412TH Test Wing
Edwards Air Force Base, California

Environmental Restoration Program

Record of Decision
Site 3
Main Base Inactive Landfill
Basewide Miscellaneous Sites
Operable Unit 7
Edwards AFB, California

Final

July 2012

ENVIRONMENTAL RESTORATION PROGRAM
RECORD OF DECISION
SITE 3
MAIN BASE INACTIVE LANDFILL
BASEWIDE MISCELLANEOUS SITES OPERABLE UNIT 7

EDWARDS AIR FORCE BASE
CALIFORNIA

JULY 2012

FINAL

PREPARED FOR

U.S. AIR FORCE 412TH TEST WING
ENVIRONMENTAL RESTORATION (412 TW/CEVR)
EDWARDS AIR FORCE BASE, CA 93524-8060

AND THE

U.S. AIR FORCE CENTER FOR ENGINEERING AND THE ENVIRONMENT/
ENVIRONMENTAL PROGRAMS EXECUTION – WEST (AFCEE/EXW)
LACKLAND AIR FORCE BASE, TX 78236-9853

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LIST OF ABBREVIATIONS AND ACRONYMS

>	greater than
-	minus
%	percent
% v/v	percent by volume
+	plus
§	section
μg/L	micrograms per liter
μS/cm	microSiemens per centimeter
$\mu g/m^3$	micrograms per cubic meter
412 TW/CEVR	412th Test Wing/Environmental Restoration
95 ABW/CETM	95th Air Base Wing/Civil Engineering Work Management Office
95 ABW/CEVR	95th Air Base Wing/Environmental Restoration
95 ABW/EM	95th Air Base Wing/Environmental Management Directorate
95 ABW/EMR	95th Air Base Wing/Environmental Restoration Division
ABW	Air Base Wing
ACM	asbestos-containing material
AECOM	AECOM Technical Services, Inc.
AF	Air Force
AFB	Air Force Base
AFCEE/ERD	Air Force Center for Environmental Excellence, Environmental Restoration Division
AFCEE/ICE	Air Force Center for Engineering and the Environment MAJCOM & Installation Support-CONUS (AFMC)
AFCEE/ISM	Air Force Center for Environmental Excellence/Installation Support, AFMC
AFCEE/EXEW	Air Force Center for Environmental Excellence/Environmental Programs Execution – West
AFFTC	Air Force Flight Test Center
AFFTC/EM	Air Force Flight Test Center, Environmental Management
AFFTC/EMR	Air Force Flight Test Center, Environmental Restoration Division
AFI	Air Force Instruction
AFMC	Air Force Materiel Command
AFRL	Air Force Research Laboratory
Alluv	alluvium
AOC	area of concern
ARAR	Applicable or Relevant and Appropriate Requirement
AVEK	Antelope Valley-East Kern
bgs	below ground surface
BHC	gamma-benzene hexachloride
BOD	biochemical oxygen demand
BTAG	Biological Technical Assistance Group
CA	California
CAI	closed, abandoned, or inactive
Cal/EPA	California Environmental Protection Agency
Cal/OSHA	California Occupational Safety and Health Administration

LIST OF ABBREVIATIONS AND ACRONYMS

CAMU	Corrective Action Management Unit
CBr	competent bedrock
CCR	California Code of Regulations
CDFG	California Department of Fish and Game
CDHS	California Department of Health Services
CDPH	California Department of Public Health
CDWR	California Department of Water Resources
CE	Civil Engineering
cells/mL	cells per milliliter
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
CFR	Code of Federal Regulations
Ch.	Chapter
CH_4	methane
CHHSL	California Human Health Screening Level
CIWMB	California Integrated Waste Management Board
CL	clay
cm/sec	centimeters per second
CO_2	carbon dioxide
COC	Contaminant of Concern
COD	chemical oxygen demand
CONUS	Continental United States
COPC	Contaminant of Potential Concern
COPEC	Contaminant of Potential Ecological Concern
CRWQCB	California Regional Water Quality Control Board
CWC	California Water Code
CWM	Chemical Warfare Materiel
DCA	dichloroethane
DCB	dichlorobenzene
DCE	dichloroethene
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyltrichloroethane
DFRC	Dryden Flight Research Center
Div.	Division
DLR	Detection Limits for Purposes of Reporting
DNAPL	dense non-aqueous phase liquid
DO	dissolved oxygen
DoD	Department of Defense
DODI	Department of Defense Instruction
DTSC	Department of Toxic Substances Control
DWR	Department of Water Resources

LIST OF ABBREVIATIONS AND ACRONYMS

e.g.	exempli gratia (for example)
Earth Tech	Earth Tech, Inc.
Earth Technology	The Earth Technology Corporation
EC	electrical conductance
EFAW	Engineering Field Activity West
EMI	electromagnetic induction
EPA	Environmental Protection Agency
ERA	Ecological Risk Assessment
ERP	Environmental Restoration Program
ET	evapotranspiration
et seq.	*et sequentes* (and the following)
FID	flame ionization detector
FFA	Federal Facility Agreement
FS	Feasibility Study
FSP	Field Sampling Plan
ft	feet
GIS	Geographic Information System
gpd	gallons per day
gpm	gallons per minute
H&S	health and safety
HERD	Human and Ecological Risk Division
HERO	Office of Human and Ecological Risk
HHRA	Human Health Risk Assessment
HI	Hazard Index
HQ	hazard quotient
i.e.	*id est* (that is)
IC	institutional control
ID	identification
ICRMP	Integrated Cultural Resources Management Plan
INRMP	Integrated Natural Resources Management Plan
J&E	Johnson and Ettinger
LDR	land disposal restrictions
LFG	landfill gas
LNAPL	light non-aqueous phase liquid
LTM	long-term monitoring
LUC	Land Use Control
m^3/day	cubic meters per day
MAG	magnetic gradiometer
MAJCOM	Major Command
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
MEC	Munitions or Explosives of Concern
mg/kg	milligrams per kilogram

LIST OF ABBREVIATIONS AND ACRONYMS

mg/L	milligrams per liter
ML	sandy silt
MNA	Monitored Natural Attenuation
MSL	mean sea level
MSWLF	Municipal Solid Waste Landfill
mV	millivolt
MW	monitoring well
N	nitrate
N_2	nitrogen
NA	not applicable
NASA	National Aeronautics and Space Administration
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
ND	not detected
NP	not promulgated
NPL	National Priorities List
No.	number
NS	not sampled
O_2	oxygen
O&M	operations and maintenance
OEHHA	Office of Environmental Health Hazard Assessment
OMB	Office of Management and Budget
ORP	oxidation-reduction potential
OSWER	Office of Solid Waste and Emergency Response
OU	Operable Unit
OU7	Operable Unit 7
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
PERA	Predictive Ecological Risk Assessment
PHC	petroleum hydrocarbons
ppb v/v	parts per billion by volume
ppm	parts per million
ppm v/v	parts per million by volume
PRG	Preliminary Remediation Goal
PRL	Potential Release Location
PVC	polyvinyl chloride
RA	Remedial Action
RAB	Restoration Advisory Board
RAO	Remedial Action Objective
RAR	Relevant and Appropriate Requirement
RAWP	Remedial Action Work Plan
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
ROD	Record of Decision

LIST OF ABBREVIATIONS AND ACRONYMS

RPM	Remedial Project Manager
RSL	Regional Screening Level
RTS	Report to Stakeholders
RWQCB	Regional Water Quality Control Board
SARA	Superfund Amendments and Reauthorization Act
SC	clayey sand
SDWA	Safe Drinking Water Act
SERA	Scoping Ecological Risk Assessment
SM	silty sand
SP	poorly-graded sand
spp.	species
SS	stainless steel
STLC	Soluble Threshold Limit Concentration
Subch.	Subchapter
SVOC	semivolatile organic compound
SW	well-graded sand
SWAT	Solid Waste Assessment Test
SWRCB	State Water Resources Control Board
TBC	To Be Considered
TCE	trichloroethene
TDL	Total Designated Level
TCLP	Toxic Characteristic Leaching Procedure
TDS	total dissolved solids
TEFA	Technical and Economic Feasibility Analysis
TEPH	total extractable petroleum hydrocarbons
Tetra Tech	Tetra Tech, Inc.
TOC	total organic carbon
TRV	toxicity reference value
TRC	Technical Review Committee
TTLC	Total Threshold Limit Concentration
TVPH	total volatile petroleum hydrocarbons
UCL	Upper Confidence Limit
UIC	underground injection control
URF	unit risk factor
USACE	United States Army Corps of Engineers
USAF	United States Air Force
USC	United States Code
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
USFWS	United States Fish and Wildlife Service
UST	underground storage tank
UTS	universal treatment standards
VC	vinyl chloride

LIST OF ABBREVIATIONS AND ACRONYMS

VFA	volatile fatty acid
VOCs	volatile organic compounds
Water Board	California Regional Water Quality Control Board, Lahontan Region
WBr	weathered bedrock

1.0 PART 1: DECLARATION

1.1 SITE NAME AND LOCATION

Edwards Air Force Base (AFB) (Base), Kern, Los Angeles, and San Bernardino Counties, California, United States Environmental Protection Agency (USEPA) Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) Identification Number: CA1570024504.

To facilitate the administration of the Environmental Restoration Program (ERP) at Edwards AFB, the Base has been divided into ten Operable Units (OUs), which are used to group sites with similar site conditions and contaminants. This decision document addresses Site 3, Main Base Inactive Landfill, which is located within Basewide Miscellaneous Sites Operable Unit 7 (OU7).

1.2 STATEMENT OF BASIS AND PURPOSE

This decision document presents the selected remedy for Site 3, Main Base Inactive Landfill, Basewide Miscellaneous Sites OU7, Edwards AFB, California, which was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended by Superfund Amendments and Reauthorization Act (SARA) of 1986, and the CERCLA regulation the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This decision document is based on the Administrative Record File for Site 3.

The United States Air Force (USAF) and the USEPA are selecting the remedy contained in this Record of Decision (ROD) in concurrence with the California Environmental Protection Agency (Cal/EPA) Department of Toxic Substances Control (DTSC) and the California Regional Water Quality Control Board (Water Board), Lahontan Region.

1.3 ASSESSMENT OF SITE 3

Site 3, Main Base Inactive Landfill, was in operation from the mid-1960s (actual year unknown) until 1976, and was used for waste disposal by the entire Base, with the exception of the Air Force Research Laboratory (AFRL). The landfill covers an estimated 67 acres, and contains an estimated 526,000 cubic yards of municipal wastes. Although the presence of hazardous or explosive materials in the buried wastes has not been confirmed, the possibility that these materials may be contained within the landfill cannot reasonably be ruled out.

Interim Removal Actions were performed under the Underground Storage Tank Investigation Program at two Potential Release Locations (PRLs) in the vicinity of Site 3; PRLs 261 and 398 (Earth Tech 1996a and 1996b). After the completion of the Interim Removal Actions, the PRLs were closed to further action by the Kern County Environmental Health Services Department in October 1996 (see Section 2.5.8).

The selected response actions for Site 3 presented in this ROD are necessary to protect public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment. For hypothetical future residents, industrial workers, and construction workers exposed to soil and soil gas at Site 3, the potential cancer risks for the various pathways are all either below 10^{-6} or within the risk management range, and noncancer Hazard Indexes (HIs) are less than 1. The potential cancer risks and noncancer HIs for hypothetical future residents exposed to the groundwater at Site 3 are considered unacceptable.

In addition, although the potential cancer risks and noncancer HIs for hypothetical future residents, industrial workers, and construction workers exposed to indoor air at Site 3 are all either at risk levels below or within USEPA's risk management range of 10^{-4} to 10^{-6}, this risk does not address the potential explosive hazard that could exist if landfill gases containing methane were to accumulate in a building, or a potential release of VOCs from a deteriorating container that could migrate, like landfill gases, as vapors to the surface and accumulate in confined spaces or buildings.

1.4 DESCRIPTION OF THE SELECTED REMEDY

The selected remedy described below is intended to be the final action for Site 3, an inactive landfill located within OU7, Basewide Miscellaneous Sites. This site is addressed independently from other sites included in OU7, and other OUs at the Base. The scope and role of OU7 within the overall management strategy for the ERP is presented in Section 2.4 in this ROD.

The strategy for Site 3 cleanup is based on the presumptive remedy for CERCLA solid waste landfill sites, and has additional institutional control (IC) and monitoring components. However, the selected remedy does not contain an active containment mechanism for contaminated groundwater due to exceptionally low groundwater yields at the site. Because historical groundwater monitoring data has established the plume is stable and not expanding, there is no need for active containment. Instead, the selected remedy relies on Monitored Natural Attenuation (MNA) and physical methods to control stormwater infiltration to groundwater for groundwater containment. The selected remedy includes limited waste consolidation, installation of an evapotranspiration (ET) cover, installation of stormwater controls, implementation of Land Use Controls (LUCs), and conducting MNA until groundwater remediation goals are achieved. An ET cover was selected in lieu of the State Prescriptive Cover prescribed by California Code of Regulations (CCR), Title 27, Section 21090, because State Prescriptive covers may be prone to desiccation in arid environments, such as that present at Edwards AFB. Desiccation cracks may provide preferential pathways through the clay barrier layer, making the barrier ineffective in meeting the performance standard for infiltration.

The main components of the selected remedy include:

1. Removing all surface debris and recycling or disposing the debris off site.

2. Excavating subsurface waste from the landfill cell on the south side of Landfill Road, the landfill cell northwest of the landfill, and the landfill cell west of the landfill and depositing the waste in cells within the fenced area of the landfill.

3. Assuring that a minimum of three feet of soils cover all landfill cells, which will include a 1-foot minimum of existing cover/foundation layer, or for newly constructed cells, common fill obtained on site, 1.5-feet of imported soils suitable for the ET cover, and 0.5 feet of vegetative topsoil layer. The ET cover will be graded to promote runoff, and minimize infiltration and erosion.

4. Construction of stormwater controls (diversion ditches) to divert surface water away from the landfill surface.

5. Implementing and maintaining LUCs (administrative controls and fencing) until the concentrations of hazardous substances in the soil and groundwater are at such levels to allow for unlimited use and unrestricted exposure. Additionally, LUCs will prevent contact by humans and animals with contaminants potentially present in the buried landfill debris and prevent the unauthorized disposal of waste.

6. Conducting MNA until remediation goals for groundwater are met.

7. Conducting gas monitoring to assure that explosive concentrations of landfill gases or VOCs are not migrating beyond the site boundary at concentrations that could cause an

explosion in a future building or confined space, or create a risk to human health from indoor air exposure in a future building.

The construction phase of the selected remedy would be completed within two years. The selected remedy is designed to bring Site 3 in compliance with Applicable or Relevant and Appropriate Requirements (ARARs) within 84 years.

1.5 STATUTORY DETERMINATIONS

The selected remedy is intended to be the final action for the site. The selected remedy is protective of human health and the environment, complies with Federal and State requirements that are applicable or relevant and appropriate to the Remedial Action, is cost effective, and uses permanent solutions and alternative treatment technologies to the maximum extent practicable.

The selected remedy for Site 3 does not satisfy the statutory preference for treatment as a principal element of the remedy because active treatment of the buried waste and groundwater at the site was not found to be practicable. The volume and heterogeneity of buried debris, and the absence of localized areas with elevated contaminant concentrations, preclude a practicable remedy in which treatment can be used effectively. Although the selected remedy does not reduce the toxicity of waste buried within the landfill, it is consistent with the presumptive remedy for landfill sites in accordance with the *Superfund Accelerated Cleanup Model* (USEPA 1992). The overall volume of waste within the landfill will be reduced by recycling as much of the surface debris as possible during surface debris removal and waste consolidation. Although the selected remedy does not include active treatment of contaminated groundwater, the installation of an ET cover and stormwater control measures will serve to reduce the mobility of potential contaminants within the waste, thereby reducing the migration of leachates into groundwater. By reducing the mobility of the contaminant source, the ET cover and stormwater control measures are expected to enhance the rate by which natural attenuation degrades the contaminants within the groundwater to harmless byproducts.

A statutory review will be conducted five years after implementation of the selected remedy at Site 3, and every five years thereafter (Five-year Review), to determine whether the selected remedy continues to be protective of human health and the environment, until the site can support unlimited use and unrestricted exposure. The Five-year Review results will be placed in the post-ROD Administrative

Record File, which is located at the 412th Test Wing, Environmental Management, Building 2650A, 5 East Popson Avenue, Edwards AFB, California 93524-8060.

1.6 RECORD OF DECISION DATA CERTIFICATION CHECKLIST

The data certification checklist provided in Table 1.6-1 identifies the locations of certain key remedy selection information included in the Decision Summary section of this ROD. Additional information can be found in the Administrative Record file for this site.

1.7 AUTHORIZING SIGNATURES AND SUPPORT AGENCY ACCEPTANCE OF THE SELECTED REMEDY

The USAF and USEPA, with concurrence from Cal/EPA DTSC and the California Regional Water Quality Control Board, Lahontan Region, are in agreement with the selected cleanup remedy for Site 3.

_______________________________ Date 17 Sep 12

MICHAEL T. BREWER
Brigadier General, USAF
Commander, 412th Test Wing
Edwards Air Force Base, California

_______________________________ Date Sept. 21, 2012

MICHAEL M. MONTGOMERY
Assistant Director
Federal Facilities and Site Cleanup Branch
United States Environmental Protection Agency, Region 9

Cal/EPA DTSC and the California Regional Water Quality Control Board, Lahontan Region, had the opportunity to review and comment on this Record of Decision, and our concerns are addressed.

_______________________________ Date 9/24/2012

ALLEN WOLFENDEN
Branch Chief San Joaquin/ Legacy Landfills Office
California Department of Toxic Substances Control

_______________________________ Date 10/2/12

PATTY Z. KOUYOUMDJIAN
Executive Officer
California Regional Water Quality Control Board, Lahontan Region

We the undersigned, having worked on the development of this document, hereby concur with the remedy selected in this ROD.

Date 9/19/12

AI DUONG
Remedial Project Manager
Edwards Air Force Base, California

Date 9/21/12

JOSEPH B. HEALY, JR.
Remedial Project Manager
Federal Facilities Cleanup Branch
United States Environmental Protection Agency, Region 9

Date 9/24/12

KEVIN DEPIES
Remedial Project Manager
Office of Military Facilities
California Department of Toxic Substances Control

Date 9/26/12

TIM POST
Remedial Project Manager
California Regional Water Quality Control Board, Lahontan Region

2.0 PART 2: DECISION SUMMARY

This decision summary provides an overview of the general characteristics of Edwards AFB, and more site-specific characteristics for the Site 3 Main Base Inactive Landfill, which is included in this ROD. In addition, the decision summary describes the remedial alternatives evaluated for Site 3, and a comparative analysis of those alternatives. The decision summary concludes with the identification of the selected remedy for Site 3, and the statutory determinations supporting the selected remedy.

This decision summary incorporates the content recommended in *A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents* (USEPA 1999b). Details regarding the *CERCLA Proposed Plan for Site 3, Main Base Inactive Landfill, Operable Unit 7 (OU7), Edwards Air Force Base, California* (AECOM Technical Services, Inc. [AECOM] 2010a) are provided in Section 2.3, Community Participation.

2.1 SITE NAME, LOCATION, AND DESCRIPTION

Edwards AFB is located approximately five miles northeast of the City of Lancaster in the Antelope Valley of southern California (Figure 2.1-1). The Base covers portions of three different counties, Kern, Los Angeles, and San Bernardino Counties, and encompasses approximately 470 square miles of the Mojave Desert. The specific site addressed in this ROD is designated as Site 3 and consists of an inactive landfill commonly referred to as the Main Base Inactive Landfill. Site 3 is located in Kern County in the Northwest Main Base area of the Base.

Site 3 is assigned to OU7, Basewide Miscellaneous Sites, which includes all ERP sites and areas of concern (AOCs) not included in other OUs at the Base. The Site 3 boundary encloses approximately 123 acres, of which approximately half (67 acres) is estimated to have been used for waste disposal (Figure 2.1-2). The former waste disposal areas at Site 3 are enclosed within a chain-link fence with the exception of one former waste disposal area (cell) located south of Landfill Road. The ground surface is generally disturbed unimproved land that is sparsely covered with high desert vegetation. Debris is known to be present on the ground surface in certain areas at Site 3.

There are no structures present at Site 3. The nearest structures to Site 3 are horse stables and an electrical substation located approximately 1,000 feet to the south. The nearest on-Base residential area to Site 3 is approximately 1,600 feet to the southeast, and the nearest off-Base residences are approximately 5.8 miles to the northeast.

The USEPA CERCLIS identification number for Edwards AFB is CA1570024504. Edwards AFB was listed on the National Priorities List (NPL) on 30 August 1990. The lead agency for environmental investigations and Remedial Action (RA) at Site 3 is the USAF. Regulatory agencies providing support and oversight of the ERP at Edwards AFB include USEPA Region 9, Cal/EPA DTSC, and the Water Board, Lahontan Region. The USAF, USEPA, Cal/EPA DTSC, and Water Board entered into a Federal Facility Agreement (FFA) for Edwards AFB in September 1990. The source of funding for the environmental investigations and Remedial Actions at Site 3 is the Air Force Environmental Restoration Account.

2.2 SITE HISTORY AND ENFORCEMENT

Site 3, Main Base Inactive Landfill, was in operation from the mid-1960s (actual year unknown) until 1976, and was used for waste disposal by the entire Base, with the exception of the AFRL. Because landfill operations at Site 3 ceased on or before November 27, 1984 (in 1976), this landfill is considered a closed, abandoned, or inactive (CAI) unit. While in operation, the cut-and-cover method of waste disposal was used at the site to contain the waste. The disposal cells varied in size, and were cut into alluvial sediments and weathered bedrock. At the end of each operating day, the waste was reportedly covered with a layer of soil. The buried waste has subsequently subsided, which has resulted in the cracking of the existing soil cover. The estimated location and areal extent of the disposal cells are shown on Figures 2.2-1 and 2.2-2.

There are no available records to indicate the total quantity or types of waste received at the Site 3 Main Base Inactive Landfill while it was active. It was speculated that disposal of residential waste and construction debris occurred at Site 3 based on observations reported during Remedial Investigation (RI) activities conducted at the site in 2000. This RI also concluded that industrial waste (including fuels and solvents) may have been deposited at the site. Additional RIs and long-term monitoring (LTM) activities were conducted at the site to determine the depth of the buried waste and assess any potential soil contamination, and to assess potential releases of contaminants to groundwater from the inactive landfill. A more detailed discussion of the site investigations conducted at Site 3 is presented in this ROD in Section 2.5.7, Site Investigations.

Based on the estimated sizes of the disposal cells and the areas of surface debris, it is estimated that 526,000 cubic yards of waste were deposited at Site 3 (The Earth Technology Corporation [Earth Technology] 1994b). It is unknown whether any munitions or other military wastes were received at Site 3 for disposal; however, there is no historical record of their disposal, and no munitions or other military wastes were encountered during test pit sampling (see Section 2.5.7.4). To date, there have been no environmental enforcement activities associated with Site 3.

2.3 COMMUNITY PARTICIPATION

Community members and local government agencies have been kept informed of ERP activities and have had opportunities for involvement in the decision-making process for the remediation of Site 3 throughout the CERCLA process. Highlights of the community involvement program are discussed below.

2.3.1 RESTORATION ADVISORY BOARD

The Edwards AFB Restoration Advisory Board (RAB) is a group that originally met quarterly and now meets semi-annually to facilitate the exchange of information and concerns between on-Base and off-Base communities, Federal and State regulatory agencies, and the Edwards AFB environmental cleanup Program Managers. The RAB was formed in late 1994, replacing the Technical Review Committee (TRC), which was established after Edwards AFB was named to the NPL in 1990. The RAB has 14 appointed public representatives (two of which are alternates); a USAF Co-chair; and Remedial Project Managers (RPMs) from Edwards AFB, the USEPA, Cal/EPA DTSC, and the Water Board, Lahontan Region. Off-Base communities represented on the RAB include Boron, California City, Lancaster, Mojave, North Edwards, and Rosamond. On-Base communities consist of Base Housing, Main Base Air Base Wing, Main Base Test Wing, National Aeronautics and Space Administration (NASA) Dryden Flight Research Center (DFRC), South Base, and the AFRL. One appointed public representative is elected by the group to serve as the Public Co-chair.

The RAB meetings are open to the public. A portion of the agenda is available for public attendees to briefly address the RAB, or they can submit written comments on forms available for that purpose and the ERP staff at the Base will provide written responses. The Air Force and regulatory agency representatives are also available informally before and after the meeting, and during breaks, to discuss poster board displays, PowerPoint presentations, or any other questions or concerns that meeting attendees may have.

An overview of the Site 3 Proposed Plan was presented at the RAB meeting for the third quarter of 2010 held in Rosamond, California (CA) on 18 August 2010.

2.3.2 REPORT TO STAKEHOLDERS

The Report to Stakeholders (RTS), a bi-monthly newsletter published by Edwards AFB, was developed for the RAB. The newsletter focuses on hazardous waste cleanup at Edwards AFB, explaining how cleanup technologies work, providing status reports on key restoration activities, and introducing RAB members through in-depth interviews. The RAB members use the newsletter as a reference tool to educate their communities. Edwards AFB currently distributes 6,000 copies of the RTS every month. The public may also access the newsletter on the Internet.

A four-page fact sheet about the Site 3 Proposed Plan was distributed with the RTS newsletter published in February 2010.

2.3.3 ADMINISTRATIVE RECORD AND INFORMATION REPOSITORIES

The Administrative Record File is maintained at the 95th Air Base Wing, Environmental Management, Building 2650A, 5 East Popson Avenue, Edwards AFB, California 93524. In addition, copies of a subset of the data and documents contained in the Administrative Record File and a complete listing of all documents contained in the Administrative Record File are available for public review in information repositories located in the cities of Lancaster and Rosamond, as well as at Edwards AFB.

Edwards AFB Library
5 West Yeager Boulevard
Building 2665
Edwards AFB, CA 93524-1295
(661) 275-2665

Kern County Public Library
Wanda Kirk Branch
3611 West Rosamond Boulevard
Rosamond, CA 93560
(661) 256-3236

Los Angeles County Public Library
601 West Lancaster Boulevard
Lancaster, CA 93534
(661) 948-5029

2.3.4 COMMUNITY INVOLVEMENT

Notices of availability of the Site 3 Proposed Plan were published in local area newspapers including the Antelope Valley Press on March 2 and March 9, 2010, and the Mojave Desert News on March 4, 2010. A notice of availability of the Proposed Plan was also published in the Desert Eagle (a Base newspaper produced by the Edwards AFB Public Affairs Office) on March 5, 2010. A public comment period was held from February 17 to April 2, 2010. During the public comment period, the RI report, the Feasibility Study (FS), the FS Addendum, and the Proposed Plan were made available to the public.

Public meetings were held on- and off-Base on March 9, 2010 to present the Proposed Plan to a broader community audience. The on-Base meeting was held from 11:00 a.m. to 1:00 p.m. at the Environmental Management, Building 2650A, 5 East Popson Avenue, Edwards AFB, California. The off-Base meeting was held from 5:00 p.m. to 7:00 p.m. at the Wanda Kirk Branch Library, 3611 West Rosamond Boulevard, Rosamond, California. No verbal or written public comments were received.

2.4 SCOPE AND ROLE OF THE OPERABLE UNIT

OUs at Edwards AFB are used to group sites with similar site conditions and contaminants, and facilitate the administration of the ERP. OU7 is one of ten OUs at Edwards AFB (Figure 2.4-1). Sites located within OU7 are designated as Basewide Miscellaneous Sites, which includes any potentially contaminated sites that are not located within another OU at the Base. There are 89 sites or AOCs assigned to OU7. However, 25 sites and two AOCs included in OU7 are managed separately under the designation OU7 Chemical Warfare Materiel (CWM) because information in historical documents indicated that activities associated with CWM may have occurred at the sites, potentially contaminating the sites with various types of chemical warfare agents and/or their degradation products. These sites have been addressed in *Environmental Restoration Program, Record of Decision, Operable Unit 7, Chemical Warfare Materiel, Edwards Air Force Base* (AECOM 2009a), which was signed by authorized signatories from the Air Force, USEPA, and State support agencies. The remaining sites in OU7 evaluated to require Remedial Action will be addressed in a separate ROD.

Site 3 is located in OU7 and is addressed separately in this ROD. This ROD contains the final remedy for Site 3, and addresses all impacted or potentially impacted media and receptors.

2.5 SITE CHARACTERISTICS

2.5.1 SITE GEOLOGY AND SEISMOLOGY

Site 3 is located in a shallow bedrock area (Figures 2.5-1 through 2.5-4) characterized by a thin layer of unconsolidated alluvial sediments (comprised mostly of silty sands and poorly graded sands) overlying weathered and fractured competent granitic bedrock.

Regionally, the bedrock is characterized as a pre-Tertiary basement complex consisting of quartz monzonite, granite, and undifferentiated metamorphic rocks (Dibblee 1967). The regional fracture system in the area of Main Base generally trends northwest-southeast with fractures typically dipping 60 degrees or more toward the northeast (Earth Tech, Inc. [Earth Tech] 2003). Based on a rock core recovered from a test boring at the Main Base Active Landfill during the Phase I Solid Waste Assessment Test (SWAT) (BSK and Associates 1990a), bedrock is extensively fractured. The recovered core consisted of pieces of granitic bedrock (typically less than an inch to six inches long) broken along fractures typically fractions of an inch thick.

Cross section B-B’ (see Figure 2.5-3) shows that the depth to weathered bedrock ranges from approximately five feet below ground surface (bgs) at the north end of the site (Monitoring Well 3-MW03) to approximately 36 feet bgs at the south end of the site (Monitoring Well 3-MW10). The depth to competent bedrock ranges from a high of approximately 18 feet bgs at the north end of the site to approximately 75 feet bgs at the south end of the site. Also, as shown on Figure 2.5-3, the waste cells were cut into the weathered bedrock, but not the competent bedrock.

This region of southern California is seismically active. The San Andreas Fault Zone is located approximately 30 miles southwest of Site 3, and the Garlock Fault Zone is located approximately 25 miles to the northwest (see Figure 2.5-1). During the last 20 years, major earthquakes recorded near Edwards AFB at greater than 5.0 on the Richter Magnitude Scale (United States Geological Survey [USGS] 2009) include the Landers and Big Bear earthquakes in June 1992 and the Mojave earthquake in July 1992.

Faults mapped in the area of Site 3 include the El Mirage Fault located approximately 800 feet to the southwest (see Figure 2.2-1), and the Muroc Fault located approximately six miles to the northeast (see Figure 2.5-1). These faults are generally parallel, northwest-southeast trending normal faults that produce horst and graben features. Several northeast-southwest trending unnamed faults, collectively referred to as the Antelope Valley Fault Zone, are located south and southeast of the site. Alluvial deposits generally conceal the surface traces of these faults. The identification of these faults is based primarily on water level differences between nearby wells on the upthrown and downthrown sides of the faults, and results from sub-regional groundwater flow simulations (Leighton and Phillips 2003).

It should be noted that the placement of the El Mirage Fault on Figure 2.5-1 is approximate and based on a regional USGS figure from Leighton and Phillips (2003). Based on lithologies derived from well logs and potentiometric surface data derived from Site 3 groundwater monitoring wells installed during the RI (see Figure 2.5-4), the fault zone is more likely within 200 feet of Site 3, just southwest of and parallel to Landfill Road. From north to south, across the possible location of the El Mirage Fault, the bedrock elevation increases approximately 13 feet, the thickness of weathered bedrock increases from approximately 6 feet to approximately 80 feet, and the potentiometric surface decreases by approximately 15 feet. In addition, the location of a dry wash (see Figure 2.2-2) coincides with the changes noted in the subsurface.

2.5.2 SITE HYDROGEOLOGY AND GROUNDWATER SUPPLY

The following section discusses the regional and local hydrogeology and groundwater supply.

2.5.2.1 Hydrogeology

Edwards AFB overlies portions of four groundwater basins as defined by the California Department of Water Resources (CDWR) (2003); the Antelope Valley Groundwater Basin (No. 6-44), Fremont Valley Groundwater Basin (No. 6-46), Harper Valley Groundwater Basin (No. 6-47), and Middle Mojave River Valley Groundwater Basin (No. 6-41) (Figure 2.5-5). The Base also overlies portions of three groundwater subbasins as defined by the USGS (2005); the Lancaster and North Muroc Subbasins within the boundary of the Antelope Valley Groundwater Basin, and the Gloster Subbasin within the boundary of the Fremont Valley Groundwater Basin. In addition to these subbasins, the Base also encompasses areas of bedrock outcrops and shallow bedrock in the Rosamond and Bissell Hills (west and northwest part of the Base), the Hi Vista Area (south central and southeast part of the Base), and Leuhman Ridge in the area of the AFRL (Figure 2.5-1).

Groundwater at Edwards AFB occurs mainly in unconsolidated alluvial deposits in these groundwater basins and subbasins. In the Lancaster Subbasin, the unconsolidated alluvial deposits are known to exceed thicknesses of 1,500 feet. Depth to groundwater used for beneficial purposes from water supply wells on-Base is generally between 100 and 125 feet bgs.

Site 3 is located near the Bissell Hills in an upland drainage area within the Antelope Valley Groundwater Basin (see Figure 2.5-5). This area is characterized by shallow bedrock and low groundwater yield. Groundwater in the area occurs in fractured bedrock overlain by thin alluvium.

A map showing groundwater elevation isopleths in the area surrounding Site 3 based on water levels measured in July 2009 is presented on Figure 2.5-6. As shown on the map, the groundwater elevation isopleths generally mimic the surface topography, which is generally influenced by the bedrock topography. The groundwater flow directions generally mimic the surface drainage. In the area surrounding the site, groundwater flow directions are to the southwest on the north side of Landfill Road and to the northeast on the south side of Landfill Road toward a northwest-southeast trending buried bedrock valley filled with alluvial stream channel deposits (Mojave Creek). The groundwater flow direction then trends to the southeast toward Roger Dry Lake. The hydraulic gradients in the area range from approximately 0.02 feet per foot to approximately 0.07 feet per foot. The regional surface and groundwater flow directions indicate hydraulic continuity between this area and the Lancaster Subbasin.

The El Mirage Fault (see Section 2.5.1) is considered by the USGS (Nishikawa et al. 2001; Leighton and Phillips 2003) to be a potential barrier to groundwater flow in the vicinity of Rogers Dry Lake. The USGS did not consider the behavior of the fault in the vicinity of Site 3. However, according to Nishikawa et al. (2001), vertical and horizontal displacement along faults in the Edwards AFB area can offset the more permeable water-bearing deposits juxtaposing them with the less permeable fine-grained deposits. Although these fine-grained water-bearing deposits are not present at Site 3, Nishikawa et al. (2001) also states that cementation, compaction, and extreme deformation of the water bearing deposits adjacent to faults can create low permeability zones that can act as barriers to groundwater flow. Therefore, it is possible that the El Mirage Fault may restrict groundwater flow southwest of Site 3.

Locally at Site 3, the groundwater isopleths show a potentiometric high beneath the eastern part of the inactive landfill (Figure 2.5-7). Groundwater depths at Site 3 typically range from 65 to 110 feet bgs, with the highest groundwater elevation in Monitoring Well 3-MW07, which is located at the main group of waste cells in the eastern part of the inactive landfill. In this part of the landfill, depressions and cracks have developed in the existing soil cover; these are caused by subsidence of the buried waste in the landfill cells due to its decomposition and settling over time. Surface water accumulates in the depressions and cracks during storm events and infiltrates the landfill. The likely result of the stormwater ponding at the landfill surface and the increase in stormwater recharge is the potentiometric high (artificial groundwater gradient) beneath these landfill cells. In this area, groundwater flow directions are radially outward from the artificial potentiometric high. This radial outward flow is then captured by the natural groundwater flow to the southwest toward the buried alluvial valley trending parallel to Landfill Road.

Hydrogeologic conditions at Site 3 were initially characterized during Phase I and Phase II SWATs conducted in 1990 and 1993, respectively (BSK and Associates 1990a; Earth Technology 1994a). During the Phase I SWAT, a slug test was conducted in Test Well OMTB1 (see Figure 2.2-1), and a hydraulic conductivity of 3×10^{-6} centimeters per second (cm/sec) was calculated for weathered bedrock surrounding the test well. During the Phase II SWAT, slug tests were conducted in groundwater monitoring wells where the depth to the top of the screen interval was greater than 90 feet in competent bedrock. The results of the slug tests indicate that the hydraulic conductivity of the competent bedrock ranges from 2.2×10^{-5} cm/sec to 7.1×10^{-7} cm/sec. The large variation in the hydraulic conductivity is probably due to groundwater occurrence within fractured granitic bedrock. The frequency of fractures controls the flow of groundwater into the well, and locally the fracture frequency is highly variable.

2.5.2.2 Groundwater Supply

Prior to the establishment of the Base in the 1940s, the water supply in the area was primarily from historic homestead water wells and was used for domestic and agricultural purposes. From the 1940s until early 1993, the water supply for the Base was primarily from groundwater production wells drilled and constructed by the Base.

The nearest Base production wells to Site 3 are located approximately five miles south in the Graham Ranch Well Field (see Figure 2.5-5), and produce groundwater from water-bearing zones in unconsolidated alluvial sediments.

Currently, the water supply for the Base comes from Base production wells (approximately 60 percent) and the Antelope Valley-East Kern (AVEK) Water Agency, a State water project contractor (approximately 40 percent). AVEK water for the Main Base area is delivered through an AVEK-owned feeder line that enters the Base along Rosamond Boulevard at North Gate, and AVEK water for the AFRL is delivered through another AVEK-owned feeder line that enters the Base approximately 1.1 miles south of Boron. The nearest off-Base residences that may have drinking water wells are located approximately 5.8 miles northeast of the site.

The Base contracted with AVEK to supply water to reduce groundwater withdrawals from the local aquifers in order to minimize land and lakebed subsidence. The detrimental effects of the subsidence include permanent loss of aquifer storage, increased flooding, cracks and fissures at land surface, damage to man-made structures, and intangible economic costs (Leighton and Phillips 2003). The formation of cracks and fissures on the surface of Rogers Dry Lake are of particular concern because they interfere with the use of the lakebed as an emergency landing surface for aircraft.

Groundwater yields from the groundwater monitoring wells at Site 3 are generally low. Table 2.5-1 presents a summary of the volume of groundwater purged from each monitoring well at Site 3 by bailing or pumping during well development or groundwater sampling activities. Generally, each monitoring well was bailed or pumped dry during these activities, and recharge was slow. These data indicate that the groundwater-bearing fractured bedrock at the site does not constitute an "aquifer" as the term is normally used. Underground injection control (UIC) regulations contained in 40 Code of Federal Regulations (CFR) 146.3 define an aquifer as "a geological formation, group of formations, or part of a formation that is capable of yielding a significant amount of water to a well or spring".

The USEPA has established criteria for sufficient quantities of groundwater yield from a well to be considered a potential source of drinking water in *Guidelines for Ground-Water Classification under the EPA Ground-Water Protection Strategy* (USEPA 1986), which states on page viii:

> "A potential source of drinking water is one which is capable of yielding a quantity of drinking water to a well or spring sufficient for the needs of an average family. Drinking water is taken specifically as water with a total-dissolved-solids (TDS) concentration of less than 10,000 mg/L, which can be used without treatment, or which can be treated using methods reasonably employed in a public water-supply system. The sufficient yield criterion has been established at 150 gallons/day."

Similarly, the State Water Resources Control Board (SWRCB) has established guidelines in *Adoption of Policy Entitled "Sources of Drinking Water"* (SWRCB 1988) that state:

> "All surface and ground waters of the State are considered to be suitable, or potentially suitable, for municipal or domestic water supply and should be so designated by the Regional Boards with the exception of:
>
> 1. <u>Surface and ground waters where</u>:
>
>   a. The total dissolved solids (TDS) exceed 3,000 mg/L (5,000 µS/cm, electrical conductivity) and it is not reasonably expected by Regional Boards to supply a public water system, or
>
>   b. There is contamination, either by natural processes or by human activity (unrelated to the specific pollution incident), that cannot reasonably be treated for domestic use using either Best Management Practices or best economically achievable treatment practices, or
>
>   c. The water source does not provide sufficient water to supply a single well capable of producing an average, sustained yield of 200 gallons per day."

Based on the data in Table 2.5-1, a current or future well at Site 3 is unlikely to produce sufficient quantities of groundwater for beneficial use (i.e., drinking water) because the fractured bedrock does not yield sustainable quantities to meet the guidelines established by either the USEPA or SWRCB. In addition, even if adequate quantities of the groundwater could be extracted, the extracted groundwater would require treatment due to naturally occurring elevated concentrations of arsenic. However, the Water Board does consider the area at Site 3 to be part of the Antelope Valley Groundwater Basin, for which they have designated multiple beneficial uses including municipal and domestic supply, industrial service supply, agricultural supply, and freshwater replenishment (California Regional Water Quality Control Board [CRWQCB] 2005).

2.5.3 SITE TOPOGRAPHY AND SURFACE DRAINAGE

Site 3, Main Base Inactive Landfill, is located on a gently sloping alluvial plain at elevations ranging from approximately 2,400 above mean sea level (MSL) along the northeastern boundary of the site to approximately 2,360 feet above MSL near the southeastern corner of the site (Figure 2.5-8). The ground surface slopes gently at 1 to 3 percent toward the southwest. Surface water drainage channels trend toward the inactive landfill from the northeast, pass near the site on both sides, and join a large channel (Mojave Creek) that parallels Landfill Road. All of these drainage channels are ephemeral channels that are active only during periods of rain.

A topography slope gradient map and a soil type map are presented on Figures 2.5-9 and 2.5-10, respectively. Each figure shows a significant northwest-southeast trending linearity of these features that generally coincides with the extension of the El Mirage Fault as inferred by the USGS (Nishikawa et al. 2001; Leighton and Phillips 2003).

2.5.4 SITE MAN-MADE FEATURES AND CULTURAL RESOURCES

Man-made features at or near the site include landfill gas and groundwater monitoring wells, a chain-link fence surrounding the inactive landfill, water lines, a water hydrant, an open storm sewer drainage ditch, electrical cable line, a paved road, and unpaved roads and trails (see Figures 2.1-2 and 2.2-1). There are no sewage pipes or storm drains in the vicinity of Site 3. There are no existing structures at Site 3. The nearest structures to Site 3 are horse stables and an electrical substation located approximately 1,000 feet to the south.

Air Force Instruction (AFI) 32-7065 and Department of Defense Instruction (DODI) 4715.3 require Edwards AFB to have an Integrated Cultural Resources Management Plan (ICRMP). The ICRMP is an internal Base document that is updated annually and reviewed by Base leadership every five years. It is also a component of the *General Plan, Edwards Air Force Base, California* (Edwards AFB 2009), and is used by the 412th Test Wing as a decision document for cultural resources management actions and for specific cultural resources compliance decisions.

Though areas of archeological or cultural resources have been identified in the ICRMP in the vicinity of the site, there are no archeological or cultural resources within the Site 3 boundary shown on Figure 2.1-2, or within close enough proximity to be impacted by any remedial alternative.

2.5.5 SITE ECOLOGICAL SETTING

Major fauna zonal habitats in the area of Site 3 include xerophytic (arid-phase) saltbush scrub, creosote bush scrub, and Joshua tree woodlands (Figure 2.5-11). The land at Site 3 is highly disturbed due to past activities conducted at the inactive landfill (Figure 2.5-12). The land adjacent to Landfill Road from West Forbes Avenue to the Main Base Active Landfill is also disturbed fauna habitat, as is a small area approximately 2,300 feet north of the site. Site 3 is not considered critical habitat for any threatened or endangered plant or animal species. However, the northwest part of the site is included within a study area for the sensitive species desert cymopterus (*Cymopterus deserticola)*, a rare perennial herb in the carrot family, and an area north of the site is a desert kit fox species area.

2.5.6 SITE LAND USE AND DEMOGRAPHICS

Site 3 is located in Land Use Management Area C (Developed Area [Housing/Commercial/Industrial]) (Figure 2.5-13), as designated in the *Integrated Natural Resources Management Plan (INRMP) for Edwards AFB* (USAF 2002b). According to the Base *General Plan*, the current and potential future use of the land at Site 3 and adjacent to the site on the north side Landfill Road is categorized as Research and Development (i.e., land used directly in basic or applied research such as science, medicine, and engineering). South of Landfill Road, the land adjacent to the site is categorized as Parks and Historic Sites (i.e., land administered for cemeteries, memorials, monuments, parks, parkways, and recreation areas; excludes wilderness areas).

2.5.7 SITE INVESTIGATIONS

Investigations at the Site 3 Main Base Inactive Landfill include site evaluations conducted before Edwards AFB was formally listed on the USEPA NPL on 30 August 1990; SWATs; investigations conducted to support the preparation of a closure plan; Remedial Investigations; and LTM and sampling. The following subsections summarize the work performed during these investigations.

2.5.7.1 Site Evaluations

In 1981, a site evaluation found that both domestic and commercial wastes had been deposited in the landfill (Envirodyne Engineers, Inc. 1981). During a subsequent site evaluation, various total metals constituents were detected at three times the background soil concentrations. Chlordane, dichlorodiphenyldichloroethylene [DDE], dichlorodiphenyltrichloroethane [DDT], and the polychlorinated biphenyl (PCB) Aroclor 1254 were also detected at elevated concentrations (Engineering Science 1982).

2.5.7.2 Solid Waste Assessment Tests

Phase I groundwater and air SWATs were conducted at Site 3 in 1990 (BSK and Associates 1990a and 1990b). The Phase I groundwater SWAT included a geophysical survey using seismic refraction techniques to evaluate the thickness of the alluvial deposits and the drilling of two boreholes to collect soil samples. The seismic refraction survey revealed that the thickness of the alluvial deposits at the site ranged from a few inches to as much as 40 feet bgs. The variable thickness of the uppermost stratum (consisting of soils and waste filled cells) is largely due to the irregular character of the soil-bedrock interface. The analytical results for the soil samples showed that metals (with the exception of arsenic and copper) were detected at concentrations below calculated background concentrations. Volatile organic compounds (VOCs) were not detected in any of the samples.

The Phase I air SWAT included a site traverse with a flame ionization detector (FID) in which numerous readings of VOCs and gases in excess of the instrument limit of 1,000 parts per million (ppm) were observed along fissures on the surface of the landfill, particularly in the southeastern portion of the landfill. FID readings taken at grid points spaced 25 feet apart over the surface of the landfill showed that most gas emissions from the landfill were escaping through the fissures.

Phase II groundwater and air SWATs were conducted at Site 3 from February to September 1993 (Earth Technology 1994a). Six groundwater monitoring wells (Monitoring Wells 3-MW01 to 3-MW06) were installed (see Figure 2.2-1), and soil samples were collected for laboratory analysis. Two groundwater sampling events were conducted after the wells were developed. Additionally, four gas monitoring wells (Landfill Gas Monitoring Wells 3-LFG01 to 3-LFG04) were installed around the perimeter of the site, and one gas monitoring well (Landfill Gas Monitoring Well 3-LFG05) was installed adjacent to a waste cell. Gas samples were collected from the gas monitoring wells to evaluate whether landfill gas was emanating from the waste cells. A list of all Site 3 landfill gas and groundwater monitoring wells along with a summary of their well construction parameters is presented in Table 2.5-2.

2.5.7.3 Closure and Postclosure Maintenance Plan Investigations

Phase I investigations were conducted in November 1993 to support the preparation of *Final Closure and Postclosure Maintenance Plans for the Main Base Inactive Landfill, Edwards Air Force Base, California* (Earth Technology 1994b). These investigations included a review of 1992 aerial photographs of the landfill site, geophysical surveys, and a hand-auger boring program. The geophysical surveys utilized magnetic (MAG) and electromagnetic induction (EMI) methods over 15 profiles totaling 22,800 feet, and covered approximately 111 acres to map the areal extent of the waste. A total of 81 hand-auger borings were used to estimate the areal extent and depth of the waste. The results of the Phase I investigations were used to make a preliminary estimation of the locations of the landfill cells at the site.

In April and May 1994, Phase II of the investigation program was conducted, which consisted of field mapping the surface cracks in the soil cover on the landfill surface and installation of 60 additional hand-auger borings.

The results of the field mapping, hand-auger boring program, and geophysical surveys were included in the *Final Closure and Postclosure Maintenance Plans for the Main Base Inactive Landfill, Edwards Air Force Base, California* (Earth Technology 1994b). However, a decision was made at that time not to implement the closure plan because it was determined that the site did not pose an immediate risk to human health or the environment.

2.5.7.4 Remedial Investigations

An RI was conducted at Site 3 between June and September 2000, and consisted of an asbestos survey; test pit excavations, and soil sampling to determine the depth of waste and associated contamination in the northern and southwestern portions of the landfill; a soil gas survey consisting of both an FID survey and passive soil gas sampling; groundwater monitoring well installation; and groundwater sampling. A complete discussion of the RI results is presented in *Installation Restoration Program, Remedial Investigation Site Summary Report, Site 3, Main Base Inactive Landfill, Operable Unit No. 7, Edwards AFB, California (Site 3 RI)* (Earth Tech 2001). A brief summary of the RI results is presented below.

Asbestos Survey

A total of 169 debris piles suspected to contain asbestos-containing material (ACM) were identified at Site 3. Field observations and laboratory analyses indicated that non-friable ACM was present in 127 of the 169 debris piles. The types of ACM were predominantly floor tile, but also included transite pipe, transite panels, and fire door insulation. There was no friable ACM present in any of the debris piles. The volume of non-friable ACM observed at the surface was estimated at 1,215 cubic feet (45 cubic yards).

Test Pit Excavations and Soil Sampling

A total of 25 test pits were excavated in the northern and southwestern portions of the landfill in areas where surface subsidence was apparent, or where construction and demolition debris was present at the surface. A summary of the test pit excavation logs is presented in Table 2.5-3. The analytical results of the soil sampling are summarized in Section 2.6.2.2. Waste was found in 21 of the test pits with soil cover ranging in thickness from one to three feet. Household trash (paper, plastic, glass bottles, cans, and other discarded household items) was found in 13 of the test pits, and construction and demolition debris (including concrete, lumber, plywood, pipe, conduit, wire, sheet metal, and cleared vegetation) was found in 10 of the test pits. No debris was encountered in four of the test pits. No hazardous or military waste (munitions or training aids) was encountered.

Soil Gas Survey

The FID survey resulted in 28 detections of combustible gases at levels exceeding 10 ppm (clearly elevated level). These detections were recorded over fissures or cracks in the ground surface adjacent to waste disposal cells where the subsidence of buried waste caused cracks in the soil cover on the edges of the disposal cells. The highest FID detection at the landfill was 200 ppm near Landfill Gas Monitoring Well 3-LFG05.

Laboratory analytical results of the absorbent cartridges used for the passive soil gas survey that were collected from the 60 soil gas sampling locations detected trace amounts of aromatic volatile organics, chlorinated solvents, and diesel compounds. The highest concentrations of these compounds were detected in the northern portion of four disposal cells in the northeast corner of the landfill, and in the western portion of the disposal cells in the southern portion of the landfill along Landfill Road (Earth Tech 2001).

2.5.7.5 Long-term Monitoring and Sampling

In 1997, the USAF implemented a long-term monitoring and sampling plan to assess potential releases to groundwater from the Site 3 Main Base Inactive Landfill. The plan is described in *Addendum to the Field Sampling Plan (FSP), Installation Restoration Program Remedial Investigation/Feasibility Study, Operable Units 7, 8, 9, and 10, Edwards Air Force Base (AFB), California, Main Base Inactive Landfill – Site 3, Long-Term Monitoring Plan* (Earth Tech 1997). Constituents for analysis were selected to coincide with those listed in 40 CFR 258, Appendix II.

Activities Conducted in 1997 and 1998

As part of the long-term groundwater monitoring plan, four additional monitoring wells (Monitoring Wells 3-MW07 through 3-MW10) were installed in December 1997 (see Figure 2.2-1 and Table 2.5-2). Monitoring Well 3-MW07 was installed adjacent to Landfill Gas Monitoring Well 3-LFG05 in order to evaluate the lateral extent of the solvent contamination detected in Monitoring Wells 3-MW05 and 3-MW06. Monitoring Well 3-MW09 was installed to monitor the downgradient extent of contaminants detected in samples collected from Monitoring Well 3-MW06.

All Site 3 groundwater monitoring wells were sampled in March and October of 1998 (Earth Tech 1998). Groundwater samples were analyzed for VOCs, semivolatile organic compounds (SVOCs), pesticides, PCBs, chlorinated herbicides, total extractable petroleum hydrocarbons (TEPH), total volatile petroleum hydrocarbons (TVPH), metals, common anions, and general water quality parameters.

Activities Conducted in 2000

Four groundwater monitoring wells (Monitoring Wells 3-MW11 through 3-MW14) were installed in August 2000 as part of the RI at Site 3 (Earth Tech 2001) (see Figure 2.2-1 and Table 2.5-2). All four wells were installed with the screened interval in competent bedrock. These four wells were sampled in September 2000. Groundwater samples were analyzed for VOCs, SVOCs, pesticides, PCBs, chlorinated herbicides, TEPH, TVPH, metals, common anions, and general water quality parameters.

Activities Conducted in 2005

In May and June 2005, samples were collected from the landfill gas and groundwater monitoring wells at Site 3, and analyzed to provide a more current characterization of the contamination at the site (FPM Group 2006). Gas samples were analyzed for volatile organic gases and permanent gases (carbon dioxide, methane, nitrogen, and oxygen). Groundwater samples were analyzed for VOCs, SVOCs, pesticides, PCBs, chlorinated herbicides, TEPH, TVPH, metals, common anions, and general water quality parameters.

Activities Conducted in 2007

In November and December 2007, landfill gas and groundwater sampling was conducted as part of the long-term monitoring plan for Site 3 (Earth Tech 2009). Gas samples were analyzed for volatile organic gases and permanent gases (carbon dioxide, methane, nitrogen, and oxygen). Groundwater samples were analyzed for VOCs, SVOCs, pesticides, PCBs, chlorinated herbicides, TEPH, TVPH, metals, common anions, and general water quality parameters.

2.5.7.6 Supplemental Remedial Investigation in 2008 and 2009

A supplemental RI was conducted at Site 3 between September 2008 and July 2009 (AECOM 2009b). The objectives of the supplemental RI were to:

- Update the nature and extent of the contamination found at the Site 3 landfill;
- Evaluate the possible source of nitrate;
- Evaluate the results of the supplemental RI against the Remedial Action Objectives (RAOs) and the Remedial Action alternatives selected for detailed evaluation in the *Environmental Restoration Program, Site 3 Main Base Inactive Landfill Feasibility Study, Basewide Miscellaneous, Operable Unit 7, Edwards AFB, California (Site 3 FS)* (Earth Tech 2008b); and
- Comply with USEPA guidance documents for the preparation of Feasibility Studies.

Seven new groundwater monitoring wells (Monitoring Wells 3-MW15 through 3-MW21) were installed at Site 3 between 16 and 25 February 2009 (see Figure 2.2-1 and Table 2.5-2). Six of the seven new groundwater monitoring wells (Monitoring Wells 3-MW15, 3-MW16, 3-MW17, 3-MW18, 3-MW20, and 3-MW21) were installed at depths ranging from 95 feet to 120 feet bgs to monitor groundwater near the water table. The seventh well (Monitoring Well 3-MW19) was installed at a depth of 170 feet bgs to monitor deeper groundwater. Two of the new shallow wells (Monitoring Wells 3-MW17 and 3-MW18) were installed near existing deeper wells (Monitoring Wells 3-MW02 and 3-MW09), and the deep well (Monitoring Well 3-MW19) was installed near one of the new shallow wells (Monitoring Well 3-MW20) to provide data for assessing the vertical delineation of groundwater contamination. The remaining new wells were installed in areas where wells did not exist for plume delineation.

Eight new landfill gas monitoring wells were also installed as nested pairs (Landfill Gas Monitoring Wells 3-LFG06A/B, 3-LFG07A/B, 3-LFG08A/B, and 3-LFG09A/B) at four locations at Site 3 between 23 and 24 March 2009 (see Figure 2.2-1 and Table 2.5-2). These wells were installed to supplement the existing network of landfill gas monitoring wells at the landfill for future monitoring. Each nested pair of landfill gas monitoring wells was installed to monitor shallow (A) and deeper (B) zones, with the "A" designated wells corresponding to a screened interval eight feet to 10 feet bgs, and the "B" designated wells corresponding to a screened interval 23 feet to 25 feet bgs.

All groundwater monitoring wells at Site 3 were sampled during the supplemental groundwater investigation. Monitoring Wells 3-MW01 through 3-MW14 were sampled in September 2008 and the newly installed groundwater monitoring wells (Monitoring Wells 3-MW15 through 3-MW21) were sampled in March 2009. Landfill Gas Monitoring Wells 3-LFG01 through 3-LFG05 were sampled on 16 September 2008 and the new landfill gas monitoring wells (Landfill Gas Monitoring Wells 3-LFG06A/B through 3-LFG09A/B) were sampled on 1 June 2009. In July 2009, groundwater physicochemical parameters (temperature, pH, electrical conductance [EC], dissolved oxygen [DO], oxidation-reduction potential [ORP], and turbidity) and water levels were re-measured at all groundwater monitoring wells (not just newly installed wells) to obtain a temporally consistent data set.

Groundwater samples collected from the wells during this supplemental investigation were submitted to the laboratory and analyzed for TEPH, TVPH, VOCs, SVOCs, pesticides, PCBs, chlorinated herbicides, metals and other elements, common anions, general water quality parameters, dissolved gases, biochemical oxygen demand (BOD), chemical oxygen demand (COD), and volatile fatty acids (VFA). Groundwater samples were also submitted for microbial analysis of *Dehalococcoides species (spp.)* and Methanotrophic (methane oxidizing) bacteria.

Landfill gas samples were collected from the five existing landfill gas monitoring wells at Site 3 (Landfill Gas Monitoring Wells 3-LFG01 through 3-LFG05) on 16 September 2008, and from the eight new landfill gas monitoring wells installed as nested pairs (Landfill Gas Monitoring Wells 3-LFG06A/B, 3-LFG07A/B, 3-LFG08A/B, and 3-LFG09A/B) on 1 June 2009. The landfill gas samples were submitted to the analytical laboratory for definitive-level analysis of VOCs and fixed gases (methane, oxygen, and carbon dioxide). The landfill gas samples collected from the new landfill gas monitoring wells (Landfill Gas Monitoring Wells 3-LFG06A/B through 3-LFG09A/B) were also analyzed for petroleum hydrocarbons (PHC) as gasoline.

2.5.8 INTERIM REMOVAL ACTIONS

No Interim Removal Actions other than the installation of a fence have been performed at Site 3 under CERCLA. However, Interim Removal Actions were performed under the Underground Storage Tank Investigation Program at two PRLs in the vicinity of Site 3 as follows:

- **PRL 261: Underground Storage Tank (UST) M140 (Facility 7990).** PRL 261 is located in the southeastern corner of Site 3 (see Figures 2.2-1 and 2.2-2). Facility 7990 was a trash truck steam cleaning facility, and UST M140 was a 2-feet deep by 2-feet wide by 14-feet long concrete drainage trough covered by a steel grate used as an oil/water separator (Earth Tech 1996a). UST M140 was removed on July 27, 1995. The drainage trough was steam-cleaned prior to removal, and all piping and concrete were demolished and removed. Sludge from the bottom of the trough was taken to Envirocycle, Inc., rinseate was taken to DeMenno-Kerdoon, and concrete debris was taken to the Hi-Grade Company. Soil samples were collected after the infrastructure was removed and analyzed for petroleum hydrocarbons, metals, and VOCs; all were detected well below action limits. The facility was closed to further action by Kern County Environmental Health Services Department on October 3, 1996.

- **PRL 398: UST M138 and UST M141 (Facility 7992).** PRL 398 is located approximately 390 feet north of the northern boundary of Site 3 (see Figures 2.2-1 and 2.2-2). Facility 7992 may have been used as a fuel tank facility for heavy equipment used at the landfill (Earth Tech 1996b). The USTs were twin steel rectangular tanks 3-feet high by 3-feet wide by 4-feet long, each with a capacity of 250 gallons. UST M138 was dry but may have contained gasoline. UST M141 contained three inches of diesel. The tanks were pressure washed with water, removed on July 24, 1995, and sent to Golden State Metals for Recycling. Soil samples were collected after the tanks were removed and analyzed for petroleum hydrocarbons and VOCs; all analytical results were below detection limits. The facility was closed to further action by Kern County Environmental Health Services Department on October 10, 1996.

2.6 CONCEPTUAL SITE MODEL

A pictorial Conceptual Site Model to illustrate the potential contaminant sources, exposure pathways, receptors, and contaminant fate and transport mechanisms at Site 3 is presented on Figure 2.6-1. Surface debris and landfilled wastes are sources of contamination at Site 3. Through waste decomposition, contaminants could be released to surface soils, subsurface soil or bedrock, groundwater, or the atmosphere. Stormwater could infiltrate the landfill, and enhance the transport of contaminants into the groundwater. There are no current receptors for site contaminants other than workers performing monitoring activities and animals living at or around the site, however, there could be future residential, industrial, or construction worker receptors if the site were to be developed in the future.

A flowchart showing the potential contaminant migration and exposure pathways is presented on Figure 2.6-2. Further details about the contamination sources, contaminant fate and transport processes, evidence for natural attenuation, contaminant fate and transport modeling, and evaluation of potential receptors and exposure pathways are discussed below.

2.6.1 SITE OPERATIONS AND CONTAMINATION SOURCES

Site 3, Main Base Inactive Landfill, was in operation from the mid-1960s (actual year unknown) until 1976. It is believed that waste contained within the landfill is the principal source of the Contaminants of Concern (COCs) at Site 3. There are no USTs and no sewers or storm drains in the vicinity of Site 3; therefore, they were ruled out as sources of COCs.

Although there are no available records to indicate the total quantity or types of waste received at Site 3 while it was active, household trash (including paper, plastic, glass bottles, cans, and other discarded household items) and construction and demolition debris (including concrete, lumber, plywood, pipe, conduit, wire, sheet metal, and cleared vegetation) were found in test pits excavated during RI activities (see Section 2.5.7.4). No hazardous wastes were encountered in the waste cells; however, based on previous groundwater sampling results, it is likely that fuels and solvents were deposited at the site. Although no military wastes (munitions or training aids) were encountered, and there is no historical record of their disposal at this site, their presence at the landfill is highly unlikely but cannot be ruled out.

In addition to the buried debris, surface debris consisting of construction and demolition materials (e.g., concrete, lumber, plywood, pipe, conduit, wire, sheet metal, and cleared vegetation) and non-friable ACM are present on the surface of the landfill. It is not known when the debris was deposited on the site.

The USTs, piping, and other infrastructure associated with PRLs 261 and 398 are not a source of contamination at Site 3. Soil samples collected after Interim Removal Actions were performed at the PRLs indicated that no releases occurred from these potential conveyances (see Section 2.5.8).

2.6.2 NATURE AND EXTENT OF SITE CONTAMINATION

The following subsections discuss the nature and extent of surface debris, landfilled wastes, and soil, groundwater, and landfill gas (vapor) contamination at Site 3 based on data from the previous investigations summarized in Section 2.5.7. Complete analytical results for the RI and groundwater and vapor monitoring activities at Site 3 are presented in the following documents, which are available in the Administrative Record:

- *Installation Restoration Program, Remedial Investigation Site Summary Report, Site 3, Main Base Inactive Landfill, Operable Unit No. 7, Edwards AFB, California* (Earth Tech 2001).
- *Environmental Restoration Program, Groundwater and Vapor Monitoring Report, Site 3 – Main Base Inactive Landfill* (FPM Group 2006).
- *Environmental Restoration Program, Site 3 2007 Annual Groundwater and Vapor Monitoring Report, Basewide Miscellaneous, Operable Unit 7, Edwards Air Force Base, California* (Earth Tech 2009).
- *Site 3 Main Base Inactive Landfill Feasibility Study Addendum, Basewide Miscellaneous, Operable Unit 7, Edwards Air Force Base, California (Site 3 FS Addendum)* (AECOM 2009b).

2.6.2.1 Nature and Extent of Debris

Debris is present on both the landfill surface and buried in landfill cells.

Surface Debris

Surface debris is scattered over approximately 7.4 acres of the landfill at Site 3 (see Figures 2.2-1 and 2.2-2). The debris consists of construction and demolition materials (e.g., lumber, plywood, pipe, conduit, wire, sheet metal, and cleared vegetation). The estimated volume of surface debris is 67,500 cubic feet (2,500 cubic yards). Additionally, non-friable ACM is present in many of the debris piles. The estimated volume of non-friable ACM is 1,215 cubic feet (45 cubic yards) (see Section 2.5.7.4). No friable ACM is present on the landfill surface.

Landfilled Wastes

Based on the results of the geophysical surveys and test pit excavations (Earth Technology 1994b and Earth Tech 2001), and a review of 2002 aerial photographs of the site, 22 interpreted landfill cell locations have been identified at Site 3 that contain or potentially contain buried wastes (see Figures 2.2-1 and 2.2-2). Buried waste was found in 21 of 25 test pits excavated at the site (Figure 2.6-3). The types of waste encountered in the test pits included household trash (paper, plastic, glass bottles, cans, and other discarded household items) and construction and demolition debris (concrete, lumber, plywood, pipe, conduit, wire, sheet metal, and cleared vegetation) (see Table 2.5-3). No hazardous or military waste (munitions or training aids) were encountered in any of the test pits.

Estimates of the vertical extent of the buried waste in the landfill cells are based on a combination of several methods including (1) an evaluation of the test pit logs, which, as summarized in Table 2.5-3, indicate the depth to the top and bottom of waste, if encountered (i.e., the vertical extent); (2) the interpretation of the surface expression of the landfill cells based on 2002 aerial photographs (the estimated width of a cell based on its surface expression was used to estimate the vertical extent [depth] of the cell based on trench side slope analysis of the shallow subsurface lithology [i.e., silty sands, sands] encountered during the cut and cover method of landfilling the waste); and (3) analysis of the results from two seismic refraction surveys conducted during the Phase I groundwater SWAT (BSK and Associates 1990a) (i.e., velocity analysis of the shallow surface and subsurface alluvium versus the underlying deeper weathered and competent bedrock resulting in an estimate of the vertical extent of the landfill cells along the seismic line).

Assuming the vertical extent of the buried waste in the interpreted cells ranges from an estimated six feet to an estimated 23 feet (average 13 feet thick), the estimated total volume of buried waste in the landfill cells is 14.2 million cubic feet (526,000 cubic yards).

2.6.2.2 Nature and Extent of Soil Contamination at Site 3

The presence of Contaminants of Potential Concern (COPCs) in shallow soils (less than two feet bgs) and deep soils (greater than two feet bgs) was assessed during the Remedial Investigation (see Section 2.5.7.4). No soil samples were collected in areas under the landfill cells in the eastern portion of the landfill because the depth of the cells was greater than 20 feet bgs, and were not a concern for risk assessment. Samples of the bedrock underlying the soils were not collected.

Screening Criteria

The maximum concentrations of COPCs detected in soil samples were compared to their respective calculated background concentrations, residential Preliminary Remediation Goals (PRGs) and Regional Screening Levels (RSLs), and calculated Total Designated Levels (TDLs).

Background Concentrations

Because OU7 covers such a large area with a diverse range of soil types and groundwater conditions, calculating background values characteristic of each site was not considered practical. Instead, background values calculated for selected OUs (OUs 1, 2, 4, 5, 9, and 10) that represent the range of soil types and groundwater conditions at the Base, are applied to the nearest site where background values were not specifically developed. These calculated background concentrations for the selected OUs were developed in a process approved by the RPMs, and using techniques consistent with USEPA guidance. Site 3 is in close proximity to OU1, and has similar geology and hydrogeology as OU1 sites. Therefore, the calculated background concentrations for inorganic constituents (i.e., metals and other elements) in soil for OU1 sites (Earth Tech 1996c) are applied to soil at Site 3.

PRGs/RSLs

PRGs and RSLs are conservative risk-based concentrations that are intended to assist in initial screening-level evaluations of chemical constituents in the media of concern. PRGs and RSLs are generic; they are calculated without site-specific information. Therefore, they should be viewed as guidelines, not legally enforceable cleanup standards and should not be applied as such.

The PRGs presented in this ROD are the 2004 USEPA Region 9 residential PRGs (USEPA 2004) and were used for comparison to be consistent with the results presented in the *Human Health Risk Assessment* (Earth Tech 2004) and the *Site 3 FS* (Earth Tech 2008b). However, the more recently adopted USEPA residential RSLs (USEPA 2010) and California-modified RSLs (California DTSC 2009) are also presented to evaluate if changes in recently adopted screening levels would result in a significantly different evaluation of risk.

TDLs

The TDL methodology for determining threats to groundwater from contaminated soil is contained in a guidance document published by the CRWQCB, Central Valley Region entitled, *The Designated Level Methodology for Waste Classification and Cleanup Level Determination* (CRWQCB 1989). TDL methodology is based on the more stringent of the State or Federal primary Maximum Contaminant Level (MCL) of the constituent, the leaching potential of the constituent to reach groundwater, and the environmental attenuation factor (i.e., the potential for the attenuation or reduction of the concentration of the constituent before it impacts groundwater), and is calculated as follows:

TDL (in mg/kg) = Primary MCL (in mg/L) x Leachability Factor x Attenuation Factor

Where: mg/kg is milligrams per kilogram and mg/L is milligrams per liter.

If the constituent concentrations in the soil at a site exceed the TDL, the soil is classified as a "designated waste" and is directed to waste management units, which isolate the waste from the environment.

Leachability factors and environmental attenuation factors selected were based upon information presented in (CRWQCB 1989). The leachability factors are typical values for organic and inorganic constituents. The environmental attenuation factors are based on an average degree of protection for water quality from reasonable worst-case conditions. For Site 3, the TDLs for the organic contaminants detected in the soil samples collected at the site were calculated using a leachability factor of 10 and an environmental attenuation factor of 100. The TDLs for the inorganic constituents detected in the soil samples were calculated using a leachability factor of 100 and an environmental attenuation factor of 100.

Nature and Extent of Contamination

For Site 3, the maximum concentrations of the organic contaminants detected in shallow soil samples (less than two feet bgs) and in soil samples collected at depth (greater than two feet bgs) are shown in comparison to their respective calculated TDLs, 2004 residential PRGs, and 2010 RSLs in Tables 2.6-1 and 2.6-2, respectively. The maximum concentrations of the inorganic constituents detected in shallow soil samples and in soil samples collected at depth are shown in comparison to their respective calculated background concentrations, calculated TDLs, 2004 residential PRGs, and 2010 RSLs in Tables 2.6-3 and 2.6-4, respectively.

Concentrations of contaminants detected in soil at Site 3 that exceeded background values or PRGs are shown on Figure 2.6-3. Of the organic analytes detected in the shallow soil samples collected at Site 3, only benzo(a)anthracene and benzo(a)pyrene, detected at one foot bgs in Test Pit 3-TP08, were at concentrations that exceeded their respective 2004 residential PRGs. The concentration of benzo(a)pyrene also exceeded its calculated TDL value. A TDL value for benzo(a)anthracene was not calculated because a primary MCL for this compound has not been promulgated.

For the soil samples collected at depths greater than two feet bgs, the only organic contaminants detected at concentrations that exceeded their respective residential PRGs were naphthalene (at 8.5 feet bgs in Test Pit 3-TP02), pentachlorophenol (at 12 feet bgs in 3-TP19), and total PCBs (in seven of 40 samples). Pentachlorophenol exceeded its TDL value in one of 40 samples and total PCBs exceeded its TDL value in five samples. A TDL value for naphthalene was not calculated because a primary MCL for this compound has not been promulgated.

Of the inorganic constituents detected in the shallow soil samples collected at Site 3, only arsenic (in 23 of 23 samples), iron (in one of 23 samples), and lead (in one of 23 samples) were detected at concentrations that exceeded their respective residential PRGs. Lead exceeded both its PRG and background value at one foot bgs in Test Pit 3-TP22. Detected iron concentrations did not exceed its calculated background value. The detected concentrations of arsenic did not exceed either its calculated background value or calculated TDL value.

For the soil samples collected at depths greater than two feet bgs, arsenic exceeded its PRG in 39 of 40 samples, but did not exceed its calculated background value or TDL value. Iron exceeded its PRG in three of 40 samples and its calculated background value in one sample (at 12 feet bgs at Test Pit 3-TP19).

Volume of Impacted Soil

Concentrations of COCs in soils above screening levels were only sporadically detected in isolated locations; therefore, the volume of impacted soil was not calculated.

Conclusions

Based on the comparison of the soil analytical results to calculated background concentrations, calculated TDL values, 2004 residential PRGs, and 2010 residential RSLs, impacted (i.e., contaminated) soil at Site 3 is apparently limited to a few isolated areas both in surface soils and below the landfill cells. Contaminants detected below landfill cells, due to depth, would not be accessible to human contact or animal incursions.

Uncertainties and Data Gaps

It is possible that some unknown hazardous substances not detected during environmental sampling (e.g., explosive material or other military/industrial waste) could have been placed within the landfill, although there is no record of their disposal. These substances could have contaminated the soils beneath the cells into which they were placed. However, it should be noted that hazardous substances were not found in any of the 25 test pits that were excavated, indicating a relatively low likelihood that such substances are widespread throughout the site. Also, the bedrock underlying the soils was not sampled. However, due to the relatively low concentration of contaminants in the soil overlying the bedrock, the isolated nature of the detections, and the limited capacity of bedrock to absorb contaminants, it is unlikely that the bedrock contains a significant mass of contaminants.

In addition to this subsurface contamination, it is also possible that ACM found in the surface debris may have contaminated the surface soils. No analysis for ACM in soils was performed during the Remedial Investigation. However, because all of the ACM found in the surface debris was non-friable, any of the ACM found in the soil would not be a hazardous waste.

2.6.2.3 Nature and Extent of Groundwater Contamination

The presence of COPCs in groundwater was assessed during the Remedial Investigation (see Section 2.5.7.4), long-term monitoring and sampling program (see Section 2.5.7.5), and supplemental Remedial Investigation (see Section 2.5.7.6).

Screening Criteria

Organic and inorganic COPCs in groundwater samples collected at Site 3 were compared to the more stringent of Federal or State primary MCLs (California Department of Public Health [CDPH] 2008). Inorganic COPCs were compared to calculated background concentrations.

Because OU7 covers such a large area with a diverse range of groundwater conditions, calculating background values characteristic of each site was not considered practical. Instead, background values calculated for selected OUs (OUs 1, 2, 4, 5, 9, and 10) that represent the range of groundwater conditions at the Base, are applied to the nearest site where background values were not specifically developed. These calculated background concentrations for the selected OUs were developed in a process approved by the RPMs, and using techniques consistent with USEPA guidance. Site 3 is in close proximity to OU1, and has similar geology and hydrogeology as OU1 sites. Therefore, the calculated background concentrations for inorganic constituents (i.e., metals and other elements) in groundwater for OU1 sites were applied to groundwater at Site 3 (Earth Tech 1996c). For general inorganic constituents (i.e., chloride, nitrate, sulfate, and TDS), background concentrations were calculated from a combined data set for the entire Base (AECOM 2010b).

Nature and Extent of Contamination

Groundwater sampling results for sampling events conducted in September 2008 and March 2009 are presented on Figure 2.6-4. The vertical extent of groundwater contaminants are presented on Figure 2.6-5. The maximum concentrations of the organic contaminants and inorganic constituents detected in the groundwater samples collected from groundwater monitoring wells at Site 3 between those dates are shown in Table 2.6-5 in comparison to their respective calculated background concentrations in groundwater (if applicable) and MCLs in drinking water (CDPH 2008).

The analytical results for the September 2008 and March 2009 sampling events identified several organic and inorganic constituents (cis-1,2-dichloroethene [DCE], tetrachloroethene [PCE], trichloroethene [TCE], vinyl chloride [VC], and nitrate) that are considered COPCs (AECOM 2009b). Isoconcentration maps for these selected COPCs are presented on Figures 2.6-6 through 2.6-10, respectively.

For this Decision Document, the summary of the groundwater sampling results is limited to the COPCs and is presented below. No free product (either light non-aqueous phase liquid [LNAPL] or dense non-aqueous phase liquid [DNAPL]) has ever been detected in the groundwater at the site.

Volatile Organic Compounds

VOCs were detected in seven of the 21 groundwater monitoring wells sampled during the supplemental groundwater investigation. Nineteen VOCs were detected in the groundwater samples collected, but VOCs were detected at concentrations that exceeded MCLs in only two wells (Monitoring Wells 3-MW06 and 3-MW07). Two VOCs in Monitoring Well 3-MW06 (TCE and PCE) and eight VOCs in Monitoring Well 3-MW07 (benzene, 1,4-dichlorobenzene [DCB], 1,1-dichloroethane [DCA], 1,2-DCA, cis-1,2-DCE, methylene chloride, TCE, and VC) were reported at concentrations exceeding their respective MCLs.

The VOCs detected at the highest concentrations include 1,4-DCB at 7.9 micrograms per liter (μg/L) (MCL of 5 μg/L), VC at 15 μg/L (MCL of 0.5 μg/L), methylene chloride at 18 μg/L (MCL of 5 μg/L), PCE at 19 μg/L (MCL of 5 μg/L), dichlorodifluoromethane (Freon-12) at 28 μg/L (no MCL promulgated), and TCE at 29 μg/L (MCL of 5 μg/L). Historically, these constituents have been detected the most frequently and, with the exception of Freon-12, at the highest concentrations relative to their respective MCLs.

The most VOCs (17) were detected in Monitoring Well 3-MW07, which is also the well with the highest VOC concentration (TCE at 29 μg/L).

Nitrate

Nitrate was detected in eight of the 21 groundwater monitoring wells sampled during the supplemental groundwater investigation. Nitrate concentrations ranged from 0.340 J mg/L at Monitoring Well 3-MW12 to 26.9 J mg/L at Monitoring Well 3-MW10. The calculated background concentration for nitrate in groundwater is 1.7 mg/L, which is the value calculated from a combined data set for the entire Base (AECOM 2010b).

The maximum nitrate concentration in Monitoring Well 3-MW10 is the only detected concentration that exceeded its MCL (10 mg/L). This well is located outside of the inactive landfill boundary; however, there are two water lines unrelated to landfill activities located seven feet southeast and 12 feet northwest of the well (see Figure 2.6-10). The water lines near the well may have leaked, and nitrate may have subsequently leached from the surrounding soil to the groundwater. This conclusion is supported by the following:

- The distribution of nitrate in groundwater at concentrations exceeding the MCL is limited to a single well (Monitoring Well 3-MW10) that is in proximity to two existing water lines.
- Although nitrate was detected at concentrations above its calculated background concentration (1.7 mg/L) at five groundwater monitoring wells (Monitoring Wells 3-MW07, 3-MW08, 3-MW10, 3-MW15, and 3-MW17), it only exceeded its primary MCL at Monitoring Well 3-MW10, which has no VOC contamination. In addition, of the wells that exceeded background concentrations, only Monitoring Well 3-MW07 had VOC contamination.
- Groundwater in Monitoring Well 3-MW06, which is located approximately 1,600 feet northwest of Monitoring Well 3-MW10 and less than 100 feet southwest of the landfill boundary and a water line, contains VOCs that are associated with the inactive landfill, but does not contain nitrate.
- Nitrate has historically been detected at concentrations less than its MCL in groundwater samples collected from Monitoring Well 3-MW07, which is located within the main group of landfill cells where contaminants are historically reported with the highest frequency and generally at the highest concentrations.
- Nitrate has historically been detected at concentrations less than its MCL, or has not been detected, in groundwater samples collected from Monitoring Well 3-MW14, located approximately 200 feet south (generally downgradient) of Monitoring Well 3-MW10, indicating that the detection is isolated.
- Nitrate has historically been detected at concentrations less than its MCL, or has not been detected, in groundwater samples collected from wells generally downgradient of

Monitoring Well 3-MW07 and the main group of landfill cells (Monitoring Wells 3-MW19, 3-MW20, and 3-MW21), but closer to the landfill boundary than Monitoring Well 3-MW10.

- The presence of leachable nitrate in desert soils, including soils from the Mojave Desert, has been documented by Walvoord et al. (2003). Walvoord et al. provided evidence that substantial quantities of nitrate have leached from shallow soils and accumulated in the vadose zone below the root zone, and that this nitrate can be released during irrigation and subsequently leach into and contaminate groundwater.

Nitrate concentrations in groundwater at Site 3 have historically been in the 30 mg/L to 40 mg/L range for Monitoring Well 3-MW10, while at the same time they have been less than its 10 mg/L MCL in other monitoring wells at the site. Nitrate does not have any apparent relationship to the other documented contaminants at Site 3, and it is not a concern within the landfill boundary where it has historically been in the less than 10 mg/L range. For these reasons, the Air Force believes that the source of the elevated nitrate at Monitoring Well 3-MW10 is native soils, not the inactive landfill, and is most likely not a CERCLA waste. However, there is some uncertainty in this interpretation; therefore, an investigation of the source of the nitrate is being conducted under a separate program.

Volume of Impacted Groundwater

The estimated areal extent of potentially impacted groundwater at Site 3 is approximately 2.7 million square feet (61 acres) (see Figure 2.6-4). This areal extent is based on the assumption that all of the groundwater under the footprint of the landfill is potentially impacted, along with the groundwater in the vicinity of Monitoring Well 3-MW06, which is located outside of the landfill footprint.

The estimated vertical extent of contaminants is based on data collected from three pairs of adjacent shallow and deep groundwater monitoring wells that were installed at the site (see Section 2.5.7.6), along with data from wells installed within the landfill footprint.

The paired groundwater monitoring wells are located east, southeast, and southwest of the locations of the landfill cells (see Figure 2.2-1). Based on the results of the groundwater sampling conducted in 2008 and 2009, none of the VOCs that are considered as COPCs were detected in any of the paired shallow or deep groundwater monitoring wells.

However, of the monitoring wells located between the landfill cells, Monitoring Well 3-MW07 was screened from 4.9 feet to 24.9 feet below the top of potentiometric surface and had VOC contamination at concentrations above their respective MCLs; whereas Monitoring Well 3-MW05 was screened from 30.9 feet to 50.9 feet below the top of the groundwater potentiometric surface and had similar contaminants, but at concentrations below their respective MCLs. These data suggest that a conservative estimate of the depth of groundwater contamination above MCLs is approximately 50 feet below the top of the groundwater potentiometric surface, currently located at 65 feet to 110 feet bgs. The assumed vertical extent of contaminated groundwater is based on the levels of dissolved constituents detected in the groundwater; no LNAPL or DNAPL were detected in the groundwater.

The assumed effective porosity of the fractured bedrock is 5 percent (the midpoint of the range of porosities for fractured crystalline rock [Freeze and Cherry 1979]).

Based on the above assumptions, the estimated volume of groundwater-bearing matrix (i.e., fractured bedrock) impacted by contaminated groundwater is 135 million cubic feet (5 million cubic yards). The estimated volume of potentially impacted groundwater is 50 million gallons (153 acre-feet). Assuming that all of the potentially impacted groundwater contains the maximum concentrations of PCE, TCE, and VC detected in groundwater samples collected in September 2008 and March 2009, the estimated masses of these compounds in groundwater at Site 3 are seven pounds, 13 pounds, and seven pounds, respectively.

Conclusions

Although the entire groundwater-bearing matrix beneath Site 3 is potentially contaminated with VOCs, the contamination is of relatively low concentrations and contamination above MCLs appears to be limited to areas immediately adjacent to landfill cells.

Data Gaps and Uncertainties

The footprint containing contaminated groundwater is conservatively estimated because it includes areas with only largely inert surface debris or limited subsurface waste. These areas do not have the same subsided cover materials and fissuring that provides preferential pathways for leaching of contaminants to groundwater.

2.6.2.4 Nature and Extent of Landfill Gas

Landfill gas is generated by the decomposition of organic wastes. Waste fuels and solvents also contribute to the presence of VOCs in landfill gas. The presence of COPCs in landfill gas was assessed during the Remedial Investigation (see Section 2.5.7.4), long-term monitoring and sampling program (see Section 2.5.7.5), and supplemental Remedial Investigation (see Section 2.5.7.6).

Screening Criteria

Screening criteria were not used for the assessment of VOCs in landfill gas. The concentration of methane in the gas was compared to the lower explosive limit (5 percent by volume in air).

Nature and Extent of Contamination

Landfill gas sampling results for samples collected from September 2008 and June 2009 are presented on Figure 2.6-11. The maximum concentrations of the constituents detected in landfill gas samples are shown in Table 2.6-6. The landfill gas samples were analyzed for volatile organic gases and permanent gases (carbon dioxide, methane, nitrogen, and oxygen).

Twenty-seven volatile organic gases were detected in the landfill gas monitoring wells. No regulatory limits have been established for volatile organic gases present in landfill gas. The highest concentrations of volatile organic gases were detected predominantly in Landfill Gas Monitoring Well 3-LFG05, which is located within the limits of an interpreted landfill cell. Although both fuel-related hydrocarbons (such as benzene, toluene, ethylbenzene, and xylenes) and solvent-related hydrocarbons (such as TCE and PCE) are present, the fuel-related hydrocarbons are present in higher concentrations, indicating that disposal of fuels may have occurred at the landfill. However, these fuel-related compounds are in relatively low concentrations, or are not detected in groundwater, and no LNAPL has ever been detected at the site, suggesting that fuel-related compounds may have attenuated prior to reaching groundwater.

Of the permanent gases, the levels of nitrogen, oxygen, and carbon dioxide in all perimeter wells were generally at levels found in the atmosphere (approximately 78 percent, 21 percent, and 0.04 percent, respectively), and methane was either detected at a level well below its lower explosive limit (5 percent by volume in air) or was not detected. At the well located within the limits of an interpreted landfill cell (Landfill Gas Monitoring Well 3-LFG05), the oxygen and nitrogen levels were lower than atmospheric levels, the carbon dioxide level was higher than the atmospheric level, and a higher percentage of methane (22 percent) was detected.

Volume of Matrix Impacted by Landfill Gas

The estimated areal extent of the soil and buried landfill wastes (i.e.; matrix) impacted by landfill gas at Site 3 is approximately 2.9 million square feet (66.9 acres) (see Figure 2.1-2). This areal extent is based on the assumption that all of the soil and buried landfill wastes within the footprint of the approximate landfill boundary shown on Figure 2.1-2 are potentially impacted by landfill gas.

The estimated vertical extent of the matrix that may be impacted by landfill gas is 23 feet (see Section 2.6.2.1).

Based on these assumptions, the estimated volume of matrix (i.e., soil and buried landfill wastes) impacted by landfill gas is 67.1 million cubic feet (2.5 million cubic yards).

Conclusions

These data indicate that landfill gas is not migrating much beyond the limit of the landfill cells. In addition, the relatively low concentration of methane within the landfill at Site 3 (22 percent) versus a typical value for a landfill that is generating high volumes of gas (50 percent) indicates that landfill gas generation is limited. This is despite the fact that virtually all of the test pits excavated at Site 3 (see Table 2.5-3) indicated the presence of paper, which, under anaerobic conditions, is primarily responsible for the production of landfill gas. The low generation rate may be due to the arid climate coupled with the age (over 30 years) of the waste.

Data Gaps and Uncertainties

Ambient air was not sampled, and all assessments were made using landfill gas samples collected below the landfill cover. Due to the relatively low concentrations of VOCs detected in the landfill gas, and the likely attenuation of VOCs in the gas as it passes through the existing cover, the risk from volatilization to ambient air is likely to be low, and the data gap is not significant. In addition, it is possible that a future release of volatile emissions may occur if a container of fuels or solvents degrades, releasing VOCs to the subsurface. However, such a release would be localized in nature, and would be offset by the overall decline of VOCs in the landfill over time from waste decomposition.

2.6.3 CONTAMINANT FATE AND TRANSPORT PROCESSES

Surface debris and landfilled wastes are the sources of contamination at Site 3. Through waste decomposition, contaminants can be released to surface soils, subsurface soil or bedrock, groundwater, or the atmosphere as described below.

2.6.3.1 Primary Release Mechanisms

The following subsections discuss the mechanisms by which surface debris and landfill wastes can release contaminants to other media.

Surface Soil

Stormwater may directly dissolve contaminants out of surface debris and contaminate the underlying soil. Soil cover materials can also be contaminated by landfill gas; however, bacteria present in the soil can naturally attenuate this pathway.

Subsurface Soil and Bedrock

Leachates (liquid wastes) are formed as a result of waste decomposition. In addition, decomposing waste under anaerobic conditions can produce moisture-laden landfill gas. As this gas rises in the landfill, it cools, producing condensates. Stormwater can accumulate in depressions caused by subsidence of the buried waste due to its decomposition and settling over time. This subsidence has resulted in the cracking of the existing soil cover. The accumulated stormwater can infiltrate the landfill, enter the waste, and flush leachates and condensates into the soils or bedrock below the waste. It would be expected that there would be lower levels of contamination in the bedrock than in the overlying soil because of the lower capacity of bedrock to adsorb contaminants. ACM, if undisturbed, is relatively stable in the subsurface.

Groundwater

Because the groundwater at Site 3 is not in direct contact with the waste, the primary way that groundwater can be contaminated is by leachate and condensate formation due to waste decomposition. Once saturated, these fluids can travel through open interconnected fractures in the underlying bedrock, if present, into the groundwater. The increase in stormwater recharge caused by the depressions and cracks at the landfill surface is the likely reason for the potentiometric high (artificial groundwater gradient) under the waste cells.

Landfill gas can also migrate downward and become soluble in groundwater. However, it is not likely that landfill gas significantly contributes to the current groundwater contamination (Earth Tech 2008b) because the concentrations of contaminants in groundwater are detected above the equilibrium concentrations for contaminants detected in the landfill gas, and many of the contaminants in landfill gas are not detected in the groundwater.

Indoor and Outdoor Air

Landfill gas can also be released directly to the atmosphere and contaminate outdoor air. Landfill gas can seep into on- and off-site buildings, if present. VOCs present in the landfill gas could contaminate indoor air. Methane migrating to the ground surface above the lower explosive limit (5 percent in air) can create an explosive or fire hazard if enclosed structures are constructed on or adjacent to the site.

Gas monitoring data indicates that low levels of landfill gas are being produced by the landfill, but not at levels that are projected to cause an explosive hazard due to off-site migration. VOCs contained in the landfill gas could still migrate into buildings causing a risk to human health. Under some conditions, soil gas could migrate downward through fractures in the bedrock into the groundwater. It should be noted that landfill gas production decreases over time, which would lessen the impact of landfill gas on groundwater as the landfill ages. The USEPA's LandGEM Model Version 3.02 (USEPA 2005) uses a source half-life of 30 years for landfills in arid areas.

Although there is potential for VOCs to volatilize off groundwater and impact indoor air (future construction) at the surface, the very low levels of VOCs in groundwater at Site 3, coupled with the depth to groundwater, limit the potential for impact from this pathway.

Surface Water

Primarily derived from winter storms, surface water is only sporadically present at Site 3. Surface water temporarily ponds in small subsidence depressions, but then rapidly infiltrates through ground surface cracks. For this reason, the surface water pathway is considered negligible and is not further evaluated.

2.6.3.2 Attenuation and Transport of Contaminants in Groundwater

Once the COCs reach the groundwater, they would be subject to attenuation and transport.

The primary COCs in groundwater at Site 3 are VOCs. In general, dissolved VOCs will migrate and degrade by a variety of mechanisms including advection, dispersion, sorption, abiotic/biotic degradation, and volatilization (shallow zones). The following sections summarize the processes controlling the fate and transport of those contaminants at the site that may pose risk to human health, the available migration pathways, and how the various transport and transformation processes have affected, and will affect, constituent distribution in groundwater.

Groundwater Flow

Chemicals dissolved in groundwater are transported by advection, defined as the movement of solutes (both horizontally and vertically) at the rate of groundwater flow. The groundwater flow direction and gradient, and the hydraulic conductivity at the site, were discussed in Section 2.5.2.1. The low groundwater yield from the fractured bedrock beneath Site 3 minimizes the transport of contaminants off-site and results in a relatively small volume of groundwater affected by contaminants from the landfill. Based on an average gradient of 0.04 feet per foot, a hydraulic conductivity of 2.2×10^{-5} cm/sec, and an effective porosity for fractured bedrock of 5 percent (midpoint of range of porosities for fractured crystalline rock [Freeze and Cherry 1979]), the calculated groundwater velocity is approximately 18 feet per year.

It should be noted that the impact the El Mirage Fault has on groundwater flow and contaminant transport may not have been fully defined; there is some uncertainty in the estimated groundwater hydraulic properties and contaminant transport rates. This uncertainty will be factored into the remedy for Site 3. Because there is concern that there may be as yet unidentified fracture zones that could provide preferential pathways away from the landfill area, further hydrogeological evaluation will be addressed in the Site 3 Remedial Action Work Plan (RAWP).

Attenuation Mechanisms

The following attenuation mechanisms can act to reduce the concentration of solutes in groundwater along a flow path:

- Dispersion: Dispersion is the reduction in solute concentrations along a flow path due to the spreading of the solute mass throughout a larger volume of groundwater. This spreading or hydrodynamic dispersion is related to mechanical mixing (primarily lateral and transverse) which depends upon the properties of the aquifer material. Dispersion does not remove or destroy solute within groundwater but reduces concentrations along the flow path.

- Sorption: Sorption processes involve the bonding of chemical compounds to aquifer solids based either on differences in electrical charges between the VOCs and the solids or a chemical bonding. Sorption causes a reduction in groundwater concentrations because the VOCs transfer to another phase, which retards migration of the solute along the flow path.

- Abiotic Degradation or Chemical Transformation: Abiotic degradation is the breakdown of compounds due to chemical processes that are not mediated by microorganisms. Solute concentrations will be decreased by this process due to a net removal of mass from groundwater.

- Biodegradation: Biodegradation is the breakdown of compounds due to chemical processes that are mediated by microorganisms that occur naturally in the subsurface. Chlorinated hydrocarbons have been shown to biodegrade under various oxidation/reduction conditions through three different pathways: as electron donors, as electron acceptors, or through cometabolism. Degradation can take place under aerobic (oxidizing) or anaerobic (reducing) conditions. Biodegradation causes a net loss of solute mass within groundwater and lowers average solute concentrations over time.

- Volatilization: Volatilization involves a phase change in which VOCs transfer from the liquid into the gas phase based on concentration differentials as expressed by Henry's Law. Groundwater concentrations will also change under this mechanism, but with a resulting change in mass as VOCs disperse into the atmosphere.

Solutes will move by groundwater advection in the direction of groundwater flow and disperse along the flow path based on the hydrogeologic parameters of the water-bearing unit. Solutes will also adsorb to some extent onto the organic matter in the soil with TCE having a higher adsorption rate than VC. The total mass of solutes will not change as a result of advection, dispersion, or sorption, but groundwater concentrations will generally decrease along the flow path due to mixing (dispersion) and transfer from the dissolved phase to a solid phase (sorption). In contrast, both the total mass of solutes and groundwater concentrations will be reduced as a result of abiotic and biotic degradation and volatilization (primarily in shallow zones).

Dispersion will influence solute concentrations along a flow path at any site depending upon the nature of the aquifer materials. The only other attenuation mechanism believed to be important at Site 3 is biodegradation.

The following section includes a more detailed discussion of biodegradation.

2.6.4 EVIDENCE OF NATURAL ATTENUATION IN GROUNDWATER

Degradation of chlorinated hydrocarbons can either occur by reductive dechlorination or cometabolic aerobic biodegradation. Biodegradation is considered to be the most important natural attenuation mechanism because it results in the destruction of contaminants at rates that are typically faster than abiotic degradation, resulting in a net removal of contaminant mass from the subsurface. The three lines of evidence for biodegradation are as follows (USEPA 1999a):

1. Primary lines of evidence are data from historical groundwater and/or soil chemistry samples that demonstrate a clear and meaningful trend of declining contaminant mass and/or concentrations at appropriate monitoring or sampling points. Primary lines of evidence are used to determine whether plumes are shrinking or stable.

2. Secondary lines of evidence include data from the site characterization that indirectly demonstrate the type of natural attenuation processes active at the site and determine the rate at which such processes will reduce contaminant concentrations to required levels. For example, the rate of biodegradation can be indirectly determined by measuring the levels of DO and nitrate, iron (II), sulfate, methane, carbon dioxide, and other parameters.

3. Tertiary lines of evidence include data from field or microcosm studies (conducted in or with actual contaminated site media) that directly demonstrate microbial activity in the soil or aquifer material and its ability to degrade the COCs.

The USEPA recommends collecting two lines of evidence, either the first two or the first and third, to demonstrate that biodegradation is present at a site, unless sufficient historical data exist to adequately characterize the site (USEPA 1999a). The second and third lines of evidence provide quantitative information on degradation rates that can be used to predict contaminant concentrations at future times and at potential points of exposure. The evidence also provides insight into the processes that may be degrading site constituents such as reductive dechlorination, direct mineralization, or cometabolic degradation.

2.6.4.1 Primary Lines of Evidence

Contaminants have not been detected above Primary MCLs more than 60 feet from the landfill cells indicating that the plume as a whole is stable (see also Section 2.8.3). To assess if contaminants within the plume are showing an increasing, stable, or decreasing trend, plots of contaminants detected above MCLs for wells with more than one sampling event were prepared and are included in Appendix A. These plots indicate the following:

- Benzene (Figure A-1) has only been detected above its MCL in Monitoring Well 3-MW07, which is located between landfill cells. The concentration of benzene has declined since 1998.

- 1,4-DCB (Figure A-2), a component in household insecticides such as mothballs, has only been detected above its MCL in Monitoring Well 3-MW07. 1,4-DCB is relatively stable under anaerobic conditions in groundwater, but degrades readily under aerobic conditions (Newhart 2007). Concentrations show an increasing trend in Monitoring Well 3-MW07 and in Monitoring Well 3-MW06, which is located outside of the landfill perimeter adjacent to landfill cells, but have not been detected in any downgradient wells.

- cis-1,2-DCE (Figure A-3), a potential daughter product of TCE, shows an increasing trend in Monitoring Well 3-MW07, indicating that anaerobic degradation of TCE may continue to be occurring, and that aerobic conditions that favor the degradation of cis-1,2-DCE may not be present (see the discussion below). It shows an increasing trend in Monitoring Well 3-MW06 before July 2009 that now may be stabilizing.

- Methylene chloride (Figure A-4) has been detected above its MCL in Monitoring Wells 3-MW05, 3-MW06, and 3-MW07. Monitoring Wells 3-MW05 and 3-MW06 only had concentrations above its MCL before 2000, indicating that the extent of methylene chloride contamination may be declining. Monitoring Well 3-MW07 is located between landfill cells. Concentrations of methylene chloride at the monitoring well have declined since 1998.

- PCE (Figure A-5) has only been detected above its MCL in Monitoring Wells 3-MW06 and 3-MW07. Concentrations of PCE have fluctuated without a discernable trend (Monitoring Well 3-MW06) or have been stable (Monitoring Well 3-MW07). PCE was detected below its MCL in downgradient Monitoring Well 3-MW10 in past sampling rounds, but is no longer detected, indicating that the extent of PCE contamination may be declining.

- TCE (Figure A-6) has only been detected above its MCL in Monitoring Wells 3-MW06 and 3-MW07. Concentrations of TCE have either been stable (Monitoring Well 3-MW06), or have shown an increasing followed by a decreasing trend (Monitoring Well 3-MW07). TCE was detected below its MCL in downgradient Monitoring Well 3-MW10 in past sampling rounds, but is no longer detected, indicating that the extent of TCE contamination may be declining.

- VC (Figure A-7), a potential daughter product of TCE, shows an increasing trend in Monitoring Well 3-MW07 that appears to be stabilizing, indicating that anaerobic degradation of TCE may continue to be occurring, and that aerobic conditions that favor the degradation of VC may not be present (see the discussion below).

- Nitrate (Figure A-8) has only been detected above its MCL in Monitoring Wells 3-MW07 and 3-MW10. Nitrate was detected below its MCL in Monitoring Well 3-MW07 during the last sampling round, and has declined in Monitoring Well 3-MW10 during the last two sampling rounds. It should be noted that no VOCs have been detected in Monitoring Well 3-MW10 above their MCLs, indicating that the source of the nitrate may not be from the landfill.

2.6.4.2 Secondary and Tertiary Lines of Evidence

Biodegradation is the breakdown of compounds under biologically mediated conditions. Chlorinated hydrocarbons can either degrade anaerobically via reductive dechlorination or aerobically via cometabolic dechlorination.

Evaluation of Occurrence of Reductive Dechlorination

During biodegradation via reductive dechlorination, a chlorine atom is removed and replaced with a hydrogen atom. In general, reductive dechlorination occurs with the sequential degradation of TCE to DCE (cis-1,2-DCE is most common, but trans-1,2-DCE and 1,1-DCE are also formed) to 1,2-DCA to VC and finally to ethane. An accumulation of daughter products and an increase in the concentration of chloride ions is evidence of the occurrence of reductive dechlorination in an aquifer.

The availability of a carbon substrate and the presence of competing electron acceptors limit reductive dechlorination. Because the process requires a supply of biologically oxidizable organic matter to serve as an electron donor, the presence of electron donors is the foremost screening criterion used to evaluate the potential for reductive dechlorination. Electron donors can be either anthropogenic (e.g., a commingled petroleum fuel spill that includes benzene, toluene, ethylbenzene, or xylene components) or naturally occurring (total organic carbon [TOC] concentration greater than 20 mg/L).

If oxygen is present, reductive dechlorination (which is an anaerobic process) does not proceed. Once the oxygen is consumed, anaerobic microorganisms typically use additional electron acceptors in the following order of preference: nitrate, ferric iron, sulfate, and finally carbon dioxide. Reductive dechlorination can occur under nitrate and iron-reducing conditions, but the most rapid biodegradation rates occur under sulfate-reducing and carbon dioxide-reducing (methanogenic) conditions. Therefore, the distribution of electron acceptors and the presence of dissolved methane are indicative of the potential for reductive dechlorination.

At Site 3, data that have been collected in support of all primary and secondary lines of evidence for reductive dechlorination are summarized as follows:

- **Concentrations of Reductive Dechlorination Byproducts.** The compounds cis-1,2-DCE and VC are daughter products of the reductive dechlorination of PCE and TCE under anaerobic conditions. These compounds were detected in wells with TCE and PCE, and show an increasing or stable trend (see Appendix A and the discussion above) indicating that it is likely that reductive dechlorination is occurring.

- **Dissolved Oxygen**. DO concentrations above 0.5 mg/L indicate conditions are favorable for aerobic biodegradation, whereas DO concentrations below 0.5 mg/L indicate conditions are favorable for anaerobic biodegradation. Figure 2.6-12 shows the isoconcentrations of DO in groundwater at Site 3 in July 2009. DO concentrations are below 0.5 mg/L in two wells located north and east of waste cells in the eastern portion of the landfill. Wells located within the footprint of the landfill had DO concentrations above 0.5 mg/L. These data suggest that oxygen is depleted immediately downgradient of the contaminant source indicating that conditions may be favorable for reductive dechlorination in some portions of the landfill.

- **Oxidation-Reduction Potential.** The ORP can be used to differentiate between areas of aerobic and anaerobic reactions. In aerobic conditions, the ORP will have a value greater than 150 millivolts (mV). In anaerobic conditions, the ORP will have a value less than 0 mV. In transitional environments where both aerobic and anaerobic processes are occurring, the ORP will have a value between 0 mV and 150 mV. Figure 2.6-13 shows the isopleths of ORP values in groundwater at Site 3 in July 2009. No wells had an ORP value above 150 mV, 11 wells had ORP values between 0 mV and 150 mV, and 10 wells had negative ORPs. These data indicate either transitional or anaerobic environments.

- **Total Organic Carbon.** The TOC present in groundwater is indicative of the amount of carbon available to drive reductive dechlorination of chlorinated solvents. TOC concentrations above 20 mg/L are needed to drive reductive dechlorination. In general, TOC concentrations are low or not detected at Site 3 with the exception of Monitoring Well 3-MW09. The low concentrations of TOC could limit reductive dechlorination.

- *Dehalococcoides spp.* These bacteria, which are capable of reductive dechlorination, are present in all wells (Figure 2.6-14).

Evaluation of Occurrence of Cometabolic Degradation of Chlorinated Hydrocarbons

Indicators of aerobic biodegradation (sometimes referred to as respiration) evaluated for Site 3 include physicochemical parameters such as DO and ORP; the absence of common anaerobic indicators such as daughter products of anaerobic respiration (e.g., cis-1,2-DCE and VC); and the presence of bacteria able to survive under aerobic conditions.

- **Dissolved Oxygen and ORP.** Aerobic respiration is possible at DO concentrations greater than 0.5 mg/L, and during aerobic respiration DO concentrations will decrease. As indicated in the anaerobic respiration discussion, conditions in the groundwater-bearing fractured bedrock are favorable for aerobic respiration throughout much of the plume. Aerobic respiration is also possible at ORP values greater than 50 mV. Wells with the highest ORP values (Monitoring Wells 3-MW18 and 3-MW21) were located outside the landfill boundary. However, Monitoring Well 3-MW07, which is located between landfill cells, also showed an ORP value greater than 50 mV, suggesting that conditions supporting aerobic respiration are present throughout the site.

- **Absence of Common Anaerobic Indicators.** VC was detected in Monitoring Well 3-MW07 despite the presence of indicators of aerobic respiration (elevated DO and ORP). VC is readily oxidized under aerobic conditions (USEPA 1998), and therefore it is unlikely to accumulate as a degradation byproduct in the groundwater under aerobic conditions. VC showed an increasing trend in Monitoring Well 3-MW07, after which it showed a slight decline. Therefore, it is possible that either the landfill is trending toward aerobic conditions and all of the VC has not yet been degraded, or that both aerobic and anaerobic conditions exist in close proximity within the groundwater-bearing fractured bedrock in the vicinity of this well. VC was either not detected or detected at low concentrations in groundwater in the wells beyond the landfill boundary at Site 3, suggesting that predominantly aerobic conditions may be occurring outside the landfill boundary.

- **Microbial Evidence.** Methanotrophic (methane oxidizing) bacteria able to cometabolize chlorinated hydrocarbons are present in the groundwater throughout Site 3. The highest concentrations of Methanotrophic bacteria were detected in Monitoring Wells 3-MW05 and 3-MW07, which are located between landfill cells; and appear to correlate with the distribution of dissolved methane in groundwater. This indicates that aerobic biodegradation is possible within the landfill boundary.

In summary, using the USEPA criteria, the primary line of evidence for MNA is that the groundwater plume at Site 3 is stable. The secondary line of evidence for MNA is that daughter products of reductive dechlorination such as cis-1,2-DCE and vinyl chloride are present in the groundwater at Site 3. Tertiary lines of evidence include the presence of *Dehalococcoides spp.* bacteria, which are capable of reductive dechlorination, and Methanotrophic (methane oxidizing) bacteria able to cometabolize chlorinated hydrocarbons in the groundwater at Site 3.

2.6.4.3 Contaminant Fate and Transport Modeling

Numerical fate and transport modeling was performed to (1) evaluate how different types of landfill covers (including the existing cover) affect the quantity of stormwater infiltrating the landfill, which in turn affects the quantity of leachates, condensates, and dissolved-phase contaminants entering the groundwater; and (2) evaluate the fate of the contaminants that reach groundwater.

The modeling program UNSAT-H Version 3.01 (Fayer 2000) was used to evaluate the quantity of stormwater that could infiltrate the landfill under different cover scenarios. UNSAT-H is a one dimensional, finite-difference computer modeling program that was designed to evaluate landfill cover performance. Based on logs of test pits at Site 3, the existing soil cover over the landfill cells at the landfill ranges from 1- to 2-feet thick. A soil cover thickness of 1-foot was used in the model to provide a conservative estimate of moisture infiltration under existing conditions. The modeling results indicate that for the existing cover, the calculated infiltration is approximately 20.5 inches over a 10-year period (Earth Tech 2008b). The modeling results for enhancements to the existing cover decrease the predicted infiltration rate to 7.1 inches over a 10-year period for Alternative 3 (ET Cover) and 1.6 inches over a 10-year period for Alternative 4 (Enhanced ET Cover).

MODFLOW-2000, a porous media model (Harbaugh et al. 2000), and MT3D99, a component of MODFLOW (Zheng 1999), were used to simulate contaminant transport and evaluate natural attenuation at Site 3 (Earth Tech 2008b). Although groundwater elevation data for Site 3 indicates that groundwater occurs within fractured granitic bedrock as shown on Figures 2.5-2 through 2.5-4, a standard porous media model instead of a fractured media model was selected to represent the conceptual geologic structure for Site 3. Fractured media models are useful in modeling contaminant migration through preferential pathways in bedrock. However, existing analytical data indicates that the contaminants have not migrated far beyond the Site 3 boundary. For this reason, the need to address groundwater flow through preferential pathways in fractured bedrock is minimal, and the porous media model can be used to adequately simulate site conditions. In addition, fractured media models require a thorough understanding of the fractured system throughout the model area (e.g., fracture orientation, fracture aperture, and fracture spacing). Due to the limitations of the available data, these input parameters were not evaluated and the fractured media model was not used.

The model simulations were updated in the *Site 3 FS Addendum* (AECOM 2009b) using contaminant concentrations and hydraulic head data collected during the September 2008 and March 2009 groundwater monitoring events.

Four COCs were modeled for Site 3. TCE and PCE were modeled because they were detected in four wells each. Cis-1,2-DCE and VC were modeled because they were detected in two wells each, and are degradation products of TCE and PCE. Aquifer parameters were estimated from aquifer test results and calibrated for observed site conditions. Decay coefficients for the VOCs were estimated from literature values and calibrated for site conditions.

The modeling results predict that even if no action is taken, the areal extent of groundwater contamination will decrease over time due to natural attenuation, and no additional groundwater will be contaminated. Under existing conditions, VC (the final degradation product of PCE and TCE) would degrade to a concentration below its MCL (0.5 μg/L) after approximately 139 years. Modeling also predicts that by reducing the rate of groundwater recharge and the potential for contaminants to enter the groundwater, the natural attenuation of contaminants currently in groundwater will accelerate. This acceleration of the natural attenuation rate will also cause the areal extent of groundwater contamination to decrease more quickly. The modeling results for enhancements to the existing cover decrease the predicted time for VC to degrade below its MCL to approximately 84 years for Alternative 3 (ET Cover) and 23 years for Alternative 4 (Enhanced ET Cover).

2.6.5 POTENTIAL RECEPTORS

2.6.5.1 Human

There are no current residents or construction workers at the Site 3. Current receptors at the site are limited to workers performing monitoring activities. Future receptors could include industrial and construction workers, residents (although LUCs contained in the ROD prohibit residential use of the property), and sensitive human health receptors such as daycare, hospice occupants, and public or private water supply wells. The nearest Base residential housing was located approximately 1,500 feet southeast of Site 3 until 2010, when the housing and associated infrastructure (e.g., streets, landscaping) were demolished and the land graded. The Base *General Plan* (Edwards AFB 2009) shows that the future designated use of this land is Parks and Historic Sites (i.e., land administered for cemeteries, memorials, monuments, parks, parkways, and recreation areas; excludes wilderness areas). Currently, the nearest existing Base residential housing is located approximately 3,200 feet south of the site. It is unlikely that housing would be constructed on or immediately adjacent to the landfill while the Base is still active. This is because under the long range plan contained in the Base *General Plan* (Edwards AFB 2009), the land use at Site 3 will continue to be Research and Development.

2.6.5.2 Ecological

As discussed in Section 2.5.5, the land at Site 3 is highly disturbed due to past activities. Site 3 is not considered critical habitat for any threatened or endangered plant or animal species, and none have been observed at the site. Potential ecological receptors at Site 3 include terrestrial plants, terrestrial invertebrates, reptiles, small herbivorous mammals, large carnivorous mammals, granivorous (seed and grain eating) and invertivorous birds, and raptorial avian species. Small mammals such as desert cottontails (*Sylvilagus audubonii*) and kangaroo rats (*Dipodomys sp.*); small reptiles such as side-blotched lizards (*Uta stansburiana*); and common avian species such as red-tailed hawks (*Buteo jamaicensis*), mourning doves (*Zenaida macroura*), horned larks (*Eremophila alpestris*), and house finches (*Carpodacus mexicanus*) are typical of Xerophytic-Phase Saltbush Scrub habitat and are expected to make up the majority of potential wildlife receptors present at Site 3.

Several special-status species are associated with Xerophytic-Phase Saltbush Scrub habitat at Edwards AFB. Based on the Integrated Natural Resource Management Plan (INRMP), desert tortoise (*Gopherus agassizii*) density at the site is estimated to be low (6 - 10 per 2.6 square kilometers) (USAF 2004). The Mojave ground squirrel (*Spermophilus mohavensis*) may be present at the site, because it is found incidentally throughout the Base and is attracted to Joshua trees (Johnson 1990), which are present in very small numbers at Site 3 and in the surrounding area. A 1993 spring survey identified populations of Mojave ground squirrels in areas just west of Site 3 (USAF 1993), indicating that Mojave ground squirrels may inhabit areas around the site or visit the interior of the site.

U.S. Air Force biologists visited Site 3 in April 2003 and observed common ravens (*Corvus corax*), house finches (*Carpodacus mexicanus*), sage sparrows (*Amphispiza belli*), horned larks

(*Eremophilaalpestris*), loggerhead shrikes (*Lanius ludovicianus*), western whiptails (*Cnemidophorus tigris*), side-blotched lizards (*Uta stansburiana*), and canid scat (USAF 2004).

2.6.6 EVALUATION OF EXPOSURE PATHWAYS

The following discussion provides an evaluation of current and potential future exposure pathways (see Figures 2.6-1 and 2.6-2).

2.6.6.1 Human

Potential human receptors at Site 3 include current and future site workers (industrial workers), future construction workers, and hypothetical future residents.

Direct Contact with Debris

Surface

Because the area containing the surface debris is fenced, the only current receptors are site workers conducting monitoring activities. If fencing is not maintained, users including hypothetical future residents could come into contact with the debris. However, because no hazardous waste was observed in the surface debris the risk of contact from surface debris is limited to physical hazards and chemical exposures to surface debris was not retained as a potential exposure pathway.

Subsurface

Because the area containing landfilled wastes is fenced or controlled by existing LUCs, the only current receptors are site workers. If fencing or LUCs are not maintained, users including hypothetical future residents could come into contact with the debris if the land were excavated. Although no hazardous waste was observed in the subsurface debris during test pit excavations, the possibility that such materials are present cannot be ruled out. Exposure to subsurface hazardous waste was retained as a potential exposure pathway, albeit not one that can be quantified with existing data.

Direct Contact with Soil and Bedrock

Surface

Because the area containing the potentially contaminated surface soil is fenced, the only current receptors are site workers conducting monitoring activities. If fencing is not maintained, users including hypothetical future residents could come into contact with surface soils. Although the waste deposition is heterogeneous (by nature), and data collected during the RI indicated only a few low level detections of contaminants in surface soils above screening levels, there is a risk of direct contact with potentially contaminated surface soils. The pathway was retained so that the risk to hypothetical future residents, site workers, and construction workers could be quantified as part of the Human Health Risk Assessment (see Section 2.6.7.1).

Subsurface

Because the area containing the potentially contaminated subsurface soil is fenced, the only current receptors are site workers. If fencing is not maintained, users including hypothetical future residents could come into contact with subsurface soils and weathered bedrock. Hypothetical future construction workers could come in contact with competent bedrock; however, this is unlikely because the depth to competent bedrock is in excess of 50 feet bgs.

Although no hazardous waste was observed in the subsurface debris during test pit excavations, the possibility that such materials are present cannot be ruled out. Therefore, it is possible that a container of hazardous waste, if present, could hypothetically leak, releasing contaminants to the underlying soil. Such a release would be localized in nature, and therefore is unlikely to be a significant exposure pathway. This is consistent with the fact that data collected during the RI indicated only a few low level detections of contaminants in subsurface soils at concentrations above screening levels.

The pathway was retained so that the risk to hypothetical future residents, site workers, and construction workers could be quantified as part of the Human Health Risk Assessment (see Section 2.6.7.1).

Inhalation of Particulates Emissions

Because the area is fenced, the only current receptors are site workers. Based on the nature of the surface debris, and the low levels of contaminants in surface and subsurface soils, the inhalation of particulate emissions pathway was considered unlikely to be significant to current or potential future receptors. The pathway was retained so that the risk to hypothetical future residents, site workers, and construction workers could be quantified as part of the Human Health Risk Assessment (see Section 2.6.7.1).

Inhalation of Volatile Emissions

Indoor Air

There currently are no buildings on the site so there are no current receptors who could be exposed by inhalation of volatile emissions. Hypothetical future site workers or future residents could be exposed to volatile emissions if structures designed for inhabitation were built on or adjacent to the landfill. The pathway was retained so that these risks could be quantified as part of the Human Health Risk Assessment (see Section 2.6.7.1).

Outdoor Air

The risk from outdoor air was not calculated. Due to low emissions levels, and lack of topography that could trap emissions, outdoor air was not considered a significant exposure medium and was not retained as a potential pathway.

Ingestion or Direct Contact with Surface water

Due to the highly ephemeral nature of stormwater ponding on the landfill (temporary accumulations of stormwater in surface depressions are expected to drain too quickly for significant exposure to occur), and the low concentrations of contaminants in surface soils that could contaminate the ponded stormwater, surface water was not considered a significant exposure medium and was not retained as a potential exposure pathway.

Ingestion or Direct Contact with Groundwater

Because the groundwater is not currently used for a beneficial purpose, the only current receptors are site workers conducting monitoring activities. Ingestion of groundwater by current or future site or industrial workers is not a likely pathway because there is already a water line running by the landfill that could be used to provide drinking water and because the groundwater yield is too low to make pumping impractical. Ingestion of, or direct contact with, groundwater is a potential exposure route for future residential users, although development of local groundwater is also unlikely due to low groundwater yields. The pathway was retained so that the risk to hypothetical future residents could be quantified as part of Human Health Risk Assessment (see Section 2.6.7.1).

Ingestion or Direct Contact with LNAPL or DNAPL

LNAPL or DNAPL is not present at the site.

Blast or Explosion Hazards

There is a hypothetical blast or explosion hazard if Munitions or Explosives of Concern (MEC) are buried in the landfill. Landfill gases from degradation of organic matter or unknown containers of VOCs and munitions are also a potential explosion hazard.

MEC

Although the presence of MEC cannot be totally ruled out, no MEC was encountered during test pit excavations. Also, there is no MEC readily visible on the landfill surface. Because the area containing the subsurface and surface debris is fenced, the only current receptors are construction workers. If fencing is not maintained, users including hypothetical future residents could come into contact with MEC if it is present in the landfill cells and the land were excavated. The pathway is retained; however, the risks from non-chemical hazards could not be quantified based on existing data as part of the Human Health Risk Assessment (see Section 2.6.7.1).

Landfill Gas

Landfill gas contains methane, which is explosive at concentrations between 5 percent and 15 percent by volume in air. Gas contained within the landfill is unlikely to combust or explode due to the lack of oxygen contained within the waste pore spaces. However, landfill gas can accumulate at explosive concentrations in structures built on or adjacent to a landfill. Because there are no structures currently built on or around Site 3, there are no current explosive hazards from landfill gas. However, there would be a risk to hypothetical site workers or future residents if structures were built on or adjacent to the landfill. The pathway is retained; however, the risks from non-chemical hazards could not be quantified based on existing data as part of the Human Health Risk Assessment (see Section 2.6.7.1).

2.6.6.2 Ecological

Potential ecological receptors include terrestrial plant, reptile, bird, and mammal populations living on or in the vicinity of Site 3 as discussed in Section 2.6.5.2.

Direct Contact with Debris

Surface

Animals that can burrow under, fly over, or pass through the existing fence can come into contact with surface debris. However, because no hazardous waste was observed in the surface debris, the risk from contact from surface debris is limited to physical hazards and chemical exposures to surface debris was not retained as a potential exposure pathway.

Subsurface

Animals that can burrow under, fly over, or pass through the fence can come into contact with landfilled wastes located just below the existing soil cover, which is less than one foot thick in some areas. Burrowing animals can also access the landfill cell located outside of the fenced area. Although no hazardous waste was observed in the subsurface debris during test pit excavations, the possibility that such materials are present cannot be ruled out. Exposure to subsurface hazardous waste was retained as a potential exposure pathway, albeit not one that can be quantified.

Direct Contact with Soil and Bedrock

Surface

Animals that can burrow under, fly over, or pass through the fence can come into contact with potentially contaminated surface soil. Although the waste deposition is heterogeneous (by nature), data collected during the RI indicated only a few low level detections of contaminants in surface soils, so direct contact with potentially contaminated surface soil is not considered a significant exposure pathway. The pathway was retained so that the risk to animals could be quantified as part of the Ecological Risk Assessment (see Section 2.6.7.2).

Subsurface

It is unlikely that animals would be able to burrow through landfill cells to access the underlying soil or bedrock due to the thickness of the waste layer and the presence of an anoxic environment within the waste layer, so direct contact with subsurface soil or bedrock is not considered a significant exposure pathway. Exposure to deep soils (greater than 12 feet) was not retained as a pathway.

Inhalation of Particulates Emissions

Based on the non-hazardous nature of the surface debris, and the low levels of contaminants in surface and subsurface soils, this pathway was not considered significant to current or potential future receptors. This pathway was not retained.

Inhalation of Volatile Emissions

Burrowing animals that can burrow under, fly over, or pass through the fence can come into contact with vapor emissions from the landfill. The pathway was retained so that the risk to animals could be quantified as part of the Ecological Risk Assessment (see Section 2.6.7.2).

Ingestion or Direct Contact with Surface water

Due to the highly ephemeral nature of stormwater ponding on the landfill, and the low concentrations of contaminants in surface soils, surface water was not considered a significant exposure medium and the pathway was not retained.

Ingestion or Direct Contact with Groundwater

Due to the depth to groundwater, this pathway is incomplete for biota and was not retained.

Ingestion or Direct Contact with LNAPL or DNAPL

LNAPL or DNAPL is not present at the site.

Blast or Explosion Hazards

Blast or explosion hazards could be the result of MEC buried in the landfill (if present) or landfill gases. This pathway was not retained for the reasons stated below.

MEC

Although the presence of MEC cannot be totally ruled out, no MEC was encountered during the test pit excavations. Also, there is no MEC readily visible on the landfill surface. For this reason, this pathway is likely to be incomplete.

Landfill Gas

Landfill gas contains methane, which is explosive at concentrations between 5 percent and 15 percent by volume in air. Even if landfill gas were to accumulate in burrows, the lack of an ignition source would preclude an explosive hazard. For this reason, this pathway is incomplete and was not retained.

2.6.7 SUMMARY OF SITE RISKS

This section of the ROD summarizes the results of the baseline risk assessments for Site 3. Baseline risk assessments provide estimates of the risks a site poses if no action were taken. They provide the basis for taking action and identify the contaminants and exposure pathways that need to be addressed by the Remedial Action.

2.6.7.1 Human Health Risk

Human Health Risk Assessments (HHRAs) are conducted to evaluate the potential risk to health of people living or working at a site, or in the area impacted by a site. Depending upon the nature and extent of the contamination, these people may be exposed to the contaminants in the soil, groundwater, or air through ingestion, skin contact, or inhalation.

The calculated cancer risk estimates the probability that additional cases of cancer may develop within a population if the people are exposed to the contaminated soil or groundwater. For noncancer effects, a Hazard Index is calculated, which is a numerical expression that indicates whether the concentrations of chemicals are likely to result in specific toxic effects.

In 2004, an HHRA of Site 3 was performed as part of a Basewide OU7 HHRA (Earth Tech 2004) to evaluate the potential risk to human health posed by chemicals that may have been released into the soil (including weathered bedrock) and groundwater at the site. The HHRA of Site 3 was updated in the *Site 3 FS* (Earth Tech 2008b) using more current USEPA Region 9 soil and tap water PRGs (USEPA 2004) as risk-based screening levels for the quantification of the estimated risks and hazards.

The updated groundwater risk assessment results in the *Site 3 FS* were based on the May and June 2005 groundwater sampling results for Site 3 (FPM Group 2006). In addition, an indoor air risk from the contaminants in soil gas was calculated using soil gas sampling results from this period (FPM Group 2006).

A complete discussion of the methodology used and results of the updated risk assessment are presented in Appendix C. A summary of the updated HHRA results for Site 3 is presented in Table 2.6-7 and discussed in more detail below.

Soil

The overall carcinogenic risks from soils estimated for all categories of receptors are in the cumulative risk management range of 10^{-4} to 10^{-6}. The noncarcinogenic HIs were acceptable (less than 1) for all categories of receptors. It should be noted that these risk calculations do not address the potential risk from physical hazards in the landfill wastes, or the potential risk to human health or groundwater if a container of hazardous waste were to leak. Although no containerized hazardous wastes were encountered during the Remedial Investigation, the presence of these wastes cannot be ruled out.

Groundwater

Although the groundwater at Site 3 is not considered a primary source of drinking water because the site is in an area characterized by shallow bedrock and low groundwater yield, a baseline HHRA of the contaminants detected in the groundwater was conducted to evaluate the risks associated with its hypothetical future residential use.

The results show that in a hypothetical residential groundwater use scenario, the estimated carcinogenic risk of 9 x 10^{-4} is unacceptable (greater than 10^{-4}), with TCE and VC as the primary risk drivers. In addition, the detected concentrations for each constituent exceeded their respective tap water PRGs (USEPA 2004) in five of 17 samples and three of 17 samples, respectively. The noncarcinogenic HI of 4 is also unacceptable, with alpha endosulfan and nitrate as the primary risk drivers; however, the detected concentrations for each constituent exceeded the tap water PRGs in only one of 17 samples and two of 18 samples, respectively. It should be noted that in this ROD the 2004 USEPA Region 9 tap water PRGs (USEPA 2004) were used for comparison to be consistent with the results presented in the *Human Health Risk Assessment* (Earth Tech 2004) and the *Site 3 FS* (Earth Tech 2008b).

Indoor Air

Indoor air exposures for hypothetical residential and industrial structures built within the footprint of the landfill were derived from soil gas data. Indoor air exposures for hypothetical structures built adjacent to the landfill were derived from the volatilization of contaminants from groundwater. Exposures resulting from the volatilization of chemicals from soil to indoor air were not considered during the assessment due to the lack of significant detections of volatile organic compounds in soil. The assessments were performed using the Johnson and Ettinger (J&E) (1991) vapor intrusion model, USEPA Version 3.1, as agreed during the April 2006 and March 2007 RPM meetings. The toxicity values used were selected in accordance with the approach for selecting toxicity criteria recommended in the *Air Force Risk Assessment and Risk-Based Cleanup Levels Guidance,* USAF, Memorandum for all MAJCOMs/A7/CEV, 14 July 2006 (USAF 2006), which adopts OSWER Directive 9285.7-53, Human Health Toxicity Values in Superfund Risk Assessments, December 5, 2003 (USEPA 2003). In review of the Edwards AFB HHRA reports, Cal/EPA DTSC requested that the URFs provided by the Office of Environmental Health Hazard Assessment (OEHHA) be used. At the request of Cal/EPA DTSC, a second set of indoor air risk assessments from the vapor intrusion pathway were conducted.

The potential indoor air cancer risks for all residential and industrial exposures (see Table 2.6-7) were less than 10^{-6} or within the cancer risk management range, with risks for residential exposures ranging from 3 x 10^{-6} (based on soil gas data) to 7 x 10^{-6} (based on volatilization off groundwater) or 2 x 10^{-5} using the Cal/EPA DTSC-recommended toxicity values (calculated for both scenarios) and risks for industrial exposures ranging from 1 x 10^{-7} (based on soil gas data) to 4 x 10^{-7} (based on volatilization off groundwater) (or 9 x 10^{-7} to 1 x 10^{-6} respectively using the Cal/EPA DTSC-recommended toxicity criteria). All noncancer HIs were below 1. It should be noted that due to the limited sampling for soil gas within the landfill boundary, and heterogeneities present within the landfill, the calculated future hypothetical indoor air risks may be underestimated. In addition, modeling does not take into account the potential effect of landfill gas on the migration of other volatile contaminants into future indoor air. Furthermore, it should be noted that these risk calculations do not address the potential explosive hazard that could exist if landfill gases containing methane were to accumulate in a building, should a building ever be constructed.

The indoor air modeling does not take into account the potential effect of landfill gas on the migration of other volatile contaminants into air in hypothetical future buildings.

Summary of Site Risks to Human Receptors

Although contaminants have been detected in soil above calculated background concentrations (see Section 2.6.2.2), risk assessment data are within the cancer risk management range. No hazardous wastes were found in any of the test pits excavated at the site during the RI.

Contaminants have been detected in groundwater above calculated background concentrations (see Section 2.6.2.3). Risk assessment data indicate there is an unacceptable risk to hypothetical future residential occupants from ingestion or inhalation of VOCs from extracted groundwater. Also MCLs are exceeded for benzene, 1,4-DCB, 1,1-DCA, 1,2-DCA, cis-1,2-DCE, methylene chloride, TCE, PCE, VC, and nitrate which constitute an unacceptable risk. The risk is hypothetical because there are not sufficient quantities of groundwater at the site for sustained pumping; therefore, it is unlikely that the groundwater at Site 3 would be considered a primary source of drinking water.

Contaminants have been detected in landfill gases that have the potential to migrate to the atmosphere (see Section 2.6.2.4). Risk assessment data indicate that the risk to industrial or hypothetical future residential occupants from indoor air contaminants if buildings were constructed on the site is within the cancer risk management range. The risk is hypothetical because it is unlikely that buildings would ever be constructed on buried waste due to the potential for ground subsidence and methane migration, which could create an explosive hazard and carry additional volatile contaminants into the indoor air. Similarly, there is no unacceptable risk to future residential or industrial users from volatilization of VOCs off groundwater located downgradient of the site. However, there could be an unacceptable risk to industrial or hypothetical future residential users if an undiscovered drum containing fuels or solvents were to leak, releasing VOCs to indoor air, or if localized high concentrations of VOCs were being generated in a portion of the landfill not addressed by existing landfill gas monitoring wells. In addition, methane was detected in a well located within the landfill boundary at a concentration of 22 percent. This indicates there may be an explosive risk from the landfill gas within the landfill boundary if an enclosed structure was constructed on the landfill surface. This is because the gas could migrate into the structure and become diluted to a concentration within the explosive range of methane, which is 5 to 15 percent.

2.6.7.2 Ecological Risk

Ecological Risk Assessment is a process in which exposure pathways are determined and potential chemicals of ecological concern are identified in order to evaluate potential risks to the environment and aid in the selection of remedial alternatives. The Site 3 Ecological Risk Assessments were conducted using a phased approach.

A Scoping Ecological Risk Assessment (SERA) (USAF 2004) was conducted for Site 3 to select Chemicals of Potential Ecological Concern (COPEC) and determine whether complete or potentially complete exposure pathways exist between site-related contaminants and potential ecological receptors at the site. Based on the results of the SERA, a number of inorganic and organic chemicals were found at concentrations in site media at concentrations exceeding conservative screening benchmarks and were identified as COPECs with potential exposure via ingestion and inhalation. As a result, a limited Predictive Ecological Risk Assessment (PERA) was conducted for Site 3 to provide a more quantitative assessment of the exposure and effects of the COPECs in the environment on potential ecological receptors (Tetra Tech, Inc. [Tetra Tech] 2004).

The PERA used site-specific data from applicable media (e.g., soil, groundwater, and soil vapor) in plant and animal exposure models to quantify the potential risk to potential ecological receptor groups.

Potential risks to the following receptor groups at Site 3 were calculated in the PERA:

- Terrestrial plants (as represented by rubber rabbitbrush)
- Generic terrestrial invertebrates (no specific representative)

- Reptiles:
  - Herbivorous reptiles (as represented by the desert tortoise)
  - Omnivorous reptiles (as represented by the side-blotched lizard)
- Birds:
  - Granivorous birds (as represented by the house finch)
  - Invertivorous birds (as represented by the loggerhead shrike)
  - Carnivorous birds (as represented by the red-tailed hawk)
  - Burrowing carnivorous birds (as represented by the burrowing owl)
- Mammals:
  - Burrowing small mammals (as represented by the Panamint and Merriam's kangaroo rats)
  - Burrowing carnivorous mammals (as represented by the kit fox)

The results of the PERA (Tetra Tech 2004) identified 19 COPECs at Site 3 that pose a potential risk to certain receptor groups (Table 2.6-8) by exceeding USEPA-Navy Biological Technical Assistance Group (BTAG) toxicity reference value (TRV)-based exposure limits. The BTAG developed a standard list of TRVs in 1998 to be used for assessing risk to wildlife at Navy CERCLA sites in the San Francisco area (Engineering Field Activity West [EFAW] 1998). The TRVs were subsequently used for ecological risk assessments at other Department of Defense (DoD) facilities throughout USEPA Region 9 and are the basis for TRVs used in ecological risk assessments for Cal EPA/DTSC (California DTSC 2000). The Cal/EPA DTSC TRVs consist of conservative "BTAG Low" values to be used for screening purposes and less conservative "BTAG High" values for use with the "BTAG Low" values in developing risk ranges for use by site risk managers in making risk management decisions.

Hazard quotients (HQs) were first calculated from the TRVs using the maximum concentration of a COPEC in a given media. HQs values were calculated for both "BTAG Low" and "BTAG High" TRVs. If the COPEC resulted in an HQ greater than 1, the calculations were also performed on the 95th percentile upper confidence limit (UCL) for that COPEC, if appropriate. Hazard Indices (HIs) were then calculated by summing the HQs for each exposure pathway for each species.

Soil

Contact and ingestion of COPECs in soil was found to cause a potential risk to terrestrial plant communities, terrestrial invertebrate communities, omnivorous reptile communities, granivorous bird populations, invertivorous bird populations, carnivorous raptor populations, burrowing carnivorous bird populations, burrowing herbivorous mammal populations, and burrowing invertivorous mammal populations based on conservative HQ-Low screening values (see Table 2.6-8). However, based on the less conservative HQ-High values, the only risk from soils would be to terrestrial plant communities, terrestrial invertebrate communities, omnivorous reptile communities, and invertivorous bird populations.

In addition, it should be noted that potential risks were calculated from samples collected from zero to 10 feet bgs. However, the majority of exposure of desert plants and invertebrates is expected to occur in the top two or three feet of the soil where shallow absorptive roots spread to quickly intercept the shallow penetration of limited desert rains and the soil is well aerated. Burrowing animals may dig to depths of 10 feet, but the majority of their exposure comes from eating food exposed to the top two or three feet of soil. Therefore, use of COPEC concentration data from depths greater than two to three feet overestimates risk from soil exposure pathways.

The incidentally ingested soil is also associated with foraging on the surface. It should also be noted that, of the metals that exceeded their respective TRVs, cadmium and zinc were not detected over their respective background concentrations in any shallow (less than two feet) soil samples, mercury was detected over its background concentration in only two of 23 shallow samples, and lead was detected over its background concentration in only one of 23 shallow samples. This suggests that there is no widespread metals contamination in shallow soils that would pose a risk to biota. Of the organic compounds that were identified as COPECs, pesticides (alpha-chlordane, gamma-chlordane, DDD, DDE, DDT, dieldrin, and endrin aldehyde) were only detected in two of 23 shallow samples. These data suggest that exposure by ingestion of organic compounds is likely overestimated. Additionally, because low concentrations are found sporadically throughout the site in both deep and shallow samples, and because no pesticide containers were found during the test pit excavations, the pesticide soil detections are more likely the result of spraying than of landfill disposal.

Groundwater

Due to the depth to groundwater, this pathway is incomplete for biota.

Soil Vapor (Burrows)

Inhalation of soil vapors, and in particular toluene vapors, was found to cause risk to burrowing herbivorous, invertivorous, and carnivorous mammals. However, validation studies by USGS biologists for Edwards AFB (USAF 2002a), using field gas measurements in grids of artificial burrows over three different chlorinated solvent plumes, showed that the standard burrow exposure assumptions overestimate risk. Also, tissue examination of mammals and lizards collected from over the plumes showed no significant increase in adverse effects over reference sites with no solvent plumes. Thus, the risk to burrowing mammals at Site 3 is likely overestimated.

Summary of Site Risks to Ecological Receptors

Although the COPECs were found at concentrations that predict unacceptable risks to some ecological receptors using conservative exposure and toxicity assumptions, use of protective but less conservative assumptions, coupled with only sporadic detections of contaminants indicate the risk may be overstated. Concentrations of toluene in soil vapors would be expected to decrease over time as the source of the vapors (most likely fuels) degrades over time.

In addition, it is important to take into account the suitability of the site as a viable, long-term habitat. No endangered or threatened species have been reported at Site 3, and Site 3 is not designated as critical habitat for these species. Site 3 is situated in a moderately developed industrial/developed area and is surrounded by roads, trails, undeveloped land, and other ERP sites. For these reasons, the limited risk to biota from contaminants in soil or soil vapors in this marginal environment is not significant enough to require a remedial response to mitigate these media pathways. However, there could be a risk to biota from physical hazards from surface debris. In addition, there could be a risk to biota if a container of hazardous waste located close to the landfill surface leaked in the future or was excavated by burrowing animals,, although the probability of this occurrence is low.

2.6.7.3 Pathways Retained for a CERCLA Response

Figure 2.6-15 depicts the pathways and media retained for Remedial Action based on discussions contained in Section 2.6.7.1, Summary of Site Risks to Human Receptors subsection, and in Section 2.6.7.2, Summary of Site Risks to Ecological Receptors subsection. These include:

- The risk to hypothetical future residents from contact with contaminated groundwater contaminated with VOCs;
- The risk to hypothetical future residents and hypothetical future industrial workers from a future release of volatile emissions from a leaking container of fuels or solvents to indoor air;
- The risk to hypothetical future residents, hypothetical future industrial workers, or hypothetical future construction workers from explosive hazards from methane gas accumulating in buildings or confined spaces; and
- The risk to hypothetical future residents, hypothetical future industrial workers, hypothetical future construction workers, or biota from contact with hazardous wastes that are potentially present in the buried debris and from the physical hazards of surface debris.

2.7 REMEDIAL ACTION OBJECTIVES

The USAF, USEPA, Cal/EPA DTSC and Water Board agree that humans and animals need to be protected from potential hazards posed by the buried wastes.

Therefore, based on a review of human and ecological risks, the following RAOs have been developed for Site 3:

1. Protect human health and animals from physical hazards from surface debris.
2. Protect human health and animals from hazardous wastes potentially present in the buried debris or soils contaminated by hazardous wastes potentially present in the buried debris.
3. Minimize the infiltration of stormwater, thereby reducing the risk of contaminants leaching into the groundwater and thereby reducing the levels of contaminants in groundwater exceeding safe drinking water standards (see Table 2.7-1 for applicable compliance levels).
4. Minimize erosion of the landfill cover and to prevent ponding of stormwater on the landfill surface, thereby reducing the risk of contaminants leaching into the groundwater and

reducing the levels of contaminants in groundwater exceeding safe drinking water standards (see Table 2.7-1 for applicable compliance levels).

5. Prevent further migration of groundwater contaminants that could increase groundwater contaminants to levels that exceed safe drinking water standards (see Table 2.7-1 for applicable compliance levels).

6. Protect humans from ingestion and dermal contact with contaminants in groundwater that exceed drinking water standards by restoring groundwater to safe drinking water standards, and preventing ingestion and dermal contact with the groundwater until the safe drinking water standards are achieved (see Table 2.7-1 for applicable compliance levels).

7. Protect humans in potential future buildings from exposure to indoor air contaminated with volatile chemicals emitted from the landfill at concentrations that are expected to present an indoor air inhalation risk exceeding a Hazard Index of 1 and such that cumulative risk is within or lower than the 10^{-6} to 10^{-4} cancer risk range calculated for a residential scenario (see Table 2.7-2 for soil gas concentrations which, if exceeded, would trigger remedy evaluation).

8. Prevent methane, emitted from the decomposition of wastes in the landfill, from accumulating inside buildings or other confined spaces at concentrations that pose a threat of explosion (greater than 5 percent by volume in air).

2.8 DESCRIPTION OF ALTERNATIVES

Presumptive Remedies were used to develop remedial alternatives in the *Site 3 FS* (Earth Tech 2008b) and *Site 3 FS Addendum* (AECOM 2009b). As stated in Presumptive Remedies: Policies and Procedures (USEPA 1993a), "presumptive remedies are expected to be selected at all appropriate sites except under unusual site specific circumstances." Presumptive Remedies are intended to ensure consistency in remedy selection and reduce the time and cost required to clean up similar types of sites. Although the use of Presumptive Remedies at Site 3 does not affect the need to identify COCs, remediation goals, and RAOs, the Presumptive Remedy approach streamlines the FS for the site because it:

1. Eliminates the step of identifying and performing a preliminary screening of potential treatment technologies and containment/disposal requirements. Eliminates the identification and development of general response actions associated with this step. Eliminates the need to assemble retained technologies into "complete alternatives."

2. Eliminates the need to screen the retained "complete alternatives", which is normally performed in order to reduce the number of alternatives that will be evaluated in detail.

3. Streamlines the identification of alternatives to be evaluated in detail to justify the Presumptive Remedies and the No Action alternative.

4. Streamlines the detailed evaluation of the retained alternatives against the set of nine CERCLA criteria and to each other.

In order to use a Presumptive Remedy at a specific site, sufficient site characterization must be performed to show that the site conditions match those specified for the Presumptive Remedy.

As stated in *Presumptive Remedy for CERCLA Municipal Landfill Sites* (USEPA 1993b), "Consistent with the NCP, the USEPA's expectation was that containment technologies generally would be appropriate for municipal landfill waste because the volume and heterogeneity of the waste generally make treatment impracticable." However, the presumptive remedy guidance (USEPA 1993b) recognizes that the Remedial Actions for a landfill site may include both presumptive and non-presumptive remedies. Remedies for preventing direct contact with landfill contents, minimizing infiltration and resulting contaminant leaching to groundwater, and controlling surface water runoff and erosion would be included in the presumptive remedy of containment. Remedies for treating contaminated groundwater would include non-presumptive remedies.

2.8.1 ANALYSIS OF THE USE OF THE PRESUMPTIVE REMEDY FOR SITE 3

The USEPA guidance document *Application of the CERCLA Municipal Landfill Presumptive Remedy Guidance to Military Landfills* (USEPA 1996) lists six questions that should be addressed to evaluate if the presumptive remedy can apply to military landfills.

These questions (and the evaluation of these questions) are:

1. **What Information Should Be Collected?** The guidance indicates that information on the sources, types, and volumes of landfill wastes should be sufficient to determine whether source containment is the appropriate remedy for the landfill.

   Evaluation: An evaluation of historic records, aerial photographs, and test pit logs was conducted, and a determination was made that source containment is an appropriate remedy for Site 3.

2. **How May Land Reuse Plans Affect Remedy Selection?** The guidance indicates that for smaller landfills (generally less than two acres) excavation could be considered as an option in addition to containment depending upon land reuse plans.

Evaluation: According to the Base *General Plan* (Edwards AFB 2009) there are no current plans to use the land at Site 3 for anything but its current purpose. In addition, the size of the landfill (67 acres) is in excess of what the guidance indicates is suitable for excavation.

3. **Do Landfill Contents Meet Municipal Landfill-Type Waste Definition?** To determine whether a specific military landfill is appropriate for application of the containment presumptive remedy, compare the characteristics of the wastes present in the landfill to typical municipal landfill wastes listed in the guidance.

   Evaluation: As indicated in Table 2.5-3, only household wastes and construction debris were found during excavation of test pits.

4. **Are Military-Specific Wastes Present?** Military wastes (i.e., wastes specific to military bases), especially high-hazard military wastes (such as explosively configured munitions or chemical warfare materiel), may possess unique safety, risk, and toxicity characteristics.

   Evaluation: No wastes of a military nature, or other high-hazard wastes, were found at Site 3, and there is no historical record of their disposal.

5. **Is Excavation of Contents Practical?** Although no set excavation volume limit exists, landfills with a content of more than 100,000 cubic yards (approximately two acres, 30 feet deep) would normally not be considered for excavation.

   Evaluation: Due to the estimated volume of waste (525,000 cubic yards) at Site 3, excavation is not considered practical.

6. **Can the Presumptive Remedy Be Used?**

   Evaluation: The available information indicates that the presumptive remedy for landfills can be used at Site 3.

2.8.2 EVALUATION OF GROUNDWATER TREATMENT ALTERNATIVES

Active treatment alternatives for groundwater were not retained for detailed analysis. *In situ* treatment of groundwater was not retained because hydraulic conductivities are outside the suitable range for *in situ* remediation (see Section 2.5.2.1). These *in situ* treatments included either injection of nutrients (bioremediation) or injection of chemical oxidants. *Ex situ* treatment of groundwater by either carbon or air stripping was not retained because collection methods for groundwater extraction by pumping are not practical due to the lack of sustainable yield (see Section 2.5.2.2 and Table 2.5-1).

The Air Force does not believe there would be a season where pumping might be dramatically easier for a short period of time because of the extremely low permeability of the groundwater-bearing matrix.

Also, the Air Force has not observed large seasonal fluctuations in potentiometric surface at the Main Base Landfill (located adjacent to the site), where data are collected quarterly.

Because a review of available data indicates a strong probability that natural attenuation is occurring (see Section 2.6.4), monitored natural attenuation was retained for detailed evaluation for all three active alternatives in the FS.

2.8.3 SPECIAL CONSIDERATIONS OF USEPA POLICY AND GUIDANCE

USEPA Directive Number 9200.4-17P, *Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites* (USEPA 1999a) indicates that MNA may be appropriate at sites where it can be demonstrated that site conditions support MNA, the plume is stable, drinking water supplies are not adversely affected, and the estimated remediation timeframe is reasonable. Sites where the contaminant plumes are no longer increasing in extent, or are shrinking, would be the most likely candidates for MNA remedies. The guidance also states that "MNA should be used very cautiously as the sole remedy in contaminated sites" and that "contingency remedies should generally be included as part of an MNA remedy which has been selected primarily on predictive analyses rather than documented trends of decreasing contaminant concentrations."

The selected remedy is in compliance with the guidance in USEPA (1999a) for selecting MNA and does not require a contingency remedy based on both documented trends and predictive analysis for the following reasons:

1. Evidence for natural attenuation of VOCs exists for Site 3 (see Section 2.6.4).
2. Groundwater monitoring has been conducted at Site 3 since 1993. Concentrations of PCE and TCE in the most downgradient monitoring well that formerly had contaminants (Monitoring Well 3-MW10) have decreased to nondetect (see Appendix A). In addition, contaminants have not been detected in any well that formerly did not have contaminants. This indicates that the plume is stable and that the selection of MNA is based both on predictive analysis (see Section 2.6.4) and documented trends of decreasing contaminant concentrations. Natural attenuation, coupled with minimal leachate production from this old landfill, are likely responsible for the observed stability of the relatively small plumes. Although contingencies for active remediation and active containment are normally a part of MNA remedies, there are no feasible active technologies at this time (see Section 2.8.2). In addition, the protectiveness and effectiveness of the remedy would be re-evaluated as part of the Five-year Review process.

3. Because of low aquifer yield, the groundwater beneath the site is not currently, or anticipated to be a commercial source of groundwater (see Section 2.5.2.2). Given the fact that there are no plans to use the groundwater for a beneficial purpose, the estimated remediation timeframe is reasonable. Although there may be some uncertainty in the modeled estimated remediation timeframe, because the groundwater under this site is unlikely to be used for a beneficial purpose due to exceptionally low groundwater yield, greater precision in determining cleanup times is not warranted.

4. Site-specific conditions (e.g., low groundwater conductivity and flow conditions within this area of fractured granitic bedrock) prevent use of any active in situ or ex situ technologies (see Section 2.5.2.1). Therefore, MNA is the only possible way these plumes will become restored to cleanup standards. Control of stormwater infiltration by landfill capping and the construction of stormwater control channels, although not considered treatment by the USEPA, do serve to control the flushing of leachates and condensates into the groundwater, thereby serving as a means of source control.

2.8.4 ALTERNATIVES SELECTED FOR DETAILED EVALUATION

Based on the analysis of the use of the presumptive remedy for landfills (Section 2.8.1), evaluation of groundwater treatment alternatives (Section 2.8.2), and evaluation of special considerations of USEPA policy (Section 2.8.3), the USAF evaluated in detail four alternatives to contain the waste and manage and cleanup the groundwater at Site 3. Alternative 1 was the No Action alternative. Alternative 2 included no enhancements to the existing cover, but utilized LUCs and MNA to provide protection to human health and the environment. Alternatives 3 and 4, in addition to the provisions contained in Alternative 2, included the installation of an Evapotranspiration (ET) cover on the landfill as recommended in the Desert Research Institute (2004) study for Edwards AFB. The water balance model UNSAT-H, Version 3.01 (Fayer 2000) was used to model moisture percolation for the existing conditions (Alternatives 1 and 2) and two ET cover designs which utilized soils from a local borrow source (Alternatives 3 and 4).

The State Prescriptive Cover prescribed by CCR, Title 27, Section 21090, which consists of a two-foot thick foundation layer, a one-foot thick barrier layer consisting of imported clay blended with on-Base soils, and a one-foot thick vegetative cover/topsoil layer, was screened out prior to the detailed analysis. This is because the State Prescriptive Cover was evaluated in the Site 3 FS (Earth Tech 2008b) to be prone to desiccation (shrinkage after drying) in arid environments such as that present at Edwards AFB due to its reliance on a compacted clay barrier layer. Desiccation cracks may provide preferential pathways through the clay barrier layer, making the barrier ineffective in meeting the performance standard for infiltration. In addition, a State Prescriptive cover typically is more costly than other capping systems. The selection of an alternative cover is allowed under 27 CCR § 20080(b) and (c)(2), if a State Prescriptive Cover would not attain the applicable performance standards at the site.

Although LUCs would need to be maintained in perpetuity for each of the active alternatives, a timeframe of 200 years was used to enable the Air Force to compare costs. After 200 years, the increase in the present value discounted cost is negligible. More comprehensive discussions of the different alternatives are contained in the *Site 3 FS* (Earth Tech 2008b) and *Site 3 FS Addendum* (AECOM 2009b).

The four alternatives considered were:

1. **No Action.** The NCP requires that this alternative be used as a baseline to be compared to other alternatives. This alternative assumes that No Further Action will be taken at Site 3. Access to Site 3 is currently limited to authorized personnel by a chain-link fence, signs, and locked access gates; however, these would not be maintained. This alternative has no cost under CERCLA.

2. **Land Use Controls and MNA.** This alternative includes the implementation of LUCs and MNA. Existing fences would be used to provide access controls to the site. In addition, LUCs would prohibit the use of groundwater from Site 3 for domestic or other sensitive uses until cleanup goals are reached. The existing landfill cover would be used to contain the buried municipal-type waste and surface debris would be left in place. UNSAT-H predicted that the drainage through the existing cover would be an average of 2 inches/year. Because buried wastes would be left in place at the site, and this alternative would not reduce the level of contaminants, LUCs would be applied and maintained in perpetuity (or until the contamination at the site has naturally decomposed to concentrations allowing unlimited use and unrestricted exposure). Groundwater would be monitored to track natural attenuation of contaminants and confirm that no contaminant migration is occurring. Landfill gas would be monitored to assure there is no migration of gas beyond the perimeter of the landfill. This alternative would have a present value cost of $7.3 million for the first 200 years of operation (Table 2.8-1) and reach cleanup goals for groundwater within a predicted 139 years.

3. **Waste Consolidation, Evapotranspiration (ET) Cover, Stormwater Controls, LUCs, and MNA (Selected Remedy).** This alternative includes all MNA, gas monitoring, and LUC activities listed in Alternative 2 plus the addition of a 1.5-foot-thick layer of soil (79,000 cubic yards of soil) and 6-inch-thick vegetative topsoil layer (34,000 cubic yards of soil) over the existing cover (1-foot minimum thickness); and a stormwater drainage system (Figures 2.8-1 and 2.8-2). All surface debris would be removed and transported to the Main Base Active Landfill for recycling or disposal. Any wastes, such as ACM, that cannot be accepted at the Main Base Active Landfill would be transported to a permitted off-Base facility. Subsurface waste from the waste cell on the south side of Landfill Road, the waste cell northwest of the landfill, and the waste cell west of the landfill would be excavated and

deposited in the sunken depressions of the existing waste cells after the soil covering these cells is stripped off. Any excess debris would be deposited in space adjacent to existing cells. These activities would reduce the estimated footprint of the ET cover to 32.7 acres. A minimum of 3-feet of cover soils would be deposited on the newly installed cells (1-foot of common fill obtained on site, 1.5-feet of imported ET cover, and a 6-inch-thick vegetative topsoil layer). The ET cover would be graded to promote runoff, and minimize infiltration and erosion. Stormwater controls (diversion ditches) would be constructed to divert surface water away from the landfill surface. UNSAT-H predicted that the drainage through this cover design would be an average of 0.7 inches/year. This option would have a present value cost of $14.4 million for the first 200 years of operation (see Table 2.8-1) and reach cleanup goals for groundwater within a predicted 84 years.

4. **Waste Consolidation, Enhanced ET Cover, Stormwater Controls, LUCs, and MNA.** This alternative includes all MNA, gas monitoring, and LUC activities listed in Alternatives 2 and 3 with the following exceptions. Like Alternative 3, alternative would include the removal of all surface debris. However, unlike Alternative 3, this alternative would include less consolidation of subsurface waste; therefore, the area of the enhanced ET cover that would be installed would be 56.2 acres. The existing landfill cover would be regraded. A capillary break consisting of a 3-inch thick layer of imported gravel (22,000 cubic yards) and a geotextile layer to reduce the potential for stormwater infiltration into the landfill would be installed over the regraded surface. A passive soil gas system would be installed to control migration of gas in the capillary break. A 2-foot-thick ET soil cover layer (181,000 cubic yards) would then be installed over the geotextile layer. Lastly, a 6-inch-thick vegetative topsoil layer (44,000 cubic yards) would be installed over the ET soil cover. UNSAT-H predicted that the drainage through this cover design would be an average of 0.2 inches/year. This option would have a present value cost of $22.5 million for the first 200 years of operation (see Table 2.8-1) and reach cleanup goals for groundwater within a predicted 23 years.

2.8.5 Common Elements and Distinguishing Features of Each Alternative

The alternatives considered for Site 3 do not satisfy the statutory preference for treatment as a principal element because active treatment of the buried waste and groundwater at the site was not found to be practicable. However, the alternatives are consistent with the presumptive remedy of containment for landfill sites in accordance with the Superfund Accelerated Cleanup Model (USEPA 1992) and USEPA presumptive remedy guidance documents (USEPA 1993a; 1993b; 1996) through the use of a soil cover over the buried landfill wastes, engineering controls, and LUCs.

2.8.5.1 Key Applicable or Relevant and Appropriate Requirements (ARARs) Associated with Each Alternative

Key ARARs associated with each alternative are presented in Section 2.8.7.2.

2.8.5.2 Long-Term Reliability of Remedy

For Alternative 1, the No Action alternative, the existing soil cover over the buried landfill wastes and the existing fence would likely continue to degrade or fail over time because no operations and maintenance (O&M) would be performed.

Alternatives 2, 3, and 4, would have improved long-term reliability over Alternative 1 because (1) the fence would be maintained, (2) groundwater and gas monitoring wells would be maintained and redeveloped or replaced as required, (3) LUCs would be enforced, and (4) groundwater monitoring activities would be conducted.

Alternative 2 may have decreased long-term reliability for protecting humans or biota from the potential for contacting buried hazardous wastes because the existing soil cover over the buried landfill wastes would not be maintained, and would likely continue to degrade or fail over time.

In addition to the maintenance requirements for Alternative 2, the long-term reliability for Alternatives 3 and 4 would be improved because the cover and stormwater control systems would be maintained. Maintenance of these systems would consist of patching and regrading the cover as the landfilled wastes settle and landfill subsidence occurs, and removing debris from the stormwater diversion channels. Alternative 4 would have the additional maintenance requirement for the passive soil gas venting system, which would require that passive soil gas venting wells that become damaged or dysfunctional be repaired or replaced.

2.8.5.3 Quantity of Untreated Waste and Treatment Residuals to be Disposed Off-Site or Managed On-Site in a Containment System and Degree of Residual Contamination Remaining in Such Waste

None of the alternatives would treat the waste; therefore, there would be no treatment residuals generated.

2.8.5.4 Estimated Time Required for Design and Construction

There are no design or construction components associated with Alternative 1. Alternative 2 would require an estimated two years for design and construction. Alternatives 3 and 4 would each require an estimated three years for design and construction.

2.8.5.5 Estimated Time to Reach Cleanup Levels

For Alternatives 1 and 2, the contaminant fate and transport modeling results indicate that by conducting MNA the cleanup goals for groundwater would be reached after approximately 139 years (see Section 2.6.4.1). For Alternatives 3 and 4, the modeling results indicate that cleanup goals for groundwater would be reached after approximately 84 and 23 years, respectively.

2.8.5.6 Description of Presumptive Remedy Uses and/or Innovative Technologies

All of the alternatives would use the presumptive remedy for CERCLA solid waste landfill sites, and/or allowable modifications to it; no innovative technologies would be used.

2.8.6 EXPECTED OUTCOMES OF EACH ALTERNATIVE

2.8.6.1 Available Land Uses upon Achieving Performance Standards and Estimated Timeframe to Achieve Available Use

None of the alternatives considered would return the land to unrestricted use because the buried landfill wastes would remain at the site. Therefore, LUCs are required in perpetuity within the footprint of the landfill.

2.8.6.2 Available Groundwater Uses upon Achieving Performance Standards and Estimated Timeframe to Achieve Available Use

Once groundwater cleanup goals are achieved, groundwater use at Site 3 would be unrestricted. For Alternatives 2, 3, and 4, groundwater would be available for unrestricted use after 139, 84, and 23 years, respectively. However, a future well at the site is unlikely to produce sufficient quantities of groundwater for beneficial use (i.e., municipal and domestic supply, industrial service supply, agricultural supply, or freshwater replenishment) because the fractured bedrock does not yield sustainable quantities to meet the guidelines established by either the USEPA or SWRCB (see Section 2.5.2.2).

2.8.6.3 Other Impacts or Benefits Associated with Each Alternative

Alternative 1 would have no construction or O&M activities that would impact Base operations. Alternative 2 would have very limited impact to Base operations because it would require no construction activities other than periodic replacement of monitoring wells, and O&M activities would be limited to fence repairs and groundwater and landfill gas monitoring.

For Alternative 3 and 4, other impacts at the site would likely include increased traffic and disturbance of soils during surface debris removal, waste consolidation, soil cover improvements or enhancements, landfill gas and groundwater monitoring, and increased O&M requirements over Alternative 2. The increase in O&M requirements would include repair of the landfill cover if necessitated by settling and erosion, and maintenance of stormwater control channels. However, these alternatives would have the benefit of decreasing the time groundwater monitoring would need to be performed at the site.

2.8.7 COMPARATIVE ANALYSIS OF ALTERNATIVES

The comparative analysis of the alternatives for Site 3 is presented in Tables 2.8-1 and 2.8-2. Table 2.8-1 compares the length of time the various components of the alternatives, including monitored natural attenuation, would need to occur. Table 2.8-2 summarizes the results of the comparative analysis for each of the remedial alternatives evaluated for the Site 3 landfill based on the detailed analysis criteria. The purpose of this analysis is to identify the relative advantages and disadvantages of each alternative.

Installation of a landfill cover (Alternatives 3 and 4) provides a protective barrier above the buried landfill wastes that minimizes or prevents potential exposure to the wastes from direct contact and incidental ingestion thereby eliminating these exposure routes for human and ecological receptors. Installation of the landfill cover also minimizes infiltration of stormwater, and therefore minimizes the leaching of contaminants to groundwater.

2.8.7.1 Overall Protection of Human Health and the Environment

All of the alternatives for Site 3, with the exception of Alternative 1 (No Action), would provide adequate overall protection of human health. Alternative 2 would provide protection to current site workers and potential future residents through the use of LUCs and groundwater and gas monitoring. LUCs would limit access to the site and to contaminated groundwater beneath the site, and reduce the physical hazards associated with exposed surface debris. Groundwater and gas monitoring would track the attenuation of contaminants from the landfill wastes and assure that the LUCs would remain protective. Alternatives 3 and 4 would provide additional protection to site workers over Alternative 2 by eliminating the physical hazards associated with the surface debris through removal, and from incidental exposure to uncovered buried debris by the addition of a soil cover. In addition, by enhancing the existing cover and providing stormwater controls, infiltration of stormwater would be reduced over existing conditions, which in turn would reduce the mobilization of contaminants trapped in the vadose zone into the groundwater.

All of the alternatives would provide some protection to biota through the use of a chain-link fence. This fence could degrade over time under Alternative 1. For both Alternatives 1 and 2, animals that are able to go through, over, or under the fence could be exposed to contaminated soil, surface or buried wastes, landfill gases venting through cracks in the landfill cover, or landfill gases filling burrows. Alternatives 3 and 4 would provide additional protection to biota over Alternative 2 by eliminating the physical hazards associated with surface debris through removal, and by making it more difficult for biota to come in contact with buried waste and contaminated soils (they would have to burrow through more than three feet of cover and shallow-rooted vegetation to do so). Also, landfill covers serve to naturally attenuate VOCs in landfill gas, lessening the vapor risk to animals burrowing into the landfill cover.

Alternatives 1 and 2 would neither increase nor decrease the existing risk to biota during construction because no changes would be made to the fence or landfill cover. Alternatives 3 and 4 would impact biota living at the landfill site during grading and capping activities. This risk could be mitigated by conducting a pre-construction survey and relocating any Federal or California protected species (see Appendix B, Table B-1, Items 3 through 9) and burrowing animals found on the site. The installation of a vegetative cover could make the landfill more attractive than a bare cover to species small enough to go through the fence. However, if colonies of burrowing animals are found inside the landfill, a management strategy that may include relocation of the colonies of burrowing animals will be devised by a qualified biologist.

2.8.7.2 Compliance with ARARs

The Resource Conservation and Recovery Act (RCRA), Subtitle D (40 CFR Part 258) and CCR, Title 27 have been identified as "relevant and appropriate" to the management of CERCLA landfill sites (see Tables B-1 and B-2, Appendix B). Alternative 1 is not expected to comply with the action-specific ARARs for landfill containment identified in RCRA, Subtitle D and CCR, Title 27.

Alternatives 2, 3, and 4 include LUCs and MNA, and therefore comply with the monitoring requirements of CCR Title 27 for CAI units (see Table B-2). Alternative 2, however, does not include a landfill cover that is protective of groundwater and does not include stormwater controls, and therefore is not compliant with Title 27, Sections 20080 (b, c, and g), 20365, and 21090 (see Table B-2).

Alternatives 3 and 4 would be compliant with CCR, Title 27, Chapter 1, Section 20080(b), which allows consideration of alternatives to construction or prescriptive standards contained in SWRCB-promulgated regulations, provided that the specified alternative is consistent with performance goals addressed by the standard and affords equivalent protection against water quality impairment.

Although Alternative 4 allows for less infiltration of stormwater into the landfill, Alternative 3 would provide at least equivalent groundwater protection to the State Prescriptive Cover for the following reasons:

- Stormwater ponding and infiltration through the landfill cover would be significantly reduced by cover enhancements and drainage structures.
- The performance of the Alternative 3 cover will at a minimum afford equivalent protection against water quality impairment and could exceed that of a State Prescriptive Cover, considering the potential for desiccation of the clay barrier layer.

In addition, modeling predicts that all three alternatives will meet chemical-specific ARARs (regulatory limits for contaminants in the groundwater) within 139 years. Alternative 4 is projected to meet chemical-specific ARARs within the shortest period of time, that is, 23 years.

2.8.7.3 Long-Term Effectiveness and Permanence

All of the alternatives, with the exception of Alternative 1 (No Action), would provide long-term effectiveness and permanence. Alternative 1 would provide minimal long-term effectiveness because failure or destruction of the perimeter fences would permit access to the landfill and exposure of trespassers to physical human hazards. Alternatives 2, 3, and 4 would provide long-term access control, ICs, and LTM to track natural attenuation of contaminants and confirm that no contaminant migration is occurring in groundwater. The maintenance component included in these alternatives would ensure that access controls, stormwater controls (for Alternatives 3 and 4), and groundwater monitoring wells remain effective.

Alternatives 3 and 4 would provide additional long-term effectiveness compared to Alternative 2 by including waste containment and infiltration minimization. The landfill cover would minimize the potential for direct contact with buried landfill wastes and potential contaminant migration resulting from infiltration.

Modeling predicts that cleanup levels would be achieved for groundwater under Alternatives 2, 3, and 4 after 139, 84, and 23 years, respectively.

2.8.7.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Stormwater infiltration modeling and contaminant fate and transport modeling was performed to evaluate how the different alternatives affected the mobility of COCs in the landfill and groundwater-bearing fractured bedrock, and the rate at which the COCs attenuate over time (see Section 2.6.4).

Stormwater infiltration modeling results indicate that under existing conditions (Alternatives 1 and 2); the calculated infiltration is approximately 20.5 inches over a 10-year period (Earth Tech 2008b). For Alternative 3, the calculated infiltration is approximately 7.1 inches over a 10-year period; and for Alternative 4, the calculated infiltration is approximately 1.6 inches over a 10-year period.

Contaminant fate and transport modeling results indicate that for Alternatives 1 and 2, VC (the final degradation product of PCE and TCE) would degrade to a concentration below its MCL (0.5 μg/L) after approximately 139 years. For Alternatives 3 and 4, VC would degrade below its MCL after approximately 84 years and 23 years, respectively.

For these reasons, Alternatives 3 and 4 would provide a reduction in the potential for contaminant mobility by containing the waste and minimizing stormwater infiltration through the landfill cover. This reduction in infiltration would reduce the flux of contaminants from the landfill to the groundwater, and decrease the hydraulic head under the landfill. This reduction in hydraulic head would decrease the mobility of contaminants in the groundwater. Alternative 4 is more effective in reducing the mobility of contaminants than Alternative 3 due to an enhanced cover design that reduces the potential for stormwater to infiltrate the landfill.

None of the alternatives would reduce the toxicity or volume of contaminants contained within the landfill through treatment; however, the volume of contaminants would naturally attenuate over time. For Alternatives 3 and 4, the stormwater controls and enhancements to the existing soil cover would reduce the mobility of contaminants by physical processes that are not considered treatment by the USEPA.

2.8.7.5 Short-Term Effectiveness

Alternatives 1 and 2 provide immediate short-term effectiveness by using existing access controls to prevent direct contact with landfill surface debris. Alternatives 3 and 4 prevent direct contact with debris after it is removed, thereby achieving effectiveness within two years, however, construction workers could be exposed to physical hazards or toxic materials during handling of debris during waste consolidation and transport. The hazards associated with these activities are relatively minor and can be managed through the use of proper waste handling and safety measures. Workers conducting LTM and sampling, or installing additional fencing or stormwater drainage channels, would be exposed to minimal health risks.

Enlarging the borrow source pits to obtain the cover soils will result in the loss of desert habitat. Because Alternative 4 uses 177,000 cubic yards of ET cover materials that must be obtained from an on-Base borrow source compared to 79,000 cubic yards of ET cover materials for Alternative 3, implementation of Alternative 4 is more sensitive to cover material availability. It should be noted that both alternatives would cause a significant increase in truck traffic on Base (an estimated 14,800 round trips to a borrow pit for Alternative 4 compared to 6,600 round trips for Alternative 3). Borrow sources are located throughout the Base. Some are near Site 3 and one is 26 miles away. Transporting soil from these borrow pits to Site 3 would increase diesel fuel use and resulting air pollutants.

2.8.7.6 Implementability

All alternatives can be technically implemented, except for Alternative 1 where there is no action to implement. Alternative 2 involves only access control inspection and maintenance, well abandonment and installation, and LTM. Materials, equipment, and labor for these tasks are readily available and implementation of this alternative should be relatively uncomplicated.

The implementation of Alternatives 3 and 4 will be slightly more difficult and may be affected by the availability of cover materials in on-Base borrow pits that meet design specifications. These alternatives rely on the presence of an adequate on-site borrow source with suitable hydraulic conductivity (10^{-4} cm/sec) for landfill cover construction. Conventional equipment can be used for landfill cover construction. Because the landfill and the surrounding area are USAF property, it is not expected that special permits, easements, or right-of-ways would be required for implementation of these alternatives.

Alternative 3 would require time and labor for waste handling, enhancements to the existing cover, and installation of stormwater controls; however, implementation of this alternative should also be relatively uncomplicated.

Alternative 4 presents additional implementation issues associated with the construction of a landfill cover system. This alternative would require additional quality assurance/quality control to ensure proper construction of the capillary break layer and passive soil gas venting system. The Alternative 3 ET cover is not impermeable and therefore would not cause gas to accumulate. This is because ET covers are specifically designed so that the stormwater will not saturate the cover (at Site 3 UNSAT-H modeling software was used in the design); therefore, the permeability of the cover would be maintained.

2.8.7.7 Cost

The alternatives vary considerably in upfront capital costs. Alternative 1 has no associated capital costs. Alternative 2 has an upfront capital cost of $0.3 million for design and monitoring well installation. Alternative 3 has an upfront capital cost of $8.1 million for design and construction of an ET cover. Alternative 4 has an upfront capital cost of $18.8 million for design and construction of an enhanced ET cover. Although Alternatives 2, 3, and 4 have progressively decreasing groundwater monitoring costs, it should also be noted that LTM costs may be decreased over time for all alternatives once trends for monitoring results are established.

2.8.7.8 State Acceptance

Alternatives 1 and 2 are not acceptable to the State agencies because they are not protective of human health and the environment and do not comply with ARARs. The State agencies accept Alternatives 3 and 4 as being protective of human health and the environment and in compliance with ARARs.

2.8.7.9 Community Acceptance

The Site 3 Proposed Plan and fact sheets were made available to the public during a public comment period, and meetings were held to receive public input on the alternatives presented in the Proposed Plan. Because no comments were received for any alternatives in the Proposed Plan during the public comment period or meetings, it is assumed that the selected remedy is acceptable to the community.

2.8.8 PRINCIPAL THREAT WASTES

Principal threat wastes are those source materials considered to be highly toxic or highly mobile that generally cannot be reliably contained or would present a significant risk to human health or the environment should exposure occur. No highly toxic wastes have been encountered at Site 3. In addition, the mobility of wastes contained within the landfill will be mitigated through placement of the landfill cover and implementation of stormwater controls.

2.9 SELECTED REMEDY

The USAF and USEPA, with concurrence from Cal/EPA DTSC and the Water Board, Lahontan Region, selected Alternative 3 for Site 3. Figure 2.8-1 shows a conceptual layout of the selected remedy, and Figure 2.8-2 shows a cross section of the conceptual cover design for the selected remedy. The Site 3 remedy is fully contained within the LUC boundary (shown in Figure 2.8-1) that applies to both groundwater and vapor controls. The Air Force has combined the soil gas and groundwater controls within this combined boundary for ease of implementation due mainly to the convenient availability of already existing perimeter non-detect monitoring wells for groundwater and for soil gas (highlighted in yellow in Figure 2.8-1).

The LUC boundary wells will act as sentry wells. They provide a reasonable buffer zone distance from the location of the groundwater plume and the location of the waste cells, where contamination is expected to remain and decrease in concentration over time. Also, by using a single, combined LUC boundary for groundwater and soil gas, the Air Force will more easily and cost-effectively manage the LUCs. The Air Force will periodically monitor these LUC boundary wells to verify the conceptual model that methane and VOCs at concentrations above action levels in soil gas are not migrating from waste cells outward from Site 3 (see Section 2.9.3), and that contaminated groundwater is not being pulled outward by potential future uncontrolled groundwater extraction wells located near Site 3. Based on future design characterization studies and other remedy monitoring, some additional monitoring wells may be installed along the inside of the combined LUC boundary to address any design uncertainties identified post-ROD. The depth of this LUC zone is set at 50 feet below the top of the potentiometric surface, currently located 65 to 110 feet bgs, which is the estimated vertical extent of VOC concentrations in groundwater above MCLs (see Section 2.6.2.3 Nature and Extent of Groundwater Contamination).

2.9.1 DESCRIPTION OF THE SELECTED REMEDY

The selected remedy described below is intended to be the final actions for Site 3, and is addressed independently of the other sites and OUs at Edwards AFB. The selected remedy consists of the following components:

Waste Consolidation

1. **Removal of all surface debris.** All debris will be removed from the landfill surface. Surface debris that can be recycled will be trucked to the Main Base Active Landfill recycling center. All non-hazardous surface debris that cannot be recycled will be disposed at the Main Base Active Landfill. All potentially hazardous debris will be handled as described in Remedy Component #4; all ACM will be handled as described in Remedy Component #5 (addresses RAO #1).

2. **Excavation and consolidation of waste from waste cells**. All debris from the waste cell on the south side of Landfill Road, the cell northwest of the landfill, and the cell west of the landfill will be excavated. Non-hazardous debris will be contained within the designated footprint of the landfill (see Figure 2.8-1). All potentially hazardous debris will be handled as described in Remedy Component #4; all ACM will be handled as described in Remedy Component #5. Excavations will be backfilled with clean fill materials (addresses RAO #2).

3. **Assessment of potentially hazardous soils.** Stained soil will be removed to the extent feasible (i.e., until no stained soil is visually observed and/or detected using handheld monitoring instruments) if observed during the excavation and waste consolidation activities described in Remedy Component #2. Criteria for excavation extent will be included in the Site 3 RAWP. The bottom and sidewalls of the excavation will be sampled, analyzed, and evaluated to determine whether any further action is warranted. The stained soils will be assessed and disposed as described in Remedy Component #4 (addresses RAO #2).

4. **Disposal of hazardous waste.** All potentially hazardous waste encountered during waste consolidation activities will be taken to the Base Hazardous Waste Disposal Facility for profiling and off-site disposal. Handling of suspected hazardous waste will be performed in

accordance with hazardous waste handling/disposal regulations identified in Appendix B, Table B-1, Items 10 through 13, and Item 16. (addresses RAO #2).

5. **Disposal of ACM.** Any surface or subsurface ACM will be placed in bags or containers to prevent dispersion of asbestos fibers. Water will be sprayed prior to packaging to minimize airborne transport of fibers. The bags or containers will be disposed at an off-site landfill permitted to accept ACM (addresses RAO #1).

Cover Enhancements

6. **Installation of ET cover.** All cells will have a minimum of three feet of cover soils (one foot [minimum] to two feet of common fill obtained from existing soils on site, 1.5-feet of imported ET cover, and a 6-inch-thick vegetative topsoil layer) (addresses RAO #s 1, 2, 3, 4, and 5).

7. **Installation of vegetation.** The ET cover will be revegetated with shallow-rooted plants to enhance evapotranspiration and minimize root invasion of the waste cells to limit plant uptake of potential waste cell contaminants. Long-term maintenance of the landfill cover will include measures to prevent the growth of deep-rooting plants that potentially could be ingested by animals (addresses RAO #s 2 and 4).

8. **Source of ET cover soils.** Soils for the ET cover for Site 3 will be obtained from one or more of the borrow pits at the Base that potentially contain soils with a hydraulic conductivity of 1×10^{-4} cm/sec. Soils for the vegetative topsoil layer will be obtained off-Base (addresses RAO #s 1, 2, 3, 4, and 5).

Stormwater Controls

9. **Grading of ET cover.** The ET cover will be graded to promote runoff, and minimize infiltration and erosion (addresses RAOs #s 3 and 4).

10. **Construction of Stormwater Controls.** Stormwater controls (diversion ditches) will be constructed to channel water away from the landfill surface. Approximately 8,000 linear feet of drainage channels and a siltation basin will be constructed to collect and direct stormwater away from the landfill cover (addresses RAO #s 3 and 4).

LUCs

LUCs consist of both engineering control (EC) and institutional control (IC) components listed and described below. LUCs will be implemented and administered according to requirements and procedures described and listed in Section 2.9.7, Land Use Control Implementation and Administration, and will be managed through the Base Geographic Information System as referenced in the Base *General Plan* (Edwards AFB 2009) (see Section 2.9.7.2). Remedy Components #11 and #12 have the same LUC boundaries for ease of implementation.

11. **Institutional controls to protect human health from ingestion or contact with contaminated groundwater.**

a. **Groundwater LUC Boundary**. The LUC boundary restricting groundwater use will be set as shown on Figure 2.8-1 to fully contain the plume boundary exceeding the MCLs (see Table 2.7-1). The boundary is set to encompass all groundwater monitoring wells with concentrations of VOCs exceeding the MCLs and point of compliance monitoring wells (addresses RAO #6).

b. **Institutional controls to restrict installation of groundwater extraction wells.** The installation of groundwater extraction wells for the purpose of groundwater consumption will be prohibited within the LUC area boundary (addresses RAO #6).

12. **Institutional controls to protect human health from inhalation of indoor air potentially contaminated with VOCs and explosive hazards from landfill gas.**

a. **Vapor LUC Boundary**. The LUC boundary restricting building construction (structures designed for occupancy) will be set as shown on Figure 2.8-1 to fully contain all areas containing buried debris and existing point of compliance vapor monitoring wells. The boundary is set to fully contain any areas that could have a vapor risk to indoor air from a future release of containerized fuels or solvents within the landfill (see Table 2.7-2) or have methane gas concentrations over the lower explosive limit (5 percent by volume in air) (addresses RAO #s 7 and 8).

b. **Structures**. No structures designed for occupancy will be constructed within the LUC area boundaries (addresses RAO #s 7 and 8).

13. **Institutional controls to protect human health from potential hazards from buried waste. The access control boundary restricting site access will coincide with the existing site fence line (see Figure 2.8-1). Only Air Force authorized personnel will be allowed within the fenced boundary. Signs will be posted that prohibit unauthorized access (addresses RAO #2).**

a. **Recreational Activities**. Recreational activities within the fenced boundary will be prohibited.

b. **Waste Disposal**. Except for waste consolidation activities described in Remedy Components #1 through #5, disposal of additional wastes at the site are prohibited.

c. **Waste Excavation.** Only Air Force-authorized personnel will be allowed to excavate within the access control boundary. All excavations will require an activity-specific RAWP that would be subject to regulatory agency approval.

14. **Institutional controls to protect infrastructure.**

a. **Protection and access to infrastructure.** Infrastructure related to the remedy, including, but not limited to, the landfill cover, fencing, stormwater controls, and monitoring wells will be protected by ICs from activities that may negatively impact their ongoing maintenance, effectiveness, and safety. Access to monitoring wells will be maintained (addresses RAO #s 2, 6, 7, and 8).

b. **Maintenance of landfill cover and infrastructure.** The ET landfill cover, stormwater system, access controls (fencing and gates), and monitoring wells will be visually inspected and maintained as long as the LUCs are in effect. Holes and fissures in the landfill cover due to settlement or erosion will be filled, and repairs to fencing will be made. Visual inspections will also be conducted to assess colonization by burrowing animals at least annually. If colonies of burrowing animals are found inside the landfill, a management strategy that may include relocation of the colonies of burrowing animals will be devised by a qualified biologist (addresses RAO #s 2, 3, 4, and 5).

c. **Application of Water**. Application of water within the fenced boundary will be limited to that required for maintenance of cover vegetation to minimize the potential for water to infiltrate below the landfill cover (addresses RAO #3).

15. **Institutional controls to protect species from direct contact with landfill waste that potentially could contain physical or chemical hazards or any associated contaminated soils or food sources.**

a. **Studies**. Prior to completion of the RAWP, a study will be conducted to evaluate if species requiring protection under Federal or California regulations (see Appendix B, Table B-1, Items 3 through 9) are in the area. Additional protective measures may be included in the RAWP as a result of this study (addresses RAO #s 1 and 2).

b. Fencing. Existing fencing will be enhanced with a tortoise-proof fence and concrete dams will be installed at all gates to prevent entry to the site by the desert tortoise (addresses RAO #2).

c. **Visual Inspections**. Conduct visual inspections and post-closure maintenance of the landfill cover and fencing as described in Remedy Component #14b to prevent access to buried waste by burrowing animals (addresses RAO #2).

Monitored Natural Attenuation

16. **Adequacy of existing groundwater monitoring wells.** Existing groundwater monitoring wells will be assessed in the RAWP for adequacy in monitoring contaminant plume containment and attenuation. The assessment will include a study to identify if there are preferential pathways in the vicinity of the landfill, such as faults or fracture zones, that could affect groundwater flow and contaminant transport (addresses RAO #6).

17. **Frequency of groundwater monitoring.** Groundwater monitoring will be conducted at selected groundwater monitoring wells at a frequency agreed to by all regulatory agencies as sufficient to ensure that groundwater contamination is not migrating off-site and natural attenuation is occurring. Samples will be collected and analyzed for VOCs, metals, and nitrate. Details of the groundwater monitoring program will be specified in the RAWP. The plan will also include procedures to be used in establishing site-specific background metal, nitrate, and other element concentrations for Site 3 (addresses RAO #6).

18. **Exceedance of cleanup standards for groundwater.** If the concentrations of COCs in groundwater exceed the cleanup standards indicated in Table 2.7-1 at the LUC boundary (see Remedy Component #11a), additional groundwater monitoring wells will be installed to delineate the plume extent, and a study will be conducted to evaluate methods of controlling the groundwater migration (addresses RAO #6).

19. **Replacement and abandonment of groundwater monitoring wells.** Damaged groundwater monitoring wells will be repaired or replaced during the Remedial Action. Replaced groundwater monitoring wells will be destroyed in accordance with California standards for destroying wells. At site closeout, all groundwater monitoring wells at the site will be destroyed in accordance with §19, California Monitoring Well Standards for destroying wells (addresses RAO #6).

Gas Monitoring

20. **Adequacy of existing landfill gas monitoring wells.** Existing landfill gas wells will be assessed for adequacy (i.e., to determine if the number or placement of existing landfill wells is sufficient) in the RAWP (addresses RAO #s 7 and 8).

21. **Frequency of landfill gas monitoring.** Landfill gas monitoring will be conducted at the landfill gas wells at a frequency agreed to by all regulatory agencies as sufficient to ensure that landfill gas is not migrating off-site at concentrations above action levels (see Remedy Component #22). Samples will be analyzed for permanent gases including methane and VOCs (addresses RAO #s 7 and 8).

22. **Exceedance of action levels for landfill or explosive gases.** If the concentrations of VOCs and/or methane in landfill gas monitoring wells exceed the action levels indicated in Table 2.7-2, additional landfill gas monitoring wells will be installed to delineate the extent of the impacted area, and a study will be conducted to evaluate methods of controlling the gas migration, and mitigation will be instituted based on the study (addresses RAO #s 7 and 8).

23. **Replacement and abandonment of landfill gas monitoring wells.** The replacement of damaged landfill gas monitoring wells will occur as required during the Remedial Action. All damaged landfill gas monitoring wells will be destroyed in accordance with California standards for destroying wells. At site closeout, all landfill gas monitoring wells at the site will be destroyed in accordance with California standards for destroying wells (addresses RAO #s 7 and 8).

Five-Year Review

24. **Review of groundwater protectiveness and effectiveness of LUCs.** Five-year Reviews will be conducted until unlimited use and unrestricted exposure levels are attained to ensure that the remedy continues to be protective of groundwater, and that LUCs continue to be effective in protecting human health and the environment (addresses RAO #s 1 through 8). In addition, detection of COCs above MCLs in monitoring wells that did not previously have a detection above MCLs, if confirmed by four or more rounds of sampling, will lead

to an evaluation of the protectiveness of Monitored Natural Attenuation as the selected remedy for groundwater contamination.

2.9.2 Cleanup Standards for Contaminants of Concern in Groundwater

Although the groundwater at Site 3 is not currently a source of drinking water, it is classified as a "potential drinking water source" by Cal/EPA DTSC and the Water Board. Cal/EPA DTSC and the Water Board also believe that in addition, the contaminants in the groundwater must be cleaned up as required by Section 13304 of the California Water Code. Cleanup standards for COCs in groundwater are listed in Table 2.7-1.

2.9.3 Performance Monitoring Standards for Landfill Gas

Landfill gas monitoring will be conducted as part of the remedy (see Remedy Components #20 through #23) to assure that if structures intended for occupancy were constructed immediately outside of the Land Use Control Boundary Restricting Groundwater Use and Building Construction (see Figure 2.8-1), there would be no unacceptable human health risks from indoor air vapor intrusion, and no explosive risk from methane. Performance monitoring standards in Table 2.7-2 are protective of human health from exposures to volatile organic compounds in indoor air from vapor migration, as well as explosive hazards from methane.

Eighteen chemicals that are considered COCs in soil gas were detected in gas samples collected from eight perimeter landfill gas monitoring wells installed as nested pairs (Landfill Gas Wells 3-LFG06A/B, 3-LFG07A/B, 3-LFG08A/B, and 3-LFG09A/B) during the June 2009 sampling event (see Table 2.7-2). At least one of these chemicals was detected in each landfill gas monitoring well. In addition to the 18 COCs, action levels were also developed for seven COCs detected in interior gas monitoring wells that potentially could migrate to perimeter wells (see Table 2.7-2).

Action levels for soil gas were developed separately for the shallower A-level wells and the deeper B-level wells. For the shallower wells, a depth of eight feet was used, and for the deeper wells, a depth of 23 feet was used. These depths correspond to the top of the slotted screen intervals in a nested pair of landfill gas monitoring wells. The deeper of the paired wells satisfy California Code of Regulations, Title 27, §20925(c) which requires that the depth of gas monitoring well [screen] equal the "maximum depth of waste."

With the exception of compounds identified in bold type, the soil gas concentrations in Table 2.7-2 which, if exceeded, would trigger remedy evaluation are based on the Air Force's interpretation and application of the 23 April 2007 issue paper developed by DoD and the ECOS, *Identification and Selection of Values/Criteria for CERCLA and Hazardous Waste Site Risk Assessments in the Absence of IRIS Values* (ECOS-DoD 2007). The Air Force and State of California do not agree on the proper interpretation and application of this ECOS-DoD issue paper. As discussed earlier, the State of California has developed more protective toxicity criteria for selected compounds (bolded in Table 2.7-2) present at Site 3. Using the California criteria results in more protective soil gas concentrations than those proposed by the Air Force based on ECOS-DoD (2007).

To avoid a lengthy dispute and facilitate the timely implementation of a remedy that all parties believe is protective of human health and the environment, for those constituents where the Air Force and the State of California toxicity criteria differ, the Air Force, U.S. EPA and Cal/EPA DTSC have agreed to soil gas concentrations at the mid-point (bolded levels in Table 2.7-2) between the Air Force and the State of California preferred values. The Cal/EPA DTSC agreement is based on the site's particular attributes (remote location, and controlled human access, use, and exposure); and relies on the fact that the resulting estimated cumulative risk is in the lower end of the risk management range. This is consistent with State of California policy for managing human health risk. The agreement of the parties to this compromise is site-specific and is not a precedent for other Air Force sites.

For chemicals detected in soil gas but not included in the RSLs, surrogate chemicals were assigned. These assignments were generally based on structural and toxicity similarities. Surrogates were assigned to four chemicals; 1,2-dichlorobenzene was used as a surrogate for 1,3-dichlorobenzene, trichlorotrifluoroethane was used as a surrogate for 1,2-dichlorotetrafluoroethane, and p-xylene was used a surrogate for 4-ethyltoluene and for m,p-xylenes.

The model was used to calculate cancer risks and non-cancer hazard quotients for each chemical. A standard concentration of 1,000 micrograms per cubic meter ($\mu g/m^3$) was used for these calculations. Screening values were developed by back-calculating the concentration of each chemical that corresponded to either a cancer risk of 1 x 10^{-6} or a Hazard Index of 1; whichever concentration was lower. The results of the screening level calculations are presented in Table 2.7-2.

The action level for methane will be set at the lower explosive limit for landfill gas (5 percent by volume in air) at the LUC boundary as measured in landfill gas wells per CCR, Title 27 Section 20919.5.

2.9.4 NO ACTION LEVELS FOR SOIL

During excavation, all debris and stained soil (to the extent feasible) will be removed. The excavation bottom and sidewalls will be sampled to document any soil contamination remaining at the excavation sites. The sampling data will be used to evaluate the leaching potential of remaining contaminants to groundwater and to determine if any changes need to be made to the CSM.

Action levels for soil samples collected at the limits of excavation during waste consolidation are not provided because the waste is being consolidated to reduce the footprint of the landfill to minimize landfill cover costs, not to reduce risk. The LUC Boundary will not be reduced based on the waste consolidation effort.

2.9.5 SUMMARY OF THE ESTIMATED COSTS FOR THE SELECTED REMEDY

The selected remedy is preferred because it is the lowest cost alternative that is protective of human health and the environment and complies with ARARs. A summary of the escalated costs and the present value discounted costs for the selected remedy is presented in Table 2.9-1. The information in this table is based on the best available information regarding the anticipated scope of the selected remedy. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the selected remedy. Major changes may be documented in the form of a memorandum in the Administrative Record file or a ROD Amendment. This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.

The present value cost of the selected remedy is an estimated $14.4 million dollars. This cost estimate includes groundwater monitoring for 84 years, inspection and maintenance of the access controls, and repair and maintenance of the landfill cover and stormwater system for 200 years.

2.9.6 EXPECTED OUTCOMES OF THE SELECTED REMEDY

The selected remedy will also meet all RAOs. The selected remedy for Site 3 will address risks presented by the potential dermal, ingestion, and inhalation pathways of exposure to buried landfill wastes and contaminated groundwater. The selected remedy will also address the potential risks to human health from inhalation of indoor air containing VOCs above USEPA's risk management range of 10^{-4} to 10^{-6} and explosive hazards by restricting all building construction within the LUC boundary (see Figure 2.8-1). The selected remedy will reduce contaminant concentrations in the groundwater below primary MCLs through MNA, and will include LTM to verify that contaminants do not migrate outside the LUC boundary. Groundwater within the LUC boundary will be restored in a reasonable timeframe considering the present lack of use, present feasibility of use, and the potential future groundwater use(s).

The selected remedy for Site 3 maintains the current land use at the site (Research and Development) with minimal impact on the current or anticipated future uses (Research and Development; Parks and Historic Sites) in the area surrounding the site. Minimal environmental impacts are expected from implementation of the selected remedy. A study will be conducted to assess the presence of threatened or endangered species in the area prior to implementing the remedy to evaluate if additional LUC measures are required to protect ecological resources. The selected remedy will have no adverse impacts on cultural resources. No adverse human health impacts from the Remedial Action are anticipated to occur on- or off-Base. No local socioeconomic or community revitalization impacts are anticipated.

The selected remedy is protective of human health and the environment. Protectiveness in this context encompasses long-term reliability of the remedy. If the conditions of protectiveness or reliability cease to be met, additional Remedial Actions will be implemented to enhance or augment the selected remedy. Protectiveness must be ensured through a monitoring program designed to detect releases from LUC areas, the migration of contaminants to water supply wells, or other releases that would indicate a possible failure of one of the remedy components. The monitoring data must be provided to the USEPA on a regular basis to ensure adequate performance of the selected remedy. The footprints of areas within the LUC boundary impacted with COCs will be updated in the GIS from ERP documents as new information becomes available.

The Air Force will conduct a full assessment of the protectiveness of the selected remedy at least every five years where contamination remains above levels that allow for unlimited use and unrestricted exposure.

2.9.7 LAND USE CONTROLS IMPLEMENTATION AND ADMINISTRATION

The Air Force is committed to implement, monitor, maintain, and enforce remedies that protect human health and the environment in accordance with CERCLA and the NCP.

2.9.7.1 General Requirements

LUC measures to be used at Site 3 are in accordance with specific provisions of 22 CCR Section 67391.1 that were determined by the Air Force to currently be relevant and appropriate requirements. Subsections (a), (b), and (e)(2) of 22 CCR Section 67391.1 provide that if a remedy at property owned by the Federal Government results in hazardous substances remaining on the property at concentrations not suitable for unlimited use and unrestricted exposure, and it is not feasible to record a Land Use Covenant (as is the case with Site 3), then the ROD is to clearly define and include limitations on land use and other IC mechanisms to ensure that future land use will be compatible with the levels of hazardous substances remaining on the property.

The Air Force will implement the following LUC measures at Site 3.

1. Include in the Geographic Information System as referenced in the Base *General Plan* (Edwards AFB 2009) any specific restrictions and LUCs required at Site 3, a statement that restrictions are required because of the presence of pollutants or contaminants, the current land users and uses of the site, the geographic control boundaries, and the objectives of the land use restrictions.

2. Land Use Controls will be maintained until the concentration of hazardous substances in the soil and groundwater are at such levels to allow for unrestricted use and exposure.

3. The Air Force shall not modify or terminate LUCs, implementation actions, or modify land use without approval from the USEPA, Cal/EPA DTSC, and Water Board. The Air Force shall seek prior concurrence before any anticipated action that may disrupt the effectiveness of the LUCs or any action that may alter or negate the need for LUCs.

4. The Air Force is responsible for implementing, maintaining, reporting on, and enforcing the LUCs. Although the Air Force may later transfer these procedural responsibilities to another party by contract, property transfer agreement, or through other means, the Air Force shall retain ultimate responsibility for remedy integrity.

5. The Air Force will notify the USEPA, Cal/EPA DTSC, and Water Board as soon as practicable but no longer than 10 days after discovery of any activity that is inconsistent with the IC objectives or use restrictions, or any other action that may interfere with the effectiveness of the ICs. The Air Force will notify the USEPA, Cal/EPA DTSC, and Water Board regarding how the Air Force has addressed or will address the breach within 10 days of sending the USEPA, Cal/EPA DTSC, and Water Board notification of the breach.

6. The Air Force shall notify the USEPA, Cal/EPA DTSC, and Water Board 45 days in advance of any proposed land use changes that are inconsistent with LUC objectives or the selected remedy.

7. Whenever the Air Force transfers real property that is subject to LUCs and resource use restrictions to another Federal agency, the transfer documents shall require that the Federal transferee include the LUCs and applicable resource use restrictions in its resource use plan or equivalent resource use mechanism. The Air Force shall advise the recipient Federal agency of all obligations contained in the ROD, including the obligation that a State Land Use Covenant will be executed and recorded pursuant to 22 CCR Section 67391.1 in the event the Federal agency transfers the property to a non-Federal entity.

8. Whenever the Air Force proposes to transfer real property subject to resource use restrictions and LUCs to a non-Federal entity, it will provide information to that entity in the draft deed and transfer documents regarding necessary resource use restrictions and LUCs, including the obligation that a State Land Use Covenant will be executed and recorded pursuant to 22 CCR Section 67391.1. The signed deed will include LUCs and resource restrictions equivalent to those contained in the State Land Use Covenant and this ROD.

9. The Air Force will provide notice to the USEPA, Cal/EPA DTSC, and Water Board at least six months prior to any transfer or sale of Site 3 so that the USEPA, Cal/EPA DTSC, and Water Board can be involved in discussions to ensure that appropriate provisions are included in the transfer terms or conveyance documents to maintain effective LUCs. If it is not possible for the facility to notify the USEPA, Cal/EPA DTSC, and Water Board at least six months prior to any transfer or sale, then the facility will notify the USEPA, Cal/EPA DTSC, and Water Board as soon as possible but no later than 60 days prior to the transfer or sale of any property subject to LUCs. In addition to the land transfer notice and discussion provisions above, the Air Force further agrees to provide the USEPA, Cal/EPA DTSC, and Water Board with similar notice, within the same timeframes, of Federal-to-Federal transfer of property. The Air Force shall provide a copy of the executed deed or transfer assembly to the USEPA, Cal/EPA DTSC, and Water Board.

10. The Air Force will address as soon as practicable any activity that is inconsistent with LUC objectives or use restrictions or any other action that may interfere with the effectiveness of LUCs, but in no case will the process be initiated later than 30 days after the Air Force becomes aware of the activity.

11. Monitoring of the environmental use restrictions and controls will be conducted annually by the Air Force. The monitoring results will be included in a separate report or as a section of another environmental report, if appropriate, and provided to the USEPA, Cal/EPA DTSC, and Water Board. The annual monitoring reports will be used in preparation of the Five-year Review to evaluate the effectiveness of the selected remedy.

12. The annual monitoring report, submitted to the regulatory agencies by the Air Force, will evaluate the status of the ICs and how any IC deficiencies or inconsistent uses have been addressed. The annual evaluation will address whether the use restrictions and controls referenced above were communicated in the deed(s), whether the owners and State and local agencies were notified of the use restrictions and controls affecting the property, and whether use of the property has conformed to such restrictions and controls.

It is understood that the Air Force is responsible for remedy implementation and ensuring integrity of the remedy, including monitoring, maintaining, reporting, and enforcing the identified controls. If the Air Force determines that it cannot meet specific LUC requirements, it is understood that the remedy may be reconsidered and that additional measures may be required to ensure the protection of human health and the environment.

In addition, to assure the USEPA, Cal/EPA DTSC, Water Board, and the public that the Air Force will fully comply with and be accountable for the performance measures identified herein, the Air Force will submit to the USEPA, Cal/EPA DTSC, and Water Board in a timely manner an annual monitoring report on the status of LUCs and/or other Remedial Actions, including the operation and maintenance and monitoring thereof, and how any LUC deficiencies or inconsistent uses have been addressed. The report also will be filed in the information repositories. The report will not be subject to approval and/or revision by the USEPA, Cal/EPA DTSC, and Water Board. The annual monitoring reports will be used in preparation of the Five-year Reviews to evaluate the effectiveness of the remedy and will verify that State and local agencies were notified of the use restrictions and controls affecting the property and that the use of the property has conformed to such restrictions and controls.

2.9.7.2 Implementation Procedures

Only USAF-approved projects are allowed on-Base and they must be covered by one of the following documents: Air Force Flight Test Center (AFFTC) Form 5926 (Civil Engineering [CE] Work Clearance Request), Air Force (AF) Form 332 (CE Work Request), and/or AF Form 813 (Request for Environmental Impact Analysis). The AFFTC Form 5926 is required for any project that involves mechanical soil excavation or drilling, such as digging trenches for underground lines, excavating soil for building foundations, or drilling to install groundwater monitoring wells.

Documentation of LUCs and Restricted Areas

All areas requiring LUCs will be documented in the Edwards AFB Geographic Information System (GIS) as referenced in the Base *General Plan* (Edwards AFB 2009). The Base *General Plan* (Edwards AFB 2009) includes general information about LUCs, and incorporates the GIS, which contains site-specific LUC information, by reference. The updated Base *General Plan* (Edwards AFB 2009) resides in the office of the Base Community Planner in hard copy and electronic formats for official use only. A copy of the Base *General Plan* (Edwards AFB 2009) is included in the Administrative Record for Site 3. Restrictions required by the ROD will be entered into the GIS as referenced in the Base *General Plan* (Edwards AFB 2009).

The footprints of areas within the LUC boundary impacted with COCs will be updated in the GIS from ERP documents as new information becomes available. The Air Force shall provide additional details regarding engineered LUCs (e.g., fences and signs) for Site 3 in the RAWP to be submitted in accordance with the FFA schedule. The Site 3 RAWP is an enforceable primary document under Section 7.3 of the FFA.

The Air Force shall notify the USEPA, Cal/EPA DTSC, and Water Board in advance of any changes to the Base *General Plan* (Edwards AFB 2009) and internal procedures that would affect the LUCs.

Enforcement Process

Any project requiring change in land use designation and/or construction requires approval by the Environmental Management Office to ensure compliance with the Base *General Plan* (Edwards AFB 2009). Environmental Management has primary responsibility to ensure that LUCs are enforced; however, the Installation Commander has the ultimate responsibility for the enforcement of LUCs.

An AF Form 332, the CE Work Request, must be submitted and approved before the start of any building project on the Base. Approval of this form involves the comparison of the building site with the constraints in the Base *General Plan* (Edwards AFB 2009) and GIS. The Work Request serves as the document for communicating any construction constraints to the appropriate offices. Any constraints at the site result in the disapproval of the form unless the requester makes appropriate modifications to the building plans. The CE Work Management Office is responsible for the final approval of proposed building projects through the Configuration Control Board review process.

An AFFTC Form 5926, the EAFB CE Work Clearance Request, will also be used to enforce the groundwater LUCs. The requester submits an AFFTC Form 5926 to CE Customer Service, for any project that involves any mechanical soil excavation, and it is circulated to appropriate offices for review of needed safety procedures. Approval of this form involves the comparison of the site with the constraints in the Base *General Plan* (Edwards AFB 2009) and GIS. The CE Real Estate Office is responsible for the final approval of excavation projects through the permit review process.

Removal of Site-Specific Restrictions

Until Site 3 is cleaned to standards appropriate for unlimited use and unrestricted exposure, the Air Force will maintain the LUCs. Once the cleanup standards designated for the site are achieved, and risks from the identified exposure pathways are reduced to standards appropriate for unlimited use and unrestricted exposure, there will be no need to maintain, monitor, report on, or enforce LUCs. When site conditions no longer pose a threat to human health or the environment, Site 3 will be eligible for unlimited use and unrestricted exposure. Prior to altering or ceasing any LUC activity, the Air Force must pursue the written approval of the USEPA, Cal/EPA DTSC, and Water Board to eliminate the LUCs based on their determination that the LUC requirements are no longer necessary to protect public health and the environment.

2.9.8 STATUTORY DETERMINATIONS

The following sections discuss how the selected remedy meets the statutory requirements.

Protection of Human Health and the Environment

The selected remedy will protect human health and the environment by preventing unauthorized access to the buried debris present at the site through LUCs and repair and maintenance of the cover materials. Land Use Controls will also protect human health through prohibiting the use of groundwater and construction of buildings designed for occupation at their respective LUC boundaries. Groundwater will be protected from COCs present in the landfill by minimizing the infiltration of stormwater into the landfill through use of an ET cover and stormwater controls. Contaminated groundwater will be prevented from migrating and will be cleaned to MCLs through MNA.

Compliance with ARARs

The selected remedy will comply with the Federal and State ARARs identified for the Remedial Action and agreed upon by the Air Force, USEPA, Cal/EPA DTSC, and the Water Board listed in Appendix B and discussed in Section 2.9.9). No waiver of ARARs is necessary for the selected remedy.

Cost Effectiveness

A cost-effective remedy under CERCLA is one whose "costs are proportional to its overall effectiveness" (NCP §300.430(f)(1)(ii)(D)). The "overall effectiveness" of a remedial alternative is determined by evaluating the following three of the five balancing criteria used in the detailed analysis of alternatives: (1) long-term effectiveness and permanence; (2) reduction in toxicity, mobility and volume through treatment; and (3) short-term effectiveness.

The selected remedy provides both short-term effectiveness and long-term effectiveness and permanence through both LUCs and the installation of a landfill cover. LUCs are a cost effective method of keeping unauthorized personnel from accessing contaminated groundwater and subsurface debris at this active Base, because the infrastructure to implement them is largely in place. The selected alternative also utilizes a monolithic ET cover, which is lower in cost than the enhanced ET cover included in Alternative 4, but still protects human receptors and animals from contact with potentially hazardous debris, and protects the landfill from stormwater infiltration which could lead to the leaching of contaminants into groundwater.

Although the selected remedy does not rely on active treatment to reduce the toxicity, mobility, and volume of wastes, it does provide cost effective reductions in waste toxicity through natural attenuation, and reduces the mobility of contaminants in the landfill by reducing stormwater infiltration.

The selected remedy is also the lowest cost remedy that complies with ARARs (see Table 2.8-1). Note that Alternative 4 also complies with ARARs and has a shorter cleanup time for the groundwater to reach MCLs (23 years versus 84 years), however, the higher present value cost ($22.5 million versus $14.4 million) cannot be justified because there are no plans to use the groundwater at Site 3 due to low yields.

Utilization of Permanent Solutions and Alternative Treatment Technologies to the Maximum Extent Practicable

The selected alternative does, to the maximum extent practicable, incorporate permanent solutions or alternative treatment technologies, and provides the best balance among long-term effectiveness and permanence, short-term effectiveness, implementability, and cost. It is expected to be permanent and effective over the long-term as long as routine maintenance of the fence, cover, and erosion control features is performed, and the LUCs are enforced. The selected alternative does not utilize groundwater treatment in part due to the very low aquifer hydraulic conductivity. However, due to natural degradation, low contaminant concentrations, and the low aquifer hydraulic conductivity, the plume is believed to be stable and/or shrinking.

Preference for Treatment as a Principal Element

Because treatment of the potential contaminant source at the site (i.e., buried municipal waste) was not found to be practicable due to the volume and heterogeneity of the waste, this remedy does not satisfy the statutory preference for treatment as a principal element of the remedy. The size of the landfill, and the fact that there are no localized areas at the site with elevated contaminant concentrations that represent a major source of contamination, preclude a remedy in which contaminants could be excavated and treated effectively. In addition, containment (i.e., preventing the migration of contaminants by physical means [ET cover and stormwater controls] and LUCs) is the presumptive remedy for landfills (USEPA 1993b and 1996).

Even so, although none of the alternatives reduce the toxicity or volume of contaminants through active treatment, the toxicity of contaminants in groundwater will be reduced by natural attenuation.

Five-Year Review Requirements

Five-year Reviews will be required, to ensure the remedy continues to remain effective, as long as contaminants remaining on-site are present at levels that do not allow for unlimited use and unrestricted exposure. For groundwater, the Five-year Review requirement will cease once MCLs are achieved via natural degradation processes.

2.9.9 COMPLIANCE WITH ARARS

The selected remedy for Site 3 will comply with the Federal and State ARARs identified for the Remedial Action and agreed upon by the Air Force, USEPA, Cal/EPA DTSC, and the Water Board (see Appendix B).

2.9.9.1 Chemical-Specific ARARs

Chemical-specific ARARs are promulgated, health- or risk-based numerical values that, when applied to site-specific conditions, establish acceptable concentrations of a chemical that may be found in, or discharged to, the ambient environment. If a chemical has more than one cleanup level, the most stringent level is identified as an ARAR to be met for the Remedial action. Chemical-specific ARARs identified for the Remedial Action include the following State requirements:

- Primary Drinking Water Standards (Non-zero Maximum Contaminant Level Goals [MCLGs] and MCLs) (Item No. 1 in Table B-1), which are more stringent than Federal standards; and
- The beneficial uses and the water quality criteria based upon such uses established in the Water Quality Control Plan, South Lahontan Basin (Basin Plan) (Item No. 2 in Table B-1).

Chemical-specific ARARs identified for the Remedial action include the following Federal requirement:

- Primary Drinking Water Standards (Non-zero MCLGs and MCLs) (Item No. 1 in Table B-1).

Applicability of State of California Promulgated Standards as ARARs for Groundwater Contaminant Plumes

The selected alternative for Site 3 and the determination that MCLs are ARARs are necessitated by the SWRCB Resolution No. 88-63 ("Adoption of Policy Entitled 'Sources of Drinking Water'") classification of all groundwater in the State as a potential source of drinking water (if the water meets certain quality criteria), and the Water Board designation in the Basin Plan of the groundwater at Site 3 as a potential source of drinking water. The Air Force has determined that the requirement in SWRCB Resolution No. 92-49 ("Policies and Procedures for Investigation and Cleanup and Abatement of Discharges under Water Code Section 13304") to "clean up and abate the effects of discharges in a manner that promotes attainment of either background water quality, or the best water quality which is reasonable if background levels of water quality cannot be restored" is not an ARAR for the purpose of this Remedial Action. Notwithstanding this determination (see the Air Force, USEPA, and Water Board positions discussed below), the Air Force has met the intent of SWRCB Resolution No. 92-49 by conducting a Technical and Economic Feasibility Analysis (TEFA) (AECOM 2012) in accordance with CCR, Title 23, Section 2550.4, Chapter 15.

Air Force Position

The Air Force's position is that all Remedial Actions under CERCLA must, as a threshold matter, be determined by the lead agency to be necessary to protect human health and/or the environment from unacceptable risk, and furthermore must be appropriate and relevant to the circumstances of a site release (42 United States Code [USC] Section 9621(a) and (d)(1)). Both CERCLA and the NCP focus on cleaning up contaminated groundwater, where practicable and achievable within a reasonable timeframe, to a standard that will restore the designated uses of the groundwater, not to the lowest standard achievable regardless of risk (42 USC Section 9621(d)(2)(B)(i) and 40 CFR Section 300.430(a)(1)(iii)(F)). As discussed in Section 2.5.2, groundwater in the vicinity of Site 3 is not a current source of drinking water, and is unlikely to be developed as a future source of drinking water due to low yields (see Section 2.5.2.2).

Accordingly, California non-degradation provisions, including their requirement to conduct a Technical and Economic Feasibility Analysis, or TEFA, to justify cleanup levels greater than background, (to include SWRCB Resolution No. 92-49 and the Basin Plan) based on achieving background or the lowest cleanup standard that is technically and economically achievable are not risk-based, necessary, or relevant or appropriate to returning contaminated groundwater to a drinking water standard of service; and, therefore, the Air Force does not consider them to be ARARs.

Regarding applicability, and without prejudice to the Air Force's position above, the California non-degradation provisions, such as SWRCB Resolution 92-49, are not applicable because they are directed toward State agencies who in turn are directing cleanup under State law, whereas this is a Federal CERCLA cleanup action where the State is a support agency; or apply to current discharges as opposed to historic releases or further migration of such releases; or apply to specific, discrete regulated units that received hazardous waste after 26 July 1982, none of which apply here.

State non-degradation provisions are not relevant and appropriate requirements (RARs) because:

- CERCLA requires that the Air Force select a Remedial Action determined to be necessary under Section 9604 of CERCLA, that the Remedial Action attain a degree of cleanup of hazardous substances which at a minimum is protective of human health and the environment, and that all remedies be relevant and appropriate under the circumstances presented by the hazardous substance release (42 USC § 9621(a) and (d)(1). Remedial Actions and selected cleanup levels then must be necessary for and be reasonably related to ensuring protectiveness of either human health or the environment. CERCLA and the NCP further require that for groundwater non-zero MCLGs be met where relevant and appropriate to the circumstances of the release, and where the MCLG is not relevant and appropriate that the corresponding MCL be met where similarly relevant and appropriate (42 USC § 9621(d)(2) and 40 CFR § 300.430(e)(2)(i)(B) and (C)). The NCP similarly has the expectation that contaminated groundwater be cleaned up or restored to a level that supports the designated uses of the groundwater wherever practicable within a reasonable timeframe given the particular cite circumstances (40 CFR § 300.430(iii)(F)).
- Cleanup beyond a non-zero MCLG or a corresponding MCL to background or a level that is technologically and economically feasible is not reasonably related to the beneficial use of groundwater designated for actual or potential potable uses nor is it necessary or relevant and appropriate to the safe use of the groundwater for drinking water. As discussed above, California non-degradation provisions requiring that cleanup standards be set at background or the lowest standard technically and economically feasible, are not reasonable related to any actual or potential use of the water or risks to users thereof.

Based upon all of the above, the only provisions of the California regulations that are potential ARARs are those State MCLs that require more stringent cleanup concentrations or standards than the Federal MCLs. If State MCLs are the same as Federal MCLs, they are not more stringent and therefore are not ARARs. If a State MCL is more stringent than the Federal MCL, then it is an ARAR under CERCLA as set forth in 42 USC Section 9621(d)(2)(A)(ii).

Although tables in this ROD may contain information showing COCs to the Water Board and comparison of these COCs to Water Quality Objectives including Secondary MCLs, the presentation of these data do not constitute an admission by the Air Force that Water Quality Objectives are ARARs.

As to State secondary MCLs, the Air Force position is the same as the USEPA's, secondary MCLs are not ARARs.

USEPA Position Regarding State Requirements as ARARs for Site 3

Only State standards, requirements, criteria, or limitations that have been promulgated under State environmental or facility-siting laws that are more stringent than Federal ARARs and that have been identified by the State of California in a timely manner are potential State ARARs.

With regard to the Porter-Cologne Water Quality Control Act, it is USEPA's position that the Act itself is not an ARAR; rather, it is an enabling statute that authorizes the SWRCB to regulate activities which may affect the quality of the waters of the State. With regard to the Basin Plan, it is the USEPA's position that only those parts of the Basin Plan which set out the designated uses (beneficial uses) and the water quality criteria based upon such uses (water quality objectives) meet the NCP definition of substantive standards. Other parts of the Basin Plan express general goals and/or enumerate factors that the Regional Boards consider in the process of enforcing water quality standards; these do not set standards themselves.

With regard to SWRCB Resolution No. 92-49, only Section III.G has substantive standards that are potentially relevant and appropriate to CERCLA groundwater cleanups. The first three pages of SWRCB Resolution No. 92-49 contain "Whereas" clauses, followed by Sections I and II which state the policies and procedures that the Regional Boards apply in overseeing cleanups.

Likewise, Sections III.A through III.E simply enumerate the factors the Regional Boards must consider in implementing cleanups. Section III.F requires the Regional Board to require cleanup actions to conform to SWRCB Resolution No. 68-16 ("Statement of Policy with Respect to Maintaining High Quality Waters in California"), and to implement the provisions of Chapter 15 that are applicable to the cleanup activity. While SWRCB Resolution No. 68-16 and Chapter 15 regulations have substantive requirements that impact cleanup standards, these two State requirements have to be analyzed in and of themselves as to whether they are potential ARARs, independent of their incorporation by reference in SWRCB Resolution No. 92-49. It is the USEPA's position that SWRCB Resolution No. 68-16 is an ARAR when setting limits for discharge or reinjection into groundwater; it is not an ARAR for setting aquifer cleanup standards in CERCLA groundwater cleanup. This is because the USEPA does not believe that continuing migration of contamination in groundwater is a "discharge" subject to SWRCB Resolution No. 68-16. It is the USEPA's position that Chapter 15 has limited applicability to CERCLA cleanups because of the exemption language in Section 2511(d) which generally exempts cleanups undertaken by or at the direction of public agencies. Incorporation of SWRCB Resolution No. 68-16 and Chapter 15 into SWRCB Resolution No. 92-49 does not broaden the applicability of these two State regulations outside these parameters.

With regard to secondary MCLs, the USEPA has consistently stated that these are not ARARs because they are not promulgated Federal environmental standards that go to the protection of human health and the environment. Even when promulgated by the State, secondary MCLs address taste and odor. The USEPA considers taste and odor cosmetic, not health-based environmental standards. The NCP remedy selection process is based on the CERCLA mandate to protect human health and the environment.

Water Board Position Regarding State Requirements

SWRCB Resolution No. 92-49 and 68-16

The Water Board has identified SWRCB Resolution No. 92-49 and CCR, Title 23, Section 2550.4 as proposed ARARs for determining cleanup standards for VOCs in the groundwater at Edwards AFB. The Air Force and the Water Board disagree about whether these Water Board requirements are ARARs for this cleanup.

With regard to SWRCB Resolution No. 92-49, the Water Board asserts that this resolution is an applicable requirement for remedial actions of the contaminated groundwater and complies with CCR, Title 23, Section 2550.4. Furthermore, the Water Board does not believe that the application of SWRCB Resolution No. 92-49 is strictly limited to Section III.G. In this case, SWRCB Resolution No. 92-49 requires remediation of the contaminated groundwater to the lowest concentration levels of constituents technically and economically feasible, which must at least protect the beneficial uses of groundwater, but need not be more stringent than is necessary to achieve background levels of the constituents in groundwater.

With regard to SWRCB Resolution No. 68-16, the Water Board asserts that this resolution is an ARAR for the injection of any discharge of waste or proposed discharge of waste into groundwater and is not strictly limited to a discharge of waste to treat contaminants. Waste is defined pursuant to Water Code Section 13050, subdivision (d), and includes, but is not limited to, injected chemical reagents. A discharge also occurs where polluted groundwater migrates to areas of high quality groundwater.

Discharges subject to SWRCB Resolution No. 68-16 include the continuing migration of any in situ treatment reagents or other waste as defined in Water Code Section 13050(d) from the injection wells to groundwater. Under SWRCB Resolution No. 68-16, some degradation may be allowed so long as the cleanup action applies best practicable treatment and control to prevent further migration of waste to "Waters of the State" at concentration levels that exceed water quality objectives or impact beneficial uses. "Waters of the State" includes surface water and groundwater pursuant to Water Code Section 13050(e).

Porter-Cologne Water Quality Control Act (Water Code Section 13000 et seq.)

The Water Board asserts that various provisions of the Porter-Cologne Water Quality Control Act are applicable requirements. First of all, Water Code Section 13000 is an applicable requirement and requires the activities and factors which may affect the quality of the waters of the State shall be regulated to attain the highest water quality which is reasonable, considering all demands being made and to be made on those waters and the total values involved, beneficial and detrimental, economic and social, tangible and intangible. Water Code Section 13000 applies to contaminants in "waters of the State" as defined in Water Code Section 13050, subdivision (e) and to contaminants in soil that may degrade waters of the State.

Second, Water Code Section 13243 is an applicable requirement and states that the Water Board may specify certain conditions or areas where the discharge of waste, or certain types of waste, will not be permitted. Water Code Section 13243 applies to discharges of soil or contaminants where the discharge may affect water quality.

Third, Water Code Section 13267(b) is an applicable requirement and states that the Water Board may require any person suspected of discharging, or who proposes to discharge, waste to furnish technical or monitoring program reports. Water Code Section 13267(b) applies to discharges of soil or contaminants where the discharge may affect water quality.

Fourth, Water Code Section 13304(a) is an applicable requirement and states that the Water Board may require any person who causes or permits any waste to be deposited where it is, or probably will be, discharged to waters of the State and create a condition of pollution or nuisance to clean up the waste or abate the effects of the waste. Water Code Section 13304(a) applies to discharges of soil or contaminants where the discharge may affect water quality.

Fifth, Water Code Section 13375 is an applicable requirement and states that the discharge of any radiological, chemical, or biological warfare agent into the waters of the state is prohibited. Water Code Section 13375 applies to discharges of radiological, chemical, or biological warfare agents.

Furthermore, although not a provision of State law, the California Water Quality Control Board, Central Valley Region's "Designated Level Methodology for Waste Classification and Cleanup Level Determination" is a "To Be Considered" requirement and provides guidance on how to classify waste according to CCR, Title 23, Division 3, Chapter definitions. This document is to be considered in determining the classification of wastes and contaminated soils.

California Code of Regulations, Title 23, Division 3, Chapter 15

With regard to CCR, Title 23, Division 3, Chapter 15, the Water Board asserts that Chapter 15 regulates all discharges of hazardous waste to land that may affect water quality. A "waste management unit" is defined in Chapter 15 as "an area of land, or a portion of a waste management unit, at which waste is discharged" (CCR, Title 23, Section 2601). Pursuant to Water Code Section 13050(d), the definition of "waste" is extremely broad and includes the injection of one or more chemicals to groundwater to the extent that there is a discharge to an "area of land".

CCR, Title 23, Section 2550.4 requires the consideration of beneficial uses when establishing cleanup standards above background. The factors that are to be considered by Edwards AFB in performing a TEFA for groundwater are listed under CCR, Title 23, Section 2550.4(d). Section 2550.6 requires monitoring for compliance with RAOs for three years from the date of achieving the cleanup standards. Section 2550.10 requires implementation of corrective action measures that ensure Title 23 cleanup standards are achieved through the zone affected by the release by removing waste constituents or by treating them in place.

Basin Plan

With respect to the Basin Plan, the Water Board asserts that Chapter 2, Beneficial Uses; Chapter 3, Water Quality Objectives; and the sections in Chapter 4, Implementation entitled "Regionwide

Prohibitions", "Requirements for Site Investigation and Remediation", and "Cleanup Levels" are ARARs and apply to determine the appropriate cleanup standard in groundwater to protect beneficial uses and to meet the water quality objectives.

Secondary MCLs

With respect to secondary MCLs, the Water Board asserts that the taste and odor water quality objective specified in the Basin Plan for the Lahontan Region, which incorporates State primary and secondary drinking water standards, is an ARAR that applies to the establishment of cleanup standards at Site 3. In particular, secondary MCLs for taste and odor based on drinking water standards specified in Table 64449-A (Secondary Maximum Contaminant Levels - Consumer Acceptance Limits) and Table 64449-B of Section 64449 (Secondary Maximum Contaminant Levels and Compliance), CCR, Title 22, as incorporated by reference in the Basin Plan, are ARARs and water quality objectives which apply to groundwater.

Conclusion

In summary, (1) SWRCB Resolution No. 92-49; (2) Water Code Sections 13000, 13243, 13267(b), 13304(a), and 13375, (3) Chapter 2, Beneficial Uses; Chapter 3, Water Quality Objectives; and the Sections "Regionwide Prohibitions", "Requirements for Site Investigation and Remediation" and "Cleanup Levels" in Chapter 4, Implementation of the Basin Plan; (4) CCR, Title 23, Division 3, Chapter 15; and (5) secondary MCLs are applicable requirements because they specifically address remedial actions taken in order to protect the quality of the "Waters of the State". They are substantive requirements that are legally enforceable, of general applicability, and more stringent than Federal requirements. Furthermore, although the Air Force has recognized the applicability of SWRCB Resolution No. 68-16, the Water Board notes that the appropriate scope of the applicability of SWRCB Resolution No. 68-16 in this particular case is subject to some disagreement between the Air Force and the Water Board.

Technical and Economic Feasibility Analysis (TEFA)

The Air Force conducted a qualitative TEFA (AECOM 2012) to evaluate the feasibility of achieving cleanup standards for groundwater more stringent than Federal and State MCLs. Fate and transport modeling indicates that the selected remedy for cleaning the groundwater (natural attenuation) has the potential of cleaning the groundwater to background concentrations. As discussed in the TEFA, according to the fate and transport modeling, cis-1,2-DCE is the last constituent to reach background (it is a degradation product of other constituents). For the purpose of this analysis, the background level for cis-1,2-DCE is considered to be 0.5 μg/L, which is based on the California Department of Health Services (CDHS) Detection Limits for Purposes of Reporting (DLRs): Regulated Contaminants (CDPH 2010), in lieu of the statistical methods referenced in 23 CCR 2550.4 and described in 23 CCR 2550.7.

The present value cost of the selected remedy to clean the groundwater at Site 3 to background concentrations is an estimated $14.7 million dollars. This cost estimate includes groundwater monitoring for 113 years (the time required for cis-1,2-DCE to degrade to background concentrations) versus 84 years to clean to MCLs. However, there is no benefit to cleaning to background concentrations because, due to exceptionally low yields, it is unlikely that the groundwater at Site 3 would be used for a beneficial purpose, and Site 3 is not adjacent to an aquifer that can be used for beneficial purpose. In addition, clean closure of the site would be required to assure cleanup of the groundwater to background concentrations because a future release from the landfill from an isolated waste source could result in a detectable concentration of a COC above background concentrations, but below MCLs. Clean closure was eliminated as a remedial alternative as being impractical.

All parties agree that the groundwater cleanup levels established in this Record of Decision, as supported by the TEFA, provides substantive compliance with SWRCB Resolution No. 92-49 and CCR, Title 23, Section 2550.4. SWRCB Resolution No. 92-49 and CCR, Title 23, Section 2550.4 are intended to result in cleanup to the lowest standard that is technically and economically feasible and that will protect beneficial uses of the "Waters of the State". All parties agree that, at this time, cleanup standards for all VOCs in the groundwater are State or Federal MCLs, whichever is more stringent.

Summary

The parties, however, desire to avoid disputing the issue of whether certain provisions of State law are ARARs, particularly if, in utilizing the State non-degradation provisions and the TEFA analyses therein, a joint determination can be made that cleanup to background for substances released from the site are not technically and economically feasible. The parties acknowledge that one factor specified in the NCP for determining the relevance and appropriateness of any requirement is the variance, waiver, or exemption provisions specified in the requirement (40 CFR Section 300.400(g)(2)(v)). Accordingly, without prejudice to the positions of the respective parties, which all parties have respectively reserved and preserved, and without any precedence, the Air Force conducted an analysis of the technical and economic feasibility of achieving cleanup standards more stringent than MCLs. In doing so, the Air Force is neither directly nor indirectly acknowledging that either concentration levels below MCLs or the TEFA process itself are ARARs. The Air Force has determined that it is not technically or economically feasible to clean the groundwater at Site 3 to background concentrations for all substances released from Site 3, and that it is not necessary to do so, in this particular case, to protect human health and the environment. Further, as a result of the TEFA evaluations, all parties agree that the groundwater cleanup levels established in this ROD are the lowest concentrations technically and economically achievable. Based in part on information in the TEFA, the USEPA, Cal/EPA DTSC, and Water Board agree with the TEFA analysis and determination that, in this particular case, the CERCLA and NCP compliant cleanup standards in the groundwater shall be the Federal or State MCLs, whichever are more stringent. The Cal/EPA DTSC and Water Board further concur that such standards will not pose a substantial threat or potential hazard to human health.

2.9.9.2 Location-Specific ARARs

Location-specific ARARs are restrictions on the concentrations of hazardous substances or on activities solely because they are in specific locations such as floodplains, wetlands, historic places, and sensitive ecosystems or habitats. Location-specific ARARs identified for the Site 3 Remedial Action include the following State requirements listed as Relevant and Appropriate:

- California Endangered Species Act (Item No. 5 in Table B-1);
- Wildlife Species/Habitats (Item No. 6 in Table B-1);
- Fully Protected Bird Species (Item No. 7 in Table B-1);
- Fully Protected Mammals (Item No. 8 in Table B-1); and
- Fully Protected Amphibians and Reptiles (Item No. 9 in Table B-1).

As stated in Air Force Instruction 32-7064, dated 17 September 2004, State-protected species will be protected when practicable and the appropriate State authority will be contacted if conflicts arise. The State may provide procedures for minimization of impacts and harm to species.

It is the Air Force's position that California Fish and Game Code Section 3503 is not an ARAR. However, based on a recent USAF bird survey at this site, California Department of Fish and Game (CDFG) believes that compliance with the MBTA (Item No. 4 in Table B-1) would effectuate substantive compliance with California Fish and Game Code Section 3503 for this Remedial Action because all of the birds listed in the survey are Migratory Birds as defined in the MBTA.

Location-specific ARARs identified for the Site 3 Remedial Action include the following Federal requirements:

- Endangered Species Act of 1973, Section 7(c) (Item No. 3 in Table B-1); and
- Migratory Bird Treaty Act (MBTA) (Item No. 4 in Table B-1).

The selected alternative will comply with location-specific ARARs as annotated in Table B-1.

2.9.9.3 Action-Specific ARARs

Action-specific ARARs are technology- or activity-based requirements or limitations that apply to particular remedial activities. Action-specific ARARs identified for the Site 3 Remedial Actions include the following State requirements:

- Standards Applicable to Generators of Hazardous Waste (Item No. 10 in Table B-1);
- Sources of Drinking Water Policy (Item No. 11 in Table B-1) (Note: because this is a policy, not a regulation, the Air Force considers this item as TBC);
- Definition of and Criteria for Identifying Hazardous Wastes (Item No. 12 in Table B-1);
- Land Disposal Restrictions (LDR) (Item No. 13 in Table B-1);
- Land Use Controls (Item No. 14 in Table B-1);
- Department of Resources and Recovery (CalRecycle) Requirements for Non-Hazardous Waste Management Units (Item No. 15 in Table B-1); and
- CalRecycle Standards for Handling and Disposal of Asbestos-containing Waste (Item No. 16 in Table B-1).

State requirements specific to landfills are found in Table B-2.

Action-specific requirements also include the following Federal requirements:

- Standards Applicable to Generators of Hazardous Waste (Item No. 10 in Table B-1); and
- Definition of and Criteria for Identifying Hazardous Wastes (Item No. 12 in Table B-1);

The selected remedy will comply with action-specific ARARs as annotated in Tables B-1 and B-2.

2.9.10 DOCUMENTATION OF SIGNIFICANT CHANGES FROM THE PROPOSED PLAN

There are no significant changes from the Proposed Plan.

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3.0 PART 3: RESPONSIVENESS SUMMARY

This Responsiveness Summary is intended to provide a summary of information about the views of the public regarding both the remedial alternatives and general concerns about Site 3 submitted during the public comment period. Notices of availability of the Proposed Plan were published in the local area newspapers: the Antelope Valley Press on March 2 and March 9, 2010, and the Mojave Desert News on March 4, 2010. A notice of availability of the Proposed Plan was also published in the Desert Eagle (a Base newspaper produced by the Edwards AFB Public Affairs Office) on March 5, 2010. A public comment period was held from February 17 to April 2, 2010. During the public comment period, the RI report, FS, FS Addendum, and Proposed Plan were made available to the public.

Public Availability Sessions were held on- and off-Base on March 9, 2010 to present the Proposed Plan to a broader community audience. The on-Base meeting was held from 11:00 a.m. to 1:00 p.m. at Environmental Management, Building 2650A, 5 East Popson Avenue, Edwards AFB, California. The off-Base meeting was held from 5:00 p.m. to 7:00 p.m. at the Wanda Kirk Branch Library, 3611 Rosamond Boulevard, Rosamond, California.

No comments were received from the public during the public comment period.

LIST OF TABLES

TABLE 1.6-1. RECORD OF DECISION DATA CERTIFICATION CHECKLIST

Key Remedy Selection Information	Document Section/ Table Number
Remedy Components	Sections 1.4 and 2.9.1
Chemicals of Concern (COCs) and their respective concentrations	Section 2.6.2, Tables 2.6-5 and 2.6-6
Baseline risk represented by the COCs	Section 2.6.7 and Tables 2.6-7 and 2.6-8
Cleanup levels established for COCs and the basis for these levels	Section 2.7 and Tables 2.7-1 and 2.7-2
How source materials constituting principal threat will be addressed	Section 2.8.8
Current and reasonably anticipated future land use assumptions and current and potential future beneficial uses of groundwater used in the baseline risk assessment and ROD	Sections 2.5.6 and 2.6.7
Potential land and groundwater use that will be available at the site as a result of the Selected Remedy	Section 2.8.6
Estimated capital, annual operation and maintenance (O&M), and total present worth costs, discount rate, and the number of years over which the remedy cost estimates are projected	Section 2.9.5 and Table 2.8-1
Key factor(s) that led to selecting the remedy	Section 2.8 and Table 2.8-2

Notes:

COCs Chemicals of Concern
O&M operations and maintenance
ROD Record of Decision

TABLE 2.5-1. EVALUATION OF THE POSSIBLE FUTURE USE OF GROUNDWATER AT SITE 3 AS A SOURCE OF DRINKING WATER

Well	Groundwater Yields Measured during Well Development [a]	Total Dissolved Solids [b] (mg/L)	Evaluated Potential for Future Sustainable Yield of 200 Gallons per Day [c]
3-MW01	• Well dry after bailing 33 gallons in 62 minutes (Day 1) • Well dry after bailing 31 gallons in 43 minutes (Day 2) • Well dry after bailing 21 gallons in 24 minutes (Day 3)	680	Unlikely
3-MW02	• Well dry after bailing 45 gallons in 91 minutes (Day 1) • Well dry after bailing 68 gallons in 107 minutes (Day 2) • Well dry after bailing 37 gallons in 53 minutes (Day 3)	550	Unlikely
3-MW03	• Well dry after bailing 80 gallons in 178 minutes (Day 1) • Well dry after bailing 72 gallons in 122 minutes (Day 2) • Well dry after bailing 66 gallons in 87 minutes (Day 3)	400	Unlikely
3-MW04	• Well dry after bailing 50 gallons in 74 minutes (Day 1) • Well dry after bailing 32 gallons in 46 minutes (Day 2) • Well dry after bailing 32 gallons in 52 minutes (Day 3)	550	Unlikely
3-MW05	• Bailed 150 gallons from the well over 3 days; the well was bailed dry each day (Day 1)	880	Unlikely
3-MW06	• Pumped 375 gallons in 180 minutes (Day 1)	590	Possible
3-MW07	• Well dry after bailing 30 gallons in 10 minutes (Day 1) • Well dry after bailing 30 gallons in 10 minutes. Using a pump at rates of 0.75 and 0.5 gpm, well almost dry after pumping 62.5 gallons in 80 minutes (Day 2)	4,000	Unlikely
3-MW08	• Well dry after bailing 20 gallons in 10 minutes (Day 1) • Well dry after bailing 30 gallons in 20 minutes (Day 2) • Using a pump at rates of 0.75, 0.5, 0.3, and 0.2 gpm, well almost dry after pumping 48.5 gallons in 130 minutes (Day 3)	520	Unlikely
3-MW09	• Well dry after bailing 40 gallons in 80 minutes (Day 1)	1,300	Unlikely
3-MW10	• Well dry after bailing 45 gallons in 70 minutes (Day 1)	1,500	Unlikely
3-MW11	• Well dry after bailing 50 gallons in 60 minutes (Day 1) • Well dry after bailing 15 gallons in 10 minutes (Day 2)	540	Unlikely
3-MW12	• Well dry after bailing 15 gallons in 35 minutes (Day 1) • Well dry after bailing 4 gallons in 5 minutes (Day 2)	620	Unlikely
3-MW13	• Well dry after bailing 17 gallons in 37 minutes; well almost dry after pumping 10 gallons in 26 minutes (Day 1)	650	Unlikely

TABLE 2.5-1. EVALUATION OF THE POSSIBLE FUTURE USE OF GROUNDWATER AT SITE 3 AS A SOURCE OF DRINKING WATER

(Page 2 of 2)

Well	Groundwater Yields Measured during Well Development [(a)]	Total Dissolved Solids [(b)] (mg/L)	Evaluated Potential for Future Sustainable Yield of 200 Gallons per Day [(c)]
3-MW14	• Well dry after bailing 45 gallons in 50 minutes; well almost dry after pumping 10 gallons in 40 minutes (Day 1)	660	Unlikely
3-MW15	• Well almost dry after pumping 60 gallons in 1 hour (Day 1) • Well dry after pumping 41 gallons in 1 hour (Day 2)	513	Unlikely
3-MW16	• Well dry after bailing 18 gallons in 50 minutes (Day 1)	912	Unlikely
3-MW17	• Well dry after bailing 26 gallons in 1 hour and 40 minutes (Day 1) • Well dry after pumping 14 gallons in 26 minutes (Day 2)	1,250	Unlikely
3-MW18	• Well dry after pumping 13 gallons in 55 minutes (Day 1) • Well dry after bailing 9 gallons in 20 minutes (Day 2)	1,300	Unlikely
3-MW19	• Well almost dry after bailing and pumping 120 gallons in 5 hours and 50 minutes (including stoppage time to allow for recharge) (Day 1)	627	Unlikely
3-MW20	• Well dry after pumping 21 gallons in 45 minutes (Day 1) • Well dry after pumping 15 gallons in 20 minutes (Day 2)	651	Unlikely
3-MW21	• Well dry after pumping 25 gallons in 30 minutes (Day 1) • Well dry after pumping 32 gallons in 1 hour and 20 minutes (Day 2)	772	Unlikely

Notes:

(a) Typical groundwater yields are based on data summarized from the field Well Development Logs.
(b) Source: FPM Group (2006) and AECOM (2009b).
(c) Source: State Water Resources Control Board (1988). It should be noted that a water source with total dissolved solids exceeding 3,000 mg/L, or that does not provide sufficient water to supply a single well capable of producing an average sustained yield of 200 gallons per day, is not reasonably expected to supply public water systems.

gpm gallons per minute
mg/L milligrams per liter

TABLE 2.5-2. LANDFILL GAS AND GROUNDWATER MONITORING WELL CONSTRUCTION PARAMETERS – SITE 3

(Page 1 of 2)

Well ID	Date Installed	Well Total Depth (feet bgs)	Depth to Water Drilling (feet bgs)	Depth to Water Static (feet bgs)	Ground Surface Elevation (feet MSL)	Top of Casing Elevation (feet MSL)	Casing Diameter (inches)	Casing Type	Screen Interval (feet bgs)	Screen Length (feet)	Formation Screened	Depth to Groundwater June 2009 [a] (feet bgs)	Height of Water Level Above Top of Well Screen [b] (feet)
Landfill Gas Monitoring Wells													
3-LFG01	2/03/1993	6	NA	NA	2,368.13	2,370.06	2	PVC	3-6	3	CL/SM	NA	NA
3-LFG02	2/03/1993	6	NA	NA	2,383.85	2,385.51	2	PVC	3-6	3	SM	NA	NA
3-LFG03	2/03/1993	6	NA	NA	2,406.07	2,407.31	2	PVC	3-6	3	SM/WBr	NA	NA
3-LFG04	2/03/1993	5.9	NA	NA	2,397.94	2,400.46	2	PVC	2.9-5.9	3	SM/SP	NA	NA
3-LFG05	2/03/1993	8	NA	NA	2,385.35	2,387.18	2	PVC	5-8	3	SM	NA	NA
3-LFG06A	3/24/2009	10	NA	NA	2,365.85	2,367.56	1	PVC	8-10	2	SP	NA	NA
3-LFG06B	3/24/2009	25	NA	NA	2,365.85	2,367.56	1	PVC	23-25	2	SW	NA	NA
3-LFG07A	3/24/2009	10	NA	NA	2,380.62	2,382.49	1	PVC	8-10	2	SW	NA	NA
3-LFG07B	3/24/2009	25	NA	NA	2,380.62	2,382.52	1	PVC	23-25	2	SW	NA	NA
3-LFG08A	3/24/2009	10	NA	NA	2,399.83	2,401.13	1	PVC	8-10	2	WBr	NA	NA
3-LFG08B	3/24/2009	25	NA	NA	2,399.83	2,401.10	1	PVC	23-25	2	WBr	NA	NA
3-LFG09A	3/23/2009	10	NA	NA	2,373.88	2,375.73	1	PVC	8-10	2	SW	NA	NA
3-LFG09B	3/232009	25	NA	NA	2,373.88	2,375.69	1	PVC	23-25	2	WBr	NA	NA
Groundwater Monitoring Wells													
3-MW01	2/28/1993	115	97	86	2,367.10	2,369.11	4	PVC/SS	90-110	20	WBr	80.05	9.85
3-MW02	2/25/1993	170	164	90	2,383.60	2,385.46	4	PVC/SS	147.5-167.5	20	CBr	83.32	63.68
3-MW03	2/28/1993	166.6	162	111	2,406.40	2,408.31	4	PVC/SS	145-165	20	CBr	106.46	38.54
3-MW04	2/23/1993	172	160	119	2,397.20	2,399.22	4	PVC/SS	150-5-170.5	20	CBr	109.32	41.18
3-MW05	6/25/1993	120.5	77	77	2,376.94	2,378.94	4	PVC/SS	100-120	20	CBr	69.15	30.85
3-MW06	6/22/1993	105	94	79	2,369.54	2,371.54	4	PVC/SS	85-105	20	CBr	73.61	11.39
3-MW07	12/01/1997	110	97	65	2,387.05	2,388.77	4	PVC/SS	70-90	20	CBr	65.06	4.94

TABLE 2.5-2. LANDFILL GAS AND GROUNDWATER MONITORING WELL CONSTRUCTION PARAMETERS – SITE 3
(Page 2 of 2)

Well ID	Date Installed	Well Total Depth (feet bgs)	Depth to Water Drilling (feet bgs)	Depth to Water Static (feet bgs)	Ground Surface Elevation (feet MSL)	Top of Casing Elevation (feet MSL)	Casing Diameter (inches)	Casing Type	Screen Interval (feet bgs)	Screen Length (feet)	Formation Screened	Depth to Groundwater June 2009 [(a)] (feet bgs)	Height of Water Level Above Top of Well Screen [(b)] (feet)
3-MW08	12/02/1997	100	99	87	2,371.09	2,373.36	4	PVC/SS	80-100	20	WBr/CBr	85.11	-5.11
3-MW09	12/03/1997	180	180	126	2,366.70	2,368.67	4	PVC/SS	134-154	20	CBr	84.90	49.10
3-MW10	12/03/1997	120	109	82	2,362.67	2,364.71	4	PVC/SS	97-117	20	CBr	78.46	18.54
3-MW11	8/07/2000	120.5	115	82	2,368.45	2,370.10	4	PVC/SS	100-120	20	CBr	77.74	22.26
3-MW12	8/08/2000	115	95	94	2,369.21	2,370.77	4	PVC/SS	95-115	20	CBr	85.34	9.66
3-MW13	8/10/2000	97	95	85	2,364.84	2,366.33	4	PVC/SS	77-97	20	WBr/CBr	79.05	-2.05
3-MW14	8/02/2000	120	110	88	2,361.92	2,363.68	4	PVC/SS	88-108	20	CBr	80.47	7.53
3-MW15	2/24/2009	120	108	101	2,393.92	2,397.01	4	PVC/SS	100-120	20	WBr	100.50	-0.50
3-MW16	2/20/2009	115	108	101	2,387.72	2,390.88	4	PVC/SS	95-115	20	CBr	82.81	12.19
3-MW17	2/23/2009	100	NA	86	2,384.42	2,387.28	4	PVC/SS	80-100	20	CBr	85.41	-5.41
3-MW18	2/25/2009	105	NA	99	2,366.66	2,369.51	4	PVC/SS	85-105	20	CBr	96.82	-11.82
3-MW19	2/18/2009	170	NA	88	2,371.70	2,374.53	4	PVC/SS	150-170	20	CBr	87.80	62.20
3-MW20	2/19/2009	95	NA	94	2,371.25	2,374.15	4	PVC/SS	75-95	20	CBr	87.77	-12.77
3-MW21	2/17/2009	100	NA	82	2,365.89	2,368.71	4	PVC/SS	80-100	20	CBr	82.45	-2.45

Notes:

[(a)] Groundwater levels measured on June 3, 2009.
[(b)] A negative value indicates the top of screen is above the June 3, 2009 water level.

bgs	below ground surface	NA	not applicable
CBr	competent bedrock	PVC	polyvinyl chloride
CL	clay	SM	silty sand
ID	identification	SP	poorly-graded sand
LFG	landfill gas	SS	stainless steel
MSL	mean sea level	SW	well-graded sand
MW	monitoring well	WBR	weathered bedrock

TABLE 2.5-3. SUMMARY OF THE TEST PIT EXCAVATION LOGS – SITE 3

(Page 1 of 2)

Test Pit Number	Surface Features in Area of Test Pit	Type of Refuse Encountered	Depth to Top of Refuse (ft bgs)	Depth to Bottom of Refuse (ft bgs)
3-TP01	Subsidence indicating possible refuse disposal cell	Paper, plastic, glass bottles, cans, cloth, lumber, wire, pipe, car tires	2.5	9.0
3-TP02	Subsidence indicating possible refuse disposal cell	Paper, glass bottles, cans, cloth, lumber, telephone wire, pipe	2.0	8.5
3-TP03	Subsidence indicating possible refuse disposal cell	Paper, plastic, glass bottles, cans, cloth, lumber	1.5	8.0
3-TP04	Subsidence indicating possible refuse disposal cell	No refuse encountered	No refuse encountered	No refuse encountered
3-TP05	Subsidence indicating refuse disposal cell	Paper, plastic, glass bottles, cans, cloth, iron pipe, bundled cardboard and newspaper	0.75	11.0
3-TP06	Subsidence indicating possible refuse disposal cell	Paper, plastic, glass bottles, cans, cloth, cleared vegetation, bundled paper	1.5	> 12.5 (bottom not found)
3-TP07	Covered with construction and demolition debris	Concrete debris (1' to 2' diameter)	2.0	5.0
3-TP08	Covered with construction and demolition debris	Concrete (1' to 2' diameter), asphalt (0.5' to 1' diameter), lumber, plywood	1.0	10.0
3-TP09	Subsidence indicating possible refuse disposal cell	No refuse encountered	No refuse encountered	No refuse encountered
3-TP10	Covered with construction and demolition debris	Lumber, plywood, metal pipe to 6' bgs; paper, plastic, glass bottles, cans below 6'	1.5	> 12.0 (bottom not found)
3-TP11	Covered with construction and demolition debris	Concrete (0.5' to 1' diameter), lumber, plywood, cleared vegetation	2.0	> 12.0 (bottom not found)
3-TP12	Subsidence indicating possible refuse disposal cell	Concrete (1' to 2' diameter), lumber, plywood, conduit, wire, sheet metal	1.5	10.0
3-TP13	Subsidence indicating possible refuse disposal cell	Concrete (2' to 3' diameter), bricks, lumber, plywood, conduit, metal pipe	2.5	9.0
3-TP14	Subsidence indicating possible refuse disposal cell	Lumber, plywood, pipe, conduit, sheet metal, steel bands, paper	1.5	6.0
3-TP15	Subsidence indicating possible refuse disposal cell	No refuse encountered	No refuse encountered	No refuse encountered

TABLE 2.5-3. SUMMARY OF THE TEST PIT EXCAVATION LOGS – SITE 3

Test Pit Number	Surface Features in Area of Test Pit	Type of Refuse Encountered	Depth to Top of Refuse (ft bgs)	Depth to Bottom of Refuse (ft bgs)
3-TP16	Subsidence indicating possible refuse disposal cell	Lumber, plywood, pipe, conduit, sheet metal, roof shingles	1.0	5.0
3-TP17	Subsidence indicating possible refuse disposal cell	Concrete (1' to 3' diameter), asphalt, pipe, metal filings, road signs	1.0	9.0
3-TP18	Subsidence indicating possible refuse disposal cell	No refuse encountered	No refuse encountered	No refuse encountered
3-TP19	Subsidence indicating possible refuse disposal cell	Paper, glass bottles, cans, concrete, asphalt, pipe, conduit, cleared vegetation	2.0	> 12.0 (bottom not found)
3-TP20	Subsidence indicating possible refuse disposal cell	Paper, bottles, paint cans, cloth, concrete, asphalt, lumber, conduit, wire	1.5	> 12.0 (bottom not found)
3-TP21	Subsidence indicating possible refuse disposal cell	Paper, glass bottles, cans, cloth, lumber, plywood, pipe, conduit, sheet metal	2.5	9.0
3-TP22	Subsidence indicating possible refuse disposal cell	Paper, glass, cans, cloth, lumber, plywood, pipe, conduit, wire, cleared vegetation	3.0	> 11.0 (bottom not found)
3-TP23	Subsidence indicating possible refuse disposal cell	Paper, glass, cans, cloth, concrete, asphalt, lumber, pipe, wire, cleared vegetation	2.5	> 10.0 (bottom not found)
3-TP24	Subsidence indicating possible refuse disposal cell	Paper, glass, cans, cloth, lumber, plywood, pipe, wire	2.0	> 10.0 (bottom not found)
3-TP25	Subsidence indicating possible refuse disposal cell	Paper, glass, cans, cloth to 1.75' bgs; concrete, asphalt below 1.75'	1.5	3.5

Notes:

>	greater than
ft	feet
bgs	below ground surface

TABLE 2.6-1. MAXIMUM CONCENTRATIONS OF ORGANIC CONTAMINANTS DETECTED IN SHALLOW SOIL SAMPLES COMPARED TO CALCULATED TDLs, RESIDENTIAL PRGs, AND RESIDENTIAL RSLs - SITE 3

(Page 1 of 2)

Analyte	Maximum Concentration (mg/kg)	Location ID of Maximum Concentration	Sample Depth (ft bgs)	No. Detections/ Total No. Samples	Calculated TDL Value [(a)] (mg/kg)	No. Samples Exceeding Calculated TDL Value/Total No. Samples	2004 Residential PRG [(b)] (mg/kg)	No. Samples Exceeding Residential PRG/Total No. Samples	2010 Residential RSL [(c)] (mg/kg)	No. Samples Exceeding Residential RSL/Total No. Samples
Petroleum Hydrocarbons										
unknown extractable hydrocarbon	170	3-TP22	1	2/23	-	-	NP	-	NP	-
Volatile Organics										
acetone	0.026	3-TP14	1	2/2	-	-	14,000	0/2	61,000	0/2
p-isopropyltoluene	0.0030 J	3-TP08	1	1/23	-	-	NP	-	NP	-
methylene chloride	0.0014 J	3-TP10	1	6/23	5	0/23	9.1	0/23	11	0/23
toluene	0.0023 J	3-TP06	1	12/23	150	0/23	520	0/23	5,000	0/23
m- & p-xylene	0.0019 J	3-TP05	0.5	2/23	-	-	NP	-	NP	-
xylenes, total	0.0019 J	3-TP05	0.5	2/23	1,750	0/23	270	0/23	7,200	0/23
Semivolatile Organics										
benzo(a)anthracene	0.96	3-TP08	1	2/23	-	-	0.62	1/23	0.15	2/23
benzo(a)pyrene	0.60	3-TP08	1	1/23	0.2	1/23	0.062	1/23	0.015	1/23
benzo(k)fluoranthene	0.38	3-TP23	1	1/23	-	-	0.38 [(d)]	0/23	0.38 [(e)]	0/23
bis(2-ethylhexyl)phthalate	1.4	3-TP08	1	1/23	4	0/23	35	0/23	35	0/23
chrysene	1.4	3-TP08	1	2/23	-	-	3.8 [(d)]	0/23	3.8 [(e)]	0/23
fluoranthene	1.9	3-TP08	1	2/23	-	-	2,300	0/23	2,300	0/23
phenanthrene	1.9	3-TP08	1	2/23	-	-	NP	-	NP	-
pyrene	5.0	3-TP08	1	2/23	-	-	2,300	0/23	1,700	0/23
Pesticides and PCBs										
Aroclor 1254	0.18	3-TP23	1	5/23	-	-	NP	-	0.22	0/23
Aroclor 1260	0.18	3-TP08	1	1/23	-	-	NP	-	0.22	0/23
alpha-chlordane	0.018	3-TP23	1	2/23	-	-	NP	-	NP	-
gamma-chlordane	0.011	3-TP23	1	2/23	-	-	NP	-	NP	-
4,4'-DDD	0.0052	3-TP10	1	1/23	-	-	2.4	0/23	2	0/23
4,4'-DDE	0.011	3-TP10	1	1/23	-	-	1.7	0/23	1.4	0/23
4,4'-DDT	0.013	3-TP10	1	2/23	-	-	1.7	0/23	1.7	0/23
dieldrin	0.0048	3-TP10	1	2/23	-	-	0.03	0/23	0.03	0/23
endrin aldehyde	0.16 (J7)	3-TP08	1	2/23	-	-	NP	-	NP	-
PCBs, sum	0.18	3-TP08	1	6/23	0.5	0/23	0.22	0/23	0.089 [(e)]	3/23
Chlorinated Herbicides										
dalapon	0.33	3-TP14	1	10/23	200	0/23	1,800	0/23	1,800	0/23

TABLE 2.6-1. MAXIMUM CONCENTRATIONS OF ORGANIC CONTAMINANTS DETECTED IN SHALLOW SOIL SAMPLES COMPARED TO CALCULATED TDLs, RESIDENTIAL PRGs, AND RESIDENTIAL RSLs - SITE 3

Notes:

Data for soil samples collected from test pits in July 2000.
Bolded analytes were detected above screening criteria.

(a) TDL (mg/kg) = Primary MCL (mg/L) (if promulgated) x Leachability Factor (10) x Attenuation Factor (100) (CRWQCB 1989).
(b) USEPA Region 9 PRGs (USEPA 2004) were used to be consistent with the results presented in the *Human Health Risk Assessment* (Earth Tech 2004) and the *Site 3 FS* (Earth Tech 2008b).
(c) Source: *Regional Screening Levels (Formerly PRGs), Region 9-Specific Information* (USEPA 2010).
(d) CAL-Modified PRG (USEPA 2004).
(e) Source: *DTSC recommended methodology for use of U.S. EPA Regional Screening Levels (RSLs) in HHRA risk assessment process at Department of Defense sites and facilities* (California DTSC 2009).

-	not applicable
4,4'-DDD	dichlorodiphenyldichloroethane
4,4'-DDE	dichlorodiphenyldichloroethylene
4,4'-DDT	dichlorodiphenyltrichloroethane
CRWQCB	California Regional Water Quality Control Board
DTSC	Department of Toxic Substances Control
ft bgs	feet below ground surface
FS	feasibility study
HHRA	Human Health Risk Assessment
ID	identification
MCL	Maximum Contaminant Level; more stringent of the Federal or State primary MCL (CDHS 2003)
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
No.	number
NP	not promulgated

Laboratory Data Qualifier:

J Estimated result. Result is less than the reporting limit.

Earth Tech Data Validation Qualifier:

(J7) Estimated value. Initial or continuing calibration unacceptable. Indicates possible low bias.

TABLE 2.6.2. MAXIMUM CONCENTRATIONS OF ORGANIC CONTAMINANTS DETECTED IN SOIL SAMPLES COLLECTED AT DEPTH COMPARED TO CALCULATED TDLs, RESIDENTIAL PRGs, AND RESIDENTIAL RSLs - SITE 3

(Page 1 of 2)

Analyte	Maximum Concentration (mg/kg)	Location ID of Maximum Concentration	Sample Depth (ft bgs)	No. Detections/ Total No. Samples	Calculated TDL Value [(a)] (mg/kg)	No. Samples Exceeding Calculated TDL Value/Total No. Samples	2004 Residential PRG [(b)] (mg/kg)	No. Samples Exceeding Residential PRG/Total No. Samples	2010 Residential RSL [(c)] (mg/kg)	No. Samples Exceeding Residential RSL/Total No. Samples
Petroleum Hydrocarbons										
gasoline	1.6 M	3-TP19	12	1/23	-	-	NP	-	NP	-
PHC, total recoverable	16.6	3-MW06	10	1/17	-	-	NP	-	NP	-
unknown extractable hydrocarbon	780	3-TP19	12	16/23	-	-	NP	-	NP	-
unknown volatile hydrocarbon	2.4 (K)	3-TP10	12	1/23	-	-	NP	-	NP	-
Volatile Organics										
acetone	0.032	3-MW05	20	1/17	-	-	14,000	0/17	61,000	0/17
n-butylbenzene	0.016	3-TP19	12	6/23	-	-	240	0/23	240 [(e)]	0/23
sec-butylbenzene	0.0077	3-TP19	12	5/23	-	-	220	0/23	220 [(e)]	0/23
chlorobenzene	0.028	3-TP22	11	2/40	70	0/40	150	0/40	290	0/40
1,2-dichlorobenzene	0.015	3-TP22	11	3/80	600	0/80	600	0/80	1,900	0/80
1,4-dichlorobenzene	0.24	3-TP23	10	9/80	5	0/80	3.4	0/80	2.4	0/80
ethylbenzene	0.048	3-TP19	12	6/40	300	0/40	400	0/40	5.4	0/40
isopropylbenzene	0.0090	3-TP19	12	4/23	-	-	570	0/23	NP	-
p-isopropyltoluene	0.058	3-TP19	12	9/23	-	-	NP	-	NP	-
n-propylbenzene	0.022	3-TP19	12	5/23	-	-	240	0/23	NP	-
tetrachloroethene (PCE)	0.0026 J	3-TP19	12	1/40	5	0/40	0.48	0/40	0.55	0/40
toluene	0.011 J G	3-TP05	11	5/40	150	0/40	520	0/40	5,000	0/40
1,2,4-trichlorobenzene	0.0022 J	3-TP22	11	2/63	5	0/63	62	0/63	22	0/63
trichloroethene (TCE)	0.0013 J	3-TP19	12	1/40	5	0/40	0.053	0/40	2.8	0/40
1,2,4-trimethylbenzene	0.18	3-TP19	12	12/23	-	-	52	0/23	62	0/23
1,3,5-trimethylbenzene	0.062	3-TP19	12	5/23	-	-	21	0/23	780	0/23
m- & p-xylene	0.12	3-TP19	12	7/40	-	-	NP	-	NP	-
o-xylene	0.017	3-TP19	12	3/40	-	-	NP	-	NP	-
xylenes, total	0.137	3-TP19	12	7/40	1,750	0/40	270	0/40	7,200	0/40
Semivolatile Organics										
bis(2-ethylhexyl)phthalate	1.9	3-TP19	12	8/40	4	0/40	35	0/40	35	0/40
butyl benzyl phthalate	1.1	3-TP05	11	1/40	-	-	12,000	0/40	210	0/40
naphthalene	2.5 G	3-TP02	8.5	11/63	-	-	1.7 [(d)]	2/63	3.6	0/23
pentachlorophenol	7.7	3-TP19	12	1/40	1	1/40	3	1/40	3	1/40
Pesticides and PCBs										
Aroclor 1242	0.074	3-TP05	11	3/40	-	-	NP	-	0.22	0/40
Aroclor 1248	3.5	3-TP23	10	3/40	-	-	NP	-	0.22	3/40
Aroclor 1254	7.2	3-TP24	10	5/40	-	-	NP	-	0.22	3/40
Aroclor 1260	1.1	3-TP22	11	1/40	-	-	NP	-	0.22	1/40

TABLE 2.6.2. MAXIMUM CONCENTRATIONS OF ORGANIC CONTAMINANTS DETECTED IN SOIL SAMPLES COLLECTED AT DEPTH COMPARED TO CALCULATED TDLs, RESIDENTIAL PRGs, AND RESIDENTIAL RSLs - SITE 3

(Page 2 of 2)

Analyte	Maximum Concentration (mg/kg)	Location ID of Maximum Concentration	Sample Depth (ft bgs)	No. Detections/ Total No. Samples	Calculated TDL Value [(a)] (mg/kg)	No. Samples Exceeding Calculated TDL Value/Total No. Samples	2004 Residential PRG [(b)] (mg/kg)	No. Samples Exceeding Residential PRG/Total No. Samples	2010 Residential RSL [(c)] (mg/kg)	No. Samples Exceeding Residential RSL/Total No. Samples
Pesticides and PCBs *(Continued)*										
alpha-chlordane	0.21	3-TP24	10	7/40	-	-	NP	-	NP	-
gamma-chlordane	0.17	3-TP24	10	6/40	-	-	NP	-	NP	-
4,4'-DDD	0.011	3-TP08	10	1/40	-	-	2.4	0/40	2	0/40
4,4'-DDE	0.065	3-TP21	9	3/40	-	-	1.7	0/40	1.4	0/40
4,4'-DDT	0.013	3-TP16	5	2/40	-	-	1.7	0/40	1.7	0/40
dieldrin	0.0048	3-TP16	5	5/40	-	-	0.03	0/40	0.03	0/40
endrin aldehyde	0.014	3-TP08	10	1/40	-	-	NP	-	NP	-
PCBs, sum	7.2	3-TP24	10	12/40	0.5	5/40	0.22	7/40	0.089 [(e)]	7/40
Chlorinated Herbicides										
dalapon	0.13 COL	3-TP14	6	6/23	200	0/23	1,800	0/23	1,800	0/23

Notes:

Data for soil samples collected from July 1992 through October 1996.
Bolded analytes were detected above screening criteria.

(a) TDL (mg/kg) = Primary MCL (mg/L) (if promulgated) x Leachability Factor (10) x Attenuation Factor (100) (CRWQCB 1989).
(b) USEPA Region 9 PRGs (USEPA 2004) were used to be consistent with the results presented in the *Human Health Risk Assessment* (Earth Tech 2004) and the *Site 3 FS* (Earth Tech 2008b).
(c) Source: *Regional Screening Levels (Formerly PRGs), Region 9-Specific Information* (USEPA 2010).
(d) CAL-Modified PRG (USEPA 2004).
(e) Source: *DTSC recommended methodology for use of U.S. EPA Regional Screening Levels (RSLs) in HHRA risk assessment process at Department of Defense sites and facilities* (California DTSC 2009).

-	not applicable
4,4'-DDD	dichlorodiphenyldichloroethane
4,4'-DDE	dichlorodiphenyldichloroethylene
4,4'-DDT	dichlorodiphenyltrichloroethane
CRWQCB	California Regional Water Quality Control Board
DTSC	Department of Toxic Substances Control
FS	feasibility study
ft bgs	feet below ground surface
HHRA	Human Health Risk Assessment
ID	identification
MCL	Maximum Contaminant Level; more stringent of the Federal or State primary MCL (CDHS 2003)
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
No.	number
NP	not promulgated
PCBs	polychlorinated biphenyls
PRG	preliminary remediation goal
RSL	regional screening level
TDL	total designated level
USEPA	United States Environmental Protection Agency

Laboratory Data Qualifiers:

M This sample has GC/FID characteristics that are similar to gasoline.
J Estimated result. Result is less than the reporting limit.
G Elevated reporting limit. The reporting limit is elevated due to matrix interference.
COL More than 40 percent RPD between primary and confirmation results. The lower of the two results is reported.

Earth Tech Data Validation Qualifier:

(K) Estimated value. Recoveries for one or more surrogates are above QC limits. Values may be biased high.

TABLE 2.6-3. MAXIMUM CONCENTRATIONS OF INORGANIC CONSTITUENTS DETECTED IN SHALLOW SOIL SAMPLES COMPARED TO CALCULATED BACKGROUND CONCENTRATIONS, CALCULATED TDLs, RESIDENTIAL PRGs, AND RESIDENTIAL RSLs - SITE 3

Analyte	Maximum Concentration (mg/kg)	Location ID of Maximum Concentration	Sample Depth (ft bgs)	No. Detections/ Total No. Samples	Calculated Background Concentration [a] (mg/kg)	No. Samples Exceeding Background/ Total No. Samples	Calculated TDL Value [b] (mg/kg)	No. Samples Exceeding Calculated TDL Value/Total No. Samples	2004 Residential PRG [c] (mg/kg)	No. Samples Exceeding Residential PRG/Total No. Samples	2010 Residential RSL [d] (mg/kg)	No. Samples Exceeding Residential RSL/Total No. Samples
Metals and Other Elements												
aluminum	25,100	3-TP20	1	23/23	25,835	0/23	10,000	11/23	76,000	0/23	77,000	0/23
arsenic	18.0	3-TP20	1	23/23	28.61	0/23	100	0/23	0.062	23/23	0.062 [f]	23/23
barium	126	3-TP20	1	23/23	345	0/23	10,000	0/23	5,400	0/23	15,000	0/23
beryllium	0.92	3-TP20	1	19/23	1.2	0/23	40	0/23	150	0/23	16 [f]	0/23
calcium	25,100	3-TP12	1	23/23	144,000	0/23	-	-	NP	-	NP	-
chromium, total	17.1	3-TP20	1	23/23	30.44	0/23	500	0/23	210	0/23	NP	-
cobalt	7.9	3-TP20	1	1/23	14.15	0/23	-	-	900	0/23	23	0/23
copper	18.3	3-TP23	1	22/23	28.1	0/23	-	-	3,100	0/23	3,100	0/23
iron	27,300	3-TP20	1	23/23	34,822	0/23	-	-	23,000	1/23	55,000	0/23
lead	194	3-TP22	1	23/23	18.9	1/23	-	-	150 [e]	1/23	80 [f]	1/23
magnesium	11,200	3-TP20	1	23/23	20,134	0/23	-	-	NP	-	NP	-
manganese	563	3-TP20	1	23/23	942.8	0/23	-	-	1,800	0/23	1,800	0/23
mercury	0.32	3-TP08	1	3/23	0.14	2/23	20	0/23	23	0/23	5.6	0/23
nickel	9.5	3-TP08	1	18/23	17.1	0/23	1,000	0/23	1,600	0/23	1,500	0/23
potassium	5,480	3-TP20	1	23/23	7,610	0/23	-	-	NP	-	NP	-
selenium	0.59	3-TP20	1	1/23	-	-	500	0/23	390	0/23	390	0/23
silver	1.3	3-TP23	1	1/23	1.25	1/23	-	-	390	0/23	390	0/23
sodium	961	3-TP21	1	10/23	12,608	0/23	-	-	NP	-	NP	-
vanadium	42.5	3-TP20	1	23/23	77.12	0/23	-	-	78	0/23	390	0/23
zinc	97.0	3-TP20	1	23/23	126	0/23	-	-	23,000	0/23	23,000	0/23

Notes:

Data for soil samples collected from test pits in July 2000.
Bolded analytes were detected above both background and TDLs or PRGs.

[a] Background level calculated for Operable Unit 1 (Earth Tech 1996c).
[b] TDL (mg/kg) = Primary MCL (mg/L) (if promulgated) x Leachability Factor (100) x Attenuation Factor (100) (CRWQCB 1989).
[c] USEPA Region 9 PRGs (USEPA 2004) were used to be consistent with the results presented in the *Human Health Risk Assessment* (Earth Tech 2004) and the *Site 3 FS* (Earth Tech 2008b).
[d] Source: *Regional Screening Levels (Formerly PRGs), Region 9-Specific Information* (USEPA 2010).
[e] CAL-Modified PRG (USEPA 2004).
[f] Source: *DTSC recommended methodology for use of U.S. EPA Regional Screening Levels (RSLs) in HHRA risk assessment process at Department of Defense sites and facilities* (California DTSC 2009).

-	not applicable	ID	identification	NP	not promulgated
CRWQCB	California Regional Water Quality Control Board	MCL	Maximum Contaminant Level; more stringent of the Federal or State primary MCL (CDHS 2003)	PRG	preliminary remediation goal
DTSC	Department of Toxic Substances Control			RSL	regional screening level
FS	feasibility study	mg/kg	milligrams per kilogram	TDL	total designated level
ft bgs	feet below ground surface	mg/L	milligrams per liter	USEPA	United States Environmental Protection Agency
HHRA	Human Health Risk Assessment	No.	number		

TABLE 2.6-4. MAXIMUM CONCENTRATIONS OF INORGANIC CONSTITUENTS DETECTED IN SOIL SAMPLES COLLECTED AT DEPTH COMPARED TO CALCULATED BACKGROUND CONCENTRATIONS, CALCULATED TDLs, RESIDENTIAL PRGs, AND RESIDENTIAL RSLs - SITE 3

Analyte	Maximum Concentration (mg/kg)	Location ID of Maximum Concentration	Sample Depth (ft bgs)	No. Detections/ Total No. Samples	Calculated Background Concentration [(a)] (mg/kg)	No. Samples Exceeding Background/ Total No. Samples	Calculated TDL Value [(b)] (mg/kg)	No. Samples Exceeding Calculated TDL Value/Total No. Samples	2004 Residential PRG [(c)] (mg/kg)	No. Samples Exceeding Residential PRG/Total No. Samples	2010 Residential RSL [(d)] (mg/kg)	No. Samples Exceeding Residential RSL/Total No. Samples
Metals and Other Elements												
aluminum	19,000	3-TP23	10	40/40	25,835	0/40	10,000	11/40	76,000	0/40	77,000	-
arsenic	14.9	3-MW06	25	39/40	28.61	0/40	100	0/40	0.062	39/40	0.062 [(f)]	39/40
barium	202	3-TP20	12	40/40	345	0/40	10,000	0/40	5,400	0/40	15,000	0/40
beryllium	0.77	3-TP23	10	26/40	1.2	0/40	40	0/40	150	0/40	16 [(f)]	0/40
cadmium	6.9	3-TP21	9	6/40	0.79	5/40	50	0/40	37	0/40	NP	-
calcium	32,100	3-MW03	5	40/40	144,000	0/40	-	-	NP	-	NP	-
chromium, total	47.3	3-TP20	12	40/40	30.44	1/40	500	0/40	210	0/40	NP	-
cobalt	8.9	3-TP20	12	20/40	14.15	0/40	-	-	900	0/40	23	0/40
copper	118	3-TP20	12	37/40	28.1	2/40	-	-	3,100	0/40	3,100	0/40
iron	35,700	3-TP19	12	40/40	34,822	1/40	-	-	23,000	3/40	55,000	0/40
lead	132	3-TP20	12	23/40	18.9	5/40	-	-	150 [(e)]	0/40	80 [(f)]	2/40
magnesium	7,880	3-TP23	10	40/40	20,134	0/40	-	-	NP	-	NP	-
manganese	434	3-TP22	11	40/40	942.8	0/40	-	-	1,800	0/40	1,800	0/40
mercury	1.2 RLA	3-TP19	12	9/40	0.14	6/40	20	0/40	23	0/40	5.6	0/40
molybdenum	7.1	3-TP20	12	1/40	3.8	1/40	-	-	390	0/40	390	0/40
nickel	31.2	3-TP20	12	14/40	17.1	1/40	1,000	0/40	1,600	0/40	1,500	0/40
potassium	4,290	3-TP23	10	40/40	7,610	0/40	-	-	NP	-	NP	-
selenium	1.3	3-TP19	12	5/40	-	-	500	0/40	390	0/40	390	0/40
silver	2.7	3-TP20	12	5/40	1.25	4/40	-	-	390	0/40	390	0/40
sodium	904	3-MW01	30	36/40	12,608	0/40	-	-	NP	-	NP	-
vanadium	34.8	3-TP08	10	40/40	77.12	0/40	-	-	78	0/40	390	0/40
zinc	516	3-TP20	12	40/40	126	7/40	-	-	23,000	0/40	23,000	0/40

Notes:

Data for soil samples collected from July 1992 through October 1996.
Bolded analytes were detected above both background and TDLs or PRGs.

(a) Background level calculated for Operable Unit 1 (Earth Tech 1996c).
(b) TDL (mg/kg) = Primary MCL (mg/L) (if promulgated) x Leachability Factor (100) x Attenuation Factor (100) (CRWQCB 1989).
(c) USEPA Region 9 PRGs (USEPA 2004) were used to be consistent with the results presented in the *Human Health Risk Assessment* (Earth Tech 2004) and the *Site 3 FS* (Earth Tech 2008b).
(d) Source: *Regional Screening Levels (Formerly PRGs), Region 9-Specific Information* (USEPA 2010).
(e) CAL-Modified PRG (USEPA 2004).
(f) Source: *DTSC recommended methodology for use of U.S. EPA Regional Screening Levels (RSLs) in HHRA risk assessment process at Department of Defense sites and facilities* (California DTSC 2009).

-	not applicable	MCL	Maximum Contaminant Level; more stringent of the Federal or State primary MCL (CDHS 2003)	RLA	Elevated reporting limit. The reporting limit is elevated due to sample dilution
CRWQCB	California Regional Water Quality Control Board	mg/kg	milligrams per kilogram	RSL	regional screening level
DTSC	Department of Toxic Substances Control	mg/L	milligrams per liter	TDL	total designated level
FS	feasibility study	No.	number	USEPA	United States Environmental Protection Agency
ft bgs	feet below ground surface	PRG	preliminary remediation goal		
HHRA	Human Health Risk Assessment	NP	not promulgated		
ID	identification				

TABLE 2.6-5. MAXIMUM CONCENTRATIONS OF ORGANIC AND INORGANIC CONSTITUENTS DETECTED IN GROUNDWATER COMPARED TO CALCULATED BACKGROUND CONCENTRATIONS AND PRIMARY MCLs - SITE 3

Analyte	Unit	Maximum Concentration	Location ID of Maximum Concentration	Sampling Date of Maximum Concentration	No. Detections/ Total No. Samples	Calculated Background Concentration [(a)]	No. Samples Exceeding Background/ Total No. Samples	Maximum Contaminant Level [(b)] (MCL)	No. Samples Exceeding MCL/Total No. Samples
Petroleum Hydrocarbons									
C6-C10, total	mg/L	0.045 J	3-MW07	09/22/2008	2/24	-	-	NP	-
C10-C28, total	mg/L	0.26 J	3-MW07	09/22/2008	2/24	-	-	NP	-
Volatile Organics									
benzene	μg/L	1.5	3-MW07	09/22/2008	3/24	-	-	1	1/21
chlorobenzene	μg/L	0.27 J	3-MW07	09/22/2008	1/24	-	-	70	0/21
chloroform	μg/L	1.4	3-MW15	03/31/2009	2/24	-	-	NP	-
1,2-dichlorobenzene	μg/L	1.7	3-MW07	09/22/2008	1/24	-	-	600	0/21
1,4-dichlorobenzene	μg/L	7.9	3-MW07	09/22/2008	5/24	-	-	5	1/21
dichlorodifluoromethane	μg/L	28	3-MW07	09/22/2008	5/24	-	-	NP	-
1,1-dichloroethane	μg/L	7.9	3-MW07	09/22/2008	4/24	-	-	5	1/21
1,2-dichloroethane	μg/L	0.97 J	3-MW07	09/22/2008	1/24	-	-	0.5	1/21
1,1-dichloroethene	μg/L	0.47 J	3-MW07	09/22/2008	2/24	-	-	6	0/21
cis-1,2-dichloroethene	μg/L	12	3-MW07	09/22/2008	3/24	-	-	6	1/21
trans-1,2-dichloroethene	μg/L	0.52 J	3-MW07	09/22/2008	1/24	-	-	10	0/21
1,2-dichloropropane	μg/L	1.2	3-MW07	09/22/2008	3/24	-	-	5	0/21
isopropylbenzene	μg/L	0.99 J	3-MW07	09/22/2008	1/24	-	-	NP	-
p-isopropyltoluene	μg/L	0.49 J	3-MW07	09/22/2008	1/24	-	-	NP	-
methylene chloride	μg/L	18	3-MW07	09/22/2008	1/24	-	-	5	1/21
tetrachloroethene (PCE)	μg/L	19	3-MW06	09/17/2008	5/24	-	-	5	1/21
trichloroethene (TCE)	μg/L	29	3-MW07	09/22/2008	4/24	-	-	5	2/21
trichlorofluoromethane	μg/L	1.8 J	3-MW05	09/23/2008	1/24	-	-	150	0/21
trihalomethanes, total	μg/L	1.4	3-MW15	03/31/2009	2/24	-	-	80	0/21
vinyl chloride	μg/L	15	3-MW07	09/22/2008	3/24	-	-	0.5	1/21
Semivolatile Organics									
bis(2-ethylhexyl)phthalate	μg/L	7.0 J	3-MW09	09/24/2008	1/28	-	-	4	1/21
Pesticides and PCBs									
aldrin	μg/L	0.0030 J	3-MW02	09/22/2008	1/24	-	-	NP	-
alpha-BHC	μg/L	0.035 J	3-MW06	09/17/2008	5/24	-	-	NP	-
beta-BHC	μg/L	0.0054 J	3-MW13	09/25/2008	1/24	-	-	NP	-
delta-BHC	μg/L	0.015 J	3-MW06	09/17/2008	1/24	-	-	NP	-
gamma-BHC	μg/L	0.032 J	3-MW04	09/18/2008	4/24	-	-	0.2	0/21
4,4'-DDD	μg/L	0.040 J	3-MW04	09/18/2008	4/24	-	-	NP	-
4,4'-DDT	μg/L	0.0054 J	3-MW07	09/22/2008	3/24	-	-	NP	-

TABLE 2.6-5. MAXIMUM CONCENTRATIONS OF ORGANIC AND INORGANIC CONSTITUENTS DETECTED IN GROUNDWATER COMPARED TO CALCULATED BACKGROUND CONCENTRATIONS AND PRIMARY MCLs - SITE 3

Analyte	Unit	Maximum Concentration	Location ID of Maximum Concentration	Sampling Date of Maximum Concentration	No. Detections/ Total No. Samples	Calculated Background Concentration [(a)]	No. Samples Exceeding Background/ Total No. Samples	Maximum Contaminant Level [(b)] (MCL)	No. Samples Exceeding MCL/Total No. Samples
Pesticides and PCBs *(Continued)*									
dieldrin	μg/L	0.027 J	3-MW07	09/22/2008	1/24	-	-	NP	-
endosulfan sulfate	μg/L	0.032 J	3-MW15	03/30/2009	3/24	-	-	NP	-
endrin	μg/L	0.043 J	3-MW04	09/18/2008	3/24	-	-	2	0/21
endrin aldehyde	μg/L	0.013 J	3-MW19	03/26/2009	1/24	-	-	NP	-
heptachlor	μg/L	0.0072 J	3-MW08	09/17/2008	3/24	-	-	0.01	0/21
methoxychlor	μg/L	0.022 J	3-MW04	09/18/2008	1/24	-	-	30	0/21
Chlorinated Herbicides									
2,4-D	μg/L	0.67 J	3-MW07	09/22/2008	1/24	-	-	70	0/21
dicamba	μg/L	0.73 J	3-MW07	09/22/2008	1/24	-	-	NP	-
MCPA	μg/L	25 J	3-MW07	09/22/2008	1/24	-	-	NP	-
Silvex	μg/L	0.55 J	3-MW07	09/22/2008	1/24	-	-	50	0/21
Unfiltered Metals									
aluminum	mg/L	0.507	3-MW19	03/26/2009	11/24	13.6	0/24	1	0/21
arsenic	mg/L	0.113	3-MW07	09/22/2008	16/24	0.12	0/24	0.01	10/21
barium	mg/L	0.154 J	3-MW07	09/22/2008	24/24	0.28	0/24	1	0/21
beryllium	mg/L	0.000132 J	3-MW03	09/18/2008	1/24	-	-	0.004	0/21
cadmium	mg/L	0.00178 J	3-MW01	09/16/2008	8/24	-	-	0.005	0/21
calcium	mg/L	742	3-MW07	09/22/2008	24/24	588	1/24	NP	-
chromium, hexavalent	mg/L	0.00030 J	3-MW08	09/17/2008	3/24	-	-	NP	-
chromium, total	mg/L	0.0820	3-MW05	09/23/2008	13/24	6.2	0/24	0.05	1/21
cobalt	mg/L	0.00183 J	3-MW08	09/17/2008	3/24	0.032	0/24	NP	-
copper	mg/L	0.0331	3-MW18	03/25/2009	9/24	0.074	0/24	NP	-
iron	mg/L	0.874	3-MW06	09/17/2008	14/24	29	0/24	NP	-
lead	mg/L	0.0100	3-MW04	09/18/2008	6/24	-	-	0.015	0/21
magnesium	mg/L	120	3-MW07	09/22/2008	24/24	118	1/24	NP	-
manganese	mg/L	0.382	3-MW06	09/17/2008	23/24	0.66	0/24	NP	-
mercury	mg/L	0.000643 J	3-MW07	09/22/2008	9/24	0.0021	0/24	0.002	0/21
molybdenum	mg/L	0.146	3-MW16	03/25/2009	11/24	0.44	0/24	NP	-
nickel	mg/L	0.216	3-MW08	09/17/2008	19/24	1.1	0/24	0.1	4/21
potassium	mg/L	15.9	3-MW18	03/25/2009	24/24	17.1	0/24	NP	-
selenium	mg/L	0.0132	3-MW16	03/25/2009	1/24	-	-	0.05	0/21
sodium	mg/L	341	3-MW18	03/25/2009	24/24	1,380	0/24	NP	-
thallium	mg/L	0.00761 J	3-MW08	09/17/2008	3/24	-	-	0.002	3/21

TABLE 2.6-5. MAXIMUM CONCENTRATIONS OF ORGANIC AND INORGANIC CONSTITUENTS DETECTED IN GROUNDWATER COMPARED TO CALCULATED BACKGROUND CONCENTRATIONS AND PRIMARY MCLs - SITE 3

Analyte	Unit	Maximum Concentration	Location ID of Maximum Concentration	Sampling Date of Maximum Concentration	No. Detections/ Total No. Samples	Calculated Background Concentration [(a)]	No. Samples Exceeding Background/ Total No. Samples	Maximum Contaminant Level [(b)] (MCL)	No. Samples Exceeding MCL/Total No. Samples
Unfiltered Metals *(Continued)*									
vanadium	mg/L	0.00915 J	3-MW15	03/31/2009	16/24	0.2	0/24	NP	-
zinc	mg/L	0.495	3-MW19	03/26/2009	12/24	0.13	1/24	NP	-
Filtered Metals									
aluminum	mg/L	0.0200 J	3-MW18	03/25/2009	7/8	13.6	0/8	1	0/7
arsenic	mg/L	0.0149	3-MW15	03/31/2009	8/8	0.12	0/8	0.01	2/7
barium	mg/L	0.0158 J	3-MW17	03/24/2009	8/8	0.28	0/8	1	0/7
cadmium	mg/L	0.000964 J	3-MW17	03/24/2009	4/8	-	-	0.005	0/7
calcium	mg/L	198	3-MW17	03/24/2009	8/8	588	0/8	NP	-
cobalt	mg/L	0.00112 J	3-MW15	03/31/2009	2/8	0.032	0/8	NP	-
copper	mg/L	0.0352	3-MW18	03/25/2009	7/8	0.074	0/8	NP	-
lead	mg/L	0.00504 J	3-MW17	03/24/2009	1/8	-	-	0.015	0/7
magnesium	mg/L	38.1	3-MW17	03/24/2009	8/8	118	0/8	NP	-
manganese	mg/L	0.188	3-MW20	03/24/2009	8/8	0.66	0/8	NP	-
mercury	mg/L	0.000355 J	3-MW07	09/22/2008	2/8	0.0021	0/24	0.002	0/21
molybdenum	mg/L	0.143	3-MW16	03/25/2009	5/8	0.44	0/8	NP	-
nickel	mg/L	0.0796	3-MW15	03/31/2009	5/8	1.1	0/8	0.1	0/7
potassium	mg/L	16.2	3-MW18	03/25/2009	8/8	17.1	0/8	NP	-
selenium	mg/L	0.0141	3-MW16	03/25/2009	1/8	-	-	0.05	0/7
sodium	mg/L	344	3-MW18	03/25/2009	8/8	1,380	0/8	NP	-
vanadium	mg/L	0.00843 J	3-MW15	03/31/2009	8/8	0.2	0/8	NP	-
zinc	mg/L	0.0917	3-MW19	03/26/2009	8/8	0.13	0/8	NP	-
Dissolved Gases									
carbon dioxide	mg/L	624 J	3-MW07	09/22/2008	23/23	-	-	NP	-
ethane	mg/L	0.00038 J	3-MW05	09/23/2008	1/24	-	-	NP	-
methane	mg/L	0.71	3-MW07	09/22/2008	10/24	-	-	NP	-
General Inorganics									
alkalinity, bicarb. (as $CaCO_3$)	mg/L	580	3-MW09	09/24/2008	25/25	-	-	NP	-
alkalinity, total (as $CaCO_3$)	mg/L	580	3-MW09	09/24/2008	25/25	-	-	NP	-
BOD, five day	mg/L	14	3-MW09	09/24/2008	2/23	-	-	NP	-
chloride	mg/L	1,500	3-MW07	09/22/2008	24/24	713 [(c)]	1/24	NP	-
COD - chemical oxygen demand	mg/L	130 (S)	3-MW09	09/24/2008	23/24	-	-	NP	-
cyanide	mg/L	0.0172	3-MW16	03/25/2009	4/23	-	-	0.15	0/21

TABLE 2.6-5. MAXIMUM CONCENTRATIONS OF ORGANIC AND INORGANIC CONSTITUENTS DETECTED IN GROUNDWATER COMPARED TO CALCULATED BACKGROUND CONCENTRATIONS AND PRIMARY MCLs - SITE 3

Analyte	Unit	Maximum Concentration	Location ID of Maximum Concentration	Sampling Date of Maximum Concentration	No. Detections/ Total No. Samples	Calculated Background Concentration [a]	No. Samples Exceeding Background/ Total No. Samples	Maximum Contaminant Level [b] (MCL)	No. Samples Exceeding MCL/Total No. Samples
General Inorganics *(Continued)*									
nitrogen, nitrate (as N)	mg/L	26.9 J	3-MW10	09/30/2008	12/25	1.7 [c]	5/25	10	1/21
nitrogen, nitrite (as N)	mg/L	0.0790 J	3-MW15	03/31/2009	1/26	-	-	1	0/21
phosphorus	mg/L	0.74 (S)	3-MW09	09/24/2008	15/24	-	-	NP	-
sulfate	mg/L	390	3-MW16	03/25/2009	24/24	1,128 [c]	0/24	NP	-
total dissolved solids	mg/L	5,000	3-MW07	09/22/2008	25/25	2,360 [c]	1/25	NP	-
total organic carbon	mg/L	45	3-MW09	09/24/2008	20/24	-	-	NP	-
Microbials									
Dehalococcoides spp	cells/mL	15.5 (S)	3-MW14	09/29/2008	24/24	-	-	NP	-
methane oxidizing bacteria	cells/mL	88,000 (S)	3-MW05	09/23/2008	4/4	-	-	NP	-

Notes:

Data were from groundwater samples collected in September 2008 and March 2009.

[a] Background level calculated for OU1 (Earth Tech 1996c).
[b] Federal (USEPA) and Title 22 California Code of Regulations (CDPH 2008).
[c] Background level calculated from a combined data set for the entire Base (AECOM 2010b).

-	not applicable
μg/L	micrograms per liter
BOD	biological oxygen demand
CDPH	California Department of Public Health
cells/mL	cells per milliliter
ID	identification
MCL	Maximum Contaminant Level
mg/L	milligrams per liter
No.	number
NP	not promulgated
spp.	species
USEPA	United States Environmental Protection Agency

Earth Tech Data Qualifiers:

J	Estimated value.
(S)	Screening data.

TABLE 2.6-6. MAXIMUM CONCENTRATIONS OF PETROLEUM HYDROCARBONS, VOLATILE ORGANIC COMPOUNDS, AND FIXED GASES IN LANDFILL GAS – SITE 3

Analyte	Unit	Maximum Concentration	Location ID of Maximum Concentration	Sampling Date of Maximum Concentration	No. Detections/ Total No. Samples	No. Wells with Hits/ Total No. Wells Sampled
Petroleum Hydrocarbons						
PHC as gasoline	ppm v/v	3.0 J	3-LFG09A	06/01/2009	8/9	7/8
Volatile Organics						
acetone	ppb v/v	73	3-LFG01	09/16/2008	5/15	4/13
benzene	ppb v/v	81	3-LFG05	09/16/2008	14/15	12/13
benzyl chloride	ppb v/v	5.2 J	3-LFG05	09/16/2008	1/15	1/13
2-butanone (MEK)	ppb v/v	12 J	3-LFG01	09/16/2008	8/15	7/13
carbon disulfide	ppb v/v	70 J	3-LFG05	09/16/2008	4/15	4/13
chlorobenzene	ppb v/v	25	3-LFG05	09/16/2008	2/15	2/13
chloroform	ppb v/v	28	3-LFG08B	06/01/2009	10/15	9/13
1,2-dichlorobenzene	ppb v/v	9.3 J	3-LFG05	09/16/2008	2/15	2/13
1,3-dichlorobenzene	ppb v/v	0.33 J	3-LFG09A	06/01/2009	6/15	5/13
1,4-dichlorobenzene	ppb v/v	110	3-LFG05	09/16/2008	2/15	2/13
dichlorodifluoromethane	ppb v/v	170	3-LFG05	09/16/2008	14/15	12/13
cis-1,2-dichloroethene	ppb v/v	61	3-LFG05	09/16/2008	1/15	1/13
1,2-dichlorotetrafluoroethane	ppb v/v	44	3-LFG05	09/16/2008	5/15	4/13
ethylbenzene	ppb v/v	1,300	3-LFG05	09/16/2008	8/15	7/13
4-ethyltoluene	ppb v/v	310	3-LFG05	09/16/2008	8/15	7/13
styrene	ppb v/v	1.0 J	3-LFG09A	06/01/2009	8/15	7/13
tetrachloroethene (PCE)	ppb v/v	28	3-LFG06B	06/01/2009	7/15	5/13
toluene	ppb v/v	180	3-LFG05	09/16/2008	15/15	13/13
trichloroethene (TCE)	ppb v/v	15 J	3-LFG05	09/16/2008	2/15	2/13
trichlorofluoromethane	ppb v/v	4.0 J	3-LFG06B	06/01/2009	6/15	5/13
trihalomethanes, total	ppb v/v	28	3-LFG08B	06/01/2009	10/15	9/13
1,2,4-trimethylbenzene	ppb v/v	290	3-LFG05	09/16/2008	12/15	11/13
1,3,5-trimethylbenzene	ppb v/v	200	3-LFG05	09/16/2008	7/15	7/13
vinyl chloride	ppb v/v	160	3-LFG05	09/16/2008	1/15	1/13
m- & p-xylene	ppb v/v	2,500	3-LFG05	09/16/2008	15/15	13/13
o-xylene	ppb v/v	560	3-LFG05	09/16/2008	12/15	11/13
xylenes, total	ppb v/v	3,060	3-LFG05	09/16/2008	15/15	13/13

TABLE 2.6-6. MAXIMUM CONCENTRATIONS OF PETROLEUM HYDROCARBONS, VOLATILE ORGANIC COMPOUNDS, AND FIXED GASES IN LANDFILL GAS – SITE 3

Analyte	Unit	Maximum Concentration	Location ID of Maximum Concentration	Sampling Date of Maximum Concentration	No. Detections/ Total No. Samples	No. Wells with Hits/ Total No. Wells Sampled
Fixed Gases						
carbon dioxide	% v/v	23	3-LFG05	09/16/2008	15/15	13/13
methane	% v/v	22	3-LFG05	09/16/2008	13/15	11/13
nitrogen	% v/v	86	3-LFG09A	06/01/2009	15/15	13/13
oxygen	% v/v	23	3-LFG09A	06/01/2009	15/15	13/13

Notes:

Data were from landfill gas samples collected in September 2008 and June 2009.

% v/v percent by volume
ID identification
No. number
PHC petroleum hydrocarbons
ppb v/v parts per billion by volume
ppm v/v parts per million by volume

Earth Tech Data Qualifier:

J Estimated value

TABLE 2.6-7. SUMMARY OF HUMAN HEALTH RISK ASSESSMENT RESULTS – SITE 3

(Page 1 of 2)

Potential Exposure Pathway	Exposure Medium	Cancer Risk	Primary Risk Drivers[a]	Noncancer Hazard Index[b]	Primary Risk Drivers[a]
Residential	Soil	5×10^{-6}	*	0.4	*
	Groundwater[c]	9×10^{-4}	TCE (50%) vinyl chloride (32%)	4	alpha-endosulfan (57%) nitrate (38%)
	Indoor Air[d]	7×10^{-6}	*	0.1	*
	Indoor Air[e]	3×10^{-6}	*	0.04	*
	Indoor Air[f]	2×10^{-5}	*	0.1	*
	Indoor Air[g]	2×10^{-5}	*	0.04	*
Industrial	Soil	2×10^{-6}	*	0.07	*
	Groundwater	-	-	-	-
	Indoor Air[d]	4×10^{-7}	*	0.02	*
	Indoor Air[e]	1×10^{-7}	*	< 0.01	*
	Indoor Air[f]	1×10^{-6}	*	0.02	*
	Indoor Air[g]	9×10^{-7}	*	< 0.01	*
Construction Worker	Soil	2×10^{-8}	*	0.03	*
	Groundwater	-	-	-	-
	Indoor Air	-	-	-	-

TABLE 2.6-7. SUMMARY OF HUMAN HEALTH RISK ASSESSMENT RESULTS – SITE 3

Notes:

The summary results presented in this table are based on the revised Human Health Risk Assessment tables included in the *Site 3 FS* (Earth Tech 2008b).

(a) As determined by the Human Health Risk Assessment. If the total cancer risk is greater than $1x10^{-4}$ or the Hazard Index is greater than 1, a constituent is shown as a primary risk driver and the number in parentheses is the percentage of the total risk accounted for by the constituent.

(b) A Hazard Index less than 1 is considered generally acceptable (USEPA 1991).

(c) The primary cancer risk drivers, TCE and vinyl chloride, were detected at concentrations that exceeded the Tap Water Preliminary Remediation Goals (USEPA 2004) in five of 17 samples and three of 17 samples, respectively. The primary noncancer risk drivers, alpha-endosulfan and nitrate, were detected at concentrations that exceeded the Tap Water Preliminary Remediation Goals in only one of 17 samples and two of 18 samples, respectively. The 2004 Tap Water Preliminary Remediation Goals (USEPA 2004) were used to be consistent with the results presented in the *Human Health Risk Assessment* (Earth Tech 2004) and the *Site 3 FS* (Earth Tech 2008b).

(d) Results based on soil gas data and USEPA-recommended toxicity values (see Appendix C, Table C-5).

(e) Results based on volatilization from groundwater and USEPA-recommended toxicity values (see Appendix C, Table C-7).

(f) Results based on soil gas data and California DTSC-recommended toxicity values (see Appendix C, Table C-6).

(g) Results based on volatilization from groundwater California DTSC-recommended toxicity values (see Appendix C, Table C-8).

* Indicates the primary risk drivers are not shown because the total risk is within the risk management range based on the USEPA (1980 and 1991) exposure risk criteria.

\- An exposure risk was not calculated because pathway is not complete.

% percent

TCE trichloroethene

TABLE 2.6-8. ECOLOGICAL RECEPTOR GROUPS AND MAXIMUM HAZARD QUOTIENTS FOR CONTAMINANTS OF POTENTIAL CONCERN – SITE 3

Ecological Receptor Group	COPCs Exceeding Screening HQ=1	Max HQ-Low (Screening)[1]	Max HQ-High (Remediation)[2]	Exposure Route	Source Table in PERA[4]
Terrestrial Plant Communities	Cadmium and zinc	Inorganic: 5.9 (zinc)	Inorganic: 1.4 (zinc)[3]	Soil (via contact)	App. B.1
Terrestrial Invertebrate Communities	Mercury	Inorganic: 3.2 (mercury)	Inorganic: 3.2 (mercury)[3]	Soil (via contact)	App. B.2
Herbivorous Reptile Communities	None	< 1	< 1	Soil (via ingestion)	App. B.3
Omnivorous Reptile Communities	Lead; alpha-chlordane; 4,4'-DDD; 4,4'-DDE; 4,4'-DDT; gamma-chlordane; endrin aldehyde	Inorganic: 3.3 (lead) Organic: 186 (endrin aldehyde)	Inorganic: < 1 Organic: 18 (endrin aldehyde)	Soil (via ingestion)	App. B.4
Granivorous Bird Populations	Cadmium; lead; zinc; phenanthrene; Aroclor 1248; Aroclor 1254; Aroclor 1260;	Inorganic: 93 (Lead) Organic: 11 (Aroclor 1254)	Inorganic: < 1 Organic: < 1	Soil (via ingestion)	App. B.5
Invertivorous Bird Populations	Lead; mercury; phenanthrene; Aroclor 1254; Aroclor 1260; alpha-chlordane; dieldrin; 4,4'-DDD; 4,4'-DDE; 4,4'-DDT; gamma-chlordane	Inorganic: 175 (Lead) Organic: 312 (4,4'-DDT)	Inorganic: < 1 Organic: 5.6 (alpha chlordane)	Soil (via ingestion)	App. B.6
Carnivorous Raptor Populations	Lead; Aroclor 1248; and Aroclor 1254; endrin aldehyde	Inorganic: 24 (lead) Organic: 3.9 (Aroclor 1254)	Inorganic: < 1 Organic: < 1	Soil (via ingestion)	App. B.10

TABLE 2.6-8. ECOLOGICAL RECEPTOR GROUPS AND MAXIMUM HAZARD QUOTIENTS FOR CONTAMINANTS OF POTENTIAL CONCERN – SITE 3

Ecological Receptor Group	COPCs Exceeding Screening HQ=1	Max HQ-Low (Screening)[1]	Max HQ-High (Remediation)[2,5,6]	Exposure Route	Source Table in PERA[4]
Burrowing Carnivorous Bird Populations	Lead; Aroclor 1254; alpha-chlordane; 4,4'-DDT; endrin aldehyde	Inorganic: 13 (lead) Organic: 116 (endrin aldehyde)	Inorganic: < 1 Organic: 11 (endrin aldehyde)	Soil (via ingestion)	App. B.11
Burrowing Herbivorous Mammal Populations	Cadmium ; zinc (via ingestion)	Inorganic: 1.5 (zinc) Organic: < 1	Inorganic: < 1 Organic: < 1	Soil (via ingestion)	App. B.7
	Toluene; vinyl chloride; and total xylenes	Organic: 44 (toluene)	Organic: 44 (toluene)[3]	Soil vapor (via inhalation)	App. C.1
Burrowing Invertivorous Mammal Populations	Cadmium; zinc; bis(2-ethylhexyl) phthalate; endrin aldehyde	Inorganic: 1.5 (zinc) Organic: < 1	Inorganic: < 1 Organic: < 1	Soil (via ingestion)	App. B.8
	Toluene; vinyl chloride; total xylenes	44 (toluene)	44 (toluene)[3]	Soil vapor (via inhalation)	App. C.2
Burrowing Carnivorous Mammal Populations	None	< 1	< 1	Soil (via ingestion)	App. B.12
	Toluene; vinyl chloride; total xylenes	27 (toluene)	27 (toluene)[3]	Soil vapor (via inhalation)	App. C.3

TABLE 2.6-8. ECOLOGICAL RECEPTOR GROUPS AND MAXIMUM HAZARD QUOTIENTS FOR CONTAMINANTS OF POTENTIAL CONCERN – SITE 3

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Notes:

[1] Highest HQ based on 95% UCL exposure and EPA TRV-Low for conservative screening value.

[2] Highest HQ based on 95% UCL exposure and EPA TRV-High for ecological preliminary remediation goal.

[3] No difference in Tier 2 screening values for this pathway.

[4] Source: Tetra Tech (2004).

[5] Pesticides (alpha-chlordane, gamma-chlordane, DDD, DDE, DDT, dieldrin, and endrin aldehyde) were only detected in two of 23 shallow samples. These data suggest that exposure by ingestion of organic compounds is likely overestimated. Additionally, because low concentrations are found sporadically throughout the site in both deep and shallow samples, and because no pesticide containers were found during the test pit excavations, the pesticide soil detections are more likely the result of spraying than of landfill disposal.

[6] Vapor risk from toluene may be overestimated. Validation studies by USGS biologists for Edwards AFB (USAF 2002a), using field gas measurements in grids of artificial burrows over three different chlorinated solvent plumes, showed that the standard burrow exposure assumptions overestimate risk.

App.	Appendix
COPC	Contaminant of Potential Concern
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyltrichloroethane
HQ	hazard quotient
PERA	Predictive Ecological Risk Assessment
TRV	toxicity reference values
UCL	Upper Confidence Limit

TABLE 2.7-1. CLEANUP STANDARDS FOR CONTAMINANTS OF CONCERN IN GROUNDWATER AT SITE 3

Contaminants of Concern	Maximum Concentration Detected [a] (μg/L)	Current Residential Cancer Risk/ Noncancer Hazard Index [b]	Basis for Listing as a Chemical of Concern	Selected Cleanup Standard [c] (μg/L)	Cancer Risk/ Noncancer Hazard Index at Cleanup Standard [d]
benzene	1.5	3.66×10^{-6}/NA	Exceeds the MCL.	1	2.44×10^{-6}/NA
1,4-dichlorobenzene	7.9	1.84×10^{-5}/NA	Exceeds the MCL.	5	1.16×10^{-5}/NA
1,1-dichloroethane	7.9	3.29×10^{-6}/NA	Exceeds the MCL.	5	2.08×10^{-6}/NA
1,2-dichloroethane	0.97	6.47×10^{-6}/NA	Exceeds the MCL.	0.5	3.33×10^{-6}/NA
cis-1,2-dichloroethene	12	NA/0.032	Exceeds the MCL.	6	NA/0.016
methylene chloride	18	3.75×10^{-6}/NA	Exceeds the MCL.	5	1.04×10^{-6}/NA
tetrachloroethene (PCE)	19	1.73×10^{-4}/NA	Exceeds the MCL and the cancer risk exceeds the threshold carcinogenic risk criteria of 1×10^{-4}.	5	4.55×10^{-5}/NA
trichloroethene (TCE)	29	1.45×10^{-5}/NA	Exceeds the MCL.	5	2.50×10^{-6}/NA
vinyl chloride	15	9.38×10^{-4}/NA	Exceeds the MCL and the cancer risk exceeds the threshold carcinogenic risk criteria of 1×10^{-4}.	0.5	3.13×10^{-5}/NA

Notes:

[a] See Table 2.6-5.

[b] Expressed as the ratio of the maximum concentration to the tap water RSLs (USEPA 2010) x 1×10^{-6} for carcinogens, and the ratio of the maximum concentration to the tap water RSLs for noncarcinogens.

[c] Shows the more stringent of Federal and State primary MCLs (CDPH 2008). Constituents exceeding secondary MCLs have not been included. The Water Board disagrees that remediation standards should only be developed for constituents where concentrations exceed a primary MCL. The Water Board Position is: "In order to comply with state regulations, groundwater cleanup for this site must achieve the concentration limits (or concentrations limits greater than background) established according to Section 20400, Title 27, California Code of Regulations. The constituents of concern, according to Title 27, California Code of Regulations, are not limited to Comprehensive Environmental Response Compensation and Liability Act (CERCLA) hazardous wastes and do include other constituents released from the unit or formed as a result of waste decomposition."

[d] Expressed as the ratio of the MCL to the tap water RSLs x 1×10^{-6} for carcinogens, and the ratio of the MCL to the tap water RSLs for noncarcinogens.

μg/L micrograms per liter
CDPH California Department of Public Health
MCL Maximum Contaminant Level
NA not applicable
RSL Regional Screening Level
USEPA United States Environmental Protection Agency

TABLE 2.7-2. SOIL GAS CONCENTRATIONS IN PERIMETER GAS MONITORING WELLS WHICH IF EXCEEDED WOULD TRIGGER REMEDY EVALUATION

(Page 1 of 2)

	Toxicity Criteria				Maximum Detected Concentration	Depth of Maximum Detection	Current Potential Residential Risk[b]		Performance Monitoring Standard[c] (ppb v/v)	
	IUR		RfC							
Analyte	$((\mu g/m^3)^{-1})$	Source	(mg/m^3)	Source	(ppbv)	(feet)	Cancer Risk	Hazard Quotient	8 Foot Depth	23 Foot Depth
Volatile Organic Compounds Detected in Perimeter Gas Monitoring Wells[a]										
benzene [1]	2.9E-05	OEHHA	3.0E-02	IRIS	39	23	2E-07	< 0.01	2.6E+01	6.7E+01
benzene [2]	7.8E-06	IRIS					2E-07	< 0.01	9.7E+01	2.5E+02
benzene [3]									**6.15E+01**	**1.59E+02**
2-butanone			5.0E+00	IRIS	7.7	8		< 0.01	1.8E+06	4.7E+06
carbon disulfide			7.0E-01	IRIS	1.8	23		< 0.01	2.0E+05	5.6E+05
chloroform [1]	5.3E-06	OEHHA	9.8E-02	ATSDR	28	23	6E-07	< 0.01	1.9E+01	4.7E+01
chloroform [2]	2.3E-05	IRIS	9.8E-02	ATSDR			1E-07	< 0.01	1.1E+02	2.8E+02
chloroform [3]									**6.45E+01**	**1.64E+02**
1,3-dichlorobenzene [d]			2.0E-01	HEAST	0.33	8		< 0.01	4.0E+04	1.1E+05
dichlorodifluoromethane			2.0E-01	HEAST	110	23		< 0.01	5.1E+04	1.4E+05
1,2-dichlorotetrafluoroethane [e]			3.0E+01	HEAST	12	23		< 0.01	4.7E+05	1.2E+07
ethylbenzene	2.5E-06	OEHHA	1.0E+00	IRIS	0.74	23	1E-09	< 0.01	2.5E+02	6.6E+02
4-ethyltoluene [f]			7.0E-01	OEHHA	1.7	8		< 0.01	1.9E+05	4.8E+05
styrene [1]			9.0E-01	OEHHA	1	8		< 0.01	2.6E+05	6.9E+05
styrene [2]			1.0E+00	IRIS				< 0.01	2.9E+05	7.6E+05
styrene [3]									**2.75E+05**	**7.25E+05**
Tetrachloroethene [1]	5.9E-06	OEHHA	3.5E-02	OEHHA	28	23	2E-07	< 0.01	7.0E+01	1.8E+02
Tetrachloroethene [2]	2.6E-7	IRIS	4.0E-2	IRIS	28	23	7E-09	< 0.01	1.6E+02	4.2E+02
Tetrachloroethene [3]									**1.15E+02**	**3.00E+02**
toluene [1]			3.0E-01	OEHHA	6	8		< 0.01	8.3E+04	2.1E+05
toluene [2]			5.0E+00	IRIS				< 0.01	1.4E+06	3.6E+06
toluene [3]									**7.42E+05**	**1.91E+06**
trichloroethene	4.1E-6	IRIS	2.0E-03	IRIS	1.5	23	5E-09	< 0.01	1.2E+02	3.1E+02
trichlorofluoromethane			7.0E-01	HEAST	4	23		< 0.01	1.3E+05	3.3E+05
1,2,4-trimethylbenzene			7.0E-03	PPRTV	3	8		< 0.01	2.0E+03	5.4E+03
1,3,5-trimethylbenzene			3.5E-02	PPRTV	1.7	8		< 0.01	1.0E+04	2.7E+04
m,p-xylenes [f]			7.0E-01	OEHHA	2.9	23		< 0.01	1.8E+05	4.8E+05
o-xylene			7.0E-01	OEHHA	1.6	23		< 0.01	1.6E+05	4.3E+05

TABLE 2.7-2. SOIL GAS CONCENTRATIONS IN PERIMETER GAS MONITORING WELLS WHICH IF EXCEEDED WOULD TRIGGER REMEDY EVALUATION

(Page 2 of 2)

Analyte	Toxicity Criteria: IUR ((μg/m³)⁻¹)	Toxicity Criteria: IUR Source	Toxicity Criteria: RfC (mg/m³)	Toxicity Criteria: RfC Source	Maximum Detected Concentration (ppbv)	Depth of Maximum Detection (feet)	Current Potential Residential Risk[b]: Cancer Risk	Current Potential Residential Risk[b]: Hazard Quotient	Performance Monitoring Standard [c] (ppb v/v): 8 Foot Depth	Performance Monitoring Standard [c] (ppb v/v): 23 Foot Depth
Volatile Organic Compounds Detected in Interior Gas Monitoring Wells that Potentially Could Migrate to Perimeter Wells (see Table 2.6-6)										
acetone			3.0E+01	ATSDR	-	-	-	-	1.0E+07	2.5E+07
benzylchloride			3.5E-01	IRIS	-	-	-	-	1.1E+01	2.8E+01
chlorobenzene			5.0E-02	PPRTV	-	-	-	-	1.3E+04	3.4E+04
1,2-dichlorobenzene			2.0E-01	HEAST	-	-	-	-	4.2E+04	1.1E+05
1,4-dichlorobenzene	1.1E-05	OEHHA	8.0E-01	OEHHA	-	-	-	-	4.4E+01	1.2E+02
cis-1,2-dichoroethene			7.0E-03	Cal-EPA/ DTSC [4]	-	-	-	-	2.1E+03	5.5E+03
vinyl chloride [1]	7.8E-05	OEHHA	1.0E-01	IRIS	-	-	-	-	1.0E+01	2.6E+01
vinyl chloride [2]	8.8E-06	IRIS	1.0E-01	IRIS					1.2E+02	3.2E+02
vinyl chloride [3]									**6.50E+01**	**1.73E+02**
Explosive Gas Concentrations Detected in Perimeter Gas Monitoring Wells[a]										
Methane	N/A	N/A	N/A	N/A	0.0023%	8	N/A	N/A	5%[g]	5%[g]

Notes:

[a] Data are from landfill gas samples collected at landfill gas monitoring wells installed as nested pairs (Wells 3-LFG06A/B, 3-LFG07A/B, 3-LFG08A/B, and 3-LFG09A/B) on 1 June 2009.

[b] For each contaminant of concern, the maximum concentration detected and the depth to the top of the screen interval was used in the calculation of the cancer risk and noncancer hazard quotient.

[c] The Johnson and Ettinger (J&E) 1991 model was used to calculate the concentration corresponding to an acceptable cancer risk or Hazard Quotient. The value of the soil vapor concentration was iterated until the cancer risk was equal to 1 x 10^{-6} or the Hazard Quotient was equal to 1. If a chemical was evaluated for both cancer and non-cancer endpoints, the smaller of the two concentrations was used as the final value.

[d] The compound 1,2-dichlorobenzene was used as a surrogate.

[e] The compound 1,1,2-trichloro,2,2,1-trifluoroethane was used as a surrogate.

[f] The compound p-xylene was used as a surrogate.

[g] Lower explosive limit for methane.

[1] Toxicity criteria based on California Environmental Protection Agency Department of Toxic Substance Control (Cal/EPA DTSC)-recommended values.

[2] Toxicity criteria based on Air Force Risk Assessment and Risk-Based Cleanup Levels Guidance (USAF, Memorandum for all MAJCOMs/A7/CEV, 14 July 2006).

[3] Selected toxicity criteria **(in bold)** based on midpoint of Notes (1) and (2) above.

[4] Value used in 2011 version of the Cal/EPA DTSC Johnson & Ettinger model and recommended by Cal/EPA DTSC for vapor intrusion assessment.

μg/m³ micrograms per cubic meter
ATSDR Agency for Toxic Substances and Disease Registry
HEAST Health Effects Assessment Summary Tables
IRIS Integrated Risk Information System
IUR Inhalation Unit Risk factor. This value was used to calculate the cancer risk and/or the risk-based screening concentration based on the cancer endpoint.
OEHHA Office of Environmental Health Hazard Assessment
PPRTV Provisional Peer-Reviewed Toxicity Values
RfC Reference Concentration. This value was used to calculate the Hazard Quotient and/or the risk-based screening concentration based on the non-cancer endpoint.
mg/m³ milligrams per cubic meter
ppbv parts per billion, by volume

TABLE 2.8-1. COSTS OF THE EVALUATED ALTERNATIVES FOR SITE 3

	1. No Action	2. LUCs and MNA	3. Waste Consolidation, ET Cover, Stormwater Controls, LUCs, and MNA (Selected Remedy)	4. Waste Consolidation, Enhanced ET Cover, Stormwater Controls, LUCs, and MNA
Timeframe (years)				
LUC Maintenance/ Five-year Reviews (1)	-	200	200	200
Cover/Stormwater Control Maintenance (2)	-	NA	200	200
MNA Requirement (3)	-	139	84	23
Landfill Gas Monitoring (4)	-	30	30	30
Cost (current dollars) (5)				
Design	-	$23,000	$283,000	$512,000
Capital	-	$323,000	$7,840,000	$18,304,000
Operation and Maintenance	-	$27,956,000	$21,271,000	$13,990,000
Five-Year Reviews and Closeout (Periodic)	-	$1,790,000	$1,891,000	$1,890,000
Total	$0	$30,092,000	$31,285,000	$34,696,000
Present Value Cost (2.7% discount)				
Design	-	$23,000	$283,000	$512,000
Capital	-	$314,000	$7,485,000	$17,395,000
Operation and Maintenance	-	$6,753,000	$6,382,000	$4,350,000
Five-Year Reviews and Closeout (Periodic)	-	$257,000	$267,000	$268,000
Total	$0	$7,347,000	$14,417,000	$22,525,000

Notes:

(1) Although LUCs would need to be maintained in perpetuity, a timeframe of 200 years was used to enable the Air Force to compare costs between the three active alternatives. After 200 years, the increase in the present value discounted cost is negligible.

(2) For alternatives that have a cover and stormwater maintenance component (Alternatives 3 and 4), it is assumed that the maintenance requirement must be equivalent to that for the LUCs. Failure to maintain the cover could cause infiltration of stormwater into the landfill and re-contaminate the groundwater.

(3) Based on the number of years for the final toxic degradation product (vinyl chloride) to reach its Maximum Contaminant Level (MCL).

(4) Based on Title 27 requirements for landfill gas monitoring.

(5) Current dollars are equivalent to Present Value Cost (0% discount).

% percent
LUC Land Use Control
MCL Maximum Contaminant Level
MNA Monitored Natural Attenuation
NA not applicable

As recommended by the USEPA, cost estimates for each alternative are to be within an accuracy range of –30 to +50 percent. The complete cost estimates can be found in AECOM (2009b), Appendix I. The estimates contained in this Record of Decision have been adjusted to eliminate costs associated with replacement of monitoring wells after MCLs are achieved.

A discount factor of 2.7 percent was used to calculate the present value cost in accordance with Office of Management and Budget (OMB) Circular No. A-94, Appendix C (OMB 2008).

TABLE 2.8-2. EVALUATION CRITERIA FOR THE COMPARISON OF ALTERNATIVES

(Page 1 of 2)

Evaluation Criteria	**1. No Action**	**2. LUCs and MNA**	**3. Waste Consolidation, ET Cover, Stormwater Controls, LUCs, and MNA (Selected Remedy)**	**4. Waste Consolidation, Enhanced ET Cover, Stormwater Controls, LUCs, and MNA**
Threshold Criteria – Requirements that each alternative must meet to be eligible for selection				
Overall Protection of Human Health and the Environment	**No.** Does not protect humans or animals from COCs in soil, soil vapor, or groundwater.	**No.** Protects humans but not animals from COCs in soil and soil vapor.	**Yes.** Cover soils, fencing, and LUCs protect human health and the environment.	**Yes.** Cover soils, fencing, and LUCs protect human health and the environment.
Compliance with ARARs	**Not applicable.** No action proposed; ARARs do not apply.	**No.** Does not comply with Federal or State regulations for closed landfills.	**Yes.** Complies with monitoring and capping requirements for closed landfills.	**Yes.** Complies with monitoring and capping requirements for closed landfills.
Balancing Criteria – Used to weigh major trade-offs among alternatives				
Long-term Effectiveness and Permanence	**Poor.** Does not reduce the potential in long-term to exposure to COCs.	**Good.** Reduces the potential in long-term to exposure to COCs by humans through LUCs.	**Better.** Cover soils, fencing, and LUCs provide long-term protection to human health and the environment.	**Better.** Cover soils, fencing, and LUCs provide long-term protection to human health and the environment slightly better than Alternative 3.
Reduction of Toxicity, Mobility, or Volume through Treatment [(a)]	**Poor.** Toxicity and volume reduced through natural attenuation; mobility not affected.	**Poor.** Toxicity and volume reduced through natural attenuation; mobility not affected.	**Good.** Toxicity and volume reduced through natural attenuation; mobility reduced by landfill cover.	**Better.** Toxicity and volume reduced through natural attenuation; mobility reduced by enhanced landfill cover.
Short-term Effectiveness	**Good.** Existing LUCs reduce short-term risks to humans but not animals.	**Better.** Enhanced LUCs reduce short-term risks; low risk to workers performing action.	**Good.** May be increased risks to site workers and the environment during excavation and construction. However, these risks are relatively minor and can be managed through the use of proper waste handling and safety practices.	**Good.** Increased risks to site workers and the environment during construction slightly greater than Alternative 3. However, these risks are relatively minor and can be managed through the use of proper waste handling and safety practices.
Implementability	**Not applicable.** No action proposed.	**Best.** Alternative easily implemented.	**Better.** Cover soils available, but may not be near site.	**Good.** Cover soils available, but may not be near site. Design and construction of Alternative 4 more complex than Alternative 3.

TABLE 2.8-2. EVALUATION CRITERIA FOR THE COMPARISON OF ALTERNATIVES

(Page 2 of 2)

Evaluation Criteria	1. No Action	2. LUCs and MNA	3. Waste Consolidation, ET Cover, Stormwater Controls, LUCs, and MNA (Selected Remedy)	4. Waste Consolidation, Enhanced ET Cover, Stormwater Controls, LUCs, and MNA
Cost (Present Value; see Table 2.8-1 for details)	**Capital:** $0 M **Total:** $0 M	**Capital:**$0.3 M **Total:** $7.3 M	**Capital:** $7.8 M **Total:** $14.4 M	**Capital:** $17.9 M **Total:** $22.5 M
Modifying Criteria – Fully considered only after the public comment period for the proposed plan				
State Acceptance [(b)]	Not acceptable.	Not acceptable.	To be determined.	To be determined.
Community Acceptance	No public comments specific to this alternative.	No public comments specific to this alternative.	No public comments specific to this alternative.	No public comments specific to this alternative.

Notes:

[(a)] For all alternatives, the only reduction of toxicity or volume of contaminants that would occur is by natural processes, not treatment. For Alternative 3 and 4, stormwater controls and enhancements to the existing soil cover would reduce the mobility of contaminants by physical processes that are not considered treatment by the USEPA.

[(b)] State acceptance for Alternatives 3 and 4 to be determined after agency review of draft final Record of Decision.

ARARs applicable or relevant and appropriate requirements
COCs contaminants of concern
ET evapotranspiration
LUCs land use controls
MNA monitored natural attenuation
USEPA United States Environmental Protection Agency

TABLE 2.9-1. SUMMARY OF ESCALATED COSTS AND PRESENT VALUE COSTS FOR THE SELECTED REMEDY AT SITE 3

Year	Remedial Design (Capital)	Phase I Remedial Action (Capital)	Phase II Remedial Action (Capital)	MNA (O&M)[a]	Operations and Maintenance (O&M)[b]	Soil Gas Monitoring (O&M)[c]	Five Year Review (Periodic)	Site Closeout (Periodic)[d]	Total	Present Value Discount Factor (2.7%)[e]	Present Value Total
1	$283,121								$283,121	1.000	$283,121
2		$2,000,243		$107,629		$42,278			$2,150,150	0.974	$2,093,623
3			$5,840,396	$107,629	$366,404	$12,227			$6,326,656	0.948	$5,998,371
4				$107,629	$51,765	$12,227			$171,621	0.923	$158,438
5				$107,629	$51,765	$12,227			$171,621	0.899	$154,273
6				$107,629	$51,765	$12,227			$171,621	0.875	$150,217
7				$107,629	$51,765	$12,227	$39,064		$210,685	0.852	$179,561
8				$107,629	$51,765	$12,227			$171,621	0.830	$142,422
9				$107,629	$51,765	$12,227			$171,621	0.808	$138,678
10				$107,629	$51,765	$12,227			$171,621	0.787	$135,032
11				$107,629	$51,765	$12,227			$171,621	0.766	$131,482
12				$107,629	$51,765	$12,227	$39,064		$210,685	0.746	$157,166
13				$107,629	$51,765	$12,227			$171,621	0.726	$124,659
14				$107,629	$51,765	$12,227			$171,621	0.707	$121,382
15				$107,629	$51,765	$12,227			$171,621	0.689	$118,191
16				$107,629	$51,765	$12,227			$171,621	0.671	$115,084
17				$107,629	$51,765	$12,227	$39,064		$210,685	0.653	$137,565
18				$107,629	$51,765	$12,227			$171,621	0.636	$109,112
19				$107,629	$51,765	$12,227			$171,621	0.619	$106,243
20				$107,629	$51,765	$12,227			$171,621	0.603	$103,450
21				$107,629	$51,765	$12,227			$171,621	0.587	$100,731
22				$107,629	$51,765	$12,227	$39,064		$210,685	0.572	$120,408
23				$107,629	$51,765	$12,227			$171,621	0.556	$95,504
24				$107,629	$51,765	$12,227			$171,621	0.542	$92,993
25				$107,629	$51,765	$12,227			$171,621	0.528	$90,548
26				$107,629	$51,765	$12,227			$171,621	0.514	$88,168
27				$107,629	$51,765	$12,227	$39,064		$210,685	0.500	$105,391
28				$107,629	$51,765	$12,227			$171,621	0.487	$83,593

TABLE 2.9-1. SUMMARY OF ESCALATED COSTS AND PRESENT VALUE COSTS FOR THE SELECTED REMEDY AT SITE 3

(Page 2 of 8)

Year	Remedial Design (Capital)	Phase I Remedial Action (Capital)	Phase II Remedial Action (Capital)	MNA (O&M)[a]	Operations and Maintenance (O&M)[b]	Soil Gas Monitoring (O&M)[c]	Five Year Review (Periodic)	Site Closeout (Periodic)[d]	Total	Present Value Discount Factor (2.7%)[e]	Present Value Total
29				$107,629	$51,765	$12,227			$171,621	0.474	$81,395
30				$107,629	$51,765	$12,227			$171,621	0.462	$79,255
31				$107,629	$51,765	$12,227			$171,621	0.450	$77,172
32				$107,629	$660,494		$39,064		$807,187	0.438	$353,419
33				$107,629	$51,765				$159,394	0.426	$67,954
34				$107,629	$51,765				$159,394	0.415	$66,168
35				$107,629	$51,765				$159,394	0.404	$64,428
36				$107,629	$51,765				$159,394	0.394	$62,734
37				$107,629	$51,765		$39,064		$198,458	0.383	$76,056
38				$107,629	$51,765				$159,394	0.373	$59,479
39				$107,629	$51,765				$159,394	0.363	$57,915
40				$107,629	$51,765				$159,394	0.354	$56,393
41				$107,629	$51,765				$159,394	0.344	$54,910
42				$107,629	$51,765		$39,064		$198,458	0.335	$66,570
43				$107,629	$51,765				$159,394	0.327	$52,061
44				$107,629	$51,765				$159,394	0.318	$50,692
45				$107,629	$51,765				$159,394	0.310	$49,360
46				$107,629	$51,765				$159,394	0.302	$48,062
47				$107,629	$51,765		$39,064		$198,458	0.294	$58,268
48				$107,629	$51,765				$159,394	0.286	$45,568
49				$107,629	$51,765				$159,394	0.278	$44,370
50				$107,629	$51,765				$159,394	0.271	$43,204
51				$107,629	$51,765				$159,394	0.264	$42,068
52				$107,629	$51,765		$39,064		$198,458	0.257	$51,001
53				$107,629	$51,765				$159,394	0.250	$39,885
54				$107,629	$51,765				$159,394	0.244	$38,836
55				$107,629	$51,765				$159,394	0.237	$37,815
56				$107,629	$51,765				$159,394	0.231	$36,821

TABLE 2.9-1. SUMMARY OF ESCALATED COSTS AND PRESENT VALUE COSTS FOR THE SELECTED REMEDY AT SITE 3

Year	Remedial Design (Capital)	Phase I Remedial Action (Capital)	Phase II Remedial Action (Capital)	MNA (O&M)[(a)]	Operations and Maintenance (O&M)[(b)]	Soil Gas Monitoring (O&M)[(c)]	Five Year Review (Periodic)	Site Closeout (Periodic)[(d)]	Total	Present Value Discount Factor (2.7%)[(e)]	Present Value Total
57				$107,629	$51,765		$39,064		$198,458	0.225	$44,640
58				$107,629	$51,765				$159,394	0.219	$34,910
59				$107,629	$51,765				$159,394	0.213	$33,993
60				$107,629	$51,765				$159,394	0.208	$33,099
61				$107,629	$51,765				$159,394	0.202	$32,229
62				$107,629	$660,494		$39,064		$807,187	0.197	$158,919
63				$107,629	$51,765				$159,394	0.192	$30,556
64				$107,629	$51,765				$159,394	0.187	$29,753
65				$107,629	$51,765				$159,394	0.182	$28,971
66				$107,629	$51,765				$159,394	0.177	$28,209
67				$107,629	$51,765		$39,064		$198,458	0.172	$34,199
68				$107,629	$51,765				$159,394	0.168	$26,746
69				$107,629	$51,765				$159,394	0.163	$26,042
70				$107,629	$51,765				$159,394	0.159	$25,358
71				$107,629	$51,765				$159,394	0.155	$24,691
72				$107,629	$51,765		$39,064		$198,458	0.151	$29,934
73				$107,629	$51,765				$159,394	0.147	$23,410
74				$107,629	$51,765				$159,394	0.143	$22,794
75				$107,629	$51,765				$159,394	0.139	$22,195
76				$107,629	$51,765				$159,394	0.136	$21,612
77				$107,629	$51,765		$39,064		$198,458	0.132	$26,201
78				$107,629	$51,765				$159,394	0.129	$20,490
79				$107,629	$51,765				$159,394	0.125	$19,952
80				$107,629	$51,765				$159,394	0.122	$19,427
81				$107,629	$51,765				$159,394	0.119	$18,916
82				$107,629	$51,765		$39,064		$198,458	0.116	$22,933
83				$107,629	$51,765				$159,394	0.113	$17,935
84				$107,629	$51,765				$159,394	0.110	$17,463

TABLE 2.9-1. SUMMARY OF ESCALATED COSTS AND PRESENT VALUE COSTS FOR THE SELECTED REMEDY AT SITE 3

Year	Remedial Design (Capital)	Phase I Remedial Action (Capital)	Phase II Remedial Action (Capital)	MNA (O&M)[a]	Operations and Maintenance (O&M)[b]	Soil Gas Monitoring (O&M)[c]	Five Year Review (Periodic)	Site Closeout (Periodic)[d]	Total	Present Value Discount Factor (2.7%)[e]	Present Value Total
85				$107,629	$51,765				$159,394	0.107	$17,004
86					$51,765				$51,765	0.104	$5,377
87					$51,765		$39,064		$90,829	0.101	$9,187
88					$51,765				$51,765	0.098	$5,098
89					$51,765				$51,765	0.096	$4,964
90					$51,765				$51,765	0.093	$4,834
91					$51,765				$51,765	0.091	$4,706
92					$51,765		$39,064		$90,829	0.089	$8,041
93					$51,765				$51,765	0.086	$4,462
94					$51,765				$51,765	0.084	$4,345
95					$51,765				$51,765	0.082	$4,231
96					$51,765				$51,765	0.080	$4,119
97					$51,765		$39,064		$90,829	0.077	$7,038
98					$51,765				$51,765	0.075	$3,906
99					$51,765				$51,765	0.073	$3,803
100					$51,765				$51,765	0.072	$3,703
101					$51,765				$51,765	0.070	$3,606
102					$51,765		$39,064		$90,829	0.068	$6,160
103					$51,765				$51,765	0.066	$3,419
104					$51,765				$51,765	0.064	$3,329
105					$51,765				$51,765	0.063	$3,241
106					$51,765				$51,765	0.061	$3,156
107					$51,765		$39,064		$90,829	0.059	$5,392
108					$51,765				$51,765	0.058	$2,992
109					$51,765				$51,765	0.056	$2,914
110					$51,765				$51,765	0.055	$2,837
111					$51,765				$51,765	0.053	$2,762
112					$51,765		$39,064		$90,829	0.052	$4,720

TABLE 2.9-1. SUMMARY OF ESCALATED COSTS AND PRESENT VALUE COSTS FOR THE SELECTED REMEDY AT SITE 3

(Page 5 of 8)

Year	Remedial Design (Capital)	Phase I Remedial Action (Capital)	Phase II Remedial Action (Capital)	MNA (O&M)[a]	Operations and Maintenance (O&M)[b]	Soil Gas Monitoring (O&M)[c]	Five Year Review (Periodic)	Site Closeout (Periodic)[d]	Total	Present Value Discount Factor (2.7%)[e]	Present Value Total
113					$51,765				$51,765	0.051	$2,619
114					$51,765				$51,765	0.049	$2,550
115					$51,765				$51,765	0.048	$2,483
116					$51,765				$51,765	0.047	$2,418
117					$51,765		$39,064		$90,829	0.045	$4,131
118					$51,765				$51,765	0.044	$2,292
119					$51,765				$51,765	0.043	$2,232
120					$51,765				$51,765	0.042	$2,173
121					$51,765				$51,765	0.041	$2,116
122					$51,765		$39,064		$90,829	0.040	$3,616
123					$51,765				$51,765	0.039	$2,006
124					$51,765				$51,765	0.038	$1,954
125					$51,765				$51,765	0.037	$1,902
126					$51,765				$51,765	0.036	$1,852
127					$51,765		$39,064		$90,829	0.035	$3,165
128					$51,765				$51,765	0.034	$1,756
129					$51,765				$51,765	0.033	$1,710
130					$51,765				$51,765	0.032	$1,665
131					$51,765				$51,765	0.031	$1,621
132					$51,765		$39,064		$90,829	0.030	$2,770
133					$51,765				$51,765	0.030	$1,537
134					$51,765				$51,765	0.029	$1,497
135					$51,765				$51,765	0.028	$1,457
136					$51,765				$51,765	0.027	$1,419
137					$51,765		$39,064		$90,829	0.027	$2,425
138					$51,765				$51,765	0.026	$1,345
139					$51,765				$51,765	0.025	$1,310
140					$51,765				$51,765	0.025	$1,276

TABLE 2.9-1. SUMMARY OF ESCALATED COSTS AND PRESENT VALUE COSTS FOR THE SELECTED REMEDY AT SITE 3

Year	Remedial Design (Capital)	Phase I Remedial Action (Capital)	Phase II Remedial Action (Capital)	MNA (O&M)[a]	Operations and Maintenance (O&M)[b]	Soil Gas Monitoring (O&M)[c]	Five Year Review (Periodic)	Site Closeout (Periodic)[d]	Total	Present Value Discount Factor (2.7%)[e]	Present Value Total
141					$51,765				$51,765	0.024	$1,242
142					$51,765		$39,064		$90,829	0.023	$2,122
143					$51,765				$51,765	0.023	$1,178
144					$51,765				$51,765	0.022	$1,147
145					$51,765				$51,765	0.022	$1,117
146					$51,765				$51,765	0.021	$1,087
147					$51,765		$39,064		$90,829	0.020	$1,858
148					$51,765				$51,765	0.020	$1,031
149					$51,765				$51,765	0.019	$1,004
150					$51,765				$51,765	0.019	$977
151					$51,765				$51,765	0.018	$952
152					$51,765		$39,064		$90,829	0.018	$1,626
153					$51,765				$51,765	0.017	$902
154					$51,765				$51,765	0.017	$879
155					$51,765				$51,765	0.017	$855
156					$51,765				$51,765	0.016	$833
157					$51,765		$39,064		$90,829	0.016	$1,423
158					$51,765				$51,765	0.015	$790
159					$51,765				$51,765	0.015	$769
160					$51,765				$51,765	0.014	$749
161					$51,765				$51,765	0.014	$729
162					$51,765		$39,064		$90,829	0.014	$1,246
163					$51,765				$51,765	0.013	$691
164					$51,765				$51,765	0.013	$673
165					$51,765				$51,765	0.013	$655
166					$51,765				$51,765	0.012	$638
167					$51,765		$39,064		$90,829	0.012	$1,090
168					$51,765				$51,765	0.012	$605

TABLE 2.9-1. SUMMARY OF ESCALATED COSTS AND PRESENT VALUE COSTS FOR THE SELECTED REMEDY AT SITE 3

Year	Remedial Design (Capital)	Phase I Remedial Action (Capital)	Phase II Remedial Action (Capital)	MNA (O&M)[a]	Operations and Maintenance (O&M)[b]	Soil Gas Monitoring (O&M)[c]	Five Year Review (Periodic)	Site Closeout (Periodic)[d]	Total	Present Value Discount Factor (2.7%)[e]	Present Value Total
169					$51,765				$51,765	0.011	$589
170					$51,765				$51,765	0.011	$574
171					$51,765				$51,765	0.011	$559
172					$51,765		$39,064		$90,829	0.011	$954
173					$51,765				$51,765	0.010	$530
174					$51,765				$51,765	0.010	$516
175					$51,765				$51,765	0.010	$502
176					$51,765				$51,765	0.009	$489
177					$51,765		$39,064		$90,829	0.009	$835
178					$51,765				$51,765	0.009	$464
179					$51,765				$51,765	0.009	$451
180					$51,765				$51,765	0.008	$439
181					$51,765				$51,765	0.008	$428
182					$51,765		$39,064		$90,829	0.008	$731
183					$51,765				$51,765	0.008	$406
184					$51,765				$51,765	0.008	$395
185					$51,765				$51,765	0.007	$385
186					$51,765				$51,765	0.007	$375
187					$51,765		$39,064		$90,829	0.007	$640
188					$51,765				$51,765	0.007	$355
189					$51,765				$51,765	0.007	$346
190					$51,765				$51,765	0.007	$337
191					$51,765				$51,765	0.006	$328
192					$51,765		$39,064		$90,829	0.006	$560
193					$51,765				$51,765	0.006	$311
194					$51,765				$51,765	0.006	$303
195					$51,765				$51,765	0.006	$295
196					$51,765				$51,765	0.006	$287

TABLE 2.9-1. SUMMARY OF ESCALATED COSTS AND PRESENT VALUE COSTS FOR THE SELECTED REMEDY AT SITE 3

(Page 8 of 8)

Year	Remedial Design (Capital)	Phase I Remedial Action (Capital)	Phase II Remedial Action (Capital)	MNA (O&M)[a]	Operations and Maintenance (O&M)[b]	Soil Gas Monitoring (O&M)[c]	Five Year Review (Periodic)	Site Closeout (Periodic)[d]	Total	Present Value Discount Factor (2.7%)[e]	Present Value Total
197					$51,765		$39,064		$90,829	0.005	$490
198					$51,765				$51,765	0.005	$272
199					$51,765				$51,765	0.005	$265
200					$51,765				$51,765	0.005	$258
201					$51,765				$51,765	0.005	$251
202							$39,064	$328,034	$367,098	0.005	$1,734
Totals	$283,121	$2,000,243	$5,840,396	$9,040,836	$14,268,177	$396,871	$1,562,564	$328,034	$31,285,326		$14,417,005

Notes:

[a] Based on the number of years (84) for the final toxic degradation product (vinyl chloride) to reach its Maximum Contaminant Level (MCL) in groundwater. Groundwater would be monitored annually for natural attenuation parameters.

[b] O&M costs include the removal and installation of ten groundwater monitoring wells and four soil gas monitoring wells every 30 years (Years 32 and 62) until vinyl chloride reaches its MCL in groundwater.

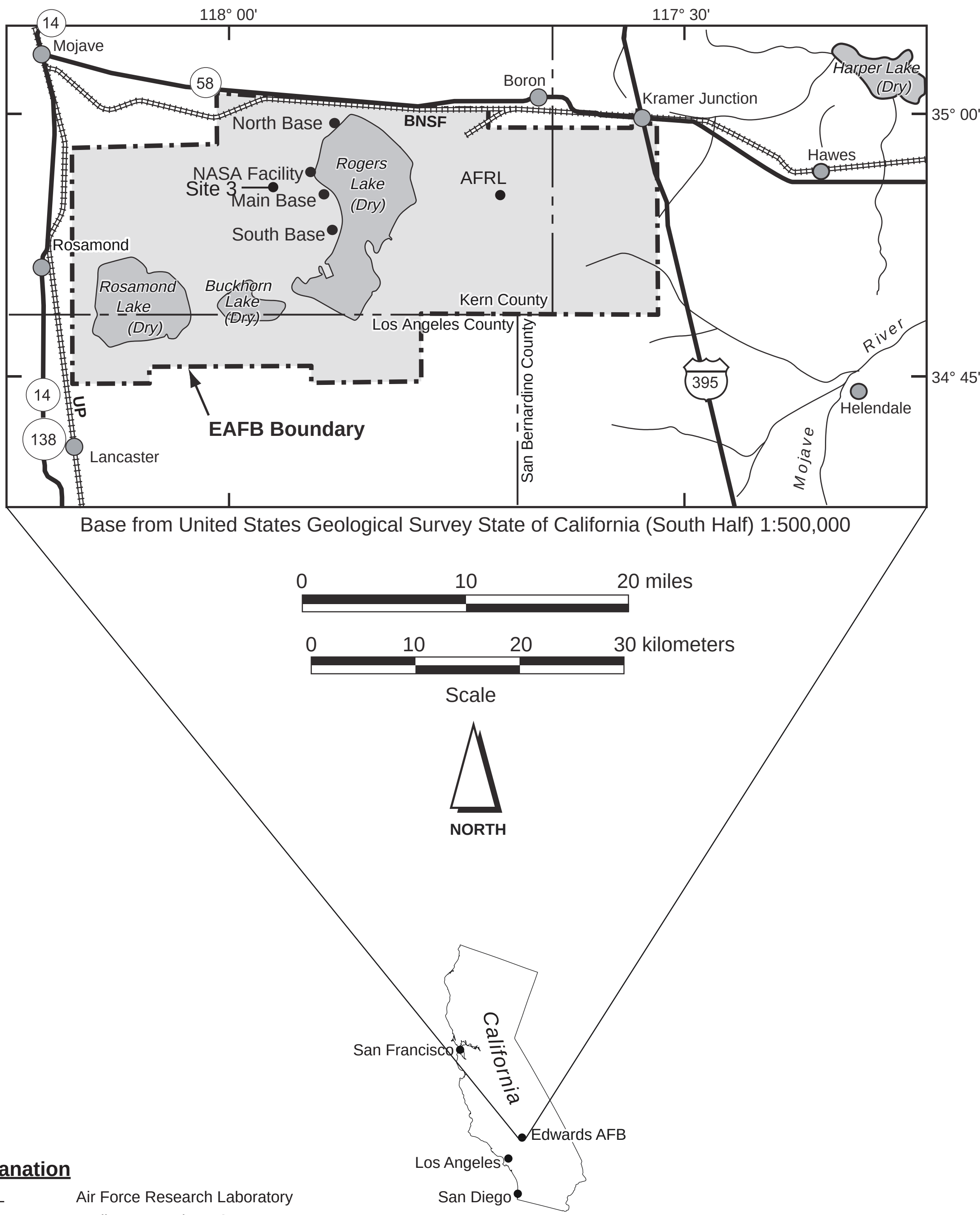
[c] Based on Title 27 requirements for landfill gas monitoring. Landfill gas monitoring would be conducted annually for 30 years.

[d] Site closeout costs include the destruction of all groundwater and landfill gas monitoring wells at the site.

[e] A discount factor of 2.7 percent was used to calculate the present value cost in accordance with Office of Management and Budget (OMB) Circular No. A-94, Appendix C (OMB 2008). Although Land Use Controls (LUCs) would need to be maintained in perpetuity, a timeframe of 200 years was used to enable the Air Force to compare costs between the evaluated alternatives. After 200 years, the increase in the present value discounted cost is negligible.

% percent
LUC Land Use Control
MCL Maximum Contaminant Level
MNA monitored natural attenuation
O&M operations and maintenance
OMB Office of Management and Budget

LIST OF FIGURES



Explanation

AFRL	Air Force Research Laboratory
BNSF	Burlington Northern Santa Fe
Co.	County
Kramer Jct.	Kramer Junction
NASA	National Aeronautics and Space Administration
UP	Union Pacific
U.S.	United States
(symbol)	Cities
(symbol)	Railroads
(symbol)	County Lines
(symbol)	Rivers

Site 3 ROD

Edwards AFB Location Map

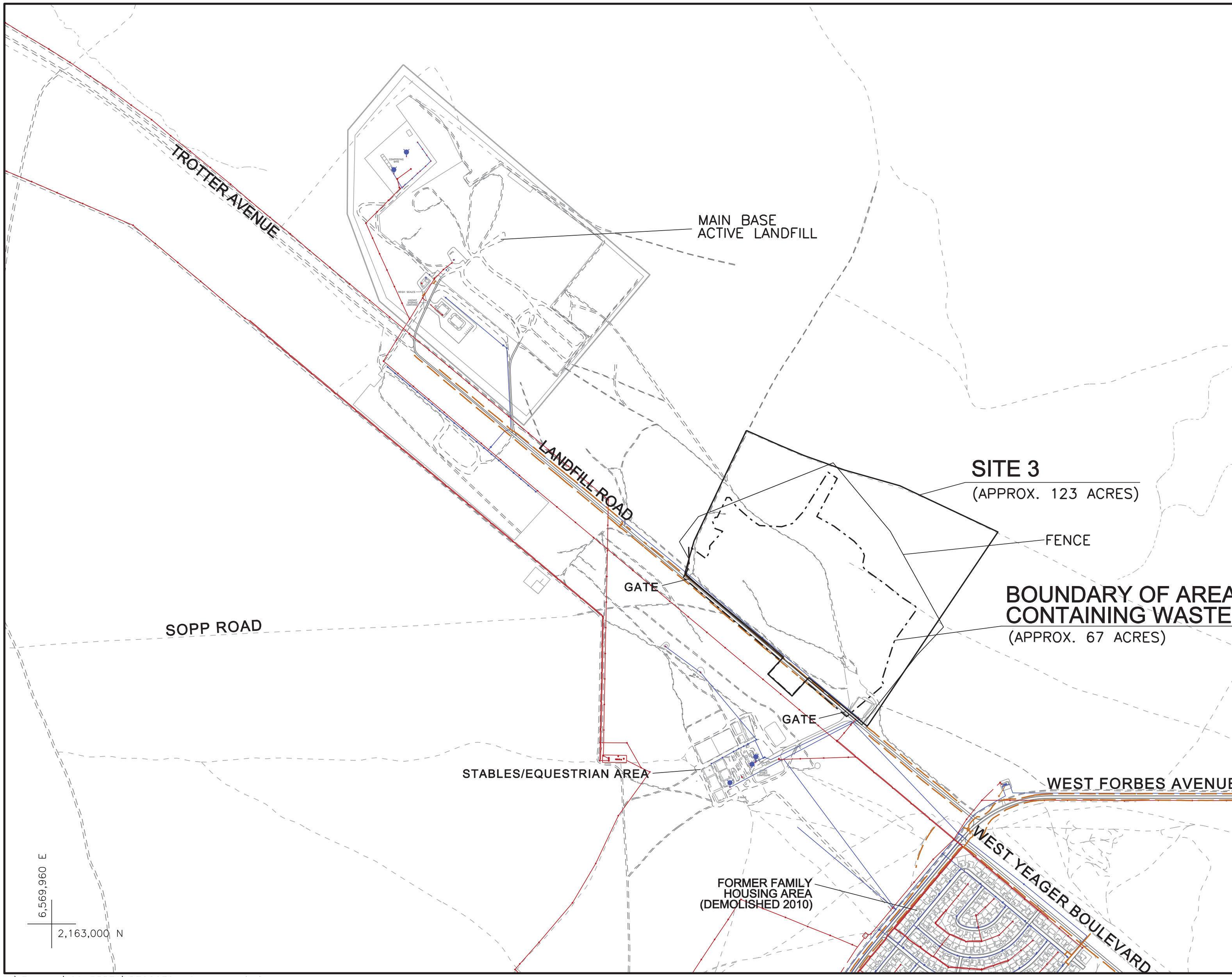
Date 07-12

Project No. 60133579

Edwards AFB

Figure **2.1-1**

6013-3579.04.92 EAFB Site 3 ROD



Site 3 ROD

Site 3
Main Base Inactive Landfill
Location Map

Date 07-12	Edwards AFB	Figure
Project No. 60133579		2.1-2

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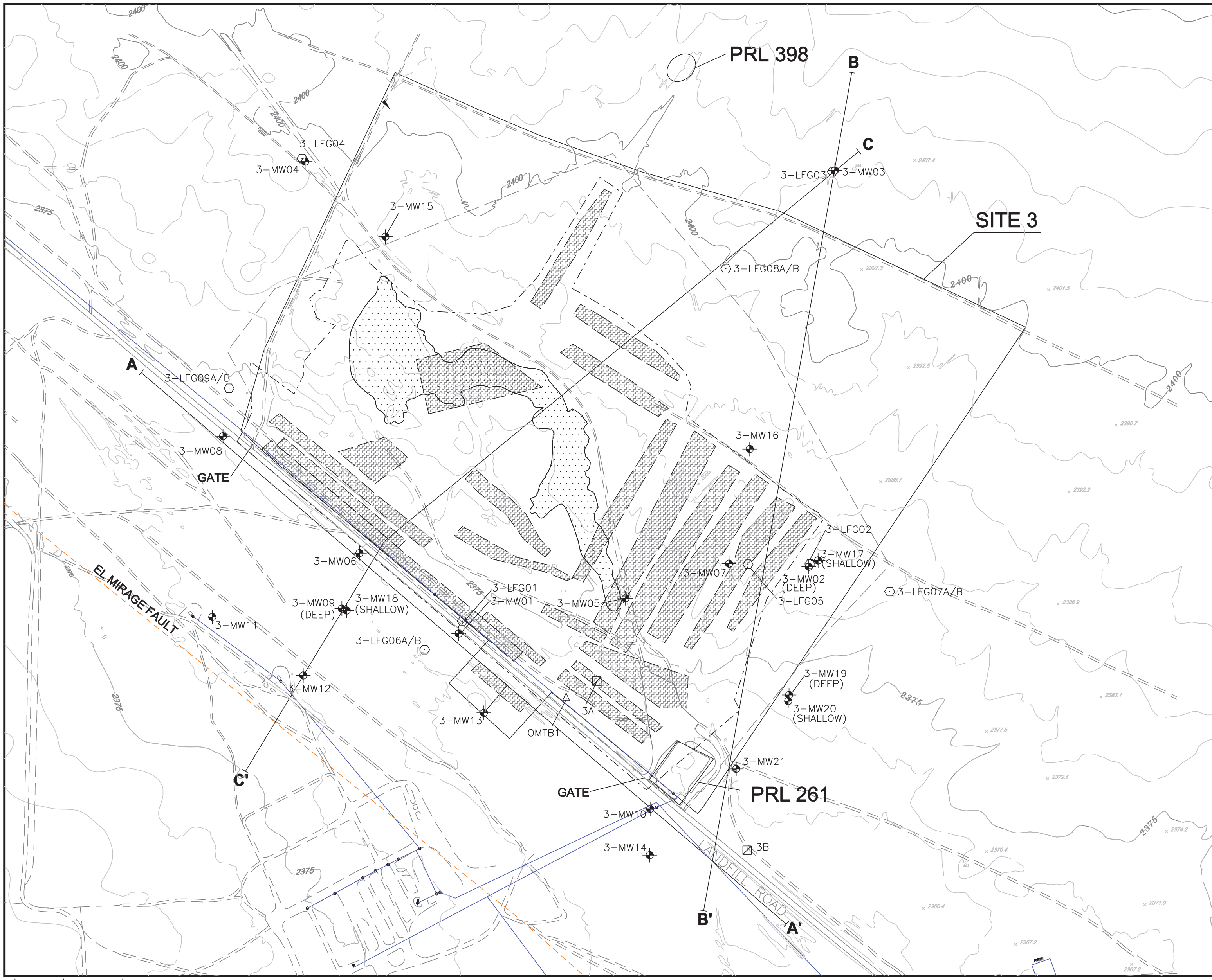

EXPLANATION

3-MW02	GROUNDWATER MONITORING WELL LOCATION
3-LFG02	LANDFILL GAS MONITORING WELL LOCATION
3B	SURFACE SAMPLE LOCATION
OMTB1	EXISTING SOIL BORING LOCATION
	AREA COVERED WITH SURFACE DEBRIS. PREDOMINANTLY CONSTRUCTION AND DEMOLITION WASTE, AS MAPPED IN THE FIELD AND NOTED ON AERIAL PHOTOGRAPHS TAKEN ON 01-01-92.
	INTERPRETED CELL LOCATION
	APPROXIMATE LANDFILL BOUNDARY
x	FENCE
	WATER LINE
2400	TOPOGRAPHIC CONTOUR (FEET ABOVE MEAN SEA LEVEL)
	FAULT (DASHED WHERE APPROXIMATELY LOCATED) (MODIFIED FROM NISHIKAWA ET AL. 2001; LEIGHTON AND PHILLIPS 2003)
A — A'	LOCATION OF CROSS SECTION
PRL	POTENTIAL RELEASE LOCATION

NOTES

1. CROSS SECTION A-A' SHOWN ON FIGURE 2.5-2.
2. CROSS SECTION B-B' SHOWN ON FIGURE 2.5-3.
3. CROSS SECTION C-C' SHOWN ON FIGURE 2.5-4.

NORTH

0 200 400 FEET
SCALE IN FEET

Site 3 ROD

Site 3
Main Base Inactive Landfill
Site Map with Well Locations

Date 07-12	Edwards AFB	Figure
Project No. 60133579		2.2-1

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EXPLANATION

- GROUNDWATER MONITORING WELL LOCATION
- LANDFILL GAS MONITORING WELL LOCATION
- SOIL BOREHOLE LOCATION
- AREAL EXTENT OF SURFACE DEBRIS (PREDOMINANTLY CONSTRUCTION AND DEMOLITION WASTE). BASED ON FIELD MAPPING AND REVIEW OF 2002 AERIAL PHOTOGRAPHS.
- INTERPRETED CELL LOCATION
- APPROXIMATE LANDFILL BOUNDARY
- FENCE
- FAULT (DASHED WHERE APPROXIMATELY LOCATED) (MODIFIED FROM NISHIKAWA ET AL. 2001; LEIGHTON AND PHILLIPS 2003)

PRL POTENTIAL RELEASE LOCATION

Site 3 ROD		
Site 3 Main Base Inactive Landfill Aerial Photograph (December 2002)		
Date 07-12 Project No. 60133579	Edwards AFB	Figure 2.2-2

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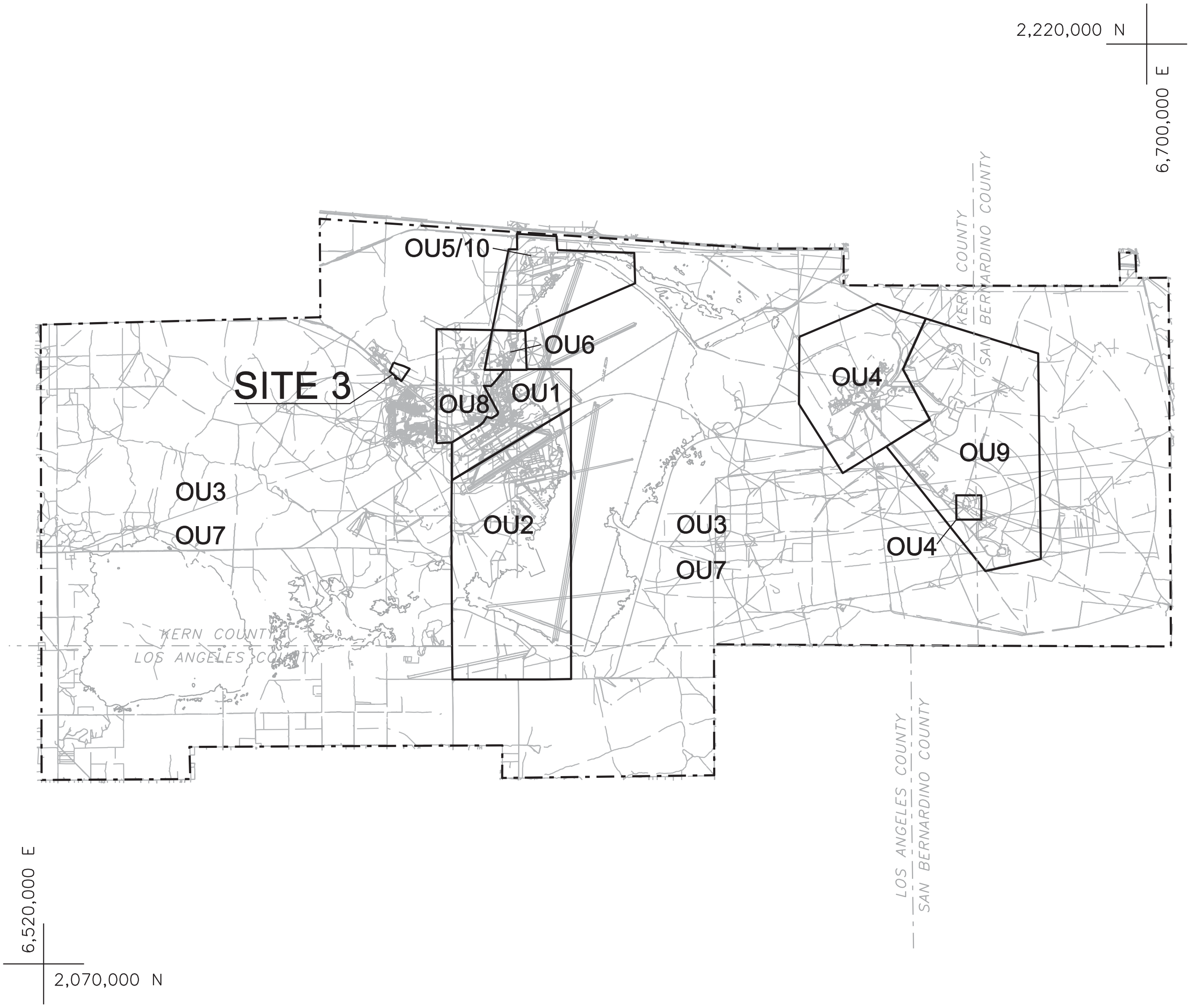

DESIGNATED OPERABLE UNITS

OU1	MAIN BASE FLIGHTLINE
OU2	SOUTH BASE
OU3	BASEWIDE WATER WELLS
OU4	AIR FORCE RESEARCH LABORATORY
OU5/10	NORTH BASE
OU6	NASA DRYDEN
OU7	BASEWIDE MISCELLANEOUS
OU8	NORTHWEST MAIN BASE
OU9	AIR FORCE RESEARCH LABORATORY – EAST

Site 3 ROD

Location Map of Operable Units at Edwards Air Force Base

Date 07-12

Project No. 60133579

Edwards AFB

Figure 2.4-1

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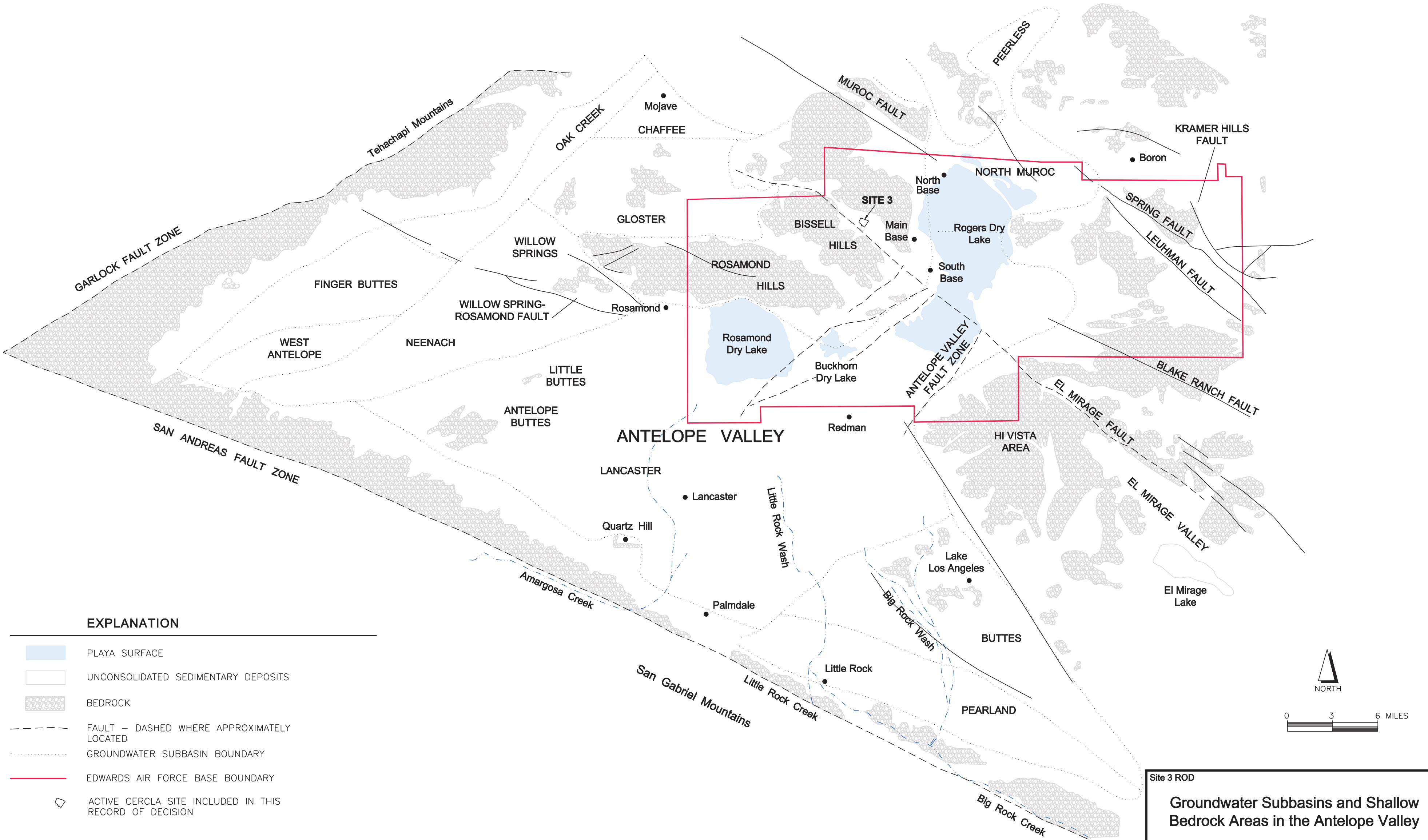

EXPLANATION

- PLAYA SURFACE
- UNCONSOLIDATED SEDIMENTARY DEPOSITS
- BEDROCK
- FAULT – DASHED WHERE APPROXIMATELY LOCATED
- GROUNDWATER SUBBASIN BOUNDARY
- EDWARDS AIR FORCE BASE BOUNDARY
- ACTIVE CERCLA SITE INCLUDED IN THIS RECORD OF DECISION

MODIFIED FROM DIBBLEE, 1960; BLOYD, 1967; LONDQUIST AND OTHERS, 1993; AND GARY DIXON (U.S. GEOLOGICAL SURVEY, WRITTEN COMMUN., 1993)

Site 3 ROD

Groundwater Subbasins and Shallow Bedrock Areas in the Antelope Valley

Date 07–12	Edwards AFB	Figure
Project No. 60133579		2.5–1

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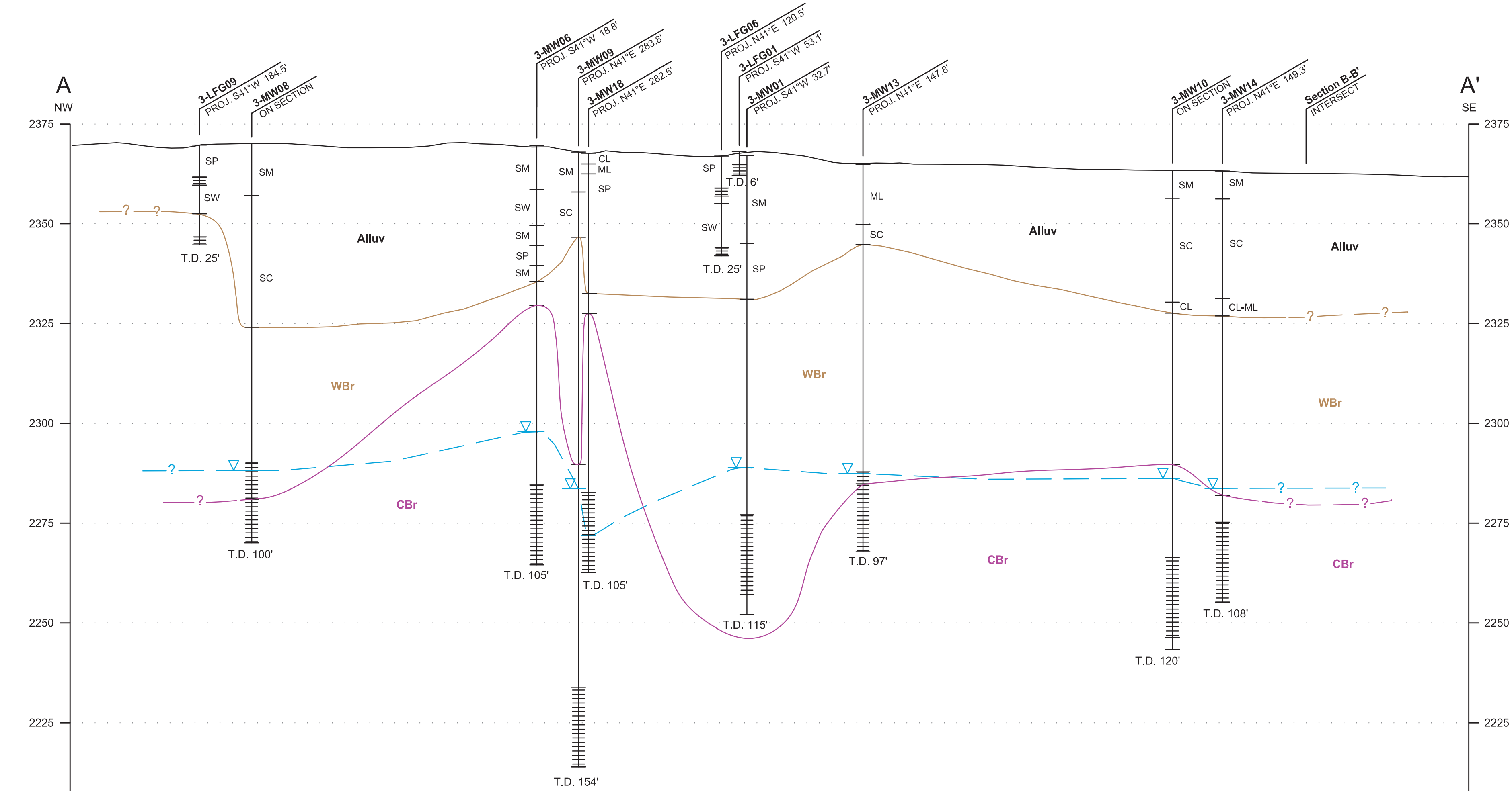

EXPLANATION

T.D.	TOTAL DEPTH IN FEET BELOW GROUND SURFACE
PROJ.	PROJECTED
(symbol)	SCREENED INTERVAL
(symbol)	WATER LEVEL
(line)	ALLUVIUM – WBr – CONTACT
(line)	WBr – CBr CONTACT
(dashed line)	GROUNDWATER POTENTIOMETRIC SURFACE BASED ON APRIL 2009 DATA

Alluv	ALLUVIUM
CBr	COMPETENT BEDROCK
WBr	WEATHERED BEDROCK
CL	CLAY
SC	CLAYEY SAND
SM	SILTY SAND
SP	SAND
ML	SANDY SILT
SW	GRAVELLY SAND
NW	NORTHWEST
SE	SOUTHEAST
T.D.	TOTAL DEPTH (IN FEET BELOW GROUND SURFACE)

NOTE

1. SEE FIGURE 2.2–1 FOR CROSS SECTION LINE.

0 125 250 FT
HORIZONTAL SCALE IN FEET

0 12.5 25 FT
VERTICAL SCALE IN FEET
VERTICAL EXAGGERATION: 1:10

Site 3 ROD

Site 3 Main Base Inactive Landfill Cross Section A-A'

Date 07–12
Project No. 60133579
Edwards AFB
Figure 2.5–2

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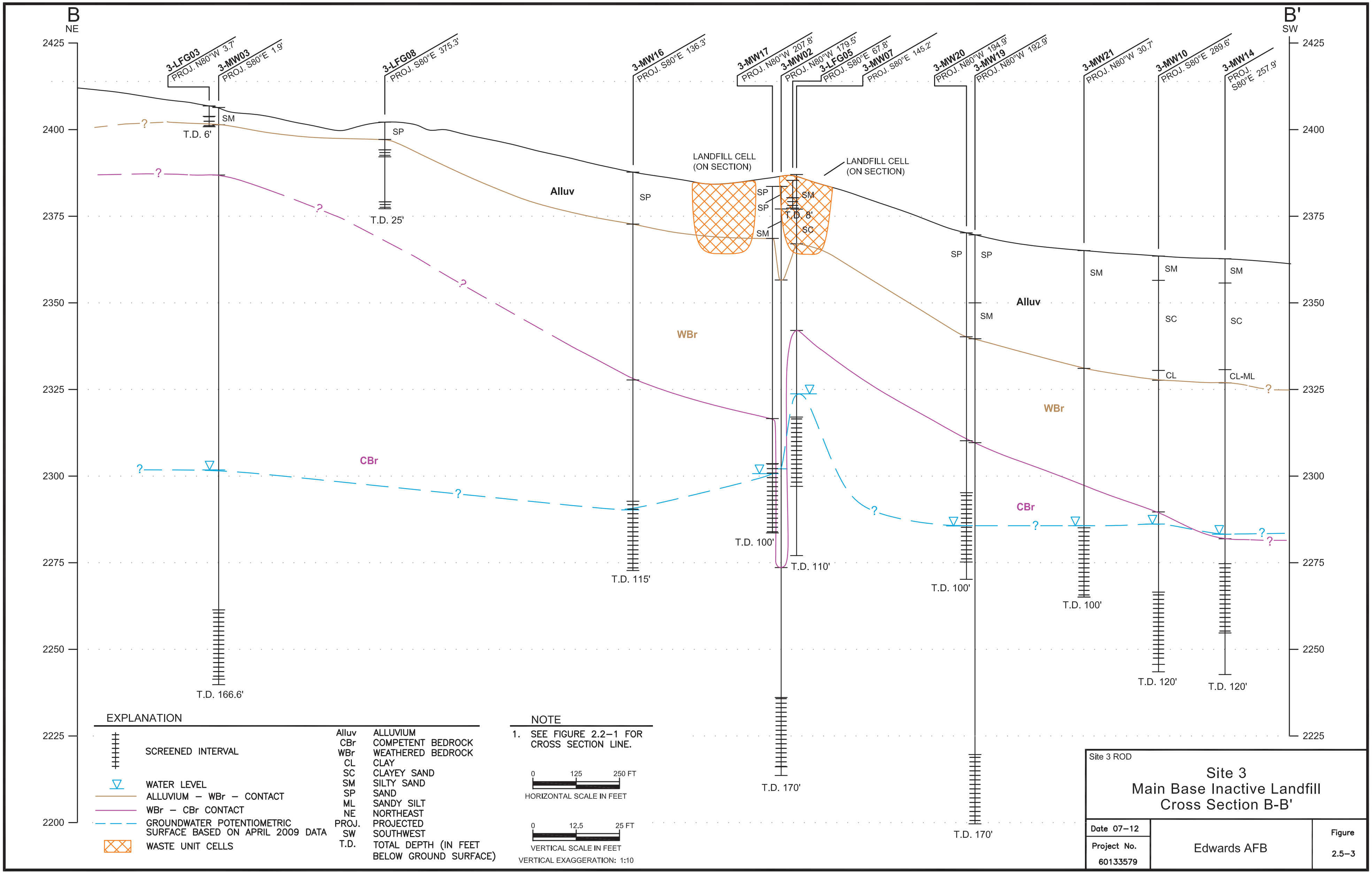
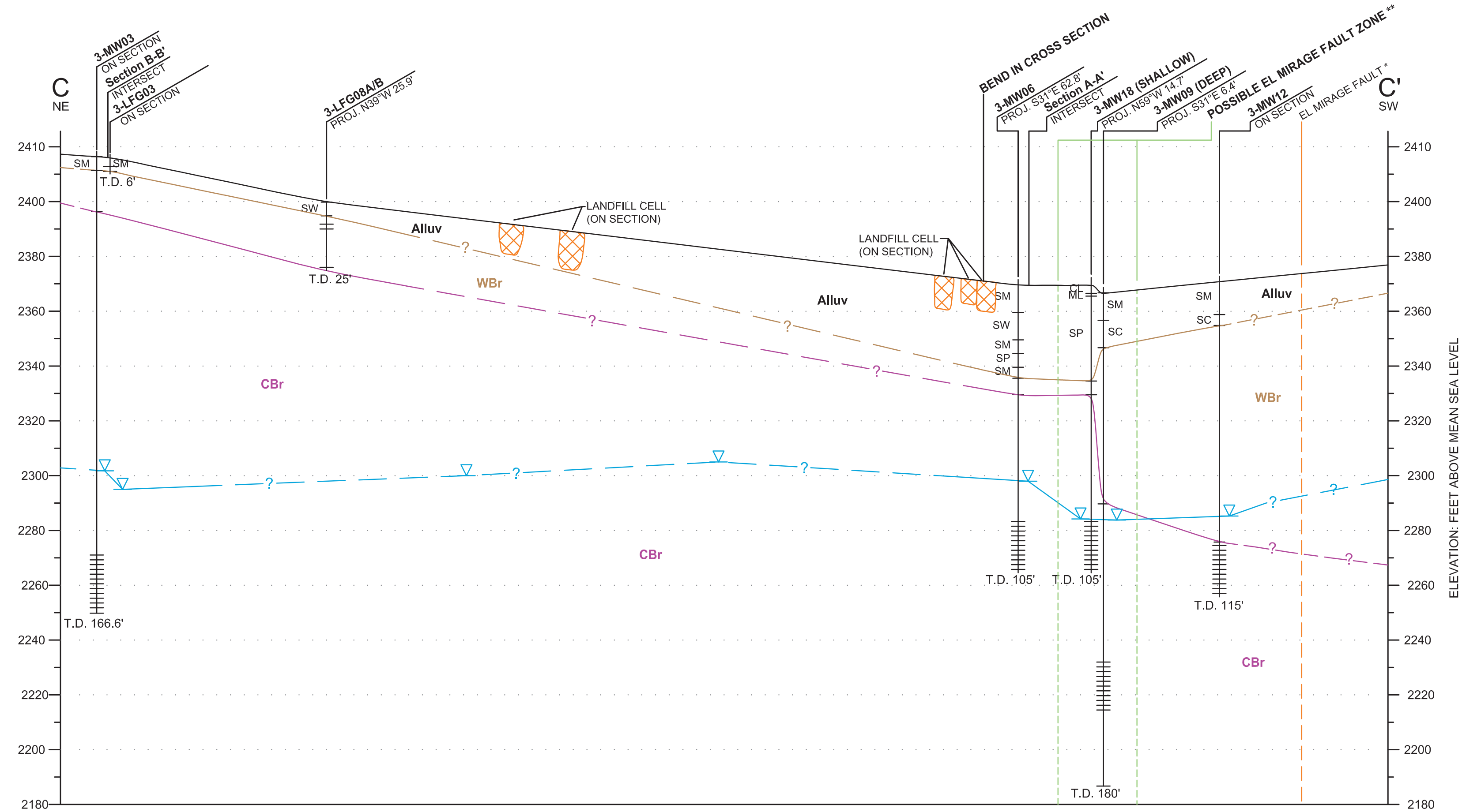

B
NE
B'
SW
2425
2400
2375
2350
2325
2300
2275
2250
2225
2200
3-LFG03 PROJ. N80°W 3.7'
3-MW03 PROJ. S80°E 1.9'
3-LFG08 PROJ. S80°E 375.3'
3-MW16 PROJ. S80°E 136.3'
3-MW17 PROJ. N80°W 207.8'
3-MW02 PROJ. N80°W 179.5'
3-LFG05 PROJ. S80°E 67.8'
3-MW07 PROJ. S80°E 145.2'
3-MW20 PROJ. N80°W 194.9'
3-MW19 PROJ. N80°W 192.9'
3-MW21 PROJ. N80°W 30.7'
3-MW10 PROJ. S80°E 289.6'
3-MW14 PROJ. S80°E 257.9'
LANDFILL CELL (ON SECTION)
LANDFILL CELL (ON SECTION)
Alluv
Alluv
WBr
WBr
CBr
CBr
SM
SP
SP
SP
SP
SM
SM
SC
SP
SP
SM
SM
SM
SM
SC
SC
CL
CL-ML
T.D. 6'
T.D. 25'
T.D. 115'
T.D. 100'
T.D. 8'
T.D. 110'
T.D. 170'
T.D. 100'
T.D. 170'
T.D. 100'
T.D. 120'
T.D. 120'
T.D. 166.6'
EXPLANATION
SCREENED INTERVAL
WATER LEVEL
ALLUVIUM – WBr – CONTACT
WBr – CBr CONTACT
GROUNDWATER POTENTIOMETRIC SURFACE BASED ON APRIL 2009 DATA
WASTE UNIT CELLS
Alluv ALLUVIUM
CBr COMPETENT BEDROCK
WBr WEATHERED BEDROCK
CL CLAY
SC CLAYEY SAND
SM SILTY SAND
SP SAND
ML SANDY SILT
NE NORTHEAST
PROJ. PROJECTED
SW SOUTHWEST
T.D. TOTAL DEPTH (IN FEET BELOW GROUND SURFACE)
NOTE
1. SEE FIGURE 2.2–1 FOR CROSS SECTION LINE.
0 125 250 FT
HORIZONTAL SCALE IN FEET
0 12.5 25 FT
VERTICAL SCALE IN FEET
VERTICAL EXAGGERATION: 1:10
Site 3 ROD
Site 3
Main Base Inactive Landfill
Cross Section B-B'
Date 07–12
Project No. 60133579
Edwards AFB
Figure 2.5–3



EXPLANATION

- ALLUVIUM – WBr – CONTACT
- WBr – CBr CONTACT
- LANDFILL CELL
- POTENTIOMETRIC SURFACE–OCTOBER 2009 (DASHED WHERE INFERRED)
- SCREEN INTERVAL
- *FAULT (DASHED WHERE APPROXIMATELY LOCATED) (MODIFIED FROM NISHIKAWA ET AL. 2001; LEIGHTON AND PHILLIPS 2003)
- **POSSIBLE LOCATION OF EL MIRAGE FAULT ZONE BASED ON ERP WELL DATA

Alluv	ALLUVIUM
CBr	COMPETENT BEDROCK
WBr	WEATHERED BEDROCK
CL	CLAY
SC	CLAYEY SAND
SM	SILTY SAND
SP	SAND
ML	SANDY SILT
ERP	ENVIRONMENTAL RESTORATION PROGRAM
T.D.	TOTAL DEPTH (IN FEET BELOW GROUND SURFACE)

NOTE

1. FOR CROSS SECTION LINE SEE FIGURE 2.2–1.

0 150 300 FT
HORIZONTAL SCALE IN FEET

0 20 40 FT
VERTICAL SCALE IN FEET
VERTICAL EXAGGERATION: 1:7.5

Site 3 ROD

Site 3
Main Base Inactive Landfill
Cross Section C-C'

Date: 07–12
Project No. 60133579
Edwards AFB
Figure 2.5–4

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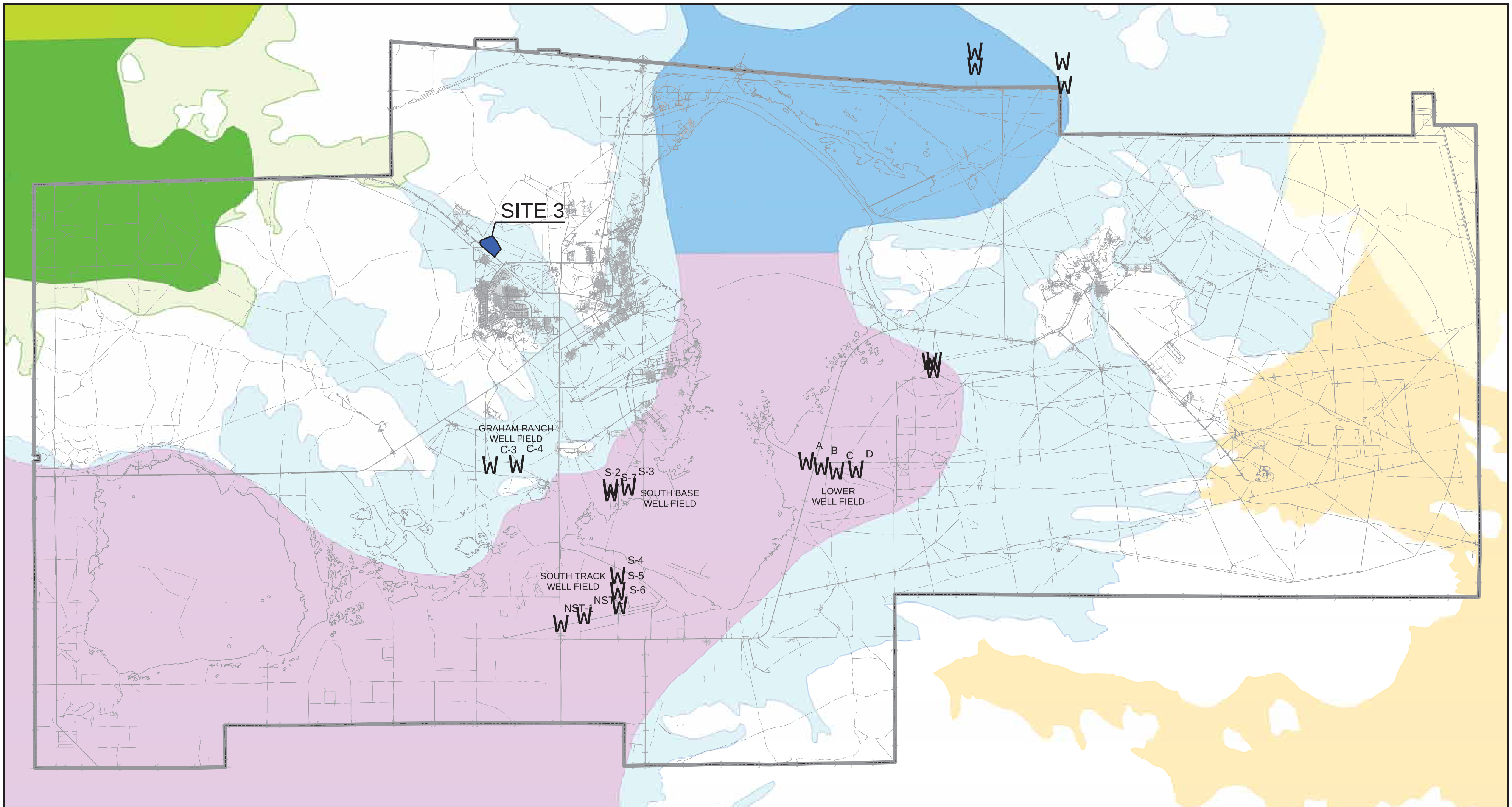

EXPLANATION

- PAVED ROAD
- UNPAVED ROAD
- TRAIL
- W BASE SUPPLY WELL
- UPLAND AREAS

NOTES

1. HYDROLOGIC UNITS BASED ON DWR BULLETIN 118 (CDWR 2003).
2. USGS SUBBASIN BOUNDARIES FROM USGS (2005) FACT SHEET.

6-44 ANTELOPE VALLEY BASIN (DWR)

- RECHARGE AREA (DWR)
- LANCASTER SUBBASIN (USGS)
- NORTH MUROC SUBBASIN (USGS)

6-46 FREMONT VALLEY BASIN (DWR)

- RECHARGE AREA (DWR)
- GLOSTER SUBBASIN (USGS)
- CHAFFEE SUBBASIN (USGS)

6-41 MIDDLE MOJAVE RIVER VALLEY BASIN (DWR)

- RECHARGE AREA (DWR)

6-47 HARPER VALLEY BASIN (DWR)

- RECHARGE AREA (DWR)

Site 3 ROD

DWR Hydrologic Basins and USGS Subbasins

Date 07-12	Edwards AFB	Figure 2.5-5
Project No. 60133579		

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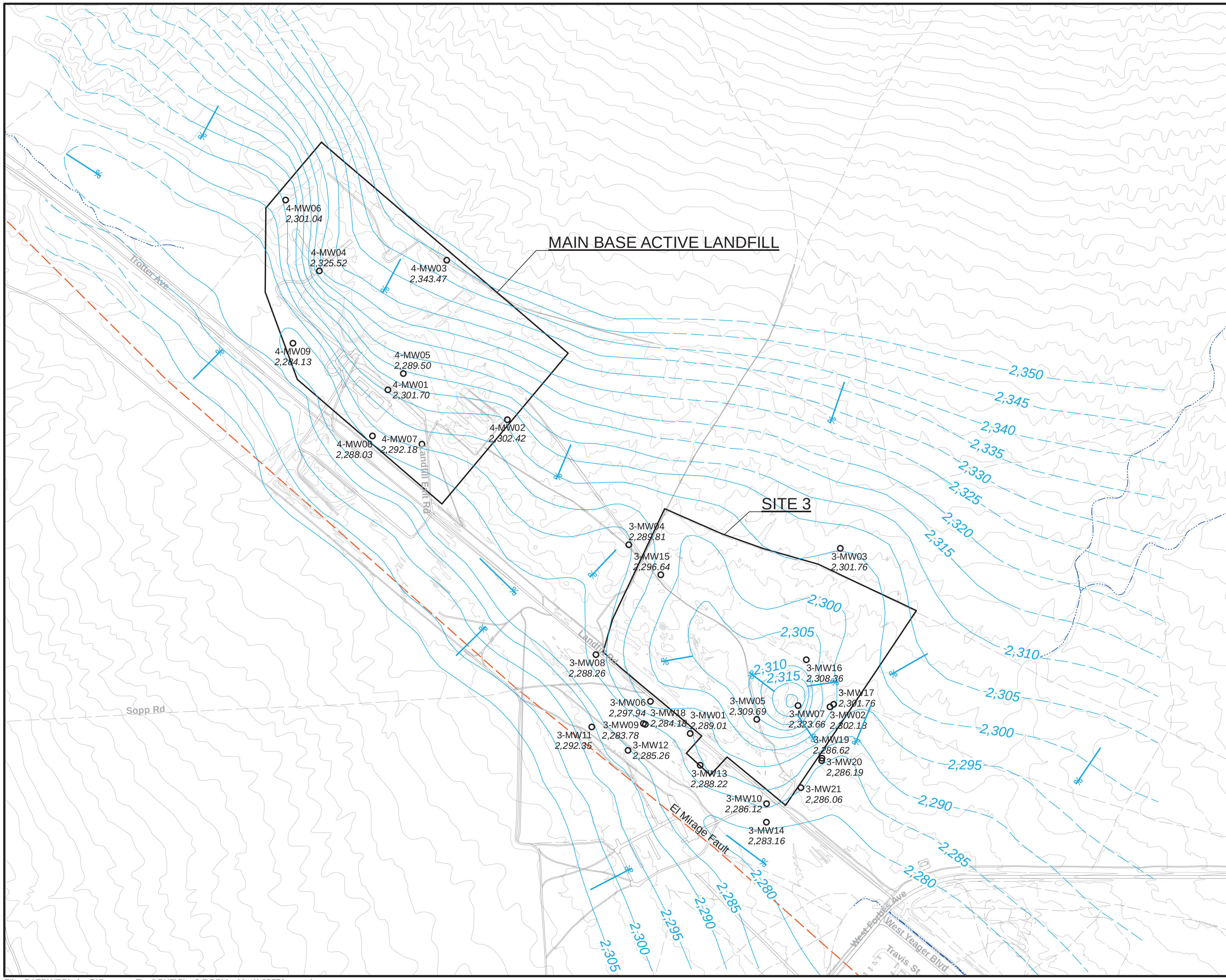

Site 3 ROD

Groundwater Isopleths in the Area Surrounding Site 3 Main Base Inactive Landfill July 2009

Date 07-12	Edwards AFB	Figure
Project No. 60133579		2.5-6

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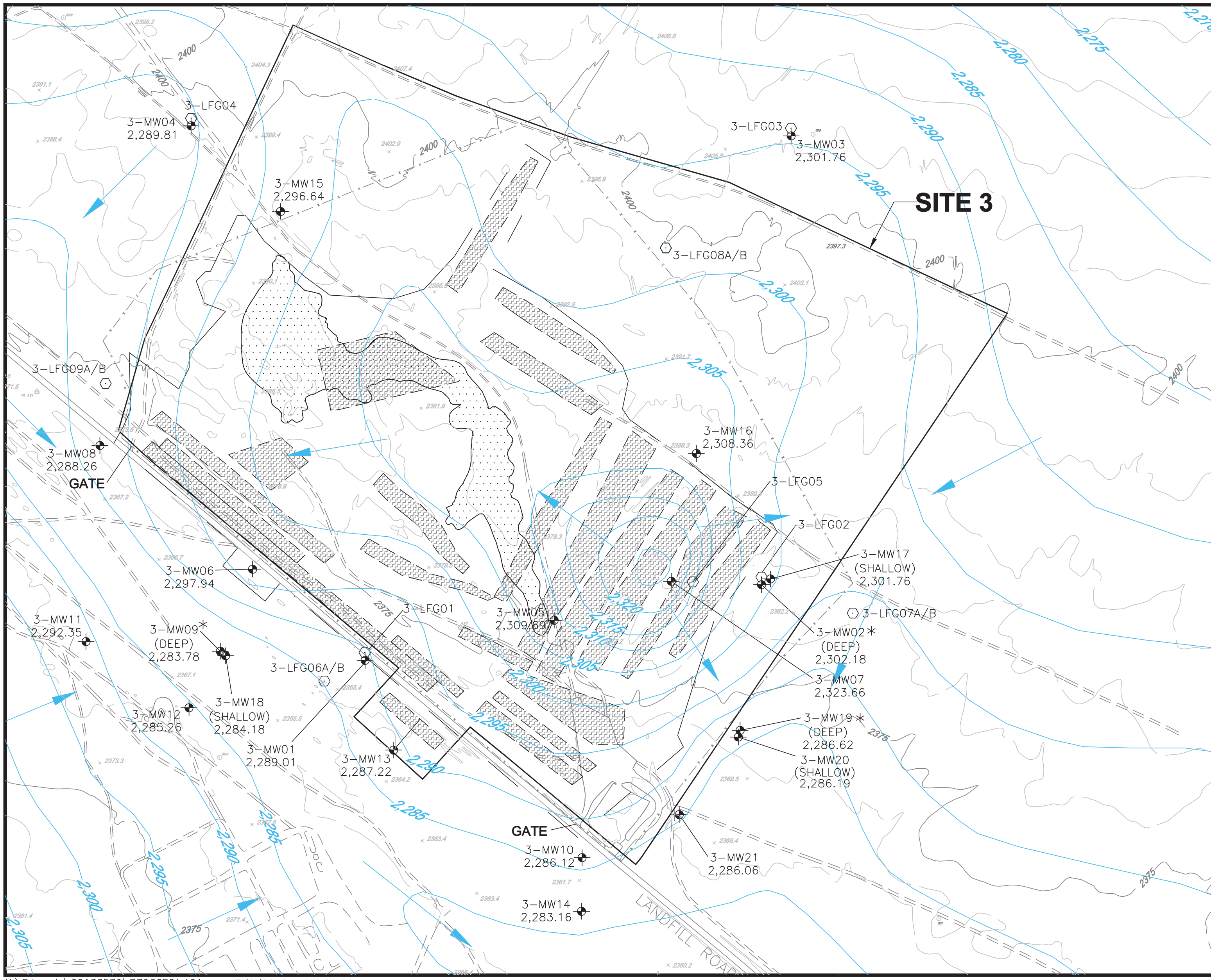

Site 3 ROD

Site 3
Main Base Inactive Landfill
Groundwater Isopleths
July 2009

Date 07-12
Project No. 60133579
Edwards AFB
Figure 2.5-7

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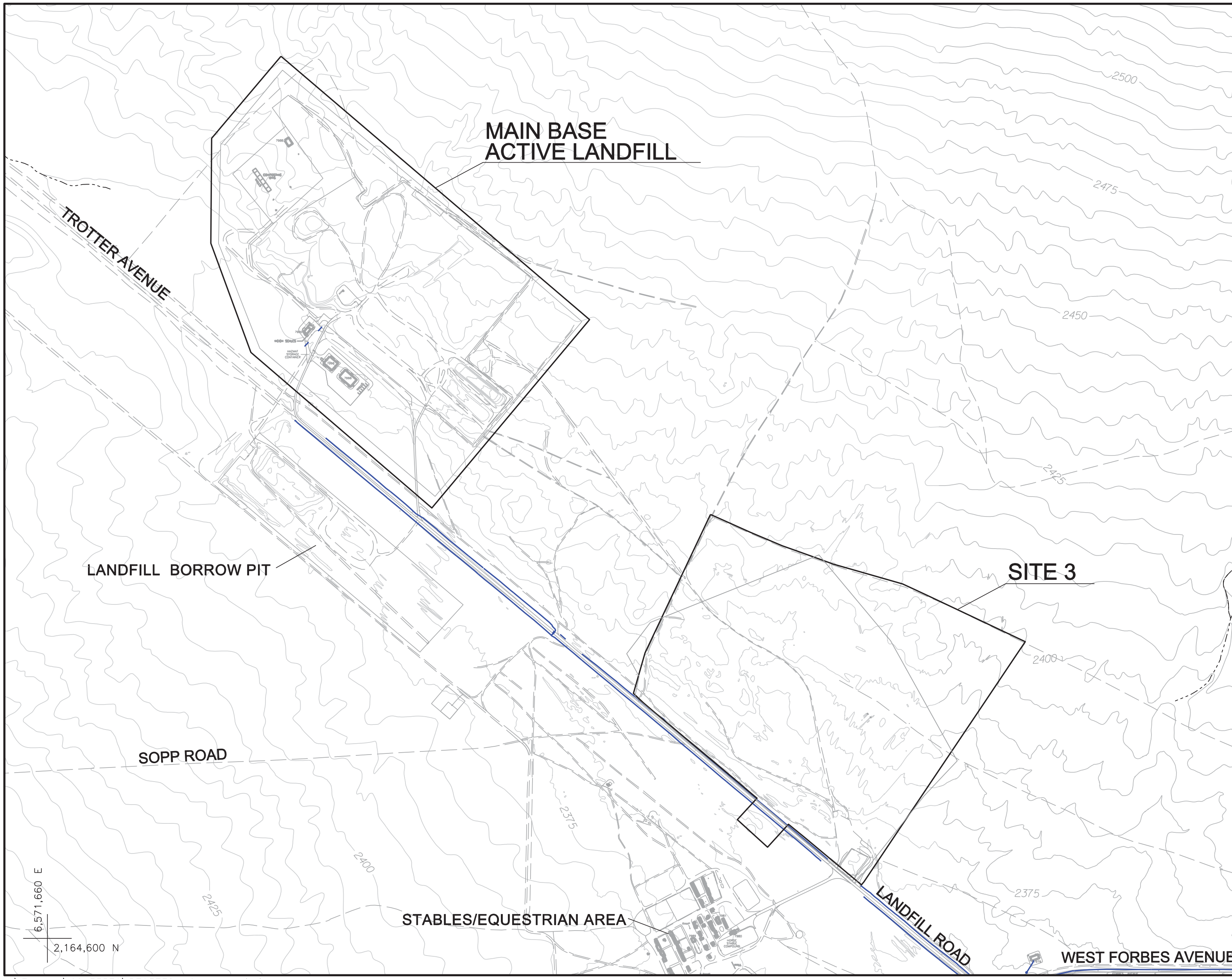

Site 3 ROD

Site 3
Topography and Drainage

Date 07-12
Project No. 60133579

Edwards AFB

Figure 2.5-8

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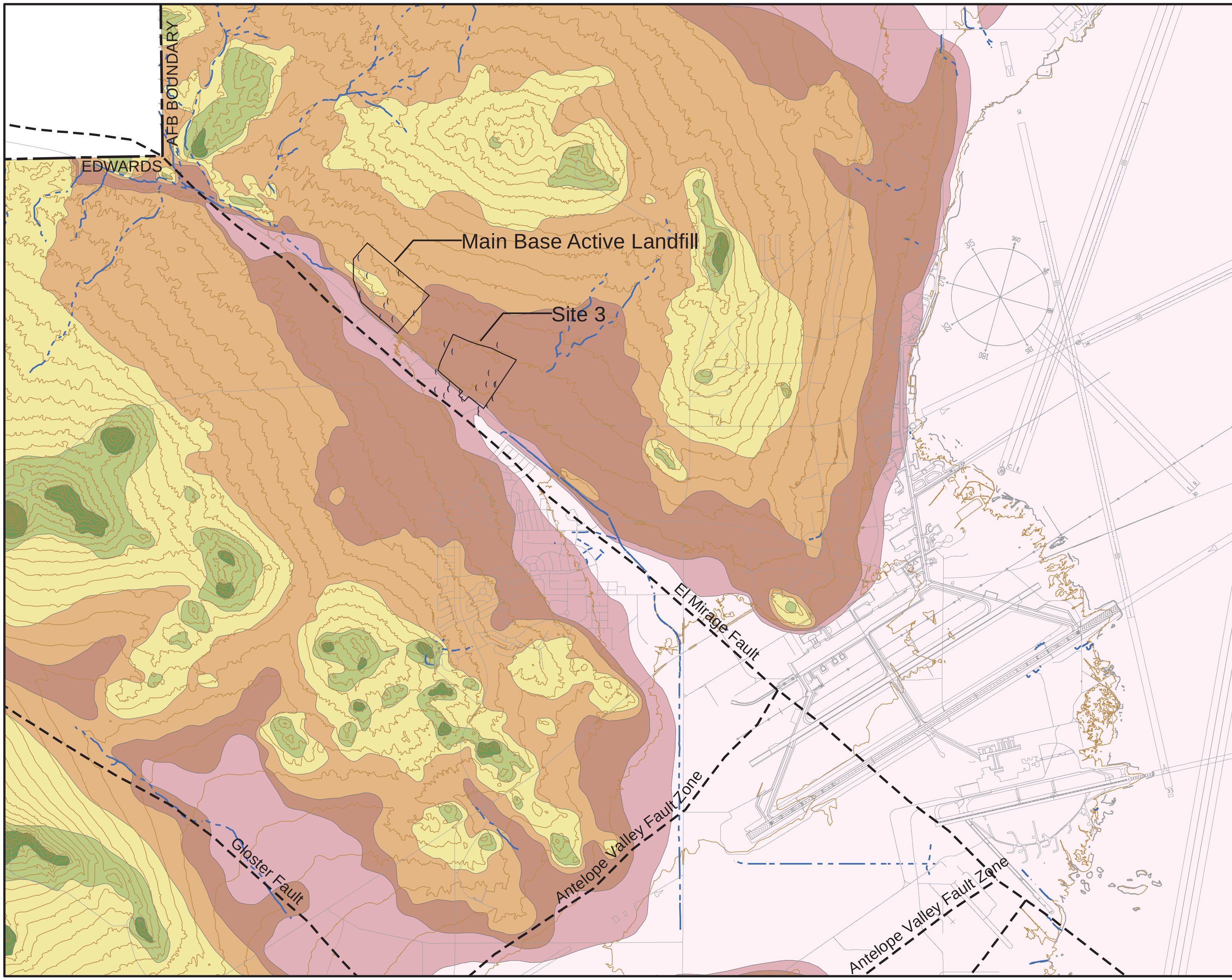

Site 3 ROD

Site 3
Slope Gradient
Main Base Inactive Landfill

Date 07-12	Edwards AFB	Figure
Project No. 60133579		2.5-9

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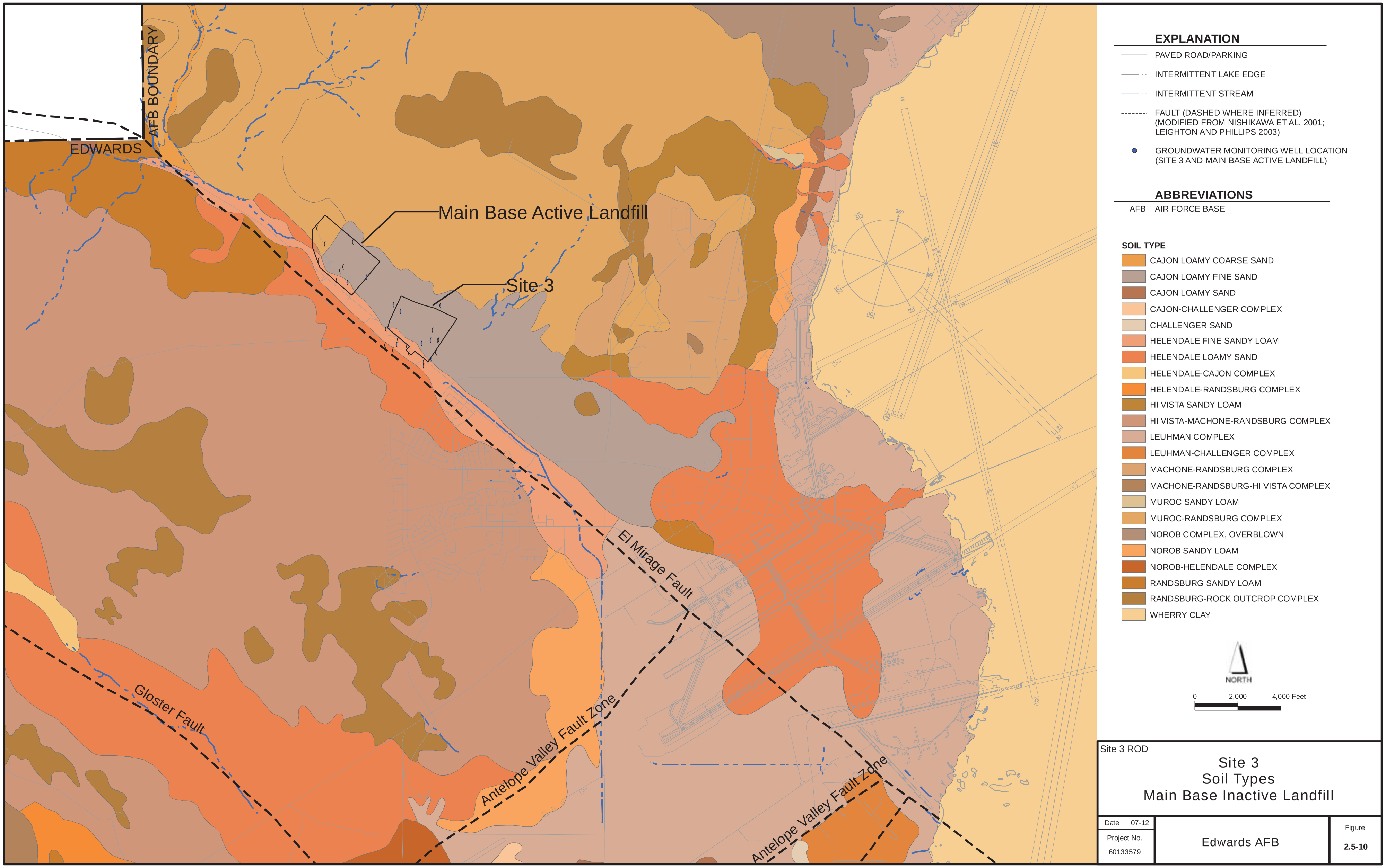

Site 3 ROD

Site 3
Soil Types
Main Base Inactive Landfill

Date 07-12 Project No. 60133579	Edwards AFB	Figure 2.5-10

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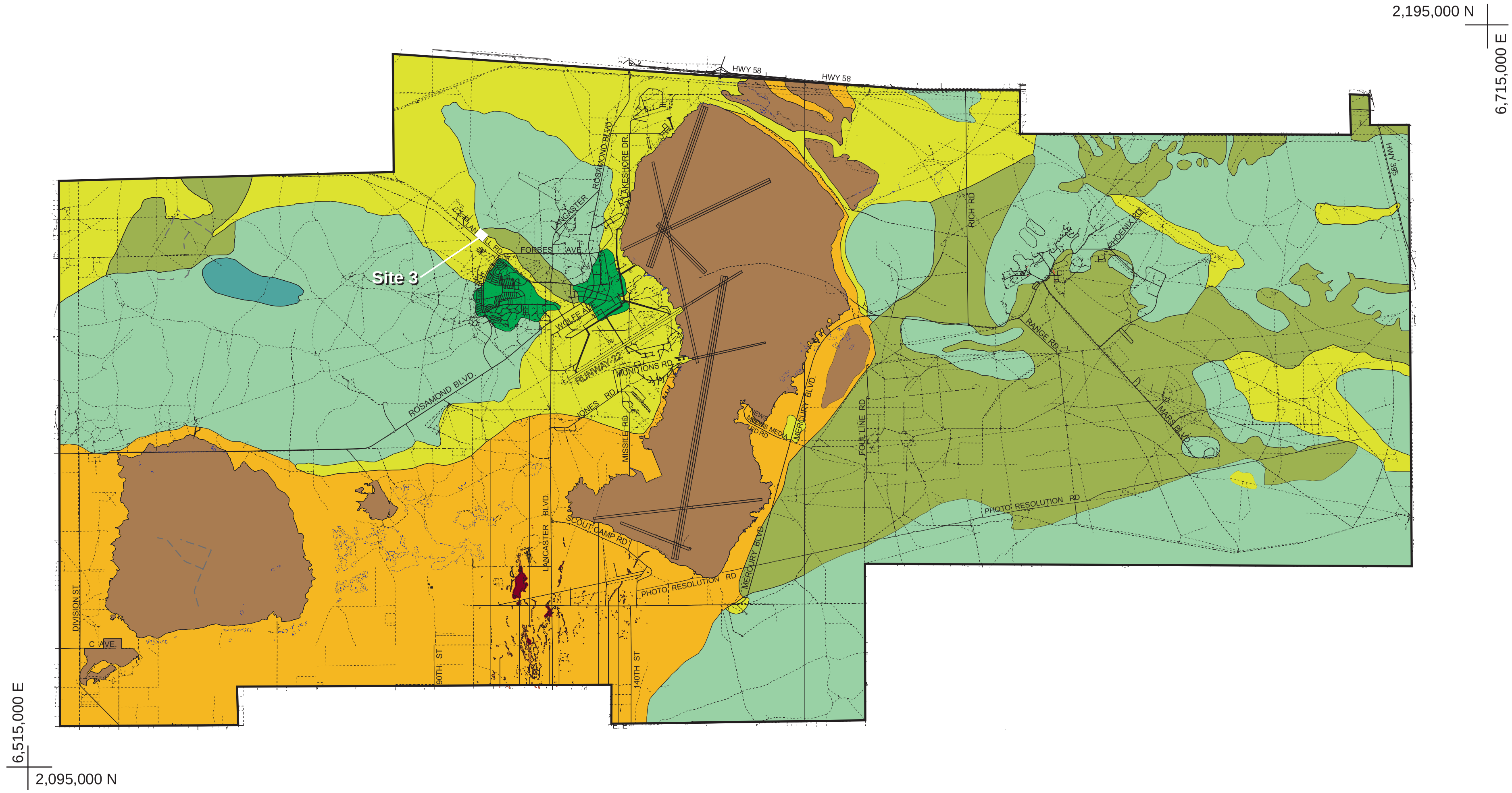


Habitats and Plant Communities

- Xerophytic Saltbush Scrub
- Urban/Developed Areas
- Playa
- Mesquite Woodland
- Joshua Tree Woodland
- Halophytic Saltbush Scrub
- *Hymenoclea-Lycium*
- Creosote Bush Scrub

Explanation

- Paved Roads
- Unpaved Roads
- Base Boundary

North

0 1 2 3 4 miles
Scale

BASE MAP REFERENCE:
GRW Engineers Inc. 1992 Photogrammetric Survey of Edwards AFB, CA. Lexington, KY

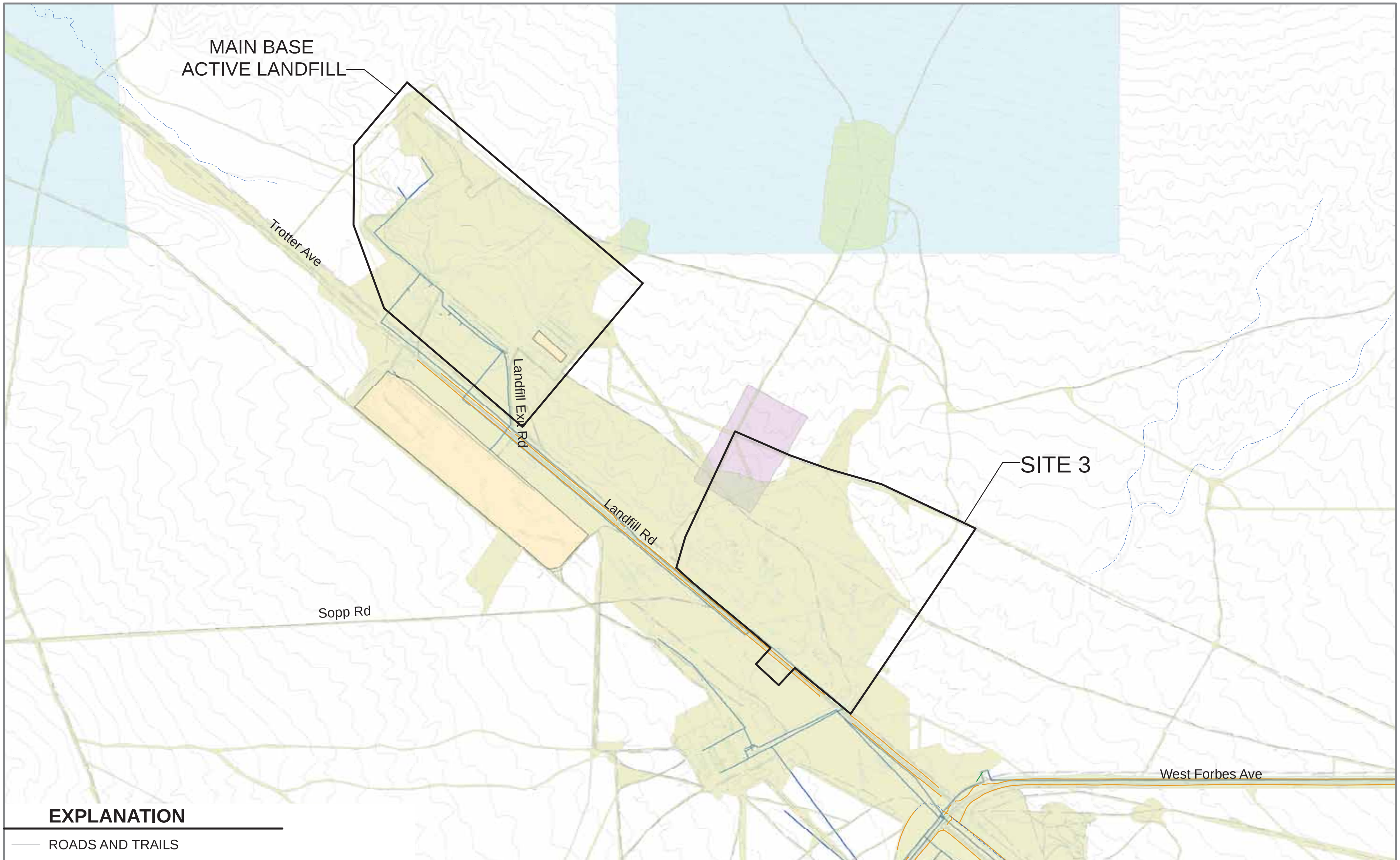
BASE MAP COORDINATES:
North American Datum 1983 (U.S. Feet)

Source: USAF (2002b)

Site 3 ROD

Habitats and Plant Communities at Edwards AFB

Date 07-12	Edwards AFB	Figure
Project No. 60133579		2.5-11



EXPLANATION

- ROADS AND TRAILS
- INTERMITTENT STREAM
- OPEN STORM SEWER DRAINAGE
- WATER LINE
- TOPOGRAPHIC CONTOUR (5-FOOT INTERVAL)
- BORROW PIT
- DISTURBED FAUNA HABITAT
- DESERT CYMOPTERUS STUDY AREA
- DESERT KIT FOX SPECIES AREA

NOTES

1. THE DESERT CYMOPTERUS STUDY AREA OUTLINES THE AREA WHERE A STUDY WAS CONDUCTED IN THE PAST. THE STUDY IS NO LONGER BEING PERFORMED. THERE ARE NO DESERT CYMOPTERUS KNOWN TO EXIST INSIDE THE SITE 3 BOUNDARY. THE DESERT CYMOPTERUS IS A RARE PLANT, BUT IS NOT LISTED.

2. A DESERT KIT FOX DEN MAY HAVE BEEN OBSERVED IN THE PAST IN THE DESERT KIT FOX SPECIES AREA. THE DESERT KIT FOX IS NOT A LISTED SPECIES.

Site 3 ROD

Site 3
Disturbed Fauna Habitat Areas

Date 07-12	Edwards AFB	Figure
Project No. 60133579		**2.5-12**

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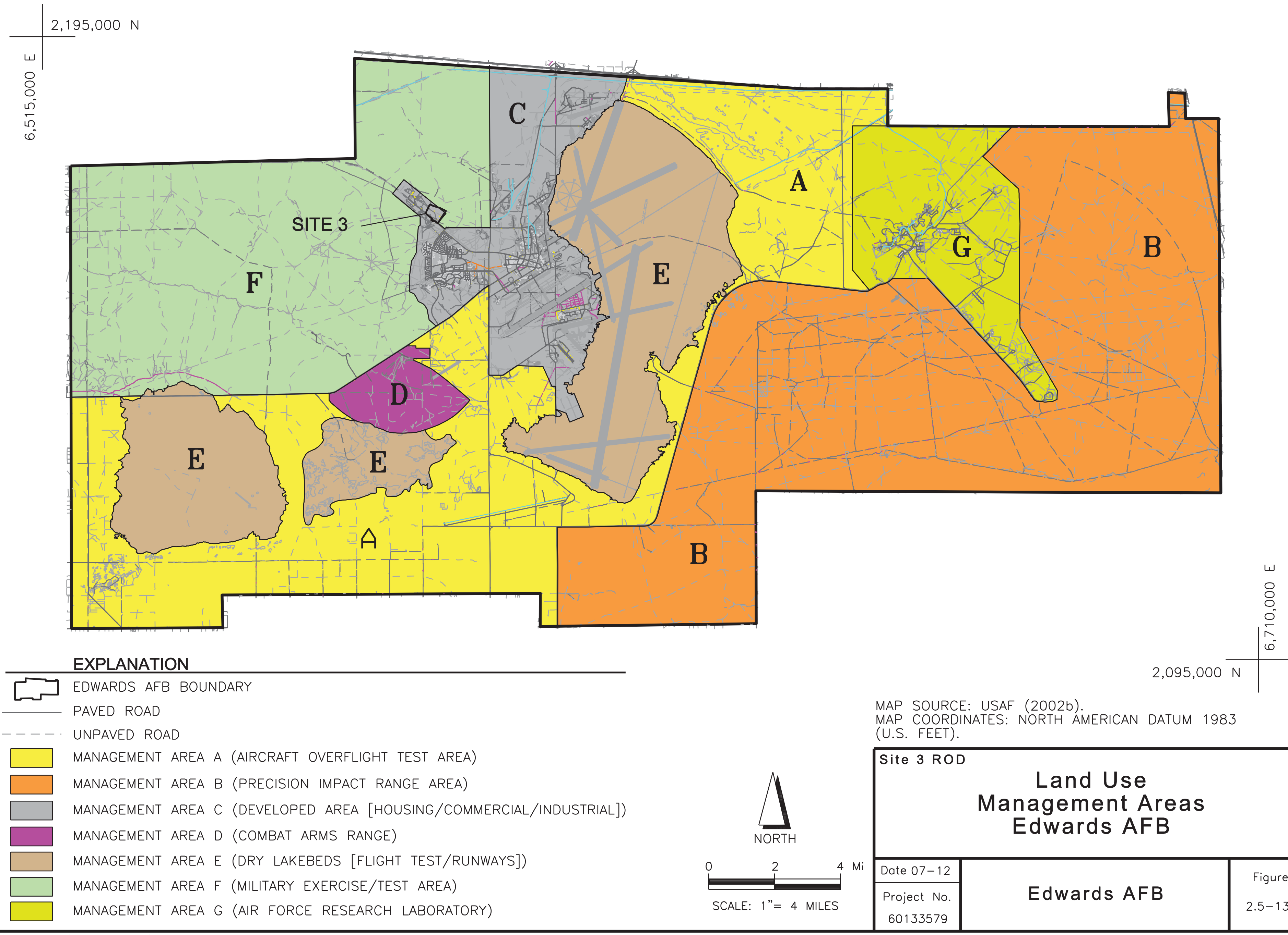

MAP SOURCE: USAF (2002b).
MAP COORDINATES: NORTH AMERICAN DATUM 1983 (U.S. FEET).

Site 3 ROD		
Land Use Management Areas Edwards AFB		
Date 07-12	Edwards AFB	Figure 2.5-13
Project No. 60133579		

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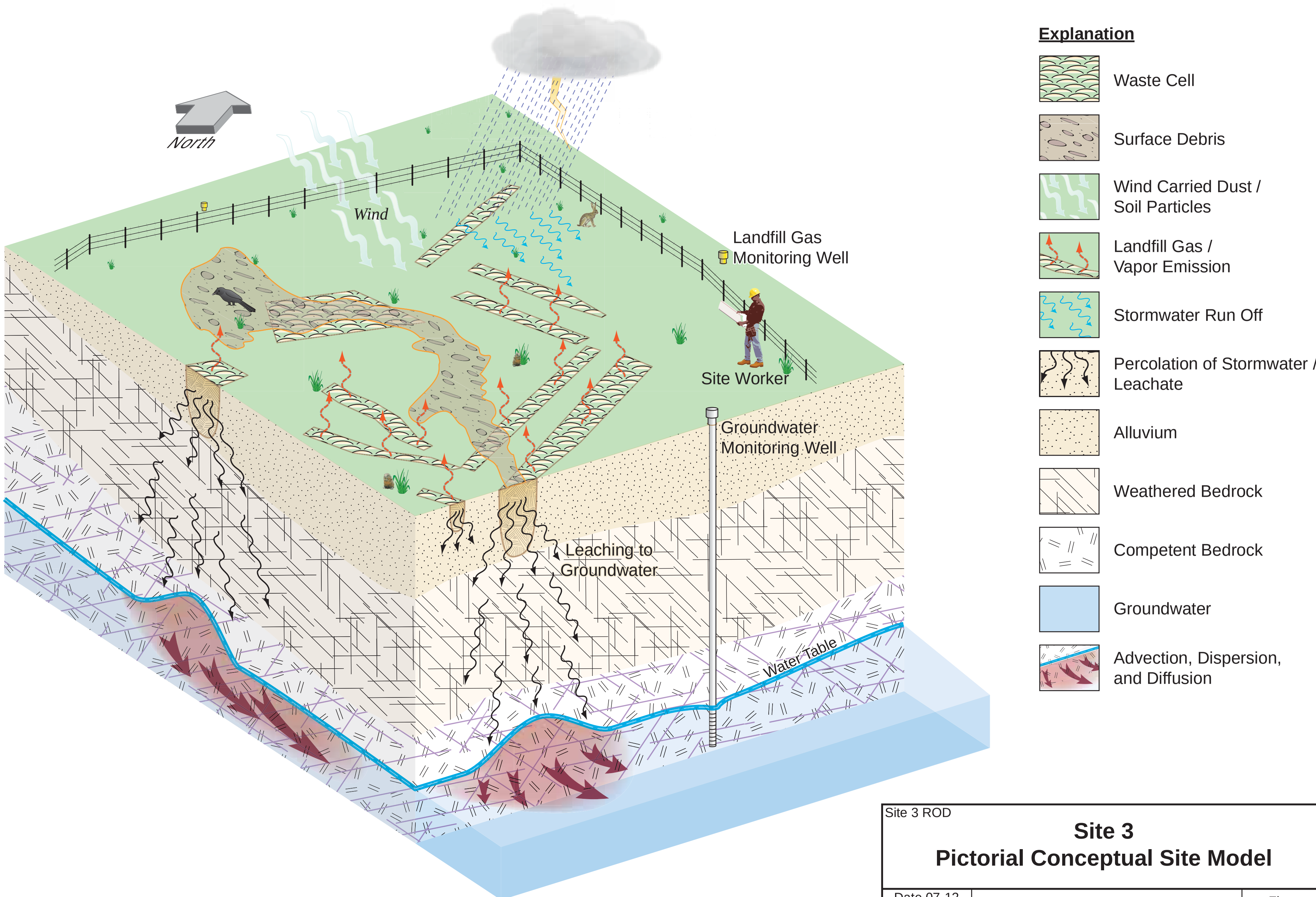
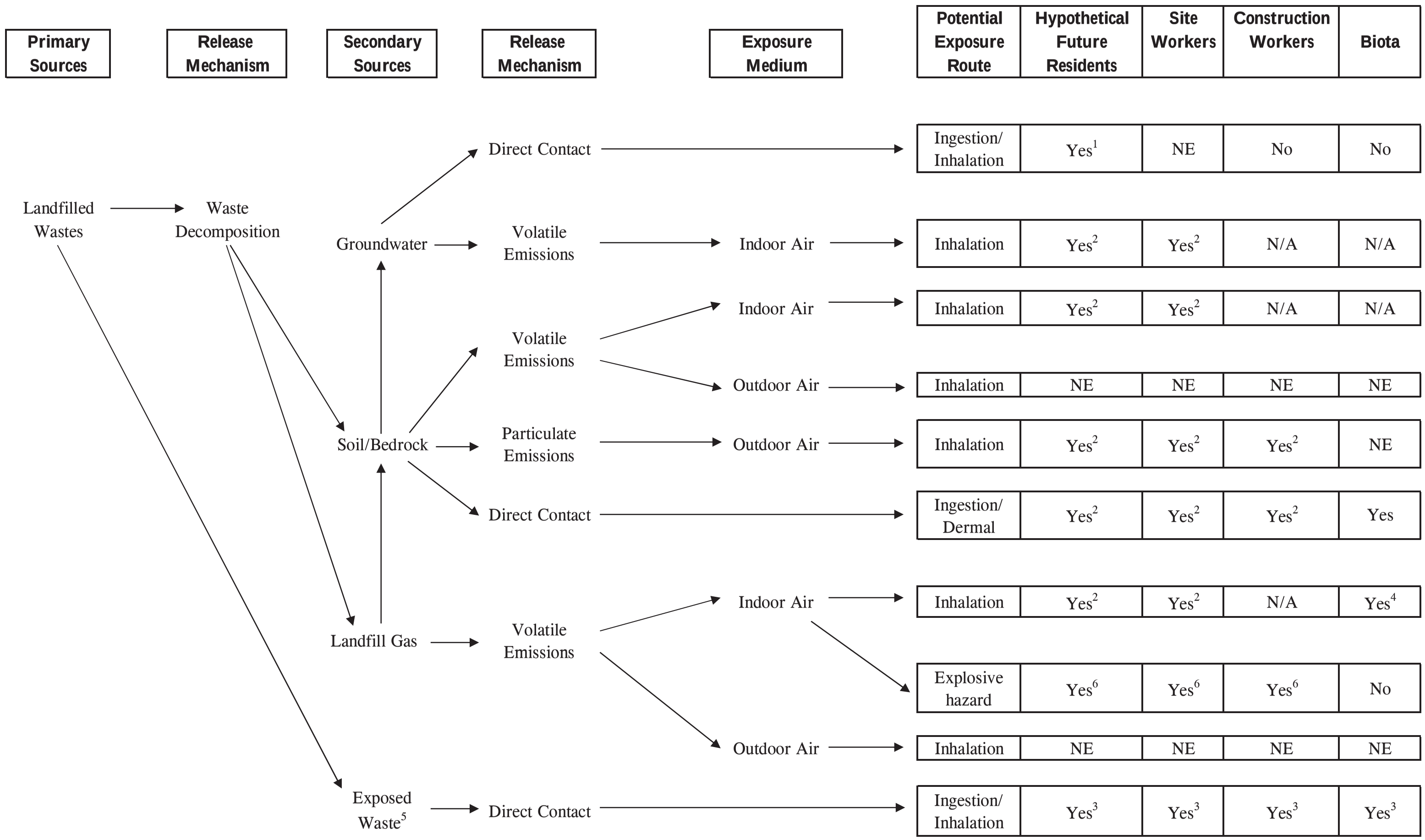


Site 3 ROD

Site 3
Pictorial Conceptual Site Model

Date 07-12 Project No. 60161391	Edwards AFB	Figure **2.6-1**

FIGURE 2.6-2. SITE 3 EXPOSURE PATHWAYS



Notes:

Leachate formed as a result of waste decomposition is a source of groundwater contamination.

[1] Although technically a pathway, sufficient quantities of groundwater do not exist for sustained pumping.

[2] Although technically a pathway, risks are within the risk management range (see Table 2.6-7).

[3] Potential pathway; the presence of hazardous substances has not been confirmed, however, the possibility that these materials are contained within the landfill cannot be reasonably ruled out.

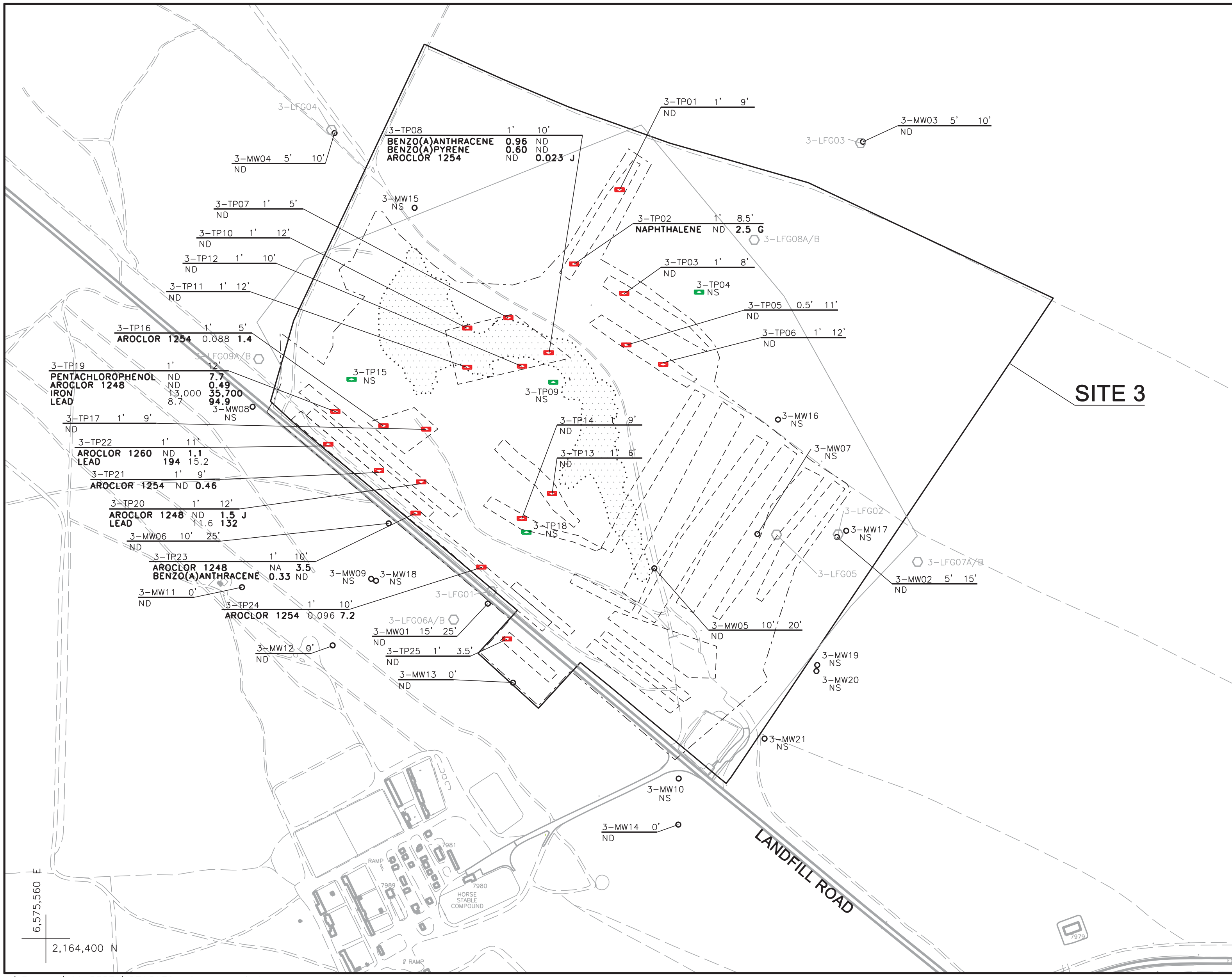
[4] Pathway is for soil vapors accumulating in burrows.

[5] Pathway is for hazardous waste potentially buried in the landfill; hazardous waste has not been detected in surface debris or in site investigation test pits.

[6] Potential explosive hazard from methane in landfill gas to future residents, office workers, or construction workers in confined spaces.

N/A not applicable; receptor is not considered likely to be in contact with the exposure medium.

NE not evaluated; pathway not considered significant by the risk assessors.



EXPLANATION

- TEST PIT LOCATION (BURIED DEBRIS ENCOUNTERED)
- TEST PIT LOCATION (NO BURIED DEBRIS ENCOUNTERED)
- LANDFILL GAS MONITORING WELL LOCATION
- GROUNDWATER MONITORING WELL LOCATION
- AREAL EXTENT OF SURFACE DEBRIS (PREDOMINANTLY CONSTRUCTION AND DEMOLITION WASTE).BASED ON FIELD MAPPING AND REVIEW OF 2002 AERIAL PHOTOGRAPHS.
- INTERPRETED CELL LOCATION
- APPROXIMATE LANDFILL BOUNDARY
- FENCE

mg/kg	MILLIGRAMS PER KILOGRAMS
NA	NOT ANALYZED
ND	NOT DETECTED
NS	NOT SAMPLED
PRG	PRELIMINARY REMEDIATION GOAL (SOURCE: UNITED STATES ENVIRONMENTAL PROTECTION AGENCY 2004)
RSL	REGIONAL SCREENING LEVEL (SOURCE: UNITED STATES ENVIRONMENTAL PROTECTION AGENCY 2010)

LABORATORY DATA QUALIFIERS:

G	ELEVATED REPORTING LIMIT.THE REPORTING LIMIT IS ELEVATED DUE TO MATRIX INTERFERENCE.
J	ESTIMATED RESULT. RESULT IS LESS THAN THE REPORTING LIMIT.

NOTES:

1. ORGANIC ANALYTES DETECTED ABOVE THE 2004 RESIDENTIAL PRGs OR 2010 RSLs ARE SHOWN.
2. INORGANIC ANALYTES DETECTED ABOVE BOTH THE BACKGROUND VALUES AND RESIDENTIAL PRGs OR 2010 RSLs ARE SHOWN.
3. CONCENTRATIONS THAT EXCEED RESIDENTIAL PRGs OR 2010 RSLs ARE IN BOLD.
4. ALL PARAMETER UNITS ARE mg/kg, EXCEPT WHERE NOTED.

NORTH

0 200 400 FEET

SCALE: 1"= 400'

Site 3 ROD

Site 3 Concentrations of Contaminants in Soil Exceeding Background Concentrations,RSLs,and PRGs

Date 07-12	Edwards AFB	Figure 2.6-3
Project No. 60133579		

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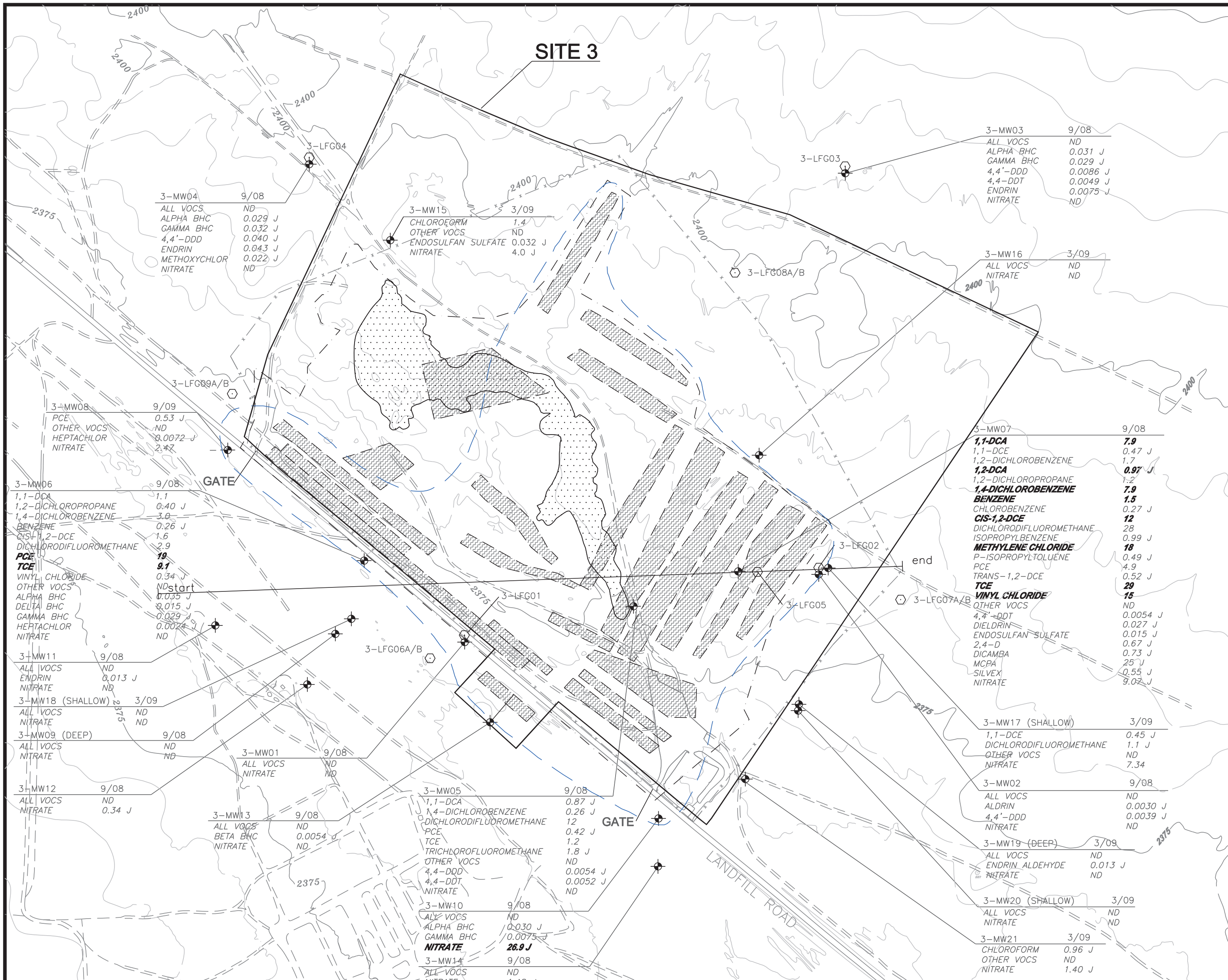

EXPLANATION

AREA COVERED WITH SURFACE DEBRIS. PREDOMINANTLY CONSTRUCTION AND DEMOLITION WASTE, AS MAPPED IN THE FIELD AND NOTED ON AERIAL PHOTOGRAPHS TAKEN ON 01-01-92.

INTERPRETED CELL LOCATION

APPROXIMATE LANDFILL BOUNDARY

ESTIMATED EXTENT OF POTENTIALLY IMPACTED GROUNDWATER ABOVE MCLS

FENCE

2400 TOPOGRAPHIC CONTOUR (FEET ABOVE MEAN SEA LEVEL)

LOCATION OF CROSS SECTION (SEE FIGURE 2.6-5)

3-MW02 GROUNDWATER MONITORING WELL LOCATION

3-LFG02 LANDFILL GAS MONITORING WELL LOCATION

2,4-D	(2,4-DICHLOROPHENOXY) ACETIC ACID
BHC	HEXACHLOROCYCLOHEXANE
DCA	DICHLOROETHANE
DCE	DICHLOROETHENE
DDD	DICHLORODIPHENYLDICHLOROETHANE
DDT	DICHLORODIPHENYLTRICHLOROETHANE
MCL	MAXIMUM CONTAMINANT LEVEL
MCPA	2-METHYL-4-CHLOROPHENOXYACETIC ACID
ND	NOT DETECTED
PCE	TETRACHLOROETHENE
ROD	RECORD OF DECISION
SILVEX	2,4,5-TRICHLOROPHENOXY-ALPHA-PROPANOIC ACID
TCE	TRICHLOROETHENE
VOCS	VOLATILE ORGANIC COMPOUNDS

DATA VALIDATION QUALIFIER

J ESTIMATED VALUE.

NOTES

1. ALL CONCENTRATIONS ARE IN MICROGRAMS PER LITER ($\mu g/L$); EXCEPT NITRATE CONCENTRATIONS ARE IN MILLIGRAMS PER LITER (mg/L).
2. BOLD FONT INDICATES ANALYTE EXCEEDING RESPECTIVE MCL (SOURCE: CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (2008)).
2. HIGHEST RESULT SHOWN FOR DUPLICATE SAMPLES.

NORTH

0 200 400 FEET

SCALE IN FEET

Site 3 ROD

Site 3
Organic Compounds and Nitrate Detected in Groundwater September 2008 and March 2009

Date 07-12

Project No. 60133579

Edwards AFB

Figure 2.6-4

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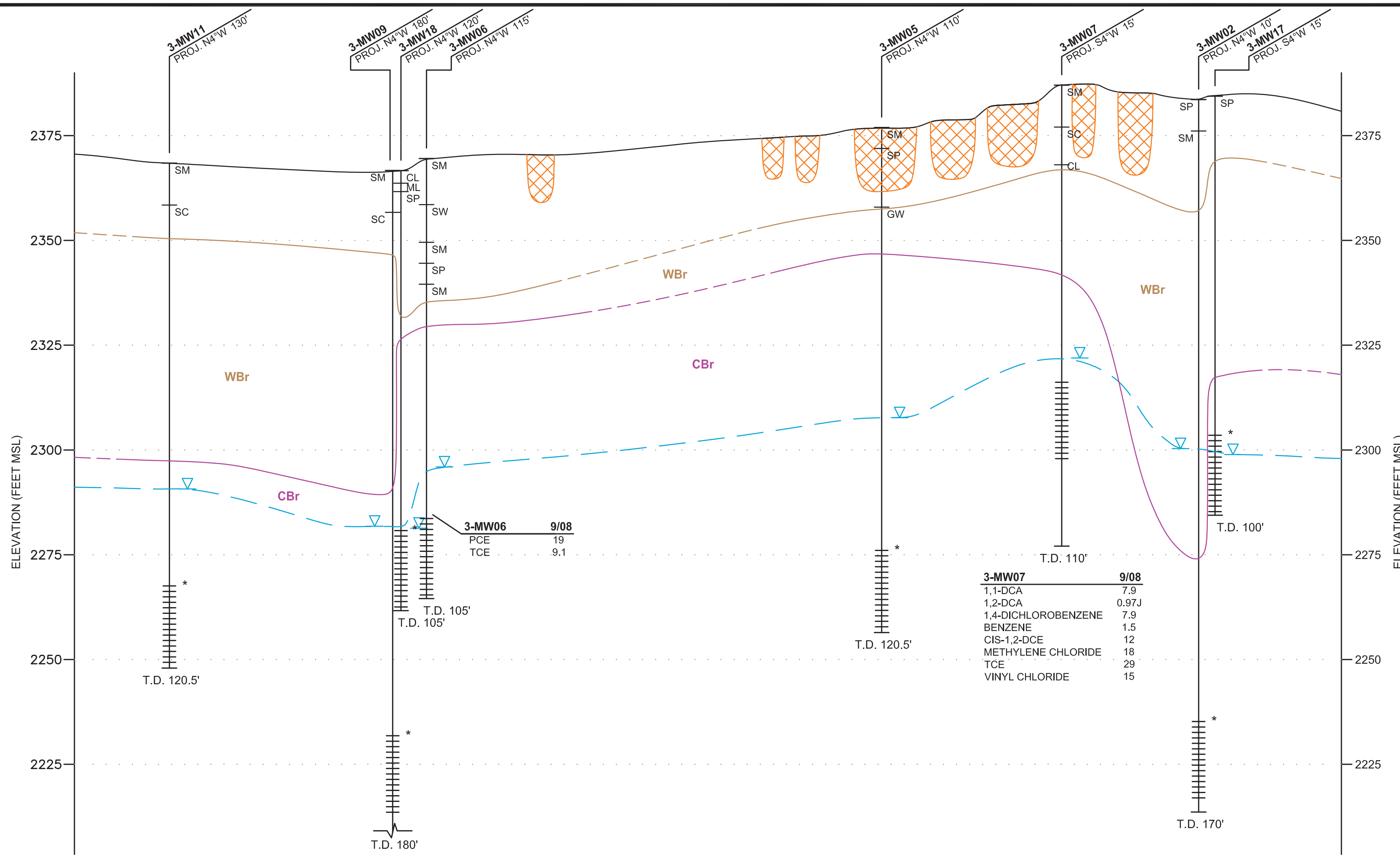

3-MW06	9/08
PCE	19
TCE	9.1

3-MW07	9/08
1,1-DCA	7.9
1,2-DCA	0.97J
1,4-DICHLOROBENZENE	7.9
BENZENE	1.5
CIS-1,2-DCE	12
METHYLENE CHLORIDE	18
TCE	29
VINYL CHLORIDE	15

EXPLANATION

- SCREENED INTERVAL
- WATER LEVEL
- ALLUVIUM – WBr – CONTACT
- WBr – CBr CONTACT
- GROUNDWATER POTENTIOMETRIC SURFACE BASED ON APRIL 2009 DATA
- WASTE UNIT CELLS

Alluv	ALLUVIUM
CBr	COMPETENT BEDROCK
CL	CLAY
DCA	DICHLOROETHANE
DCE	DICHLOROETHENE
MCL	MAXIMUM CONTAMINANT LEVEL
ML	SANDY SILT
MSL	MEAN SEA LEVEL
NE	NORTHEAST
PCE	TETRACHLOROETHENE
PROJ.	PROJECTED
ROD	RECORD OF DECISION
SC	CLAYEY SAND
SM	SILTY SAND
SP	SAND
SW	SOUTHWEST
TCE	TRICHLOROETHENE
T.D.	TOTAL DEPTH (IN FEET BELOW GROUND SURFACE)
WBr	WEATHERED BEDROCK
*	NO CONTAMINANTS DETECTED AT CONCENTRATIONS ABOVE MCLs

NOTES

1. SEE FIGURE 2.6–4 FOR CROSS SECTION LINE.
2. ALL CONCENTRATIONS ARE IN MICROGRAMS PER LITER (µg/L).
3. ONLY CONTAMINANTS EXCEEDING RESPECTIVE MCLs ARE LISTED (SOURCE: CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (2008)).

0 125 250 FT
HORIZONTAL SCALE IN FEET

0 12.5 25 FT
VERTICAL SCALE IN FEET
VERTICAL EXAGGERATION: 1:10

Site 3 ROD

Site 3
Vertical Extent of Contaminants
Detected in Groundwater
September 2008 and March 2009

Date 07–12
Project No. 60161391
Edwards AFB
Figure 2.6–5

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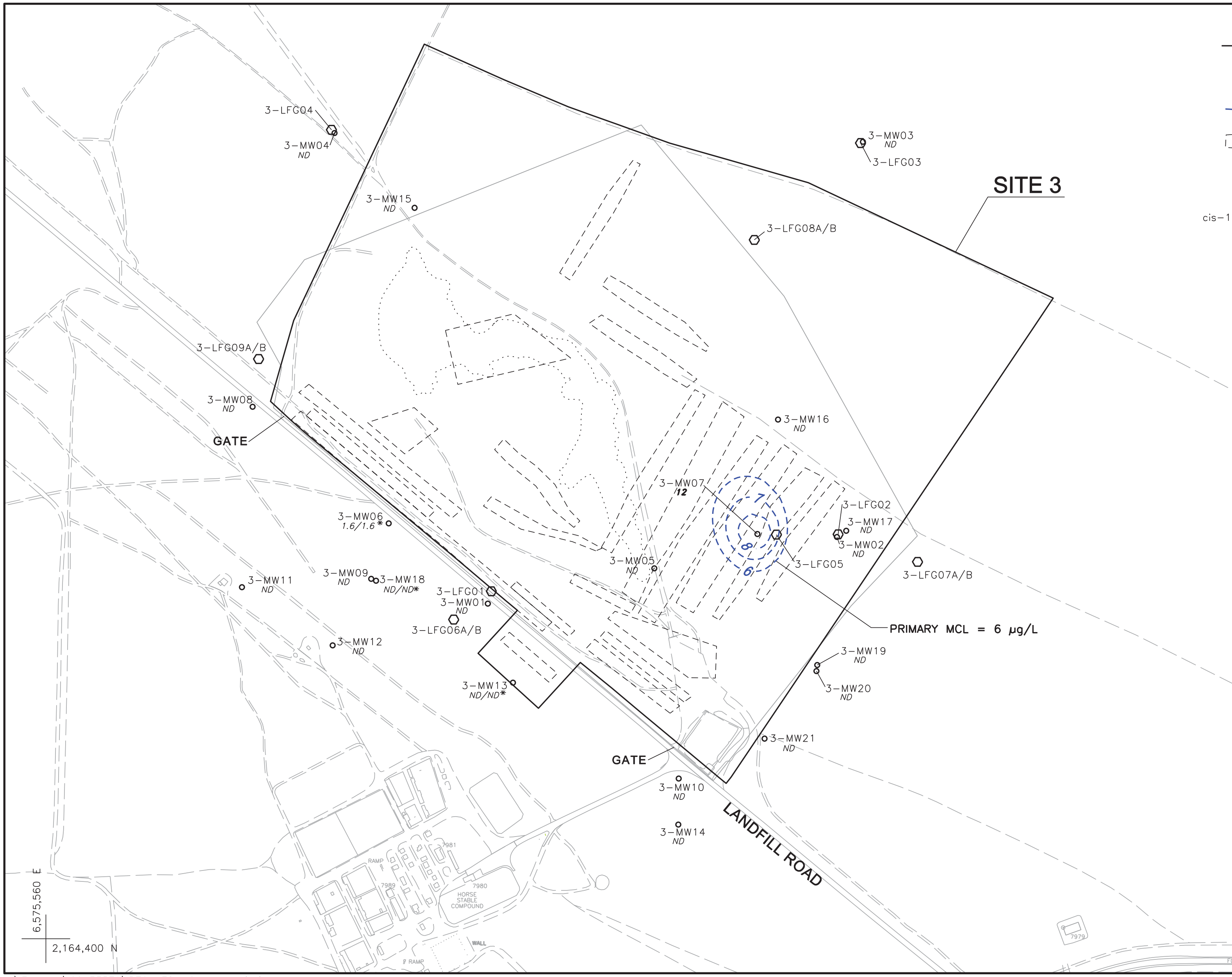

EXPLANATION

- o MONITORING WELL LOCATION WITH cis-1,2-DCE CONCENTRATIONS IN μg/L
- ⬡ LANDFILL GAS MONITORING WELL LOCATION
- — 6 — cis-1,2-DCE CONTOUR (DASHED WHERE INFERRED)
- [dashed box] INTERPRETED LANDFILL CELL LOCATION
- * DUPLICATE SAMPLE

μg/L MICROGRAMS PER LITER
cis-1,2-DCE cis-1,2-DICHLOROETHENE
MCL MAXIMUM CONTAMINANT LEVEL (SOURCE: CALIFORNIA DEPARTMENT OF PUBLIC HEALTH 2008)
ND NOT DETECTED

NOTE

1. CONCENTRATIONS IN BOLD EXCEED THE PRIMARY MCL OF 6 μg/L.

MONITORING WELL	cis-1,2-DCE CONCENTRATION (μg/L)
3-MW01	ND
3-MW02	ND
3-MW03	ND
3-MW04	ND
3-MW05	ND
3-MW06	1.6/1.6*
3-MW07	**12**
3-MW08	ND
3-MW09	ND
3-MW10	ND
3-MW11	ND
3-MW12	ND
3-MW13	ND/ND*
3-MW14	ND
3-MW15	ND
3-MW16	ND
3-MW17	ND
3-MW18	ND/ND*
3-MW19	ND
3-MW20	ND
3-MW21	ND

Site 3 ROD

Site 3 cis-1,2-DCE Concentrations in Groundwater September 2008 and March 2009

Date 07-12
Project No. 60133579
Edwards AFB
Figure 2.6-6

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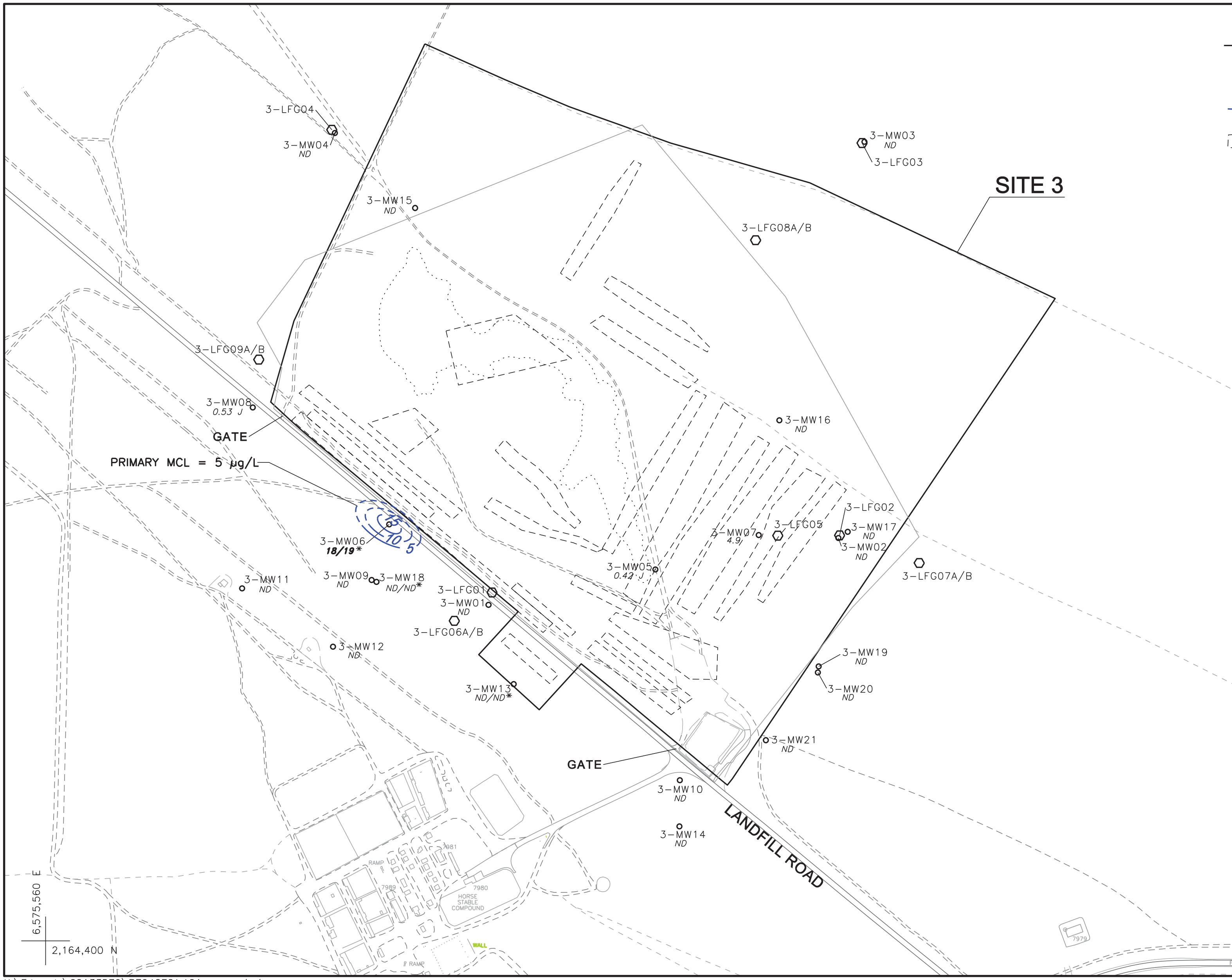

EXPLANATION

- ○ MONITORING WELL LOCATION WITH PCE CONCENTRATIONS IN μg/L
- ⬡ LANDFILL GAS MONITORING WELL LOCATION
- — 5 — PCE CONTOUR (DASHED WHERE INFERRED)
- [ ] INTERPRETED LANDFILL CELL LOCATION
- * DUPLICATE SAMPLE
- μg/L MICROGRAMS PER LITER
- MCL MAXIMUM CONTAMINANT LEVEL (SOURCE: CALIFORNIA DEPARTMENT OF PUBLIC HEALTH 2008)
- ND NOT DETECTED
- PCE TETRACHLOROETHENE

DATA VALIDATION QUALIFIER:

J ESTIMATED VALUE.

NOTE

1. CONCENTRATIONS IN BOLD EXCEED THE PRIMARY MCL OF 5 μg/L.

MONITORING WELL	PCE CONCENTRATION (μg/L)
3-MW01	ND
3-MW02	ND
3-MW03	ND
3-MW04	ND
3-MW05	0.42 J
3-MW06	**18/19** *
3-MW07	4.9
3-MW08	0.53 J
3-MW09	ND
3-MW10	ND
3-MW11	ND
3-MW12	ND
3-MW13	ND/ND*
3-MW14	ND
3-MW15	ND
3-MW16	ND
3-MW17	ND
3-MW18	ND/ND*
3-MW19	ND
3-MW20	ND
3-MW21	ND

NORTH

0 200 400 FEET

SCALE: 1"= 400'

Site 3 ROD

Site 3 PCE Concentrations in Groundwater September 2008 and March 2009

Date 07-12

Project No. 60133579

Edwards AFB

Figure 2.6-7

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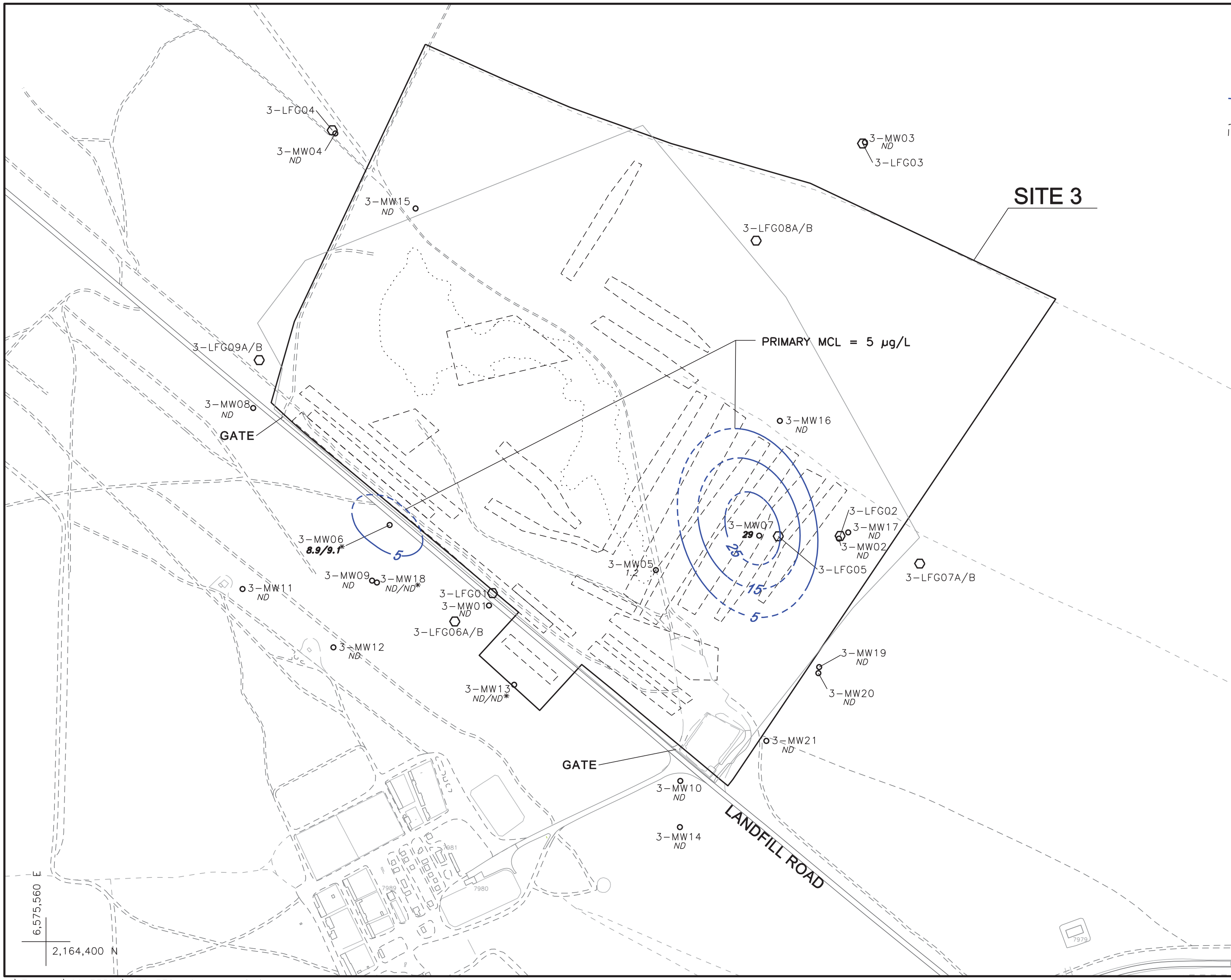

EXPLANATION

o	MONITORING WELL LOCATION WITH TCE CONCENTRATIONS IN μg/L
⬡	LANDFILL GAS MONITORING WELL LOCATION
—10—	TCE CONTOUR (DASHED WHERE INFERRED)
[ ]	INTERPRETED LANDFILL CELL LOCATION
*	DUPLICATE SAMPLE
μg/L	MICROGRAMS PER LITER
MCL	MAXIMUM CONTAMINANT LEVEL (SOURCE: CALIFORNIA DEPARTMENT OF PUBLIC HEALTH 2008)
ND	NOT DETECTED
TCE	TRICHLOROETHENE

DATA VALIDATION QUALIFIER:

J ESTIMATED VALUE.

NOTE

1. CONCENTRATIONS IN BOLD EXCEED THE PRIMARY MCL OF 5 μg/L.

MONITORING WELL	TCE CONCENTRATION (μg/L)
3-MW01	ND
3-MW02	ND
3-MW03	ND
3-MW04	ND
3-MW05	1.2
3-MW06	**8.9/9.1***
3-MW07	**29**
3-MW08	ND
3-MW09	ND
3-MW10	ND
3-MW11	ND
3-MW12	ND
3-MW13	ND/ND*
3-MW14	ND
3-MW15	ND
3-MW16	ND
3-MW17	ND
3-MW18	ND/ND*
3-MW19	ND
3-MW20	ND
3-MW21	ND

NORTH

0 200 400 FEET

SCALE: 1"= 400'

Site 3 ROD

Site 3 TCE Concentrations in Groundwater September 2008 and March 2009

Date 07-12		Figure
Project No. 60133579	Edwards AFB	2.6-8

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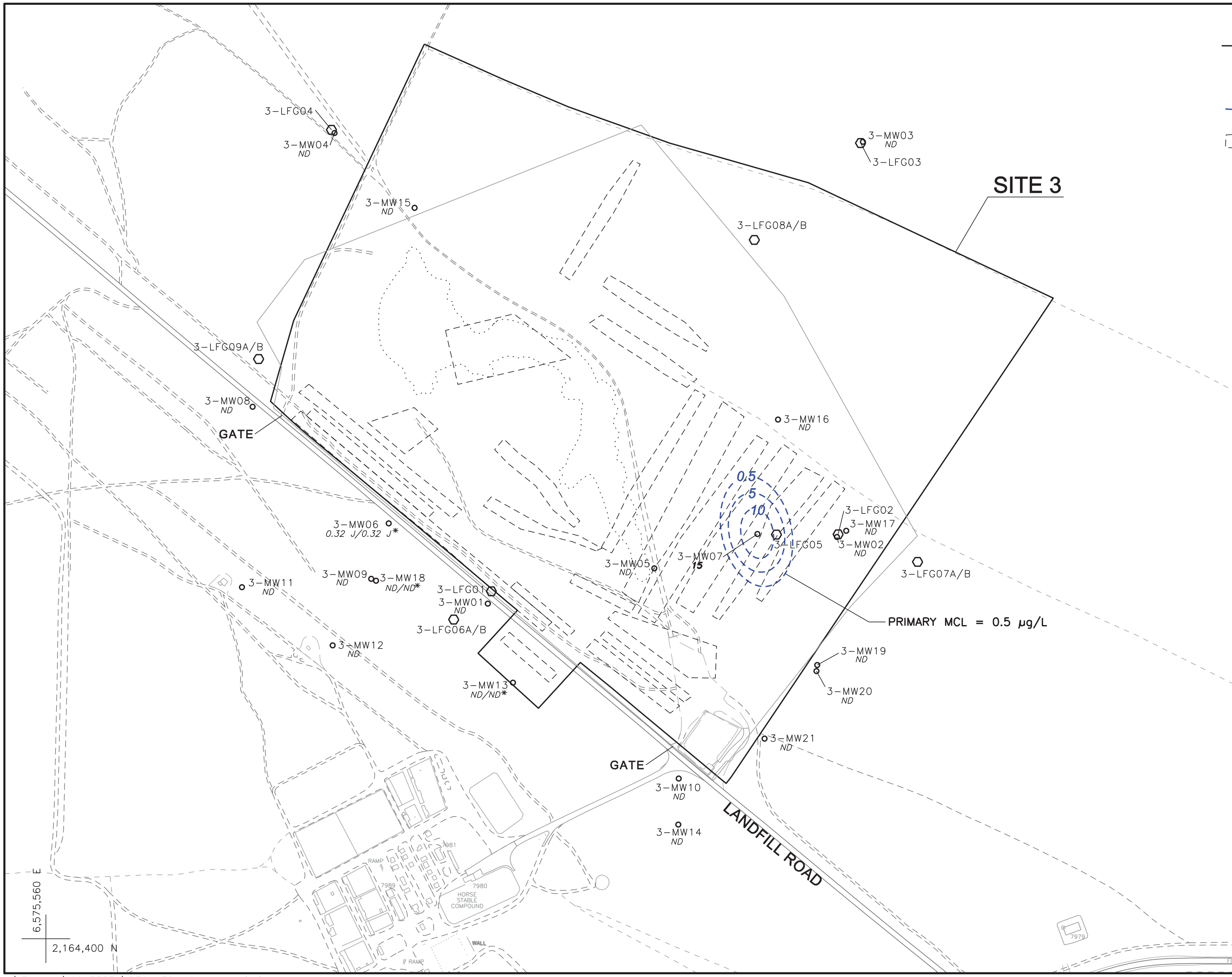

EXPLANATION

- ○ MONITORING WELL LOCATION WITH VINYL CHLORIDE CONCENTRATIONS IN µg/L
- ⬡ LANDFILL GAS MONITORING WELL LOCATION
- — 5 — VINYL CHLORIDE CONTOUR (DASHED WHERE INFERRED)
- [ ] INTERPRETED LANDFILL CELL LOCATION
- * DUPLICATE SAMPLE

µg/L MICROGRAMS PER LITER
MCL MAXIMUM CONTAMINANT LEVEL (SOURCE: CALIFORNIA DEPARTMENT OF PUBLIC HEALTH 2008)
ND NOT DETECTED

DATA VALIDATION QUALIFIER:

J ESTIMATED VALUE.

NOTE

1. CONCENTRATIONS IN BOLD EXCEED THE PRIMARY MCL 0.5 µg/L.

MONITORING WELL	VINYL CHLORIDE CONCENTRATION (µg/L)
3-MW01	ND
3-MW02	ND
3-MW03	ND
3-MW04	ND
3-MW05	ND
3-MW06	0.32 J/0.34 J*
3-MW07	**15**
3-MW08	ND
3-MW09	ND
3-MW10	ND
3-MW11	ND
3-MW12	ND
3-MW13	ND/ND*
3-MW14	ND
3-MW15	ND
3-MW16	ND
3-MW17	ND
3-MW18	ND/ND*
3-MW19	ND
3-MW20	ND
3-MW21	ND

NORTH

0 200 400 FEET

SCALE: 1"= 400'

Site 3 ROD

Site 3
Vinyl Chloride Concentrations in Groundwater September 2008 and March 2009

Date 07-12
Project No. 60133579
Edwards AFB
Figure 2.6-9

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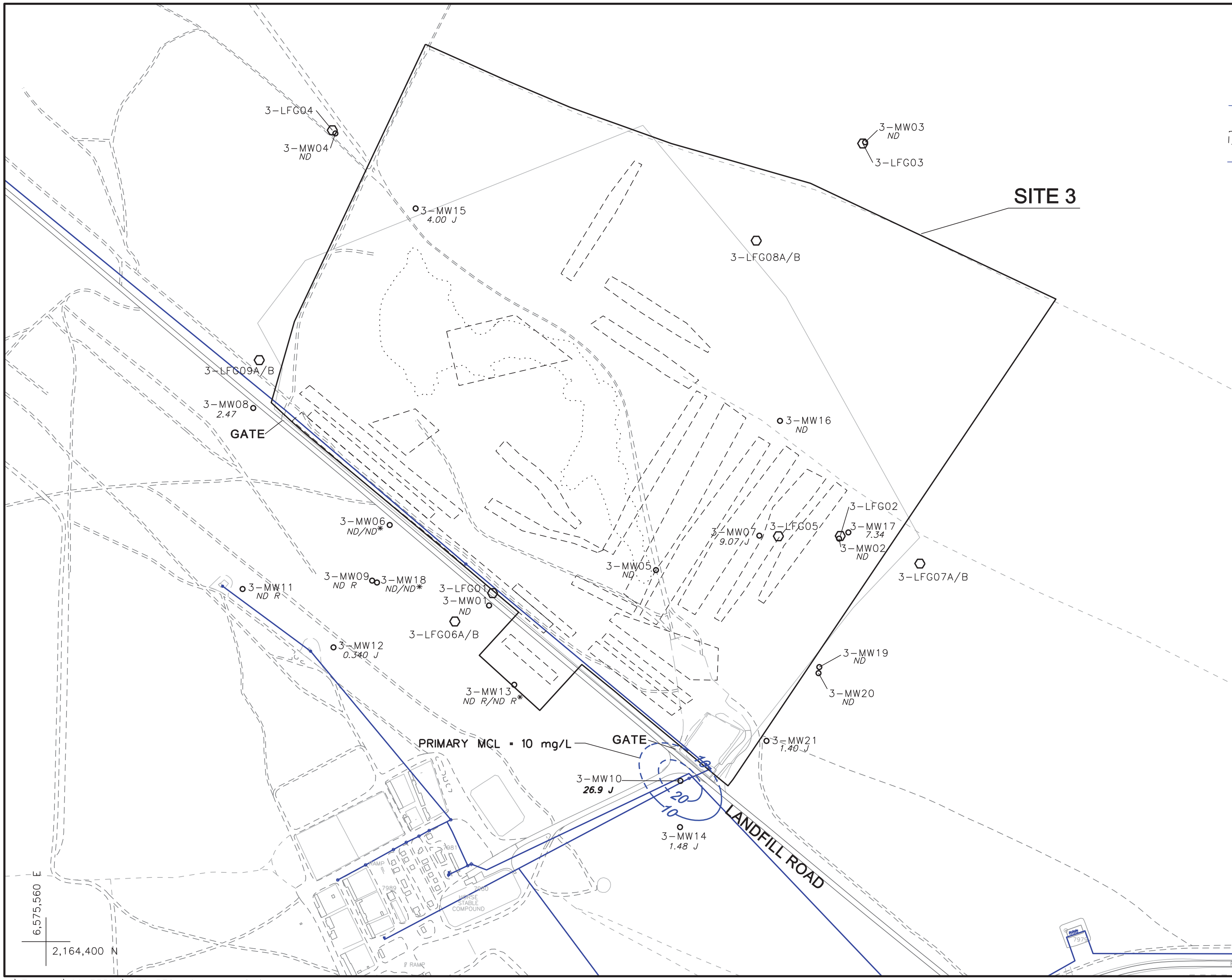

EXPLANATION

- ○ MONITORING WELL LOCATION WITH NITRATE CONCENTRATIONS IN mg/L
- ⬡ LANDFILL GAS MONITORING WELL LOCATION
- —10— NITRATE CONTOUR (DASHED WHERE INFERRED)
- INTERPRETED LANDFILL CELL LOCATION
- WATER LINE
- * DUPLICATE SAMPLE

mg/L MILLIGRAMS PER LITER
MCL MAXIMUM CONTAMINANT LEVEL (SOURCE: CALIFORNIA DEPARTMENT OF PUBLIC HEALTH 2008)
ND NOT DETECTED

DATA VALIDATION QUALIFIER:

J ESTIMATED VALUE.
R RESULT ND BUT REJECTED

NOTE

1. CONCENTRATIONS IN BOLD EXCEED THE PRIMARY MCL.

MONITORING WELL	NITRATE CONCENTRATION (mg/L)
3-MW01	ND
3-MW02	ND
3-MW03	ND
3-MW04	ND
3-MW05	ND
3-MW06	ND/ND*
3-MW07	9.07 J
3-MW08	2.47
3-MW09	ND R
3-MW10	**26.9 J**
3-MW11	ND R
3-MW12	0.340 J
3-MW13	ND R/ND*R
3-MW14	1.48 J
3-MW15	4.00 J
3-MW16	ND
3-MW17	7.34
3-MW18	ND/ND*
3-MW19	ND
3-MW20	ND
3-MW21	1.40 J

Site 3 ROD

Site 3
Nitrate Concentrations
in Groundwater
September 2008 and March 2009

Date 07-12
Project No. 60133579
Edwards AFB
Figure 2.6-10

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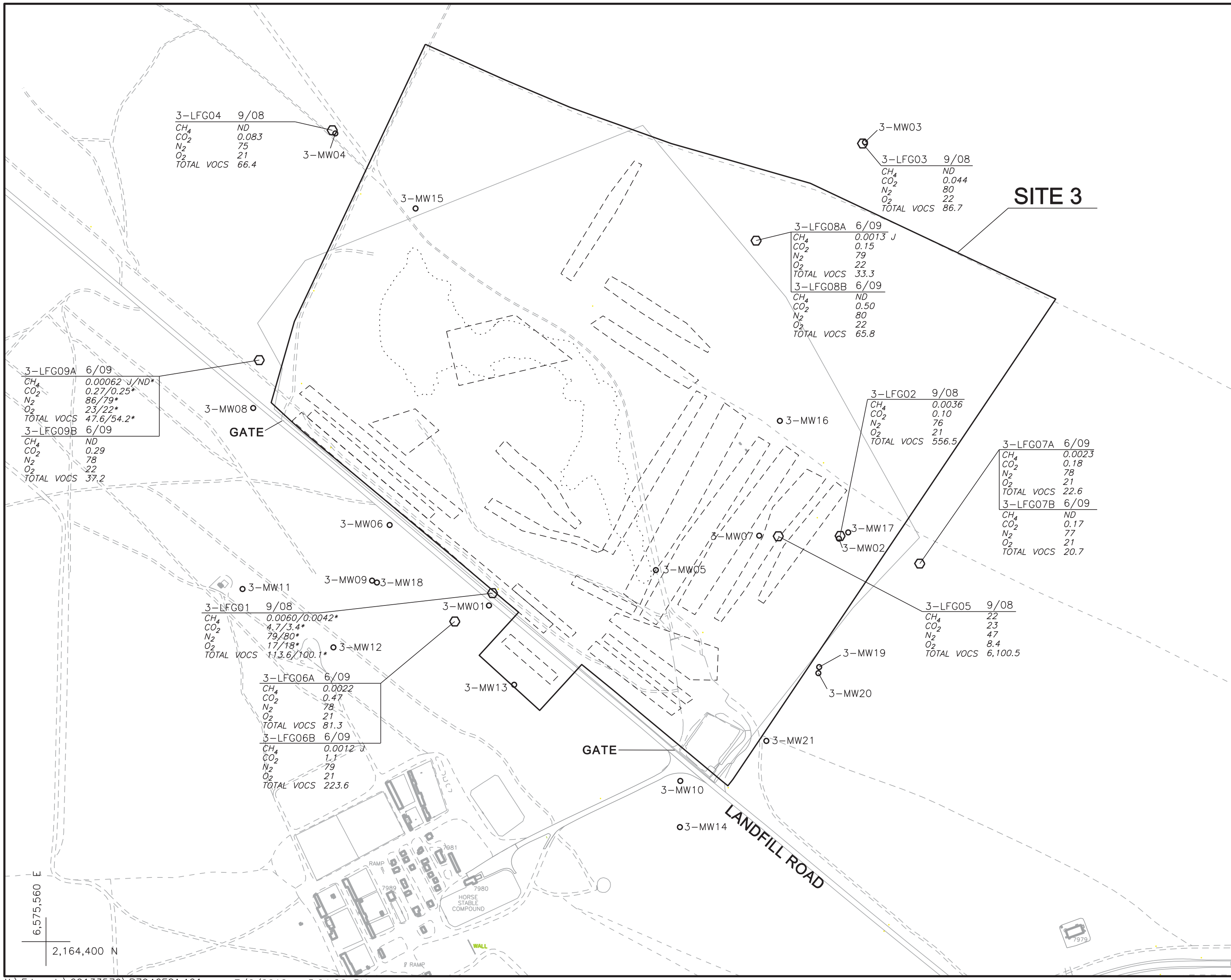

EXPLANATION

- ○ MONITORING WELL LOCATION
- ⬡ LANDFILL GAS MONITORING WELL LOCATION
- [ ] INTERPRETED LANDFILL CELL LOCATION
- * DUPLICATE SAMPLE

CH_4	METHANE
CO_2	CARBON DIOXIDE
N_2	NITROGEN
ND	NOT DETECTED
O_2	OXYGEN
VOC	VOLATILE ORGANIC COMPOUNDS

DATA VALIDATION QUALIFIER:

J ESTIMATED VALUE

NOTES

1. RESULTS FOR FIXED GASES (METHANE, CARBON DIOXIDE, NITROGEN AND OXYGEN) ARE IN PERCENT BY VOLUME (% v/v).
2. RESULTS FOR VOLATILE ORGANIC COMPOUNDS ARE IN PARTS PER BILLION BY VOLUME (ppb v/v) AND ARE FROM TO-14 ANALYSIS.

Site 3 ROD

Site 3
Landfill Gas Sampling Analytical Results for Fixed Gases and Total VOCs September 2008 and June 2009

Date 07-12	Edwards AFB	Figure
Project No. 60133579		2.6-11

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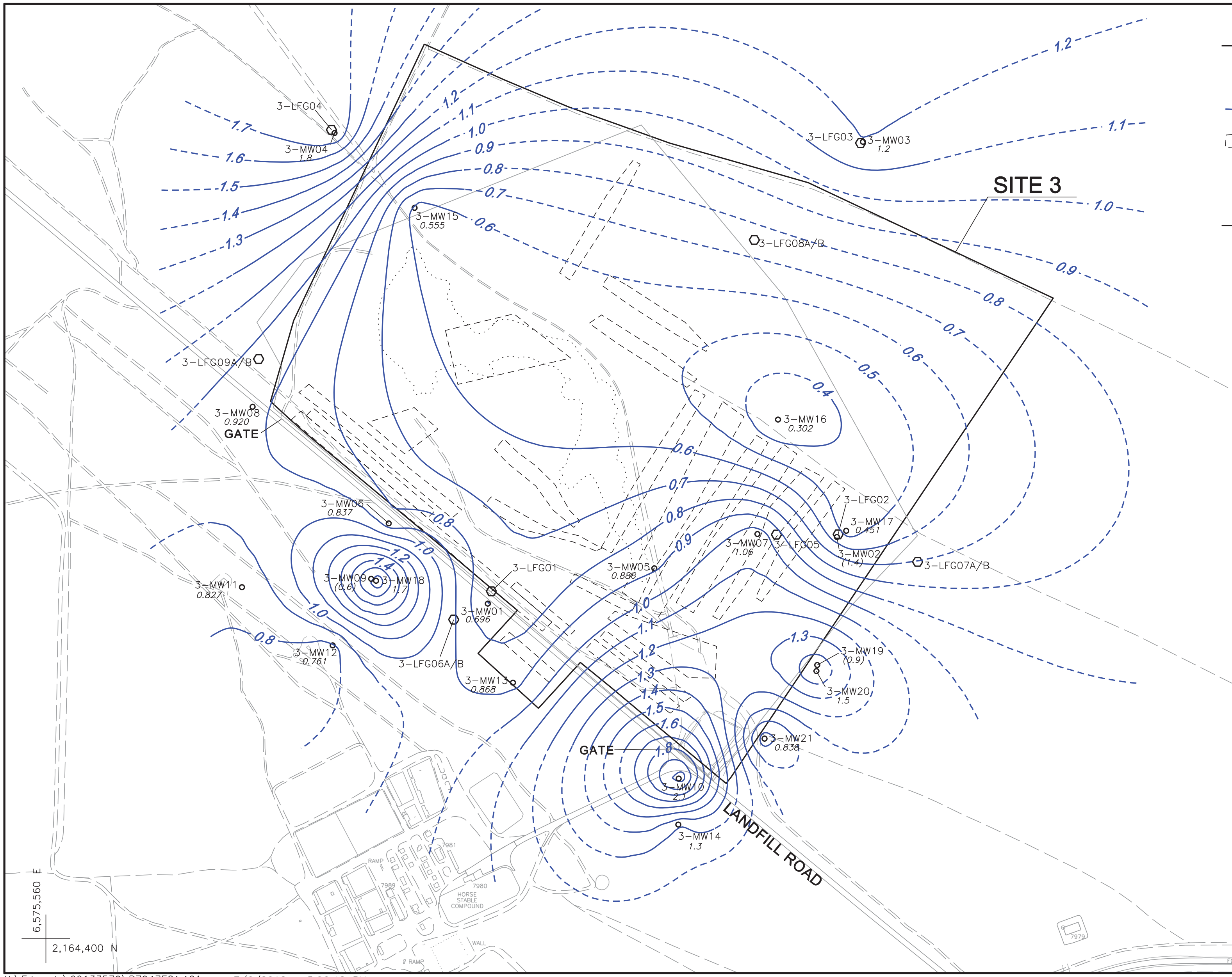

EXPLANATION

- ○ MONITORING WELL LOCATION WITH DISSOLVED OXYGEN CONCENTRATIONS IN mg/L
- ⬡ LANDFILL GAS MONITORING WELL LOCATION
- —0.5— DISSOLVED OXYGEN CONTOUR (DASHED WHERE INFERRED)
- [ ] INTERPRETED LANDFILL CELL LOCATION
- mg/L MILLIGRAMS PER LITER

NOTE

1. DISSOLVED OXYGEN CONCENTRATIONS IN PARENTHESES ARE FROM DEEPER WELL OF PAIRED WELLS. CONCENTRATIONS NOT USED IN CONTOURING.

MONITORING WELL	DISSOLVED OXYGEN CONCENTRATION (mg/L)
3-MW01	0.696
3-MW02	(1.4)
3-MW03	1.2
3-MW04	1.8
3-MW05	0.886
3-MW06	0.837
3-MW07	1.06
3-MW08	0.920
3-MW09	(0.6)
3-MW10	2.1
3-MW11	0.827
3-MW12	0.761
3-MW13	0.868
3-MW14	1.3
3-MW15	0.555
3-MW16	0.302
3-MW17	0.451
3-MW18	1.7
3-MW19	(0.9)
3-MW20	1.5
3-MW21	0.838

Site 3 ROD

Site 3
Dissolved Oxygen Concentrations in Groundwater
July 2009

Date 07-12
Project No. 60133579
Edwards AFB
Figure 2.6-12

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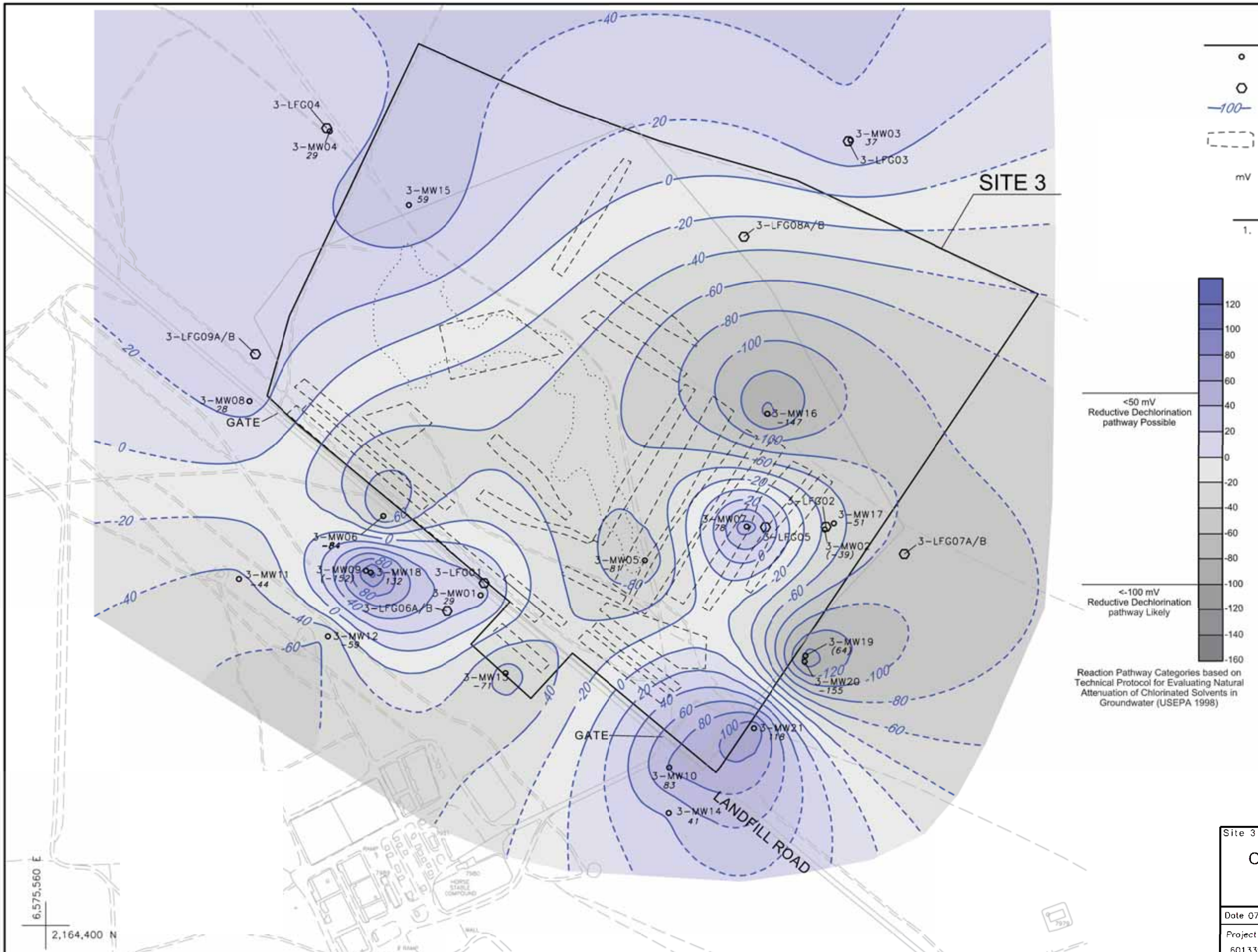

EXPLANATION

- o MONITORING WELL LOCATION WITH OXIDATION-REDUCTION POTENTIAL IN mV
- LANDFILL GAS MONITORING WELL LOCATION
- -100- OXIDATION-REDUCTION POTENTIAL CONTOUR (DASHED WHERE INFERRED)
- INTERPRETED LANDFILL CELL LOCATION
- mV MILLIVOLT

NOTE

1. OXIDATION-REDUCTION POTENTIAL VALUES IN PARENTHESES ARE FROM DEEPER WELL OF PAIRED WELLS. VALUE NOT USED IN CONTOURING.

MONITORING WELL	OXIDATION-REDUCTION POTENTIAL (mV)
3-MW01	29
3-MW02	(-39)
3-MW03	37
3-MW04	29
3-MW05	-81
3-MW06	-84
3-MW07	78
3-MW08	28
3-MW09	(-152)
3-MW10	83
3-MW11	-44
3-MW12	-59
3-MW13	-71
3-MW14	41
3-MW15	59
3-MW16	-147
3-MW17	-51
3-MW18	132
3-MW19	(64)
3-MW20	-155
3-MW21	118

NORTH

0 200 400 FEET

SCALE: 1"= 400'

Site 3 ROD

Site 3 Oxidation-Reduction Potential in Groundwater July 2009

Date 07-12

Project No. 60133579

Edwards AFB

Figure 2.6-13

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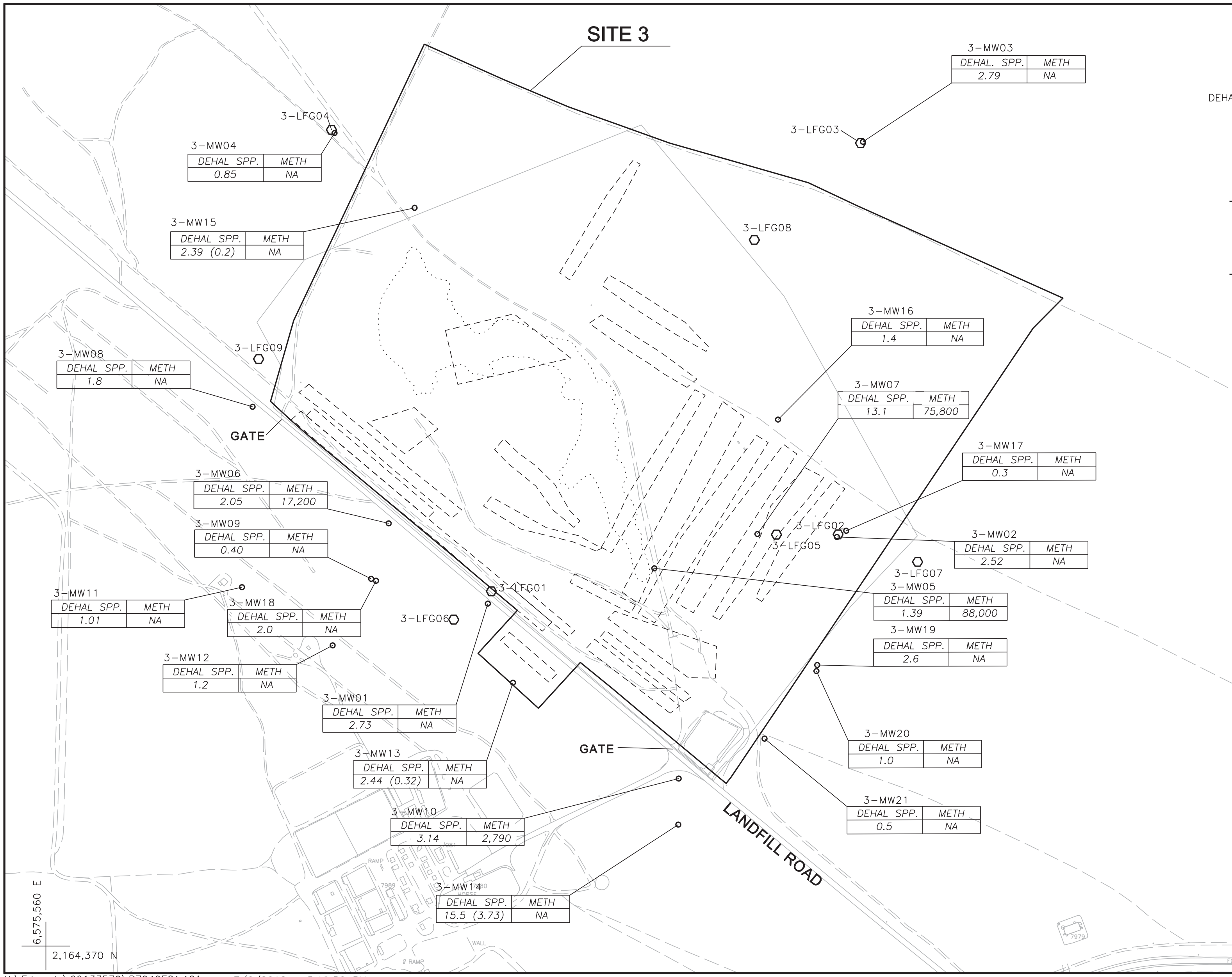

EXPLANATION

- ○ MONITORING WELL LOCATION
- ⬡ LANDFILL GAS MONITORING WELL LOCATION
- [- - -] INTERPRETED LANDFILL CELL LOCATION

DEHAL SPP. DEHALOCOCCOIDES SPP. RESULTS (CELLS/ML)
METH METHANOTROPHIC BACTERIA RESULTS (CELLS/ML)
ML MILLILITER
NA NOT ANALYZED
SPP. SPECIES

NOTES

1. MICROBIAL ANALYTICAL RESULTS REPORTED IN CELLS PER MILLILITER (ML).
2. VALUES IN PARENTHESES ARE DUPLICATE SAMPLES.

REFERENCE

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY (USEPA), 1998. *TECHNICAL PROTOCOL FOR EVALUATING NATURAL ATTENUATION OF CHLORINATED SOLVENTS IN GROUNDWATER. OFFICE OF RESEARCH AND DEVELOPMENT.* EPA 600/R-98/128. WASHINGTON, DC. SEPTEMBER.

Site 3 ROD

Site 3
Microbial Analytical Results

Date 07-12	Edwards AFB	Figure
Project No. 60133579		2.6-14

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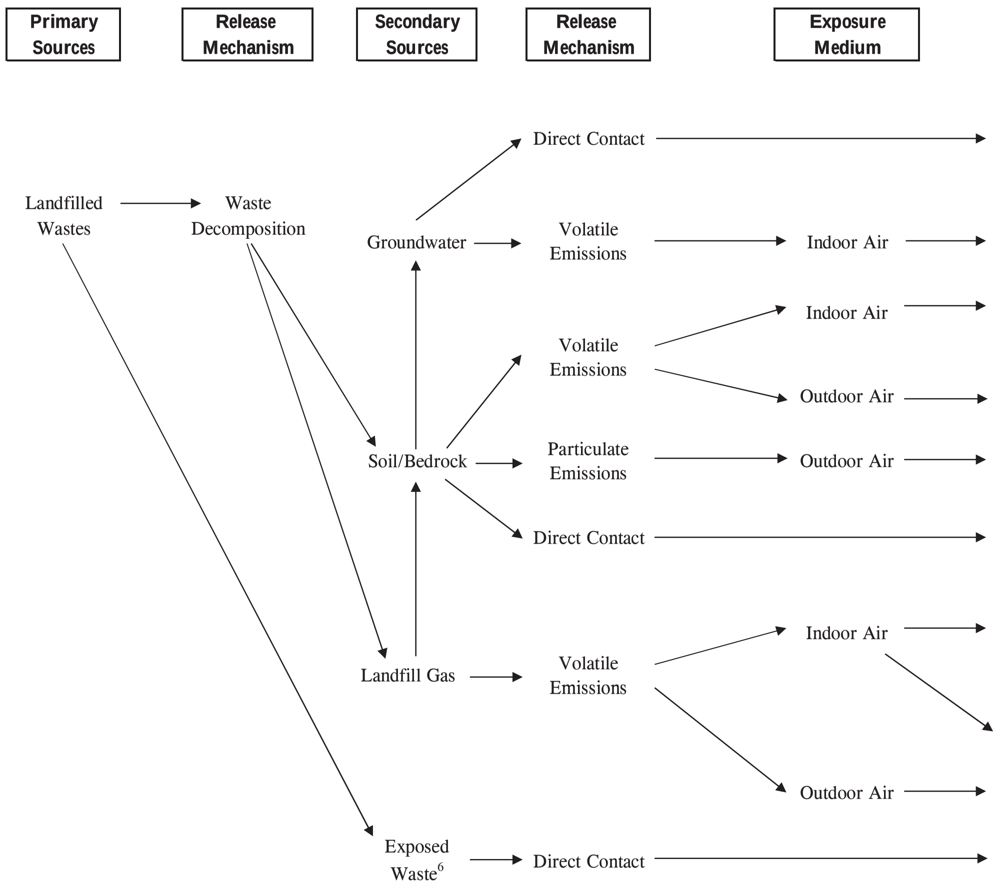
FIGURE 2.6-15. PATHWAYS RETAINED FOR A CERCLA RESPONSE



Potential Exposure Route	Hypothetical Future Residents	Site Workers	Construction Workers	Biota
Ingestion/ Inhalation	Yes[1]	NE	No	No
Inhalation	Yes[2]	Yes[2]	N/A	N/A
Inhalation	Yes[2]	Yes[2]	N/A	N/A
Inhalation	NE	NE	NE	NE
Inhalation	Yes[2]	Yes[2]	Yes[2]	NE
Ingestion/ Dermal	Yes[2]	Yes[2]	Yes[2]	Yes
Inhalation	Yes[3]	Yes[3]	N/A	Yes[4]
Explosive hazard	Yes[5]	Yes[5]	Yes[5]	No
Inhalation	NE	NE	NE	NE
Ingestion/ Inhalation	Yes[7]	Yes[7]	Yes[7]	Yes[7]

Notes:

Yellow highlights indicate pathways retained for CERCLA response

Grey shading indicates pathways not retained either because the pathway does not exist or risks were less than or within the risk management range, and action based on the risk calculations is not warranted.

[1] Although retained as a pathway, sufficient quantities of groundwater do not exist for sustained pumping.

[2] Although technically a pathway, risks are within the risk management range (see Table 2.6-7).

[3] Potential future risk if an undiscovered drum containing fuels or solvents were to leak, releasing volatile organic compounds to indoor air

[4] Risk for soil vapors accumulating in burrows likely overestimated based on validation study (United States Air Force [USAF] 2002a).

[5] Potential explosive hazard from methane in landfill gas to future residents, office workers, or construction workers in confined spaces.

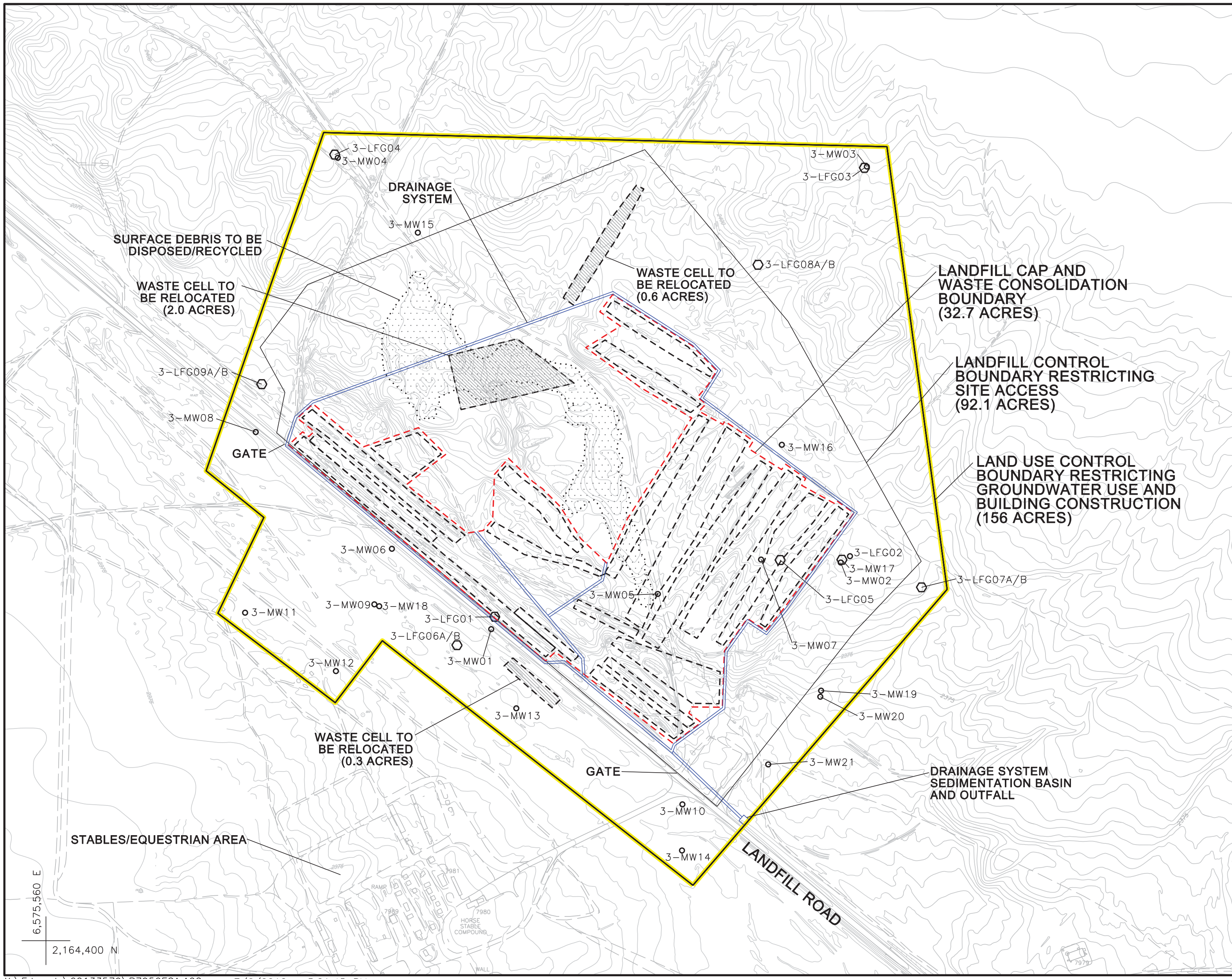
[6] Pathway is for hazardous waste potentially buried in the landfill; hazardous waste has not been detected in surface debris or in site investigation test pits.

[7] Potential pathway; the presence of hazardous substances has not been confirmed, however, the possibility that these materials are contained within the landfill cannot be reasonably ruled out.

CERCLA Comprehensive Environmental Response, Compensation, and Liability Act

N/A not applicable; receptor is not considered likely to be in contact with the exposure medium.

NE not evaluated; pathway not considered significant by the risk assessors.



EXPLANATION

- GROUNDWATER MONITORING WELL LOCATION
- LANDFILL GAS MONITORING WELL LOCATION
- INTERPRETED CELL LOCATION
- DRAINAGE CHANNEL TO BE INSTALLED
- AREAL EXTENT OF SURFACE DEBRIS TO BE DISPOSED/RECYCLED (PREDOMINANTLY CONSTRUCTION AND DEMOLITION WASTE). BASED ON FIELD MAPPING AND REVIEW OF 2002 AERIAL PHOTOGRAPHS.
- FENCE
- TOPOGRAPHIC ISOELEVATION LINE (FEET ABOVE MEAN SEA LEVEL) 1-FOOT CONTOUR INTERVAL

NOTE

1. THE NUMBER AND LOCATIONS OF NEW AND EXISTING WELLS TO BE MONITORED WILL BE DETERMINED DURING THE REMEDIAL DESIGN PHASE.

Site 3 ROD

Site 3
Conceptual Layout
of the Selected Remedy

Date 07-12	Edwards AFB	Figure
Project No. 60133579		2.8-1

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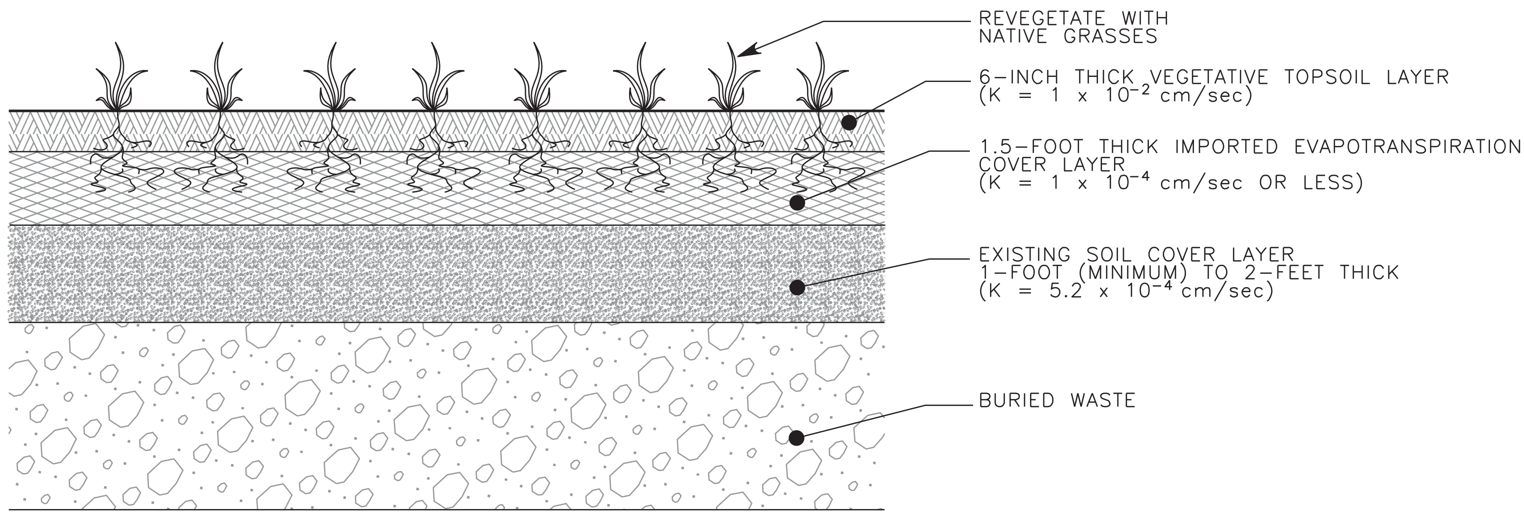

NOT TO SCALE

EXPLANATION

K	HYDRAULIC CONDUCTIVITY
cm/sec	CENTIMETERS PER SECOND

Site 3 ROD

Site 3 Conceptual Cover Design Cross Section for the Selected Remedy

Date 07-12

Project No. 60133579

Edwards AFB

Figure 2.8-2

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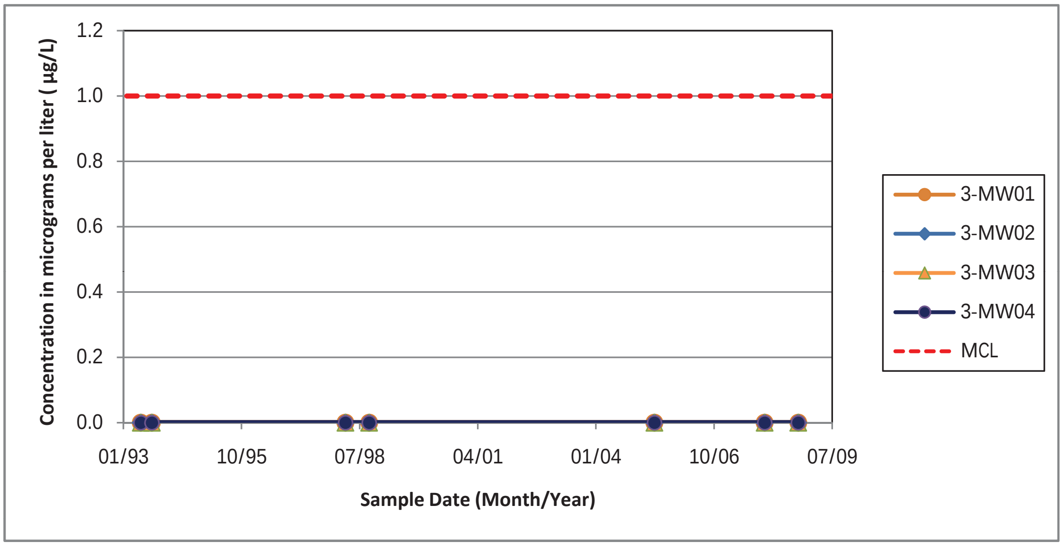
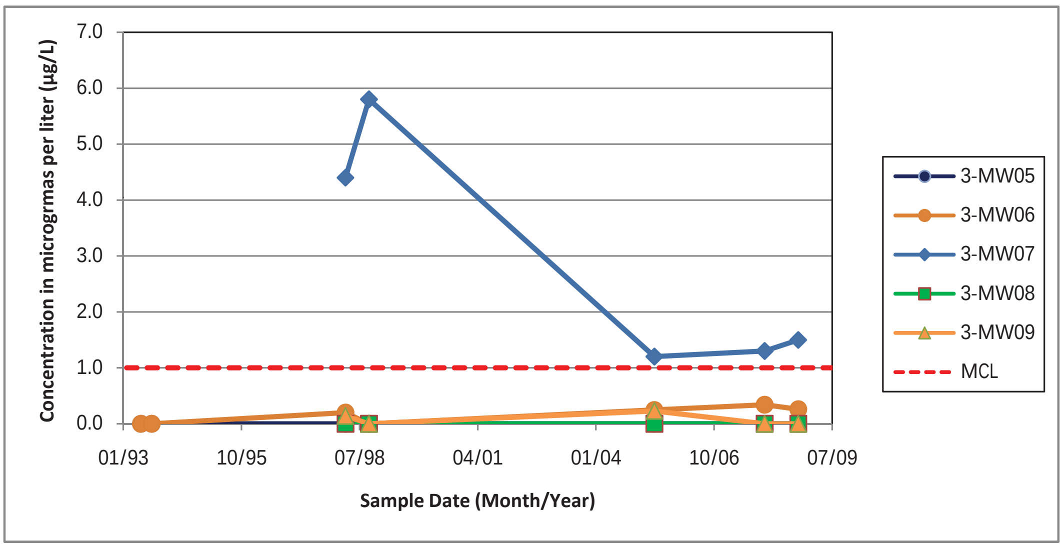
APPENDIX A

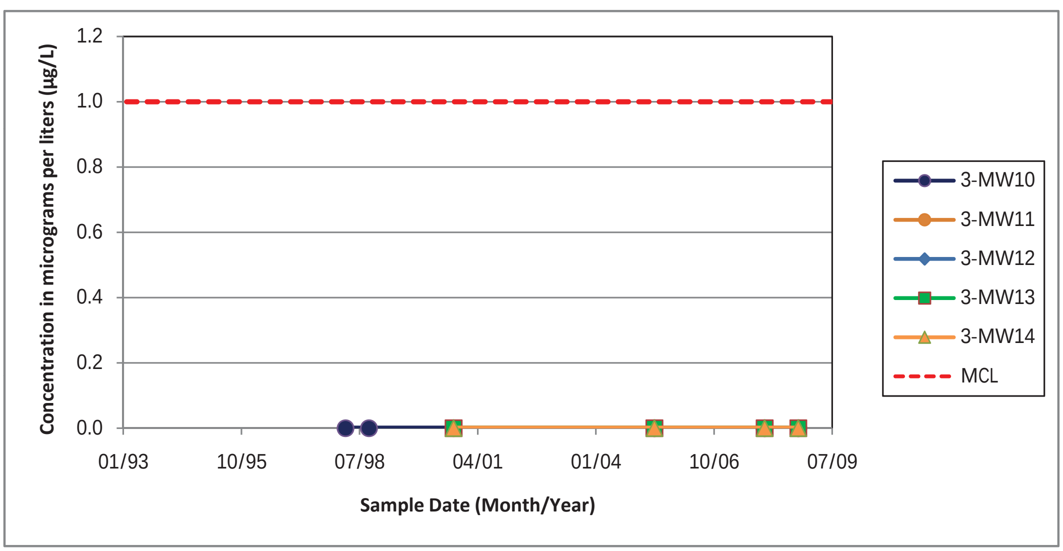
TIME TREND PLOTS FOR SELECT VOLATILE ORGANIC COMPOUNDS AND NITRATE IN GROUNDWATER AT SITE 3

- Figure A-1 Benzene in Groundwater
  Site 3 Inactive Landfill Groundwater Monitoring Wells
- Figure A-2 1,4-Dichlorobenzene in Groundwater
  Site 3 Inactive Landfill Groundwater Monitoring Wells
- Figure A-3 Cis-1,2-Dichloroethene in Groundwater
  Site 3 Inactive Landfill Groundwater Monitoring Wells
- Figure A-4 Methylene Chloride in Groundwater
  Site 3 Inactive Landfill Groundwater Monitoring Wells
- Figure A-5 Tetrachloroethene in Groundwater
  Site 3 Inactive Landfill Groundwater Monitoring Wells
- Figure A-6 Trichloroethene in Groundwater
  Site 3 Inactive Landfill Groundwater Monitoring Wells
- Figure A-7 Vinyl Chloride in Groundwater
  Site 3 Inactive Landfill Groundwater Monitoring Wells
- Figure A-8 Nitrate in Groundwater
  Site 3 Inactive Landfill Groundwater Monitoring Wells

FIGURE A-1. BENZENE IN GROUNDWATER
SITE 3 INACTIVE LANDFILL GROUNDWATER MONITORING WELLS

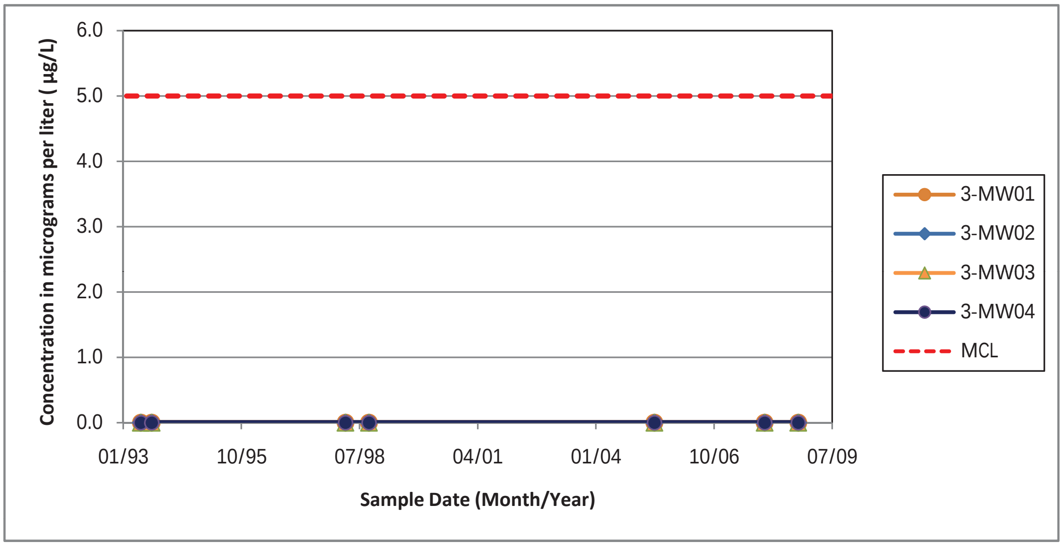


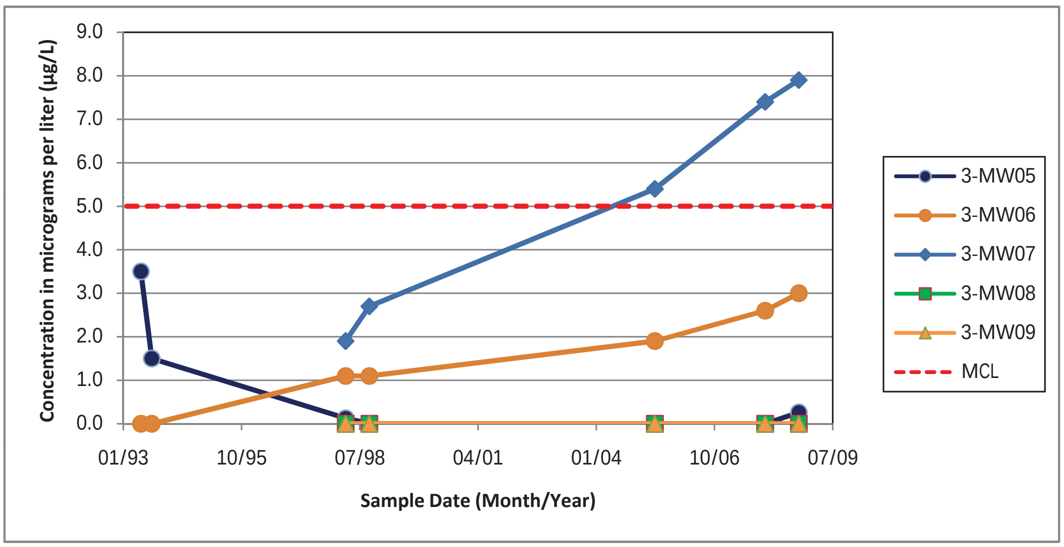


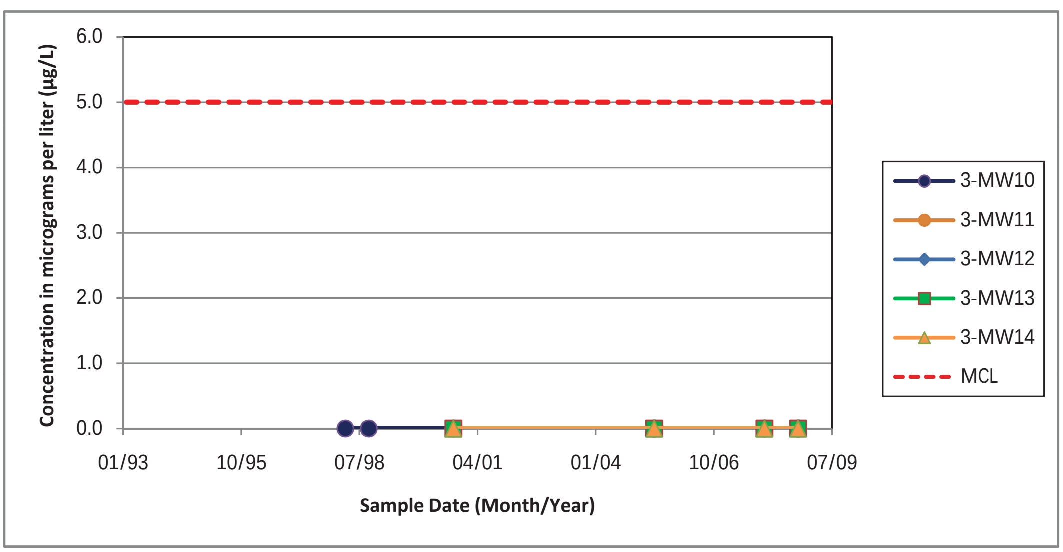


Notes:
Time trend plots for groundwater monitoring wells with more than one sampling event. Non-detect values represented by 0.

FIGURE A-2. 1,4-DICHLOROBENZENE IN GROUNDWATER
SITE 3 INACTIVE LANDFILL GROUNDWATER MONITORING WELLS

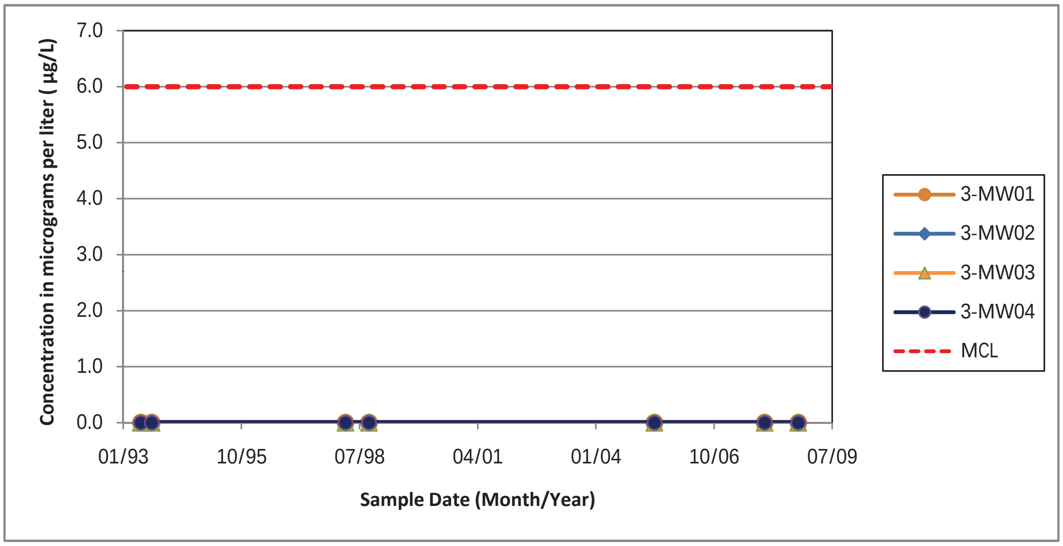


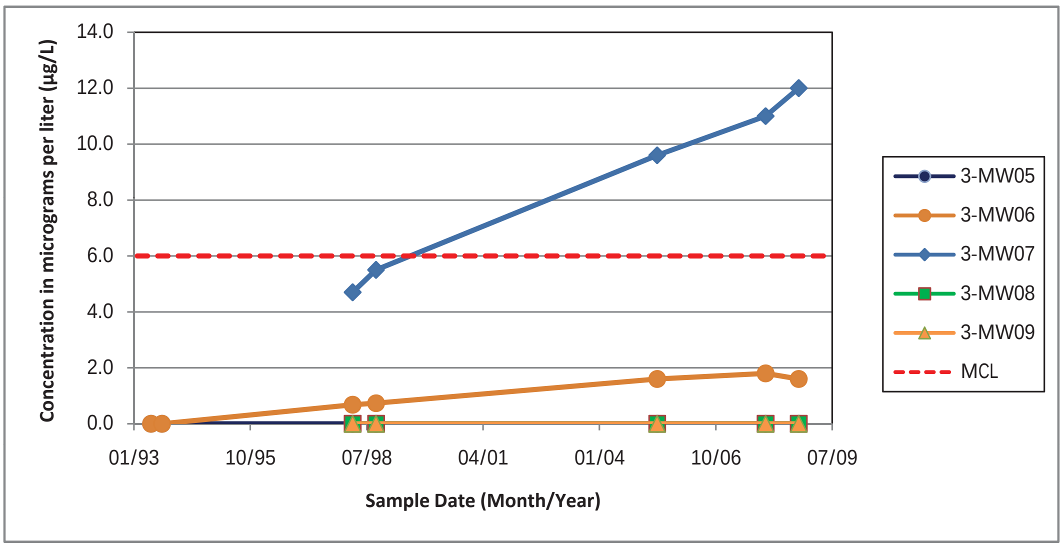


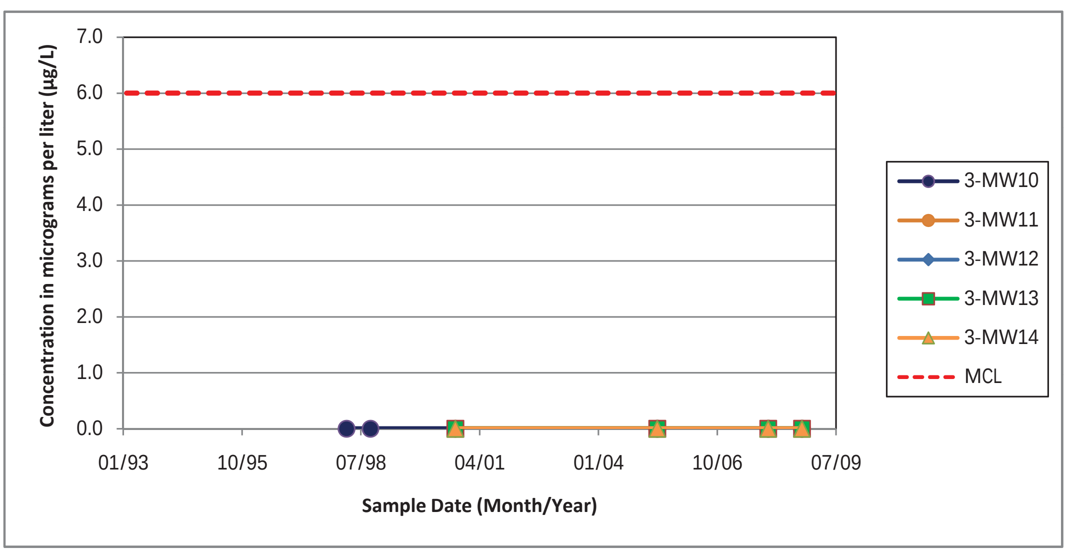


Notes:
Time trend plots for groundwater monitoring wells with more than one sampling event. Non-detect values represented by 0.

FIGURE A-3. CIS-1,2-DICHLOROETHENE IN GROUNDWATER
SITE 3 INACTIVE LANDFILL GROUNDWATER MONITORING WELLS

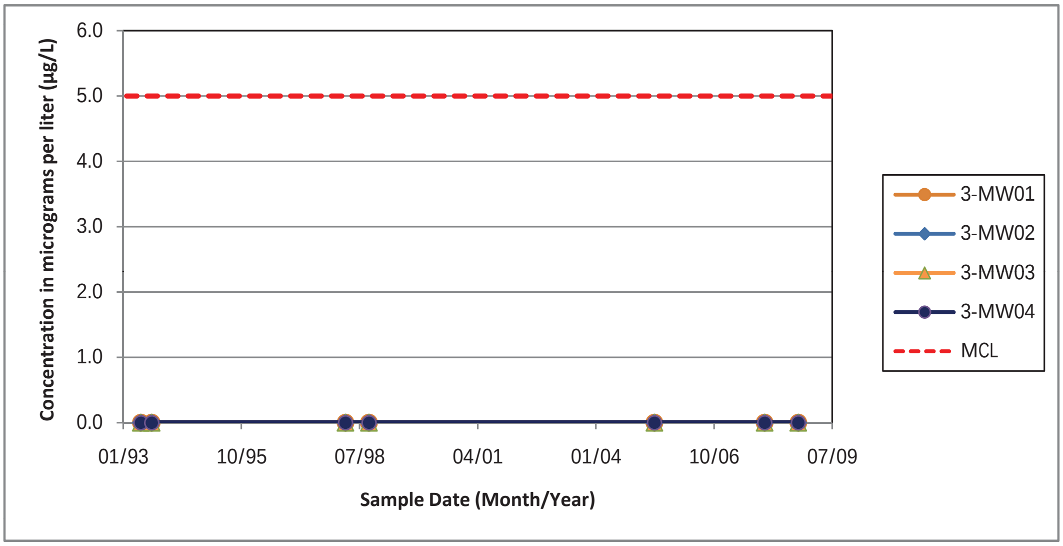


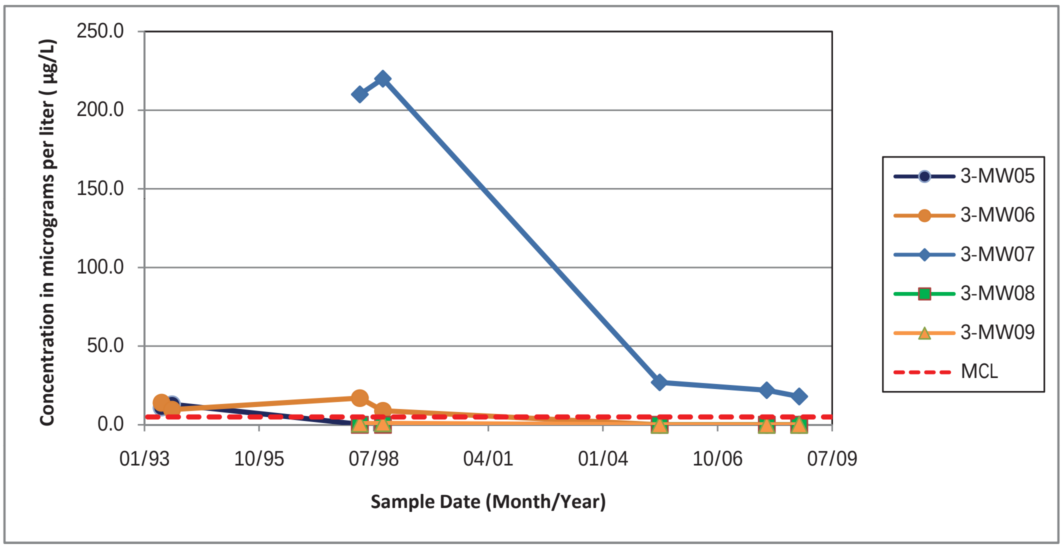


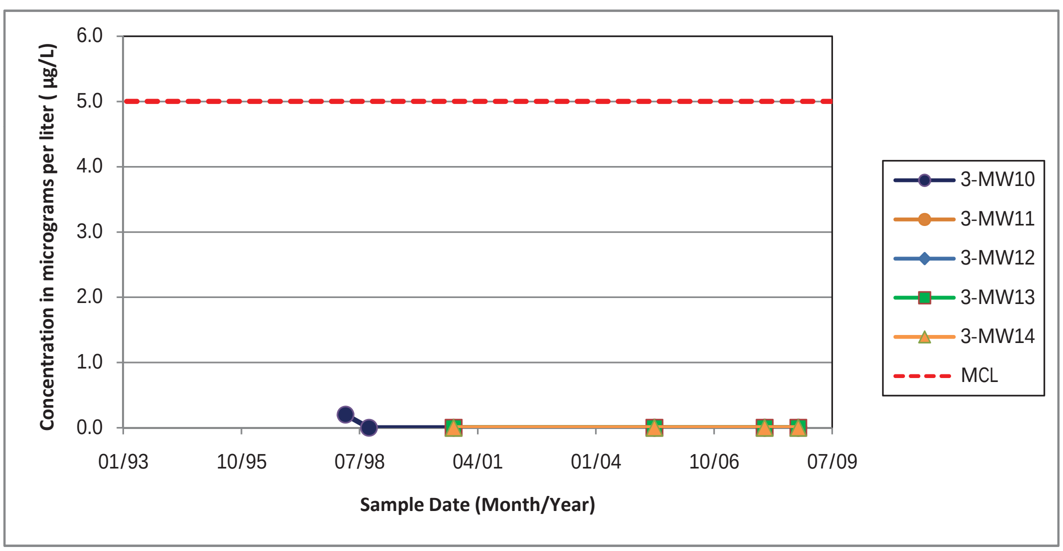


Notes:
Time trend plots for groundwater monitoring wells with more than one sampling event. Non-detect values represented by 0.

FIGURE A-4. METHYLENE CHLORIDE IN GROUNDWATER
SITE 3 INACTIVE LANDFILL GROUNDWATER MONITORING WELLS

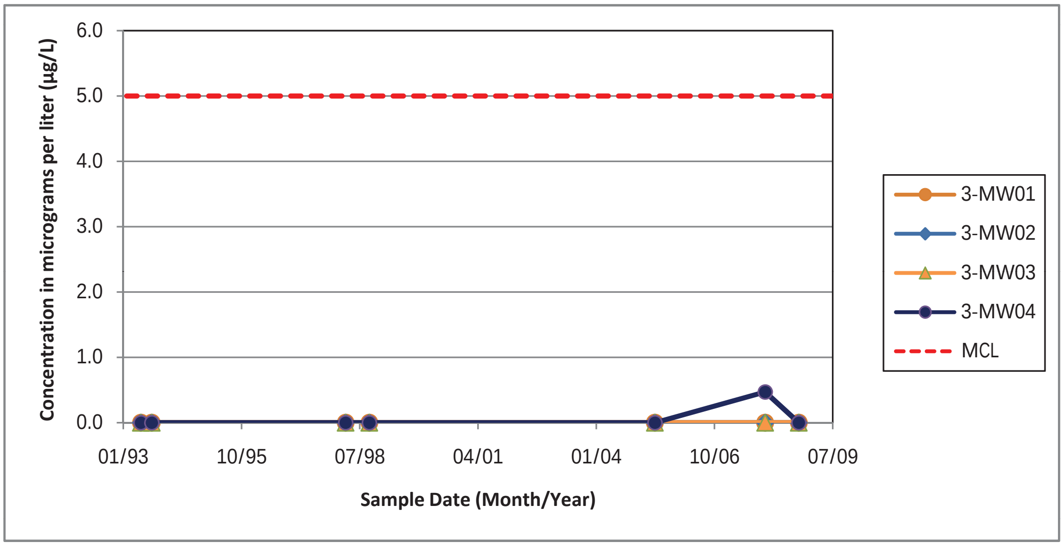


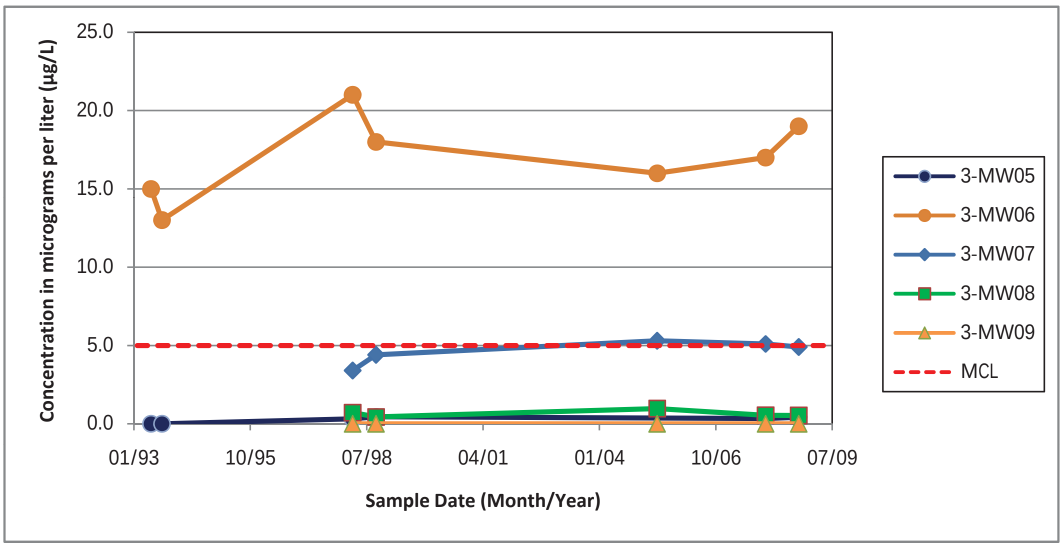


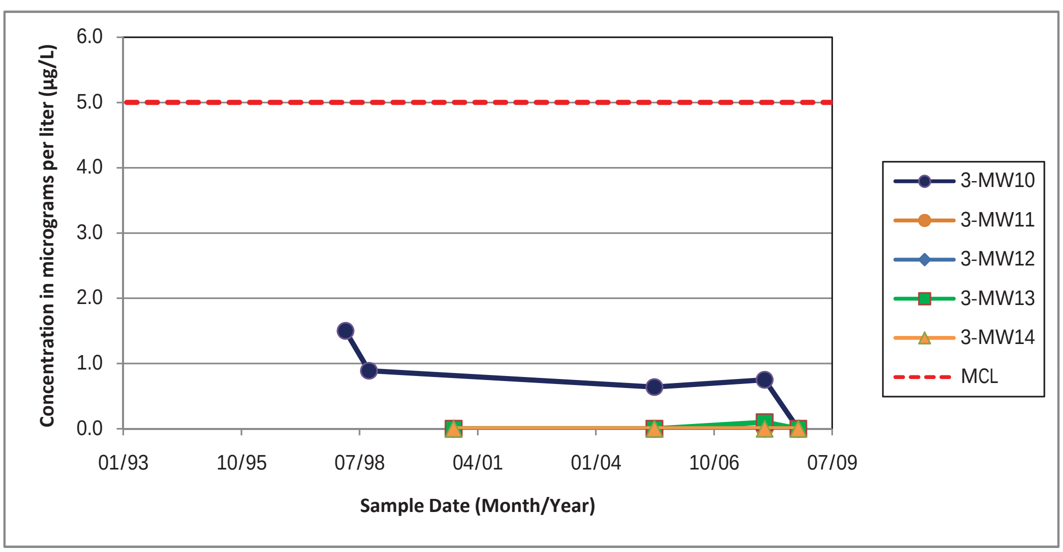


Notes:
Time trend plots for groundwater monitoring wells with more than one sampling event. Non-detect values represented by 0.

FIGURE A-5. TETRACHLOROETHENE IN GROUNDWATER
SITE 3 INACTIVE LANDFILL GROUNDWATER MONITORING WELLS

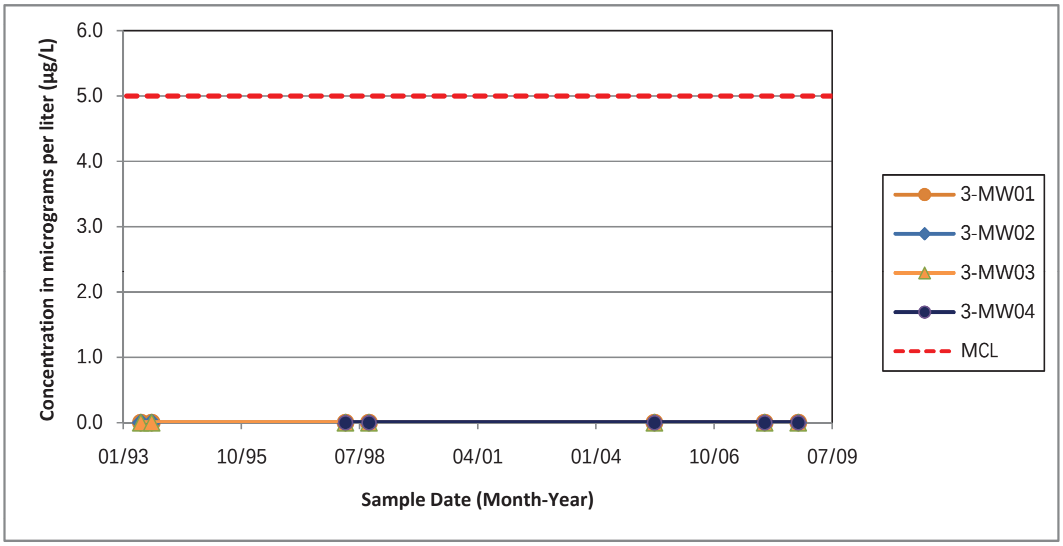


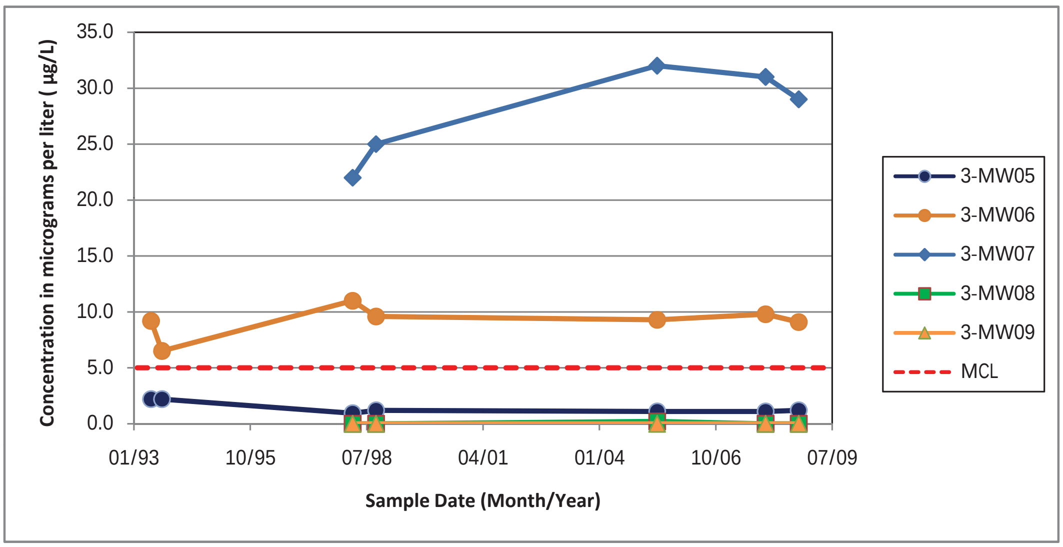


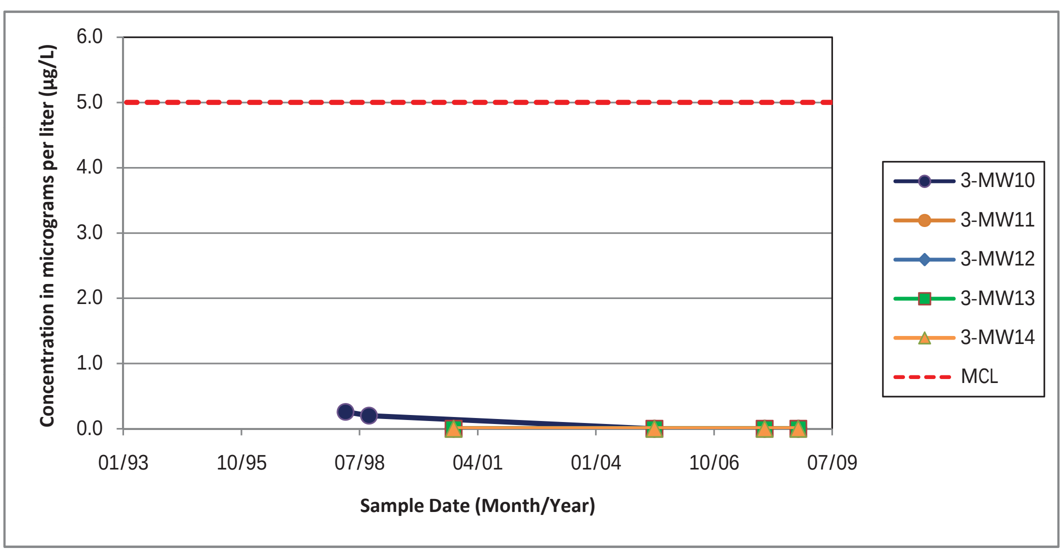


Notes:
Time trend plots for groundwater monitoring wells with more than one sampling event. Non-detect values represented by 0.

FIGURE A-6. TRICHLOROETHENE IN GROUNDWATER
SITE 3 INACTIVE LANDFILL GROUNDWATER MONITORING WELLS

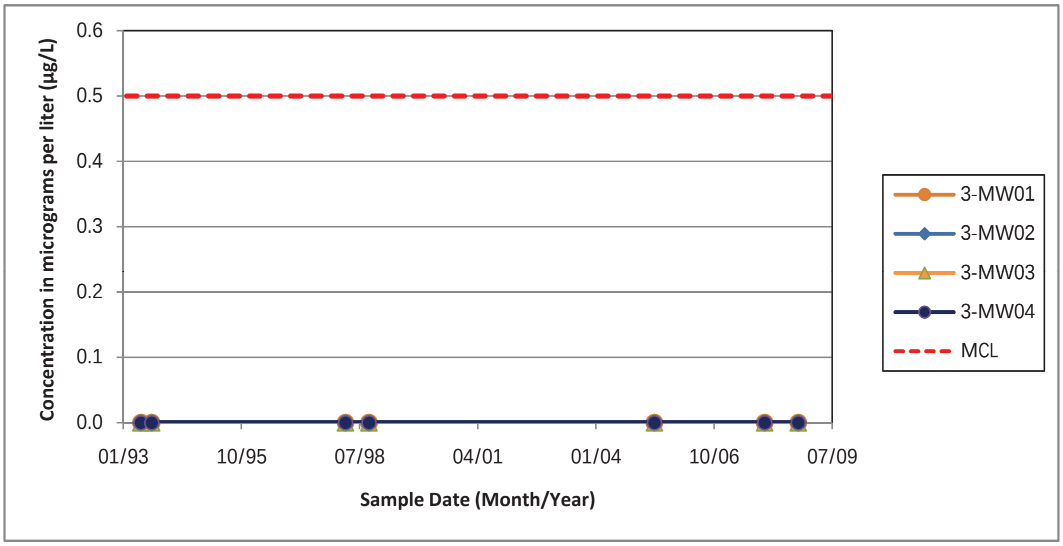


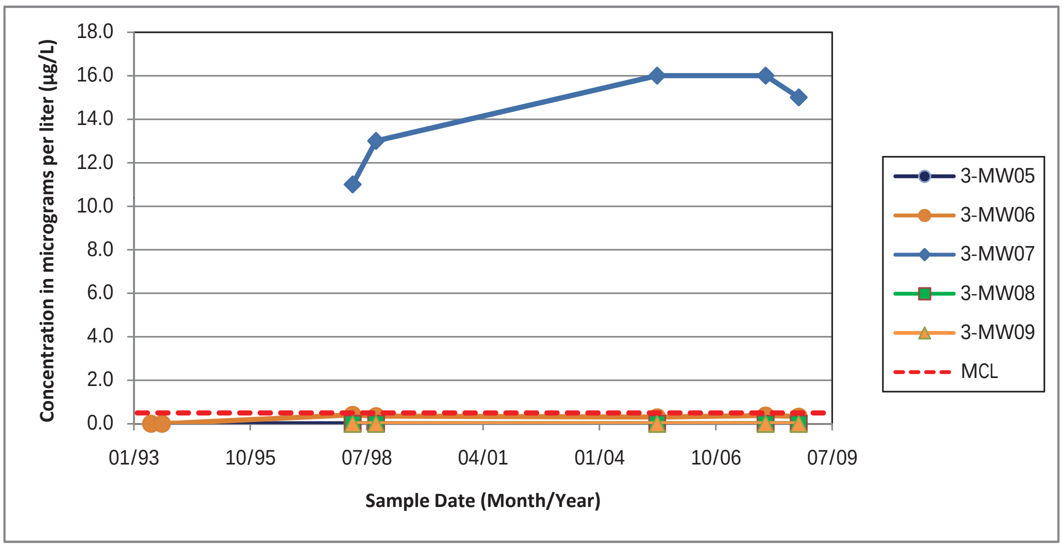


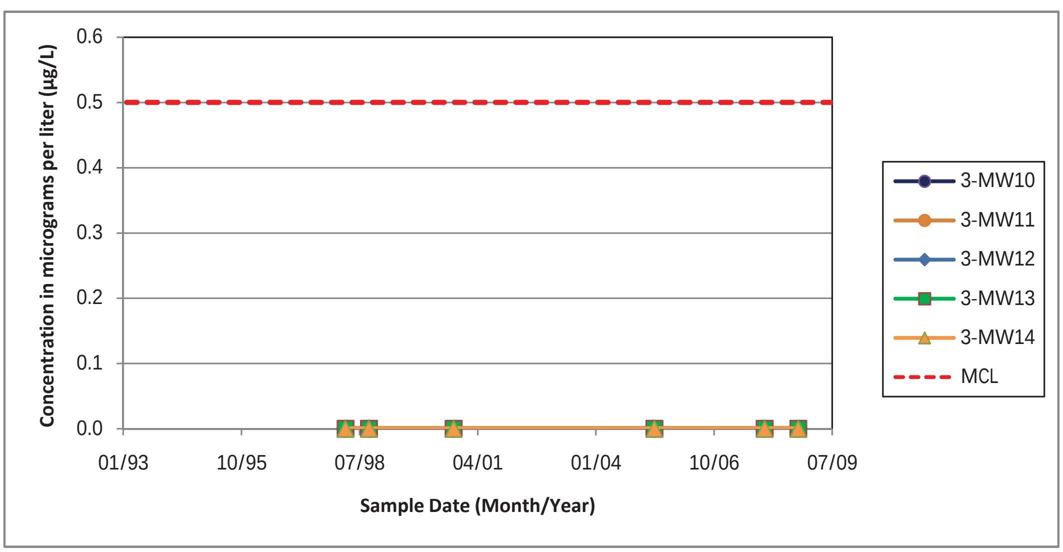


Notes:
Time trend plots for groundwater monitoring wells with more than one sampling event. Non-detect values represented by 0.

FIGURE A-7. VINYL CHLORIDE IN GROUNDWATER
SITE 3 INACTIVE LANDFILL GROUNDWATER MONITORING WELLS

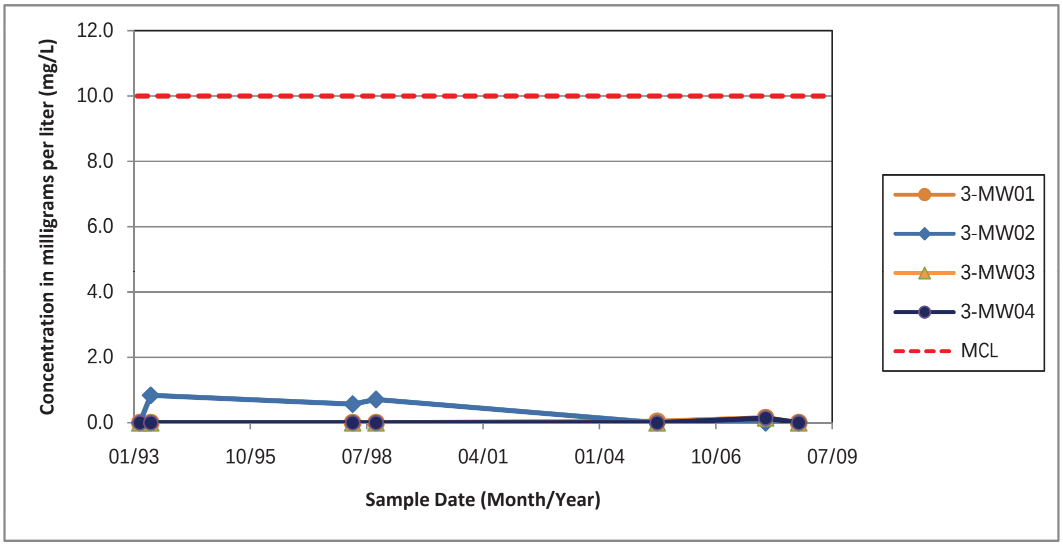


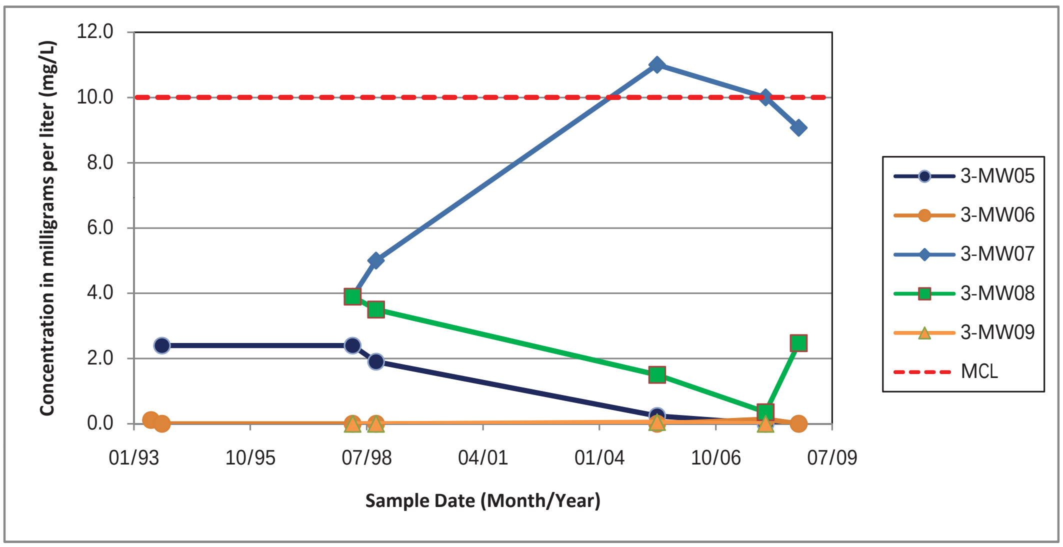


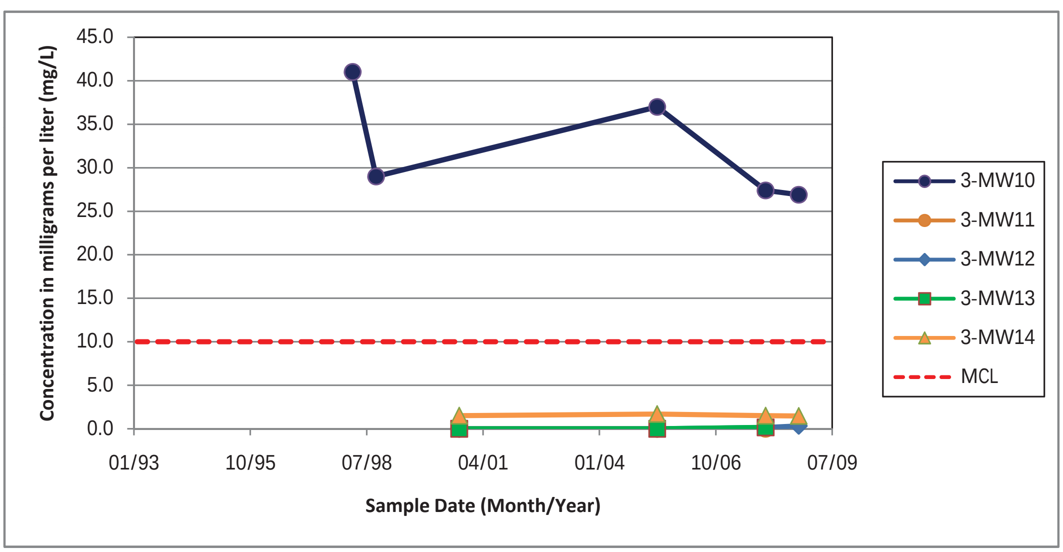


Notes:
Time trend plots for groundwater monitoring wells with more than one sampling event. Non-detect values represented by 0.

FIGURE A-8. NITRATE IN GROUNDWATER
SITE 3 INACTIVE LANDFILL GROUNDWATER MONITORING WELLS







Notes:
Time trend plots for groundwater monitoring wells with more than one sampling event. Non-detect values represented by 0.

APPENDIX B

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS FOR SITE 3

TABLE B-1. APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS FOR SITE 3

Item No.	Requirement	Citation	Federal or State Requirement	Description	ARAR Determination	Comments
Chemical-specific ARARs						
1	Primary Drinking Water Standards (Non-zero MCLGs and MCLs)	Safe Drinking Water Act, 40 CFR Part 141, Sections 141.11, 141.50-.51, 141.61-.62 40 CFR Part 300, Sections 300.430(e)(2)(i)(C)	Federal	MCLGs are goals under the SDWA which are set at levels at which no adverse health effects will occur and allow an adequate margin of safety. MCLs are promulgated and enforceable maximum concentrations of drinking water priority pollutants that are set as closely as feasible to MCLGs, considering best technology, treatment techniques, and other factors. The NCP states that primary drinking water standards are legally applicable only to drinking water at the tap, but are relevant and appropriate as cleanup standards for groundwater and surface water that have been determined to be current or future drinking water sources. Under CERCLA 121(d)(2)(A), Remedial Actions shall attain MCLGs where relevant and appropriate. The NCP provides that where an MCLG has been set at a level of zero, the MCL for that contaminant shall be attained.	Relevant and appropriate	This regulation addresses drinking water-based cleanup goals for groundwater at Site 3. The AF and State agree, in this particular case, that use of MCLs as cleanup standards, in conjunction with Institutional Controls, is protective of human health at Site 3. For contaminants that have different Federal and State MCLs, only the more stringent MCL will be considered an ARAR.
		22 CCR, Div. 4, Ch. 15, Articles 4, 4.5, and 5.5, Sections 64431 et seq. 64444	State	Establishes standards for public water supply systems, including primary MCLs. State MCLs must be at least as stringent as Federal MCLs. State MCLs are incorporated into State and Regional Water Quality Board Water Quality Control Plans as water quality objectives for protection of current and potential drinking water supply sources. MCLs are some of the applicable upper-end objectives for ambient groundwater and surface water where the water is a source of drinking water, as defined in the Water Quality Control Plans.		
2	Water Quality Control Plan, South Lahontan Basin (Basin Plan)	23 CCR, Div. 4, Ch. 1, Article 6, Section 3950; Water Code Sections 13140 and 13240	State	The Porter-Cologne Water Quality Control Act established authority of the SWRCB and RWQCB to regulate discharges into Waters of the State. The Basin Plan establishes beneficial uses and the water quality criteria based upon such uses (water quality objectives). The Basin Plan serves to protect the beneficial uses and water quality of the surface water and groundwater in the South Lahontan Basin.	Relevant and appropriate	The beneficial uses listed in Section 2 of the Basin Plan are relevant and appropriate.
Location-specific ARARs						
3	Endangered Species Act of 1973, Section 7 (c)	50 CFR Parts 200 and 402	Federal	Requires formal consultation with the USFWS if activities have the potential to alter the natural environment of listed endangered and threatened species.	Relevant and appropriate	Endangered or threatened species and/or critical habitat are found at Edwards AFB. Site 3 is not considered to be critical habitat.
4	Migratory Bird Treaty Act	50 CFR Parts 10 and 20 (16 USC Section 703 et seq.)	Federal	Prohibits unlawful taking, possession, and sale of almost all species of native birds in the United States.	Applicable	Edwards AFB has over 200 species of birds. Actions need to be taken during the Remedial Action to avoid take of birds.

Item No.	Requirement	Citation	Federal or State Requirement	Description	ARAR Determination	Comments
Location-specific ARARs (*continued*)						
5	California Endangered Species Act	California Fish and Game Code, Div. 3, Ch. 1.5, Article 1, Sections 2050-2055; Article 3, Section 2080. 14 CCR, Div. 1, Subdivision 3, Ch. 6, Article 1, Sections 670.1, 670.5, and 783 et. seq.	State	Establishes species, subspecies, and varieties of native California plants or animals as endangered, threatened, or rare. Prohibits the taking, importation, or sale of any species, or any part thereof, of an endangered species or a threatened species. Prohibits releases and/or actions that would have a deleterious effect on species or their habitat. Contains provisions concerning CDFG coordination and consultation with State and Federal agencies and with project applicants. 14 CCR Section 670.1 provides a listing of the plants of California to be declared endangered, threatened, or rare. 14 CCR Section 670.5 provides a listing of the animals of California to be declared endangered or threatened. 14 CCR Section 783 et. seq. provides the implementation regulations for the California Endangered Species Act.	Relevant and appropriate	Relevant and Appropriate if there are endangered or threatened species in the area that could be affected if actions are not taken to conserve the species, and where State law has a listing that is more stringent than the Federal Endangered Species Act and Migratory Bird Treaty Act. As stated in Air Force Instruction 32-7064, dated 17 Sept. 2004, State authority will be contacted if conflicts arise to determine if any conservation measures can be feasibly implemented to avoid or mitigate impacts.
6	Wildlife Species/Habitats	California Fish and Game Code, Div.3, Ch. 1, Section 2000; Div. 4, Part 2, Ch. 1, Sections 3511 and 3513; and Div. 9, Ch. 1, Section 12000 et. seq. 14 CCR, Div. 1, Subdivision 2, Ch. 1, Section 250; Ch. 7, Section 507; Subdivision 3, Ch. 1, Section 650	State	Prohibits the taking of birds and mammals, except as otherwise provided in the Fish and Game Code and 14 CCR. Section 3511 provides that it is unlawful to take or possess any of the following fully protected birds: (a) American peregrine falcon; (b) Brown pelican; (c) California black rail; (d) California clapper rail; (e) California condor; (f) California least tern; (g) Golden eagle; (h) Greater sandhill crane; (i) Light-footed clapper rail; (j) Southern bald eagle; (k) Trumpeter swan; (l) White-tailed kite; (m) Yuma clapper rail.	Relevant and appropriate	Relevant and Appropriate to the extent that such fully protected birds are located on or near Site 3. As stated in Air Force Instruction 32-7064, dated 17 Sept. 2004, State authority will be contacted if conflicts arise to determine if any conservation measures can be feasibly implemented to avoid or mitigate impacts.
7	Fully Protected Birds	California Fish and Game Code, Div. 4, Part 2, Ch. 1, Section 3503.5	State	Section 3503.5 prohibits the take, possession, or destruction of any birds in the orders of Falconiformes or Strigiformes (birds-of-prey) or to take, possess, or destroy the nest or eggs of any such bird except as otherwise provided by this code or any regulation adopted pursuant thereto.	Relevant and appropriate	Relevant and Appropriate to the extent that birds-of-prey, or their nest and eggs, are located on or near Site 3. As stated in Air Force Instruction 32-7064, dated 17 Sept. 2004, State authority will be contacted if conflicts arise to determine if any conservation measures can be feasibly implemented to avoid or mitigate impacts.

TABLE B-1. APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS FOR SITE 3

Item No.	Requirement	Citation	Federal or State Requirement	Description	ARAR Determination	Comments
Location-specific ARARs (*continued*)						
8	Fully Protected Mammals	California Fish and Game Code, Div. 4, Part 3, Ch. 2, Section 4000 et. seq. Ch. 10, Section 4800 et. seq. 14 CCR, Div. 1, Subdivision 2, Ch. 5, Section 460	State	Actions must be taken to assure that no fully protected mammals are taken or possessed at any time. Section 4000 et. seq. provides that a fur-bearing mammal may be taken only with a trap, a firearm, bow and arrow, poison under a proper permit, or with the use of dogs. The Code identifies fur-bearing mammals as the following: pine marten, fisher, wolverine, mink, river otter, gray fox, cross fox, silver fox, red fox, kit fox, raccoon, beaver, badger, and muskrat. Section 4800 et. seq. requires that action must be taken to avoid injuring, taking, possessing or transporting any mountain lion. Mountain lions are specially protected mammals in California. It is unlawful to take, injure, possess, transport, or sell any mountain lion or any part or product thereof. Violation of this section is a misdemeanor. 14 CCR Section 460 makes it unlawful to take fisher, martin, river otter, desert kit fox, and red fox.	Relevant and appropriate	Relevant and Appropriate if regulated mammals and/or their habitat are located on or near Site 3. As stated in Air Force Instruction 32-7064, dated 17 Sept. 2004, State authority will be contacted if conflicts arise to determine if any conservation measures can be feasibly implemented to avoid or mitigate impacts.
9	Fully Protected Amphibians and Reptiles	California Fish and Game Code, Div. 5, Ch. 1, Section 5000 et. seq. 14 CCR, Div. 1, Subdivision 1, Ch. 5, Section 40.	State	Section 5000 makes it unlawful to sell, purchase, harm, take, possess, or transport any tortoise or parts thereof, or to shoot any projectile at a tortoise. This does not apply to the taking of any tortoise when authorized by the department for education, scientific, or public zoological purposes. 14 CCR Section 40 makes it unlawful to capture, collect, intentionally kill or injure, possess, purchase, propagate, sell, transport, import, or export any native reptile or amphibian, or parts thereof unless under special permit from the department issued pursuant to 14 CCR Sections 650, 670.7, or 783 of these regulations, or as otherwise provided in the Fish and Game Code or these regulations.	Relevant and appropriate	Numerous reptile species may be present at Site 3. Site 3 does not contain critical tortoise habitat; however, tortoises occur on Edwards AFB. The Base INRMP details, or incorporates by reference, the management practices to be followed at sites with desert tortoise habitat. As stated in Air Force Instruction 32-7064, dated 17 Sept. 2004, State authority will be contacted if conflicts arise to determine if any conservation measures can be feasibly implemented to avoid or mitigate impacts.
Action-specific ARARs						
10	Standards Applicable to Generators and Transporters of Hazardous Waste	40 CFR Part 262 49 CFR 171-177 and 49 USC 1801-1813	Federal	These regulations apply to generators of hazardous waste. Edwards AFB is a large quantity generator of hazardous waste (EPA ID CA1570024504) and is already subject to these requirements. Establishes requirements for transporters of hazardous wastes including requirements for registration of hazardous waste transporters, requirements for the packaging and labeling of hazardous wastes for transport, and requirements for the placarding of vehicles transporting hazardous waste. 49 USC 1801-1813 is the Hazardous Materials Transportation Act – Standards Applicable to Transport of Hazardous Materials	Relevant and Appropriate if wastes are hazardous as defined by 22 CCR	Relevant and Appropriate to waste generated (soil cuttings, purge water from groundwater sampling, hazardous waste excavated during waste cell consolidation) as part of Site 3 Remedial Action if these wastes are hazardous. Substantive requirements are potentially ARARs if excavated soils or treatment residuals exceed RCRA or California hazardous waste[a] thresholds. Hazardous remediation waste may be stored on-site in Temporary Units. These Temporary Units are not subject to the less than 90-day accumulation time requirement. Temporary Units may operate for one year with an opportunity for a 1-year extension. Relevant and Appropriate to the transport of any hazardous waste generated as part of the Site 3 Remedial Action. Also Relevant and Appropriate to transport of asbestos to the extent that it contains 1% or more friable asbestos.

Item No.	Requirement	Citation	Federal or State Requirement	Description	ARAR Determination	Comments
Action-specific ARARs *(continued)*						
10 (*cont.*)	Standards Applicable to Generators and Transporters of Hazardous Waste	22 CCR, Div. 4.5, Ch. 12, Articles 1-4, Sections 66262.10-.47 22 CCR, Div. 4.5, Ch. 14, Article 9, Sections 66264.170 -.179	State	Establishes standards for generators of RCRA and California hazardous wastes[a], including those for hazardous waste determination, accumulation, identification numbers, manifesting, pre-transport, and record-keeping and reporting requirements. Establishes standards for the use and management of containers for the storage of hazardous waste.	Relevant and Appropriate if wastes are hazardous as defined by 22 CCR	Relevant and Appropriate to RCRA and California hazardous wastes[a] generated as part of the Site 3 Remedial Action. Also applicable to transport of asbestos to the extent that it contains 1% or more friable asbestos. Relevant and Appropriate to RCRA and California hazardous wastes[a] generated as part of the Site 3 Remedial Action.
11	Sources of Drinking Water Policy	SWRCB Resolution No. 88-63; Porter-Cologne Water Quality Act (CWC Sections 13000, 13140, 13240); H&S Code Section 25356.1.5 (a)	State	Resolution 88-63 has been incorporated into all Regional Board Basin Plans, including the Lahontan Water Board Basin Plan. This resolution designates all groundwater 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 waste water conveyance facility, or the water cannot reasonably be treated for domestic use using either best management practices or best economically achievable treatment practices.	TBC	Although the resolution is a policy, and therefore not an ARAR, the AF agrees with the designation of the potential future use of the groundwater for this site as drinking/domestic use.
12	Definition of and Criteria for Identifying Hazardous Wastes	40 CFR 261.3 22 CCR, Div. 4.5, Ch. 11, Article 1, Sections 66261.2-.3; Article 3, Sections 66261.24-.33; Article 5, Sections 66261.100-.101	Federal State	Defines wastes that are subject to regulation as a RCRA or California hazardous waste[a]. Excavated contaminated soil, extracted groundwater, and spent treatment residuals (e.g., granular activated carbon) must be classified using AF knowledge of the timing and nature of the release as well as waste toxicity characteristic testing. If, after good faith effort, the AF determines that the contaminated soil or groundwater contains a listed RCRA or California hazardous waste[a] or fails the Federal or State toxicity characteristic tests, then the excavated soil or extracted groundwater is considered hazardous based on the USEPA "contained-in" policy and must be managed as hazardous remediation waste. Contaminated soils or groundwater that are treated *in situ* are not subject to the identification or classification requirements.	Applicable if wastes are hazardous as defined by 22 CCR	The definitions of hazardous waste in Article 1 and toxicity characteristic criteria (i.e., TTLC and STLC levels) in Section 66261.24 are potentially applicable for the characterization of soil cuttings from well installation, purge water from groundwater monitoring, or hazardous wastes excavated during waste cell consolidation.
13	Land Disposal Restrictions (LDR)	22 CCR, Div. 4.5, Ch. 14, Article 15.5, Sections 66264.550-.553, including 66264.552.5 for California[a] hazardous wastes; Ch. 18, Section 66268	State	Identifies hazardous wastes that are restricted from land disposal without prior treatment to UTS. Hazardous remediation wastes that are managed off-site are subject to the LDR UTS specified in Section 66268 for wastewater (liquid) and non-wastewater (solid). Hazardous soils must be treated to 90% reduction in concentration capped at 10 times the UTS for principal hazardous constituents (90% capped at 10 x UTS). On-site treatment or disposal of hazardous remediation wastes are not strictly subject to the LDR treatment standards, but are subject to similar treatment standards specified in the Corrective Action Management Unit Amendment Rule codified in 40 CFR 264.550-.555 and 22 CCR 66264.550-.553.	Applicable if wastes are hazardous as defined by 22 CCR	LDRs are applicable to off-site disposal of soil cuttings, purge water, or hazardous wastes excavated during waste cell consolidation if these remediation wastes are RCRA or California hazardous waste[a], as determined through toxicity characteristic testing using TCLP and TTLC/STLC.

TABLE B-1. APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS FOR SITE 3

Item No.	Requirement	Citation	Federal or State Requirement	Description	ARAR Determination	Comments
Action-specific ARARs *(continued)*						
14	Land Use Controls	22 CCR, Div. 4.5, Ch. 39, Section 67391.1; California Civil Code, Div. 3, Part 1, Title 3, Section 1471(a) through (f)	State	Requires that if a remedy will result in hazardous substances remaining on a property at levels unsuitable for unrestricted use and unlimited exposure, the limitations or controls are clearly set forth and defined in the Remedial Action decision document, and that the decision document include an implementation and enforcement plan. In the event of a property transfer, requires the State to enter into restrictive Land Use Covenants with land-owners and their successors, with exceptions for Federal-to-Federal property transfers.	Relevant and Appropriate	Institutional controls, limiting exposure to contaminated groundwater, are required at Site 3 until hazardous substance concentrations in groundwater are suitable for unrestricted use. Institutional controls will be required at Site 3 as long as the buried waste remains in place. Although it is not contemplated that property at Site 3 will be transferred, in the event that such property is transferred, the AF and the State have agreed to follow the procedure laid out in the Basewide Land Use Control Implementation Plan. USEPA agrees that the substantive portions of the regulation referenced are ARARs. USEPA specifically considers sections (a), (d), (e), and (f) of 22 CCR, Section 67391.1 to be ARARs for this ROD. The Cal/EPA DTSC position is that all of the State regulation is an ARAR.
15	Department of Resources Recycling and Recovery (CalRecycle) Requirements for Non Hazardous Waste Management Units	27 CCR, Division 2, Subdivision 1, Chapter 1, Article 1; Chapter 3, Subchapter 2-5, Sections 20200 through 21420 Note: See also Table B-2 for detailed discussion	State	Requirements for non-hazardous waste management units. These regulations also replace those codified by SWRCB in Title 23, Division 3, Chapter 15 regarding cleanup of hazardous waste discharges, including Remedial Action groundwater monitoring requirements. Requirements include classification, design, siting, construction, operation, monitoring, and closure and post-closure care. Sets forth the performance standards and the minimum substantive requirements for proper closure, post-closure maintenance, and ultimate reuse of solid waste disposal sites to assure that public health and safety and the environment are protected from pollution due to the disposal of solid waste. Sets up narrative standards for the cleanup of discharges of hazardous wastes to Waters of the State in accordance with SWRCB Resolution 92-49, Section III.G.	Relevant and appropriate	Title 27 regulations are applicable for on-site facilities that manage non-hazardous remediation wastes. Portions of these regulations are more stringent than 40 CFR Part 258 for landfills without liner systems. Units that were closed, abandoned, or inactive (CAI) before November 27, 1984 (CAI units) may not need to meet all of the Closure and Post-Closure Maintenance requirements of CCR, Title 27. Chapter 1, Article 1, Section 20090 exempts CERCLA Remedial Actions taken at unauthorized waste discharge sites from SWRCB provisions of this subdivision provided that wastes removed from sites are discharged according to Section 20200 *et seq.* and that wastes contained at the release sites follow applicable SWRCB provisions of this division to the extent feasible. Section 20080(b) allows for engineered alternatives to the prescriptive cover requirements in Subch. 5 if the prescriptive cover standards are not feasible and the alternative is both consistent with the performance goals and affords equivalent protection. The performance standards in Chapter 3, Subch. 5, Article 1, Section 20950(a)(2)(A) apply to closure and post-closure care for disposal sites closed as a landfill (i.e., with wastes contained in place). The performance standard in Section 20950(a)(2)(B) applies to disposal sites that are clean-closed (i.e., all wastes removed from the disposal sites).
16	CalRecycle Standards for Handling and Disposal of Asbestos-containing Waste	14 CCR, Division 7, Chapter 3.5, Articles 1 through 3	State	Establishes minimum standards that define the acceptable management of asbestos-containing wastes. The standards apply only to the owner or operator of a solid waste facility who disposes of asbestos-containing waste pursuant to Health and Safety Code Section 25143.7.	Relevant and Appropriate	To assure the safe handling of asbestos-containing waste during relocation of surface debris and waste cell consolidation, non-administrative provisions of 14 CCR Chapter 3.5, Articles 1 through 3 will be followed to the extent practicable.

Notes:
[a] California hazardous waste (as used in this table) is the same as non-RCRA hazardous waste as defined in Section 66261.101 of CCR Title 22.

%	percent	Div.	Division	ppm	parts per million
AF	Air Force	DTSC	Department of Toxic Substances Control	RCRA	Resource Conservation and Recovery Act
AFB	Air Force Base	e.g.	exempli gratia (for example)	ROD	Record of Decision
ARARs	Applicable or Relevant and Appropriate Requirements	EPA	Environmental Protection Agency	RWQCB	Regional Water Quality Control Board
Basin Plan	Water Quality Control Plan for Lahontan Region	et seq.	et sequentes (and the following)	SDWA	Safe Drinking Water Act
CAI	closed, abandoned, or inactive	gpd	gallons per day	STLC	soluble threshold limit concentration
Cal/EPA	California Environmental Protection Agency	H&S	health and safety	Subch.	subchapter
CalRecycle	California Department of Resources Recycling and Recovery	i.e.	id est (that is)	SWRCB	State Water Resources Control Board
CCR	California Code of Regulations	ID	identification	TBC	to be considered
CDFG	California Department of Fish and Game	INRMP	Integrated National Resources Management Plan	TCLP	toxic characteristic leaching procedure
CDPH	California Department of Public Health	LDR	land disposal restriction	TDS	total dissolved solid
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act	MCL	Maximum Contaminant Level	TTLC	total threshold limit concentration
CFR	Code of Federal Regulations	MCLG	Maximum Contaminant Level Goal	USC	United States Code
Ch.	Chapter	NCP	National Contingency Plan	USEPA	United States Environmental Protection Agency
CWC	California Water Code	No.	number	UTS	universal treatment standard
				USFWS	United States Fish and Wildlife Service

TABLE B-2. PORTIONS OF TITLE 27, CALIFORNIA CODE OF REGULATIONS THAT ARE APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS FOR SITE 3

Citation	Description	ARAR Determination	Comments
§20080(b, c, and g) CAI units	Allows for engineered alternatives to State Prescriptive Cover that afford equivalent protection against water quality impairment. Allows for demonstration that meeting the equivalent protection requirement is unreasonably and unnecessarily burdensome, or will cost substantially more than alternatives that meet the criteria, or is impractical and will not promote attainment of applicable performance standards. Defines closed, abandoned, or inactive (CAI) units as those that were closed, abandoned, or inactive on or before November 27, 1984.	Applicable	During preparation of the Remedial Action Work Plan, a technical evaluation will be performed to assure that the final cover provides equivalent protection against impairment of groundwater to a cover built in accordance with applicable prescriptive standards under Title 27, Section 21090(a)(1-3). Site 3 will be treated as a CAI unit because presumably any waste deposited post November 27, 1984 is inert surface debris and closure will comply with California Code of Regulations, Title 27, Section 21090(a)(1) through (a)(4).
§20365 Precipitation and drainage controls	Specifies performance standards for diversion and drainage facilities.	Relevant and appropriate	§20365 will be followed to the extent feasible in the design and construction of stormwater controls. A conceptual design of the stormwater control system is included in the ROD; greater details will be contained in the Remedial Action Work Plan.
§20380 Water monitoring	Specifies detection, evaluation, and corrective action program requirements. Defines the required monitoring programs and their triggers. An evaluation monitoring program would be required to assess when a "measurably significant release" occurs as defined in California Code of Regulations, Title 27, Section 20164.	Relevant and appropriate	During the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Remedial Investigation/Feasibility Study (RI/FS) phase, the Air Force sampled and analyzed the groundwater at Site 3, and therefore has met the intent of the Municipal Solid Waste Landfill (MSWLF) detection program and evaluation requirements incorporated by reference in Title 27 (40 Code of Federal Regulations [CFR] 258.54-258.56) to monitor for "applicable" or "approved" Appendix II constituents.

TABLE B-2. PORTIONS OF TITLE 27, CALIFORNIA CODE OF REGULATIONS THAT ARE APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS FOR SITE 3

Citation	Description	ARAR Determination	Comments
§20390 Water quality protection standards	Specifies components of a Water Quality Protection Standard (Water Standard) as: (a) list of constituents of concern, (b) concentration limits, (c) point of compliance, and (d) monitoring points.	Relevant and appropriate	§20390 would be followed to the extent feasible to develop the monitoring program. The contaminants of concern (COCs) and their respective remediation goals are included in the ROD. Point of compliance wells and monitoring points will be established in the Remedial Action Work Plan.
§20395 Constituents of concern	Includes all waste constituents, reaction products, and hazardous constituents reasonably expected to be in, or derived from, the waste contents.	Relevant and appropriate	It is the Air Force's position that COCs would be limited to those constituents posing a risk to human health or the environment. During the CERCLA RI/FS process, the Air Force sampled and analyzed the groundwater at Site 3 for constituents listed in 40 CFR 258, Appendix II, and therefore has met the intent of the MSWLF detection program requirements (40 CFR 258.54-258.56) to monitor for "applicable" or "approved" Appendix II constituents. A final list of the COCs is contained in the ROD.
§20400 Concentration limits	Must be established for all constituents of concern and be equal to background values or a concentration limit greater than background	Relevant and appropriate	It is the Air Force's position that MCLs, not background concentrations, be used as health-protective constituent concentration limits. A TEFA has been performed to evaluate appropriate concentration limits for COCs.
§20405 Monitoring points and point of compliance	Point of compliance is a vertical surface located at the hydraulically downgradient limit of the unit extending into the uppermost aquifer under the unit.	Relevant and appropriate	§20405 will be followed to the extent feasible to develop the monitoring program. The point of compliance will be included on figures contained in the ROD and Remedial Action Work Plan.

TABLE B-2. PORTIONS OF TITLE 27, CALIFORNIA CODE OF REGULATIONS THAT ARE APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS FOR SITE 3

Citation	Description	ARAR Determination	Comments
§20415 General water quality monitoring and system requirements	Specifies actions and requirements for developing and implementing groundwater monitoring and Remedial Actions.	Relevant and appropriate	§20415 will be followed to the extent feasible to develop the monitoring program. A general description of the monitoring program will be included in the ROD; greater details concerning the program will be contained in the Remedial Action Work Plan.
§20420(k)(7) Optimal demonstration	Allows demonstration that a source other than the landfill is the cause of evidence of a release.	Relevant and appropriate	§20420(k)(7) will be followed to the extent feasible for evaluating the elevated nitrate concentrations detected in groundwater samples collected from Monitoring Well 3-MW10. If it is determined that the elevated nitrate concentrations come from a source other than the landfill, the Title 27 Corrective Action requirements will not apply for this portion of the site. The timeframes stipulated in this section for demonstrating the source of the release are not applicable to the Remedial Action.
§20425 Evaluation monitoring program	The nature and extent of the release must be determined.	Relevant and appropriate	§20425 will be followed to the extent feasible to characterize the nature and extent of the release. However, the timeframes stipulated in this section for executing the evaluation monitoring program are not applicable to the Remedial Action.
§20430 Corrective action program	Requires corrective action to: (a) remediate releases from the unit, and (b) achieve compliance with the Water Standard throughout the zone affected by the release and prevent further noncompliance due to a continued release.	Relevant and appropriate	§20430 will be followed to the extent feasible for implementing the Remedial Action. However, the timeframes and reporting frequencies stipulated in this section for executing the corrective action program are not applicable to the Remedial Action.

TABLE B-2. PORTIONS OF TITLE 27, CALIFORNIA CODE OF REGULATIONS THAT ARE APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS FOR SITE 3

Citation	Description	ARAR Determination	Comments
§20921 Gas Monitoring and Control.	Requires that: (1) The concentration of methane gas must not exceed 1.25% by volume in air within any portion of any on-site structures. (2) The concentration of methane gas migrating from the disposal site must not exceed 5% by volume in air at the disposal site permitted facility boundary or an alternative boundary approved in accordance with §20925. (3) Trace gases shall be controlled to prevent adverse acute and chronic exposure to toxic and/or carcinogenic compounds.	Relevant and appropriate	The requirements of this section were used to develop action levels for methane and screening levels for volatile organic compounds in landfill gas. The timeframes and other administrative requirements stipulated in this section are not applicable to the Remedial Action.
§20932 Monitored Parameters (Gas)	Requires monitoring of monitoring wells and on site structures for methane. May require monitoring for trace gases when there is a possibility of acute or chronic exposure due to hazardous waste.	Relevant and appropriate	Landfill gas wells will be monitored for methane and volatile organic compounds during the Remedial Action. There are currently no on-site structures and none are planned.

TABLE B-2. PORTIONS OF TITLE 27, CALIFORNIA CODE OF REGULATIONS THAT ARE APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS FOR SITE 3

Citation	Description	ARAR Determination	Comments
§21090 Closure and post-closure maintenance requirements	Requires a low hydraulic conductivity layer and drainage control.	Relevant and appropriate	§21090, subsections (a) and (b) will be followed to the extent feasible in implementing the cover design and grading of the site.

Notes:

§	Section
CAI	closed, abandoned, or inactive
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COCs	contaminants of concern
FS	Feasibility Study
MCL	Maximum Contaminant Level
MSWLF	Municipal Solid Waste Landfill
MW	monitoring well
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
RWQCB	Regional Water Quality Control Board

APPENDIX C

REVISED HUMAN HEALTH RISK ASSESSMENT

APPENDIX C
REVISED HUMAN HEALTH RISK ASSESSMENT

In 2004, a Human Health Risk Assessment (HHRA) of Site 3 was performed to evaluate the potential risk to human health posed by chemicals that may have been released into the soil and groundwater at the site (Earth Tech 2004d). The assessment was conducted in two steps; 1) a preliminary assessment which used maximum site soil and groundwater concentrations and USEPA-recommended risk-based levels (i.e., the 2002 Preliminary Remediation Goals [PRGs]) to calculate cancer risks and non-cancer hazards, and 2) a detailed assessment which calculated site-specific risk and hazards for those chemicals and pathways which were determined to be of concern based on the results of the preliminary assessment.

The HHRA was updated for the Site 3 Feasibility Study (FS) (Earth Tech 2008b) using USEPA Region 9 2004 PRGs. The revised groundwater risk assessment used the May and June 2005 groundwater sampling results for Site 3, the most recent available at that time (FPM Group 2006). In addition, the indoor risk from soil gas was calculated using the most recent soil gas sampling results for Site 3 available at that time (FPM Group 2006).

For the purpose of the updated assessment, the 95 percent upper confidence limit of the mean (95% UCLs) was used to represent soil, groundwater, and soil vapor concentrations. The 95% UCLs were calculated using the USEPA-recommended software ProUCL version 3.0. When the 95% UCL exceeded the maximum detected concentration, or insufficient data were available to calculate a 95% UCL, the maximum concentration was used.

The results of the assessment as presented in the following sections show that the soil risks for the residential, industrial, and construction exposure scenarios were less than or within the U.S. EPA risk management range for cumulative cancer risk (total cumulative cancer risk of 1×10^{-4} to 1×10^{-6}) and at or below a Hazard Index of 1 for non-cancer effects. For this reason, no additional assessment was determined to be necessary. In accordance with OSWER Directive 9355.0-30 (USEPA 1991), remediation goals for groundwater were triggered by Maximum Contaminant Levels (MCLs), therefore further refinement of the risk assessment for groundwater was evaluated not to be warranted.

C.1 CONCEPTUAL MODEL AND IDENTIFIED EXPOSURE PATHWAYS

The exposure scenarios and pathways were similar to the ones considered in the original Site 3 HHRA, with the exception that an indoor air pathway was added.

The exposure scenarios consisted of residential, industrial, and construction/excavation scenarios. The exposure pathways used for each scenario is outlined below:

Receptors:

- **Soil** – residential, industrial, and construction/excavation.
- **Groundwater** – residential.
- **Indoor air** – residential and industrial.

Pathways:

- **Soil** – risk calculations based on USEPA Region 9PRGs, and consisted of ingestion, dermal, inhalation of volatile organic compounds (VOCs) and inhalation of semi-volatile organic compounds (SVOCs) from fugitive dust.
- **Groundwater** – risk calculations based on PRGs and consisted of ingestion and inhalation of VOCs during showering.
- **Indoor air** – risk calculation estimates represent the risks from the potential volatilization of subsurface VOCs to the indoor air of hypothetical overlying structures.

C.2 ASSESSMENT OF SOIL AND GROUNDWATER EXPOSURE PATHWAYS

The assessment for the soil and groundwater exposure pathways was conducted as discussed in the original Site 3 HHRA. All organic chemical data were used. The concentrations of inorganic chemicals (e.g., metals, cyanide, nitrate, etc.) in soil (Table C-1) and groundwater (Table C-2) were first compared to the background concentrations used in the HHRA. The chemicals with concentrations greater than background concentrations and those for which no background concentrations are available were conservatively assumed to be site-related and were carried forward into the assessment. Those that did not exceed their background concentrations were not considered further.

Consistent with the original Site 3 HHRA, PRGs were used to quantify incremental cancer risks and non-cancer hazards from potential exposure to chemicals separately and in combination with other chemicals. These risks and hazards were estimated using a ratio of the concentration of each chemical to its specific PRG for soil and groundwater. The estimation was made for both residential and industrial receptors, and was also made for a construction/excavation receptor using the industrial PRG modified to account for the differences in exposure factors between industrial and construction/excavation receptors. This assessment was considered health-protective because the PRGs consider all potential residential and industrial pathways to be complete.

It should be noted that the soil data used for this assessment was selected to represent the soil above the refuse. This reflects the assumption that, although no future development is anticipated, this development would occur directly above the landfill without disturbing the landfill cover, and that the refuse itself would not be moved. Thus, direct contact with soil beneath the refuse is not assumed to occur. Tables C-3 and C-4 present the quantification of risks and hazards for chemicals detected in soil and groundwater, respectively.

C.3 CALCULATION OF RISKS AND HAZARDS FOR THE INDOOR AIR EXPOSURE PATHWAY

The initial baseline Site 3 HHRA did not include subsurface vapor intrusion and subsequent inhalation of VOCs in indoor air because no buildings were present on or adjacent to the site. However, as agreed in an April 2006 Remedial Project Manager meeting, the revised assessment includes the assessment of this pathway for future residential and industrial structures. Soil vapor concentration results were obtained from gas probes installed at the site (FPM Group 2006). These data were used to assess risks within the footprint of the landfill rather than estimating volatilization from soil or groundwater because the soil vapor data better represent the actual source of airborne VOCs (i.e., the refuse) and because using measured soil vapor data eliminates the uncertainties of having the vapor intrusion model estimate these results from soil or groundwater data.

The estimation of potential indoor air cancer risk and non-cancer hazards was conducted using Version 3.1 of the Johnson and Ettinger (J&E) vapor intrusion model (Johnson and Ettinger 1991) provided by the USEPA (available at www.epa.gov/oswer/riskassessment/airmodel/johnson_ettinger.htm). The J&E model simulates the upward diffusion of the vapor within the unsaturated zone toward the surface, the infiltration of the vapor through the building foundation, and the dispersion into the living space, and then estimates the cancer risks and non-cancer hazards resulting from the inhalation of the indoor air. For the purpose of simulating these processes, the health-protective default values for the J&E model parameters were used unless more site-specific information was available. Thus, for the residential scenario, the values for building-related parameters were the default values recommended in the J&E model. For the industrial scenario, the dimensions of a typical building at Edwards AFB (which coincides with the J&E model default residential dimensions) were used, but the minimum design standard building air exchange rate used for general purpose buildings at the Base (1.11 exchanges per hour) was used to estimate some of the building-related parameters. The soil type assumed for this assessment (a silt loam) was representative of the soil described for the site, and the soil parameters related to soil type (e.g., total and water-filled porosity) were the default values recommended by the J&E model for this soil. The diffusion path length used in J&E modeling was 5 feet; the depth of soil vapor probe 3-LFG05 which was the location from which most of the VOCs were detected.

For the risk assessment portion of the J&E modeling, site-specific values for exposure duration (10 years versus 25 years) were used for the industrial scenario for consistency with the initial Site 3 HHRA, and the values of the remaining exposure parameters for both the residential and industrial scenarios were those typically recommended in State and Federal risk assessment guidance. The use of these values was consistent with the approach used in the HHRA.

The toxicity values used were selected in accordance the approach for selecting toxicity criteria recommended in the *Air Force Risk Assessment and Risk-Based Cleanup Levels Guidance, Memorandum for all MAJCOMs/A7/CEV*, 14 July 2006 (USAF 2006), which adopts OSWER Directive 9285.7-53, *Human Health Toxicity Values in Superfund Risk Assessments*, December 5, 2003 (USEPA 2003). Surrogate compounds were used for chemicals detected at the site but were not included in the J&E chemical database. These chemicals and the surrogates used are listed in Tables C-5 through C-8. Table C-5 presents the quantification of indoor air risks and hazards from chemicals detected in soil gas.

At the request of Cal/EPA DTSC, a second set of risk results were prepared. These results, presented in Table C-6, are the same as for Tables C-5 except that the toxicity criteria recommended by Cal/EPA

DTSC (i.e., those that result in the most conservative assessment) are used in place of those recommended in USAF 2006 and OSWER Directive 9285.7-53 (USEPA 2003). Regardless of the source of the toxicity values, both Tables C-5 and C-6 demonstrate risks within the risk management range (USEPA 1991).

In addition to the indoor air assessment described above, a second indoor air assessment was conducted to address the hypothetical future scenario where a building is constructed immediately adjacent to the site. In this case, the source of VOCs would be the groundwater impacted by site VOCs. The J&E modeling was conducted as described above, using the 95% UCL of the groundwater VOC concentrations and the shallowest depth to groundwater at the site (65 feet) as the value for the volatilization path length. The values for the toxicity criteria, groundwater concentrations, and risk results are presented in Table C-7. As with the soil vapor risk assessment discussed above, a second set of risks were calculated using the values recommended by Cal/EPA DTSC. These results are presented in Table C-8. Regardless of the source of the toxicity values, both Tables C-7 and C-8 demonstrate risks within the risk management range (USEPA 1991).

C.4 LANDFILL GAS RISKS AND SCREENING GOALS

The USEPA Version 3.1 of the J&E model (Johnson and Ettinger 1991) was used to calculate potential indoor air risks and risk-based action levels for VOCs that are protective of human health under the hypothetical residential exposure scenario for persons living indoors at the Land Use Control boundary as described in Section C.3.

Eighteen chemicals that are considered Contaminants of Concern (COCs) in soil gas were detected in gas samples collected from eight perimeter landfill gas monitoring wells installed as nested pairs (Wells 3-LFG06A/B, 3-LFG07A/B, 3-LFG08A/B, and 3-LFG09A/B) during the June 2009 sampling event (see Table 2.7-2 of the main text). At least one of these chemicals was detected in each landfill gas monitoring well. In addition to the 18 COCs, screening levels were also developed for seven COCs detected in interior gas monitoring wells that potentially could migrate to perimeter wells (see Table 2.6-6 of the main text). For the purpose of calculating the potential cancer risks and non-cancer hazards, the maximum concentration of each VOC detected in soil gas at the site was used. These concentrations and the depths at which they were detected are presented in Table C-9.

Screening levels for soil gas were developed separately for the shallower A-level wells and the deeper B-level wells. For the shallower wells, a depth of eight feet was used, and for the deeper wells, a depth of 23 feet was used. These depths correspond to the top of the slotted screen intervals in a nested pair of landfill gas monitoring wells.

Toxicity criteria to develop the screening levels were consistent with the criteria used for the May 2010 USEPA Regional Screening Levels (RSLs). These criteria were selected in accordance with the hierarchy of OSWER Directive 9285.7-53 (USEPA 2003), DoD Instruction 4715.18 (2009), and USAF 2006. Briefly, this approach uses values from the USEPA Integrated Risk Information System (IRIS) as the Tier 1 source. If values are not available from IRIS, USEPA provisional peer-reviewed toxicity values are consulted as Tier 2 sources followed by Tier 3 sources such as Cal/EPA OEHHA. An alternative means of selecting toxicity criteria was recommended by DTSC in the 2 December 2010 RPM meeting. This method involves the use of the most conservative toxicity values rather than a tiered approach. For the purpose of this assessment, both approaches were presented. For most chemicals, there were no differences in the toxicity criteria with either approach. However, there were a few chemicals (benzene, styrene, and toluene), for which different toxicity values would be identified depending on the approach used for the selection of the toxicity value. In these cases, the risks and screening levels were calculated using both sets of toxicity criteria. The values for the toxicity criteria are presented in Table C-9. For chemicals detected in soil gas but not included in the RSLs, surrogate chemicals were assigned. These assignments were generally based on structural and toxicity similarities. Surrogates were assigned to three chemicals; dichlorodifluoromethane was used as a surrogate for 1,2-dichlorotetrafluoroethane, and p-xylene was used a surrogate for 4-ethyltoluene and for m,p-xylenes.

The J&E model was used to calculate cancer risks and non-cancer hazard quotients for each chemical. Screening values were developed by back-calculating the concentration of each chemical that corresponded to either a cancer risk of 1×10^{-6} or a Hazard Index of 1; whichever concentration was lower. The results of the screening level calculations are presented in Table C-9. The results show that none of the individual chemicals presents a cancer risk greater than 1×10^{-6} or a non-cancer hazard greater than 1. Although the cumulative cancer risk of 1.6×10^{-6} mathematically exceeds 1×10^{-6}, given that toxicity values, site concentrations, and risk results are significant only to a single digit, this result is not considered significantly different from 1×10^{-6}. In addition, key uncertainties contributing to the determination of no actionable risk include the fact that the risks are based on maximum detected values rather than values representative of those over an area as large as a structure. The second is the assumption that a residential structure will be built on the Land Use Control boundary of the landfill. Furthermore, the cumulative cancer risk is within the NCP cumulative cancer risk management range.

C.5 UNCERTAINTIES IN LANDFILL GAS RISK ASSESSMENT

It should be noted that the vapor intrusion modeling for volatile organic gases does not account for the effect methane, which is produced at the site below the ground surface, may have in the transport of these gases. Therefore, the vapor intrusion analysis may under-predict indoor air concentrations.

Additionally, although explosive risks from methane are not quantified by J&E vapor intrusion modeling, acute effects (e.g. explosive hazards) of methane are addressed with landfill gas monitoring as part of the remedy.

TABLES

TABLE C-1. COMPARISON OF CONCENTRATIONS OF INORGANIC ANALYTES IN SOIL TO BACKGROUND, SITE 3

Analyte[1]	95% UCL Concentration[2]	Background Concentration[2, 3]	Check if Maximum Detected Concentration is Greater Than Background
aluminum	1.25E+04	2.58E+04	
antimony	ND	7.50E+00	
arsenic	7.19E+00	2.86E+01	
barium	7.07E+01	3.45E+02	
beryllium	4.60E-01	1.20E+00	
cadmium	ND	7.90E-01	
chromium, total	9.19E+00	3.04E+01	
cobalt	3.27E+00	1.42E+01	
copper	9.32E+00	2.81E+01	
iron	1.56E+04	3.48E+04	
lead	5.63E+01	1.89E+01	√
manganese	2.96E+02	9.43E+02	
mercury	1.39E-01	1.40E-01	
molybdenum	ND	3.80E+00	
nickel	5.55E+00	1.70E+01	
selenium	2.99E-01	5.00E-01	
silver	6.10E-01	1.25E+00	
thallium	ND	NE	
vanadium	2.52E+01	7.71E+01	
zinc	6.21E+01	1.26E+02	

Notes:

[1] Results for macronutrients (calcium, magnesium, potassium, and sodium) are not included in this comparison.
[2] Concentration in milligrams per kilogram (mg/kg).
[3] Background values for OU1 used for comparison. See text.

95%UCL 95 percent upper confidence limit of the mean
ND not detected
NE not established

TABLE C-2. COMPARISON OF CONCENTRATIONS OF INORGANIC ANALYTES IN GROUNDWATER TO BACKGROUND, SITE 3

Analyte[1]	95% UCL Concentration[2]	Background Concentration[2, 3]	Check if Maximum Detected Concentration is Greater Than Background
aluminum	6.11E-01	1.36E+01	
antimony	ND	6.00E-02	
arsenic	1.50E-02	1.20E-01	
barium	9.80E-02	2.80E-01	
beryllium	7.90E-04	2.00E-03	
cadmium	ND	5.00E-03	
chromium, hexavalent	ND	NE	
chromium, total	1.64E-01	6.20E+00	
cobalt	3.00E-03	3.20E-02	
copper	ND	7.40E-02	
cyanide	6.60E-03	NE	
fluoride	9.24E-01	5.00E+00	
iron	1.86E+00	2.90E+01	
lead	ND	2.10E-02	
manganese	2.46E-01	6.60E-01	
mercury	8.90E-04	2.10E-03	
molybdenum	3.30E-02	4.40E-01	
nickel	1.21E-01	1.10E+00	
nitrogen, nitrate (as N)	1.55E+01	NE	
selenium	ND	1.90E-02	
silver	1.20E-03	1.00E-02	
thallium	ND	4.00E-01	
vanadium	5.00E-03	2.00E-01	
zinc	1.10E-02	1.30E-01	

Notes:

[1] Results for macronutrients (calcium, magnesium, potassium, and sodium) are not included in this comparison.
[2] Concentration in milligrams per liter (mg/L).
[3] Background values for OU1 used for comparison. See text.

95% UCL — 95 percent upper confidence limit of the mean
ND — not detected
NE — not established

TABLE C-3. QUANTITATION OF RISKS AND HAZARDS FOR CHEMICALS DETECTED IN SOIL, SITE 3

Analyte	95%UCL Concentration	Residential PRG	Industrial PRG	Residential PRG Quantification: Carcinogens	Residential PRG Quantification: Noncarcinogens	Industrial PRG Quantification: Carcinogens	Industrial PRG Quantification: Noncarcinogens
Inorganic Analytes (mg/kg)							
lead	5.63E+01	1.50E+02	8.00E+02		0.38		0.07
Organic Analytes (mg/kg)					<0.01		<0.01
acetone	2.60E-02	1.40E+04	5.40E+04		<0.01		<0.01
alpha-chlordane	6.50E-03	1.62E+00 c	6.47E+00 c	4.00E-09		1.01E-09	
benzo(a)anthracene	2.84E-01	6.21E-01 c	2.11E+00 c	4.57E-07		1.35E-07	
benzo(a)pyrene	2.26E-01	6.21E-02 c	2.11E-01 c	3.64E-06		1.07E-06	
benzo(k)fluoranthene	1.96E-01	3.78E-01 c	1.28E+00 c	5.18E-07		1.53E-07	
bis(2-ethylhexyl) phthalate	3.36E-01	3.47E+01 c	1.23E+02 c	9.67E-09		2.73E-09	
chrysene	3.48E-01	3.78E+00 c	1.28E+01 c	9.20E-08		2.71E-08	
dalapon	1.67E-01	1.83E+03	1.85E+04		<0.01		<0.01
dieldrin	3.00E-03	3.04E-02 c	1.08E-01 c	9.87E-08		2.78E-08	
endrin aldehyde	4.30E-02	1.83E+01 s	1.85E+02 s		<0.01		<0.01
fluoranthene	6.51E-01	2.29E+03	2.20E+04		<0.01		<0.01
gamma-chlordane	4.60E-03	1.62E+00 c	6.47E+00 c	2.83E-09		7.11E-10	
methylene chloride	2.40E-03	9.11E+00 c	2.05E+01 c	2.64E-10		1.17E-10	
p,p'-DDD	3.00E-03	2.44E+00 c	9.95E+00 c	1.23E-09		3.01E-10	
p,p'-DDE	7.00E-03	1.72E+00 c	7.02E+00 c	4.07E-09		9.97E-10	
p,p'-DDT	7.00E-03	1.72E+00 c	7.02E+00 c	4.07E-09		9.97E-10	
PCB-1254 (Aroclor 1254)	8.00E-02	2.22E-01 c	7.44E-01 c	3.61E-07		1.08E-07	
PCB-1260 (Aroclor 1260)	5.80E-02	2.22E-01 c	7.44E-01 c	2.61E-07		7.80E-08	
p-cymene (p-isopropyltoluene)	2.60E-03	5.72E+02 s	1.98E+03 s		<0.01		<0.01
phenanthrene	6.33E-01	2.19E+04 s	1.00E+05 s		<0.01		<0.01
pyrene	1.43E+00	2.32E+03	2.91E+04		<0.01		<0.01
toluene	2.10E-03	5.20E+02	5.20E+02		<0.01		<0.01
xylene (m,p)	2.60E-03	2.75E+02	4.20E+02		<0.01		<0.01
Residential and Industrial PRG Risk Quantification for Constituents in Soil [1]				5.45E-06	0.38	1.61E-06	0.07
						Carcinogens	Noncarcinogens
Construction Worker PRG Risk Quantification for Constituents in Soil [2]						2.47E-08	0.03

Notes:

1 Calculated as the ratio of the maximum detected concentration to the PRGs for noncarcinogens. This ratio is multiplied by 1 x 10^{-6} for carcinogens (see Earth Tech 2001a).
2 Calculated as the product of 0.015 and the industrial risk, and 0.384 and the industrial hazard. See text.
c Indicates that chemical is evaluated based on its carcinogenic potential.
s Surrogate. PRG for these chemicals have not been established. The following surrogates are substituted:

Analyte	Surrogate
p-cymene (p-isopropyltoluene)	cumene (isopropylbenzene)
phenanthrene	anthracene
endrin aldehyde	endrin

95%UCL 95 percent upper confidence limit of the mean
mg/kg milligrams per kilogram
PRG preliminary remediation goal (see USEPA 2004)

TABLE C-4. QUANTITATION OF RISKS AND HAZARDS FOR CHEMICALS DETECTED IN GROUNDWATER, SITE 3

Analyte	95%UCL Concentration	Tap Water PRG		Residential PRG Quantification: Carcinogens	Residential PRG Quantification: Noncarcinogens
Inorganic Analytes (mg/L)					
cyanide	6.60E-03	7.30E-01			<0.01
nitrogen, nitrate (as N)	1.55E+01	1.00E+01			1.55
Organic Analytes (μg/L)					
acetone	5.50E+00	5.50E+03			<0.01
benzene	3.99E-01	3.50E-01	c	1.14E-06	
chlorobenzene	2.50E-01	1.10E+02			<0.01
chloroform	5.10E-01	1.70E-01	c	3.00E-06	
1,2-dichlorobenzene	5.97E-01	3.70E+02			<0.01
1,4-dichlorobenzene	2.24E+00	5.00E-01	c	4.48E-06	
dichlorodifluoromethane	1.11E+01	3.90E+02			0.03
1,1-dichloroethane	3.21E+00	8.10E+02			<0.01
1,2-dichloroethane	3.73E-01	1.20E-01	c	3.11E-06	
1,1-dichloroethene	5.00E-01	3.40E+02			<0.01
cis-1,2-dichloroethene	3.82E+00	6.10E+01			0.06
trans-1,2-dichloroethene	5.00E-01	1.20E+02			<0.01
1,2-dichloropropane	6.22E-01	1.60E-01	c	3.89E-06	
isopropylbenzene	5.47E-01	6.60E+02			<0.01
p-isopropyltoluene	5.00E-01	6.60E+02			<0.01
methylene chloride	1.14E+01	4.30E+00	c	2.64E-06	
tetrachloroethene (PCE)	6.49E+00	1.00E-01	c	6.49E-05	
trichloroethene (TCE) [2]	1.25E+01	2.80E-02	c	4.48E-04	
trichloroethene (TCE) [3]	1.25E+01	1.40E+00	c	8.95E-06	
trichlorofluoromethane	1.16E+00	1.30E+03			<0.01
vinyl chloride	6.03E+00	2.10E-02	c	2.87E-04	
naphthalene	5.72E-01	9.20E-02	c	6.22E-06	
aldrin	8.10E-02	4.00E-03	c	2.03E-05	
alpha-BHC	7.80E-02	1.10E-02	c	7.09E-06	
beta-BHC	4.16E-01	1.10E-02	c	3.78E-05	
delta-BHC	1.05E-01	3.70E-02	c	2.84E-06	
gamma-BHC	1.96E-01	5.20E-02	c	3.77E-06	
alpha-endosulfan	5.10E-02	2.20E-02			2.32
methoxychlor	3.49E-01	1.80E+02			<0.01
2,4-dichlorophenoxyacetic acid	6.80E-01	3.60E+02			<0.01
dalapon	6.20E+01	1.10E+03			0.06
dicamba	1.40E+00	1.10E+03			<0.01
dinoseb	1.80E-01	3.60E+01			<0.01
silvex	5.50E-01	NA			NA
PRG Risk Quantification for Constituents in Groundwater [1]		Total [2] :		8.96E-04	4.06
		Total [3] :		4.57E-04	4.06

Notes:

[1] Calculated as the ratio of the maximum detected concentration to the PRG for noncarcinogens. This ratio is multiplied by 1 x 10^{-6} for carcinogens (see Earth Tech, 2001a).
[2] Risk assessed using USEPA PRG.
[3] Risk assessed using Cal-Modified PRG.
c Indicates that chemical is evaluated based on its carcinogenic potential.
S Surrogate. PRG for this chemical has not been established. The following surrogates are substituted:

Analyte	Surrogate
p-cymene (p-isopropyltoluene)	cumene (isopropylbenzene)

95%UCL 95 percent upper confidence limit of the mean
μg/L micrograms per liter
mg/L milligrams per liter
NA not available
PRG Preliminary Remediation Goal (see USEPA 2004)

TABLE C-5. RESULTS OF INDOOR AIR MODELING BASED ON SOIL VAPOR CONCENTRATIONS AND USING US EPA RECOMMENDED TOXICITY VALUES, SITE 3

	Toxicity Criteria					Residential			Industrial	
	IUR ($[\mu g/m^3]^{-1}$)	Source	RfC (mg/m^3)	Source	95%UCL (ppb v/v)	cancer	non-cancer		cancer	non-cancer
acetone (a)			3.2E-01	IRIS	100		<0.01			<0.01
benzene (a)	7.80E-06	IRIS	3.0E-02	IRIS	22	3.50E-07	<0.01		1.90E-08	<0.01
carbon disulfide			7.0E-01	IRIS	5.66		<0.01			<0.01
chloroethane	8.30E-07	NCEA	1.0E+01	IRIS	2.99	7.80E-09	<0.01		4.20E-10	<0.01
chloroform	2.30E-05	IRIS			1.06	8.40E-08	NA		4.50E-09	NA
1,2-dichlorobenzene (a)			2.0E-01	HEAST	1		<0.01			<0.01
1,4-dichlorobenzene (a)	1.10E-05	OEHHA	8.0E-01	IRIS	140	4.90E-06	<0.01		2.60E-07	<0.01
dichlorodifluoromethane			2.0E-01	NCEA	310		<0.01			<0.01
1,1-dichloroethene (a)			2.0E-01	IRIS	1		<0.01			<0.01
cis-1,2-dichloroethene (a)			3.5E-02	PPRTV	27		<0.01			<0.01
trans-1,2-dichloroethene (a)			7.0E-02	IRIS	1		<0.01			<0.01
1,2-dichlorotetrafluoroethane (a)			3.0E+01	HEAST	15		<0.01			<0.01
ethylbenzene (a)			1.0E+00	IRIS	230		<0.01			<0.01
4-ethyltoluene (a)			4.0E-01	IRIS	32		<0.01			<0.01
methylene chloride	4.70E-07	IRIS	3.0E+00	HEAST	1.26	1.40E-09	<0.01		7.70E-11	<0.01
tetrachloroethene (PCE) (a)	5.90E-06	OEHHA	6.0E-01	NCEA	16	3.50E-07	<0.01		1.90E-08	<0.01
toluene (a)			4.0E-01	IRIS	54		<0.01			<0.01
trichloroethene (TCE)	2.00E-06	OEHHA	6.0E-01	OEHHA		4.80E-08	<0.01		2.60E-09	<0.01
trichlorofluoromethane (a)			7.0E-01	HEAST	10		<0.01			<0.01
1,2,4-trimethylbenzene (a)			6.0E-03	NCEA	24		0.02			<0.01
1,3,5-trimethylbenzene (a)			6.0E-03	NCEA	56		0.05			<0.01
vinyl chloride (a)	8.80E-06	IRIS	1.0E-01	IRIS	92	1.50E-06	<0.01		7.90E-08	<0.01
xylenes, total (a)			1.0E-01	IRIS	430		0.02			<0.01
					Total :	7.24E-06	0.12	Total :	3.85E-07	0.02

Notes:

The 95% UCL concentration was used to assess the vapor intrusion pathway, except as noted.

(a) The maximum concentration was used due to limited number of detections.

Ethylbenzene used as surrogate for 4-ethyltoluene.

Trichlorotrifluoroethane used as surrogate for dichlorotetrafluoroethane and trichlorofluoroethane.

95% UCL 95 percent upper confidence limit of the mean
$\mu g/m^3$ micrograms per cubic meter
HEAST Health Effects Assessment Summary Tables
IRIS Integrated Risk Information System
IUR Inhalation Unit Risk factor. This value was used to calculate the cancer risk and/or the risk-based screening concentration based on the cancer endpoint.
mg/m^3 milligrams per cubic meter
NCEA National Center for Environmental Assessment
OEHHA Office of Environmental Health Hazard Assessment
ppb v/v parts per billion by volume
PPRTV Provisional Peer Reviewed Toxicity Values
RfC Reference Concentration. This value was used to calculate the Hazard Quotient and/or the risk-based screening concentration based on the non-cancer endpoint.

TABLE C-6. RESULTS OF INDOOR AIR MODELING BASED ON SOIL VAPOR CONCENTRATIONS AND USING CALIFORNIA DTSC-RECOMMENDED TOXICITY VALUES, SITE 3

	Toxicity Criteria					Residential			Industrial	
	IUR		RfC		95%UCL					
	(($\mu g/m^3)^{-1}$)	Source	(mg/m^3)	Source	(ppb v/v)	cancer	non-cancer		cancer	non-cancer
acetone (a)			3.2E-01	IRIS	100		<0.01			<0.01
benzene (a)	2.90E-05	OEHHA	3.0E-02	IRIS	22	1.30E-06	<0.01		6.90E-08	<0.01
carbon disulfide			7.0E-01	IRIS	5.66		<0.01			<0.01
chloroethane	8.30E-07	NCEA	1.0E+01	IRIS	2.99	7.80E-09	<0.01		4.20E-10	<0.01
chloroform	2.30E-05	IRIS			1.06	8.40E-08	NA		4.50E-09	NA
1,2-dichlorobenzene (a)			2.0E-01	HEAST	1		<0.01			<0.01
1,4-dichlorobenzene (a)	1.10E-05	OEHHA	8.0E-01	IRIS	140	4.90E-06	<0.01		2.60E-07	<0.01
dichlorodifluoromethane			2.0E-01	NCEA	310		<0.01			<0.01
1,1-dichloroethene (a)			2.0E-01	IRIS	1		<0.01			<0.01
cis-1,2-dichloroethene (a)			7.0E-03	OEHHA	27		0.02			<0.01
trans-1,2-dichloroethene (a)			7.0E-02	IRIS	1		<0.01			<0.01
1,2-dichlorotetrafluoroethane (a)			3.0E+01	HEAST	15		<0.01			<0.01
ethylbenzene (a)			1.0E+00	IRIS	230		<0.01			<0.01
4-ethyltoluene (a)			4.0E-01	IRIS	32		<0.01			<0.01
methylene chloride	4.70E-07	IRIS	3.0E+00	HEAST	1.26	1.40E-09	<0.01		7.70E-11	<0.01
tetrachloroethene (PCE) (a)	5.90E-06	OEHHA	6.0E-01	NCEA	16	3.50E-07	<0.01		1.90E-08	<0.01
toluene (a)			4.0E-01	IRIS	54		<0.01			<0.01
trichloroethene (TCE)	2.00E-06	OEHHA	6.0E-01	OEHHA		4.80E-08	<0.01		2.60E-09	<0.01
trichlorofluoromethane (a)			7.0E-01	HEAST	10		<0.01			<0.01
1,2,4-trimethylbenzene (a)			6.0E-03	NCEA	24		0.02			<0.01
1,3,5-trimethylbenzene (a)			6.0E-03	NCEA	56		0.05			<0.01
vinyl chloride (a)	7.80E-05	OEHHA	1.0E-01	IRIS	92	1.30E-05	<0.01		7.00E-07	<0.01
xylenes, total (a)			1.0E-01	IRIS	430		0.02			<0.01
					Total :	1.97E-05	0.14	Total :	1.06E-06	0.02

Notes:

The 95% UCL concentration was used to assess the vapor intrusion pathway, except as noted.

Trichlorotrifluroethane used as surrogate for dichlorotetrafluoroethane and trichlorofluoroethane.

Ethylbenzene used as surrogate for 4-ethyltoluene.

(a) The maximum concentration was used due to limited number of detections.

95% UCL 95 percent upper confidence limit of the mean
$\mu g/m^3$ micrograms per cubic meter
HEAST Health Effects Assessment Summary Tables
IRIS Integrated Risk Information System
IUR Inhalation Unit Risk factor. This value was used to calculate the cancer risk and/or the risk-based screening concentration based on the cancer endpoint.
mg/m^3 milligrams per cubic meter
NCEA National Center for Environalmental Assessment
OEHHA Office of Environmental Health Hazard Assessment
ppb v/v parts per billion by volume
PPRTV Provisional Peer Reviewed Toxicity Values
RfC Reference Concentration. This value was used to calculate the Hazard Quotient and/or the risk-based screening concentration based on the non-cancer endpoint.

TABLE C-7. RESULTS OF INDOOR AIR MODELING BASED ON GROUNDWATER DATA AND USING US EPA-RECOMMENDED TOXICITY VALUES, SITE 3

	Toxicity Criteria					Residential			Industrial	
	IUR		RfC		95%UCL					
	$((\mu g/m^3)^{-1})$	Source	(mg/m^3)	Source	$(\mu g/L)$	cancer	non-cancer		cancer	non-cancer
acetone			3.2E-01	IRIS	5.5		<0.01			<0.01
benzene	7.80E-06	IRIS	3.0E-02	IRIS	0.399	1.70E-08	<0.01		9.10E-10	<0.01
chlorobenzene			6.00E-02	NCEA	0.25		<0.01			<0.01
chloroform	2.30E-05	IRIS			0.51	5.10E-08	NA		2.70E-09	NA
1,2-dichlorobenzene			2.00E-01	HEAST	0.597		<0.01			<0.01
1,4-dichlorobenzene	1.10E-05	OEHHA	8.0E-01	IRIS	2.24	4.40E-08	<0.01		2.30E-09	<0.01
dichlorodifluoromethane			2.0E-01	NCEA	11.12		0.03			<0.01
1,1-dichloroethane			5.00E-01	HEAST	3.21		<0.01			<0.01
1,2-dichloroethane	2.60E-05	IRIS			0.373	1.20E-08	NA		6.40E-10	NA
1,1-dichloroethene			2.0E-01	IRIS	0.5		<0.01			<0.01
cis-1,2-dichloroethene			3.5E-02	PPRTV	3.82		<0.01			<0.01
trans-1,2-dichloroethene			7.0E-02	IRIS	0.5		<0.01			<0.01
1,2-dichloropropane	1.90E-05	HEAST	4.00E-03	IRIS	0.622	3.00E-08	<0.01		1.60E-09	<0.01
isopropylbenzene			4.00E-01	IRIS	0.547		<0.01			<0.01
p-isopropyltoluene			4.00E-01	IRIS	0.5		<0.01			<0.01
methylene chloride	4.70E-07	IRIS	3.0E+00	HEAST	11.36	1.40E-08	<0.01		7.60E-10	<0.01
tetrachloroethene (PCE)	5.90E-06	OEHHA	6.0E-01	NCEA	6.49	5.40E-07	<0.01		2.90E-08	<0.01
trichloroethene (TCE)	2.00E-06	OEHHA	6.0E-01	OEHHA		2.20E-07	<0.01		1.20E-08	<0.01
trichlorofluoromethane			7.0E-01	HEAST	1.16		<0.01			<0.01
vinyl chloride	8.80E-06	IRIS	1.0E-01	IRIS	6.03	1.80E-06	<0.01		9.70E-08	<0.01
naphthalene	3.40E-05	OEHHA	3.00E-03	IRIS	0.572	7.00E-09	<0.01		3.80E-10	<0.01
					Total :	2.74E-06	0.04	Total :	1.47E-07	<0.01

Notes:

Isopropylbenzene used as surrogate for isopropyltoluene.

Trichlorotrifluroethane used as surrogate for trichlorofluoroethane.

95%UCL 95 percent upper confidence limit of the mean

$\mu g/L$ micrograms per liter

$\mu g/m^3$ micrograms per cubic meter

HEAST Health Effects Assessment Summary Tables

IRIS Integrated Risk Information System

IUR Inhalation Unit Risk factor. This value was used to calculate the cancer risk and/or the risk-based screening concentration based on the cancer endpoint.

mg/m^3 milligrams per cubic meter

NCEA National Center for Environalmental Assessment

OEHHA Office of Environmental Health Hazard Assessment

PPRTV Provisional Peer Reviewed Toxicity Values

RfC Reference Concentration. This value was used to calculate the Hazard Quotient and/or the risk-based screening concentration based on the non-cancer endpoint.

TABLE C-8. RESULTS OF INDOOR AIR MODELING BASED ON GROUNDWATER DATA AND USING CALIFORNIA DTSC-RECOMMENDED TOXICITY VALUES, SITE 3

	Toxicity Criteria					Residential			Industrial	
	IUR		RfC		95%UCL					
	(($\mu g/m^3)^{-1}$)	Source	(mg/m^3)	Source	($\mu g/L$)	cancer	non-cancer		cancer	non-cancer
acetone			3.2E-01	IRIS	5.5		<0.01			<0.01
benzene	2.90E-05	OEHHA	3.0E-02	IRIS	0.399	6.30E-08	<0.01		7.40E-09	<0.01
chlorobenzene			6.00E-02	NCEA	0.25		<0.01			<0.01
chloroform	2.30E-05	IRIS			0.51	5.10E-08	NA		2.70E-09	NA
1,2-dichlorobenzene			2.00E-01	HEAST	0.597		<0.01			<0.01
1,4-dichlorobenzene	1.10E-05	OEHHA	8.0E-01	IRIS	2.24	4.40E-08	<0.01		2.30E-09	<0.01
dichlorodifluoromethane			2.0E-01	NCEA	11.12		0.03			<0.01
1,1-dichloroethane			5.00E-01	HEAST	3.21		<0.01			<0.01
1,2-dichloroethane	2.60E-05	IRIS			0.373	1.20E-08	NA		6.40E-10	NA
1,1-dichloroethene			2.0E-01	IRIS	0.5		<0.01			<0.01
cis-1,2-dichloroethene			7.0E-03	OEHHA	3.82		<0.01			<0.01
trans-1,2-dichloroethene			7.0E-02	IRIS	0.5		<0.01			<0.01
1,2-dichloropropane	1.90E-05	HEAST	4.00E-03	IRIS	0.622	3.00E-08	<0.01		1.60E-09	<0.01
isopropylbenzene			4.00E-01	IRIS	0.547		<0.01			<0.01
p-isopropyltoluene			4.00E-01	IRIS	0.5		<0.01			<0.01
methylene chloride	4.70E-07	IRIS	3.0E+00	HEAST	11.36	1.40E-08	<0.01		7.60E-10	<0.01
tetrachloroethene (PCE)	5.90E-06	OEHHA	6.0E-01	NCEA	6.49	5.40E-07	<0.01		2.90E-08	<0.01
trichloroethene (TCE)	2.00E-06	OEHHA	6.0E-01	OEHHA		2.20E-07	<0.01		1.20E-08	<0.01
trichlorofluoromethane			7.0E-01	HEAST	1.16		<0.01			<0.01
vinyl chloride	7.80E-05	OEHHA	1.0E-01	IRIS	6.03	1.60E-05	<0.01		8.60E-07	<0.01
naphthalene	3.40E-05	OEHHA	3.00E-03	IRIS	0.572	7.00E-09	<0.01		3.80E-10	<0.01
					Total :	1.70E-05	0.04	Total:	9.17E-07	<0.01

Notes:

Isopropylbenzene used as surrogate for isopropyltoluene.

Trichlorotrifluroethane used as surrogate for trichlorofluoroethane.

95%UCL	95 percent upper confidence limit of the mean
$\mu g/L$	micrograms per liter
$\mu g/m^3$	micrograms per cubic meter
HEAST	Health Effects Assessment Summary Tables
IRIS	Integrated Risk Information System
IUR	Inhalation Unit Risk factor. This value was used to calculate the cancer risk and/or the risk-based screening concentration based on the cancer endpoint.
mg/m^3	milligrams per cubic meter
NA	not applicable
NCEA	National Center for Environmental Assessment
OEHHA	Office of Environmental Health Hazard Assessment
PPRTV	Provisional Peer Reviewed Toxicity Values
RfC	Reference Concentration. This value was used to calculate the Hazard Quotient and/or the risk-based screening concentration based on the non-cancer endpoint.

TABLE C-9. SOIL GAS CONCENTRATIONS IN PERIMETER GAS MONITORING WELLS WHICH IF EXCEEDED WOULD TRIGGER REMEDY EVALUATION

	Toxicity Criteria				Maximum Detected Concentration	Depth of Maximum Detection	Current Potential Residential Risk[b]		Performance Monitoring Standard[c] (ppb v/v)	
	IUR		RfC							
Analyte	$((\mu g/m^3)^{-1})$	Source	(mg/m^3)	Source	(ppbv)	(feet)	Cancer Risk	Hazard Quotient	8 Foot Depth	23 Foot Depth
Volatile Organic Compounds Detected in Perimeter Gas Monitoring Wells[a]										
benzene [1]	2.9E-05	OEHHA	3.0E-02	IRIS	39	23	2E-07	<0.01	2.6E+01	6.7E+01
benzene [2]	7.8E-06	IRIS					2E-07	<0.01	9.7E+01	2.5E+02
benzene [3]									**6.15E+01**	**1.59E+02**
2-butanone			5.0E+00	IRIS	7.7	8		<0.01	1.8E+06	4.7E+06
carbon disulfide			7.0E-01	IRIS	1.8	23		<0.01	2.0E+05	5.6E+05
chloroform [1]	5.3E-06	OEHHA	9.8E-02	ATSDR	28	23	6E-07	<0.01	1.9E+01	4.7E+01
chloroform [2]	2.3E-05	IRIS	9.8E-02	ATSDR			1E-07	<0.01	1.1E+02	2.8E+02
chloroform [3]									**6.45E+01**	**1.64E+02**
1,3-dichlorobenzene [d]			2.0E-01	HEAST	0.33	8		<0.01	4.0E+04	1.1E+05
dichlorodifluoromethane			2.0E-01	HEAST	110	23		<0.01	5.1E+04	1.4E+05
1,2-dichlorotetrafluoroethane [e]			3.0E+01	HEAST	12	23		<0.01	4.7E+05	1.2E+07
ethylbenzene	2.5E-06	OEHHA	1.0E+00	IRIS	0.74	23	1E-09	<0.01	2.5E+02	6.6E+02
4-ethyltoluene [f]			7.0E-01	OEHHA	1.7	8		<0.01	1.9E+05	4.8E+05
styrene [1]			9.0E-01	OEHHA	1	8		<0.01	2.6E+05	6.9E+05
styrene [2]			1.0E+00	IRIS				<0.01	2.9E+05	7.6E+05
styrene [3]									**2.75E+05**	**7.25E+05**
Tetrachloroethene [1]	5.9E-06	OEHHA	3.5E-02	OEHHA	28	23	2E-07	<0.01	7.0E+01	1.8E+02
Tetrachloroethene [2]	2.6E-7	IRIS	4.0E-2	IRIS	28	23	7E-09	<0.01	1.6E+02	4.2E+02
Tetrachloroethene [3]									**1.15E+02**	**3.00E+02**
toluene [1]			3.0E-01	OEHHA	6	8		<0.01	8.3E+04	2.1E+05
toluene [2]			5.0E+00	IRIS				<0.01	1.4E+06	3.6E+06
toluene [3]									**7.42E+05**	**1.91E+06**
trichloroethene	4.1E-6	IRIS	2.0E-03	IRIS	1.5	23	5E-09	<0.01	1.2E+02	3.1E+02
trichlorofluoromethane			7.0E-01	HEAST	4	23		<0.01	1.3E+05	3.3E+05
1,2,4-trimethylbenzene			7.0E-03	PPRTV	3	8		<0.01	2.0E+03	5.4E+03
1,3,5-trimethylbenzene			3.5E-02	PPRTV	1.7	8		<0.01	1.0E+04	2.7E+04
m,p-xylenes [f]			7.0E-01	OEHHA	2.9	23		<0.01	1.8E+05	4.8E+05
o-xylene			7.0E-01	OEHHA	1.6	23		<0.01	1.6E+05	4.3E+05

TABLE C-9. SOIL GAS CONCENTRATIONS IN PERIMETER GAS MONITORING WELLS WHICH IF EXCEEDED WOULD TRIGGER REMEDY EVALUATION

(Page 2 of 2)

Analyte	Toxicity Criteria				Maximum Detected Concentration	Depth of Maximum Detection	Current Potential Residential Risk[b]		Performance Monitoring Standard[c] (ppb v/v)	
	IUR		RfC							
	$((\mu g/m^3)^{-1})$	Source	(mg/m^3)	Source	(ppbv)	(feet)	Cancer Risk	Hazard Quotient	8 Foot Depth	23 Foot Depth
Volatile Organic Compounds Detected in Interior Gas Monitoring Wells that Potentially Could Migrate to Perimeter Wells (see Table 2.6-6)										
acetone			3.0E+01	ATSDR	-	-	-	-	1.0E+07	2.5E+07
benzylchloride			3.5E-01	IRIS	-	-	-	-	1.1E+01	2.8E+01
chlorobenzene			5.0E-02	PPRTV	-	-	-	-	1.3E+04	3.4E+04
1,2-dichlorobenzene			2.0E-01	HEAST	-	-	-	-	4.2E+04	1.1E+05
1,4-dichlorobenzene	1.1E-05	OEHHA	8.0E-01	OEHHA	-	-	-	-	4.4E+01	1.2E+02
cis-1,2-dichoroethene			7.0E-03	Cal-EPA/ DTSC [4]	-	-	-	-	2.1E+03	5.5E+03
vinyl chloride [1]	7.8E-05	OEHHA	1.0E-01	IRIS	-	-	-	-	1.0E+01	2.6E+01
vinyl chloride [2]	8.8E-06	IRIS	1.0E-01	IRIS					1.2E+02	3.2E+02
vinyl chloride [3]									**6.50E+01**	**1.73E+02**
Explosive Gas Concentrations Detected in Perimeter Gas Monitoring Wells[a]										
Methane	N/A	N/A	N/A	N/A	0.0023%	8	N/A	N/A	5%[g]	5%[g]

Notes:

[a] Data are from landfill gas samples collected at landfill gas monitoring wells installed as nested pairs (Wells 3-LFG06A/B, 3-LFG07A/B, 3-LFG08A/B, and 3-LFG09A/B) on 1 June 2009.

[b] For each contaminant of concern, the maximum concentration detected and the depth to the top of the screen interval was used in the calculation of the cancer risk and noncancer hazard quotient.

[c] The Johnson and Ettinger (J&E) 1991 model was used to calculate the concentration corresponding to an acceptable cancer risk or Hazard Quotient. The value of the soil vapor concentration was iterated until the cancer risk was equal to 1 x 10^{-6} or the Hazard Quotient was equal to 1. If a chemical was evaluated for both cancer and non-cancer endpoints, the smaller of the two concentrations was used as the final value.

[d] The compound 1,2-dichlorobenzene was used as a surrogate.

[e] The compound 1,1,2-trichloro,2,2,1-trifluoroethane was used as a surrogate.

[f] The compound p-xylene was used as a surrogate.

[g] Lower explosive limit for methane.

[1] Toxicity criteria based on California Environmental Protection Agency Department of Toxic Substance Control (Cal/EPA DTSC)-recommended values.
[2] Toxicity criteria based on Air Force Risk Assessment and Risk-Based Cleanup Levels Guidance (USAF, Memorandum for all MAJCOMs/A7/CEV, 14 July 2006).
[3] Selected toxicity criteria **(in bold)** based on midpoint of Notes (1) and (2) above.
[4] Value used in 2011 version of the Cal/EPA DTSC Johnson & Ettinger model and recommended by Cal/EPA DTSC for vapor intrusion assessment.

$\mu g/m^3$ micrograms per cubic meter
ATSDR Agency for Toxic Substances and Disease Registry
HEAST Health Effects Assessment Summary Tables
IRIS Integrated Risk Information System
IUR Inhalation Unit Risk factor. This value was used to calculate the cancer risk and/or the risk-based screening concentration based on the cancer endpoint.
OEHHA Office of Environmental Health Hazard Assessment
PPRTV Provisional Peer-Reviewed Toxicity Values
RfC Reference Concentration. This value was used to calculate the Hazard Quotient and/or the risk-based screening concentration based on the non-cancer endpoint.
mg/m^3 milligrams per cubic meter
ppbv parts per billion, by volume