-dichloroethene (1,2-DCE), 1,1,1-trichloroethane (1,1,1-TCA), 2-butanone, xylenes, and Freons were detected in fewer than four wells. Semivolatiles organic compounds (SVOCs) and total petroleum hydrocarbons as diesel (TPH-D) were also detected at Yermo, but at much lower concentrations and detection frequencies.

3.1.1.2 Inorganics

Various metal analytes are present in groundwater throughout the Yermo Annex. These analytes are typically present in all natural waters in various amounts depending on geologic setting, contact time between the water and mineral-rich sediments or bedrock, and other factors.

Most of the metal analytes detected in groundwater at the Yermo Annex, including common ions such as calcium, iron, magnesium, potassium, and sodium, exhibit concentration distributions that can be explained simply as natural variations due to heterogeneity of the subsurface environment.

Two metal analytes, nickel and chromium, were found to exceed MCLs and to be elevated relative to their statistically defined background levels in several wells near the highly industrial operations at Building 573 on the northern section of the Yermo Annex (i.e., wells YS34-1, YS35-1, YEP-1, YS16-4, and YS16-5). Three other metal analytes, antimony, thallium and aluminum, were also detected in this area at slightly elevated levels relative to their background concentrations. However, an evaluation of the spatial and temporal distributions for these metals indicates that similarly elevated levels were also detected in other on- and off-Base areas (e.g., Well Y8-1) not associated with industrial activities.

In addition to spatial variation, large temporal variations in the concentrations of these metals throughout 4 years of sampling suggest that turbidity or sampling techniques may have also been a factor in the higher reported concentrations. Turbidity during sampling has been an ongoing issue due to the nature of the interbedded sands, silts, and clays in the alluvial aquifers at MCLB Barstow. Changes in iron concentrations from each sampling event (an indicator of sample turbidity) correlate closely to nickel and chromium concentrations in the suspected wells. All five wells around Building 573 reported their highest iron and chromium concentrations, and three of the five wells exhibited their highest nickel concentrations, during the same January 1994 sampling event. The RI yielded inconclusive answers to the questions of whether the concentrations of these five metals are naturally occurring or the result of Base activities. To resolve this issue, the Marine Corps and regulatory agencies have agreed to measure the concentrations of these five metals in a few selected groundwater monitoring wells for a minimum of four additional quarters (1 year). MCLB Barstow has agreed to amend this ROD to address cleanup options if metals are determined to be a problem after this additional sampling.

3.1.2 VOC Contaminant Sources

VOCs constitute the only confirmed class of groundwater contaminants originating from sources at three distinct areas of the Yermo Annex. The areal extent of the VOC plume and location of contaminant sources are shown on Figure 3-1.

The northern Yermo area of contamination appears to be a result of leaks and breaks in the industrial wastewater treatment plant piping associated with CAOC 16 (Building 573), past disposal activities at CAOC 15/17 (former industrial waste treatment plant), and possibly landfill activities at CAOC 35. The maximum TCE and PCE concentrations in this area were 77 and 230 micrograms per liter (µg/L), respectively, in the general area of CAOC 16. Maximum concentrations detected at the Base boundary downgradient from this area were 74 µg/L for TCE and 66 µg/L for PCE (state and federal MCLs for TCE and PCE are 5 µg/L).

The southern portion of Yermo Annex VOC plume contamination appears to have resulted from past landfill operations at CAOC 23. Maximum TCE and PCE concentrations detected in this area were 34 and 18 µg/L, respectively.

The central and most upgradient portion of the Yermo Annex VOC plume is attributed to discharges to a French drain at CAOC 26 (Building 533, Packaging and Maintenance Shop). Maximum TCE and PCE concentrations in groundwater in this area are 141 and 31 µg/L, respectively.

3.1.3 Location of Vadose Zone Contamination

Residual vadose zone contamination has been determined to be present in subsurface soils above the groundwater table in the three general source areas previously described. Vadose zone contamination can provide a continuous source of contaminants to groundwater, which could increase overall aquifer cleanup time and costs. Therefore, isolation, reduction or removal of vadose zone contamination is part of the groundwater remedial actions.

Based on intense site scoping, soil gas and geophysical surveys, visual site inspections, and soil and groundwater sampling, the Marine Corps narrowed the suspected areas of vadose zone contamination at MCLB Barstow to a handful of sites. Consistent with the spirit of CERCLA and the NCP to expedite cleanup, the Marine Corps and regulatory agencies adopted a remediation-based approach designed to shift the focus of the MCLB Barstow IRP away from site characterization and towards cleanup. Based on this approach, the extent of vadose zone and groundwater contamination were investigated to the degree necessary to confirm the need for remedial action and support remedial action decisions discussed as follows.

3.1.3.1 CAOC 16

CAOC 16 comprises the Maintenance Center Barstow (MCB) (Building 573) and its perimeter area (approximately 60 acres) (see Figure 3-1). Building 573 is the main facility of the MCLB Barstow Repair Division. Activities conducted at this facility include engine repair, rebuilding and testing, radiator and metal parts cleaning, dynamometer testing, solvent cleaning of electronic parts, and parkerizing of weapons. Because of potential significant disruptions to mission-critical operations, very limited vadose zone characterization was conducted at this site. However, based on the widespread area of VOC contamination in groundwater at levels above federal and state MCLs, and the high concentration of industrial activity at the site, the RI conservatively concluded that VOC contamination is present throughout the vadose zone underlying Building 573.

CAOC 16 was therefore included in the FS for evaluation of vadose zone and groundwater cleanup remedial alternatives.

3.1.3.2 CAOC 15/17

CAOC 15/17 is a 13-acre rectangular area located between Building 573 (CAOC 16) and the Yermo Class III Landfill (CAOC 35) (see Figure 3-1). The area encompasses the former industrial wastewater treatment plant (IWTP) including 14 evaporation basins, four sludge drying beds, a temporary pond, three oxidation ponds, the overflow area around the ponds, and a wet well. The depth to groundwater in this area is approximately 140 feet bgs. The site has been inactive since 1990.

Based on scoping information, an estimated 140,000 gallons of bilge water contaminated with oil and gasoline were reportedly discharged to the ground during regular operations between 1961 and 1970. In addition, an estimated 3,000 gallons of waste oil may have been spilled during the process of draining and transferring used oil from vehicles to drums and to tank trucks. Sludge drying beds reportedly stored both sludge from the evaporation basins for drying and contaminated soil from fuel spills mixed with sludge. All residual sludge was subject to a removal action in 1993 (Jacobs 1996).

Site characterization data including a near-surface soil organic vapor (SOV) survey and soil sampling revealed localized VOC contamination with the highest concentrations along the southern boundary with CAOC 16. Based on existing data, there is no direct evidence that widespread VOC contamination is present in the vadose zone at this CAOC, or that it represents an ongoing source of VOC contamination to groundwater that warrants source removal. Although there is uncertainty in this conclusion due to the limited vadose zone characterization in the area, the existing information points to CAOC 16 as the major source of vadose zone impacts to groundwater in the area (the highest concentrations of VOCs in groundwater at the Yermo Annex have been detected in wells near and downgradient of CAOC 16).

3.1.3.3 CAOC 26

CAOC 26, which encompasses Building 533 (the Packaging and Maintenance Shop) and the area around it, has also been identified as a major source of VOC contamination in groundwater at the Yermo Annex (see Figure 3-1).

The shop operations include cleaning, repairing, preserving, painting, and packaging various work pieces. The shop consists of a waterfall-type paint booth, several dip tanks for cleaning and preservation operations, a vapor degreaser, and a sandblasting unit. The perimeter area of Building 533 contains a steam cleaning rack, an oil/water separator, a darkly discolored area to the west, and a French drain area (formerly misidentified as underground storage tank [UST] T-533). Wastes generated at the facility include solvents, TCE, waste oil, paint wastes, and preservatives.

Significant soil gas concentrations of TCE, PCE, and cis-1,2-dichloroethene (cis-1,2-DCE) were detected in the vadose zone in the area near the French drain. A groundwater concentration of more than 140 μg/L TCE was also reported. A leaching potential analysis using a vadose zone leaching model (VLEACH) indicated that groundwater may be affected over the next 100 years. CAOC 26 was included in the FS to evaluate vadose zone and groundwater remedial alternatives on the basis of these results.

3.1.3.4 CAOCs 23 and 35 (Municipal Landfills)

CAOCs 23 and 35 at the Yermo Annex were primarily used as municipal landfills (see Figure 3-1). Wastes disposed of at these sites consist primarily of municipal trash, industrial solid waste, scrap metal, wood, paper, and plastic packing materials. Consistent with the presumptive remedy approach, the actual contents of the landfill areas were not sampled. However, soil samples were obtained from areas beneath and around the disposal areas. The potential for chemicals detected in these samples to leach to groundwater was assessed using the Marshack and VLEACH models.

Based on downgradient groundwater monitoring data, these CAOCs are believed to have been sources of groundwater contamination at one time. The vadose zone modeling results indicate that the current chemical concentrations detected in the soil samples collected will not affect groundwater. However, these results cannot be considered representative of vadose zone conditions throughout the entire landfill area. The presumptive remedy for these CAOCs involves leaving the waste in place, capping, and long-term groundwater monitoring. Capping remedial actions are being addressed under OU 3 for CAOC 23 and OU 5 for CAOC 35. Groundwater monitoring under the substantive RCRA landfill closure requirements for both CAOCs 23 and 35 have been incorporated into this ROD.

3.1.4 Location of Groundwater Contamination

VOCs were detected in groundwater in and downgradient of the source areas discussed above.

Figures 3-2 and 3-3 show maps of the distribution of PCE and TCE in groundwater throughout the Yermo Annex. These maps, contoured using Lynx Geosystem (a geostatistical model used to visualize the extent of migration of each constituent), show the location of the three general source areas discussed in Section 3.1.2 and the extent of their dissolved plumes. The data (current as of December 1996) suggest that the dissolved plumes from the three areas have commingled to form one large plume. Therefore, the three distinct areas of groundwater contamination have been combined and designated as the Yermo Annex plume.

The Yermo Annex plume, the largest of the three VOC plumes identified at MCLB Barstow, spans an area of approximately 12,000 by 4,000 feet.

3.1.5 Contaminant Migration Routes

The following potential routes of contaminant migration were identified for OU 1:

1) **Vadose Zone Contaminant Transport**:

a) Vertical transport through the soil by desorption of chemicals bound to the surface of soil particles, and percolation of infiltrated water through the contaminated soil column.

b) Vertical and horizontal transport of contaminant vapors through soil pore space from either residual or re-vaporization of material adsorbed/absorbed onto the soil particles. Vapors can potentially recontaminate the groundwater or be emitted to the surface.

2) **Groundwater Contaminant Transport:** Vertical and horizontal transport of contaminants through the groundwater matrix.

3.1.5.1 Vadose Zone Contaminant Transport

In general, VOC compounds have a high vertical mobility in soils. At the Yermo Annex, VOCs have percolated into the top 40 feet of groundwater. The available data indicate that PCE and TCE are the predominant groundwater VOC contaminants in the Yermo Annex plume. PCE predominates in the area of CAOCs 16, 15/17, and 35, while TCE is more common at CAOCs 23 and 26.

Source leaching modeling was performed using VLEACH 2.0 (Turin 1990) to assess the future impact to groundwater from vadose zone contaminants. VLEACH modeling results for CAOC 26 indicate that vadose zone contamination will pose a significant continuous threat to groundwater for the next 100 years. VLEACH modeling results for CAOCs 16, 15/17, 23, and 35 were determined based on the limited vadose zone characterization conducted at these CAOCs and can not be considered representative of the existing vadose zone conditions. Because of this uncertainty, the Marine Corps has conservatively assumed that vadose zone contamination is present at these CAOCs and poses a threat to groundwater.

3.1.5.2 Groundwater Contaminant Transport

As shown in Figure 3-1, the Yermo Annex VOC plume extends from CAOC 26 on the western side of the Annex to the current leading edge of the plume, approximately 5,000 feet downgradient of the eastern Base perimeter. The plume has migrated from west to east in the direction of groundwater flow at an estimated rate of 60 to 70 feet per year. Contaminant levels above drinking water standards have been detected off-Base about 2,000 feet downgradient of the Base boundary. As discussed in Section 2.4, two private residence wells located in this area have been provided with well-head carbon filtration treatment systems as a precautionary measure. The next nearest known water supply well is about 2,000 feet downgradient of the leading edge of the plume. It is estimated that it would take approximately 30 years for the leading edge of the plume to reach that well. The maximum concentration expected to ever reach the well is estimated at 2.1 µg/L (which is below drinking water standards) in approximately 100 years.

Groundwater samples from intermediate depth monitoring wells (screened from 40 to 60 feet below the groundwater table) resulted in mostly concentrations of VOCs below detection limits. Therefore, a vertical extent of 40 feet was determined to be the maximum depth of groundwater VOC contamination for the purpose of designing the groundwater pump and treat system.

3.2 Summary of Yermo Annex Plume Risks

The major risk currently associated with OU 1 of MCLB Barstow is the ingestion of contaminated groundwater underlying the affected on-Base and off-Base areas. Actual or threatened releases of hazardous substances from the Yermo Annex, if not addressed by implementing the response action selected in this ROD, may present a threat to public health, welfare, or the environment.

3.2.1 Chemicals of Concern

The majority of the waste and residues generated by mission operations at the Yermo Annex have been managed, treated, and disposed of on site throughout the Base history. The chemicals measured in the vadose zone and groundwater during the RI were evaluated for inclusion as chemicals of potential concern in the risk assessment by application of screening criteria. Contaminants of concern identified in on- and off-Base groundwater at the Yermo Annex (OU 1) are listed in Tables 3-1 and 3-2, respectively.

3.2.2 Summary of Toxicity Values

Summaries of the carcinogenic and noncarcinogenic toxicity values for contaminants of concern in groundwater at the Yermo Annex (OU 1) are provided in Tables 3-3 and 3-4, respectively.

3.2.3 Human Health Risk

For the groundwater under OU 1, the baseline risk assessment (BLRA) reviewed a future hypothetical residential scenario for on- and off-Base residents in the absence of further response action (see Section 2.7.2). The BLRA showed that under this scenario for cancer risk, as many as 20 in 10,000 (2×10^{-3}) additional persons for the on-Base portion of the plume, and 10 in 10,000 (1×10^{-3}) additional persons for the off-Base portion of the plume that exceeds drinking water standards, have the potential to develop cancer during their lifetimes. These estimates were developed based on the conservative exposure assumptions outlined in Section 2.7.2. Both these estimates are above EPA's target range of 10^{-4} to 10^{-6}. For the off-Base portion of the plume impacting groundwater at levels below drinking water standards, the risk drops to 2 in 10,000 (2×10^{-4}) additional persons, which is at the upper end of EPA's target range. The chemicals of concern contributing the most to estimated cancer risk are TCE, PCE, and 1,1-DCE.

Considerable uncertainty exists regarding the above estimates relative to the cancer risk associated with 1,1-DCE, the largest contributor to risk. Specifically, evaluation of all the animal cancer bioassays suggests that 1,1-DCE is a questionable animal carcinogen. When metabolic differences between animals and humans are compared, the potential carcinogenicity of 1,1-DCE in humans is even more questionable. Therefore, the actual risk to humans may be much less than the above estimates.

For noncancer health effects, the hazard indices for the on- and off-Base portions of the plume above drinking water standards are 9.4 and 3.7, respectively. In both cases, the hazard index exceeds EPA's acceptable criterion of 1. For the off-Base portion of the plume below drinking water standards, the hazard index is 0.33, which is below the acceptable criterion of 1. The chemicals of concern contributing the most to estimated non-cancer health effects are TCE, PCE, and 1,1-DCE.

Based on the above results, groundwater containing VOC contamination above drinking water standards is a medium of concern for remedial action. In addition, the subsurface soil is a medium of concern because of potential cross-media chemical transport from subsurface soil to groundwater.

3.2.4 Ecological Risk

An ecological risk assessment was independently performed by EPA Region IX to evaluate potential effects on plants and animals from groundwater contaminants at MCLB Barstow. At most areas of the Yermo Annex, groundwater is found at depths greater than 100 feet and there is no surface water. Exposure of potential ecological receptors to VOCs in groundwater is unlikely because no groundwater discharges to local surface waters and is not accessible to plants and animals. Therefore, no complete exposure pathway to impact ecological receptors exists at the Yermo Annex (OU 1).

3.3 Rationale for Remedial Action Decisions

This section discusses the rationale used to make decisions regarding groundwater and vadose zone cleanup decisions for the Yermo Annex.

3.3.1 Groundwater Cleanup

The extent of VOC contamination at the Yermo Annex was determined during the RI/FS. Because of the large extent of the plume (approximately 6.13 billion gallons over a 12,000- by 4,000-foot area), remediation strategies were developed to evaluate cleanup options on the basis of ARAR-driven remediation goals (i.e., MCLs, background levels). The following remediation strategies were evaluated in the FS.

1) Containment of groundwater contamination at the Base boundary. This strategy captures over 90 percent of the total VOC mass estimated to exist in the aquifer, and prevents further migration of contaminants off Base, but leaves existing levels of VOCs above drinking water standards off Base untreated.

2) Containment of groundwater contamination at the MCL boundary. This strategy captures all contamination in excess of drinking water standards (i.e., MCLs) on and off Base.

3) Containment of groundwater contamination at the background boundary. This strategy captures all contamination in excess of background levels on and off Base.

Illustrations of these three different containment areas are provided in Figure 3-3. This figure shows that the Base boundary area is contained within the MCL contour area, and the MCL area is in turn contained within the background contour area. Target remediation volumes were determined for each of the three containment areas, and alternatives developed to maximize containment, extraction, and treatment effectiveness.

A technical and economical feasibility analysis (TEF) was conducted to evaluate the three remediation strategies and determine the most cost-effective, ARAR-compliant remedy that is protective of human health and the environment. The TEF analysis, presented in Appendix J of the Draft Final FS for OUs 1 and 2 (Jacobs 1996a), involved an evaluation of the technical limitations, residual risk (risk remaining in groundwater after cleanup goals have been achieved), and cost/benefits of incremental risk reduction associated with each alternative. The following summarizes the TEF analysis results and conclusions.

1) Experience gained over the past decade has shown that restoring groundwater to drinking water quality (i.e., to MCLs) or more stringent standards (i.e., background) is much more difficult than expected due to the complexities of hydrogeological and contaminant related factors. Selection of realistic cleanup goals must consider the technical limitations, economical practicality, and overall protectiveness to human health and the environment.

2) Cleanup of contaminated groundwater to MCLs and background levels would result in a residual risk of 2×10^{-4} and 2×10^{-5}, respectively. These numbers are based on very conservative assumptions and involve considerable uncertainties surrounding cancer risk estimates for 1,1-DCE (see Section 3.2.3). Excluding 1,1-DCE, these estimates would be approximately 1×10^{-5} and 5×10^{-6}. Both these levels are within EPA's risk management range and are considered protective of human health and the environment.

3) Most of the VOC contaminant mass in groundwater is within the Base boundary. Plume containment, extraction, and treatment at the Base boundary is vital to halt contaminant migration, protect off-Base resources and receptors, and accelerate groundwater cleanup. Alternatives designed for this containment strategy can effectively remove over 90 percent of the VOC contaminants in groundwater. However, this strategy by itself is not ARAR-compliant because it does not capture and treat off-Base contamination above MCLs.

4) Plume containment, extraction, and treatment at the Base and MCL boundaries would require extraction and treatment of 17.7 billion gallons of contaminated groundwater for about 30 years at an estimated present worth cost of $27.2 million. This estimate includes AS/SVE at CAOC 26 and downgradient of CAOCs 16, 15/17, and 35. This strategy would remove 95 percent of the total mass and achieve an incremental risk reduction of over 90 percent to within EPA's risk management range level. This strategy is ARAR-compliant because it captures and treats all groundwater contamination above MCLs.

5) Plume containment, extraction, and treatment at the Base and background boundaries would require extraction and treatment of 46.5 billion gallons of contaminated groundwater (over 2.5 times the MCL volume), for about 55 years at an estimated present worth of $49.2 million. The cost estimate includes AS/SVE at CAOCs 26 and downgradient of CAOCs 16, 15/17. and 35. This strategy would almost double the time and cost of cleanup to MCLs, and only reduce VOC mass by an additional 4 percent (to 99 percent), and human health risks by an additional 9 percent (to 99 percent).

The cleanup duration and contaminant mass removal estimates used in the above analysis are based in part on limited vadose zone data available, particularly at CAOCs 16 and 15/17. Additional soil sampling and vadose zone gas monitoring will be conducted at these and other CAOCs during implementation of the remedial action. The results of this sampling will be used, among other tasks, to evaluate the long-term- and cost-effectiveness of the selected remedy as described in Section 3.3.2. below.

In summary, both background levels and MCLs cleanup goals are considered protective of human health and the environment. Remediating to background levels versus MCLs would result in only a minimal incremental difference in risk reduction and mass removal while doubling the cleanup costs and duration.

Based on these findings, and the technical limitations of extraction and treatment technology, the TEF analysis concluded that cleanup to background levels is technically and economically infeasible. Therefore, the Marine Corps selected MCLs as the cleanup goal for the Yermo Annex VOC plume.

3.3.2 Source Reduction

Vadose zone contamination was determined to exist at five major CAOCs underlying the Yermo Annex: 16, 15/17, 23, 26, and 35. Continued releases to groundwater from these CAOCs could reduce the effectiveness of remediation efforts and extend the duration of cleanup. This section documents the rationale for determining the need for, and extent of, source reduction for each CAOC.

3.3.2.1 CAOC 16

The Maintenance Center Barstow (Building 573 and its perimeter area) is the most active and trafficked industrial area at the Yermo Annex. The entire perimeter of Building 573 is used as a passageway for vehicular traffic and testing, maintenance and storage of military equipment in the process of being refurbished.

Several source reduction options were evaluated for this CAOC in the FS.

1) **Soil excavation.** This option is not feasible because of the depth of the contamination (140 feet to groundwater) and the density of physical

improvements (i.e., buildings, structures, equipment) and industrial activity at Building 573.

2) **In situ vertical AS/SVE.** A small-scale AS/SVE pilot study conducted during the RI/FS demonstrated that this technology would effectively remove VOC contamination from the vadose zone and groundwater underlying Building 573. However, the pilot study also evidenced significant logistical problems during installation and operation of the system due to the high traffic flow and concentration of industrial activity and infrastructure at this CAOC. These problems would be compounded in an attempt to install a full-scale system. The presence of numerous underground utilities in the area would require clearance, dictate placement of wells, and could cause significant disruptions to utility service during system installation. Vertical clearance inside Building 573 is inadequate to accommodate the large drilling equipment required. Overall, these problems would severely limit the efficiency and cost-effectiveness of any system that could be installed. Based on these limitations, the Marine Corps determined that installing a full-scale vertical AS/SVE would result in major disruptions to mission-critical operations, and that this option is not feasible under the current site conditions.

3) **In situ horizontal SVE and AS/SVE.** This option was considered as a way to overcome the limitations of vertical drilling. However, the relatively deep groundwater table (140 feet), overall length of drilling needed to provide coverage of the Building 573 area (1,000 feet), and high cost of the technology ($500 per linear foot of drilling), make this option largely ineffective and extremely cost-prohibitive. MCLB also evaluated a variation of this option which involved SVE only. Under this variation, samples needed for soil contamination characterization would be collected using the horizontal drilling techniques. Following the investigative stage, the same horizontal borings would be cased and completed to function as soil vapor extraction wells. According to the economic evaluation for this option, a total of approximately $26 to $38 million would be required for soil investigation and completion of the SVE facilities. There is uncertainty in this initial capital cost, because the characteristics of the required SVE wells are at the practical limits of the technological for horizontal well construction. The estimated annual operating cost for the horizontal SVE option is $400,000.

4) **In situ vertical AS/SVE downgradient of CAOC 16.** This last option involved placing a vertical AS/SVE system off the hardstand area, downgradient of Building 573, to overcome the logistical problems encountered by the other options. This option would intercept and remove VOC contamination from groundwater as it passes through the system flowing away from the facility. This option would not effectively remove VOC contamination in the vadose zone directly under Building 573. The existing 10-inch-thick concrete stand provides an effective protection barrier against potential leaching of vadose zone contaminants into groundwater due to infiltration. However, VOC contamination in the vadose zone could still migrate to groundwater through the process of VOC vapor diffusion and dispersion of soil pores.

Based on the existing conditions at CAOC 16, the Marine Corps determined that the last option (Option 4: In situ vertical AS/SVE downgradient of CAOC 16) is the most practical and cost-effective alternative to address VOC contamination. The Marine Corps evaluation indicates the other options are not feasible at this time, because of technical and economic reasons. Those options include Option 1 (soil excavation), Option 2 (in situ vertical AS/SVE), Option 3 (in situ horizontal AS/SVE), and the horizontal SVE variation of Option 3.

The DON and regulatory agencies have agreed not to include vadose zone cleanup of this CAOC as part of the final remedy for the Yermo Annex plume and to further evaluate the technical and economic feasibility of vadose zone cleanup at this CAOC according to the criteria outlined in Section 2.8.7 of this ROD.

3.3.2.2 CAOC 26

The Packaging and Maintenance Shop area has been identified as a major source of vadose zone contamination and included in the groundwater NTCRA being conducted at the Yermo Annex. The following source reduction options were evaluated for this CAOC in the FS.

1) **Soil excavation.** This option is not feasible because of the depth of the contamination (140 feet to groundwater) and the presence of physical improvements (i.e., buildings, structures, equipment).

2) **In situ vertical AS/SVE.** This option involves installing and operating a full-scale AS/SVE system designed to provide complete coverage of the vadose zone and groundwater source areas at CAOC 26. This option was selected as the preferred remedy at CAOC 26 based on the results of the AS/SVE pilot study conducted at CAOC 16 during the RI/FS, which demonstrated that this technology is effective in removing VOC contamination from the vadose zone and groundwater. AS/SVE is expected to be effective at CAOC 26 because of its similar hydrogeologic characteristics to CAOC 16. The AS/SVE system is being implemented as part of the Yermo Annex groundwater NTCRA and incorporated into the selected remedy for OU 1 documented in this ROD.

Because the existing system's SVE wells at CAOC 26 are screened at depth (i.e., within 10 feet of the groundwater table), there is some uncertainty at this time regarding the efficiency of the SVE system to effectively remove contamination from the near-surface soils. Because of this, there exists the potential for residual VOC contamination in the near-surface soils to impact future receptors at the site, either through direct soil contact or through vapor migration and inhalation. To address this, the Navy will perform an evaluation to determine if residual vadose zone contamination represents a threat to potential future on-site receptors. If the evaluation demonstrates that a potential threat to human health exists, then the Navy will include in a written notification to the FFA signatories i) an evaluation of the need for any additional remedial action and ii) a description of the changes necessary to the selected remedy for the Yermo Annex plume in the ROD for OU 1. The Navy will add appropriate language to the MCLB Barstow Master Plan describing the potential threat, along with any restrictions on site use. The language to be added to the Master Plan will be provided to the FFA signatories for review and concurrence prior to it being placed in the Master Plan.

The results of the vadose zone monitoring will be incorporated into the FFA primary document to be submitted to the agencies as established in Section 2.8.12 of this ROD.

<u>Vadose Zone Modeling to Determine AS/SVE System "Shut Off"</u>

Performance parameters for vadose zone modeling will be measured by using the nested vapor probes located at 30-, 60-, and 90-foot depths in the vadose zone at CAOC 26. The vapor probe data will provide an indication of the VOC mass removal in the vadose zone and will be used to derive vadose zone soil concentrations of VOCs for input to the vadose zone model. VLEACH or another appropriate vadose zone fate and transport model will be used to assess when residual VOC levels in the soil no longer pose a threat to groundwater and to demonstrate whether vadose zone cleanup has been achieved for Item 1 of Section 2.8.4 of this ROD.

3.3.2.3 CAOCs 23 and 35

These CAOCs were primarily used as municipal landfills and are believed to have been sources of groundwater contamination at one time. These CAOCs are no longer in use and are classified as inactive waste management units. The presumptive remedy approach for CERCLA municipal landfills is capping and long-term groundwater monitoring. Capping actions are being addressed under OU 3 for CAOC 23 and OU 5 for CAOC 35. The capping options being considered either eliminate or significantly limit infiltration thus eliminating or minimizing further potential impacts to groundwater. Therefore, no further vadose zone action is being considered for these CAOCs under OUs 1 and 2. However, the groundwater monitoring requirements for CAOCs 23 and 35 are being addressed under OUs 1 and 2.

3.4 Description of Remedial Action Alternatives, Yermo Annex Plume

Ten alternatives for the remediation of groundwater and vadose zone soil in OU 1 are presented in this section. These alternatives are discussed in detail in the Draft Final FS for OUs 1 and 2 (Jacobs 1996a) and summarized in this section. Alternative 7 was screened out during the preliminary evaluation stage and is not included in the ten alternatives discussed herein.

3.4.1 Alternative 1 – No Action

Under this alternative, no further action would be taken to clean up or control contamination from vadose zone soil or groundwater. The existing site conditions would not change. No costs are associated with this alternative. The no action alternative provides a baseline for comparing the other alternatives.

3.4.2 Alternative 2 – Institutional Controls/Groundwater Monitoring

This alternative includes the implementing of institutional controls and initiating a long-term groundwater monitoring program. This alternative relies on natural processes such as dispersion degradation, sorption, and volatilization to reduce VOC concentrations. Institutional controls will ensure that the affected groundwater will not be used in the future, thereby maintaining the current lack of exposure to, and risks from, chemicals in groundwater.

Institutional controls include restrictions on the use of untreated groundwater for drinking water, and provisions for wellhead treatment of affected water supply wells within the Yermo Annex plume. The institutional controls to restrict access to contaminated groundwater for on-Base areas will be documented in the Base Master Plan, a document that MCLB Barstow uses to coordinate and plan future activities (e.g., new construction). For off-Base areas, they could include but not be limited to zoning ordinances implemented by county agencies that restrict use of groundwater in these areas. The Marine Corps will provide the necessary information to appropriate county agencies identifying the areas that have been impacted by groundwater contamination exceeding MCLs. The Marine Corps will support county agencies with any technical information needed for the county to implement these restrictions.

This alternative also includes a long-term monitoring program to monitor groundwater beneath and downgradient of contaminant sources. Groundwater monitoring involves sampling existing and new monitoring wells as required to monitor trends in contaminant concentrations, evaluate remediation progress and contaminant migration patterns, and provide early warning to potentially affected downgradient users. One of the goals of the long-term monitoring program is to determine the effectiveness of the selected remedy. To support this determination, the monitoring program will include vadose zone monitoring at potential sources.

A Post-ROD vadose zone and groundwater monitoring plan for the Yermo Annex remedial action will be prepared under the authority of this ROD outlining the monitoring well network, sampling and analytical methods, sampling frequency and major decision points to be made during monitoring (e.g., adding or removing monitoring wells from the network, changing sampling frequency or analytical parameters, etc.). The Post-ROD Monitoring Plan will be a primary FFA deliverable to be submitted to the agencies within one year of the signing of the ROD.

The post-ROD monitoring plan will also include necessary post-closure groundwater monitoring at CAOCs 23 and 35 landfills.

The cost for Alternative 2 includes approximately $250,000 in capital costs and $140,000 in yearly operation and maintenance (O&M) costs to put in place institutional controls and implement the long-term groundwater monitoring programs for a total present worth cost of $2.5 million. Groundwater modeling indicates that it would take this alternative over 500 years to naturally degrade contaminants to levels below drinking water standards. Except for the no action alternative, all alternatives include institutional controls and long-term groundwater monitoring.

3.4.3 Alternative 3 – Groundwater Removal (Extraction Wells at Base Boundary), Ex Situ Treatment, and Discharge

This alternative involves installing eight groundwater extraction wells at the eastern boundary of the Base to capture the on-Base portion of the plume, followed by activated carbon treatment of the extracted water. The treated water is recharged into the aquifer via two infiltration galleries located upgradient of the contaminant plume. MCLB Barstow estimates that this system would extract 600 to 800 gallons per minute (gpm) of water from the top 50 feet of the shallow aquifer. The main purpose of this alternative is to prevent the higher groundwater contamination on-Base from moving into lower contamination areas off-Base. This also would begin reducing concentrations of VOCs in groundwater in the Yermo Annex area by removing the majority of the contamination from the aquifer. The on-Base portion of the plume represents about 90 percent of the total VOC contamination in the Yermo Annex area. The major components of this alternative would consist of:

- Implementing institutional controls described in Alternative No. 2.
- Designing and constructing groundwater extraction wells (already in place).
- Designing and installing an on-site aboveground treatment system and a retention and recycling system including two infiltration galleries (already in place).

- Starting up and operating this system (already in operation).
- Transporting, regenerating, recycling, and disposing of the spent filters.
- Operating a long-term groundwater monitoring program (in progress).

The approximate volume of groundwater requiring remediation is estimated to be 3.5 billion gallons. The cost for Alternative 3 includes $4.3 million in capital costs to construct the treatment system (all of which has already been constructed as part of the Yermo Annex NTCRA), and $410,000 in yearly O&M costs to operate the system, for an estimated total present worth cost of $14.1 million. Groundwater modeling indicates that it would take this alternative about 190 years for the on-Base portion and over 500 years for the off-Base portion of the VOC plume to degrade to levels below drinking water standards.

3.4.4 Alternative 4 – Groundwater Removal (Extraction Wells at Base Boundary and Off-Base Background Boundary), Ex Situ Treatment, and Discharge

This alternative is similar to Alternative 3, but includes 11 additional off-Base wells to capture the entire plume at the background (leading edge) boundary. MCLB Barstow estimates that this system would extract 1,400 to 1,900 gpm from the aquifer. This alternative evaluates the option of cleaning up all VOC-contaminated groundwater to background levels. The major components of this alternative are the same as for Alternative 3. The approximate volume of groundwater requiring remediation under this alternative is 6.13 billion gallons. The cost for Alternative 4 includes $9.5 million in capital costs to construct the treatment system (of which $4.3 million have already been constructed as part of the Yermo Annex NTCRA), and $868,000 in yearly O&M costs to operate the system, for an estimated total present worth cost of $30.1 million. Groundwater modeling indicates that it would take this alternative about 320 years for the on-Base portion and 70 years for the off-Base portion of the plume to clean up to background levels.

3.4.5 Alternative 5 – Groundwater Removal (Extraction Wells at Base Boundary and Off-Base MCL Boundary), Ex Situ Treatment, and Discharge

This alternative provides an intermediate option between Alternatives 3 and 4. Alternative 5 is also similar to Alternative 3, but includes four additional off-base wells to capture the off-Base portion at the MCL boundary. This system is estimated to extract 900 to 1,200 gpm from the aquifer. This alternative evaluates the option of cleaning up all VOC-contaminated groundwater to meet federal and state drinking water standards. The major components of this alternative are the same as for Alternative 3. The approximate volume of groundwater requiring remediation under this alternative is 3.75 billion gallons. The cost for Alternative 5 includes $6.4 million in capital costs to construct the treatment system (of which $4.3 million have already been constructed as part of the Yermo Annex NTCRA), and $643,000 in yearly O&M costs to operate the system, for an estimated total present worth cost of $21.8 million. Groundwater modeling indicates that it would take this alternative about 160 years for the on-Base portion and 20 years for the off-Base portion of the plume to clean up to levels below drinking water standards.

3.4.6 Alternative 6 – Groundwater Removal (Extraction Wells at Base Boundary and CAOC 26 Boundary), Ex Situ Treatment, and Discharge

This alternative is a variation of Alternative 3, designed to reduce the time to clean up the on-Base portion of the contaminant plume to below drinking water standards by 40 years, from 190 to 150 years. Alternative 6 involves four additional on-Base groundwater extraction wells to intercept the portion of the VOC plume originating from CAOC 26. This system would extract from 900 to 1,200 gpm from the aquifer. The major components of this alternative are the same as for Alternative 3. The approximate volume of groundwater requiring remediation under this alternative is 3.5 billion gallons. The cost for Alternative 6 includes $6.6 million in capital costs to construct the treatment system (all of which has already been constructed as part of the Yermo Annex NTCRA), and

$662,000 in yearly O&M costs to operate the system, for an estimated total present worth cost of $19.3 million.

3.4.7 Alternative 8A – Groundwater Removal and Source Reduction (Extraction Wells at Base Boundary and CAOC 26 Boundary, AS/SVE at CAOC 26), Ex Situ Treatment, and Discharge

Alternative 8A, and all alternatives that follow, incorporate source removal into the remedial action. These alternatives are designed to significantly reduce the time to clean up the groundwater VOC contamination by removing contaminants trapped in the vadose zone soils and groundwater underneath the original source. The vadose zone is the area of unsaturated subsurface soil overlying groundwater. Contaminants trapped in the vadose zone can provide a continuous source of contaminants to groundwater for many years, thus prolonging the cleanup efforts. Alternative 8A is a variation of Alternative 6, which includes AS/SVE treatment at CAOC 26. This alternative is estimated to further reduce the time of Alternative 6 to clean up the on-Base portion of the plume to below drinking water standards by 110 years, from 150 to 40 years. The cost for Alternative 8A includes $7.5 million in capital costs to construct the treatment system (all of which has already been constructed as part of the Yermo Annex NTCRA), and $787,000 in yearly O&M costs to operate the system, for an estimated total present worth cost of $21.3 million.

3.4.8 Alternative 8B – Groundwater Removal and Source Reduction (Extraction Wells at Base Boundary and CAOC 26 Boundary, AS/SVE at CAOC 26 and Downgradient of CAOCs 16, 15/17, and 35), Ex Situ Treatment, and Discharge

Alternative 8B further expands on Alternative 8A by adding AS/SVE treatment downgradient of CAOCs 16, 15/17, and 35. This alternative eliminates an additional 10 years of treatment, reducing the total time to clean up the on-Base portion of the plume to below drinking water standards to 30 years. The cost for Alternative 8B includes $9.4 million in capital costs to construct the treatment system (all of which has already been constructed as part of the Yermo Annex

NTCRA), and $968,000 in yearly O&M costs to operate the system, for an estimated total present worth cost of $22.1 million.

As mentioned above, Alternative 8B already is being fully implemented in the form of a CERCLA NTCRA at the Yermo Annex. The objective of the removal action is to stop all further migration of contaminants off of the Base, begin to address the main sources, and accelerate groundwater cleanup.

3.4.9 Alternative 8C – Groundwater Removal and Source Reduction (Extraction Wells at Base Boundary, Off-Base MCL Boundary, and CAOC 26 Boundary; AS/SVE at CAOC 26 and Downgradient of CAOCs 16, 15/17, and 35), Ex Situ Treatment, and Discharge

Alternative 8C is the same as Alternative 8B, except that it captures and treats the off-Base portion of the VOCs plume above MCLs to meet federal and state drinking water standards. The off-Base portion of the plume below MCLs will not be captured; instead it will be allowed to naturally attenuate because it already meets drinking water standards. The cleanup times to MCLs are estimated at about 30 years. The cost for Alternative 8C includes $10.9 million in capital costs to construct the treatment system (of which $9.4 million have already been constructed as part of the Yermo Annex NTCRA), and $1.2 million in yearly O&M costs to operate the system, for an estimated total present worth cost of $27.1 million.

3.4.10 Alternative 8D – Groundwater Removal and Source Reduction (Extraction Wells at Base Boundary, Off-Base Background Boundary, and CAOC 26 Boundary; AS/SVE at CAOC 26 and Downgradient of CAOCs 16, 15/17, and 35), Ex Situ Treatment, and Discharge

This alternative is also similar to Alternative 8B, but involves full capture of the off-Base plume at the background (leading edge) boundary and cleanup of the entire VOCs contaminated groundwater to background levels. The cleanup times is estimated at about 55 years. The cost for Alternative 8D includes $14.3

million in capital costs to construct the treatment system (of which $9.4 million has already been constructed as part of the Yermo Annex NTCRA), and $1.9 million in yearly O&M costs to operate the system, for an estimated total present worth cost of $49.2 million.

3.5 Summary of Comparative Analysis of Alternatives

This section summarizes the evaluation of remedial alternatives conducted to select the alternative that provides the best balance with respect to the nine statutory evaluation criteria in the NCP and discussed in Section 2.9.

The selected alternative for addressing the groundwater contamination at the Yermo Annex is Alternative 8C – groundwater removal and source reduction (extraction wells at Base boundary, off-Base MCL boundary, and CAOC 26 boundary; AS/SVE at CAOC 26 and downgradient of CAOCs 16, 15/16, and 35), Ex Situ Treatment and Discharge. Based on the current information, this alternative appears to provide the best balance of trade-offs among the alternatives with respect to the nine EPA evaluation criteria.

The following analysis summarizes the evaluation of remedial alternatives under the three criteria groups: threshold criteria, primary balancing criteria, and modifying criteria (see Section 2.9). Table 3-5 presents a comparison between each of the alternatives for achievement of a specific criterion.

3.5.1 Threshold Criteria

3.5.1.1 Overall Protection of Human Health and the Environment

The no action alternative does not provide adequate protection of human health and the environment if the groundwater were to be used as drinking water in the future. The institutional controls alternative (Alternative 2) provides protection by restricting future use. The calculated human health risk for Alternatives 3 through 6, 8A, 8B, 8C, and 8D is at the upper end of the EPA's target risk range. However, given the conservative nature of the risk assessment and the uncertainties in the toxicological data used to derive the risk estimates for 1,1-DCE, it is likely that the actual risk posed to a hypothetical residential receptor would be well within the EPA target risk range. Assuming that institutional controls are effective, particularly in off-Base areas, all alternatives except the no action alternative are considered to be protective of human health and the environment. However, only Alternatives 3 to 8D use active measures to reduce contamination, reduce the future threat to human health and the environment, and more quickly remediate to cleanup levels.

3.5.1.2 Compliance with ARARs

A summary of the potentially applicable ARARs for groundwater protection at MCLB Barstow is provided in Section 2.10. All alternatives comply with location-specific ARARs because no ecological, natural, or cultural resources are threatened by the groundwater contamination. All alternatives also comply with action-specific ARARs; specifically, state antidegradation ARARs for treated groundwater discharges, VOC emissions control, and groundwater monitoring requirements.

The Lahontan RWQCB has classified the aquifer underlying the Yermo Annex as a potential drinking water source. Alternatives 2, 3, 6, 8A, and 8B do not comply with the chemical-specific federal and state ARARs for drinking water standards (i.e., MCLs, nonzero MCL goals, or risk-based concentrations) because they do not capture the off-Base portion of the plume above MCLs. Alternatives 4, 5, 8C, and 8D comply with all location-, action-, and chemical-specific ARARs.

3.5.2 Primary Balancing Criteria

3.5.2.1 Long-Term Effectiveness and Permanence

Groundwater and vadose zone modeling were used to estimate how long it would take to achieve MCLs or background concentrations at the point of compliance for all the alternatives evaluated.

All alternatives except Alternative 1 provide moderate to high long-term effectiveness and permanence. The results indicate that Alternatives 2 through 6 would require a relatively long time to achieve remedial goals (150 to over 500 years). Alternative 2 can effectively reduce risk by restricting the use of untreated groundwater for drinking water and providing wellhead treatment when warranted. However, if these control measures cannot be implemented or maintained, Alternative 2 would not comply with this criterion. Alternative 8C will meet cleanup levels by providing a capture zone that will prevent migration of contaminants exceeding drinking water standards, and will extract and treat all contaminated groundwater above these standards in an estimated 30-year timeframe. Levels of contamination present in the vadose zone at CAOCs 16 and 15/17 may affect the long-term effectiveness of the selected remedy and result in increasing the 30-year remediation time estimate.

3.5.2.2 Reduction of Toxicity, Mobility, or Volume through Treatment

Alternatives 1 and 2, the no action and institutional controls alternatives, would not provide for a reduction in toxicity, mobility, and volume through treatment because they are not treatment options. All other alternatives would achieve moderate to high reduction of toxicity, mobility, or volume through active extraction and treatment and AS/SVE remediation.

3.5.2.3 Short-Term Effectiveness

Due to the length of the remedial action, short-term risks are the same as current risks. Except for the no action alternative, all alternatives rely on institutional controls for short-term effectiveness of community protection. Such controls are more effective on-Base. If off-Base controls cannot be maintained, short-term effectiveness would be compromised.

The no action and institutional control alternatives would have the least immediate harmful effect on human health and the environment, but would also provide less protection in the short term. The active remediation alternatives would slightly increase the risk of exposure by pumping and handling of contaminated groundwater. However, use of proper worker protection and safety measures would reduce these risks to safe levels.

3.5.2.4 Implementability

The no action alternative is the easiest to implement because there is nothing to implement. Imposing institutional controls off-Base will require state, local, and community involvement.

Extraction and treatment and AS/SVE are proven, commercially available, readily implementable, and simple to operate technologies. As discussed in Section 3.3.2, constructibility issues at or near Building 573 will prevent installing an AS/SVE system directly underneath CAOC 16. In all other on-Base areas, no problems are expected during installation of extraction wells and treatment systems. Construction of off-Base extraction wells will require obtaining access to private property through coordination with private land owners and local officials.

3.5.2.5 Cost Effectiveness

The selected alternative (Alternative 8C) is the second most costly, with an estimated present worth value of $27.1 million, exceeded only by Alternative 8D with a present worth of $49.2 million. Alternative 8C costs more than most of the other alternatives, but is the only groundwater remedy that meets the threshold criteria for protection of human health and the environment and complies with ARARs in an estimated 30-year time frame. The higher cost is therefore justifiable and cost effective. Approximately $10 million in the capital cost of alternative 8C and 1 year of O&M costs have already been incurred in the implementation of the groundwater NTCRA at the Yermo Annex.

3.5.3 Modifying Criteria

3.5.3.1 State Acceptance

The California State DTSC and RWQCB have reviewed and approved the OUs 1 and 2 FS and Proposed Plan, and agree with the selected final remedy for the Yermo Annex plume.

3.5.3.2 Community Acceptance

Minor verbal comments were received from the public concerning the proposed actions for OUs 1 and 2. These comments are included on Page 27 of the public meeting transcripts provided in Appendix C, and in Section 6, "Responsiveness Summary."

3.6 Summary of Selected Remedy For the Yermo Annex Plume

As required by CERCLA and the NCP, and based on the results of the detailed analysis of alternatives presented above, MCLB Barstow selected Alternative 8C as the final remedy to address groundwater and vadose zone contamination at the Yermo Annex.

For the contaminated groundwater above MCLs, the selected remedy consists of remediation of the contaminant plume by pump and treat, with ex situ treatment and recharge of treated groundwater back into the aquifer, and enhanced by AS/SVE. This remedy will consist of containing and extracting the contaminated groundwater from the upper 50 feet of the aquifer, treating it on site through a carbon infiltration system and recharging it back into the aquifer through two infiltration galleries at the upgradient edge of the plume. Air sparge effluent from AS/SVE systems will be discharged to the atmosphere after it has been filtered for organic compounds. Air discharges will comply with the discharge standards and requirements of the local air pollution control district. The used carbon filter media will be taken off site for recharge and reused.

The groundwater extraction wells will be arranged at three areas consisting of four on-Base extraction wells designed to capture the plume originating from CAOC 26, eight wells at the eastern boundary of the Base to capture the on-Base portion of the plume, and four off-Base wells at the MCL boundary of the plume to capture the off-Base portion of the plume above MCLs. The four groundwater extraction wells for CAOC 26 and the eight wells on the eastern boundary of the Base have already been installed. Locations, sizing, and pumping rates for these wells were determined by evaluating the results of pumping tests conducted as part of the remedial design phase. The four off-Base wells at the MCL boundary still need to be located and installed.

Contaminated groundwater will be pumped to the water treatment system, treated, and recharged at the upgradient edge of the plume through the infiltration galleries. The groundwater carbon filtration and AS/SVE treatment systems for CAOCs 26 and 16 have already been constructed and are currently operational. The four off-Base extraction wells at the MCL boundary will eventually be connected to the existing groundwater treatment system. Because the underlying aquifer is relatively slow moving (60 ft/yr), the infiltration galleries will be used to help enhance movement of contaminated groundwater toward the extraction wells. Extracting and treating the groundwater will continue until the performance standards (see Table 2-1) are achieved. Clean up of the contaminated groundwater at OU 1 to MCLs is estimated to take 30 to 40 years.

This remedy includes periodic vadose zone and groundwater monitoring to track changes in the level and extent of contamination. The major components consist of:

- Implementing institutional controls.
- Designing and constructing groundwater extraction wells, monitoring wells and SVE wells, as necessary.
- Designing and constructing a groundwater extraction and monitoring system, a groundwater treatment system, and two infiltration galleries.
- Designing and installing two AS/SVE systems, one at CAOC 26 and a second one downgradient of CAOCs 16, 15/17, and 35, and conducting vadose zone soil gas monitoring to assess the effectiveness of these systems.
- Starting and operating these systems.

- Transporting, regenerating, recycling, and/or disposing of the spent filters.
- Operating and maintaining of a long-term vadose zone and groundwater monitoring program that includes periodic monitoring of selected COCs in soil vapor and groundwater monitoring and extraction wells, to be specified in a post-ROD OU 1 Remedial Action Groundwater Monitoring Plan (OHM 1996a).
- Conducting quarterly sampling of groundwater for 1 year for five dissolved metals (nickel, chromium, antimony, thallium and aluminum) at selected wells in the area of CAOC 16 to ascertain if these metals are naturally occurring or the result of Base activities.
- Closure criteria.

To ensure that human health and the environment are protected in the future, institutional controls will be implemented that include access restrictions to prevent the on-Base use of untreated groundwater for domestic use, which includes ingestion, dermal contact and inhalation as routes of exposure. Wellhead treatment will be provided for any existing water supply wells that fall within the area of the plume exceeding MCLs. The DON will provide necessary information to appropriate county agencies identifying off-Base areas impacted by groundwater contamination exceeding MCLs. The DON will support county agencies with any technical information needed for the county to implement restrictions on construction and use of wells in the affected areas.

The written concurrence of the FFA signatories is required before the DON takes any action at a CAOC that would be inconsistent with the prohibition against use of untreated groundwater at the Yermo Annex for domestic use. If any such action is proposed, the DON must provide the FFA signatories with written notification of such proposed action. The notice shall include (i) an evaluation of the risk to human health and the environment, (ii) an evaluation of the need for any additional remedial action as a result of the proposed action, and (iii) a description of the changes necessary to the selected remedy for the Yermo Annex plume in the ROD for OUs 1 and 2.

The written notice of proposed action shall be submitted to the FFA signatories at least 60 days prior to the commencement date for the proposed action. The EPA will advise whether a ROD amendment or an Explanation of Significant Differences (ESD) document is required. The response from the FFA signatories is due within 30 days of the DON's written notice of proposed action. The DON may not commence any action without the written concurrance of the FFA signatories.

The DON shall notify the FFA signatories of any plan to lease or transfer Yermo Annex real property to a non-federal or federal entity, notify the transferee or lessee of the prohibition on use of groundwater at the Yermo Annex for domestic use and include the restrictions in the transfer or lease. Such notification shall be provided at least 45 days in advance of the lease or transfer conveyance. The DON shall comply with Section 120(h)(3) of CERCLA in any such transfers.

The DON will also provide the FFA signatories with 30 days advance notice of any amendment to the Master Plan that could affect either the substance or the language of the Yermo Annex Master Plan groundwater use restriction amendment.

The MCLB Barstow Base Master Plan will be amended to incorporate the above-mentioned restrictions on access to and use of contaminated groundwater for drinking water purposes on-Base. The Master Plan amendments will include language that 1) prohibits the on-Base use of untreated groundwater for domestic use; 2) describes the risk to human health and the environment from use of the contaminated groundwater; and 3) references the MCLB Barstow OUs 1 and 2 RI/FS and ROD. The language in the Master Plan amendments will also include the title and dates of the above-listed documents and their storage location. These amendments to the Master Plan will be completed by the DON within 1 year of signing the MCLB Barstow OUs 1 and 2 ROD. The FFA signatories will be provided with a draft copy for review and comment of the amendments to the Master Plan reflecting the above languague.

The groundwater remedy for OU 1 is consistent with the requirements of Section 121 of CERCLA and the NCP. The remedy will reduce the mobility, toxicity, and volume of contaminated groundwater at the site. In addition, the remedy is protective of human health and the environment, will attain all federal and state applicable or relevant and appropriate requirements, is cost-effective, and uses permanent solutions to the maximum extent practicable. The remedy for OU 1 is consistent with previous removal actions at the site. Based on the information available at this time, the selected remedy represents the best balance among the criteria used to evaluate remedies.

3.6.1 Performance Standards for Groundwater and Source Reduction

Groundwater from the aquifer shall be monitored until cleanup goals (performance standards) set for in Table 2-1 are achieved as agreed upon by the DON and the regulatory agencies. See Sections 2.8 and 3.3. for discussion of source reduction performance standards.

3.6.2 Infiltration Standards

Treated groundwater that will be recharged into the aquifer passed through the infiltration galleries shall comply with the substantive general waste discharge requirements for land disposal of treated groundwater, Lahontan RWQCB Board Order No. 6-93-106. These requirements are listed in Table 3-6. Meeting these requirements complies with SWRCB Resolution 68-16 and the Basin Plan. The general discharge requirements of Board Order No. 6-93-106 have monitoring requirements that verify compliance. A schedule for compliance appropriate for this monitoring shall be established in the Yermo Annex Remedial Action Groundwater Monitoring Plan.

3.6.3 Groundwater and Vadose Zone Monitoring

Groundwater and vadose zone monitoring shall be conducted for the Yermo Annex plume during the remedial action in accordance with the Yermo Annex Remedial Action Groundwater Monitoring Plan (see Section 3.4.2) to verify that the remedial action is being effective towards achieving remedial action objectives (RAOs). The Remedial Action Groundwater Monitoring Plan will consists of existing and new groundwater monitoring wells if necessary, to determine if RAOs are being met. Vadose zone monitoring will consist of the existing soil vapor probes at CAOC 26, and three additional probes at CAOC 16 to be installed post-ROD. The DON will monitor the vadose zone and groundwater as specified in the groundwater monitoring plan, until it is demonstrated that the remedial action has effectively and permanently reduced the VOC contamination to within the remedial goals (RGs) set forth in Table 2-1. The criteria for assessing the effectiveness of the remedial action shall also be included in the groundwater monitoring plan. If monitoring indicates that RGs have not been met in accordance with these criteria, the groundwater remedial action will continue until the RGs are achieved. The results of the groundwater monitoring will be evaluated every 5 years, and the duration and frequency of the groundwater monitoring modified as appropriate until it is determined that the remedial action has been completed.

Groundwater monitoring for CAOCs 23 and 35 will entail collection and analysis of groundwater samples for compliance monitoring per CCR Title 22 (RCRA landfill closure requirements). Compliance monitoring will involve quarterly collection of one sample per well from at least two downgradient and one upgradient monitoring wells for 2 years. Groundwater samples will be analyzed for VOCs (EPA Method 8260) and general chemistry quarterly for 2 years. It is assumed that the data gathered in the initial two years of monitoring will provide adequate trend data of the groundwater plume, so that the frequency of sampling events will be reduced to half (i.e., semiannual) for the following 28 years. The results of the groundwater monitoring will be reevaluated every 5 years, and the duration and/or frequency of the groundwater monitoring may be further modified based on the results of the reevaluations.

As discussed in Section 3.1.1.2, groundwater monitoring will be conducted to measure the concentrations of five metals (nickel, chromium, antimony, thallium and aluminum) in a few selected groundwater monitoring wells in the area of CAOC 16 for a minimum of four additional quarters (1 year). The exact wells to be sampled and the sampling schedule will be specified in the Remedial Action Groundwater Monitoring Plan for the Yermo Annex. Data will be provided to the agencies in the Quarterly Groundwater Monitoring Report for the Yermo Annex. The conclusions and recommendations resulting from this sampling will be submitted to the agencies in a primary FFA document.

3.7 Statutory Determination

As a lead federal agency, the Marine Corps' primary responsibility at its CERCLA sites is to undertake remedial actions that achieve adequate protection of human health and the environment. In addition, Section 121 of CERCLA established several other statutory requirements and preferences. These specify that, when complete, the selected remedial action for this site must comply with applicable or relevant and appropriate environmental standards as established under federal and state environmental laws unless a statutory waiver is justified. The selected remedy also must be cost effective and use permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. Finally, the statute includes a preference for remedies that employ treatment that permanently and significantly reduce the volume, toxicity, or mobility of hazardous wastes as their principal element. The following sections discuss how the selected remedy meets these statutory requirements.

3.7.1 Protection of Human Health and the Environment

The selected remedy protects human health and the environment by remediating the contaminant plume through extraction, ex situ treatment and recharge of treated groundwater back into the aquifer. The selected remedy protects human health and the environment by eliminating, reducing, and controlling risk through remediation and institutional controls.

3.7.2 Compliance with ARARs

As stated in Section 2.10, remedial actions performed under CERCLA must comply with all ARARs. The selected alternative for the Yermo Annex plume was found to comply with all the ARARs presented in Tables 2-2 through 2-7.

3.7.3 Cost Effectiveness

Cost effectiveness is determined by comparing the cost of all alternatives being considered with their overall effectiveness to determine whether the costs are proportional to the effectiveness achieved. The Marine Corps evaluates the incremental cost of each alternative as compared to the increased effectiveness of the remedy. The selected remedy for groundwater is remediation through extraction, with ex situ treatment and recharge of treated groundwater back into the aquifer. The selected remedy includes groundwater extraction wells at the Base boundary, at the off-Base MCL boundary, and at the CAOC 26 boundary. It also includes AS/SVE at CAOC 26 and downgradient of CAOCs 15/17, 16, and 35 to enhance the pump and treat remediation system.

Based on the information obtained, this selected remedy will provide the best balance of trade-offs among the alternatives with respect to the nine criteria provided by EPA to evaluate the alternatives. This remedy is more costly than the other alternatives considered except Alternative 8D. Alternative 8D would remediate groundwater to background levels; however, it would take almost double the time and cost of Alternative 8C while only marginally reducing the human health risk. Alternative 8C is the only alternative projected to remediate groundwater to MCL in 30 years, making Alternative 8C cost effective. Therefore, the higher cost is justified and cost effective.

3.7.4 Use of Permanent Solutions to the Maximum Extent Practicable

MCLB Barstow, EPA, DTSC, and CRWQCB believe that the selected remedy is the most appropriate remedial approach for the Yermo Annex groundwater and vadose zone and provides the best balance among the evaluation criteria for the remedial alternatives considered. The AS/SVE enhanced extraction and treatment remedy for groundwater is a permanent remedy. The selected remedy will return the groundwater back into the same aquifer; it meets the statutory requirement to use permanent solutions and treatment technologies to the maximum extent practicable.

3.7.5 Preference for Treatment as a Principal Element

The statutory preference for treatment at the Yermo Annex will be met through remediation of groundwater by AS/SVE enhanced extraction and treatment of contaminated groundwater.

3.8 Documentation of Significant Change

The final remedy for the Yermo Annex plume, Alternative 8C, has not been changed or refined from the Proposed Plan.

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Table 3-1
Yermo Plume - On-Base
Maximum Groundwater Concentrations of VOCs and Associated MCLs

VOC	Maximum Groundwater Concentration (ug/L)	Federal MCL (ug/L)	California MCL (ug/L)	PRGs (mg/L)
Contaminants Exceeding Drinking Water Standards (MCLs)				
1,1-Dichloroethene (1,1-DCE)	41	7	6	
1,2-Dichloroethane (Ethylene Dichloride or EDC) (1,2-DCA)	4	5	0.5	
1,2-Dichloroethene, Total	1	70	6	
Benzene	13	5	1	
Tetrachloroethene (PCE)	230	5	5	
Trichloroethene (TCE)	310	5	5	
Contaminants Not Exceeding Drinking Water Standards (MCLs)				
1,1,1-Trichloroethane	2	200	200	
1,1-Dichloroethane	4	-	5	
1,1,2-Trichloro-1,2,2-Trifluorothane (Freon 113)	4	-	1200	
cis-1,2-Dichloroethene (cis-1,2-DCE)	35	70	6	
trans-1,2-Dichloroethene	0.5	100	10	
2-Butanone (methyl ethyl ketone)	19	-	-	1900
2-Hexanone	8	-	-	Not available
4-Methyl-2-Pentanone (methyl isobutyl ketone)	7	-	-	160
Acetone [1]	11			610
Bromodichloromethane	3	100	-	-
Bromoform (Tribromomethane)	17	100	-	-
Carbon Disulfide	34	-	-	21
Carbon Tetrachloride	0.1	0.5		
Chloroform [1]	1	100		
Chloromethane [1]	1	-	-	1.5
Dibromochloromethane	10	100	-	-
1,2-Difluoro-1,1,2,2-Tetrachloroethane (Freon 112)	2			
1,2-Difluoro-1,1,2,2-Tetrafluoroethane (Freon 112)	2			
Methylene Chloride[1]	3	5		
Toluene	6	150		
Trichlorofluoromethane (Freon 11)	130		150	
Xylene (Total)	0.8	10000	1750	

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

Data includes most recent groundwater monitoring conducted by OHM Remediation Services, Inc. (OHM 1994, 1995, 1996).

Table 3-2
Yermo Plume - Off-Base
Maximum Groundwater Concentrations of VOCs and Associated MCLs

VOC	Maximum Groundwater Concentration (ug/L)	Federal MCL (ug/L)	California MCL (ug/L)
Contaminants Exceeding Drinking Water Standards (MCLs)			
Tetrachloroethene (PCE)	15	5	5
Trichloroethene (TCE)	9	5	5
Contaminants Not Exceeding Drinking Water Standards (MCLs)			
1,1-Dichloroethene (1,1-DCE)	0.5	7	6
1,2-Dichloroethane (1,2-DCA)	1	5	5
1,2-Dichloroethene Total (1,2-DCE, TOTAL)	6	70	6
cis-1,2- Dichloroethene (cis-1,2 DCE)	5	70	6
Dibromochloromethane	0.3	100	-
1,1-Dichloroethane (1,1-DCA)	0.3	-	5

Data includes most recent groundwater monitoring conducted by OHM Remediation Services, Inc. (OHM 1994, 1995, 1996).

Table 3-3

Carcinogenic Toxicity Values for Chemicals of Concern in Groundwater and Vadose Zone at Yermo Annex

Contaminant	Ingestion Slope Factor* (mg/kg-day)	Inhalation Slope Factor* (mg/kg-day)	Dermal Slope Factor* (mg/kg-day)
1,1,1-Trichloroethane (1,1,1-TCA)	NA	NA	NA
1,1-Dichloroethane (1,1-DCA)	NA	NA	NA
1,1-Dichloroethene (1,1-DCE)	0.6	0.18	0.6
1,2-Dichloroethane	0.091	0.091	0.091
2-Butanone	NA	NA	NA
Bromoform	0.0079	0.0039	0.0079
Chloroform	0.0061	0.081	0.0061
Dibromochloromethane	0.084	0.084	0.084
Tetrachloroethene (PCE)	0.052	0.002	0.052
Toluene	NA	NA	NA
Trichloroethene (TCE)	0.011	0.006	0.011

mg/kg-day = milligrams per kilogram per day
NA = Not Available
* Source: Integrated Risk Information System (IRIS). 1996.

Table 3-4
Noncarcinogenic Toxicity Values for Chemicals of Concern in Groundwater and Vadose Zone at Yermo Annex

Contaminant	Ingestion Reference Dose* (mg/kg-day)	Inhalation Reference Dose* (mg/kg-day)	Dermal Reference Dose* (mg/kg-day)
1,1,1-Trichloroethane (1,1,1-TCA)	0.09	0.29	0.09
1,1-Dichloroethane (1,1-DCA)	0.1	0.14	0.1
1,1-Dichloroethene (1,1-DCE)	0.009	0.009	0.009
1,2-Dichloroethane	NA	NA	NA
2-Butanone	0.6	0.29	0.6
Bromoform	0.02	0.02	0.02
Chloroform	0.01	0.01	0.01
Dibromochloromethane	0.02	0.02	0.02
Tetrachloroethene (PCE)	0.01	0.01	0.01
Toluene	0.2	0.11	0.2
Trichloroethene (TCE)	0.006	0.006	0.006

mg/kg-day = milligrams per kilogram per day
NA = Not Available
* Source: Integrated Risk Information System (IRIS). 1996.

Table 3-5
Summary of Comparative Analysis - Yermo Plume
MCLB Barstow

Criteria	Alternatives									
	Y-GW-1	Y-GW-2	Y-GW-3	Y-GW-4	Y-GW-5	Y-GW-6	Y-GW-8A	Y-GW-8B	Y-GW-8C	Y-GW-8D
Overall Protection of Human Health and the Environment	No	Within Risk Management Range **								
Compliance with ARARs	* No	* No	* No	Yes	Yes	* No	* No	* No	Yes	Yes
Long-Term Effectiveness and Permanence	Low	Mod	Mod	High	High	Mod	Mod	Mod	High	High
Reduction of Toxicity, Mobility, or Volume	Low	Low	Mod	High	Mod	Mod	Mod	Mod	High	High
Short-Term Effectiveness	Low	Mod	High	Mod	Mod	High	High	High	Mod	Mod
Implementability	High	High	High	Low	Mod	High	High	High	Mod	Low
Duration of Remedy										
Time to MCLs (years)	>500	>500	*** 190	180	160	*** 150	*** 40	*** 30	30	30
Time to Background (years)	>500	>500	*** 350	320	280	*** 265	*** 70	*** 55	55	55
Present Cost ($ millions) 20 Years Duration	0	2.0	9.3	20.3	14.7	14.8	16.3	19.8	24.2	35.9
Remediation to MCLs	0	3.5	14.1	30.1	21.8	19.3	21.3	22.1	27.1	40.8
Remediation to Background	0	3.5	14.1	30.1	21.9	19.4	23.2	26.4	32.6	49.2

* ARARs achieved over time through natural groundwater attenuation (<500 years).

** Alternatives Y-GW-2 through Y-GW-8D all result in residual risks that fall within EPA's risk management range of 10^{-6} to 10^{-4}. Cleanup to MCLs would result in an upper-bound incremental risk of approximately 2×10^{-4} (1×10^{-5} without 1,1-DCE) while cleanup to background (0.5 µg/L) would result in a risk of approximately 2×10^{-5} (5×10^{-6} without 1,1-DCE).

*** On-Base portion of plume only. Off-Base portion of plume would achieve ARARs in over 500 years.

Alternative Y-GW-1: No Action
Alternative Y-GW-2: Institutional Controls and Groundwater Monitoring
Alternative Y-GW-3: Groundwater Removal (at Base Boundary), Ex Situ Treatment, and Discharge
Alternative Y-GW-4: Groundwater Removal (Extraction Wells at Base Boundary and Off-Base at Background Edge of Plume), Ex Situ Treatment, and Discharge
Alternative Y-GW-5: Groundwater Removal (Extraction Wells at Base Boundary and at Off-Base MCL Edge of Plume), Ex Situ Treatment, and Discharge
Alternative Y-GW-6: Groundwater Removal (Extraction Wells at Base Boundary and in CAOC 26), Ex Situ Treatment, and Discharge
Alternative Y-GW-8A: Alternative Y-GW-6 with Air Sparging and SVE at CAOC 26
Alternative Y-GW-8B: Alternative Y-GW-8A with Additional Air Sparging and SVE downgradient of CAOCs 16, 15/17, and 35.
Alternative Y-GW-8C: Alternative Y-GW-8B with Extraction Wells Off-Base at MCL Edge of Plume
Alternative Y-GW-8D: Alternative Y-GW-8B with Extraction Wells Off-Base at Background Edge of Plume

ARARs - Applicable or relevant and appropriate requirements.
Mod - Moderate.
NA - Not applicable.

Table 3-6
Treated Groundwater Discharge Limitations
Lahontan RWQCB Board Order No. 6-93-106

Constituent	30-day Median (µg/L)	Daily Maximum (µg/L)
Total Petroleum Hydrocarbons (C2-C46)	<50	100
Benzene	<0.50	1.0
Toluene	<0.50	42.0
Ethylbenzene	<0.50	29.0
Total Xylenes	<0.50	17.0
Total Lead[a]	<1.0	15.0
Naphthalene	<0.5	20
MTBE	<40	40
EDB	<0.02	0.02
1,2-DCA	<0.50	0.50
1,1,1-TCA	<0.50	200
PCE	<0.50	5.0
TCE	<0.50	5.0
Trans-1,2 DCE	<0.50	10
Cis-1,2 DCE	<0.50	6
1,1-DCE	<0.50	6
1,2-DCE	<0.50	5
1,1,2-TCA	<0.50	32
Vinyl chloride	<0.50	0.5

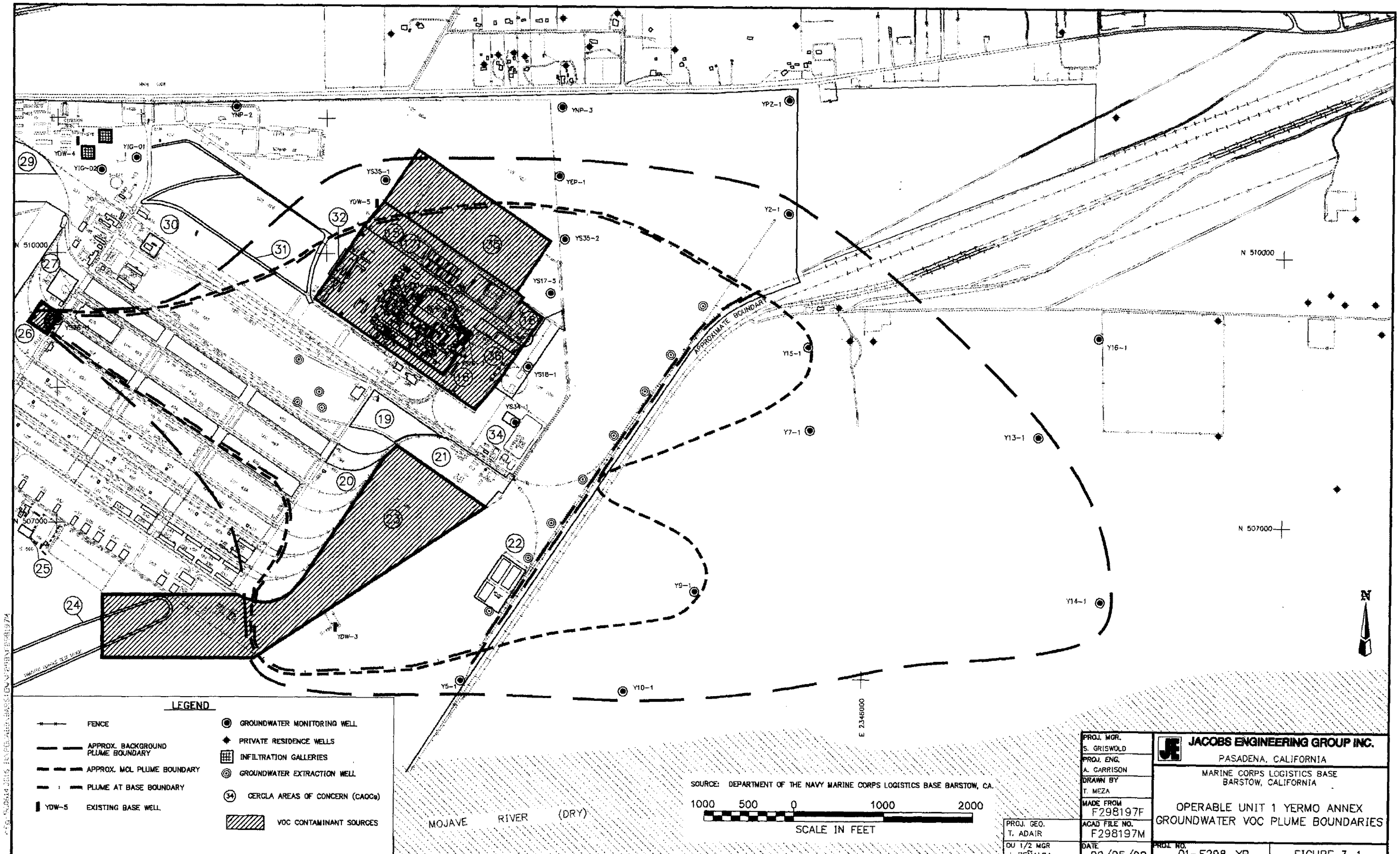
The discharge shall have a pH of not less than 6.0 pH units nor more than 9.0 pH units.

The discharge shall have a dissolved oxygen concentration not less than 1.0 mg/L.

[a] These numbers could be higher based on background of the aquifer being discharged to.

Source:

The treated groundwater discharge limitations are reproduced here from the California Regional Water Quality Control Board Lahontan Region, Board No. 6-93-106, General Waste Discharge Requirements for Land Disposal of Treated Groundwater, Harold J. Singer, Executive Officer, November, 19, 1993.



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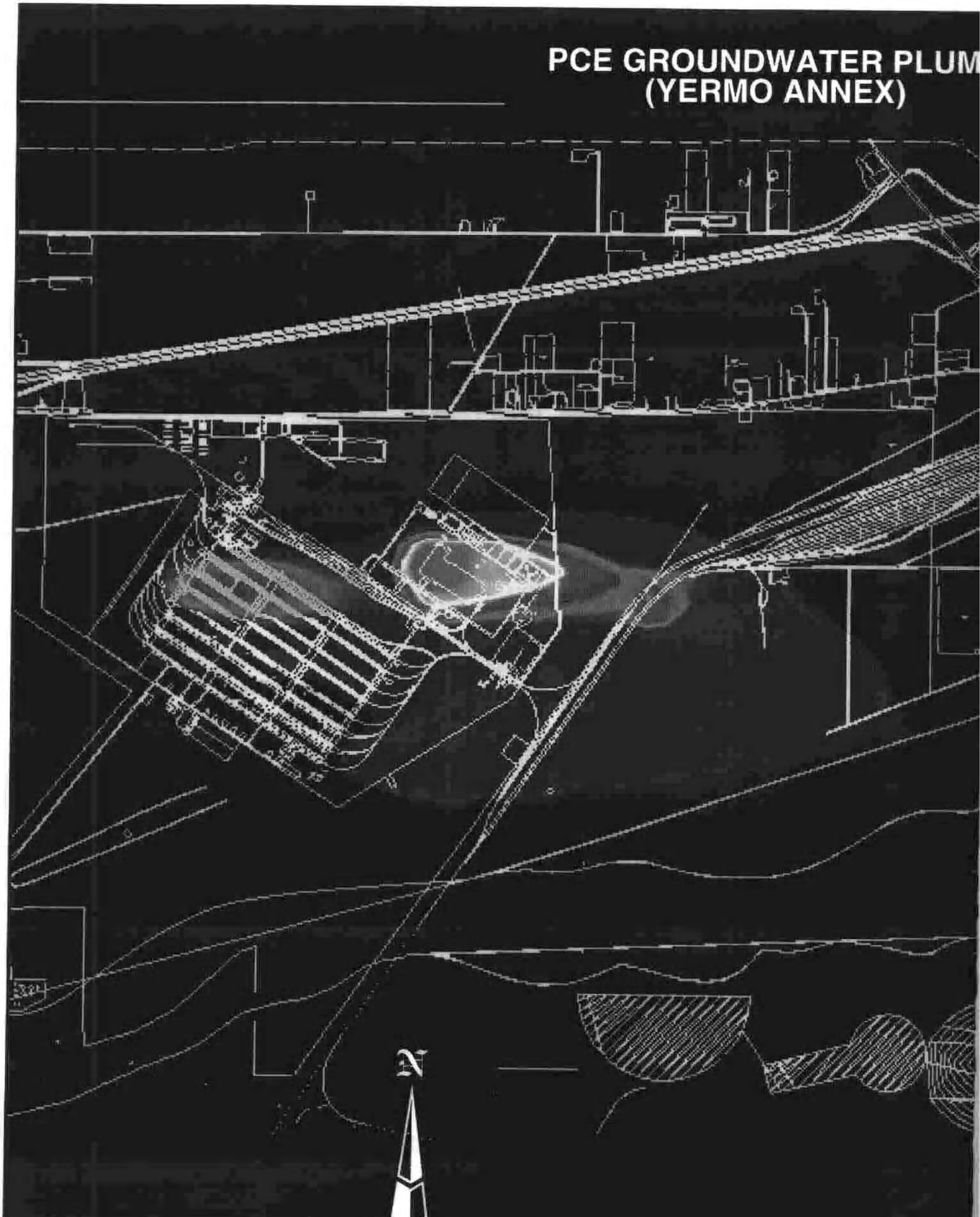
PCE GROUNDWATER PLUM
(YERMO ANNEX)
N