95th Air Base Wing
Edwards Air Force Base, California

Environmental Restoration Program

Record of Decision
Air Force Research Laboratory
Soil and Debris Sites
Operable Units 4 and 9
Edwards AFB, California

Final

May 2008

ENVIRONMENTAL RESTORATION PROGRAM
RECORD OF DECISION
AIR FORCE RESEARCH LABORATORY
SOIL AND DEBRIS SITES
OPERABLE UNITS 4 AND 9

EDWARDS AIR FORCE BASE
CALIFORNIA

MAY 2008

FINAL

Prepared for

U.S. AIR FORCE 95th AIR BASE WING
ENVIRONMENTAL RESTORATION DIVISION (95 ABW/EMR)
EDWARDS AFB, CA 93524-8060

and the

ERP PROGRAM OFFICE
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BROOKS CITY–BASE, TX 78235-5112

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LIST OF ABBREVIATIONS AND ACRONYMS

°F	degrees Fahrenheit
µg/100 cm^2	micrograms per 100 square centimeters
µg/L	micrograms per liter
95 ABW/EMR	95th Air Base Wing/Environmental Restoration Division
AFB	Air Force Base
AFCEE/EXEW	Air Force Center for Engineering and the Environment/Environmental Programs Execution - West
AFRL	Air Force Research Laboratory
AOC	area of concern
ARAR	Applicable or Relevant and Appropriate Requirement
ASTM	American Society for Testing and Materials
AVEK	Antelope Valley-East Kern Water Agency
BB	butylbenzene
bgs	below ground surface
Blvd.	Boulevard
CAI	closed, abandoned, or inactive
Cal/EPA	California Environmental Protection Agency
CAMU	Corrective Action Management Unit
CCR	California Code of Regulations
CE	Civil Engineering
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CIWMB	California Integrated Waste Management Board
Co.	County
CO_2	carbon dioxide
COC	chemical of concern (CERCLA definition)
CoC	constituent of concern (CCR Title 27 definition)
COPEC	chemical of potential ecological concern
CZ	containment zone
DCE	dichloroethene
DCFM	dichlorodifluoromethane
DNAPL	dense non-aqueous phase liquid
DTSC	Department of Toxic Substances Control
DFRC	Dryden Flight Research Center
DMP	detection monitoring program
DWR	Department of Water Resources
EAFB	Edwards Air Force Base
EAFB GP	Edwards Air Force Base General Plan
EE/CA	engineering evaluation/cost analysis
EIAP	Environmental Impact Assessment Process
EOD	explosive ordnance disposal
ERA	ecological risk assessment
ERP	Environmental Restoration Program

FCPMP	Final Closure and Post-Closure Maintenance Plan
FFA	Federal Facility Agreement
FS	feasibility study
ft	feet
FTA	fire training area
g	gram
GCL	geosynthetic clay liner
GIS	geographic information system
gpm	gallons per minute
HB&A	Higginbotham/Briggs & Associates
HDPE	high-density polyethylene
HEF	high energy fuel
HHRA	human health risk assessment
HI	hazard index
HpCDD	heptachlorodibenzo-p-dioxin
HpCDF	heptachlorodibenzofuran
HxCDD	hexachlorodibenzo-p-dioxin
ICBM	intercontinental ballistic missile
Ind.	industrial
IPB	isopropylbenzene
IRA	interim remedial action
J&E	Johnson and Ettinger
KCEHSD	Kern County Environmental Health Services Department
kg	kilogram
LTM	long-term monitoring
LUC	land use control
LUFT	Leaking Underground Fuel Tank
MCL	maximum contaminant level
MCLG	maximum contaminant level goal
MEC	munitions and explosives of concern
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MMRP	Military Munitions Response Program
MSWLF	municipal solid waste landfill
MTBE	methyl-tert-butyl ether
NA	not applicable
NASA	National Aeronautics and Space Administration
ND	non detect
NDMA	N-nitrosodimethylamine
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NE	not established or not evaluated
NEPA	National Environmental Policy Act
NFA	no further action
NFEI	no further ecological investigation
ng/g	nanograms per gram
NL	notification level

NPC	no public comment
NPL	National Priorities List
NRHP	National Register of Historical Places
OCDD	octachlorodibenzo-p-dioxin
OCDF	octachlorodibenzofuran
OMB	Office of Management and Budget
OU	operable unit
PAH	polycyclic aromatic hydrocarbon
PB	propylbenzene
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
PCMMP	Post-Closure Maintenance and Monitoring Plan
PERA	predictive ecological risk assessment
pg/g	picograms per gram
PID	photoionization detector
PIRA	Precision Impact Range Area
PP	proposed plan
PPE	personal protective equipment
PRG	preliminary remediation goal
RA	remedial action
RAB	Restoration Advisory Board
RACER™	Remedial Action Cost Engineering and Requirements
RAO	remedial action objective
RAR	relevant and appropriate
RAWP	Remedial Action Work Plan
RCRA	Resource Conservation and Recovery Act
Res.	residential
RI	remedial investigation
RL	reporting limit
ROD	record of decision
RPM	Remedial Project Manager
RP-1	Rocket Propellant-1
SARA	Superfund Amendments and Reauthorization Act
SERA	scoping ecological risk assessment
SI	site investigation
SLDU	subsurface land disposal unit
SLUC	State Land Use Covenant
START	Strategic Arms Reduction Treaty
STLC	soluble threshold limit concentration
SVE	soil vapor extraction
SVOC	semivolatile organic compound
SWAT	solid waste assessment test
SWRQCB	State Water Resource Quality Control Board
TBC	to be considered
TCDD	tetrachlorodibenzo-p-dioxin
TCDF	tetrachlorodibenzofuran

TCE	trichloroethene
TCLP	toxicity characteristic leaching procedure
TDS	total dissolved solids
TEFA	technical and economic feasibility analysis
TEF	toxic equivalency factor
TEPH	total extractable petroleum hydrocarbons
TEQ	toxic equivalency
TI	technical impracticability
TMB	trimethylbenzene
TSCA	Toxic Substances Control Act
TSDF	treatment, storage, and disposal facility
TVPH	total volatile petroleum hydrocarbons
UEH	unknown extractable hydrocarbon
U.S.	United States
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
UST	underground storage tank
UVH	unknown volatile hydrocarbon
VIP	vapor intrusion pathway
VOC	volatile organic compound
WDR	waste discharge requirement
WQO	water quality objective

1.0 PART 1: DECLARATION

1.1 SITE NAME AND LOCATION

The Air Force Research Laboratory (AFRL); Edwards Air Force Base (AFB); Kern and San Bernardino Counties; California; United States Environmental Protection Agency (USEPA) Identification Number CA1570024504.

1.2 STATEMENT OF BASIS AND PURPOSE

This decision document presents the selected remedies for the soil and debris sites at Operable Units (OUs) 4 and 9 at Edwards AFB, California, which were 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 National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This decision document is based on the Administrative Record File for OUs 4 and 9. Except for Sites 6 and 113, final remedies for groundwater at these sites are (or will be) presented in other Records of Decision (RODs).

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

1.3 ASSESSMENT OF OPERABLE UNITS 4 AND 9

This ROD addresses the soil and debris media at 16 sites and two areas of concern (AOCs) located within OUs 4 and 9, and also the groundwater medium at Sites 6 and 113. These sites and AOCs are hereafter referred to as the "soil and debris sites."

1.3.1 OU 4 FURTHER ACTION SITES

The OU 4 Soil and Debris sites that require further action to protect public health or welfare or the environment are as follows:

- Site 13: AFRL Closed Landfill;
- Site 36: Test Area 1-21 Former Wastewater Evaporation Tank;
- Site 167: Test Area 1-46 Beryllium Firing Range;
- Site 312: Test Area 1-14 Polychlorinated Biphenyl (PCB) Spill Area; and
- Site 318: Test Area 1-120 Catch Basin and Evaporation Pond.

The selected response actions presented in this ROD for these sites are necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.

1.3.2 OU 9 FURTHER ACTION SITES

The OU 9 Soil and Debris sites that require further action to protect public health or welfare or the environment are as follows:

- Sites 6 and 113: Abandoned Mine Shafts 1 and 2; and
- Site 115: Test Area 1-100 Missile Silos 1 and 2.

The selected response actions presented in this ROD for these sites are necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.

1.3.3 OUS 4 AND 9 NO FURTHER ACTION SITES

The Air Force, as the lead agency, has determined that no further action (NFA) is necessary to protect public health or welfare or the environment at the following sites and AOCs:

- Site 7: Test Area 1-46 Beryllium-Contaminated Earth Piles;
- Site 26: Former Fire Training Area;

- Site 150: Building 8451 Former Waste Evaporation Ponds;
- Sites 153 and 396: Dry Wells associated with Buildings 8419, 8421, 8423, 8425, and 8431;
- Site 166: Building 8240 Former Waste Discharge Area and Removed Waste Oil Underground Storage Tank (UST);
- AOCs 170 and 171: Building 8595 Indoor Vapor Degreaser Pit and Indoor Sump;
- Site 172: Building 8595 Outdoor Waste Sump; and
- Site 329: Test Area 1-46 Former Wash Rack and Oxidation Pond.

Interim remedial actions (IRAs) have reduced formerly high contaminant concentrations at Sites or AOCs 7, 26, 153, 166, 170, 171, 172, and 396 to levels acceptable for unrestricted use. Furthermore, only low-level contamination was originally found at Sites 150 and 329, leaving no need for cleanup actions.

1.3.4 BEDROCK AND GROUNDWATER CONTAMINANT ISSUES

For purposes of this ROD, a distinction is made between contaminants in the soil and/or debris, and contaminants in the underlying bedrock and/or groundwater (see Section 2.4). With the exceptions of Sites 6 and 113, this ROD addresses remedies for the soil (i.e., the unconsolidated alluvium) and debris only, including their associated vapor intrusion pathways (VIPs).

The groundwater below many of the soil and debris sites contains chemicals of concern (COCs) at levels that could be harmful to human health. In some cases, the groundwater contaminants are also assumed to be present in the overlying unsaturated granitic bedrock. These groundwater and bedrock contaminants are generally part of larger areas of groundwater contamination (Plate 1) addressed, or soon to be addressed, separately in other CERCLA RODs as discussed below. Because Sites 6 and 113 do not overlie any of these larger areas of groundwater contamination, a remedy for groundwater contamination associated with these sites is also presented in this ROD.

South AFRL Area. Past disposal practices at Sites/AOCs 13, 26, 150, 153, 166, 170, 171, 172, and 396 (and at other nearby AFRL sites not discussed in this ROD) contributed, or may have contributed, to groundwater contamination by chlorinated solvents, petroleum hydrocarbons, N-nitrosodimethylamine (NDMA), and/or perchlorate. The contaminants from these multiple sources form two widespread

and commingled impacted areas known as the Sites 37 and 133 Groundwater Plumes. The Sites 37 and 133 Groundwater Plumes, as well as the VIP associated with the groundwater contamination, are addressed through land use controls (LUCs) as described in the ROD for the South AFRL area (Earth Tech 2007a), signed in September 2007.

AFRL Arroyos Area. Activities at Site 36 contributed perchlorate contamination to the extensive Site 162 Groundwater Plume (which also includes chlorinated solvents and NDMA from other nearby AFRL sites not discussed in this ROD). Groundwater contamination below Site 36, and possible risk via the VIP from groundwater, will be addressed as part of the forthcoming ROD for the AFRL Arroyos area.

Northeast AFRL and Mars Boulevard Areas. Activities at Sites 115 and 318 (and at other nearby AFRL sites not discussed in this ROD) resulted in groundwater contamination by chlorinated solvents, petroleum fuels, NDMA, and/or perchlorate. The groundwater plumes below these sites are expected to merge with the Sites 177 and 325 Groundwater Plumes located within the Northeast AFRL area. Sites 7, 167, and 329 are located within the Mars Boulevard area. Groundwater contamination (and any VIP issues) at Sites 115, 318, 7, 167, and 329 will be addressed as part of the forthcoming ROD for the Northeast AFRL and Mars Boulevard areas.

1.4 DESCRIPTION OF THE SELECTED REMEDIES

Operations at OUs 4 and 9 resulted in releases of hazardous substances that are distinct and not commingled with hazardous substances released at other OUs at Edwards AFB. The selected remedies summarized below are intended to be the final actions for the soil and debris sites, and are addressed independently of the other OUs and sites at Edwards AFB. Full descriptions of the selected remedies are included in Sections 2.5 through 2.7. The total cost for implementation of all remedies over a 30-year timeframe is estimated at $5,011,000 in today's dollars; the annual cost to continue these remedies beyond 30 years is estimated at $142,000.

1.4.1 FURTHER ACTION SITES IN OU4

1.4.1.1 Site 13 – Closed AFRL Landfill

The strategy for managing potentially hazardous soil, trash, and debris at the closed landfill involves maintaining environmental control and integrity of the existing landfill cover system through continued compliance with the *Site 13 Post-Closure Maintenance and Monitoring Plan (PCMMP,* Earth Tech 2002), including proposed modifications to certain monitoring requirements. This includes:

- Quarterly inspections and maintenance of the cover, the drainage diversion system, the five gas monitoring wells, and the site security measures (fences and gates); and
- Quarterly field monitoring of the five gas monitoring wells for methane and volatile organic compounds (VOCs) with laboratory confirmation samples collected periodically.

If the proposed modifications to the Site 13 PCMMP are approved, sampling of groundwater monitoring wells in the vicinity of the closed landfill will be performed as part of long-term monitoring (LTM) under the South AFRL ROD. As long as potentially hazardous trash and debris remain in the landfill, LUCs will be enforced and reviews will be conducted every 5 years to assess the protectiveness of the selected remedy.

1.4.1.2 Site 36 – Test Area 1-21 Former Wastewater Evaporation Tank

Perchlorate-contaminated soil that exceeds residential use levels at Site 36 will be excavated and disposed off-site at a properly licensed treatment, storage, and disposal facility (TSDF). However, potentially contaminated bedrock (that cannot be excavated) will be managed through LUCs so that the public health is not impacted. Locked vehicle gates and warning signs will be installed, and reviews will be conducted every 5 years (as long as contamination remains above unrestricted use levels) to assess the protectiveness of the selected remedy.

1.4.1.3 Site 167 – Test Area 1-46 Beryllium Firing Range

The strategy for managing buried beryllium-contaminated soil and debris at Site 167 involves regular inspection and maintenance of the subsurface land disposal unit (SLDU) cover system and site fences (installed in 1996). Additionally, signs will be posted on the fences to warn personnel of the presence of buried beryllium-contaminated material. Additional LUCs will be implemented so that the public

health is not impacted. Reviews will be conducted every 5 years (as long as contamination remains above unrestricted use levels) to assess the protectiveness of the selected remedy. Soil outside the fenced SLDU now qualifies for unrestricted use with NFA.

1.4.1.4 Site 312 – Test Area 1-14 PCB Spill Area

The overall cleanup strategy for PCBs in soil and concrete at Site 312 involves closure through physical removal of the contaminated media. The selected remedy is designed to return the site to conditions suitable for residential (i.e., unrestricted) use. Closure will be accomplished through excavation of soil exhibiting PCB contamination above the 1.0 milligram per kilogram (mg/kg) Toxic Substances Control Act (TSCA) limit for hypothetical residential use (i.e., most of the soil in the substation); and by cutting the concrete pad and removing the portions exhibiting surface contamination in excess of the 10 micrograms per 100 square centimeters (μg/100 cm^2) TSCA limit for residential use. The removed soil and concrete will be disposed off base at a properly licensed TSDF.

1.4.1.5 Site 318 – Test Area 1-120 Catch Basin and Evaporation Pond

Contamination in soil from polycyclic aromatic hydrocarbons (PAHs) at Site 318 will be managed through the use of LUCs implemented so that soil contaminants do not impact the public health. Locked vehicle gates and warning signs will be installed, and reviews will be conducted every 5 years (as long as contamination remains above unrestricted use levels) to assess the protectiveness of the selected remedy.

1.4.2 FURTHER ACTION SITES IN OU9

1.4.2.1 Sites 6 and 113 – Abandoned Mine Shafts 1 and 2

Potentially-explosive debris buried in the capped Sites 6 and 113 mine shafts will be managed through the use of LUCs. This will be accomplished by limiting the land use (within the LUC boundaries) to on-site waste management; and by preventing site access by the general public, industrial workers, and unauthorized construction workers. The LUCs will also include groundwater monitoring. Degraded on-site fences and warning signs will be replaced, and reviews will be conducted every 5 years (as long as the potential hazards exist) to assess the protectiveness of the selected remedy.

1.4.2.2 Site 115 – Test Area 1-100 Missile Silos 1 and 2

Potentially-explosive debris in the Site 115 missile silos will be managed through the use of LUCs. This will be accomplished by limiting the land use (within the LUC boundaries) to on-site waste management; and by preventing site access by the general public, industrial workers, and unauthorized construction workers. Fences and warning signs will be installed, and reviews will be conducted every 5 years (as long as the potential hazards exist) to assess the protectiveness of the selected remedy.

1.5 STATUTORY DETERMINATIONS

The selected remedies are protective of human health and the environment, comply with Federal and State requirements that are applicable or relevant and appropriate to the remedial actions, and are cost effective. However, the selected remedies do not satisfy the preference for treatment as a principal element that permanently and significantly reduces the toxicity, mobility, or volume of hazardous substances, pollutants, or contaminants. The rationale for this departure is provided for each site in Part 2 – Decision Summary.

1.6 AUTHORIZING SIGNATURES AND SUPPORT AGENCY ACCEPTANCE OF THE SELECTED REMEDIES

Nancy P Wharton

Date 9 May 08

NANCY P. WHARTON, Colonel, USAF
Commander, 95th Air Base Wing
Edwards Air Force Base, California

Date 4 August 08

MICHAEL M. MONTGOMERY
U.S. EPA Branch Chief, Federal Facilities and Site Cleanup Branch
U.S. Environmental Protection Agency, Region 9

The State of California, Department of Toxic Substances Control and the California Regional Water Quality Control Board, Lahontan Region had an opportunity to review and comment on this Record of Decision, and our concerns were addressed.

Anthony J. Landis

Date 8-11-08

ANTHONY J. LANDIS, P.E.
Supervising Hazardous Substances Engineer II
Cal Center Cleanup Program
California Department of Toxic Substances Control

Harold J. Singer

Date August 21, 2008

HAROLD SINGER
Executive Officer
California Regional Water Quality Control Board, Lahontan Region

2.0 PART 2: DECISION SUMMARY

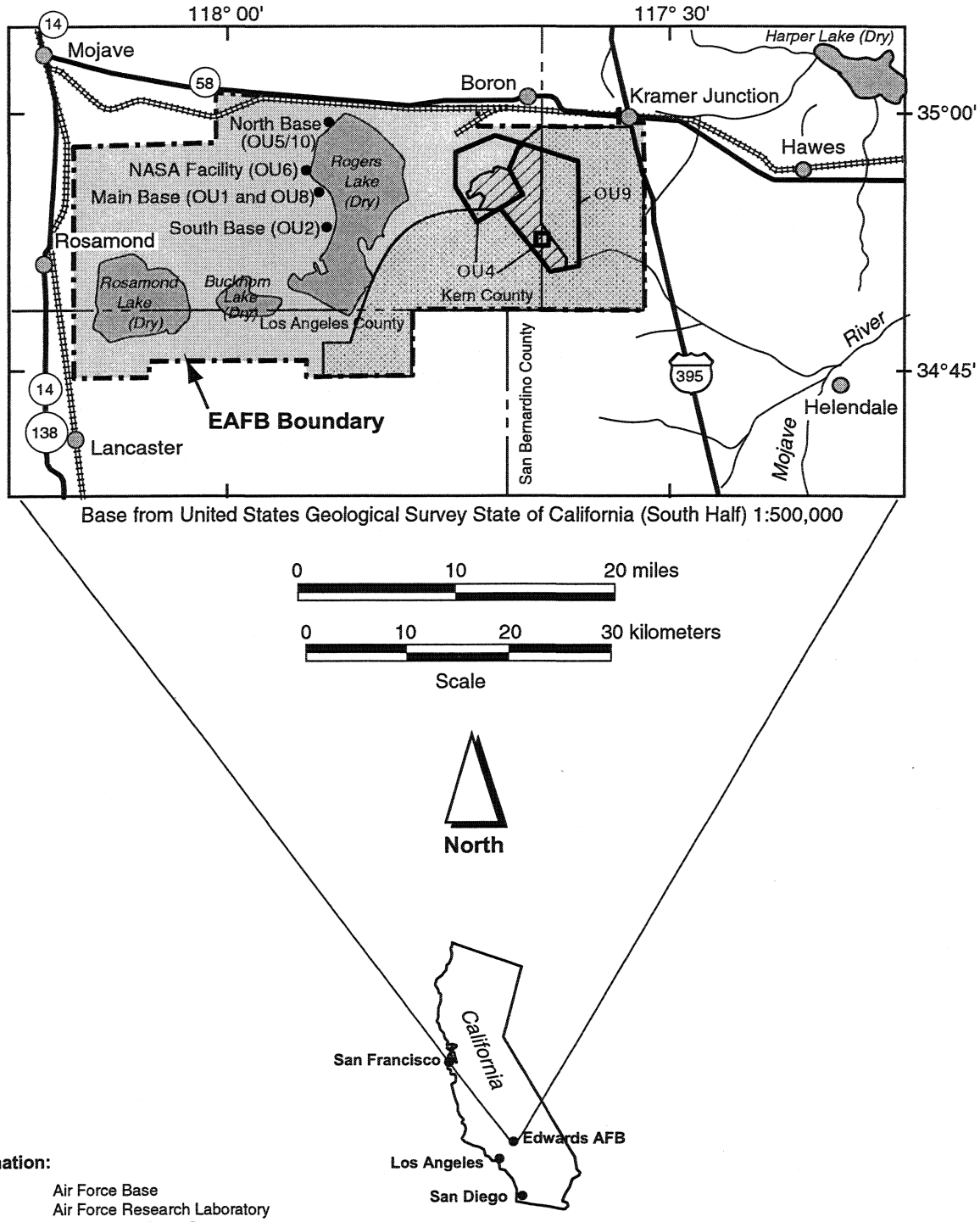
This decision summary gives an overview of the AFRL (OUs 4 and 9) at Edwards AFB, and provides more site-specific characteristics for the 16 sites and two AOCs that are included in this ROD. In addition, the decision summary (1) describes the remedial alternatives evaluated for each site (where applicable); (2) provides a comparative analysis of those alternatives; and (3) identifies the selected remedy for each site and the statutory determinations supporting the selected remedy.

This decision summary was prepared following the guidelines recommended in *A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents* (USEPA 1999). However, adjustments to the order of the recommended subsections were incorporated to accommodate the inclusion of site-specific information in the Site Characteristics subsections.

Details regarding public involvement in the *CERCLA Proposed Plan for Cleanup at the Soil and Debris Sites, OUs 4 and 9, AFRL, Edwards AFB, California* (Earth Tech 2007b), hereafter referred to as the *Soil and Debris Sites PP*, are provided in Section 2.3, Community Participation. The *Soil and Debris Sites PP* can be found in the administrative record file and information repositories.

2.1 NAME, LOCATION, AND BRIEF DESCRIPTION OF THE AFRL, OPERABLE UNITS 4 AND 9 AT EDWARDS AIR FORCE BASE

Edwards AFB is located in southern California approximately 5 miles northeast of the city of Lancaster (Figure 2.1-1). The Base covers portions of Kern, Los Angeles, and San Bernardino Counties. With the exception of Sites 6 and 113 (both located in San Bernardino County) all of the soil and debris sites are located in Kern County (Figure 2.1-2). The soil and debris sites are located entirely within Edwards AFB, and none are closer than 1.5 miles from the base boundary. The nearest residential area is the off-base community of Boron, located 3 miles from the closest soil and debris site. The USEPA 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 remedial investigation (RI) and remedial action (RA) at the facility is the Air Force.



Explanation:

AFB	Air Force Base
AFRL	Air Force Research Laboratory
EAFB	Edwards Air Force Base
NASA	National Aeronautics and Space Administration
OU	Operable Units
	Air Force Research Laboratory Area
	Precision Impact Range Area (PIRA)
	Cities
	Railroads
	County Lines
	Rivers

Note: OU3 and OU7, which are not shown, consist of base-wide water wells and miscellaneous/individual sites located outside other OUs, respectively.

OUs 4 and 9 Soil and Debris Sites ROD

Edwards AFB Location Map

Date 05-08	Air Force Research Laboratory Edwards AFB	Figure **2.1-1**
Project No. 87503		

87503.10.04.17.01

SITE 115

TEST AREA 1-100

GEMINI ROAD

TEST AREA 1-125

TEST AREA 1-120

LEUHMAN RIDGE

SITE 318

SITE 312

SITE 36

TEST AREA 1-14

SITE 150

SITE 153

TEST AREA 1-30

TEST AREA 1-32

AFRL CE YARD

SITE 26

SITE 396

SITE 166

TEST AREA 1-121

TEST AREA 2-10

TEST AREA 1-110

MERCURY BLVD

SITE 13

AOC 170

AOC 171

SITE 172

MARS BLVD

SEWAGE TREATMENT PLANT

TEST AREA 1-38

LIQUID PROPELLANT STORAGE COMPLEX

TEST AREA 1-42

SITE 167

SITE 7

SITE 329

TEST AREA 1-46

TEST AREA 1-52

TEST AREA 1-36

KERN COUNTY / SAN BERNARDINO COUNTY

2,170,500 N

6,678,200 E

SITE 6

SITE 113

6,649,900 E

2,143,500 N

EXPLANATION

- BUILDING
- STORAGE TANK
- PAVED ROAD
- UNPAVED ROAD
- TRAIL

SITES CODED IN RED REQUIRE FURTHER ACTION

SITES CODED IN GREEN REQUIRE NO FURTHER ACTION

NORTH

0 1500 3000 FEET

SCALE: 1"= 3000'

OUs 4 and 9 Soil and Debris Sites ROD

Site Locations and Topography

Date 5-08	Air Force Research Laboratory Edwards AFB	Figure 2.1-2
Project No. 87503		

EDWARDS\ 87503\B6582FGA.A01

Regulatory agencies providing support and oversight of the Environmental Restoration Program (ERP) at Edwards AFB include the USEPA Region 9, Cal/EPA DTSC, and the Water Board. The Air Force, USEPA, Cal/EPA DTSC, and Water Board entered into a Federal Facility Agreement (FFA) for Edwards AFB in September 1990.

The AFRL at Edwards AFB has been used as a rocket research and testing facility for over 50 years (since the 1950s). During that time, workers involved in research, testing, evaluation, and maintenance activities used toxic and hazardous materials. In the past, materials were spilled or otherwise released to the ground surface or subsurface. Contamination at the soil and debris sites resulted from former activities at several rocket test areas and industrial facilities, a landfill, a fire training area, and two historic mineral mines. These sites and AOCs fall into two general categories:

1. Further Action Sites exhibit contamination or hazards that require additional remedial action and/or long-term LUCs in order to protect human health and the environment. Sites 13, 36, 167, 312, and 318 in OU4; and Sites 6, 113, and 115 in OU9 are in this category.

2. NFA Sites are those in which either (1) IRAs have successfully reduced formerly high soil contaminant concentrations to levels acceptable for unrestricted use; or (2) only low-level soil contamination was originally found, leaving no need for cleanup actions. The NFA sites include Sites or AOCs 7, 26, 150, 153, 166, 170, 171, 172, 329, and 396.

2.2 ENVIRONMENTAL SETTING

2.2.1 CLIMATE

The climate at Edwards AFB is characteristic of the high desert regions of California, with hot, dry summers and cool, slightly moist, mild winters. Temperatures in summer commonly exceed 100 degrees Fahrenheit (^{o}F), while winter temperatures may drop to below freezing. The mean annual rainfall is approximately 5 inches per year, with approximately 80 percent of precipitation falling between November and March.

2.2.2 GEOLOGY

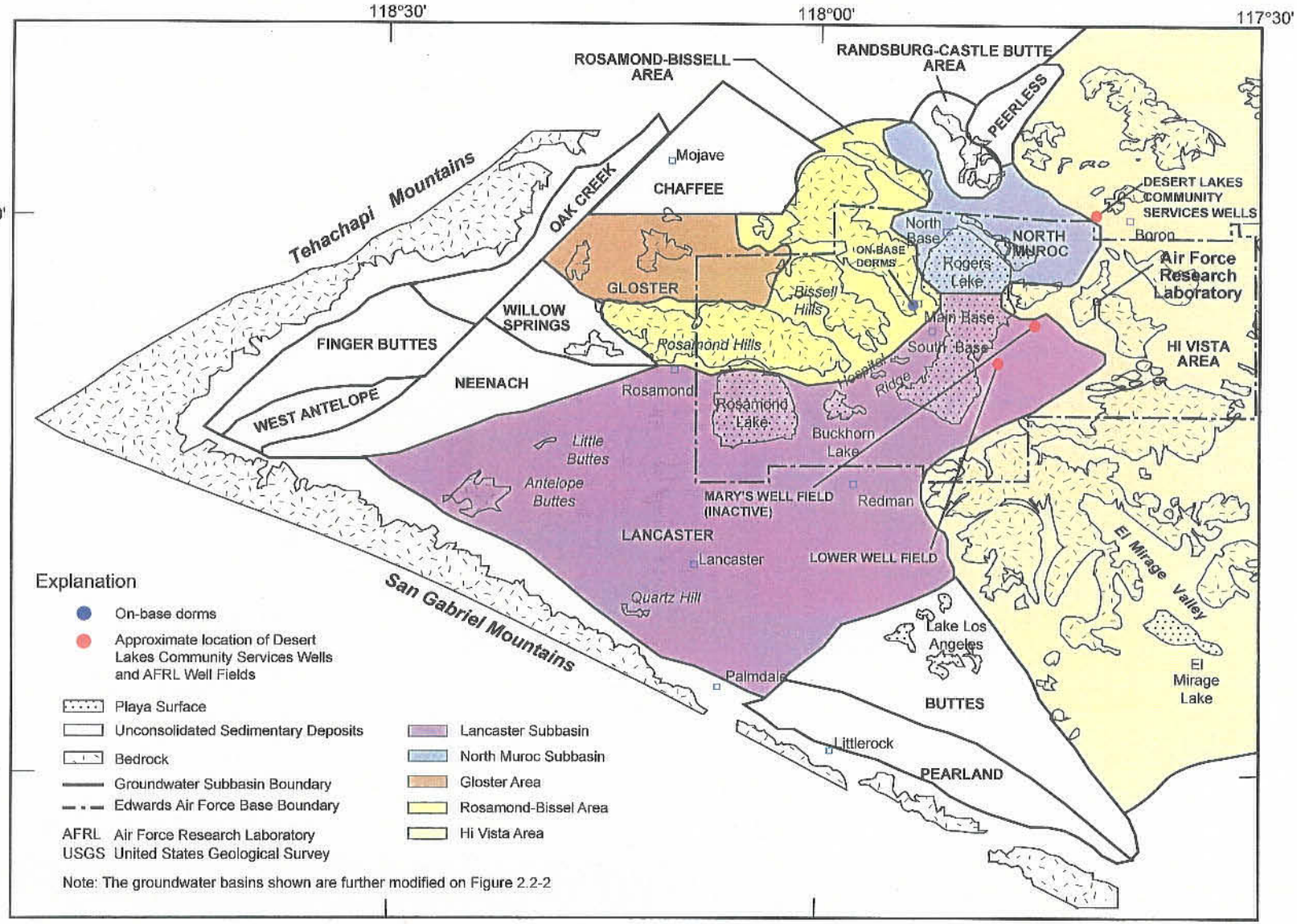
The regional subsurface geology at the AFRL is characterized as a crystalline granitic bedrock complex overlain in areas by a thin veneer of unconsolidated alluvium increasing in thickness down slope from

the crest of Leuhman Ridge. The underlying bedrock consists of pre-Tertiary plutonic crystalline rock; predominantly quartz monzonite intruded by granite that forms Leuhman Ridge, and a Tertiary volcanic rock (dacite) that forms Haystack Butte. The unconsolidated material consists of fine-grained, feldspar, quartz, and rock-fragment sand derived from the exposed and underlying bedrock complex. A more comprehensive discussion of the geology is presented in the *Feasibility Study (FS) Report, Soil and Debris Sites at AFRL, OUs 4 and 9* (Earth Tech 2006a) which can be found in the administrative record and information repositories (see Section 2.3.3). This feasibility study document is hereafter referred to as the *Soil and Debris Sites FS*.

2.2.3 HYDROGEOLOGY

As defined by the United States Geological Survey (USGS 2006), Edwards AFB overlies portions of three subbasins of the Antelope Valley groundwater basin: the North Muroc Subbasin, the Lancaster Subbasin, and the Gloster Subbasin (Figure 2.2-1). In addition, the base encompasses two areas of shallow bedrock and low groundwater yield, known as the Rosamond-Bissell and Hi Vista areas. The AFRL is located within the Hi Vista area, which provides groundwater recharge to the North Muroc and Lancaster Subbasins of the Antelope Valley Basin, and to the Middle Mojave River Valley Basin. The AFRL has not been designated as a critical recharge area.

Groundwater below the AFRL occurs within fractures in both weathered and competent granitic bedrock. Groundwater flow rates in monitoring wells screened across first water contact are generally low (less than 1 gallon per minute [gpm]), but well production rates as high as 8 gpm are found locally (i.e., in the Site 13 landfill area). Therefore, the groundwater-bearing fractured bedrock at the AFRL likely does not constitute an "aquifer" in that it does not yield useable quantities of groundwater. However, as shown on Figure 2.2-2 (adapted from California Department of Water Resources Bulletin 118 [DWR 2003]), the Water Board considers the soil and debris sites to fall within the Antelope Valley Basin 6-44, or the Middle Mojave River Valley Basin 6-41 (Sites 7, 167, and 329) for which they designate the following beneficial uses: municipal, agricultural, industrial, and freshwater replenishment.



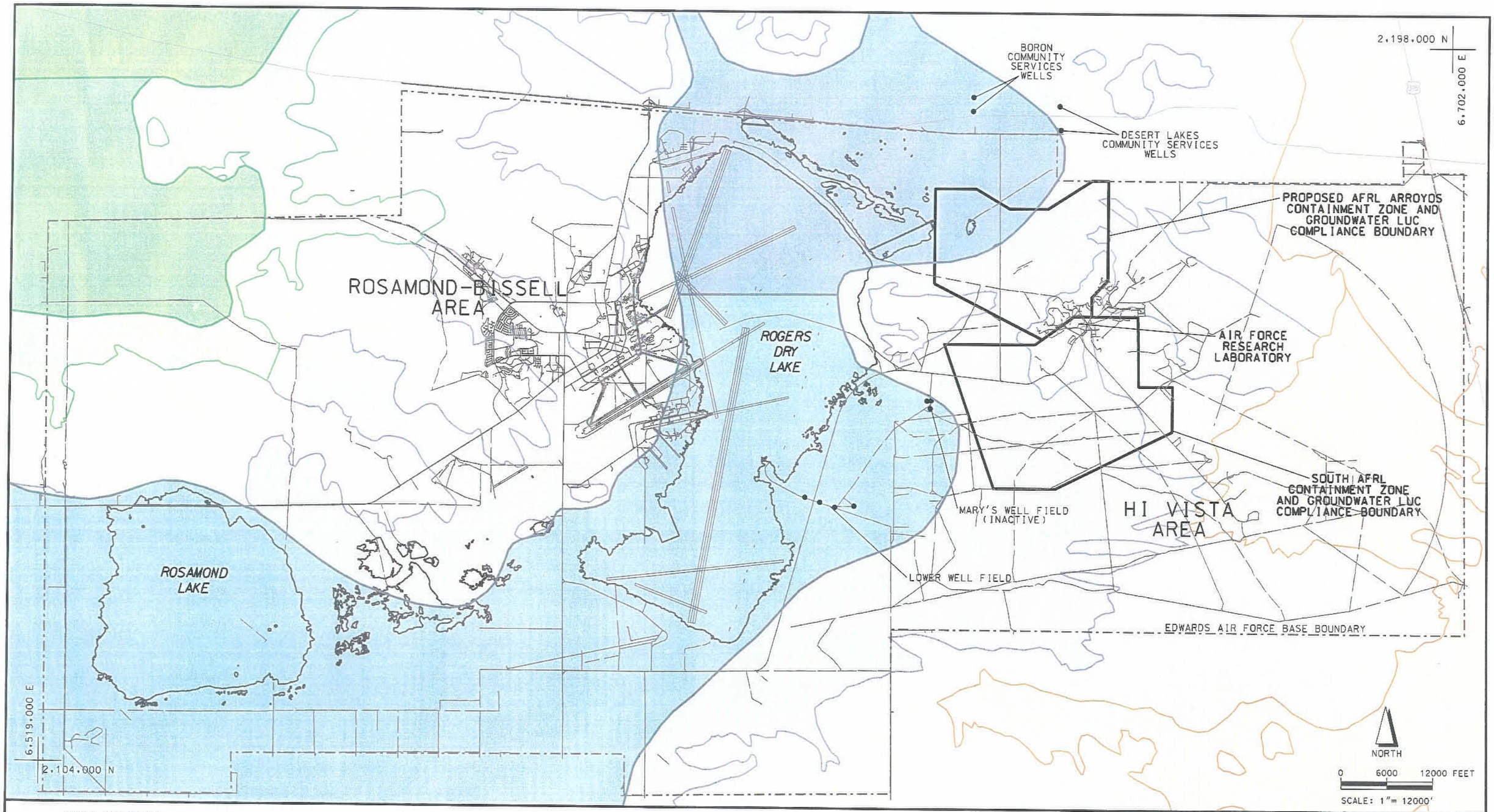
Adapted from Londquist et al. (1993).

OUs 4 and 9 Soil and Debris Sites ROD

Groundwater Subbasins and Shallow Bedrock Areas in Antelope Valley Based on USGS (2006)

Date 05-08	Air Force Research Laboratory Edwards AFB	Figure 2.2-1
Project No. 87503		

87503.10.04.17: Fig. 2.1-3



EXPLANATION

AFRL	AIR FORCE RESEARCH LABORATORY
CZ	CONTAINMENT ZONE
DWR	DEPARTMENT OF WATER RESOURCES
LUC	LAND USE CONTROL
USGS	UNITED STATES GEOLOGICAL SURVEY

NOTES:
1. HYDROLOGIC UNITS BASED ON DWR BULLETIN 118.
2. USGS SUBBASIN BOUNDARIES AS ADOPTED FROM CARLSON ET AL (1998) BASED ON GEOPHYSICAL EVIDENCE.

6-44 ANTELOPE VALLEY BASIN
- RECHARGE AREA
- LANCASTER SUBBASIN (USGS)
- NORTH MUROC SUBBASIN (USGS)

6-41 MIDDLE MOJAVE RIVER VALLEY BASIN
- RECHARGE AREA

6-46 FREMONT VALLEY BASIN
- RECHARGE AREA
- GLOSTER SUBBASIN (USGS)
- CHAFFE SUBBASIN (USGS)

6-47 HARPER VALLEY BASIN
- RECHARGE AREA

OUs 4 and 9 Soil and Debris Sites ROD

Antelope Valley 6-44 DWR Hydrologic Basin with USGS Subbasins

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Groundwater flow directions generally mimic surface drainage, with groundwater on the south side of Leuhman Ridge ultimately flowing into the Lancaster Subbasin, groundwater on the north side of Leuhman Ridge ultimately flowing into the North Muroc Subbasin, and groundwater in the Mars Boulevard area (Sites 7, 167, and 329) flowing into the Middle Mojave River Valley Basin. However, groundwater in these basins and subbasins has not been impacted by contaminants originating from the soil and debris sites.

2.2.3.1 Water Supply

Historically, potable water for the AFRL was supplied by two production well fields (shown on Figure 2.2-2): Mary's Well Field (including Wells 1, 2, and 3 that have been inactive since at least 1994) and the Lower Well Field (including Wells A, B, C, and D). The well fields are respectively located approximately 4 miles and 7.5 miles southwest of the nearest soil and debris site, and draw groundwater from the middle aquifer of the Lancaster Subbasin, which has not been contaminated by AFRL activities. Since late 1997, AFRL has purchased a portion of its potable water supply from Antelope Valley-East Kern Water Agency (AVEK), which operates a pipeline to AFRL from Boron. Well production records for 2002 show that AVEK supplied approximately 39 million gallons, or 64 percent of the water supply, in that year.

The nearest off-base groundwater production wells are operated by Boron and Desert Lakes Community Services but are currently off-line indefinitely due to high naturally-occurring arsenic concentrations. The wells are located approximately 4 miles north of the nearest soil and debris site, and tap the North Muroc Subbasin aquifer, which has not been contaminated by AFRL activities.

2.2.4 ECOLOGICAL SETTING

Vegetation throughout the AFRL is predominately Joshua Tree Woodland and Creosote Bush Scrub. The area supports special wildlife species, e.g., peregrine falcon, and sensitive plant species, e.g., Barstow woolly sunflower and desert cymopterus. Parts of the AFRL are within the Desert Tortoise Critical Habitat and in the Desert Tortoise Management Zone 2, which supports modest tortoise densities.

2.2.5 CURRENT AND POTENTIAL FUTURE LAND AND RESOURCE USES

With the exception of Sites 6 and 113, located within the Precision Impact Range Area (PIRA), the soil and debris sites are located on AFRL land; as shown on Figure 2.1-1, both the AFRL and PIRA are located entirely within Edwards AFB. According to the *Edwards AFB General Plan* (*EAFB GP,* Higginbotham/Briggs & Associates [HB&A] 2001), current and long-term land uses at the AFRL include the testing of rocket engines, extensive safety zones surrounding the test cells, and industrial, research, development and administrative uses. The *EAFB GP* also states the current and designated long-term land use for the PIRA is aircraft flight testing, explosive ordnance disposal (EOD), and placement of communication equipment. Land uses within the AFRL and PIRA are industrial in nature, and no residential uses (including day care facilities or other uses that would result in higher exposure amounts beyond worker exposures) of any portion of these Management Areas are anticipated, as the Air Force will continue to occupy the Base indefinitely. References to residential land uses, or residential receptors, at AFRL are hypothetical and are for comparison purposes only.

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 soil and debris sites 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 voluntary group that meets quarterly to facilitate the exchange of information and concerns between the 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, 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); an Air Force Co-chair; and Remedial Project Managers (RPMs) from Edwards AFB, the USEPA, Cal/EPA DTSC, and the Water Board. 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 representative is elected to serve as the Public Co-chair.

2.3.2 REPORT TO STAKEHOLDERS

The Report to Stakeholders, a monthly newsletter published by Edwards AFB, was developed for the RAB. The newsletter originally focused on hazardous waste cleanup at Edwards AFB, explaining how cleanup technologies work, providing status reports on key restoration activities, and profiles of RAB members through in-depth interviews. The RAB members use the newsletter as a reference tool to educate their communities. In September 2004, the report began news coverage of other environmental activities at Edwards AFB to include conservation and compliance issues. Edwards AFB currently distributes 6,000 copies of the Report to Stakeholders every month. The public may also access the newsletter on the World Wide Web at the site listed below.

Report to Stakeholders Website: http://www.edwards.af.mil/penvmng/documents/rts/rtspage.htm

2.3.3 INFORMATION REPOSITORIES

The administrative record file is maintained at the 95th Air Base Wing, Environmental Restoration Division, 5 East Popson Avenue, Building 2650A, Edwards AFB, CA 93524-8060. Additionally, 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 at 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

The community involvement for the preparation of this ROD is detailed in Part 3: Responsiveness Summary.

2.4 SCOPE AND ROLE OF THE OPERABLE UNIT

OUs 4 and 9 at the AFRL are two of the 10 OUs at Edwards AFB designated to group sites with similar operations, or conditions and contaminants. OUs 4 and 9 are the only OUs located east of Rogers Dry Lake and receive no hydrogeologic influence from the other OUs at Edwards AFB. The 32 sites and AOCs in OUs 4 and 9 remaining in the CERCLA process through the RI/FS have been subcategorized into soil and debris sites and into four groundwater areas (Plate 1). The remedial actions at the soil and debris sites are not dependent on the implementation of response actions at any other OU at Edwards AFB. However, the selected remedial actions at many of the soil and debris sites will supplement remedial actions for the groundwater and associated vapor intrusion pathway selected either in the completed ROD for the South AFRL, or in two forthcoming RODs for the AFRL Arroyos, the Northeast AFRL, and the Mars Boulevard areas (see Section 1.3.4).

The scope and role of this Soil and Debris Sites ROD is to address all risk pathways presenting potential exposure to surface receptors from soil and debris contaminants (risk upward). Except Sites 6 and 113, all of the OUs 4 and 9 soil and debris sites have been (or will be) fully evaluated for the threat of contaminant migration downward to groundwater, and for the threat of VOCs migrating upward (via the VIP) from the groundwater. These evaluations are either presented in the South AFRL ROD (signed in September 2007), or will be presented in the two pending RODs for the AFRL Arroyos, the Northeast AFRL, and the Mars Boulevard areas.

The scope of this Soil and Debris Sites ROD covers only a preliminary evaluation of threats to and from groundwater. This preliminary evaluation was sufficient to conclude that the remedies selected in this ROD will not adversely affect or preclude the remedies already selected for groundwater at the South AFRL, or the remedial alternatives under evaluation for the other groundwater areas. However, there are two exceptions to this general scope and role. First, the threat to groundwater at Sites 6 and 113 is evaluated in this ROD because these two sites are not located within any of the previously

identified large areas of groundwater contamination at OUs 4 and 9. The other exception is the evaluation of the VIP from buried debris sources (e.g., uncharacterized landfill materials). The groundwater RODs evaluate only groundwater and soil or bedrock material as sources of VOCs for an upward migration to the surface. This Soil and Debris Sites ROD addresses the need for remedial responses at those sites where buried debris might contain significant threats to the vapor intrusion pathway (e.g., the Site 13 closed landfill).

2.5 DECISION SUMMARY – FURTHER ACTION SITES IN OU4

2.5.1 SITE 13 – CLOSED AFRL LANDFILL

2.5.1.1 Site Name, Location, and Brief Description

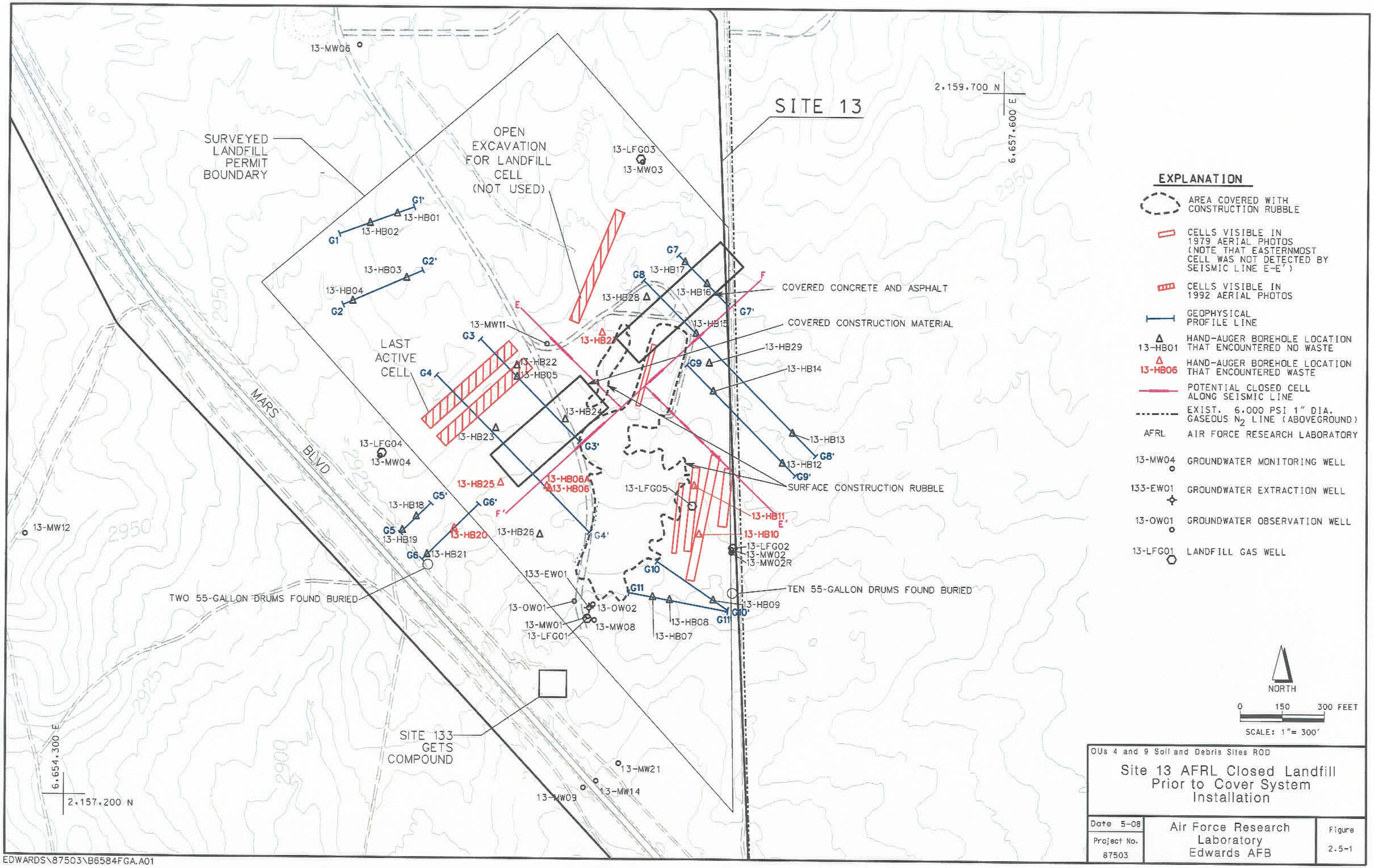
The Site 13 Closed AFRL Landfill is located approximately 1.5 miles south of Leuhman Ridge, on the eastern side of Mars Boulevard (Figure 2.1-2). The permitted landfill site boundary encompasses approximately 54 acres, just south of the Civil Engineering Yard (Figure 2.5-1).

2.5.1.2 Site History and Enforcement Activities

Site History

The AFRL Landfill began operation in 1961 and was operated without regulatory oversight until 1976. During the first 5 years, wastes were burned in one of two trenches located west of a high-pressure gaseous nitrogen line that marks the landfill's eastern boundary. Burning of wastes was discontinued in 1966, after which refuse was compacted and buried in cells with a daily cover of approximately 6 inches of clean soil. Waste cells, or trenches, were excavated from east to west and were oriented in a north-south direction. Trench dimensions were approximately 300 feet long by 20 feet wide by 15 feet deep. Bulky construction debris (mostly asphalt and concrete), was stored above ground in piles totaling approximately 35,000 cubic yards in volume. A more detailed account of the daily landfill operations is included in the *Historical Data Report* (Earth Tech 1998).

In 1976, the Water Board adopted Board Order No. 6-76-84, which established waste discharge requirements (WDRs) for the landfill. These WDRs were updated in Board Order No. 6-84-049 issued in 1984. A review of the available historic data indicated that the landfill received non-hazardous



OUs 4 and 9 Soil and Debris Sites ROD

Site 13 AFRL Closed Landfill Prior to Cover System Installation

Date 5-08	Air Force Research Laboratory Edwards AFB	Figure 2.5-1
Project No. 87503		

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commercial and construction wastes, and was restricted from receiving liquid or hazardous wastes. Site inspections conducted by the Water Board between 1977 and 1985 showed no evidence of the disposal of hazardous waste. Under California Administrative Code Title 23, Chapter 3, Subtitle 15, the landfill was designated as a Class II-2 disposal site for Group 2 wastes (non-hazardous residential, commercial, and agricultural) and Group 3 wastes (inert demolition). In 1984, Chapter 15 of California Code of Regulation (CCR) Title 23 redesignated the site as a Class III non-hazardous solid waste landfill. However, the discovery of buried waste oil drums along the landfill perimeter during implementation of the IRA (see below) indicates that hazardous liquids were disposed in, or at least near, the landfill cells.

The AFRL landfill was first identified as Site 13 under the Air Force ERP in 1984; however, the first subsurface investigations at the site (between 1990 and 1992) were undertaken as part of Solid Waste Assessment Tests (SWATs) under California Assembly Bill 3525. In February 1990, the Air Force wrote a letter to Kern County Environmental Health Services Department (KCEHSD) reporting that waste disposal activities at the landfill had been stopped in January of that year after a Phase I SWAT detected the presence of shallow groundwater in one the open landfill cells. However, additional construction debris was likely added to the existing surface piles after this date. A letter from the KCEHSD, dated May 1990, acknowledged receipt of notice that waste disposal operations had stopped at the landfill. In June 1991, the Air Force wrote a second letter to KCEHSD, transmitting a solid waste facilities permit application marked for facility closure. This letter also communicated that a Phase II SWAT was to be performed in the near future, and that all remediation for the landfill would be done under CERCLA as part of the Air Force ERP.

In June 1993, the Water Board adopted blanket Board Order No. 6-93-100 to bring WDRs for all landfills in the region into compliance with Resource Conservation and Recovery Act (RCRA) Subtitle D regulations concerning municipal solid waste landfills. The AFRL landfill is listed in Section 1 of the Board Order as No. 9 in a list of 48 Class III landfills subject to the updated WDRs.

In 1998, the RPMs agreed to an Edwards AFB proposal to close the Site 13 landfill under the CERCLA presumptive remedy for municipal landfill sites, and in compliance with landfill closure requirements in CCR Title 27 and RCRA Subtitle D as Applicable or Relevant and Appropriate Requirements (ARARs). Because the Air Force notified the Water Board of its intent to close the landfill in

compliance with CCR Title 27 requirements under CERCLA, the Water Board in September 1998 adopted Board Order 6-98-55 rescinding WDRs (Board Order Nos. 6-84-049 and 6-93-100) for the AFRL Class III landfill.

Site Characterization Sampling

This section presents a brief description of the investigations conducted in the immediate area of the Site 13 Landfill; please note that although numerous groundwater wells (not listed below) bear the Site 13 designation, they were installed as part of the larger Site 133 groundwater investigation. A more comprehensive discussion of the RI activities is presented in the *OU4 RI Summary Report* (Earth Tech 2005a) which can be found in the administrative record file and information repositories. The investigations conducted include the following, presented in chronological order:

- Between 1990 and 1992, an air and groundwater SWAT was conducted. Five landfill gas wells (13-LFG01 through 13-LFG05), and four groundwater monitoring wells (13-MW01 through 13-MW04) were installed and sampled. Soil samples were collected and analyzed from the monitoring well boreholes.

- In 1996 and 1997, site investigation (SI) and RI activities included installation and sampling of seven additional groundwater monitoring wells (13-MW06, 13-MW08, 13-MW09, 13-MW11, 13-MW12, 13-MW14, and 13-MW21) in the landfill area.

- In 1997, an Aquifer Pump Test was conducted at Well 13-EW01, using Wells 13-OW01, 13-OW02, 13-MW01 and 13-MW08 as observation wells.

- In 1998, a geophysical survey was conducted at Site 13 using magnetic and electromagnetic induction methods to delineate the boundaries of the former landfill. Twenty nine hand-augered boreholes were drilled and sampled along the survey lines.

- Between 1998 and 2002, seven rounds of groundwater sampling were conducted at Site 13 under the RI.

- Between 2001 and 2002, a cover system was installed over the Site 13 Landfill (see IRA below). Since July 2002, semiannual sampling of nine groundwater monitoring wells and quarterly monitoring of the five landfill gas wells have been conducted as part of the post-closure maintenance and monitoring program (under the approved *Site 13 PCMMP*).

Soil

Only limited soil data were collected in the landfill area because a large portion of the waste disposal site was overlain by construction material pending installation of a final cover system (see IRA below). No organic compounds were identified as COCs in soil at the landfill. Concentrations of iron (up to 33,100 mg/kg) and thallium (up to 51.4 mg/kg) exceeded both their residential preliminary remediation goals (PRGs) and background concentrations in a single sample collected from a depth of 15 feet in a borehole located on the eastern edge of the landfill.

Trash and Debris

Although the landfill was prohibited from receiving liquids or hazardous wastes, 12 drums containing waste oil were discovered during implementation of the IRA (see below) at two locations around the perimeter of the landfill (see Figures 2.5-1 and 2.5-2). It is likely that these drums were buried at some time before the landfill was regulated under WDRs. Because the risks associated with the buried debris are not known, it is assumed that human contact with the trash and debris should be avoided.

Landfill Gas

Various organic compounds including chloroform, trichlorofluoromethane (Freon 11), dichlorodifluoromethane (Freon 12), tetrachloroethene (PCE), and trichloroethene (TCE) have been detected in vapor samples collected within or surrounding the landfill. However, these compounds are also detected in the groundwater (see below) and likely represent off-gassing from the shallow groundwater and not from the contents of the landfill cells. Although these compounds were not identified as COCs, they (and methane) are identified as monitoring parameters for the Site 13 post-closure landfill gas sampling (see IRA below).

Groundwater

As addressed in the South AFRL ROD, the Site 133 groundwater contaminant plume underlies the Site 13 landfill. COCs identified within Site 133 plume include TCE, PCE, cis-1,2-dichloroethene (DCE), 1,4-dioxane, methyl-tert-butyl ether (MTBE), nitrate, and perchlorate. Other VOCs (not identified as COCs) are also present, and are regularly analyzed as part of the LTM for the South AFRL; these include (but are not limited to) chloroform, Freon 11, and Freon 12. A containment zone (CZ) has been established for the South AFRL, beyond which the groundwater plumes from

Sites 37, 120, 133, and 321 will not be allowed to migrate. Within the CZ, ARARs for groundwater have been waived on the basis of technical impracticability from an engineering perspective (TI waiver). ARARs waived include federal and state primary maximum contaminant levels (MCLs). Remedy components for the Sites 37, 120, 133, and 321 groundwater plumes, and for disruption of the VIP associated with groundwater VOCs, include land LUCs and LTM as described in the South AFRL ROD (Earth Tech 2007a) signed in September 2007.

Interim Remedial Actions

In 1994 wastes were removed from the landfill cell in which groundwater was discovered and were disposed of at the Main Base landfill. In 1999, an engineering evaluation/cost analysis (EE/CA) for Site 13 was presented in the *Final Closure and Post-Closure Maintenance Plan for the AFRL Inactive Landfill* (*Site 13 FCPMP,* Earth Tech 2000a). As written, the EE/CA included all of the elements required for, and is equivalent to, an FS report. The EE/CA evaluated four potential interim remedial actions as follows:

1. No action.
2. Access restrictions and LTM.
3. Capping in place.
4. Clean closure through removal and off site disposal of the landfill contents.

Alternative 1 was rejected during preliminary screening because it did not provide protection of human health and the environment. Alternative 4 was rejected during preliminary screening because it was not cost effective. Detailed analyses of Alternatives 2 and 3 led to the recommendation to select Alternative 3, which is a presumptive remedy for CERCLA landfills. Although more costly than Alternative 2, the landfill cap offered a greater degree of protection for human health, and protection of the underlying groundwater from rain water infiltration through the landfill cells.

The plan was reviewed and approved by the Water Board, KCEHSD, the California Integrated Waste Management Board (CIWMB), USEPA, and Cal/EPA DTSC. An *Action Memorandum, Site 13 Inactive Landfill* (Earth Tech 2001a), was signed by the regulatory agencies, documenting selection of a landfill cover system (with a geosynthetic clay liner [GCL]) as the approved IRA for Site 13. The

cover system incorporating a GCL (overlying a 2-foot-thick foundation layer and underlying a 2-foot-thick vegetative, erosion-resistant layer) was selected as an engineered alternative to the State prescriptive cover specified in CCR Title 27 Section 21090 because the GCL is expected to attain the required 1 x 10^{-6} centimeters per second (1 foot per year) or less hydraulic conductivity. A *Performance Design Package* (Earth Tech 2001b) was subsequently reviewed and approved by the regulatory agencies.

Between 2001 and 2002, a cover system (or cap) was constructed over 21 acres of the permitted landfill, and the property was surrounded by a chain-link fence with locked gates (Figure 2.5-2). Details of the cap construction are presented in the *As-Built Certification Report and Construction Quality Assurance Report for Final Closure of AFRL Landfill* (Earth Tech 2003a), and the *As-Built Report and Addendum 1, Site 13 Inactive Landfill* (Weston 2002 and 2003). Construction activities included:

1. Construction of access roads and temporary fencing around the project.
2. Clearing and grubbing of the designated work area.
3. Protection of existing monitoring wells and an aboveground high-pressure nitrogen gas line.
4. Establishment of erosion control measures that remained in place throughout construction.
5. Processing, consolidating, and compacting the demolished concrete and asphalt stockpiled on-site to form the leveling foundation layer of the cover system.
6. Removal and off-site disposal of two empty underground storage tanks that had been buried in the landfill.
7. Removal of 12 waste oil drums that had been buried along the perimeter of the landfill (see Figures 2.5-1 and 2.5-2). During the removal process, several of the corroded drums ruptured spilling their contents into the soil. The drums were disposed of at the Edwards AFB Conforming Storage Facility, and the soil impacted by the spills was disposed of at a licensed off-site TSDF.
8. Placement and compaction of 12-inch-thick clean fill on top of the leveling foundation layer.
9. Installation of the final cover system, including placement of a GCL, a 2-foot-thick vegetative clean soil cover, and a storm water drainage system on top of the cover.

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BOULEVARD
MARS
ACCESS GATE
TWO 55-GALLON DRUMS FOUND BURIED
ACCESS ROAD FROM CIVIL ENGINEERING YARD
AREA 2
LIMIT OF GRADING
SITE 133 GROUNDWATER EXTRACTION AND TREATMENT SYSTEM (GETS) COMPOUND
13-MW11
13-OW01
13-MW09
13-MW14
13-MW21
13-LFG1
13-MW01
133-EW01
13-OW02
13-MW08
PERMITTED LANDFILL SITE BOUNDARY
13-LFG3
13-MW03
LIMITS OF LAND USE CONTROLS
EARTHEN SWALE (LANDFILL ACCESS ROAD)
13-LFG5
ACCESS GATE
6,656,600 E
2,157,150 N
13-MW02
13-MW02R
13-LFG2
TEN 55-GALLON DRUMS FOUND BURIED
EXIST. 6,000 PSI 1" DIA. GN2 PIPELINE (ABOVEGROUND)
NORTH
0 80 160 FEET
SCALE: 1"= 160'

EXPLANATION

- 13-MW11 — GROUNDWATER OBSERVATION OR MONITORING WELL
- 13-LFG5 — LANDFILL GAS MONITORING WELL
- 2926 — 1' FINAL AS-BUILT CONTOUR
- LIMIT OF GRADING
- EXISTING 6,000 PSI GN2 PIPELINE
- RIPRAP ENERGY DISSIPATOR
- TRAPEZPOIDAL CHANNEL
- EARTHEN SWALE AND 2 FEET DEEP EARTHEN V-DITCH
- 8 FEET HIGH CHAIN-LINK FENCE

OUs 4 and 9 Soil and Debris Sites ROD

Site 13 Final Landfill Cover System

Date 5-08	Air Force Research Laboratory Edwards AFB	Figure 2.5-2
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10. Construction of a storm water drainage control system at the site perimeter, including energy dissipaters.

11. Revegetation of the work area.

12. Installation of site access controls, including permanent fencing, locked gates, and signage around the landfill.

The cap and fence limit access by humans and animals to the underlying soil, soil vapor, and buried debris. Additionally, the GCL (installed as part of the cap) minimizes rainwater infiltration through the landfill cells and into the shallow groundwater. The Site 13 cover system meets the substantive requirements of CCR Title 27, Division 2, Chapter 3, Subchapters 3, 4, and 5; and of 40 Code of Federal Regulations (CFR), Part 258, Subpart F (Subtitle D) of RCRA (see Table B-1, Appendix B).

Post-Closure Maintenance and Monitoring Plan

The *Site 13 PCMMP* (Earth Tech 2002) was reviewed and approved by the USEPA, the Water Board, KCEHSD, and CIWMB. Cal/EPA DTSC deferred to the Water Board for state comments. In addition to detailing the upkeep of the cover system and access controls, the plan details a detection monitoring program (DMP) for groundwater intended to assess whether or not the contents of the capped landfill are leaching contaminants into the groundwater (already impacted as part of the Site 133 plume). The *PCMMP* also details a DMP for landfill gas that includes quarterly field-monitoring of the five gas monitoring wells and periodic collection of samples for lab analysis to verify that methane and other trace gasses are not migrating up through the cover system. Inspection and maintenance of the landfill cover, and monitoring under the DMP, have been conducted in accordance with the *Site 13 PCMMP* since July 2002. Per CCR Title 27 Section 20921 (see Table B-2, Appendix B) and RCRA Section 258.61 (see Table B-1, Appendix B), the Site 13 DMP is scheduled to remain in effect for at least 30 years after landfill closure (i.e., through 2032) or as long as there is a potential threat to groundwater.

Groundwater DMP

Under the *Site 13 PCMMP*, the groundwater DMP is accomplished through regular sampling of background wells (located up and cross gradient of the landfill), point of compliance wells (located in and down gradient of the landfill), and vertical extent wells (located down gradient of the landfill). Per

requirements of Water Board Resolution 93-61 (which incorporates Title 27, Section 20420 and RCRA Section 258, Appendices I and II), the monitored parameters (sampled semiannually to annually) include VOCs, 1,4-dioxane, perchlorate, total dissolved solids (TDS), chloride, sulfate, nitrate, and pH. Additional constituents of concern (sampled less frequently) are elements (including metals), and mercury.

Proposed Changes to the Groundwater DMP

In September 2007, a final remedy was selected for Site 133 in the South AFRL ROD that includes a TI waiver of ARARs (federal and state primary MCLs) for groundwater inside a CZ that completely encompasses the landfill (see Plate 1). Other components of the South AFRL remedy include LUCs to prevent exposures to the groundwater and LTM requirements to track plume migration and refine groundwater flow and contaminant transport models (details regarding LUCs and LTM requirements will be presented in a remedial action work plan [RAWP] in development for submittal as a draft in May 2008). The duration of the South AFRL LTM is indefinite and will continue so long as groundwater contaminant levels exceed those safe for unrestricted use (anticipated to be greater than 100 years).

Based on adoption of the TI waiver with requirements for LUCs and LTM inside the South AFRL CZ, continuation of a DMP for groundwater at the Site 13 landfill to meet compliance with Title 27 prescriptive requirements is no longer considered reasonable and would be unnecessarily burdensome and redundant. Therefore, the Air Force has proposed (in a letter addressed to the Kern County Department of Health Services Department dated April 2008) that the LTM conducted as part of the South AFRL final CERCLA remedy replace (as an engineered alternative) the existing Site 13 DMP. CCR Title 27 Sections 20080 (b), 20080 (c), and 20380 (e) allow for an engineered alternative to prescriptive monitoring requirements (under CCR Title 27 Sections 20385, 20390, 20400, and 20420) provided that the following criteria are demonstrated:

- The prescriptive standard is not feasible because either it is unreasonably and unnecessarily burdensome and will cost substantially more than alternatives that meet the criteria; or it is impractical and will not promote attainment of applicable performance standards.
- The alternative is consistent with the performance goal for the prescriptive standard and affords equivalent protection against water quality impairment.

The proposed changes to the groundwater sampling program (documented in *Letter Addendum 12 to the Site 13 PCMMP* [Earth Tech 2008]) meet these criteria for the following reasons:

1. The Title 27 groundwater monitoring requirements for the Site 13 DMP were established before a CERCLA remedy was in place for the South AFRL. At that time, these monitoring requirements were consistent with attaining groundwater ARARs for the South AFRL groundwater plumes (including Site 133). However, as part of the CERCLA remedy selected for the South AFRL, groundwater ARARs have been waived within a CZ that fully encompasses the landfill; the remedy also includes LUCs and LTM requirements. Therefore, the Site 13 DMP groundwater monitoring requirements have become unreasonably and unnecessarily burdensome.

2. Because the Site 13 Closed Landfill is underlain by groundwater contaminated by upgradient sources, it is unlikely that the Site 13 DMP can achieve the performance goal of discerning a release from the landfill. At best, statistical analysis of sampling data can only give a probability that any increasing concentrations in monitoring wells represent a release from the landfill versus migration of the Site 133 plume.

3. Because both the Site 13 DMP and the South AFRL LTM program include periodic sampling of wells in the landfill area, they provide an equivalent level of groundwater protection. However, because sampling of the landfill wells under the South AFRL LTM will be performed less frequently than the annual sampling under the Site 13 DMP, and will not include all of the monitored parameters and COCs included in the DMP, the cost of the program will be significantly less.

Landfill Gas DMP

Under the *Site 13 PCMMP*, and in compliance with CCR Title 27, Division 2, Chapter 3, Subchapter 4, Article 6, the gas DMP is accomplished through quarterly field monitoring of five landfill gas monitoring wells (13-LFG01 through 13-LFG05). Between 2002 and the present the wells have been monitored quarterly for permanent gasses (methane, oxygen, and carbon dioxide [CO_2]) using a GA-90 field instrument and for VOCs using a photo ionization detector (PID). Additionally, through July 2007, vapor samples were collected annually for laboratory analyses of permanent gasses by American Society for Testing and Materials (ASTM) Method D1946 and for VOCs by EPA Method TO-14.

Nature and Extent of Residual Site Contamination

The following text discusses nature and extent of contamination following the IRA.

Soil

No specifically-identified COCs were identified in soil at Site 13. However, the limited soil sampling likely did not adequately characterize the soil at the landfill. To be conservative, it is assumed that there may be unidentified COCs in the Site 13 soil.

Trash and Debris

Trash and debris remain buried in the Site 13 landfill cells. The trash and debris have not been characterized but may contain hazardous materials. Additionally, because oil-filed drums were found buried outside of the permitted landfill boundary, it is possible that other trash and debris may be buried (undiscovered) outside the landfill cover.

Landfill Gas

Decomposing landfill wastes have the potential to generate methane gas, and any volatile material potentially deposited in the landfill could release vapors through the landfill cover. Monitoring of landfill gas wells has shown no evidence of methane migration to the wells, and though VOCs have been detected at concentrations that exceed ambient air PRGs, the compounds detected are consistent with those found in the groundwater. This suggests volatilization of VOCs from the shallow groundwater, rather than from the trash and debris buried in the landfill cells.

Groundwater

As stated earlier, the groundwater contamination below Site 13 is addressed as part of the Site 133 groundwater plume in the South AFRL ROD. The monitored parameters listed earlier are those required (under CCR Title 27) as part of the Site 13 DMP (until modifications proposed under *Letter Addendum 12 to the Site 13 PCMMP* are adopted) to detect potential discharges from the landfill to groundwater. Statistical analysis of the groundwater sampling data collected over the past 6 years shows no evidence indicating that contaminants are leaching from the capped landfill cells into the groundwater.

Conceptual Site Model

A conceptual site model illustrating the potential exposure pathways for contaminated media at Site 13 is shown on Figure 2.5-3. The landfill cover system and security measures implemented during the IRA prevent current exposures by residential, industrial, and construction receptors (and by surface water) to the capped soil, trash, and debris. However, further action (i.e., maintenance of cover/fences and LUCs) are needed to prevent future exposures. There are potentially complete exposure pathways for the inhalation of landfill gas by current or future industrial and/or construction workers; LUCS are needed to prevent these exposure pathways and future residential exposure. Additionally, there are potentially complete current and future exposure pathways for groundwater (as a receptor) through the leaching of chemicals from trash and debris buried in the landfill cells.

2.5.1.3 Current and Potential Future Land and Resource Uses

According to the *EAFB GP*, the current and anticipated future land uses at Site 13 are test and research; there are no residential land uses planned. These land uses are considered industrial for risk assessment purposes.

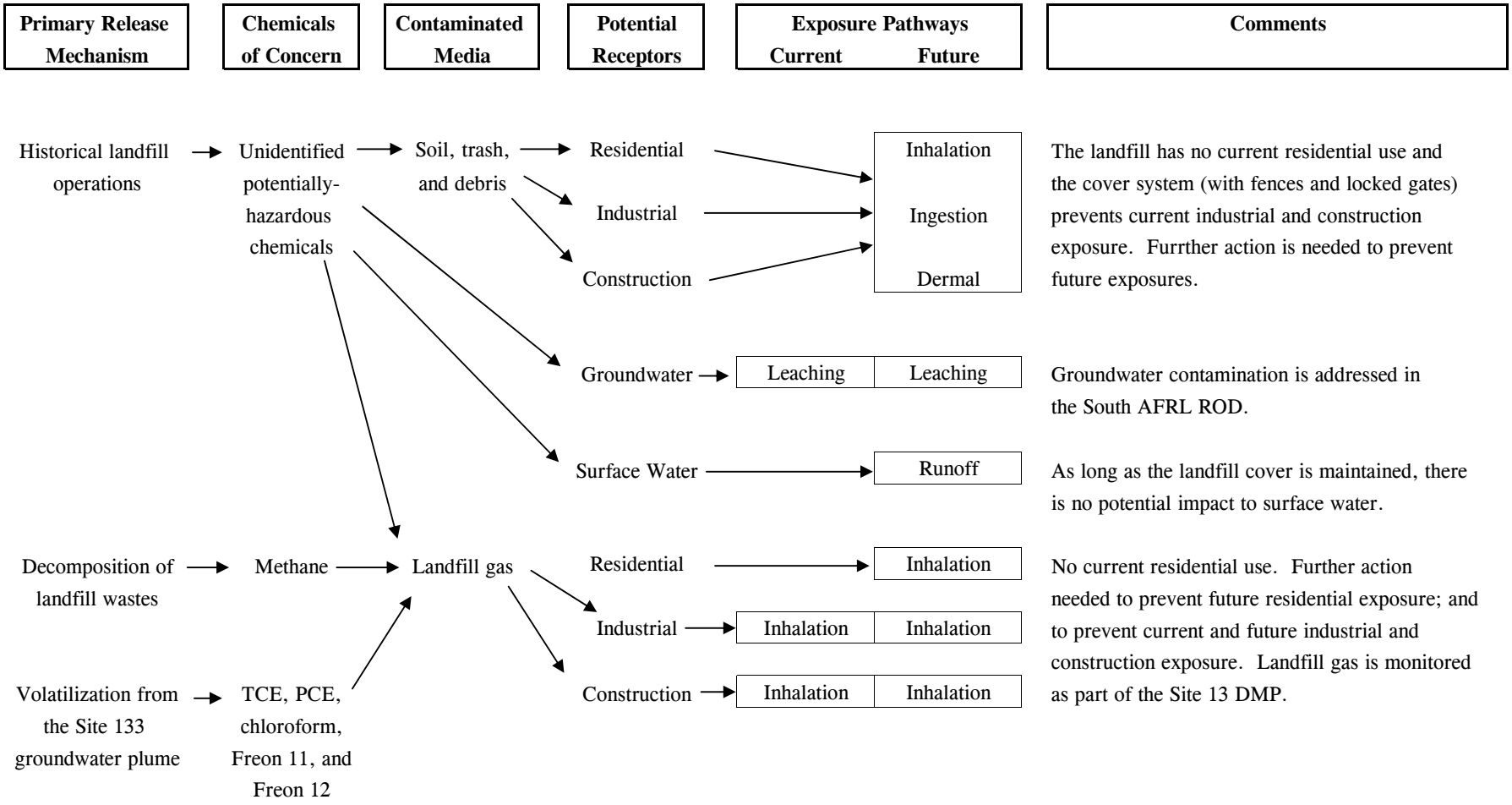
2.5.1.4 Summary of Site Risks

Human Health Risk

As detailed in the *OU4 Human Health Risk Assessment* (HHRA, Earth Tech 2004), the assessment conducted for the soil medium at Site 13 used limited sampling results collected through August 2001. Because the Site 13 soil sampling likely did not adequately characterize soil contamination at the site, and potentially hazardous contaminants that may be in the trash and debris were not addressed, the HHRA may have underestimated the risk that the landfill would pose to humans if the cover system were to fail.

Under all scenarios, the cancer risk was less than 1×10^{-6} (i.e., less than 1 in a million), within the range considered acceptable by USEPA. The non-cancer hazard index (HI) was greater than 1 (11.5) for hypothetical residential receptors, driven by maximum concentrations of iron and thallium. However, because these metals concentrations were detected at depths greater than 12 feet below ground surface (bgs), the maximum depth that is likely to be excavated for residential construction

FIGURE 2.5-3. SITE 13 CONCEPTUAL SITE MODEL - EXPOSURE PATHWAYS



Notes:

→	potentially complete pathway	PCE	tetrachloroethene
AFRL	Air Force Research Laboratory	ROD	record of decision
DMP	detection monitoring program	TCE	trichloroethene

(USEPA 1989), the elevated concentrations are not likely to be available for exposure in a hypothetical residential scenario. For the industrial and construction exposure scenarios, the HI was less than 1. Therefore, iron and thallium were not retained as COCs.

Because no VOCs were detected in the Site 13 soil, the VIP into indoor air from soil is incomplete and no evaluation of risk via this pathway was conducted. However, the South AFRL ROD details the VIP associated with the Site 133 groundwater plume, and the selected remedial response. Additionally, although no evaluation of risk via contact with the trash and debris contained in the landfill cells was performed, it is conservatively assumed that contact with these wastes should be prevented.

Ecological Risk

Because (1) the site has been capped and covered with clean soil, (2) no soil contaminants were detected in the top 10 feet, and (3) groundwater underlying the site was evaluated as part of Site 133, the Phase *I Pre-Scoping Assessment, OU4 Ecological Risk Assessment* (ERA) (USGS 2002a) identified no ecological exposure pathways to be present at Site 13. Therefore, no further ecological investigation (NFEI) was recommended, and the site did not proceed to the scoping ecological risk assessment (SERA) phase (USGS 2004a).

Threat to Groundwater and Surface Water

Because the landfill cells may contain hazardous compounds, there is a potential for impact to the groundwater. However, the landfill cap incorporates a GCL that minimizes the potential for infiltration of surface water through the landfill cells. Additionally, as previously stated, the groundwater under the landfill is already impacted by the Site 133 groundwater plume, and is within a CZ for which a TI waiver of ARARs has been granted. The landfill cap provides adequate protection of ephemeral surface water (storm runoff); there is no permanent standing water on site.

2.5.1.5 Remedial Action Objectives

The remedial action objectives (RAOs) for Site 13 are:

1. Prevent any exposure to the potentially hazardous soil, bedrock, trash and debris, and/or landfill gas by residential receptors (no residential use is planned).

2. Prevent exposure to potentially hazardous soil, trash and debris, and/or landfill gas by industrial receptors and construction workers.

3. Prevent exposure to the fire/explosive hazard from methane in landfill gas. Maximum permissible methane concentrations are 1.25 percent by volume inside structures, and 5 percent (by volume) at the landfill perimeter.

4. Limit the potential for leaching of the landfill contents to the underlying groundwater.

2.5.1.6 Description of Alternatives

Because the EE/CA (Earth Tech 2000a), conducted prior to the Site 13 IRA, contained the substantive requirements of an FS, no additional remedial alternatives were evaluated in the *Soil and Debris Sites FS* (Earth Tech 2006a).

2.5.1.7 Comparative Analysis of Alternatives

Prior to selection and implementation of the landfill cover system as an IRA, a comparative analysis of alternatives was presented in the EE/CA. A summary of this comparative analysis is presented in the Site 13 IRA discussion of this ROD.

2.5.1.8 Principal Threat Wastes

Principal threat wastes are source materials that are considered to be highly toxic or highly mobile that generally cannot be reliably contained, or would present a potential risk considered to be unacceptable to human health or the environment should exposure occur. No principal threat wastes have been identified at Site 13.

2.5.1.9 Selected Remedy

The Air Force and USEPA, with concurrence from Cal/EPA DTSC and the Water Board, selected the landfill cover system already in place, and LUCs as described below, as the long-term remedy for Site 13. The selected remedy meets the RAOs (see Section 2.5.1.5) through a combination of physical barriers (engineering LUCs), vapor monitoring, and administrative LUCs. The following discussions detail the various elements of the selected remedy.

Physical Barriers (Engineering LUCs)

Consistent with RAO Nos. 1 and 2, access to Site 13 is limited to authorized workers through the use of a security fence and locked gates. Additionally, the landfill cover eliminates potential exposures to soil, trash, and debris by all receptors except construction workers (i.e., if excavation through the cap is authorized for repairs). In addition to limiting methane migration (RAO No. 3), the cover also limits the potential for leachate migration to groundwater (RAO No. 4) through the use of a GCL and a drainage diversion system that prevents ponding of rain water and erosion of the cover.

As detailed in the *Site 13 PCMMP*, quarterly inspections and maintenance of the engineering controls will be conducted so long as the plan remains in effect (anticipated at least through June 2032). However, if the requirements of the plan expire, annual inspections with maintenance as needed will continue indefinitely so long a potentially hazardous debris remains in the landfill (see administrative LUCs below).

Monitoring

Monitoring for methane and other gasses will be conducted in accordance with the DMP for landfill gas, described in Section 2.5.1.5, with the following modifications as proposed in *Addendum 12 to* the *Site 13 PCMMP* (Earth Tech 2008): field monitoring for methane, oxygen, CO_2, and VOCs will be continued on a quarterly schedule (as required by Title 27, Section 20921 and RAO Nos. 2 and 3), but the laboratory confirmation analyses for permanent gasses and VOCs (not a Title 27 requirement) will be conducted only once every 5 years, rather than annually. If the quarterly field measurements indicate methane at concentrations exceeding 1.25 percent by volume, more frequent laboratory analyses for methane (i.e., annual) will be proposed. These modifications were proposed based on results of landfill gas monitoring over the last 6 years, which have not indicated migration of methane or VOCs from the landfill cells.

Administrative LUCs

The Site 13 LUC boundary extends approximately 200 feet beyond the landfill fence line to the north, west, and south (Figure 2.5-2), enclosing an area of approximately 37 acres. The buffer zone outside the landfill fence line encompasses the locations where drums were found during construction of the cover system, as well as areas where additional burial of hazardous materials may have occurred.

Because vehicles cannot cross the above-ground nitrogen line located east of the landfill, it is unlikely there was any disposal east of this line. Therefore, the buffer zone east of the landfill is smaller, extending only to the nitrogen line. The vertical component of the LUC boundary extends from the top of the landfill cover to the first occurrence of groundwater (approximately 14 to 38 feet bgs). The groundwater below Site 13 is subject to LUCs as part of the selected remedy presented in the South AFRL ROD.

The specific LUCs for Site 13 under this remedy are as follows:

1. Consistent with RAO No. 1, the land within the LUC boundaries will be used only for industrial purposes, and not for residential, commercial, or agricultural (especially food crop) uses; access to the site by residential receptors will be prohibited.

2. Consistent with RAO No. 2, no activities that would expose industrial workers to the contents of the landfill cells will be permitted without prior authorization from Environmental Management. Access to the site will be limited to workers, who (1) are involved in maintenance and monitoring of the final cover system, including authorized repairs; (2) are trained in hazardous waste operations; and (3) are wearing appropriate personal protective equipment (PPE).

3. Consistent with RAO No. 2, intrusive work (i.e., excavation) will only be conducted by construction workers who are trained for work at hazardous sites (current certification), are wearing appropriate protective clothing and equipment as specified in the forthcoming RAWP, and are officially authorized by Air Force Environmental Management for the specific work activity. No construction of buildings or other inhabited structures will be permitted within the LUC boundaries.

4. Discharges of water to the surface and/or subsurface at Site 13 will be prohibited (RAO No. 4).

Further discussion of the administrative LUCs, including the means for implementation and documentation, is presented in Section 2.8.1 – LUCs General Provisions.

2.5.1.10 Statutory Determinations

Under CERCLA Section 121 and the NCP, the lead agency must select remedies that meet the threshold criteria of being protective of human health and the environment, and complying with ARARs (unless a statutory waiver is justified). As balancing criteria, the remedies should also be cost effective, and should utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. Section 121(e) of CERCLA, USC Section 9621(e),

states that no federal, state, or local permit is required for remedial actions conducted entirely on site; these actions must meet the substantive but not administrative requirements of ARARs. In addition, CERCLA asserts a preference for remedies that employ treatment that permanently and significantly reduces the volume, toxicity, or mobility of hazardous wastes as a principal element, and a bias against off-site disposal of untreated wastes. The following sections discuss how the selected remedy meets these statutory requirements.

Protection of Human Health and the Environment

The selected remedy protects human health and the environment by maintaining the cover system that isolates potentially hazardous trash and debris from surface exposures, and by minimizing the infiltration of stormwater into the landfill. LUCs will prevent unauthorized access to the trash and debris buried at the site, and vapor monitoring will allow for the detection of methane gas.

Compliance with ARARs

Section 121(e) of CERCLA, USC Section 9621(e), states that no federal, state, or local permit is required for remedial actions conducted entirely on site; these actions must meet the substantive but not administrative requirements of ARARs.

Chemical-Specific ARARs. The beneficial uses designated in the *Water Quality Control Plan, South Lahontan Basin* (Basin Plan, Water Board 1994) for minor surface waters in the Antelope Hydrologic Unit and Lancaster Hydrologic Area are relevant and appropriate to the remedy selected for the Site 13 landfill (see Appendix B, Table B-1, Item 2); maintenance of drainage diversions and the landfill cover integrity will maintain these beneficial uses. Because the landfill is located inside the South AFRL CZ (refer to Plate 1), the beneficial uses of groundwater are waived due to TI as selected in the South AFRL ROD.

Location-Specific ARARs. Because the land within the Site 13 fence line has been completely disturbed, most state and federal regulations governing protection of wildlife, historical, and archeological resources are not ARARs. However, because endangered or threatened species are present at the AFRL, the following are listed as relevant and appropriate regulations (RARs):

- California Endangered Species Act (Table B-1, Item No. 4); and

- Federal Endangered Species Act (Table B-1, Item No. 5).

Field activities associated with the selected remedy for Site 13 will be coordinated with Base biologists to ensure the protection of sensitive wildlife species.

Action-Specific ARARs. The following action-specific ARARs were identified for Site 13:

- 22 CCR, Div. 4.5, Ch. 39, Section 67391.1 and Civil Code Section 1471 (Table B-1, Item No. 12) – As discussed in Section 2.5.1.9, LUCs are included as part of the selected remedy because potentially-hazardous trash and debris will remain in the landfill cells. In the event of transfer of property that includes the Site 13 LUC boundary to a non-federal entity, a land use covenant with DTSC would be required. Therefore, the cited requirements are relevant and appropriate to the selected remedy.

- CIWMB post-closure care requirements under 27 CCR Sections 20080 (b,c), 20380 (e), 20921, 20923, 20925, 20932, 20933, 20934, 20937, 20950, 21090, 21150, and 21180 (as summarized in Table B-1, Item No. 13; and detailed in Table B-2). Continued compliance with the *Site 13 PCMMP*, as modified by a reduction in monitoring requirements proposed in *Letter Addendum 12* (refer to Sections 2.5.1.2 and 2.5.1.9, will meet the relevant and appropriate requirements for post-closure maintenance and monitoring. Because groundwater monitoring is a component of the remedy selected for Site 133 in the South AFRL Containment Zone, the remedy selected for Site 13 in this ROD is exempt from groundwater monitoring requirements under Title 27.

- EPA RCRA Subtitle D post-closure care requirements for Municipal Solid Waste Landfill (MSWLF) (see Table B-1, Item No. 14). The exemption under Section 258.61(c), and the general post-closure care requirements in Section 258.61, are relevant and appropriate.

Disagreement on ARARs. The Air Force and Water Board do not agree on whether the following Water Board requirements are ARARs for Site 13:

- Specific sections of the *Basin Plan*, including but not limited to:

  - Water quality objectives (WQOs) for non-degradation (page 3-2) and certain of the WQOs for surface waters (page 3-3) and groundwater (page 3-11).

  - Region-wide prohibitions 1 through 3 (found on page 4.1-1). Items 1 and 2 prohibit discharging waste which causes a violation of narrative (including non-degradation) or numeric WQOs while Item 3 prohibits discharging waste which causes further degradation or pollution where a narrative or numeric WQO is already being violated.

  - Soil Cleanup Levels (page 4.2-4): "The Regional Board will determine soil cleanup levels for the unsaturated zone based upon threat to water quality… If it is unreasonable

to clean up soils to background concentration levels,…site-specific recommendations for soil cleanup levels (may [be] consider[ed]) provided that applicable groundwater quality objectives are met and health risks from surface or subsurface exposure meet current guidelines."

- State Water Resource Quality Control Board (SWRQCB) Resolution No. 92-49 (*Policies and Procedures for Investigation and Cleanup and Abatement of Discharges Under Water Code Section 13304),* Section III.G. This resolution requires dischargers of pollution or nuisance conditions to clean up the groundwater and establishes groundwater cleanup levels at background or some higher level that does not result in pollution.

Please see Section 2.8.2 for the individual positions held by the Air Force, the USEPA, and the Water Board regarding analysis of whether these requirements are ARARs.

Notwithstanding the Air Force position that these Water Board requirements are not ARARs for this action, the selected remedy for Site 13 meets the technical requirements of California water quality law, plans, and policies in that it protects both surface water and groundwater against impacts from the potentially-contaminated soil and debris buried in the landfill via drainage diversions and maintenance of the final cover integrity. Moreover, the selected remedy meets the following five exemption criteria cited (on p. 4.1-2) by the *Basin Plan* for restoration projects:

- Maintenance of the landfill cover will reduce or mitigate existing sources of soil erosion, water pollution, or impairment of beneficial uses;
- There is no feasible alternative to the project (i.e., clean closure of the landfill is not feasible);
- Land disturbance will be minimized in that only the already impacted area within the landfill fence line will further be disturbed;
- The landfill cover system minimize potential adverse environmental impacts; and
- The selected remedy complies with the ARARs identified in Appendix B.

Cost Effectiveness

The selected remedy represents the lowest cost at which all of the statutory requirements for Site 13 are met (see Table 2.5-1). However, it should be noted that the cost estimates presented in this ROD include only the first 30 years of remedy implementation. Given the indefinite duration of the selected remedy, the total lifecycle costs of the remedy cannot be calculated, but will likely be greater than the

30-year costs shown. Table 2.5-1 lists an estimate of the unadjusted annual cost of implementing the remedy beyond Year 30. For clarity, the following definitions are provided:

> **Escalated Costs –** Cost estimates for long-term projects are initially calculated in today's dollars. Escalation factors are then applied to approximate the inflation anticipated in the year in which the costs will be incurred.
>
> **Present Value Costs** – The funds that would need to be invested in the present to cover the long-term expenses (i.e., for the first 30 years) of a remedial alternative that incorporates recurring costs.
>
> **Unadjusted Costs** – Costs estimated using today's dollar without escalating for inflation, or discounting for present value.

Please note that present value costs are provided only to compare alternatives that have different timeframes in today's economic terms. Given that federal projects are typically funded annually on a single-year-need basis, it is unlikely that present value savings will be realized for the soil and debris site remedial actions. Therefore, only escalated costs were used to evaluate the cost effectiveness of the selected remedy.

Table 2.5-1. Site 13 Selected Remedy Cost Breakdown

Selected Alternative	Unadjusted Costs	Escalated Cost	Present Value Cost
Maintenance of Cover System and Fences (recurring costs in Years 1 to 30)	$843,000	$1,225,000	$567,000
Landfill Gas Field Monitoring (recurring costs in Years 1 to 30)	$189,000	$275,000	$127,000
Landfill Gas Laboratory Analysis (recurring costs every 5th year)	$50,000	$70,000	$36,000
Project Management and Reports (recurring costs in Years 1 to 30)	$2,412,000	$3,506,000	$1,623,000
Administrative Controls (recurring costs in Years 1 to 30)	$69,000	$100,000	$46,000
	$3,563,000	**$5,176,000**	**$2,399,000**
Annual Cost Beyond Year 30 (LUCs and cover maintenance)	$111,000*	-	-

Notes:

Escalation factors from RACER Software. Present value based on a 3% discount factor. All costs rounded to nearest $1,000.
*Assumes no landfill gas sampling is required after Year 30.

Utilization of Permanent Solutions and Alternative Treatment Technologies

The selected remedy does not incorporate permanent solutions or alternative treatment technologies. However, the protection afforded by the remedy is expected to be effective over the long term provided that procedures in the *Site 13 PCMMP* (with modified monitoring requirements) are followed and LUCs are enforced.

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, 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.

Five-Year Review Requirements

Because the selected remedy will result in hazardous substances, pollutants, or contaminants (trash and debris in landfill cells) remaining on-site above levels that allow for unrestricted use and unrestricted exposure (i.e., residential levels), a statutory review will be conducted within 5 years after initiation of the remedial action to satisfy NCP Section 300.430(f)(4)(ii), and at 5-year intervals thereafter, as long as hazardous substances remain at the site at levels that do not allow for unrestricted (residential) uses. Five-year reviews will be conducted in accordance with CERCLA Section 121(c) and are required to determine whether the remedy continues to be protective of human health and the environment.

2.5.1.11 Documentation of Significant Changes from Proposed Plan

The primary changes from the *Soil and Debris Sites PP* are the proposed revision of LTM requirements (i.e., replacement of the Site 13 DMP with LTM under the South AFRL ROD), and the proposed reduction in the frequency of landfill gas laboratory sampling to confirm field monitoring results. If approved, these changes will result in a significant reduction in the escalated cost from $7,246,000 to $5,176,000 (see Table 2.5-1 and Table C-1, Appendix C). Additionally, as per guidance in *Office of Management and Budget Circular A-94, Appendix C* (OMB 2007), the present value cost for implementing long-term LUCs, cover maintenance, and gas monitoring at Site 13 was recalculated

using a 3 percent discount factor (intended for federal projects) rather than the 7 percent (intended for private sector projects) inadvertently used in the proposed plan.

2.5.2 SITE 36 – TEST AREA 1-21 FORMER WASTEWATER EVAPORATION TANK

2.5.2.1 Site Name, Location, and Brief Description

Site 36 is located in Test Area 1-21 on the crest of Leuhman Ridge (Figure 2.1-2). Test Area 1-21 was originally used for testing rocket engines fueled by liquid propellant/oxidizer combinations, and was later converted to a solid propellant cutting facility (see Section 2.5.2.2). The removed aboveground wastewater evaporation tank was formerly located northwest of Building 8582 (Figure 2.5-4), on a steep hillside only partially accessible by all-terrain vehicles and small, tracked construction equipment. This ROD addresses only the shallow soil contamination at Site 36; contamination in the bedrock and groundwater is briefly discussed below but will be addressed in the ROD for the ARFL Arroyos area.

2.5.2.2 Site History and Enforcement Activities

Site History

The Site 36 wastewater evaporation tank was initially used as a catch basin/burn pit to dispose of liquid-waste propellants. After the test stand was converted (in 1968) to a solid propellant cutting facility, wastewater contaminated with ammonium perchlorate was collected in the aboveground tank. Dust from the solid propellant was separated out and the water was evaporated. It is likely that wastewater was also released to a natural drainage ravine west of the tank via an overflow pipe. In 2001, a compliance evaluation revealed that the steel tank had lost bottom integrity due to corrosion, resulting in unauthorized releases of wastewater to the underlying soil. In 2002, propellant cutting operations ceased at Test Area 1-21, the pipe connections from Building 8582 to the tank were severed, and propellant residues were removed from the tank.

Site Characterization Sampling

Soil

An SI was conducted at Site 36 in 1993 (The Earth Technology Corporation 1994) that consisted of sampling from six shallow hand-augered boreholes (36-HB35 to 36-HB40) located in a stained area next to the wastewater evaporation tank and in a drainage down slope of the tank outlet. However, shallow

36-MW03

2,162,900 N

36-MW02

6,651,300 E

36-MW04

TEST AREA 1-14

8620

SITE 36

36-MW01

36-HB40 0.5'
TOLUENE <0.0050
METHYLENE CHLORIDE <0.0050
BENZO (A) PYRENE <0.33
BENZO (B) FLUORANTHENE <0.33

36-HB39 0.5'
TOLUENE 0.011
METHYLENE CHLORIDE <0.0050
BENZO (A) PYRENE <0.33
BENZO (B) FLUORANTHENE <0.33

36-HB38 0.5'
TOLUENE <0.0051
METHYLENE CHLORIDE <0.0051
BENZO (A) PYRENE <0.33
BENZO (B) FLUORANTHENE <0.33

36-HB37 0.5'
BENZO (A) PYRENE 0.45
BENZO (B) FLUORANTHENE 0.35
CHRYSENE 0.35
FLUORANTHENE 0.81
METHYLENE CHLORIDE <0.0052
PHENANTHRENE 0.41
PYRENE 0.60
TOLUENE <0.0052

36-TSS11 0.0'
PERCHLORATE 0.71

36-TSS02 0.0'
TOLUENE <0.0062
METHYLENE CHLORIDE <0.0062
BENZO (A) PYRENE <0.41
BENZO (B) FLUORANTHENE <0.41

FORMER WASTE WATER EVAPORATION TANK

36-TSS01 0.0'
TOLUENE <0.0050
METHYLENE CHLORIDE <0.0050
BENZO (A) PYRENE <0.33
BENZO (B) FLUORANTHENE <0.33

SEE INSET "A"

36-TSS10 0.0'
PERCHLORATE 4.7

36-TSS14 0.0'
BENZO (A) PYRENE <0.015
BENZO (B) FLUORANTHENE <0.010

DRAINAGE SWALES

BLDG 8582

LIMIT OF LAND USE CONTROLS

TEST AREA 1-21

HYDRA BOULEVARD

MARS

SCORPIO STREET

6,650,100 E

2,161,600 N

NORTH

0 75 150 FEET

SCALE: 1"= 150'

(0')
36-TSS03
PERCHLORATE 209

(2')
36-EX01
PERCHLORATE 146

(0')
36-TSS05
PERCHLORATE 79.4

(2')
36-EX03
PERCHLORATE 6.1

(0')
36-TSS04
PERCHLORATE 1,210

(2')
36-EX02
PERCHLORATE 15.4

36-TSS09 0.0'
PERCHLORATE 21.0

36-HB36 0.5'
ACETONE 0.013
TOLUENE 0.0063
METHYLENE CHLORIDE <0.0057
BENZO (A) PYRENE <0.38
BENZO (B) FLUORANTHENE <0.38

FORMER WASTE WATER EVAPORATION TANK

PERCHLORATE EXCEEDS INDUSTRIAL PRG (100 mg/kg)

FORMER DISCHARGE PIPE

36-TSS08 0.0'
PERCHLORATE 13.6

LIMIT OF 2004 EXCAVATION

36-HB35 0.5'
ACETONE 0.024
TOLUENE 0.016
METHYLENE CHLORIDE 0.0059
BENZO (A) PYRENE <0.38
BENZO (B) FLUORANTHENE <0.38

PERCHLORATE EXCEEDS RESIDENTIAL PRG (7.8 mg/kg) FUTURE EXCAVATION

36-TSS12 0.0'
BENZO (A) PYRENE <0.015
BENZO (B) FLUORANTHENE <0.010

36-TSS13 0.0'
BENZO (A) PYRENE <0.015
BENZO (B) FLUORANTHENE <0.010

36-TSS07 0.0'
PERCHLORATE 0.48

PERCHLORATE EXCEEDS RESIDENTIAL PRG (7.8 mg/kg) FUTURE EXCAVATION

FORMER PRIMARY INLET PIPE (DASHED WHERE UNDERGROUND)

LIMIT OF LAND USE CONTROLS

36-TSS06 0.0'
PERCHLORATE 0.18

INSET A

0 10 20 FEET

SCALE: 1"= 20'

EXPLANATION

- HAND AUGER SOIL SAMPLE LOCATION, NOVEMBER 1993
- MONITORING WELL LOCATION
- SURFACE SOIL SAMPLE, SEPTEMBER 1999
- SURFACE SOIL SAMPLE, AUGUST 2004
- PROPOSED LOCKED GATE WITH WARNING SIGN

µg/L MICROGRAM PER LITER
mg/kg MILLIGRAMS PER KILOGRAM
PCE TETRACHLOROETHENE
TCE TRICHLOROETHENE
NDMA N-NITROSODIMETHYLAMINE

LOCATION NAME SAMPLE DEPTH-SOIL
PARAMETER NAME VALUE DETECTED (mg/kg)

OUs 4 and 9 Soil and Debris Sites ROD

Site 36 Map Showing Soil Sampling Results

Date 5-08	Air Force Research Laboratory Edwards AFB	Figure 2.5-4
Project No. 87503		

EDWARDS\87503\B6585FGA.A01

bedrock and the lack of drill rig access limited the samples to only the surface soils (drill rigs and excavators capable of penetrating the hard granitic bedrock present at Site 36 cannot safely access the hillside). Soil samples were analyzed for VOCs, semivolatile organic compounds (SVOCs) with nitroaromatics, hydrazine, cyanide, dioxins, and elements including metals. At the time of the SI, perchlorate had not been identified as a chemical of environmental concern and analytical methods for its detection had not been fully developed; therefore, the samples were not analyzed for perchlorate. The only compound identified as a chemical of potential concern was benzo(a)pyrene, a PAH, detected in the surface sample from Borehole 36-HB37, at a concentration of 0.45 mg/kg, exceeding its industrial PRG of 0.21 mg/kg. Other organic compounds detected in the soil included acetone, methylene chloride, toluene, benzo(b)fluoranthene, chrysene, fluoranthene, phenanthrene, and pyrene, all at concentrations below their respective PRGs. The presence of PAHs in the soil at Site 36 was thought to be due to byproducts from burn activities formerly conducted in the wastewater evaporation tank.

At the request of the RPM for Cal/EPA DTSC, two surface soil samples (36-TSS01 and 36-TSS02) were collected in the drainage to the east of the wastewater evaporation tank in September 1999. These samples were analyzed for VOCs, SVOCs, NDMA, and perchlorate with all results below reporting limits.

In 2004, six surface soil samples (36-TSS06 through 36-TSS11) were analyzed for perchlorate with concentrations ranging from 0.18 mg/kg in Sample 36-TSS06 up gradient of the tank, to 21 mg/kg at the outlet of the tank's discharge pipe west of the tank. By comparison, the industrial PRG for perchlorate in soil is 100 mg/kg. Concurrently, three surface soil samples (36-TSS12 through 36-TSS14) were collected and analyzed for PAHs at locations where PAH contaminants were previously detected. All PAH concentrations in Samples 36-TSS12 through 36-TSS14 were below reporting limits for method SW8310 (and thus below both residential and industrial PRGs). Therefore, perchlorate was the only COC retained for soil at Site 36 (Table 2.5-2).

Bedrock and Groundwater

Although sampling of the bedrock could not be conducted at Site 36 due to drill rig access constraints (see above), well sampling (conducted as part of the groundwater monitoring for the AFRL Arroyos area)

TABLE 2.5-2. SITE 36 CHEMICALS OF CONCERN

Chemicals of Concern	Maximum Detected Concentration (Post-IRA)	Current Non-Cancer Hazard Index	Basis for Listing as a Chemical of Concern	Selected Cleanup Limit	Non-Cancer Hazard Index at Cleanup Limit
Soil					
Perchlorate	146 mg/kg	18.7 (Res.) < 1.0 (Ind.)	Exceeds PRG* and non-cancer hazard index for residential scenario. Limited potential for impact to surface water (storm water runoff).	7.8 mg/kg (Res. PRG*)	1.0 (Res.) < 1.0 (Ind.)
Bedrock					
Perchlorate (suspected)	Unknown	Unknown	Potential continuing source of groundwater contamination.	To be addressed in AFRL Arroyos ROD.	Not applicable
Groundwater					
Perchlorate	260 µg/L	Not evaluated	Site 36 contributed to the perchlorate contamination in the Site 162 Groundwater Plume to be addressed in the AFRL Arroyos ROD.	To be addressed in AFRL Arroyos ROD.	Not applicable

Notes:

*	United States Environmental Protection Agency Region 9 preliminary remediation goals (USEPA 2004).
µg/L	micrograms per liter
AFRL	Air Force Research Laboratory
Ind.	industrial
IRA	interim remedial action
mg/kg	milligrams per kilogram
Res.	residential
ROD	record of decision

confirms that perchlorate has impacted the underlying groundwater at concentrations above the California MCL of 6 micrograms per liter (μg/L). Therefore, it is likely that large quantities of perchlorate-laden process water (released from leaks in the wastewater evaporation tank) seeped through the unsaturated bedrock fractures and entered the groundwater, possibly leaving behind perchlorate residue trapped in the unsaturated bedrock fractures.

Interim Remedial Actions

In August 2004, the wastewater evaporation tank and its associated piping were removed, decontaminated, and recycled as non-hazardous (Class 3) scrap metal as part of a compliance action described in the *Preliminary Site Assessment and Tank Removal Report, Building 8582 Wastewater Evaporation Tank* (Earth Tech 2005b). After tank removal, Samples 36-TSS03 through 36-TSS05 were collected from the tank footprint; perchlorate concentrations in these samples ranged from 79.4 mg/kg to 1,210 mg/kg. Following the initial sampling, soil was excavated from beneath the tank and the surrounding area to a depth of approximately 2 feet below the bottom of the tank. The scope of the compliance action limited the excavation to an estimated 10 cubic yards of loose soil. Approximately 1 foot to 3 feet of soil overlying the shallow bedrock remain on site. The excavated soil was shipped as a non-RCRA hazardous waste to a licensed TSDF.

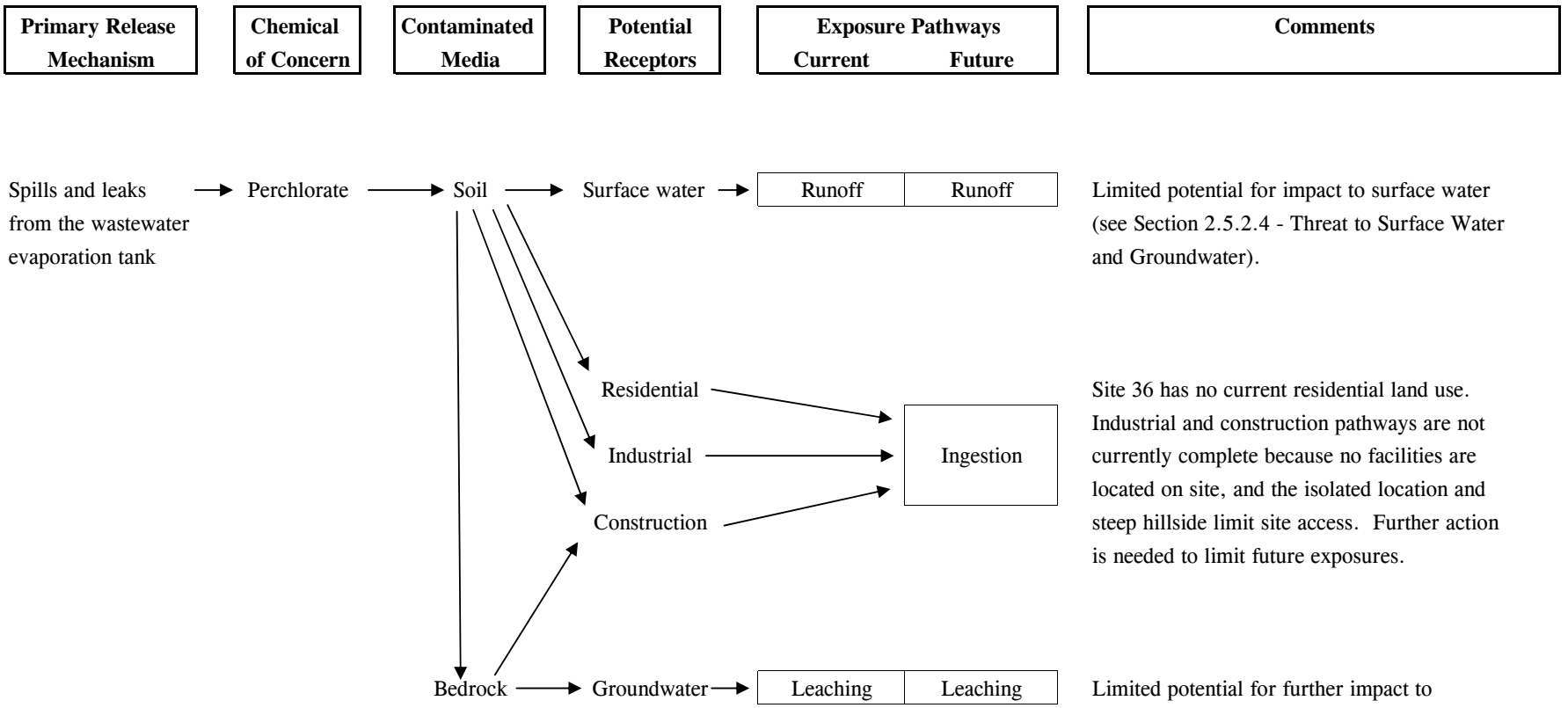
Nature and Extent of Residual Site Contamination

Following completion of the IRA, three confirmation soil samples were collected from the former tank footprint to assess concentrations of perchlorate in the soil remaining on-site following excavation. Results from the confirmation soil sampling indicated an order of magnitude reduction in perchlorate. The perchlorate concentration in one sample (146 mg/kg) exceeded the industrial PRG, and concentrations in two additional samples (21.0 mg/kg and 15.4 mg/kg) exceeded the residential PRG (for a total impacted area of approximately 0.2 acres). Based on these sampling results, the limited goals of the compliance action were met and no further excavation of soil at Test Area 1-21 was completed.

Conceptual Site Model

The conceptual site model illustrating the potential exposure pathways for Site 36 is shown on Figure 2.5-5. There are no potentially complete exposure pathways to current residential

FIGURE 2.5-5. SITE 36 CONCEPTUAL SITE MODEL - EXPOSURE PATHWAYS



Notes:

→ potentially-complete pathway
AFRL Air Force Research Laboratory
ROD record of decision

(hypothetical), industrial, or construction receptors; however, further action is required to prevent future exposures via ingestion of soil. Similar exposures are possible by future construction workers digging into the bedrock. Although the potential is limited, surface water (in the form of runoff) could be impacted by perchlorate in the soil, and groundwater could be impacted by perchlorate in the bedrock (see Section 2.5.2.4 – Threat to Groundwater and Surface Water).

2.5.2.3 Current and Potential Future Land and Resource Uses

According to the *EAFB GP*, the current and anticipated future land uses at Site 36 are test and research; these land uses are considered industrial for risk assessment purposes. No residential land uses are planned.

2.5.2.4 Summary of Site Risks

Human Health Risk

Prior to completion of the IRA, an initial HHRA was conducted. At the time, no samples had been analyzed for perchlorate or elements including metals. For all exposure scenarios, the HI was below 1; the potential cancer risks were driven by PAHs detected in one sample.

Following tank removal and partial excavation of impacted soil in 2004, a second risk assessment was performed for Site 36 using the sampling results for perchlorate (in residual soil remaining on-site) and elements, including metals. Because PAHs were not detected in confirmation soil samples, they were not included in this HHRA. The results, summarized in Table 2.5-3, indicate an HI for the hypothetical residential exposure pathway that exceeds the benchmark criterion of 1, driven by the maximum concentration of perchlorate. The HIs for the industrial (detailed assessment) and construction scenarios are less than 1. As discussed earlier, the current and reasonably anticipated future land use for all sites at the AFRL is industrial, and there are no plans for residential use.

Because perchlorate contamination of the underlying bedrock at Site 36 is likely, but has not been confirmed or quantified, no assessment of risk to a hypothetical construction worker excavating into the bedrock was conducted. Therefore, to be conservative, it is assumed that the bedrock poses an unacceptable risk to construction workers, and that excavation at the site should be restricted.

TABLE 2.5-3. QUANTIFICATION OF RISKS FOR CHEMICALS DETECTED IN SOIL - SITE 36

Analyte	Maximum Detected Concentration	Residential PRG[1]	Industrial PRG[1]	Residential Risk and Hazard Index		Industrial Risk and Hazard Index	
				Carcinogens	Noncarcinogens	Carcinogens	Noncarcinogens
Inorganic Analytes (mg/kg)							
chromium, total	1.53E+01	2.11E+02 c	4.48E+02 c	7.26E-08		3.41E-08	
copper	9.56E+01	3.10E+03	4.10E+04				
iron	5.49E+04	2.35E+04	1.00E+05		2.340		0.549
lead	2.80E+01	1.50E+02	7.50E+02		0.187		0.037
nickel	3.18E+01	1.60E+03	2.00E+04		0.020		0.002
perchlorate	1.46E+02	7.80E+00	1.00E+02		18.72		1.460
selenium	2.10E+00	3.90E+02	5.10E+03		0.005		0.076
zinc	3.28E+02	2.35E+04	1.00E+05		0.014		0.235
Total Risk and Hazard Index Quantification for Constituents in Soil[2]				7.26E-08	21.31	3.41E-08	2.361 (0.731)[3]

	Carcinogens	Noncarcinogens
Total Construction Worker Risk and Hazard Index Quantification for Constituents in Soil[4]	5.24E-10	0.907

Notes:

[1] United States Environmental Protection Agency Region 9 reliminary remediation goals (USEPA 2004).

[2] 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.

[3] Result of detailed potential health impacts assessment based on site-specific exposure criteria.

[4] Calculated as the product of 0.015 and the industrial risk, and 0.384 and the industrial hazard (Earth Tech 2004).

c Indicates that chemical is evaluated based on its carcinogenic potential.

mg/kg milligrams per kilogram

Because VOCs were not detected in the Site 36 soil above residential PRGs (see Appendix D), the VIP into indoor air from soil is incomplete and no evaluation of risk via this pathway was conducted. The forthcoming AFRL Arroyos ROD will detail the VIP associated with VOCs in the Site 162 groundwater plume (that underlies Site 36), and the selected remedial response.

Site-Specific Risk-Based Exposure Level

A risk-based exposure level is defined as the concentration that corresponds to an acceptable level of risk. An acceptable level of risk for a non-carcinogen (such as perchlorate) is defined as an HI of 1 or less. Assuming an industrial exposure scenario, a risk-based exposure level of 204 mg/kg was calculated specifically for perchlorate in Site 36 soil (Earth Tech 2006a). In general, the values for the exposure parameters used in the calculation are the default values recommended by USEPA (1991 and 1996), and from Earth Tech (2001c). However, because Edwards AFB does not represent a typical industrial setting as described in these documents, a site-specific value for exposure duration was used to more accurately represent the potential risks at this site. Based on the housing residency information and the time-on-station information contained in U.S. Air Force (1998) *Military-Specific Exposure Factors Study*, an exposure duration of 10 years was chosen. This value differs from that used in the preliminary evaluation of potential health impacts resulting from the inhalation of indoor air (25 years).

An exposure duration of 10 years is considered health-protective for military personnel because it represents a maximum site-specific value from a population whose most likely duration was noted to be 2.5 years. The exposure duration of 10 years is also considered relevant to potential civilian industrial exposures at Edwards AFB for the following reasons. First, an exposure duration of 10 years is consistent with the USEPA (1997) *Exposure Factors Handbook*, which recommends that 6.6 years represent the occupational tenure for working men and women 16 years of age and over. Second, it can be assumed that most industrial positions at Edwards AFB are either technical, administrative, service, or production oriented. According to the *Exposure Factors Handbook*, these occupational groups have an occupational tenure of 9.6, 6.9, 5.4, and 9.3 years respectively.

Ecological Risk

The SERA identified several potential wildlife receptors that were either present at Site 36 or had access to Site 36 chemicals of potential ecological concern (COPECs). The findings of the predictive

ecological risk assessment (PERA, Tetra Tech 2004) suggest that COPECs at Site 36 pose a potential risk to certain receptor groups for exposure to lead and mercury via soil and certain organics (methylene chloride and toluene) via inhalation of soil vapor. However, the potential risks to some of these receptor groups may be of limited ecological significance given the moderate quality of the habitat, the small site area, the low likelihood of threatened or endangered species, and the ability for receptors to recover.

Note that perchlorate data were not available at the time of the SERA and thus ecological risks due to the residual perchlorate contamination following the 2004 IRA was not evaluated. As described in Section 2.5.2.6, implementation of the selected remedy at Site 36 will involve excavation and off-site disposal of perchlorate in surface and near-surface soil at concentrations above the residential PRG of 7.8 mg/kg. Additionally, the excavated soil will be replaced with clean backfill leaving little exposure potential for the animals and shallow rooted plants likely to be found on site. Therefore, following remedy implementation, perchlorate in soil will not pose a significant risk to ecological receptors.

Threat to Groundwater and Surface Water

Perchlorate-laden wastewater from leaks in the Site 36 wastewater evaporation tank has previously impacted underlying groundwater. However, future discharges of perchlorate to the groundwater, and significant leaching of perchlorate to the surface water (i.e., stormwater runoff) are not reasonably expected for the following reasons:

1. To ensure that no further wastewater discharges occur at Site 36, the leaking wastewater evaporation tank and all associated piping were removed (see IRA activities above). This action removed the primary mechanism for the leaching of contaminants remaining in soil or bedrock into the groundwater. Therefore, provided there are no artificial discharges of water (i.e., non-rainwater) to the surface or subsurface, the groundwater at Site 36 is at low risk for further contamination by perchlorate.

2. Surface water is present at Site 36 only briefly during storm events; no permanent standing water is found on site.

3. Site 36 is located in a dry, high-desert climate zone with low annual precipitation (approximately 5 inches per year) and a high rate of evapotranspiration (approximately 95 percent). Therefore, even if water could pool on site, only approximately 0.25 inches of annual rainfall would be available for potential infiltration of the soil.

4. The steep terrain ensures that the ground is well drained, leaving no opportunities for pooling of rainwater at the site. This ensures that only a small fraction of precipitation infiltrates the upper soil zone, with most of the water rapidly flowing off site.

5. Because the site is located near the crest of Leuhman Ridge, there is very little up-slope ground area over which rain can collect into sheet flow. Existing drainage swales, located along the access road upslope of the site, channel what little surface flow does form away from Site 36.

6. Assuming approximately 90 cubic yards of impacted soil (weighing 1,200 kg per cubic yard), and an average perchlorate concentration of 56 mg/kg, the mass of perchlorate trapped in the soil is estimated at only 6 kg.

7. A study of the potential for migration of perchlorate to groundwater via the infiltration of natural precipitation was conducted at Site 285, OU5 - Occupied North Base (Earth Tech 2003b). The study concluded, "…if water below the rooting zone is actually moving downward at all, it is moving very slowly. More specifically, under current natural site and climatic conditions, it is estimated that it would take at least 2,400 years for precipitation, and thus dissolved perchlorate, to migrate downward from the base of the root zone and reach groundwater at 125 feet bgs." The conditions at Site 285 are more favorable for rainwater infiltration (i.e., relatively flat-lying ground surface and permeable soil from the surface to the groundwater) than those found at Site 36.

The current perchlorate contamination in groundwater below Site 36, and future impact (if any) from residual bedrock contamination, is being addressed as part of the remedial action for the AFRL Arroyos area.

2.5.2.5 Remedial Action Objectives

The RAOs for Site 36 are:

1. Prevent exposures (ingestion) by hypothetical residential receptors and biota to soil containing perchlorate at concentrations that yield a residential HI greater than 1.

2. Prevent exposure (ingestion) by industrial receptors to soil containing perchlorate above the site-specific risk-based industrial exposure level (industrial HI greater than 1).

3. Prevent exposure to potentially hazardous bedrock by construction workers.

4. Limit the potential for leaching of perchlorate from the soil by surface water.

2.5.2.6 Description of Alternatives

As described in the *Soil and Debris Sites FS*, the Air Force evaluated numerous remedial strategies to manage and/or clean up the perchlorate contamination in soil and bedrock at Site 36. After an initial screening of available technologies, four remedial alternatives were developed for detailed evaluation. Estimated costs for each alternative are presented in Table 2.5-4.

Table 2.5-4. Site 36 Remedial Alternatives Cost Breakdown

Remedial Alternatives (Selected Remedy Shown in Bold)	Unadjusted Cost	Escalated Cost	Present Value Cost
Alternative 1 – No Action Scenario	$0	$0	$0
Alternative 2 – LUCs			
Administrative Controls (recurring annual costs in Years 1 to 30)	$69,000	$100,000	$46,000
Gate and Signs (capital cost in Year 1)	$1,000	$1,000	$1,000
	$70,000	$101,000	$47,000
Alternative 3 – Excavation with Off-Site Disposal and LUCs			
Administrative Controls (recurring annual costs in Years 1 to 30)	$69,000	$100,000	$46,000
Excavation with Off-Site Disposal (capital cost in Year 1)	$54,000	$54,000	$54,000
	$123,000	**$154,000**	**$100,000**
Alternative 4 – Capping with LUCs			
Administrative Controls (recurring annual costs in Years 1 to 30)	$69,000	$100,000	$46,000
Gate and Signs (capital cost in Year 1)	$1,000	$1,000	$1,000
Install Cap (capital cost in Year 1)	$58,000	$58,000	$58,000
	$128,000	$159,000	$105,000
Annual Cost Beyond Year 30 (LUCs)	$2,000	-	-

Notes:

Escalation factors from RACER Software. Present value based on a 3% discount factor. All costs rounded to nearest $1,000.

Alternative 1 – No Action

As required by the NCP, the no action alternative is listed only to compare to other alternatives. No remedial action would be taken at Site 36.

Alternative 2 – Land Use Controls

Because the surface soil remaining at Site 36 contains perchlorate at concentrations below the industrial site-specific, risk-based exposure level for perchlorate (204 mg/kg), no further action is needed to meet RAO No 2. However, because perchlorate is present in the soil above the residential exposure limit

(7.8 mg/kg), and likely present (at unknown concentrations) in the underlying bedrock, engineering controls and administrative LUCs would be used to meet RAO Nos. 1, 3, and 4.

Engineering Controls

As described for Alternative 3 (below), a locked cable gate would be used to control vehicle access, and warning signs would be posted around the site.

Administrative LUCs

Because contamination within the underlying fractured granitic bedrock will be left in place, LUCs would be needed to ensure that future construction crews do not drill or excavate at this site without proper precautions.

The specific LUCs for Site 36 under this remedy are as follows:

1. Consistent with RAO No. 1, the land within the LUC boundary would be used only for industrial purposes, and not for residential, commercial, or agricultural uses; access to the site by residential receptors would be prohibited.

2. Consistent with RAO No. 2, access to the site by AFRL workers would not be restricted since residual levels of perchlorate in the surface soil are below the site-specific risk-based industrial exposure level of 204 mg/kg.

3. Consistent with RAO No. 3, activities that would expose construction workers to the potentially contaminated bedrock would be authorized only for individuals who (1) are involved in authorized activities; (2) are trained in hazardous waste operations; and (3) are wearing appropriate PPE. No construction of buildings or other inhabited structures would be permitted within the LUC boundary.

4. Consistent with RAO No. 4, existing drainage swales upslope of Site 36 (see Figure 2.5-4) would be maintained to minimize the rainwater that directly contacts the site. Discharge of water to the surface and/or subsurface at Site 36 would be prohibited.

Further discussion of these LUCs, including the means for implementation and documentation, is presented in Section 2.8.1 – LUCs General Provisions.

Alternative 3 – Excavation and Off-Site Disposal with Land Use Controls (Selected Remedy)

Alternative 3 combines excavation (and off-site disposal) of surface soil with LUCs to meet the RAOs listed in Section 2.5.2.5 as follows:

Excavation with Off-Site Disposal

As stated for Alternative 2, the perchlorate concentrations in the Site 36 surface soil are already below the site-specific risk-based, industrial exposure limit of 204 mg/kg; therefore, no further action is needed to meet RAO No. 2. However, to prevent unacceptable exposures to hypothetical future residential receptors and biota (RAO No. 1), excavation and off site disposal of surface soil at perchlorate concentrations that yield an HI above 1 (7.8 mg/kg) will be conducted. As described in Section 2.5.2.2 (Nature and Extent of Residual Site Contamination), perchlorate concentrations in three soil samples collected following the IRA exceeded the 7.8 mg/kg standard for perchlorate, in an area encompassing approximately 0.2 acres (see Figure 2.5-4). Assuming a maximum excavation depth of 3 feet (weathered bedrock contact), this represents a total of approximately 40 to 50 cubic yards of excavated soil. The minimum area of excavation is shown in red on Figure 2.5-4.

Because it is anticipated that contamination of the shallow unsaturated bedrock extends all the way to the groundwater (140 feet bgs), "chasing" the contaminant below the bedrock contact will not be practical. The small equipment capable of accessing the steep terrain at Site 36 will not be adequate for excavating bedrock. Therefore, LUCs (described below) will be needed to manage the perchlorate left in the bedrock.

Following excavation, samples will be collected from the bedrock surface and analyzed for perchlorate before backfilling with imported clean fill. The excavated soil will be stored temporarily in roll-off bins, and any waste (decontamination) water will be stored in 55-gallon drums. Once sampling for waste characterization is complete and results are received, the soil and wastewater will be manifested and shipped off-site at the direction of the Edwards AFB point of contact. Only a state-licensed TSDF will be selected as the disposal location with preference given to facilities with soil recycling capabilities.

Engineering Controls

In support of RAO No. 3, a locked chain or cable barrier will be used to control vehicle access via the dirt path leading to the site (see Figure 2.5-4). Additionally, signs warning of the potential health hazards will be posted on the gate, at the former tank location, and at the entrances for the principal

foot access pathways to the site. The signs will also state that access and construction must first be approved by designated base personnel.

Administrative LUCs

Because contamination within the underlying fractured granitic bedrock will likely be left in place, LUCs will be needed to ensure that future construction crews do not drill or excavate at this site without proper precautions (RAO No. 3). The boundary of these LUCs (shown in orange on Figure 2.5-4) encompasses a circular area (0.4 acres in size) centered on the former wastewater evaporation tank. The vertical component of the LUC boundary extends from the surface to the maximum anticipated excavation depth of 12 feet. It is anticipated that the bedrock and groundwater below Site 36 will be subject to LUCs as part of the forthcoming remedy for the AFRL Arroyos area.

The specific LUC objectives for Site 36 (Alternative 3) are as follows:

1. Although the post-excavation surface soil will pose a residential HI less than 1 (consistent with RAO No. 1), the potentially hazardous bedrock is near the surface (less than 3 feet bgs). Therefore, to be conservative, the land within the LUC boundary will be used only for industrial purposes, and not for residential, commercial, or agricultural uses; access to the site by residential receptors will be prohibited.

2. Consistent with RAO No. 2, access to the site by AFRL workers would not be restricted since residual levels of perchlorate in the surface soil are below the site-specific risk-based industrial exposure level of 204 mg/kg.

3. Consistent with RAO No. 3, activities that would expose construction workers to the potentially contaminated bedrock will be authorized only for individuals who (1) are involved in authorized activities; (2) are trained in hazardous waste operations; and (3) are wearing appropriate PPE. No construction of buildings or other inhabited structures will be permitted within the LUC boundary.

4. Discharge of water to the surface and/or subsurface at Site 36 will be prohibited and existing drainage swales upslope of Site 36 (see Figure 2.5-4) will be maintained to minimize the rainwater that directly contacts the site (RAO No. 4).

Further discussion of these LUCs, including the means for implementation and documentation, is presented in Section 2.8.1 – LUCs General Provisions.

Alternative 4 – Capping with Land Use Controls

As with Alternative 2, this alternative would leave perchlorate-contaminated soil and bedrock in place. However, to further reduce the potential for impact to surface water and groundwater (RAO No. 4), a cap would be built over the site. The cap would consist of a flexible membrane liner "sandwiched" between a leveling layer of clean soil and a base layer of crushed rock. The top of the cap would be surfaced with a low-maintenance layer of asphalt. Given the steep terrain at Site 36, only the area immediately adjacent to the former tank location can be accessed by construction equipment. Therefore, the cap would be limited in size to an approximate 30-foot diameter.

The LUCs needed for this alternative would be similar to those for Alternative 3, but would also include long-term maintenance of the cap to ensure its protectiveness.

2.5.2.7 Comparative Analysis of Alternatives

The comparative analysis of the alternatives for Site 36 is presented in Table 2.5-5.

Table 2.5-5. Comparative Analysis of Alternatives – Site 36

KEY L – Low M – Medium H – High NA – Not applicable NPC – No public comments received	Threshold Criteria		Balancing Criteria					Modifying Criteria	
Evaluation Criteria	Overall protection of human health and the environment	Compliance with ARARs	Long-term effectiveness and permanence	Reduction of toxicity, mobility, or volume through treatment	Short-term effectiveness	Implementability	Escalated cost (Years 1 through 30)	Public acceptance	State/Support Agency acceptance
1. No Action	L	NA	NA	NA	NA	NA	NA	NA	NA
2. LUCs	H	H	M	L	H	H	$101K	NPC	M
3. Excavation with Offsite Disposal (Selected Remedy)	H	H	H	H	H	M-H	$154K	NPC	H
4. Capping with LUCs	H	H	M-H	M	H	M-H	$159K	NPC	H

Alternative 1 does not meet the threshold criterion of being protective of human health and the environment and was therefore eliminated from further consideration. Alternatives 2 through 4 meet

both threshold criteria (see Section 2.5.2.10) and were therefore evaluated against the five balancing criteria as follows.

Alternative 2 rates high on implementability and short term effectiveness because it requires only minor construction, with little potential for construction worker exposure to perchlorate during implementation. Long-term effectiveness and permanence are rated at medium because even though surface soil at Site 36 meets site-specific risk-based exposure standards for perchlorate under the current industrial-only land use scenario, additional action would be required for the site to be used for hypothetical (i.e., not planned in the foreseeable future) residential purposes. Reduction of toxicity, mobility, or volume of contaminants through treatment are rated low because perchlorate would remain in soil, untreated, with no reduction in mobility to surface water or groundwater.

Alternative 3 rates medium to high on implementability, requiring moderately-difficult excavation on a steep hillside. Short-term effectiveness is rated high because exposures to perchlorate by construction workers during implementation will be mitigated through safe work practices and the use of PPE. Long-term effectiveness and permanence, are rated high because soil would meet risk-based exposure standards for perchlorate under the current industrial-only land use scenario, and under any hypothetical future residential scenario. Reduction of toxicity, mobility, or volume of contaminants through treatment rate high because much of the perchlorate-contaminated soil will be excavated and replaced with clean soil.

Alternative 4 rates medium to high on implementability, requiring moderately-difficult construction of a cap on a steep hillside. Short-term effectiveness is rated high because exposures to perchlorate by construction worker during implementation would be mitigated through safe work practices and the use of PPE. Long-term effectiveness and permanence rank medium to high because the cap would require maintenance to ensure long-term protection. Reduction of toxicity, mobility, or volume of contaminants through treatment is rated medium because perchlorate-contaminated soil would not be removed or treated in place, but would be encapsulated to reduce mobility.

2.5.2.8 Principal Threat Wastes

No principal threat wastes have been identified at Site 36.

2.5.2.9 Selected Remedy

The Air Force and USEPA, with concurrence from Cal/EPA DTSC and the Water Board, select Alternative 3 as the final remedy for Site 36.

2.5.2.10 Statutory Determinations

Under CERCLA Section 121 and the NCP, the lead agency must select remedies that meet the threshold criteria of being protective of human health and the environment, and complying with ARARs (unless a statutory waiver is justified). As balancing criteria, the remedies should also be cost effective, and should utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. Section 121(e) of CERCLA, USC Section 9621(e), states that no federal, state, or local permit is required for remedial actions conducted entirely on site; these actions must meet the substantive but not administrative requirements of ARARs. In addition, CERCLA asserts a preference for remedies that employ treatment that permanently and significantly reduces the volume, toxicity, or mobility of hazardous wastes as a principal element, and a bias against off-site disposal of untreated wastes. The following sections discuss how the selected remedy meets these statutory requirements.

Protection of Human Health and the Environment

Alternative 3 is protective in that the surface soil will be suitable for hypothetical residential exposure, and LUCs will be used to restrict access to potentially contaminated bedrock. Additionally, the LUCs provide protection for surface water and groundwater at the site by prohibiting discharges of water.

Compliance with ARARs

Section 121(e) of CERCLA, USC Section 9621(e), states that no federal, state, or local permit is required for remedial actions conducted entirely on site; these actions must meet the substantive but not administrative requirements of ARARs.

Chemical-Specific ARARs. The beneficial uses designated in the *Basin Plan* for minor surface waters in the Antelope Hydrologic Unit and North Muroc Hydrologic Area are relevant and appropriate to the remedy selected for Site 36 (see Appendix B, Table B-1, Item 2); removal of impacted soil from the site and maintenance of the existing drainage swales will support these beneficial uses.

Location-Specific ARARs. Because Site 36 has already been moderately disturbed, and no eligible cultural resources have been identified on site, most state and federal regulations governing the protection of wildlife, historical, or archeological resources are not ARARs. However, because endangered or threatened species are present at the AFRL, and there is a possibility that migrating birds may be present at Site 36, the following are listed as RARs:

- California Endangered Species Act (Table B-1, Item No. 4);
- Federal Endangered Species Act (Table B-1, Item No. 5); and
- Migratory Bird Treaty Act (Table B-1, Item No. 6).

Field activities associated with the selected Site 36 remedy will be coordinated with Base biologists to ensure the protection of sensitive wildlife species.

Action-Specific ARARs. The following action-specific ARAR was identified for Site 36:

- 22 CCR, Div. 4.5, Ch. 39, Section 67391.1 and Civil Code Section 1471 (Table B-1, Item No. 12).

As discussed in Section 2.5.2.6, LUCs are included as part of the selected remedy because suspected perchlorate contamination (likely in excess of the 7.8 mg/kg exposure standard) will be left in the subsurface bedrock at Site 36. In the event of transfer of property that includes the Site 36 LUC boundary to a non-federal entity, a land use covenant with DTSC would be required. Therefore, the cited requirements are relevant and appropriate to the selected remedy.

Disagreement on ARARs. The Air Force and the Water Board do not agree on whether the following Water Board requirements are ARARs for Site 36:

- Specific sections of the *Basin Plan*, including but not limited to:
  - WQOs for non-degradation (page 3-2) and certain of the WQOs for surface waters (page 3-3).
  - Region-wide prohibitions 1 through 3 (found on page 4.1-1). Items 1 and 2 prohibit discharging waste which causes a violation of narrative (including non-degradation) or numeric WQOs while Item 3 prohibits discharging waste which causes further degradation or pollution where a narrative or numeric WQO is already being violated.

- Soil Cleanup Levels (page 4.2-4): "The Regional Board will determine soil cleanup levels for the unsaturated zone based upon threat to water quality… If it is unreasonable to clean up soils to background concentration levels,…site-specific recommendations for soil cleanup levels [may [be] consider[ed]] provided that applicable groundwater quality objectives are met and health risks from surface or subsurface exposure meet current guidelines."

Please see Section 2.8.2 for the individual positions held by the Air Force, the USEPA, and the Water Board regarding analysis of whether these requirements are ARARs.

Notwithstanding the Air Force position that these Water Board requirements are not ARARs for this action, the selected remedy for Site 36 meets the technical requirements of California water quality law, plans, and policies for protection of surface waters (and groundwater) by removal of the perchlorate-impacted soil from the site, maintenance of the existing drainage swales, and prohibiting discharges of surface water. As described in Section 2.5.2.4, the threat to groundwater and surface water is minimal. Moreover, the selected remedy meets the following five exemption criteria cited (on page 4.1-2) by the *Basin Plan* for restoration projects:

- Maintenance of the existing storm water drainage swales and excavation of perchlorate-contaminated soil will reduce or mitigate existing sources of soil erosion, water pollution, or impairment of beneficial uses;
- There is no feasible alternative to the project (i.e., excavation of bedrock is not feasible);
- Land disturbance will be minimized to the area already impacted;
- Maintenance of the existing storm water drainage swales and excavation of perchlorate-contaminated soil will minimize potential adverse environmental impacts; and
- The selected remedy complies with the ARARs identified in Appendix B.

Cost Effectiveness

Although not the lowest cost alternative, the cost of the selected remedy is reasonable considering that the excavation of contaminated surface soil will reduce the mass of contaminants, and is less than twice the cost of the lowest-cost alternative that meets threshold requirements. It should be noted that the cost estimates presented in this ROD include only the first 30 years of remedy implementation. Given the indefinite duration of the LUCs, the total lifecycle costs of the remedy cannot be calculated, but will

likely be greater than the 30-year costs shown. Table 2.5-4 lists an estimate of the unadjusted annual cost of implementing the remedy beyond Year 30.

Utilization of Permanent Solutions and Alternative Treatment Technologies

The selected remedy incorporates a permanent solution (excavation with off-site disposal) for soil contamination at Site 36. Although the potentially contaminated bedrock will remain is place, the protection afforded by the remedy is expected to be effective over the long term provided routine maintenance of the gate and signs is performed, and the LUCs are enforced.

Preference for Treatment as a Principal Element

Because the soil at Site 36 will be excavated and disposed of off-site without treatment, and treatment of perchlorate that is likely to remain in the underlying bedrock is not feasible, the selected remedy does not satisfy the statutory preference for treatment as a principal element of the remedy.

Five-Year Review Requirements

Because the selected remedy will result in hazardous substances, pollutants, or contaminants (perchlorate in bedrock) remaining on-site above levels that allow for unrestricted use and unrestricted exposure (i.e., residential levels), a statutory review will be conducted within 5 years after initiation of the remedial action to satisfy NCP Section 300.430(f)(4)(ii), and at 5-year intervals thereafter, as long as hazardous substances remain at the site at levels that do not allow for unrestricted (residential) uses. Five-year reviews will be conducted in accordance with CERCLA Section 121(c) and are required to determine whether the remedy continues to be protective of human health and the environment.

2.5.2.11 Documentation of Significant Changes from Proposed Plan

In the Proposed Plan, Alternative 2 was identified as the proposed alternative. However, in this ROD, Alternative 3 was selected as the remedy because it provides greater protection of human health than Alternative 2, and includes increased protection of surface water and groundwater. Furthermore, as discussed in Section 2.5.1.11, the present value cost for implementing long-term LUCs at Site 36 was recalculated using a 3 percent discount factor rather than 7 percent, resulting in a present value increase of $15,000 for each alternative that includes LUCs (see Table C-2, Appendix C).

2.5.3 SITE 167 – TEST AREA 1-46 BERYLLIUM FIRING RANGE

2.5.3.1 Site Name, Location, and Brief Description

The Test Area 1-46 Beryllium Firing Range (Site 167) is located along Mars Boulevard, 4 miles southeast of Mercury Boulevard (Figure 2.1-2). Constructed in 1962, Test Area 1-46 includes three test stands (Figure 2.5-6) that have been inactive since the 1970s. The facilities at Test Area 1-46 were specifically designed to test small rocket engines, motors, and components using exotic propellants (especially beryllium).

2.5.3.2 Site History and Enforcement Activities

Site History

Test Stand A at Test Area 1-46 was used for testing both liquid-fueled engines and solid-fueled motors. Test Stand B was constructed to test fuels containing beryllium, hydrazine, aluminum, alcohol, and/or nitrogen tetroxide. Test Stand C was used for testing beryllium-fueled solid rocket motors. Between 1963 and 1966, numerous tests were performed at Test Stand C, with rocket motors fired in the direction of the Beryllium Firing Range. The exhaust cloud contained beryllium oxide, which was deposited on the surface soil.

Two industrial wastewater ponds at Test Area 1-46 originally handled wastewater from Test Stand B, but also may have retained wastewater generated during decontamination of beryllium-contaminated hardware from Test Stand C. The ponds are lined with 4 inches of concrete; and are underlain by a plastic liner, 0.25 inches of clay, and 4 inches of base fill material. After rocket testing was discontinued in the 1970s, the ponds were inactive for a period of approximately 20 years. In 1995, under WDRs issued by the Water Board (Board Order No. 6-95-31), a three-layer leachate control and recovery liner system was added on top of the ponds which were reactivated to accommodate saline wastewater trucked in from a research and development program elsewhere at the AFRL. The ponds are currently not in use, and the above ground liner system has been removed pending rescission of the WDRs. In July 2007, three cores were cut in the bottom of each pond in preparation for sampling of the underling soil for potential contaminants (Earth Tech 2007c).

2,146,300 N

6,671,300 E

EXPLANATION

—x—x— FENCE LINE

SITE 167

SITE 7

MARKERS FOR BERYLLIUM FIRING RANGE

SUB-SURFACE LAND DISPOSAL UNIT

EQUIPMENT BURIAL PIT

DISTURBED AREA

DEBRIS

NEW SITE 167 BOUNDARY AND LIMITS OF LAND USE CONTROLS

DISTURBED AREA

AREA B

AREA A

AREA C

TEST STAND C

OIL WATER SEPARATOR AND PUMP

CONCRETE PAD

INDUSTRIAL WASTEWATER PONDS

TANK STORAGE

TEST STAND B

AREA A

9640

TEST STAND A

6,669,500 E

2,144,100 N

NORTH

0 150 300 FEET

SCALE: 1"= 300'

OUs 4 and 9 Soil and Debris Sites ROD

Site 167 Map Showing Locations of Excavated Areas and Subsurface Land Disposal Unit

Date 5-08	Air Force Research Laboratory Edwards AFB	Figure 2.5-6
Project No. 87503		

EDWARDS\87503\B6586FGA.A01

Site Characterization Sampling

Soil

Because beryllium (from Test Stand C) was deposited as a dust on the ground surface and exhibits low mobility in soil, only surface and near-surface (less than 3 feet deep) sampling was performed. Numerous shallow soil samples were collected between 1993 and 1995 and analyzed for beryllium as well as other elements including metals. Results indicated that beryllium was present in soil at concentrations up to 51 mg/kg, well in excess of the residential (0.14 mg/kg) and industrial (1.1 mg/kg) PRGs published by USEPA Region 9 through 1996, and the AFRL background concentration of 0.9 mg/kg (The Earth Technology Corporation 1995a). However (based on updated toxicity criteria), the USEPA Region 9 has since incrementally raised the residential and industrial PRGs for beryllium to current (as of April 2008) levels of 150 mg/kg and 1,900 mg/kg, respectively. None of the sampling results at Site 167 exceed these revised PRGs. Additionally, none of the other elements (including metals) detected in surface soil at Site 167 exceeded their respective residential PRGs except arsenic, which was not detected above its AFRL background limit. A more comprehensive discussion of RI sampling activities at Site 167 is presented in the *OU4 RI Summary Report* (Earth Tech 2005a). A brief summary of sampling results obtained by Tetra Tech prior to implementing the IRA is included in Section 2.5.3.10 under Compliance with ARARs.

In July 2007, three samples were collected from the native soil immediately below each of the two industrial wastewater ponds. The samples were analyzed for VOCs, SVOCs, elements (including metals), mercury, and common anions including chloride, nitrate, orthophosphate, and sulfate. The only organic compound detected was bis(2-ethylhexyl)phthalate (a common laboratory contaminant) at 0.033 mg/kg, a qualified concentration below the reporting limit of 0.4 mg/kg and well below the residential PRG of 35 mg/kg. No inorganic compounds were detected above residential or industrial PRGs.

Groundwater

Because the approximate depth to groundwater underlying the site is 300 feet bgs, the migration of beryllium (which exhibits low mobility in soil) into groundwater is not considered likely. However, three monitoring wells were installed around the industrial wastewater ponds as required by the WDRs. Groundwater samples were collected in 1995 and analyzed for VOCs, SVOCs, elements (including

metals), alkalinity, chloride, fluoride, hardness, sulfate, and TDS. Beryllium was not detected, and no inorganic COCs were identified in the groundwater. Naphthalene was the only organic compound detected (at 2.9 μg/L, below its notification limit [NL] of 17 μg/L).

In July 2006, the three wells were again sampled for VOCs, SVOCs, elements (including metals), TDS, chloride, and sulfate (Earth Tech 2006b). Although naphthalene was not detected, cis-1,2-DCE and TCE were detected in Well 167-MW01 at J-qualified (estimated) concentrations of 0.64 μg/L and 0.42 μg/L, respectively, well below their MCLs of 6.0 μg/L and 5.0 μg/L. Additionally, acetone and diethyl phthalate (both suspected lab contaminants with no MCLs or NLs) were detected in Well 167-MW01 at J-qualified concentrations of 3.1 μg/L and 2.0 μg/L, respectively. As with the 1995 sampling, beryllium was not detected and no inorganic COCs were identified.

Interim Remedial Actions

Remedial alternatives to reduce the risk of exposure via inhalation to beryllium-contaminated soil and debris at the ground surface were evaluated for Site 167 (and Site 7) in the *Sites 7 and 167 EE/CA* (Tetra Tech 1996). As written, the EE/CA included all the elements required for, and is equivalent to, an FS report. Five remedial alternatives were evaluated: (1) access restrictions including fences and signs, (2) containment via in-situ capping, (3) in-situ treatment, (4) excavation with off-site disposal, and (5) excavation with on-site disposal. Alternative 1 was rejected in preliminary screening because it would not protect human receptors from beryllium contained in airborne dust. Alternative 2 was rejected because, without first condensing the impacted soil, the containment cap would have to be prohibitively large. Alternative 3 was rejected "due to the difficulty in implementing such a measure [technically infeasible], the undemonstrated nature of in-situ treatment for beryllium, and the scattered nature of the contamination which would render this action uneconomical." Following a detailed comparative analysis of the two excavation alternatives (4 and 5), both were found to be adequately protective of human health and the environment, and both would comply with ARARs. However, the on-site disposal option (Alternative 5) was preferred because it was more cost effective and did not involve the added liability of off-site disposal. Subsequently, an action memorandum was prepared and signed, documenting selection of an SLDU as the remedial action for Sites 7 and 167.

Regulatory Determinations in the EE/CA

At the time of the EE/CA, it was determined that the beryllium-contaminated soil and debris met the criteria for designation as a RCRA solid waste under 40 CFR Part 260 and a California hazardous waste under 22 CCR Section 66261.24(a)(8). One small soil/debris pile (approximately 2 cubic yards) also met the criteria for designation as a RCRA hazardous waste under 40 CFR Part 261. The USEPA and State regulators agreed that the risks posed by the waste could be mitigated by removing the exposure pathway (inhalation) through burial, after which the waste would no longer be considered hazardous. The Cal/EPA DTSC further determined that on-site management of the wastes could be handled in a Corrective Action Management Unit (CAMU) under 22 CCR Section 66264.552. The Water Board staff agreed that, once the California hazardous waste criteria were mitigated, the Water Board would accept the handling of beryllium wastes in a similar fashion to the handling (e.g., burial) of asbestos waste (i.e., Water Board requirements for handling of an inert waste as defined under 23 CCR Chapter 15 Section 2524 [now 27 CCR Section 20230]) would apply.

Implementation of the IRA

Tetra Tech (1998) performed a non-time-critical IRA at Site 167 between September and December 1996 that included the excavation of three areas of soil contamination to a minimum depth of 18 inches below grade. The soil was disposed into an SLDU constructed on site. The areas of excavated soil contamination (Areas A, B, and C) and the location of the SLDU are shown on Figure 2.5-6. The burial cell was excavated to a depth of 7 feet bgs with side slopes at a grade of 4:1. The base of the SLDU was excavated into weathered bedrock. Approximately 10,400 cubic yards of soil were excavated at Site 167 and buried in the SLDU. Following confirmation sampling to ensure that target concentrations of 1.1 mg/kg beryllium (the industrial PRG in 1996) were met, all excavated areas were backfilled and revegetated.

The SLDU was also used to dispose of the soil and debris removed during the IRA implemented at Site 7 (refer to Section 2.7.1.2). A pit measuring approximately 14 feet wide, 40 feet long, and 6 feet deep was excavated inside the SLDU near the northwest corner. The pit was used to bury air monitoring equipment formerly stored at Main Base and used during the original beryllium test performed at Site 167. At completion, approximately 80 cubic yards of beryllium testing equipment

and 11,900 cubic yards of contaminated soil (including building debris from Site 7 and debris generated during the reactivation of the industrial evaporation ponds) were placed in the SLDU. The unit was then backfilled to within 2 feet bgs with clean soil, capped with a high-density polyethylene (HDPE) cover to prevent rainwater infiltration, topped with 2 feet of clean soil, and revegetated with native plant species. A 6-foot chain link and barbed wire fence was installed around the SLDU.

Nature and Extent of Residual Site Contamination

Soil

Following completion of the IRA activities, laboratory analysis of soil samples collected from over 170 locations confirmed that beryllium concentrations were below the industrial PRG (for 1996) of 1.1 mg/kg, and well below the current residential and industrial PRGs for beryllium (150 mg/kg and 1,900 mg/kg, respectively). Additionally, soil sampling below the industrial wastewater ponds indicate the containment measures (concrete and plastic liners) prevented impact to the underlying soil. Therefore, no COCs were retained for soil at Site 167, and the SLDU is now considered a non-hazardous waste management unit.

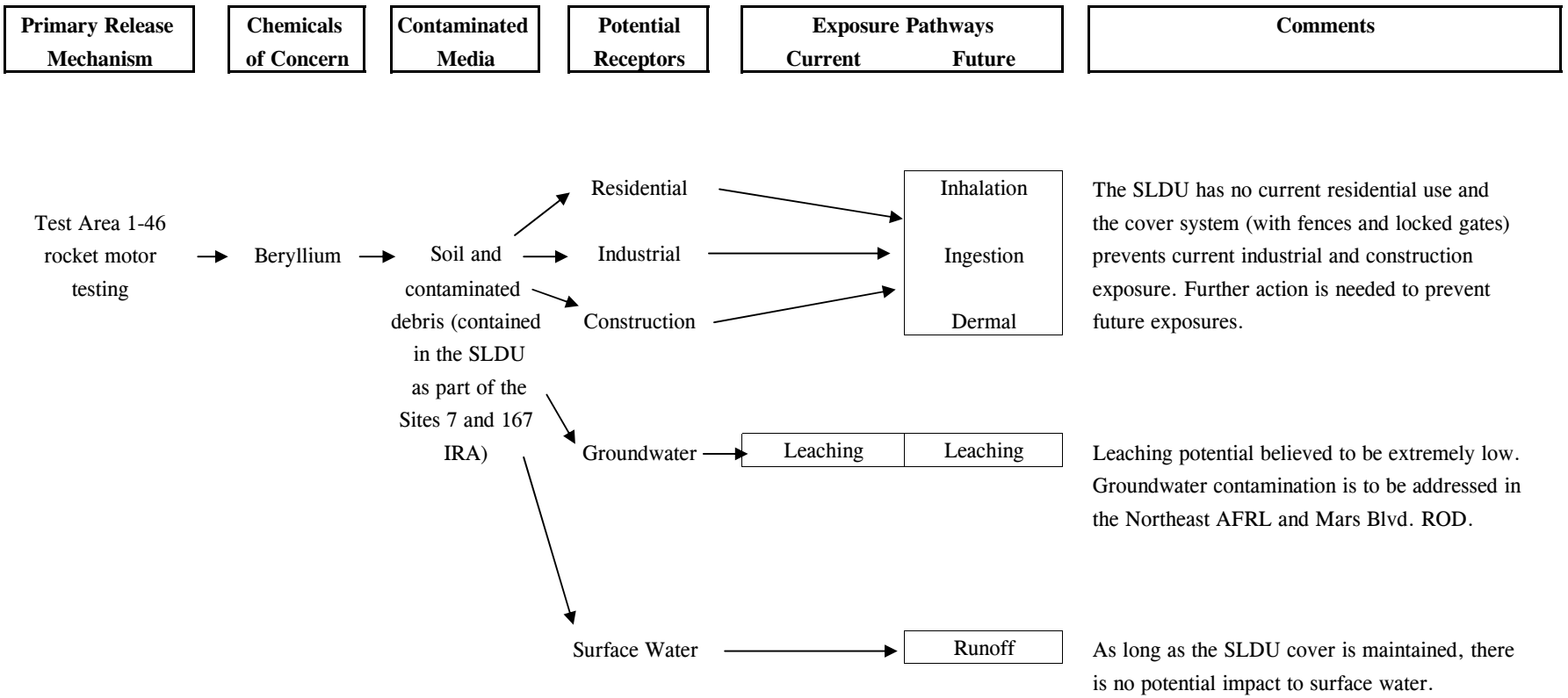
Buried Debris

Beryllium testing equipment and beryllium-contaminated building debris from Site 7 were buried in the Site 167 SLDU. Although buried debris is not known to be hazardous, it is conservatively assumed that contact by humans should be avoided.

Conceptual Site Model

The conceptual site model illustrating the potential exposure pathways for Site 167 is shown on Figure 2.5-7. The SLDU cover system and security measures prevent current exposures by residential, industrial, and construction receptors (and by surface water) to the capped soil and debris. However, further action (i.e., maintenance of cover/fences and LUCs) are needed to prevent future exposures. Due to the insoluble nature of beryllium in its oxide form, the risk of leaching into groundwater that is approximately 200 to 300 feet bgs is extremely low (see Section 2.5.3.4 – Threat to Groundwater and Surface Water).

FIGURE 2.5-7. SITE 167 CONCEPTUAL SITE MODEL - EXPOSURE PATHWAYS



Notes:

→	potentially complete pathway	IRA	interim remedial action
AFRL	Air Force Research Laboratory	ROD	record of decision
Blvd.	Boulevard	SLDU	subsurface land disposal unit

2.5.3.3 Current and Potential Future Land and Resource Uses

According to the *EAFB GP*, the current and anticipated future land uses at Site 167 are test and research (considered industrial for risk assessment purposes); no residential land uses are planned.

2.5.3.4 Summary of Site Risks

Human Health Risk

Because the IRA mitigated the inhalation exposure pathway, risk via exposure to beryllium-contaminated soil at Site 167 was not evaluated in the HHRA. The risk is considered to be acceptable for the following reasons:

1. Beryllium concentrations in confirmation soil samples collected after the IRA did not exceed the background concentration (0.9 mg/kg) established for the AFRL.

2. Both the residential and industrial PRGs for beryllium have been revised upwards by two orders of magnitude since remedial activities were performed at this site. None of the soil samples collected at any time exhibited beryllium concentrations above the revised PRGs.

3. Because the soil piles have been encapsulated in the SLDU, exposure to the beryllium-containing material beneath the cap is not likely to occur.

Because no VOCs were detected in soil, the VIP into indoor air from soil is incomplete and no evaluation of risk via this pathway was conducted. Although the soil at Site 167 poses no risk to human health, the debris (beryllium testing equipment) buried in the SLDU may pose a risk if accidentally exposed by excavation. The risk assessment process could not quantify this risk, but to be conservative, it is assumed that the risk is unacceptable. The risk from groundwater will be addressed in the ROD for the Northeast AFRL and Mars Boulevard areas.

Ecological Risk

The OU4 ERA identified no ecological exposure pathways to be present at Site 167. Therefore, NFEI was recommended, and the site did not proceed to the SERA phase. Potential exposure pathways to ecological receptors via groundwater were not evaluated due to the depth to water at Site 167 well exceeding 25 feet bgs.

Threat to Groundwater and Surface Water

Because the SLDU contains beryllium-contaminated soil and debris, there is the possibility for impact to the groundwater. However, the SLDU cap incorporates a plastic liner that minimizes the potential for infiltration of surface water through the SLDU. Additionally, as previously stated, the groundwater under Site 167 is deep (approximately 300 feet bgs), and beryllium exhibits low mobility in soil. Therefore, the potential for beryllium leaching into groundwater is low. Groundwater quality below Site 167 will be addressed in the ROD for the Northeast AFRL and Mars Boulevard areas. The SLDU cap adequately protects ephemeral surface water (storm runoff); there is no permanent standing water on site.

2.5.3.5 Remedial Action Objective

The RAOs for Site 167 are:

1. Prevent any exposure to the buried soil and debris by residential receptors (no residential use is planned).
2. Prevent exposure to potentially hazardous debris by industrial receptors and construction workers.
3. Limit the potential for leaching of the SLDU contents to the underlying groundwater.

2.5.3.6 Description of Alternatives

Because the *Sites 7 and 167 EE/CA* (Tetra Tech 1996), conducted prior to the IRA at Site 167, met the substantive requirements of an FS, no additional remedial alternatives were evaluated in the *Soil and Debris Sites FS*.

2.5.3.7 Comparative Analysis of Alternatives

Prior to selection and implementation of the SLDU, a comparative analysis of alternatives was presented in the EE/CA. A summary of this comparative analysis is presented in the Site 167 IRA discussion of this ROD.

2.5.3.8 Principal Threat Wastes

No principal threat wastes have been identified at Site 167.

2.5.3.9 Selected Remedy

The Air Force and USEPA, with concurrence from Cal/EPA DTSC and the Water Board, selected the SLDU already in place as the long-term remedy for Site 167. The following discussions detail the various elements of the selected remedy.

NFA is Selected for Soil Outside the SLDU

With the exception of the SLDU, the soil within the original Site 167 boundary now qualifies for unrestricted land use. Therefore, NFA is selected for all soil areas outside the fenced SLDU compound, and the Site 167 boundary is reduced to include only the fenced area (see Figure 2.5-6) within which further action is required. The SLDU cap integrity will be maintained as part of the LUCs discussed below.

Additional Land Use Controls are Selected to Manage Debris in the Site 167 SLDU

Although the Site 167 IRA mitigated risks to human health and the environment outside the SLDU, potentially hazardous beryllium-contaminated debris remains buried in the SLDU. Thus, the protection afforded by the SLDU depends on engineering and administrative LUCs. The existing fence line surrounding the SLDU adequately limits site access by potential receptors. However, signs are needed to warn visitors of potential health risks and to provide a contact phone number.

As shown in orange on Figure 2.5-6, the fence line marks the limits of the LUCs, enclosing an area of approximately 3 acres. The vertical component of the LUC boundary extends from the top of the SLDU cover to a depth of 10 feet, which provides a 5-foot (at minimum) buffer zone below the bottom of the SLDU.

The specific administrative LUCs for Site 167 under this remedy are as follows:

1. Consistent with RAO No. 1, the land within the LUC boundaries will be used only for industrial purposes, and not for residential, commercial, or agricultural (especially food crop) uses; access to the site by residential receptors will be prohibited.

2. Consistent with RAO No. 2, access to the site will be limited to authorized AFRL workers, and no activities that would expose industrial workers to the contents of the SLDU will be permitted without prior authorization from Environmental Management.

3. Consistent with RAO No. 2, intrusive work (i.e., excavation) will only be conducted by construction workers who are trained for work at hazardous sites (current certification), are wearing appropriate PPE as specified in the forthcoming RAWP, and are authorized by Air Force Environmental Management for the specific work activity. No construction of buildings or other inhabited structures will be permitted within the LUC boundaries.

4. Discharges of water to the surface and/or subsurface at Site 167 will be prohibited (RAO No. 3).

5. Annual inspections and maintenance of the engineering controls will be conducted to ensure the long-term integrity of the cover system.

Further discussion of these LUCs, including the means for implementation and documentation, is presented in Section 2.8.1 – LUCs General Provisions.

No Monitoring is Selected for Landfill Gas and Groundwater

The Site 167 SLDU contains only beryllium wastes which do not generate landfill gas when buried. Additionally, the potential for impact to the groundwater from Site 167 contaminants is minimal as described in the Threat to Groundwater and Surface Water section above. Therefore, the SLDU will continue to operate without a DMP for landfill gas or groundwater. Any potential groundwater remedy would be addressed in the forthcoming ROD for the Northeast AFRL and Mars Boulevard areas.

2.5.3.10 Statutory Determinations

Under CERCLA Section 121 and the NCP, the lead agency must select remedies that meet the threshold criteria of being protective of human health and the environment, and complying with ARARs (unless a statutory waiver is justified). As balancing criteria, the remedies should also be cost effective, and should utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, CERCLA asserts a preference for remedies that employ treatment that permanently and significantly reduces the volume, toxicity, or mobility of hazardous wastes as a principal element, and a bias against off-site disposal of untreated wastes. The following sections discuss how the selected remedy meets these statutory requirements.

Protection of Human Health and the Environment

The selected remedy protects human health and the environment by maintaining the cover system that isolates potentially hazardous beryllium-contaminated debris from surface exposures, and by

minimizing the infiltration of stormwater through the SLDU because the cover system incorporates an HDPE plastic sheet barrier. LUCs will prevent unauthorized access to the buried debris present in the site.

Compliance with ARARs

Section 121(e) of CERCLA, USC Section 9621(e), states that no federal, state, or local permit is required for remedial actions conducted entirely on site; these actions must meet the substantive but not administrative requirements of ARARs.

Chemical-Specific ARARs. The beneficial uses designated in the *Basin Plan* for minor surface waters in the Antelope Hydrologic Unit and Lancaster Hydrologic Area are relevant and appropriate to the remedy selected for Site 167 (see Appendix B, Table B-1, Item 2); maintenance of cover at the site will support these beneficial uses.

Location-Specific ARARs. Because the land within the Site 167 fence line has been completely disturbed, most state and federal regulations governing protection of wildlife, historical, and archeological resources are not ARARs. However, because endangered or threatened species are present at the AFRL, the following are listed as RARs:

- California Endangered Species Act (Table B-1, Item No. 4); and
- Federal Endangered Species Act (Table B-1, Item No. 5).

Field activities associated with the selected remedy for Site 167 will be coordinated with Base biologists to ensure the protection of sensitive wildlife species.

Action-Specific ARARs. The following action-specific ARARs were identified as relevant and appropriate for Site 167:

- 22 CCR, Div. 4.5, Ch. 39, Section 67391.1 and Civil Code Section 1471 (Table B-1, Item No. 12).

As discussed in Section 2.5.3.9, LUCs are included as part of the selected remedy because beryllium-contaminated debris is buried inside the SLDU at Site 167. In the event of transfer of property that

includes the Site 167 LUC boundary to a non-federal entity, a land use covenant with DTSC would be required.

- 40 CFR 264.550(b), 264.551(c). (e) and 264.552 (g) – CAMUs (Table B-1, Item No. 15).

In the EE/CA for Site 167 (Tetra Tech 1996), it was determined that the beryllium-contaminated soil and debris met the criteria for designation as a RCRA solid waste under 40 CFR Part 260 and a California (non-RCRA) hazardous waste under 22 CCR Section 66261.24(a)(8). One small soil/debris pile (2 cubic yards) also met the criteria for designation as a RCRA hazardous waste under 40 CFR Part 261. Subsequently, the wastes were consolidated into an on-site SLDU in accordance with 22 CCR, Div. 4.5, Section 66264.552 (State regulations equivalent to the federal CAMU rule adopted in 1993). On 22 January 2002, USEPA published final CAMU amendments, which included "grandfather" regulations in 40 CFR 264.550 and 264.551 for CAMUs approved prior to 22 April 2002. 40 CFR 264.552(g) states that CAMUs in which all wastes have constituent levels at or below remedial levels or goals applicable to the site do not have to comply with various requirements, including groundwater monitoring requirements at paragraph (e)(5).

The wastes inside the Site 167 SLDU meet the characteristics in 40 CFR 264.552(g) based on the fact that (1) the beryllium concentration (219 mg/kg) in only one soil sample (of 146) collected by Tetra Tech at Sites 7 and 167 prior to implementing the IRA exceeded the current residential PRG of 150 mg/kg (and this soil pile is isolated within a pit inside the SLDU); (2) none of the nine miscellaneous samples (wood, concrete, and metal wipe samples) exhibited beryllium concentrations exceeding 3.7 mg/kg; (3) the beryllium waste was demonstrated "to be essentially non-leaching when tested by the USEPA TCLP and California WET methods" (Tetra Tech 1996), and (4) depth to groundwater is approximately 300 feet bgs.

Disagreement on ARARs. The Air Force and Water Board do not agree whether the following SWRQCB requirements are ARARs for Site 167:

- Specific sections of the *Basin Plan*, including but not limited to:
  - WQOs for non-degradation (page 3-2) and certain of the WQOs for surface waters (page 3-3).

- Region-wide prohibitions 1 and 2 (found on page 4.1-1), which prohibit discharging a waste which causes a violation of narrative (including non-degradation) or numeric WQOs.

- Soil Cleanup Levels (page 4.2-4): "The Regional Board will determine soil cleanup levels for the unsaturated zone based upon threat to water quality… If it is unreasonable to clean up soils to background concentration levels,…site-specific recommendations for soil cleanup levels [may [be] consider[ed]] provided that applicable groundwater quality objectives are met and health risks from surface or subsurface exposure meet current guidelines."

Please see Section 2.8.2 for the individual positions held by the Air Force, the USEPA, and the Water Board regarding analysis of whether these requirements are ARARs.

Notwithstanding the Air Force position that these Water Board requirements are not ARARs for this action, the selected remedy for Site 167 meets the technical requirements of California water quality law, plans, and policies for protection of surface waters (and groundwater) by continued maintenance of the SLDU cover, and by prohibiting discharges of surface water. As described in Section 2.5.3.4, the threat to groundwater and surface water is minimal. Moreover, the selected remedy meets the following five exemption criteria cited (on page 4.1-2) by the *Basin Plan* for restoration projects:

- Maintenance of the SLDU cover system will reduce or mitigate existing sources of soil erosion, water pollution, or impairment of beneficial uses;

- There is no feasible alternative to the project (i.e., excavation of the SLDU with offsite disposal is not feasible);

- Land disturbance will be minimized to the already impacted area within the SUDU fence line;

- The SLDU cover system minimizes potential adverse environmental impacts; and

- The selected remedy complies with the ARARs identified in Appendix B.

Cost Effectiveness

The selected remedy represents the lowest cost at which the statutory requirements for Site 167 are met (see Table 2.5-6). However, it should be noted that the cost estimates presented in this ROD include only the first 30 years of remedy implementation. Given the indefinite duration of the selected remedy, the total lifecycle costs of the remedy cannot be calculated, but will likely be greater than the 30-year

costs shown. Table 2.5-6 lists an estimate of the annual unadjusted cost of implementing the remedy beyond Year 30.

Table 2.5-6. Site 167 Selected Remedy Cost Breakdown

Selected Alternative	Unadjusted Cost	Escalated Cost	Present Value Cost
Expand Land Use Controls (LUCs)			
Maintain SLDU Cover (recurring annual costs in Years 1 to 30)	$182,000	$254,000	$123,000
Administrative Controls (recurring annual costs in Years 1 to 30)	$69,000	$100,000	$46,000
	$251,000	**$354,000**	**$169,000**
Annual Costs Beyond Year 30 (LUCs and SLDU maintenance)	$8,000	-	-

Notes:
Escalation factors from RACER Software. Present value based on a 3% discount factor. All costs rounded to nearest $1,000.

Utilization of Permanent Solutions and Alternative Treatment Technologies

The selected remedy does not incorporate permanent solutions or alternative treatment technologies. However, the protection afforded by the remedy is expected to be effective over the long term provided the SLDU is maintained and LUCs are enforced.

Preference for Treatment as a Principal Element

This remedy does not satisfy the statutory preference for treatment as a principal element of the remedy. Permanent removal (i.e., off-site disposal) of 11,900 cubic yards of beryllium-contaminated soil was deemed economically infeasible in the EE/CA.

Five-Year Review Requirements

Because the selected remedy will result in beryllium-contaminated debris remaining in the SLDU potentially above levels that allow for unrestricted use and unrestricted exposure, a statutory review will be conducted within 5 years after initiation of the remedial action to satisfy NCP Section 300.430(f)(4)(ii), and at 5-year intervals thereafter, as long as hazardous substances remain at the site at levels that do not allow for unrestricted (residential) uses. Five-year reviews will be conducted in accordance with CERCLA Section 121(c) and are required to determine whether the remedy continues to be protective of human health and the environment.

2.5.3.11 Documentation of Significant Changes from Proposed Plan

There are no significant changes from the *Soil and Debris Sites PP*. However, as discussed in Section 2.5.1.11, the present value cost for implementing long-term LUCs and SLDU maintenance at Site 167 was recalculated using a 3 percent discount factor rather than 7 percent, resulting in present value increases of $15,000 for LUCs and $43,000 for SLDU maintenance (see Table C-3, Appendix C).

2.5.4 SITE 312 – TEST AREA 1-14 PCB SPILL AREA

2.5.4.1 Site Name, Location, and Brief Description

Site 312 is located in Test Area 1-14 at the crest of the southwestern portion of Leuhman Ridge (Figure 2.1-2). The site includes an electrical substation (Substation 11) located in a paved and fenced area approximately 100 feet northeast of Building 8620, the test area control station (Figure 2.5-8).

2.5.4.2 Site History and Enforcement Activities

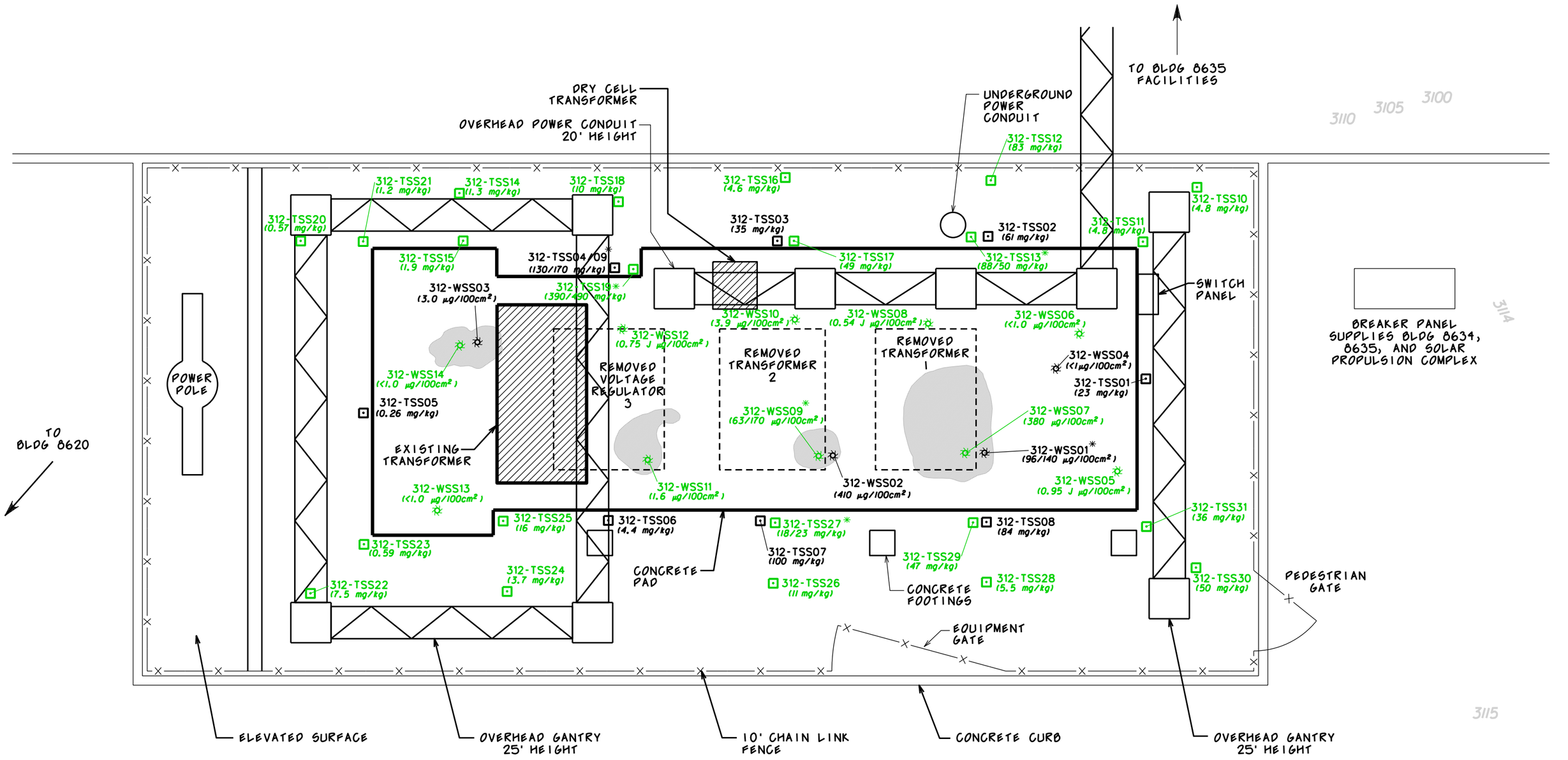
Site History

The substation, originally installed in 1965, formerly housed two electric transformer units and a voltage regulator on a 15-foot by 38-foot concrete pad; all three units utilized oils containing PCBs. The concrete pad is surrounded by a margin of gravel (4 feet to 8 feet wide), beyond which the ground is paved. The gravel is surrounded by a concrete curb that varies in height from 0.5 foot to 2 feet. The curb and pavement north, east, and west of the substation were part of the original construction. However, the pavement south of the substation was added sometime between 1977 and 1992.

In 1991, an estimated 1 pint of PCB oil was spilled onto the concrete pad during the retro-filling of one of the former transformers. Moreover, oil stains formerly visible on the concrete pad indicate that there were likely leaks or spills from all three units.

Site Characterization Sampling

As shown on Figure 2.5-8, three rounds of soil and concrete sampling have been conducted since 1994 at Site 312. Because no PCB contamination outside the substation is considered likely, no coring of the pavement to sample soil outside the substation was conducted. Additionally, given that the depth to



EXPLANATION

- PCB WIPE SAMPLE (6/94)
- PCB WIPE SAMPLE (1/06)
- SURFACE SOIL SAMPLE (3/00)
- SURFACE SOIL SAMPLE (1/06)
- * REPLICATE SAMPLE COLLECTED
- CONCRETE STAINS AS SEEN ON PHOTOS DATED 1994 OR 2000

DATA SHOWN ARE TOTAL PCB CONCENTRATIONS (AROCLOR 1254 + AROCLOR 1260)

µg/100 cm²	MICROGRAMS PER 100 SQUARE CENTIMETERS
mg/kg	MILLIGRAMS PER KILOGRAM
PCB	POLYCHLORINATED BIPHENYL

LABORATORY DATA QUALIFIER

J RESULT IS AN ESTIMATED CONCENTRATION DETECTED BELOW THE REPORTING LIMIT

NORTH

0 2.5 5 FEET

(APPROXIMATE) SCALE: 1"= 5'

OUs 4 and 9 Soil and Debris Sites ROD

Site 312 Map Showing PCB Sampling Results

Date 5-08	Air Force Research Laboratory Edwards AFB	Figure 2.5-8
Project No. 87503		

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groundwater is over 200 feet, and that PCBs exhibit low mobility in soil, groundwater contamination at Site 312 is considered unlikely and was not investigated.

Field Studies Prior to the RI

The Earth Technology Corporation (1995b) conducted an SI at Site 312 in 1994. Five wipe samples were collected from the concrete pad using the "standard wipe testing" protocol according to 40 CFR 761.125. Wipe samples 312-WSS01 (and replicate), 312-WSS02, and 312-WSS03 were collected in stained areas associated with Transformer Units 1 and 2, and the voltage regulator (Unit 3), respectively. Wipe sample 312-WSS04 was collected on the concrete pad north of Transformer Unit 1, in an unstained area. The five wipe samples were analyzed for PCBs. Aroclor 1260, a commercial mixture of PCBs, was detected at concentrations up to 410 μg/100 cm^2. Per 40 CFR Sections 761.125(c)(2)(i) and 761.125(c)(4)(iv), respectively, the TSCA cleanup concentrations for PCBs in concrete are 100 μg/100 cm^2 for industrial use in fenced, outdoor, electric substations (hereafter referred to as "industrial substation" use) and 10 μg/100 cm^2 for unrestricted uses (hereafter referred to as "residential" use).

RI Results

Nine surface soil samples (312-TSS01 through 313-TSS09) were collected from eight locations surrounding the concrete pad in March 2000. A replicate sample (312-TSS09) was collected at the location of Surface Sample 312-TSS04. Soil samples were analyzed for PCBs and for oil and grease.

Aroclor 1260 was detected at a maximum concentration of 170 mg/kg in Sample 312-TSS09. Concentrations exceeded the 2000 residential PRG of 0.22 mg/kg in all nine soil samples, and the industrial PRG (1.0 mg/kg, since lowered to 0.74 mg/kg) in all but one. Per 40 CFR Section 761.125(c)(2)(ii), the TSCA industrial substation limits for soil are 50 mg/kg if signs warning of the PCB hazard are posted, and 25 mg/kg without signs. PCB concentrations in five of the soil samples collected at Site 312 exceeded the 50 mg/kg limit, whereas concentrations in six samples exceeded the 25 mg/kg limit. Per 40 CFR Section 761.125(c)(4)(v), the TSCA limits for residential soil are 1.0 mg/kg PCBs or 10 mg/kg PCBs (if capped with clean soil). Both these standards were exceeded in all soil samples except one.

Oil and grease concentrations (not shown on Figure 2.5-8) in the nine surface soil samples ranged from less than 108 mg/kg in Sample 312-TSS05 to 4,200 mg/kg in Sample 312-TSS07. Only the oil and grease concentration in Sample 312-TSS07 exceeded the 1,000 mg/kg regulatory standard derived from the *Leaking Underground Fuel Tank (LUFT) Field Manual* (California SWRQCB 1989).

Supplemental Site Characterization

During an October 6, 2005 visit to Site 312, it was noted that the oil stains clearly visible on the concrete pad during the 1994 sampling event (and later in 2000 after transformer removal) are no longer visible. The 1994 samples exhibiting PCB contamination were collected from these stained areas. It was suspected that with time and weather, the contaminants associated with oil spillage had partially dissipated. Moreover, previous surface soil samples (from 2000) were collected only adjacent to the concrete pad and did not adequately characterize the lateral extent of the contamination away from the pad.

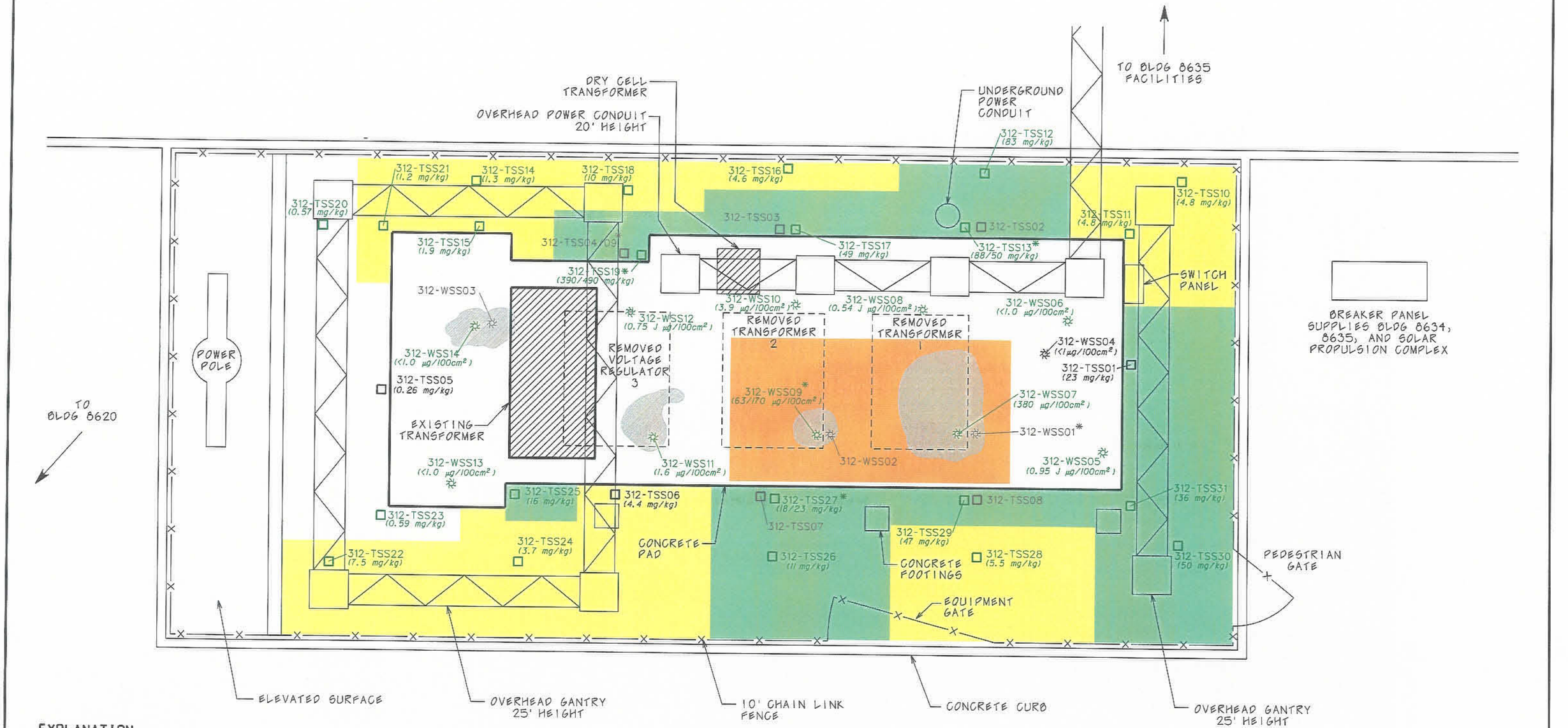
In January 2006, wipe Samples 312-WSS05 through 312-WSS14 (including one replicate) were collected to re-characterize PCB concentrations and distribution in the concrete. To better characterize the lateral extent of contamination, and to confirm PCB concentrations adjacent to the pad, surface soil Samples 312-TSS10 through 312-TSS31 (including three replicates) were collected. Complete results of the supplemental sampling are described in the *Summary Report – Soil and Wipe Sampling for PCBs at Site 312* (Earth Tech 2006c).

Interim Remedial Actions

No IRA or treatability study has been performed for the impacted soil or concrete at Site 312. However, the transformer units and voltage regulator were removed in 1998 and replaced with a single non-PCB transformer. This eliminated a potential source for additional PCB contamination at Site 312.

Nature and Extent of Residual Site Contamination

Figures 2.5-9 and 2.5-10 respectively show how the 2006 sampling results compare with TSCA limits for residential and industrial (substation) land uses (older data are also shown where not superseded by results from 2006 samples). As shown in orange on both figures, approximately 120 square feet of concrete surrounding two of the formerly visible oil stains exhibit PCBs (Aroclor 1260) above TSCA



EXPLANATION

- ✲ PCB WIPE SAMPLE (6/94)
- ✲ PCB WIPE SAMPLE (1/06)
- □ SURFACE SOIL SAMPLE (3/00)
- □ SURFACE SOIL SAMPLE (1/06)
- * REPLICATE SAMPLE COLLECTED
- CONCRETE STAINS AS SEEN ON PHOTOS DATED 1994 OR 2000

DATA SHOWN ARE TOTAL PCB CONCENTRATIONS (AROCLOR 1254 + AROCLOR 1260). ONLY LATEST AVAILABLE DATA AS OF JANUARY 2006 ARE SHOWN.

- PCBs IN SOIL EXCEED TSCA LIMIT OF 1.0 mg/kg (RESIDENTIAL USE; NO CAP)
- PCBs IN SOIL EXCEED TSCA LIMIT OF 10 mg/kg (RESIDENTIAL USE WITH CAP)
- PCBs IN CONCRETE EXCEED TSCA LIMIT OF 10 µg/100 cm² (RESIDENTIAL USE)

µg/100 cm² MICROGRAMS PER 100 SQUARE CENTIMETERS
mg/kg MILLIGRAMS PER KILOGRAM
PCB POLYCHLORINATED BIPHENYL
TSCA TOXIC SUBSTANCES CONTROL ACT

LABORATORY DATA QUALIFIER

J RESULT IS AN ESTIMATED CONCENTRATION DETECTED BELOW THE REPORTING LIMIT

NORTH

0 2.5 5 FEET
(APPROXIMATE)
SCALE: 1"= 5'

OUs 4 and 9 Soil and Debris Sites ROD

Site 312
2006 PCB Sampling Data Compared to Residential TSCA Limits

Date 5-08	Air Force Research Laboratory Edwards AFB	Figure 2.5-9
Project No. 87503		

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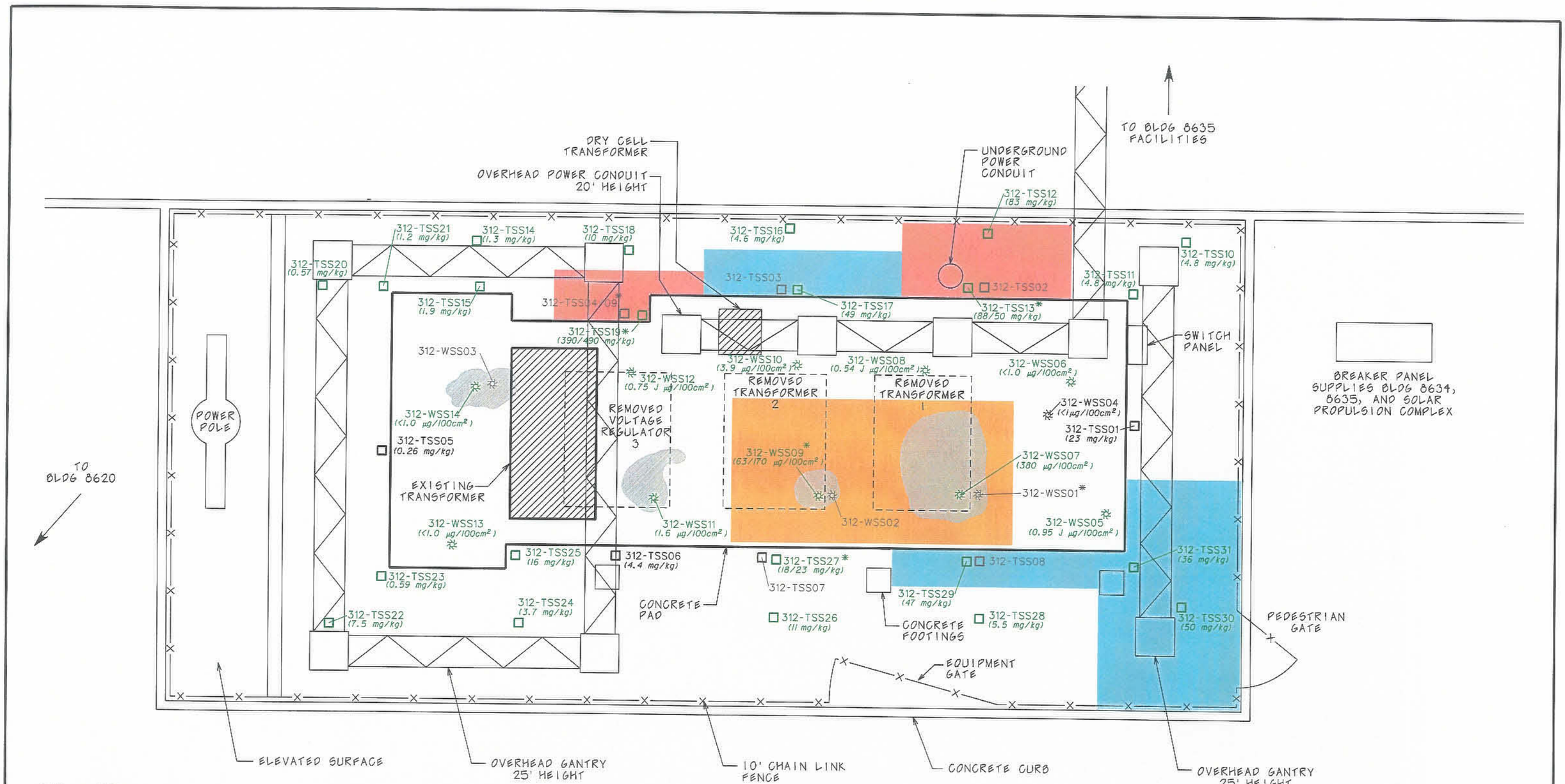


EXPLANATION

- ✲ PCB WIPE SAMPLE (6/94)
- ✲ PCB WIPE SAMPLE (1/06)
- □ SURFACE SOIL SAMPLE (3/00)
- □ SURFACE SOIL SAMPLE (1/06)
- * REPLICATE SAMPLE COLLECTED
- CONCRETE STAINS AS SEEN ON PHOTOS DATED 1994 OR 2000

DATA SHOWN ARE TOTAL PCB CONCENTRATIONS (AROCLOR 1254 + AROCLOR 1260). ONLY LATEST AVAILABLE DATA AS OF JANUARY 2006 ARE SHOWN.

- PCBs IN SOIL EXCEED TSCA LIMIT OF 25 mg/kg (FENCED INDUSTRIAL SUBSTATIONS, NO SIGNS)
- PCBs IN SOIL EXCEED TSCA LIMIT OF 50 mg/kg (FENCED INDUSTRIAL SUBSTATIONS WITH SIGNS)
- PCBs IN CONCRETE EXCEED TSCA LIMIT OF 100 µg/100 cm² (FENCED INDUSTRIAL SUBSTATIONS)

µg/100 cm²	MICROGRAMS PER 100 SQUARE CENTIMETERS
mg/kg	MILLIGRAMS PER KILOGRAM
PCB	POLYCHLORINATED BIPHENYL
TSCA	TOXIC SUBSTANCES CONTROL ACT

LABORATORY DATA QUALIFIER

J	RESULT IS AN ESTIMATED CONCENTRATION DETECTED BELOW THE REPORTING LIMIT

NORTH

0 2.5 5 FEET

(APPROXIMATE) SCALE: 1"= 5'

EDWARDS\87503\B6589FGA.A01

OUs 4 and 9 Soil and Debris Sites ROD

Site 312 2006 PCB Sampling Data Compared to Industrial TSCA Limits

Date	Project No.		Figure
5-08	87503	Air Force Research Laboratory Edwards AFB	2.5-10

limits for both residential (10 μg/100 cm^2) and industrial (100 μg/100 cm^2) uses. Over the entire concrete pad, PCB concentrations ranged from below the reporting limit of 1.0 μg/100 cm^2 in six samples to a maximum of 380 μg/100 cm^2 at 312-WSS07. As shown in both yellow and green on Figure 2.5-9, approximately 660 square feet of soil (or 73 cubic yards assuming a depth to bedrock of 3 feet) exhibit total PCBs (largely Aroclor 1260 with trace amounts of Aroclor 1254) in excess of the 1.0 mg/kg TSCA limit for residential use. Of this total area, approximately 275 square feet (shown only in green) also exhibit total PCBs in excess of the 10 mg/kg TSCA limit for capped residential use. As shown in both red and blue on Figure 2.5-10, approximately 150 square feet of soil (or 17 cubic yards) exhibit total PCBs in excess of the 25 mg/kg TSCA limit for industrial substation use without warning signs. Of this total area, approximately 50 square feet (shown only in red), also exhibit total PCBs in excess of the 50 mg/kg TSCA limit for industrial substation use with warning signs posted. Total PCB concentrations throughout the substation ranged from 0.57 mg/kg in Sample 312-TSS20 to 490 mg/kg in Sample 312-TSS19. Given that the substation is surrounded by concrete curbing (see Section 2.5.4.2), and that PCBs exhibit low mobility in soil, it is unlikely that PCB contamination extends beyond the substation fence line. PCBs are the only COCs retained for soil and concrete at Site 312 (Table 2.5-7).

Conceptual Site Model

The conceptual site model illustrating the potential exposure pathways for Site 312 is shown on Figure 2.5-11. There are no potentially complete exposure pathways to current residential (hypothetical) or industrial receptors; however, further action is required to prevent future exposures to PCBs in soil via the inhalation, ingestion, or dermal pathways. Similar exposures are possible by current or future construction workers. Due to its low mobility in soil, the risk of leaching into groundwater that is approximately 200 feet bgs is extremely low (see Section 2.5.4.4 – Threat to Groundwater and Surface Water). The concrete curbing around the substation prevent surface water runoff through the site.

2.5.4.3 Current and Potential Future Land and Resource Uses

According to the *EAFB GP*, the current and anticipated future land uses at Site 312 are test and research; there are no residential land uses planned. These land uses are considered industrial for risk assessment purposes.

TABLE 2.5-7. SITE 312 CHEMICALS OF CONCERN

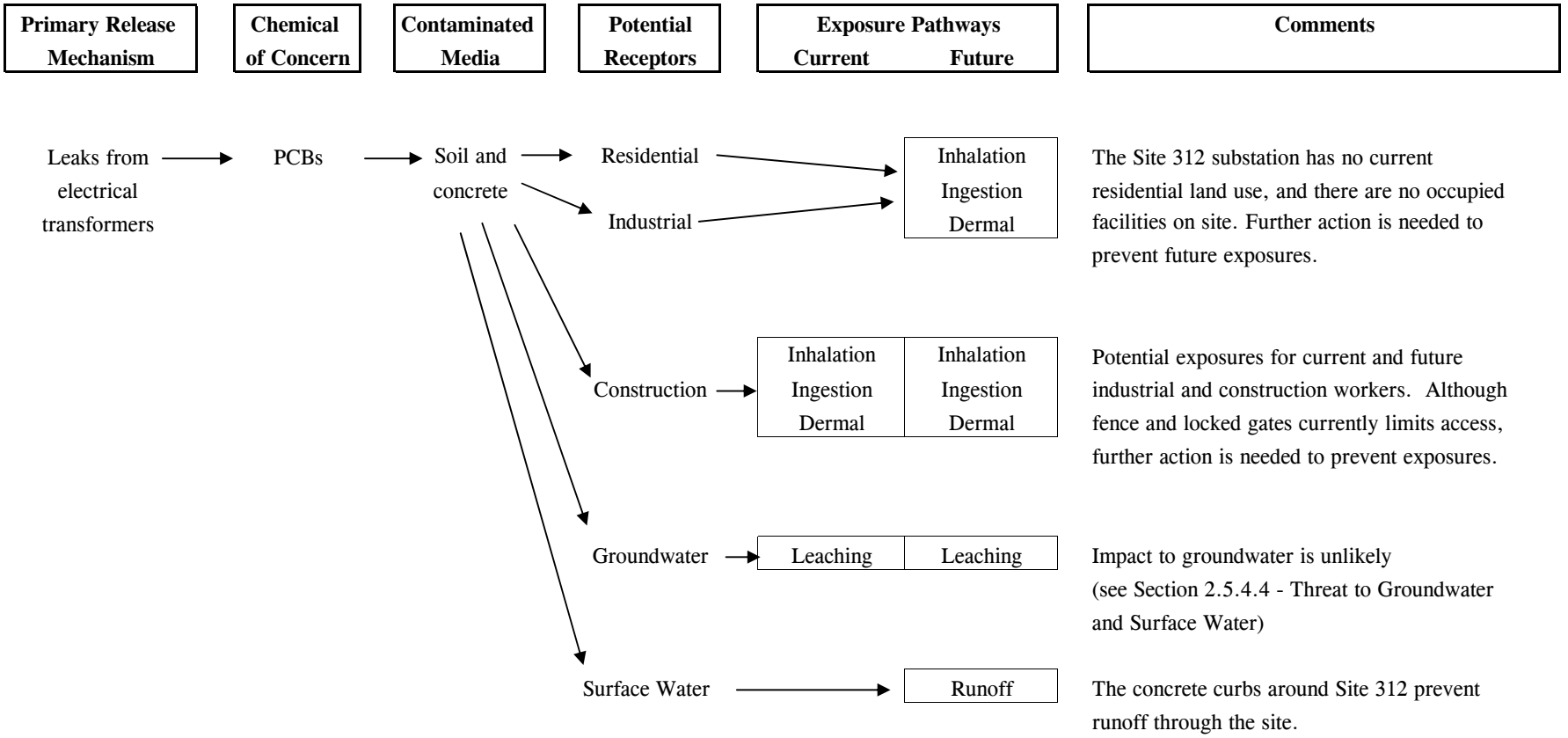
Chemicals of Concern	Maximum Detected Concentration	Current Cancer Risk	Basis for Listing as a Chemical of Concern	Selected Residential Cleanup Standard[1]	Cancer Risk at Cleanup Standard
Soil					
Total PCBs (Aroclor 1254 and Aroclor 1260)	490 mg/kg	2.21×10^{-3} (Res.) 6.62×10^{-4} (Ind.)	Exceeds residential and industrial PRGs[2] and TSCA cleanup goals for both residential and industrial substation use. Residential and industrial cancer risks exceed threshold criterion of 1×10^{-6}.	1.0 mg/kg	4.51×10^{-6} (Res.)[3] 5.95×10^{-7} (Ind.)[4]
Concrete					
Total PCBs (Aroclor 1260)	410 μg/100 cm^2	Not quantified[5]	Exceeds TSCA cleanup goals for both residential and industrial substation use.	10 μg/100 cm^2	Not quantified[6]

Notes:

(1) Standard based on TSCA Residential Cleanup Goal.
(2) United States Environmental Protection Agency Region 9 preliminary remediation goals (USEPA 2004).
(3) The residential risk (based on the USEPA Region 9 residential PRG) was calculated per methodology presented in Section 4 of the Site 312 Human Health Risk Assessment (Earth Tech 2004), using the TSCA cleanup goal (1.0 mg/kg) as the maximum concentration.
(4) The industrial risk (based on site-specific exposure criteria) was calculated per methodology presented in Section 5 of the Site 312 Human Health Risk Assessment (Earth Tech 2004), using the TSCA cleanup goal (1.0 mg/kg) as the maximum concentration.
(5) Qualitatively assumed to exceed 10^{-5} risk.
(6) Qualitatively assumed to be near 10^{-6} USEPA point of departure.

μg/100 cm^2	micrograms per 100 square centimeters
Ind.	industrial
mg/kg	milligrams per kilogram
PCBs	polychlorinated biphenyls
PRG	preliminary remediation goal
Res.	residential
TSCA	Toxic Substances Control Act

FIGURE 2.5-11. SITE 312 CONCEPTUAL SITE MODEL - EXPOSURE PATHWAYS



Notes:

→ potentially-complete pathway

PCBs polychlorinated biphenyls

2.5.4.4 Summary of Site Risks

Human Health Risk

Following collection of the supplemental samples in 2006, a preliminary evaluation of risk to human health at Site 312 from potential exposure to total PCBs in soil was performed using the USEP Region 9 PRGs (there are no risk-based criteria for oil and grease). For the industrial and construction pathways, detailed (site-specific) risk estimates were also derived. Results of the preliminary and detailed evaluations (Table 2.5-8) were an estimated carcinogenic risk of 2×10^{-3} for the hypothetical residential, 3×10^{-4} for the industrial, and 1×10^{-5} for the construction worker exposure pathways. Because the active substation is regulated as a PCB site under promulgated sections of TSCA, risk assessment criteria for land use were not used to establish cleanup levels. For comparison purposes only, the site-specific Aroclor 1260 concentration corresponding to a cancer risk of 1×10^{-6} is 2.5 mg/kg, and the concentration corresponding to a risk of 1×10^{-4} is 250 mg/kg.

Groundwater contamination is not suspected at Site 312 and no VOCs were detected in the soil. Therefore, no evaluations of risk via groundwater exposure or via soil vapor intrusion into indoor air were conducted.

Ecological Risk

The OU4 pre-scoping ERA identified no ecological exposure pathways to be present at Site 312. Therefore, NFEI was recommended, and the site did not proceed to the SERA phase.

Threat to Groundwater and Surface Water

Given that the depth to groundwater at Site 312 is over 200 feet, and that PCBs exhibit low mobility in soil, groundwater contamination at Site 312 is considered unlikely and was not investigated. Because the selected remedy involves removal of PCBs to residential use levels (see Section 2.5.4.6 – Alternative 3), the potential for future impact to groundwater is even lower. Impact to surface water is not likely in that (1) the substation is surrounded by concrete curbs that prevents storm runoff through Site 312; (2) there is no standing water present on site; and (3) the low mobility of PCBs limit the potential for leaching.

TABLE 2.5-8. QUANTIFICATION OF RISKS IN SOIL - SITE 312

Analyte	Maximum Detected Concentration	Residential PRG[1]		Industrial PRG[1]		Residential Risk and Hazard Index		Industrial Risk and Hazard Index	
						Carcinogens	Noncarcinogens	Carcinogens	Noncarcinogens
Organic Analytes (mg/kg)									
Total PCBs (Aroclor 1254 + Aroclor 1260)	4.90E+02	2.22E-01	c	7.40E-01	c	2.21E-03	NA	6.62E-04	NA
Total Risk and Hazard Index Quantification for Constituents in Soil[2]						2.21E-03	NA	6.62E-04 (2.91E-04)[3]	NA

	Carcinogens	Noncarcinogens
Total Construction Worker Risk and Hazard Index Quantification for Constituents in Soil[4]	9.93E-06 (1.26E-05)[3]	NA

Notes:

[1] United States Environmental Protection Agency Region 9 preliminary remediation goals (USEPA 2004).

[2] 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.

[3] Results of the detailed risk assessment using site-specific exposure criteria.

[4] Calculated as the product of 0.015 and the industrial risk, and 0.384 and the industrial hazard (Earth Tech 2004).

c Indicates that chemical is evaluated based on its carcinogenic potential.

mg/kg milligrams per kilogram
NA not applicable
PCBs polychlorinated biphenyls

2.5.4.5 Remedial Action Objectives

The RAOs for Site 312 are:

1. Prevent exposures (inhalation, ingestion, and dermal) by hypothetical residential receptors to soil and concrete containing PCBs above the TSCA exposure limits for residential use.

2. Prevent exposures (inhalation, ingestion, and dermal) by industrial receptors to soil and concrete containing PCBs above the TSCA exposure limits for industrial substation use.

3. Prevent exposure (inhalation, ingestion, and dermal) by construction workers to soil and concrete containing PCBs above the TSCA exposure limits for industrial substation use.

2.5.4.6 Description of Alternatives

As described in the S*oil and Debris Sites FS*, the Air Force evaluated numerous remedial strategies to manage and/or clean up the PCB contamination in soil and concrete at Site 312. After an initial screening of available technologies, three remedial alternatives were developed for detailed evaluation. Estimated costs for each alternative are presented in Table 2.5-9.

Table 2.5-9. Site 312 Remedial Alternatives Cost Breakdown

Remedial Alternatives (Selected Remedy Shown in Bold)	Unadjusted Cost	Escalated Cost	Present Value Cost
Alternative 1 – No Action Scenario	$0	$0	$0
Alternative 2 – Clean for Industrial Substation Use with Warning Signs and Other LUCs			
Administrative Controls (recurring annual costs in Years 1 to 30)	$69,000	$100,000	$46,000
Excavation of Soil with >50 mg/kg PCBs and Removal of Concrete with >100 μg/100 cm^2 (capital cost in Year 1)	$48,000	$48,000	$48,000
	$117,000	$148,000	$94,000
Alternative 3 – Clean for Unrestricted Use; Excavate and Remove Impacted Soil and Concrete			
Excavation of Soil with >1.0 mg/kg PCBs; Removal of Concrete with >10 μg/100 cm^2 PCBs (capital cost in Year 1)	$143,000	$143,000	$143,000
	$143,000	**$143,000**	**$143,000**
Annual Cost Beyond Year 30 (LUCs, Alternative 2 only)	$2,000		

Notes:

Escalation factors from RACER Software. Present value based on a 3% discount factor. All costs rounded to nearest $1,000.

Alternative 1 – No Action

As required by the NCP, the no action alternative is listed only to compare to other alternatives. No remedial action would be taken at Site 312.

Alternative 2 – Cleanup to Industrial Land Use Levels with Warning Signs and other LUCs

This alternative represents the minimum remedial action required under TSCA to allow the continued restricted use of the electrical substation. Excavation and off-site disposal of soil exhibiting PCB contamination above the 50 mg/kg TSCA limit for fenced and signed electric substations would be conducted. Results of the January 2006 soil sampling indicate that approximately 6 cubic yards of soil would require excavation. Following excavation, confirmation samples would be collected from the bottom of the pit(s) before backfilling with imported clean fill. Once sampling for waste characterization is complete and results are received, the excavated soil and any wastewater generated would be shipped off-site to a properly licensed waste-handling facility.

Alternative 2 would also involve cutting the concrete pad and removing for off-site disposal the portions exhibiting surface contamination in excess of the 100 μg/100 cm^2 TSCA limit for industrial substation use. Results of surface wipe samples collected in January 2006 indicate only one area, measuring approximately 120 square feet, requires removal to meet this criterion. Sampling of the soil under the removed concrete would be conducted to assess whether PCBs have migrated through the pad and into the soil. If PCBs are detected above 50 mg/kg, the soil would be excavated with additional sampling to verify contaminant removal.

Engineering controls would include signs placed on the substation's perimeter fencing and gates warning that PCBs are present, and that access must be authorized by designated base personnel. Also, the existing fence must be maintained and the gate must remain locked to restrict access to only authorized personnel. Administrative LUCs would be necessary to ensure the soil is remediated to unrestricted use levels if the substation is decommissioned. The LUC boundaries would coincide with the substation fence line, and would extend vertically from the surface to a depth of 10 feet (which includes a buffer zone below the shallow bedrock contact).

The specific administrative LUCs for Site 312 would be as follows:

1. Consistent with RAO No. 1, the land within the LUC boundaries would be used only for industrial purposes, and not for residential, commercial, or agricultural uses; access to the site by residential receptors would be prohibited.

2. Consistent with RAO No. 2, access to the site by industrial workers would not be prohibited since levels of PCBs in the surface soil are below the TSCA exposure limits for industrial substation use.

3. Consistent with RAO No. 3, activities that would expose construction workers to the contaminated soil and concrete would be authorized only for individuals who (1) are involved in authorized activities; (2) are trained in hazardous waste operations; and (3) are wearing appropriate PPE. No construction of buildings or other inhabited structures would be permitted within the LUC boundaries.

4. Annual inspections and maintenance of the fence and signs controls would be conducted to ensure long-term protection.

Further discussion of these LUCs, including the means for implementation and documentation, is presented in Section 2.8.1 – LUCs General Provisions.

Alternative 3 – Clean for Unrestricted Use by Excavation and Removal of Impacted Soil and Concrete (Selected Remedy)

Although the Air Force plans to use the facility at Site 312 as an industrial substation for the foreseeable future, this alternative includes cleanup to an unrestricted use, i.e., excavation and off-site disposal of soil exhibiting PCB contamination above the 1.0 mg/kg TSCA limit for residential use (no cap). Results of the January 2006 soil sampling indicate that most of the soil in the substation requires excavation to meet this criterion. The estimated total area requiring excavation measures 660 square feet, and (assuming depth to bedrock is 3 feet) contains 73 cubic yards of soil. Once sampling for waste characterization is complete and results are received, the soil and wastewater will be manifested and shipped off-site to a licensed TSDF. Following excavation, confirmation samples will be collected from the bottom of the pit(s) before backfilling with imported clean fill.

Alternative 3 also involves cutting the concrete pad and removing for off-site disposal the portions exhibiting surface contamination in excess of the 10 μg/100 cm^2 TSCA limit for residential use. Results of the January 2006 surface wipe sampling indicate the same area (approximately 120 square feet) identified in Alternative 2 requires removal to meet this criterion. Sampling of the soil under the

removed concrete will be conducted to assess whether PCBs have migrated through the pad and into the soil. If PCBs are detected above 1.0 mg/kg, the soil will be excavated with additional sampling to confirm any remaining soil is clean enough for (a hypothetical) residential use.

2.5.4.7 Comparative Analysis of Alternatives

The comparative analysis of the alternatives for Site 312 is presented in Table 2.5-10.

Alternative 1 does not meet the threshold criterion of being protective of human health and the environment and was therefore eliminated from further consideration. Alternatives 2 and 3 meet both threshold criteria (see Section 2.5.4.10) and were therefore evaluated against the five balancing criteria as follows.

Table 2.5-10. Comparative Analysis of Alternatives – Site 312

KEY L – Low M – Medium H – High NA – Not applicable NPC – No public comments received Evaluation Criteria	Threshold Criteria		Balancing Criteria					Modifying Criteria	
	Overall protection of human health and the environment	Compliance with ARARs	Long-term effectiveness and permanence	Reduction of toxicity, mobility, or volume through treatment	Short-term effectiveness	Implementability	Escalated cost (Years 1 through 30)	Public acceptance	State/Support Agency acceptance
1. No Action	L	NA	NA	NA	NA	NA	NA	NA	NA
2. Clean for Industrial Substation Use	H	H	M	M	H	M	$148K	NPC	M-H
3. Clean for Unrestricted Use (Selected Remedy)	H	H	H	H	H	M	$143K	NPC	H

Alternative 2 rates medium on implementability, requiring a temporary loss of substation use during excavation. Short-term effectiveness is rated high because exposures to PCBs by construction workers during implementation would be mitigated through safe work practices and the use of PPE. Long-term effectiveness and permanence are rated at medium because even though surface soil at Site 318 would meet TSCA exposure standards for PCBs under the current industrial substation land use scenario, additional action would be required for the site to be used for hypothetical (i.e., not planned in the

foreseeable future) residential purposes. Reduction of toxicity, mobility, or volume of contaminants through treatment are rated medium because PCBs would remain in soil above residential use levels.

Alternative 3 rates medium on implementability, requiring a temporary loss of substation use during excavation. Short-term effectiveness is rated high because exposures to PCBs by construction workers during implementation will be mitigated through safe work practices and the use of PPE. Long-term effectiveness and permanence are rated as high because the site would be left suitable for current industrial land uses, as well as any hypothetical future residential uses. Reduction of toxicity, mobility, or volume of contaminants through treatment are rated high because PCBs in soil and concrete would be reduced to residential use levels.

2.5.4.8 Principal Threat Wastes

No principal threat wastes have been identified at Site 312.

2.5.4.9 Selected Remedy

The Air Force and USEPA, with concurrence from Cal/EPA DTSC and the Water Board, selected Alternative 3. The cleanup standards for Site 312 are the TSCA residential limits of 1.0 mg/kg for soil and 10 μg/100 cm^2 for concrete.

2.5.4.10 Statutory Determinations

Under CERCLA Section 121 and the NCP, the lead agency must select remedies that meet the threshold criteria of being protective of human health and the environment, and complying with ARARs (unless a statutory waiver is justified). As balancing criteria, the remedies should also be cost effective, and should utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, CERCLA asserts a preference for remedies that employ treatment that permanently and significantly reduces the volume, toxicity, or mobility of hazardous wastes as a principal element, and a bias against off-site disposal of untreated wastes. The following sections discuss how the selected remedy meets these statutory requirements.

Protection of Human Health and the Environment

Alternative 3 would be protective in that PCB concentrations at Site 312 would be reduced to levels that are cleared for all land uses (including residential).

Compliance with ARARs

Section 121(e) of CERCLA, USC Section 9621(e), states that no federal, state, or local permit is required for remedial actions conducted entirely on site; these actions must meet the substantive but not administrative requirements of ARARs.

Chemical-Specific ARARs. The following chemical-specific ARARs were identified for Site 312:

- The beneficial uses designated in the *Basin Plan* for minor surface waters in the Antelope Hydrologic Unit and Lancaster Hydrologic Area are relevant and appropriate to the remedy selected for Site 312 (see Appendix B, Table B-1, Item 2); following implementation of the remedy, there will be no threats to surface water.
- Specific sections of TSCA (Table B-1, Item No. 3) are either applicable to, or to be considered (TBC) for, the selected remedy involving excavation of contaminated soil and removal of the PCB-impacted concrete.

Location-Specific ARARs. Because the land within the Site 312 fence line has been completely disturbed, most state and federal regulations governing protection of wildlife, historical, and archeological resources are not ARARs. However, because endangered or threatened species are present at the AFRL, and migratory birds could be present at Site 312, the following are listed as RARs:

- California Endangered Species Act (Table B-1, Item No. 4);
- Federal Endangered Species Act (Table B-1, Item No. 5); and
- Migratory Bird Treaty Act (Table B-1, Item No. 6).

Field activities associated with the selected remedy for Site 312 will be coordinated with Base biologists to ensure the protection of sensitive wildlife species.

Action-Specific ARARs. The following action-specific ARARS are listed as applicable for the excavation and off-site disposal PCB-contaminated soil and concrete (potentially RCRA or California hazardous wastes):

- Standards Applicable to Generators of Hazardous Waste (Table B-1, Item No. 8);
- Definition of and Criteria for Identifying Hazardous Wastes (Table B-1, Item No. 10); and

- Hazardous Waste Land Disposal Restrictions (Table B-1, Item No. 11).

To ensure compliance with these ARARs, soil and concrete excavated from Site 312 will be characterized prior to off-site disposal at a TSDF licensed to accept the waste.

Disagreement on ARARs. The Air Force and Water Board do not agree on whether the following SWRQCB requirements are ARARs for Site 312:

- Specific sections of the *Basin Plan*, including but not limited to:
  - WQOs for non-degradation (page 3-2) and certain of the WQOs for surface waters (page 3-3).
  - Region-wide prohibitions 1 and 2 (found on page 4.1-1), which prohibit discharging a waste which causes a violation of narrative (including non-degradation) or numeric WQOs.
  - Soil Cleanup Levels (page 4.2-4): "The Regional Board will determine soil cleanup levels for the unsaturated zone based upon threat to water quality… If it is unreasonable to clean up soils to background concentration levels,…site-specific recommendations for soil cleanup levels [may [be] consider[ed]] provided that applicable groundwater quality objectives are met and health risks from surface or subsurface exposure meet current guidelines."

Please see Section 2.8.2 for the individual positions held by the Air Force, the USEPA, and the Water Board regarding analysis of whether these requirements are ARARs.

Notwithstanding the Air Force position that these Water Board requirements are not ARARs for this action, the selected remedy for Site 312 meets the technical requirements of California water quality law, plans, and policies for protection of surface waters (and groundwater) by removal of PCB-impacted soil and concrete from the site.

Cost Effectiveness

The selected remedy is the lowest cost alternative that meets the statutory requirements.

Utilization of Permanent Solutions and Alternative Treatment Technologies

The selected remedy incorporates a permanent solution in that contaminated soil and concrete would be removed from the site. Although, excavation with off-site disposal is considered a conventional (not

alternative) remedy, it represents the best balance of tradeoffs among short-term effectiveness, long-term effectiveness and permanence, implementability, and cost.

Preference for Treatment as a Principal Element

This remedy does not satisfy the statutory preference for treatment as a principal element of the remedy. On-site treatment of PCBs in soil and concrete is largely unproven and would involve too many implementation problems given the active nature of the Site 312 substation. Therefore, off-site disposal of contaminated soil and concrete at a licensed TSDF was selected.

Five-Year Review Requirements

Because the selected remedy for Site 312 will not result in hazardous substances, pollutants, or contaminants remaining on-site, and will meet the health-protective requirements that allow for unrestricted use and unrestricted exposure (i.e., residential levels), there is no statutory requirement for 5-year reviews to determine whether the remedy continues to be protective of human health and the environment.

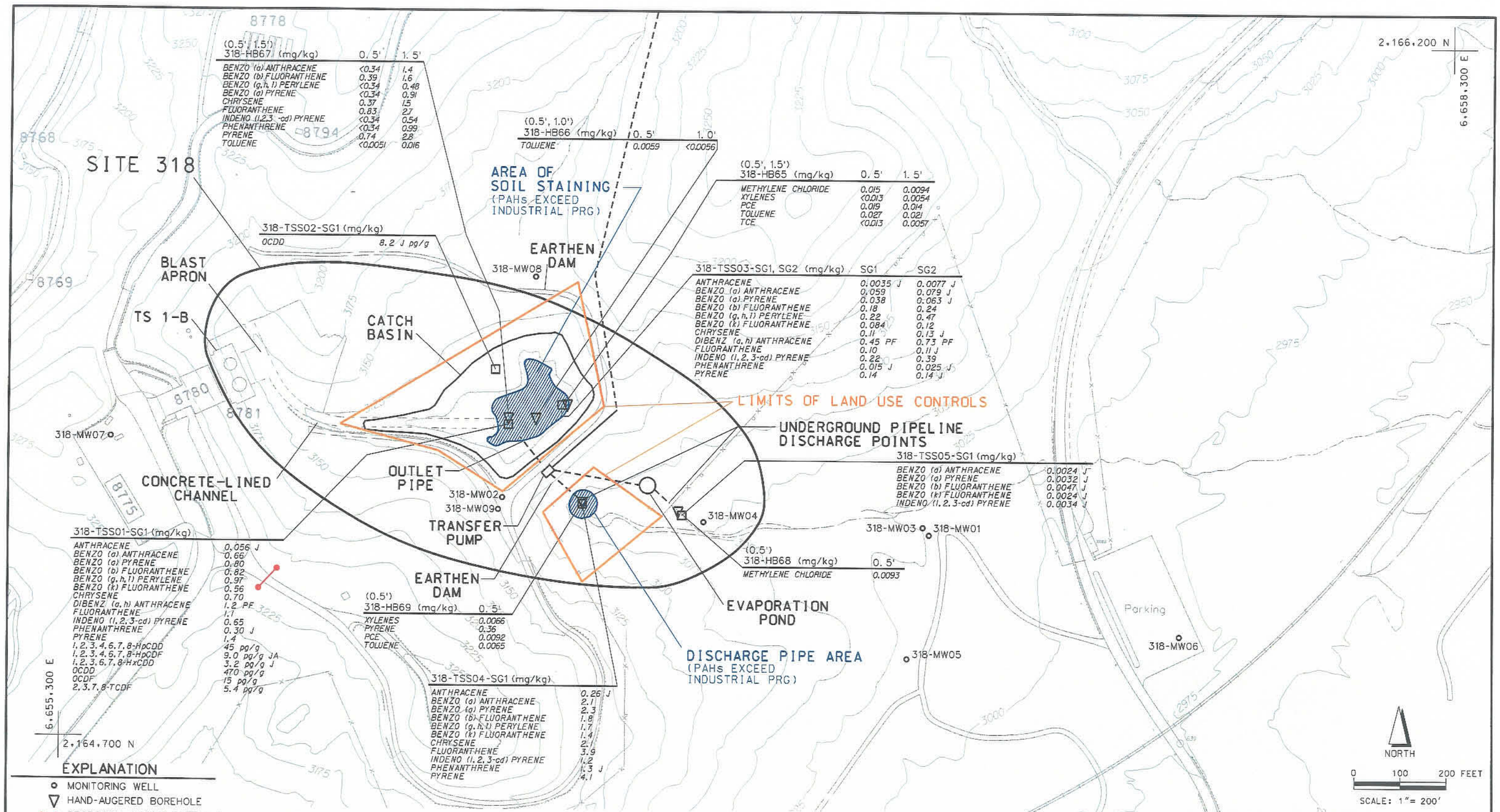
2.5.4.11 Documentation of Significant Changes from Proposed Plan

There are no significant changes from the *Soil and Debris Sites PP*. However, as discussed in Section 2.5.1.11, the present value cost for implementing long-term LUCs at Site 312 was recalculated using a 3 percent discount factor rather than 7 percent, resulting in a present value increase of $15,000 for Alternative 2 (see Table C-2, Appendix C).

2.5.5 SITE 318 – TEST AREA 1-120 CATCH BASIN AND EVAPORATION POND

2.5.5.1 Site Name, Location, and Brief Description

Site 318 is located on Leuhman Ridge within Test Area 1-120 (Figure 2.1-2). The site includes a catch basin and an evaporation pond associated with Test Stand 1-B (Figure 2.5-12). Test Stand 1-B was constructed in 1961 and used for vertical static testing of the F-1 rocket engine which burned rocket propellent-1 (RP-1, a kerosene-based liquid fuel) and liquid oxygen. Test Stand 1-B has been inactive since the conclusion of the F-1 program in 1968.



EXPLANATION

- MONITORING WELL
- HAND-AUGERED BOREHOLE
- PROPOSED LOCKED GATE WITH WARNING SIGN
- TRANSFER PIPELINE DASHED WHERE UNDERGROUND (APPROXIMATE LOCATION)
- DRY STREAM CHANNEL
- FENCE LINE

(DEPTHS SAMPLED)
LOCATION NAME SAMPLE DEPTH
PARAMETER VALUE DETECTED

PCE - TETRACHLOROETHENE
TCE - TRICHLOROETHENE
mg/kg - MILLIGRAMS PER KILOGRAM
pg/g - PICOGRAMS PER GRAM
HpCDD - HEPTACHLORODIBENZO-P-DIOXIN
HpCDF - HEPTACHLORODIBENZOFURAN
HxCDD - HEXACHLORODIBENZO-P-DIOXIN
OCDD - OCTACHLORODIBENZO-P-DIOXIN
OCDF - OCTACHLORODIBENZOFURAN
PAHs - POLYCYCLIC AROMATIC HYDROCARBONS
TCDF - TETRACHLORODIBENZOFURAN

DATA QUALIFIERS
JA - THE ANALYTE WAS POSITIVELY IDENTIFIED, BUT THE QUANTITATION IS AN ESTIMATE.
J - ESTIMATED RESULT. RESULT IS LESS THAN THE REPORTING LIMIT.
PF - THE PERCENT DIFFERENCE BETWEEN THE ORIGINAL AND CONFIRMATION ANALYSES IS GREATER THAN 50%.

OUs 4 and 9 Soil and Debris Sites ROD

Site 318 Map Showing Soil Sampling Results

Date 5-08	Air Force Research Laboratory Edwards AFB	Figure 2.5-12
Project No. 87503		

EDWARDS\87503\B6590FGA.A01

2.5.5.2 Site History and Enforcement Activities

Site History

During each engine test, approximately 60,000 gallons of RP-1 and 75,000 gallons of liquid oxygen were consumed. Following each test firing, the engine, fuel and oxidizer transfer lines, and thrust chamber were purged with gaseous nitrogen carrying a solvent (reportedly TCE), which was then discharged as a mist from the test stand. Approximately 1.5 million gallons of deluge water were used to cool the test stand's flame deflector and concrete blast apron. The deluge water, potentially contaminated with unconsumed fuel, solvent, combustion byproducts, and hydraulic fluid, drained from the blast apron through a concrete-lined drainage channel into the catch basin down slope from the test stand.

The catch basin is an unlined earthen pit approximately 30 feet deep and 70,000 square feet in surface area. The basin was formed by the construction of two steep earthen dams across a dry stream channel. Periodically, unburned RP-1 fuel slicks that formed on the surface of the water in the basin were burned off before the deluge water was recycled for the next test. Evidence of past burning practices can be seen as black soil staining in the basin. Once the deluge water in the catch basin was free of unburned fuel, it was pumped via a 3-foot-diameter outlet pipe and transfer pump back up Leuhman Ridge to a water storage tank located in Test Area 1-125. Due to the surrounding topography, the catch basin only collects rainwater that falls within a small (23-acre) area of Leuhman Ridge. Therefore, very little runoff (no more than 1.3 acre-feet per year) enters the catch basin.

A concrete-lined evaporation pond is located southeast of the catch basin. An underground pipeline (likely connected to the catch basin's outlet pipe via the transfer pump) discharges into the pond from the northwest. The evaporation pond also has an underground outlet pipe that discharges into a dry stream channel down gradient. It is possible that contaminated water from the catch basin was at times allowed to discharge to the dry stream channel.

Site Characterization Sampling

Soil

The Earth Technology Corporation (1994) conducted an SI to assess near-surface soil contamination at Site 318 in 1993. Because the steeply sloping sides of the basin prevent access to its interior by most

vehicles (including all-terrain drill rigs), soil samples were collected from hand-augered boreholes. Three boreholes (318-HB65 through 318-HB67) were sampled within the catch basin, and two boreholes (318-HB68 and 318-HB69) were sampled adjacent to discharge points in the dry stream channel down gradient of the evaporation pond and the catch basin, respectively. Shallow bedrock limited the maximum sampling depth of hand-augered boreholes to 1.5 feet. Soil samples collected from the hand-augered boreholes were analyzed for VOCs, SVOCs, dioxins, total volatile and extractable petroleum hydrocarbons (TVPH and TEPH), and elements including metals.

As summarized on Figure 2.5-12, the following VOCs were detected at trace concentrations: methylene chloride at a maximum concentration of 0.015 mg/kg (2000 residential PRG was 8.88 mg/kg, updated in 2004 to 9.1 mg/kg), PCE at a maximum of 0.019 mg/kg (2000 residential PRG was 5.69 mg/kg, updated in 2004 to 0.48 mg/kg); TCE at a maximum of 0.0057 mg/kg (2000 residential PRG was 2.77 mg/kg, Cal-modified PRG updated in 2004 to 2.9 mg/kg); toluene at a maximum of 0.027 mg/kg (2000 residential PRG of 520 mg/kg is still current); and xylenes (m,p) at a maximum of 0.0066 mg/kg (2000 residential PRG was 210 mg/kg, updated to 270 mg/kg in 2004). Because sample concentrations are at least 25 times, and up to five orders of magnitude below their respective residential PRGs, none of the VOCs were retained as COCs.

Iron and manganese were both detected above residential PRGs and background levels for the AFRL in a single sample. However, due to their limited extent, and lack of a known source of iron and manganese contamination, these metals were not retained as COCs for soil.

A number of PAHs (likely byproducts of the burning of RP-1) were detected in Borehole 318-HB67, with the concentration of benzo(a)pyrene (0.91 mg/kg) exceeding both its residential (0.062 mg/kg) and industrial (0.21 mg/kg) 2004 PRGs. All other PAHs were below both residential and industrial 2004 PRGs. No dioxins or petroleum hydrocarbons were detected in any of these samples.

In March 2004, five additional surface soil samples were collected: three from inside the catch basin; one at the downgradient end of the outlet pipe draining from the catch basin into the stream channel; and one at the downgradient end of the outlet pipe draining from the evaporation pond into the stream channel. Samples were analyzed for PAHs and dioxins/furans.

As shown on Figure 2.5-12, a total of 11 PAHs were detected in five of the six soil samples (the exception was Sample 318-TSS02 collected inside the catch basin above the level of soil staining). Four samples had concentrations of PAHs that exceeded both their respective residential and industrial PRGs for one or more of the following compounds: benzo(a)anthracene, benzo(a)pyrene, benzo(k)fluoranthene, and dibenz(a,h)anthracene. Therefore, these four PAHs were retained as COCs for the soil medium at Site 318 (Table 2.5-11).

Six dioxins and furans were detected in Sample 318-TSS01 and one dioxin was detected in Sample 318-TSS02. Because the USEPA has not established PRGs for these compounds, an estimate of the toxic equivalencies (TEQs) to 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) was made by multiplying the concentrations by toxic equivalency factors (TEFs). The TEQs for all detected dioxins and furans were then summed to yield a total TEQ for each soil sample. The results indicate a TEQ of 1.9 picograms per gram (pg/g) for Sample 318-TSS01 and a TEQ of 0.01 pg/g for Sample 318-TSS02. Both TEQs were below the residential PRG of 3.9 pg/g for 2,3,7,8-TCDD. Therefore, these analytes are not considered COCs for soil at Site 318.

Bedrock

It is possible that contaminants found in the surface soil are also present in the shallow bedrock. However, because there was no drill rig access in the catch basin, no samples of the bedrock could be obtained to verify or quantify contamination. The potential bedrock contamination (as it relates to a potential source of further groundwater contamination) will be addressed in the ROD for the Northeast AFRL and Mars Boulevard areas.

Groundwater

The groundwater underlying Site 318 is heavily impacted by chlorinated solvents from activities at Test Stand 1-B; this contamination is being addressed in the ROD for the Northeast AFRL area. The maximum concentrations of cis-1,2-DCE (76,000 μg/L), trans-1,2-DCE (15,000 μg/L), and TCE (11,000 μg/L) in the groundwater suggest the presence of a dense non-aqueous phase liquid (DNAPL) mass in contact with the groundwater.

TABLE 2.5-11. SITE 318 CHEMICALS OF CONCERN

Chemicals of Concern	Maximum Detected Concentration	Current Cancer Risk	Basis for Listing as a Chemical of Concern	Site-Specific Risk-Based Industrial Exposure Level	Cancer Risk at Exposure Limit
Soil					
Benzo(a)pyrene	0.91 mg/kg	1.46×10^{-5} (Res.) 3.15×10^{-6} (Ind.)	Both compounds exceed their residential and industrial PRGs[1], but not their site-specific risk-based industrial exposure levels. Residential and industrial cancer risks exceed threshold criterion of 1×10^{-6}.	18 mg/kg	1×10^{-4} (Ind.)
Dibenz(a,h)anthracene	1.2 mg/kg	$> 1 \times 10^{-6}$ (Res.)[2] $> 1 \times 10^{-6}$ (Res.)[2]		18 mg/kg	1×10^{-4} (Ind.)
Benzo(a)anthracene	1.4 mg/kg	2.25×10^{-6} (Res.) 4.85×10^{-7} (Ind.)	Both compounds exceed their residential PRGs[1], but not their industrial PRGs[1] or the site-specific risk-based industrial exposure levels. Residential cancer risk exceeds threshold criterion of 1×10^{-6}.	180 mg/kg	1×10^{-4} (Ind.)
Benzo(b)fluoranthene	1.6 mg/kg	2.25×10^{-6} (Res.) 4.85×10^{-7} (Ind.)		180 mg/kg	1×10^{-4} (Ind.)
Bedrock					
Potentially those detected in soil and/or groundwater	Unknown	Unknown	To be addressed in Northeast AFRL and Mars Boulevard areas ROD.	-	-
Groundwater					
Chlorinated solvents and petroleum compounds	-	-	To be addressed in Northeast AFRL and Mars Boulevard areas ROD.	-	-

Notes:

(1) United States Environmental Protection Agency Region 9 preliminary remediation goals (USEPA 2004).
(2) specific value not calculated in risk assessment.

AFRL Air Force Research Laboratory
Ind. industrial
mg/kg milligrams per kilogram
Res. residential
ROD record of decision

Interim Remedial Actions

No IRA activities have been conducted at Site 318.

Nature and Extent of Residual Site Contamination

Please see discussion of site characterization sampling above. Benzo(a)anthracene, benzo(a)pyrene, benzo(k)fluoranthene, and dibenz(a,h)anthracene are the only COCs retained for soil at Site 318. The total estimated volume of contaminated soil at Site 318 is 760 cubic yards.

Conceptual Site Model

The conceptual site model illustrating the potential exposure pathways for Site 318 is shown on Figure 2.5-13. There are no potentially complete exposure pathways to current residential (hypothetical) or industrial receptors; however, further action is required to prevent future exposures to PAHs in soil via the inhalation, ingestion, or dermal pathways. Similar exposures are possible by current or future construction workers. Although the potential is limited, groundwater and surface water could be impacted by site contaminants (see Section 2.5.5.4 – Threat to Groundwater and Surface Water).

2.5.5.3 Current and Potential Future Land and Resource Uses

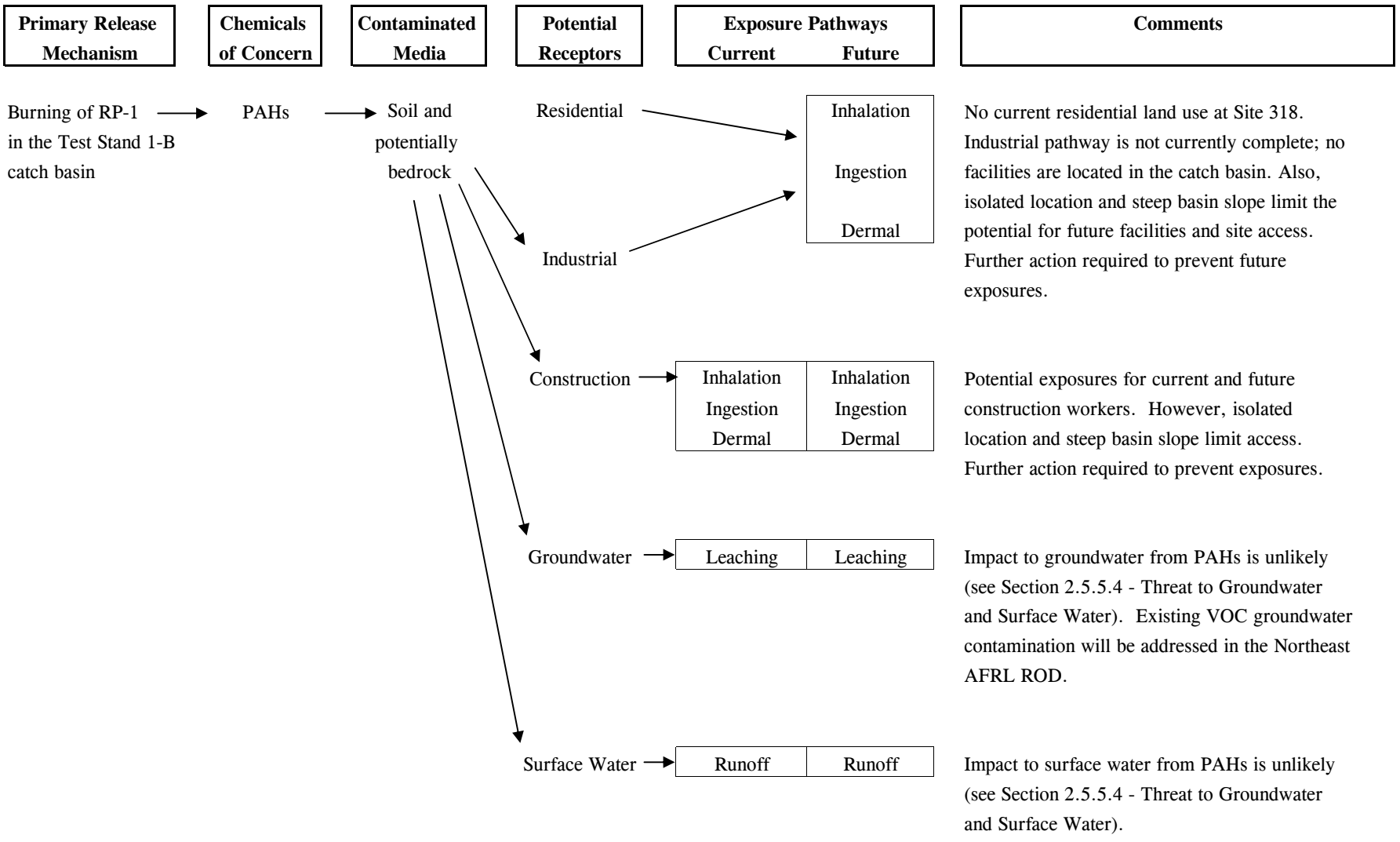
According to the *EAFB GP*, the current and anticipated future land uses at Site 318 are test and research; there are no residential land uses planned. These land uses are considered industrial for risk assessment purposes.

2.5.5.4 Summary of Site Risks

Human Health Risk

An HHRA was performed (in 2003) using sampling results collected through 2001; results are summarized in Table 2.5-12. It should be noted that the HHRA only evaluated exposure to soil; because the underlying shallow bedrock was not sampled, risk via exposure by construction workers to this potentially contaminated medium could not be quantified. This preliminary evaluation of risk, which was based on the ratio of site maximum concentrations to the 2000 PRGs, indicated a potential cancer risk for the hypothetical residential and the industrial exposure scenarios (driven by

FIGURE 2.5-13. SITE 318 CONCEPTUAL SITE MODEL - EXPOSURE PATHWAYS



Notes:

→	potentially-complete pathway	ROD	record of decision
AFRL	Air Force Research Laboratory	RP-1	Rocket Propellant-1
PAHs	polycyclic aromatic hydrocarbons	VOC	volatile organic compound

TABLE 2.5-12. QUANTIFICATION OF RISKS IN SOIL (1993 SAMPLING ONLY) - SITE 318

(Page 1 of 2)

Analyte	Maximum Detected Concentration	Residential PRG[(1)]	Industrial PRG[(1)]	Residential Risk and Hazard Index		Industrial Risk and Hazard Index	
				Carcinogens	Non-carcinogens	Carcinogens	Non-carcinogens
Inorganic Analytes (mg/kg)							
barium	6.14E+02	5.37E+03	1.00E+05		0.114		0.006
cadmium	5.00E+00	9.00E+00 c	8.09E+02	5.56E-07			0.006
chromium, total	1.65E+01	2.11E+02 c	4.48E+02 c	7.83E-08		3.68E-08	
copper	1.37E+02	2.91E+03	7.59E+04		0.047		0.002
iron	3.43E+04	2.35E+04	1.00E+05		1.462		0.343
lead	7.51E+01	4.00E+02	7.50E+02				
manganese	6.05E+03	1.76E+03	3.23E+04		3.433		0.188
mercury	1.10E-01	2.35E+01	6.13E+02		0.005		<0.001
molybdenum	7.40E+00	3.91E+02	1.02E+04		0.019		<0.001
nickel	3.88E+01	1.50E+02 c	4.09E+04	2.59E-07			<0.001
zinc	1.64E+03	2.35E+04	1.00E+05		0.070		0.016
Organic Analytes (mg/kg)							
acetone	3.30E-02	1.57E+03	6.22E+03		<0.001		<0.001
benzo(a)anthracene	1.40E+00	6.21E-01 c	2.89E+00 c	2.25E-06		4.85E-07	
benzo(a)pyrene	9.10E-01	6.21E-02 c	2.89E-01 c	1.46E-05		3.15E-06	
benzo(b)fluoranthene	1.60E+00	6.21E-01 c	2.89E+00 c	2.57E-06		5.54E-07	
benzo(g,h,i)perylene	4.80E-01	2.31E+03 s	5.42E+04 s		<0.001		<0.001
chrysene	1.50E+00	6.10E+00 c	2.89E+02 c	2.46E-07		5.20E-09	
fluoranthene	2.70E+00	2.29E+03	3.01E+04		0.001		<0.001
indeno(1,2,3-c,d)pyrene	5.40E-01	6.21E-01 c	2.89E+00 c	8.69E-07		1.87E-07	
methylene chloride	1.50E-02	8.88E+00 c	2.05E+01 c	1.69E-09		7.31E-10	
phenanthrene	9.90E-01	2.19E+04 s	1.00E+05 s		<0.001		<0.001
pyrene	2.80E+00	2.31E+03	5.42E+04		0.001		<0.001
tetrachloroethene (PCE)	1.90E-02	5.69E+00 c	1.87E+01 c	3.34E-09		1.02E-09	
toluene	2.70E-02	5.20E+02	5.20E+02		<0.001		<0.001

TABLE 2.5-12. QUANTIFICATION OF RISKS IN SOIL (1993 SAMPLING ONLY) - SITE 318

(Page 2 of 2)

Analyte	Maximum Detected Concentration	Residential PRG[1]	Industrial PRG[1]	Residential Risk and Hazard Index: Carcinogens	Residential Risk and Hazard Index: Non-carcinogens	Industrial Risk and Hazard Index: Carcinogens	Industrial Risk and Hazard Index: Non-carcinogens
trichloroethene (TCE)	5.70E-03	2.77E+00 c	6.12E+00 c	2.06E-09		9.32E-10	
xylene (m,p)	6.60E-03	2.10E+02	2.10E+02		< 0.001		< 0.001
Total Risk and Hazard Index Quantification for Constituents in Soil[2]				2.15E-05	5.152	4.42E-06	0.563

	Carcinogens	Non-carcinogens
Total Construction Worker Risk and Hazard Index Quantification for Constituents in Soil[3]	6.79E-08	0.216

Notes:

[1] United States Environmental Protection Agency Region 9 preliminary remediation goal (USEPA 2000)

[2] 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.

[3] Calculated as the product of 0.015 and the industrial risk, and 0.384 and the industrial hazard (Earth Tech 2004).

c Indicates that chemical is evaluated based on its carcinogenic potential.

s Surrogate. PRGs for these chemicals have not been established. The following surrogates are substituted:

Chemical	Surrogate
benzo(g,h,i)perylene	pyrene
phenanthrene	anthracene

mg/kg milligrams per kilogram

concentrations of PAHs) within the range considered to be generally acceptable (10^{-6} to 10^{-4}). The cancer risk is acceptable (10^{-8}) for the construction exposure scenario. For non-carcinogens, the HI was estimated to be below 1 for the industrial and construction exposure scenarios, and above 1 for the hypothetical residential exposure scenario, driven by maximum concentrations of iron and manganese (these metals are not considered to be COCs in soil as explained in Section 2.5.5.2 – Site Characterization Sampling). Because no VOCs were detected in the Site 318 soil above residential PRGs (Appendix D), no evaluation of risk via the VIP into indoor air from soil was conducted. The forthcoming Northeast AFRL ROD will include an evaluation of the VIP associated with the Site 318 groundwater plume, and the selected remedial response.

Site-Specific Risk-Based Exposure Level

As with perchlorate at Site 36 (see Section 2.5.2.4 for methodology), site-specific risk-based soil exposure levels were calculated (based on a target industrial cancer risk of 1 x 10^{-4}) specifically for PAHs via direct contact with soil and/or inhalation of particulates (dust). These exposure levels (Earth Tech 2006a) are as follows:

- benzo(a)pyrene - 18 mg/kg;
- dibenz(a,h)anthracene - 18 mg/kg;
- benzo(a)anthracene - 180 mg/kg; and
- benzo(b)fluoranthene - 180 mg/kg.

None of the four PAHs were detected at concentrations above the site-specific, risk-based exposure levels.

Ecological Risk

The SERA identified potentially complete exposure pathways to ecological receptors via contaminants in the soil at Site 318. The PERA (Tetra Tech 2004) results suggested that there is a potential risk to certain receptor groups for exposure to several metals via soil, and some organic compounds via inhalation of soil vapor. However, the ecological risks are considered acceptable because (as stated in the PERA):

> …It is important to note that past physical disturbance contributes in part to this conclusion [potential risk to certain receptor groups], and chemical contamination is not the sole justification… Results for the terrestrial receptors at Site 318 did not show any systematic trend (e.g., a consistent and substantial risk for all receptors for a certain suite of constituents) that would indicate the potential for impact to the community as a whole.

Threat to Groundwater and Surface Water

Only low-level concentrations of VOCs (including PCE, TCE, toluene, and xylenes), PAHs, dioxins, and furans were detected at the bottom of the Site 318 catch basin (see Section 2.5.5.2). It is therefore unlikely that residual soil contaminants pose a threat of contamination to groundwater already significantly impacted by VOCs. Moreover, because PAHs, dioxins, and furans exhibit low solubility in water and strong sorption to soil grains, surface contamination by these chemicals should tend to remain localized, and are not likely to impact surface water or groundwater (at 70 feet bgs). This lack of mobility in the soil is confirmed by sampling results: PAHs and dioxins have persisted in the basin's surface soils for nearly 40 years (since 1968), but have not migrated into the groundwater, despite the fact that no attempts have been made to prevent rainwater from entering the catch basin. Only ephemeral surface water (stormwater runoff) is present; there is no permanent standing water on site.

To provide quantitative support for the assumption that Site 318 contaminants pose little threat to groundwater, VLEACH® software (specifically designed for modeling transport of organic compounds in the vadose zone) was used to estimate the mass flux of VOCs, PAHs, and dioxins/furans from the Site 318 soil to the groundwater. A worst-case scenario was conservatively assumed as follows:

1. A sand medium (with high effective porosity) was assumed from the ground surface to groundwater at 70 feet bgs; in reality, only 1 to 2 feet of sandy soil is present in the catch basin overlying fractured bedrock with a low effective porosity (the model does not allow selection of fractured bedrock as an option for the geologic formation).

2. All net precipitation (i.e., precipitation minus transpiration) recharges the aquifer; for the AFRL this would be approximately 0.25 inches per year (see Section 2.5.2.4).

3. The entire volume of soil in the catch basin is contaminated with the four VOCs at the maximum concentrations detected.

Even under these assumptions, the model results indicate very little total transport of VOCs (and negligible transport of PAHs and dioxins/furans) to the groundwater. The simulated flux of VOCs over a 1,000-year period are as follows: PCE (1.2 grams [g]), TCE (0.46 g), toluene (1.6 g), and xylenes

(0.45 g). The model simulates no measurable transfer of PAHs or dioxins/furans from the soil to the groundwater over the same time period.

2.5.5.5 Remedial Action Objectives

The RAOs for Site 318 are:

1. Prevent exposures (inhalation, ingestion, and dermal) by hypothetical residential receptors to soil containing PAHs at concentrations that yield residential cancer risks greater than 1×10^{-6}.

2. Prevent exposure (inhalation, ingestion, and dermal) by industrial receptors to soil containing PAHs above their site-specific risk-based industrial exposure level (industrial cancer risk greater than 1×10^{-4}). Although results from limited soil sampling in the catch basin do not exceed these PAH limits, it is conservatively assumed that higher concentrations may be present.

3. Prevent exposure to potentially hazardous bedrock by construction workers.

4. Limit the potential for leaching of soil contaminants from the soil into the groundwater.

2.5.5.6 Description of Alternatives

As described in the *Soil and Debris Sites FS*, the Air Force evaluated numerous remedial strategies to manage and/or clean up the PAH contamination in soil at Site 318. After an initial screening of available technologies, three remedial alternatives were developed for detailed evaluation. Estimated costs for each alternative are presented in Table 2.5-13.

Table 2.5-13. Site 318 Remedial Alternatives Cost Breakdown

Remedial Alternatives (Selected Remedy Shown in Bold)	Unadjusted Cost	Escalated Cost	Present Value Cost
Alternative 1 – No Action Scenario	$0	$0	$0
Alternative 2 – LUCs Only at Both Contaminant Sites			
Administrative Controls (recurring annual costs in Years 1 to 30)	$69,000	$100,000	$46,000
Gate and Signs (capital cost in Year 1)	$1,000	$1,000	$1,000
	$70,000	**$101,000**	**$47,000**
Alternative 3 – In-Situ Land Farming and Excavation			
Excavation with Off-Site Disposal at Discharge Pipe Area (capital cost in Year 1)	$35,000	$35,000	$35,000
In-Situ Land Farming in Catch Basin (capital costs in Years 1 and 2)	$243,000	$243,000	$243,000
	$278,000	$278,000	$278,000
Annual Cost Beyond Year 30 (LUCs, Alternative 2 only)	$2,000	-	-

Notes:

Escalation factors from RACER Software. Present value based on a 3% discount factor. All costs rounded to nearest $1,000.

Alternative 1 – No Action

As required by the NCP, the no action alternative is listed only to compare to other alternatives. No remedial action would be taken at Site 318.

Alternative 2 – Land Use Controls Only (Selected Remedy)

LUCs at Site 318 will be implemented so that contaminants do not impact the health of base personnel or that of future residents or workers. This will be accomplished by preventing site access by hypothetical residential receptors, and limiting site access by industrial and construction workers. LUCs will include both engineering and administrative controls. The boundaries of these LUCs (shown in orange on Figure 2.5-12) were drawn to include both locations where soil sampling results indicate that PAHs exceed concentrations that yield residential cancer risks greater than 1×10^{-6}. The vertical component of the LUC boundary extends from the surface to 12 feet bgs, the maximum likely depth of excavation. It is anticipated that the groundwater below Site 318 will be subject to LUCs as part of the forthcoming remedy for the Northeast AFRL area.

Engineering Controls

Because the surface soil at Site 318 already meets the industrial site-specific risk-based exposure levels for PAHs (the only COCs), and the site is located in a remote, abandoned test area that is likely to receive minimal foot or vehicle traffic, fencing is not needed to restrict access. Rather, a locked chain or cable barrier will be used to control vehicle access to the site via the sole unpaved access road. Additionally, signs warning of the potential health threats will be posted on the gate and around the catch basin and the discharge pipe area. The signs would also state that access and construction must first be approved by designated base personnel. Annual inspections and maintenance of the engineering controls (gates and signs) will be conducted to ensure long-term protection.

Administrative LUCs

The specific administrative LUCs for Site 318 under this remedy are as follows:

1. Consistent with RAO No. 1, the land within the LUC boundaries will be used only for industrial purposes, and not for residential, agricultural, or commercial use; access to the site by residential receptors will be prohibited.

2. Consistent with RAO No. 2, access to the site by AFRL industrial workers and non-excavation construction workers will be restricted since levels of PAHs in the soil might exceed $1x10^{-4}$ risk in some locations.

3. Consistent with RAO No. 3, activities that would expose construction workers to the potentially contaminated bedrock will be authorized only for individuals who (1) are involved in authorized activities; (2) are trained in hazardous waste operations; and (3) are wearing appropriate PPE. No construction of buildings or other inhabited structures will be permitted within the LUC boundaries.

4. Consistent with RAO No. 4, discharge of water to the surface and/or subsurface at Site 318 will be prohibited. Hypothetically, if Test Stand 1-B is reactivated at some future date, and if the new operations require a deluge water system, the Site 318 catch basin would have to be lined to prevent water infiltration.

Further discussion of these LUCs, including the means for implementation and documentation, is presented in Section 2.8.1 – LUCs General Provisions.

Alternative 3: In-Situ Enhanced Bioremediation (Land Farming) in the Catch Basin, and Excavation with Off-Site Disposal at the Discharge Pipe Area

This alternative combines in-situ enhanced bioremediation (land farming) to treat in place the PAH-contaminated soil in the Site 318 catch basin, and conventional excavation with off-site disposal at the discharge pipe area. If successful, this alternative would achieve unrestricted use at Site 318. Biodegradation would be stimulated by increasing aeration, maintaining moist conditions, providing nutrients, and in some cases, adding microorganisms. Conventional agricultural equipment would be used to break up, mix, and aerate the soil. To maintain aeration, the soil would be tilled regularly during treatment. Moisture and nutrients would be added as needed using irrigation equipment such as spray irrigators, overhead sprinklers, and watering attachments to farming equipment. The treatment time is estimated to be 2 years. However, because the contaminated soil is located at the bottom of a deep catch basin with steeply sloping sides, it is uncertain that the needed equipment can enter the basin without extensive access route modifications (i.e., construction of soil ramps to lessen the grade). If needed, these ramps would significantly increase the cost, and impact the schedule, of the cleanup. Additionally, if the shallow bedrock (which could not be sampled) is also impacted by PAHs, land farming would not be effective.

Given the limited volume of contaminated soil expected at the discharge pipe area (approximately 20 cubic yards) and assuming that tracked excavators can access the site, conventional excavation with off-site disposal would provide a fast, simple, and proven remedial solution. This operation would follow procedures similar to those detailed for Site 36. However, land farming of soil in the large catch basin was proposed over excavation due to the much larger volume of soil that would need to be removed. Also, the steep terrain at Site 318 prevents access to the bottom of the catch basin by the large excavators.

2.5.5.7 Comparative Analysis of Alternatives

The comparative analysis of the alternatives for Site 318 is presented in Table 2.5-14.

Table 2.5-14. Comparative Analysis of Alternatives – Site 318

KEY L – Low M – Medium H – High NA – Not applicable NPC – No public comments received Evaluation Criteria	Threshold Criteria		Balancing Criteria					Modifying Criteria	
	Overall protection of human health and the environment	Compliance with ARARs	Long-term effectiveness and permanence	Reduction of toxicity, mobility, or volume through treatment	Short-term effectiveness	Implementability	Escalated cost (Years 1 through 30)	Public acceptance	State/Support Agency acceptance
1. No Action	L	NA	NA	NA	NA	NA	NA	NA	NA
2. LUCs (Selected Remedy)	H	H	M	L	H	H	$101K	NPC	H
3. In-Situ Land Farming and Excavation with Offsite Disposal	H	H	H	H	H	M	$278K	NPC	H

Alternative 1 does not meet the threshold criterion of being protective of human health and the environment and was therefore eliminated from further consideration. Alternatives 2 and 3 meet both threshold criteria (see Section 2.5.5.10) and were therefore evaluated against the five balancing criteria as follows.

Alternative 2 rates high on implementability and short term effectiveness because it requires only minor construction, with little potential for construction worker exposure to site COCs during implementation.

Long-term effectiveness and permanence are rated at medium because even though surface soil at Site 318 meets site-specific risk-based exposure standards for PAHs under the current industrial-only land use scenario, additional action would be required for the site to be used for hypothetical (i.e., not planned in the foreseeable future) residential purposes. Moreover, reduction of toxicity, mobility, or volume of contaminants through treatment are rated low because PAHs would remain in soil, untreated, with no reduction in mobility.

Alternative 3 rates medium on implementability, requiring moderately-difficult land farming in a steep catch basin with limited access. Short-term effectiveness is rated high because exposures to site COCs by construction worker during implementation would be mitigated through safe work practices and the use of PPE. Long-term effectiveness and permanence are rated high because soil would meet risk-based exposure standards for PAHs under the current industrial-only land use scenario, and under any hypothetical future residential scenario. Reduction of toxicity, mobility, or volume of contaminants through treatment rate high because much of the PAH-contaminated soil will be treated in-situ or excavated and replaced with clean soil.

2.5.5.8 Principal Threat Wastes

No principal threat wastes have been identified at Site 318.

2.5.5.9 Selected Remedy

The Air Force and USEPA, with concurrence from Cal/EPA DTSC and the Water Board, selected Alternative 2.

2.5.5.10 Statutory Determinations

Under CERCLA Section 121 and the NCP, the lead agency must select remedies that meet the threshold criteria of being protective of human health and the environment, and complying with ARARs (unless a statutory waiver is justified). As balancing criteria, the remedies should also be cost effective, and should utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, CERCLA asserts a preference for remedies that employ treatment that permanently and significantly reduces the volume, toxicity, or

mobility of hazardous wastes as a principal element, and a bias against off-site disposal of untreated wastes. The following sections discuss how the selected remedy meets these statutory requirements.

Protection of Human Health and the Environment

Alternative 2 (LUCs) would be protective in that the locked vehicle gate, warning signs, and administrative controls would effectively limit site access to industrial receptors and construction workers with proper training.

Compliance with ARARs

Section 121(e) of CERCLA, USC Section 9621(e), states that no federal, state, or local permit is required for remedial actions conducted entirely on site; these actions must meet the substantive but not administrative requirements of ARARs.

Chemical-Specific ARARs. The beneficial uses designated in the *Basin Plan* for minor surface waters in the Antelope Hydrologic Unit and North Muroc Hydrologic Area are relevant and appropriate to the remedy selected for Site 318 (see Appendix B, Table B-1, Item 2); as described in Section 2.5.5.4) the threat to surface water is minimal.

Location-Specific ARARs. Because Site 318 has already been heavily disturbed, most state and federal regulations governing the protection of wildlife or archeological resources are not ARARs. However, endangered or threatened species are present at the AFRL, and there is a possibility that migrating birds may be present on Site 318 land. Also, Test Stand 1-B (located near the Site 318 catch basin) is eligible for listing with the National Register of Historic Places. Therefore, the following are listed as RARs:

- California Endangered Species Act (Table B-1, Item No. 4);
- Federal Endangered Species Act (Table B-1, Item No. 5);
- Migratory Bird Treaty Act (Table B-1, Item No. 6); and
- National Historical Preservation Act (Table B-1, Item No. 7).

Field activities associated with the selected Site 318 remedy will be coordinated with Base biologists to ensure the protection of sensitive wildlife species, and Test Stand 1-B will not be disturbed.

Action-Specific ARARs. The following action-specific ARAR was identified for Site 318:

- 22 CCR, Div. 4.5, Ch. 39, Section 67391.1 and Civil Code Section 1471 (Table B-1, Item No. 12).

As discussed in Section 2.5.5.6, LUCs are included as part of the selected remedy because PAHs (at concentrations that yield residential cancer risks greater than 1×10^{-6}) will be left in place in the soil at Site 318. In the event of transfer of property that includes the Site 318 LUC boundary to a non-federal entity, a land use covenant with DTSC would be required. Therefore, the cited requirements are relevant and appropriate to the selected remedy.

Disagreement on ARARs. The Air Force and the Water Board do not agree on whether the following Water Board requirements are ARARs for Site 318:

- Specific sections of the *Basin Plan*, including but not limited to:
  - WQOs for non-degradation (page 3-2) and certain of the WQOs for surface waters (page 3-3).
  - Region-wide prohibitions 1 through 3 (found on page 4.1-1). Items 1 and 2 prohibit discharging waste which causes a violation of narrative (including non-degradation) or numeric WQOs while Item 3 prohibits discharging waste which causes further degradation or pollution where a narrative or numeric WQO is already being violated.
  - Soil Cleanup Levels (page 4.2-4): "The Regional Board will determine soil cleanup levels for the unsaturated zone based upon threat to water quality… If it is unreasonable to clean up soils to background concentration levels,…site-specific recommendations for soil cleanup levels [may [be] consider[ed]] provided that applicable groundwater quality objectives are met and health risks from surface or subsurface exposure meet current guidelines."

Please see Section 2.8.2 for the individual positions held by the Air Force, the USEPA, and the Water Board regarding analysis of whether these requirements are ARARs.

Notwithstanding the Air Force position that these Water Board requirements are not ARARs for this action, the selected remedy for Site 318 meets the technical requirements of California water quality law, plans, and policies for protection of surface waters (and groundwater) in that discharges of surface water will be prohibited, and (as described in Section 2.5.5.4) the threat to groundwater and surface water is minimal.

Cost Effectiveness

The selected remedy is the lowest cost alternative that meets the statutory requirements. However, it should be noted that the cost estimates presented in this ROD include only the first 30 years of remedy implementation. Given the indefinite duration of the selected remedy, the total lifecycle costs of the remedy cannot be calculated, but will likely be greater than the 30-year costs shown. Table 2.5-13 lists an estimate of the unadjusted annual cost of implementing the remedy beyond Year 30.

Utilization of Permanent Solutions and Alternative Treatment Technologies

The selected remedy does not incorporate permanent solutions or alternative treatment technologies. However, the protection afforded by the remedy is expected to be effective over the long term provided routine maintenance of the gate and signs is performed, and the LUCs are enforced.

Preference for Treatment as a Principal Element

Because on site treatment of the soil in the Site 318 catch basin would present significant difficulties in implementation, the selected remedy does not satisfy the statutory preference for treatment as a principal element of the remedy.

Five-Year Review Requirements

Because the selected remedy will result in hazardous substances, pollutants, or contaminants (PAHs in soil) remaining on-site above levels that allow for unrestricted use and unrestricted exposure (i.e., residential levels), a statutory review will be conducted within 5 years after initiation of the remedial action to satisfy NCP Section 300.430(f)(4)(ii), and at 5-year intervals thereafter, as long as hazardous substances remain at the site at levels that do not allow for unrestricted (residential) uses. Five-year reviews will be conducted in accordance with CERCLA Section 121(c) and are required to determine whether the remedy continues to be protective of human health and the environment.

2.5.5.11 Documentation of Significant Changes from Proposed Plan

There are no significant changes from the *Soil and Debris Sites PP*. However, as discussed in Section 2.5.1.11, the present value cost for implementing long-term LUCs at Site 318 was recalculated using a 3 percent discount factor rather than 7 percent, resulting in a present value increase of $15,000 for Alternative 2 (see Table C-2, Appendix C).

2.6 DECISION SUMMARY – FURTHER ACTION SITES IN OU9

2.6.1 SITES 6 AND 113 – ABANDONED MINE SHAFTS 1 AND 2

2.6.1.1 Site Name, Location, and Brief Description

Sites 6 and 113 are located approximately 4 miles east of Leuhman Ridge (Figure 2.1-2) inside the remote, access-controlled PIRA. Sites 6 and 113 include Abandoned Mine Shafts 1 and 2, respectively (Figure 2.6-1). Each mine shaft measures approximately 12 feet by 12 feet and is estimated to be between 200 feet and 300 feet deep. Given that there is no evidence that pumping facilities were present at Site 6 or Site 113, it is unlikely that the shafts extend below the first encountered groundwater (approximately 250 feet to 260 feet bgs). Also, because the mineshafts were excavated into nearly flat terrain, and only limited mine tailings are found at the surface, it is likely that the shafts are vertical (or near-vertical) and do not incorporate horizontal galleries.

2.6.1.2 Site History and Enforcement Activities

Site History

Abandoned Mine Shaft Nos. 1 and 2 were originally dug as mineral mines (date unknown), but were used for waste disposal between 1959 and 1967. Materials disposed in the mine shafts may have included low-pressure cylinders containing fuels and oxidizers such as pentaborane, high-energy fuels (HEFs), and fluorine. Liquid rocket fuel (presumably RP-1) was then poured on top of the cylinders and ignited, resulting in multiple explosions that continued for approximately 8 hours. Stainless steel and scrap iron were also placed in the mine shafts, as was "contaminated" plumbing from Test Area 1-21.

Prior to the RI, the Air Force backfilled the mine shafts with soil and placed asphalt caps over the entrances to prevent access and to protect the underlying groundwater from rainwater infiltration through the buried debris. Because the mine shafts were excavated into surface exposures of low permeability, hard crystalline bedrock, the caps are small (15 feet square) and only cover the dirt filled mine openings. Barbed-wire fences with warning signs were installed around each mine shaft but have since fallen into disrepair.

6-MW01	12/01	6/02	1/03	7/03	9/05	8/07
ACETONE	-		2.7 J	-	-	-
METHYLENE CHLORIDE	0.490 J	<2.0	<2.0	<2.0	-	-
NDMA	0.00250	0.00513 J5	**0.0907**	0.00359	0.0032	0.0019 J

113-MW01	11/01	6/02	1/03	7/03	9/05	8/07
CHLOROFORM	0.126 J	<1.0	<1.0	<1.0	-	-
NAPHTHALENE	0.373 J	<1.0	<1.0	<1.0	-	-
1,2,3-TRICHLOROBENZENE	0.174 J	<1.0	<1.0	<1.0	-	-
TCE	0.815 J	<1.0	<1.0	<1.0	-	-
BENZOIC ACID	12.4 J	<49	<48	-	-	-
PHENOL	2.57 J	<9.8	<9.5	-	-	-
DIETHYL PHTHALATE	<10	<9.8	2.0 J	-	-	-
NDMA	0.00670	<0.0020*	**0.010**	**0.0130**	<0.002	<0.002
1,4-DIOXANE	0.290 J	<1.0*	<1.0	-	-	-

SITE 6

SITE 113

SITE 118

TEST AREA 1-36

9025

LIMITS OF LAND USE CONTROLS

APPROXIMATE LOCATION OF ABANDONED MINE SHAFT NO. 1

APPROXIMATE LOCATION OF ABANDONED MINE SHAFT NO. 2

2,168,600 N

6,687,200 E

6,675,000 E

2,162,700 N

2750 2725 2700 2775 2800 2825 2850 2875 2900 2925

EXPLANATION

- MONITORING WELL
- APPROXIMATE LOCATION OF ABANDONED MINE SHAFT

LOCATION NAME DATE
PARAMETER NAME VALUE DETECTED (µg/L)

TCE TRICHLOROETHENE
NDMA N-NITROSODIMETHYLAMINE
* SAMPLE COLLECTED IN JULY 2002
J ESTIMATED CONCENTRATION DETECTED BELOW THE REPORTING LIMIT
RESULTS SHOWN IN BOLD EXCEED THE NOTIFICATION LEVEL FOR NDMA.

NORTH

0 400 800 FEET

SCALE: 1"= 800'

OUs 4 and 9 Soil and Debris Sites ROD

Sites 6 and 113 Map Showing Well Sampling Results

Date 5-08	Air Force Research Laboratory Edwards AFB	Figure 2.6-1
Project No. 87503		

EDWARDS\87503\B6591FGA.A01

Site Characterization Sampling

Soil

The unconsolidated soil at Sites 6 and 113 ranges in thickness from 0 feet to 2 feet; and the underlying bedrock is characterized as a hard to very hard quartz monzonite (similar to granite). However, because the mine shafts may contain explosive material, the RPMs agreed that drilling boreholes to collect soil samples in the immediate vicinity would pose too great a risk. Therefore no soil samples were collected and no specific COCs were identified in soil at Sites 6 and 113. Potential contaminants include but are not limited to petroleum fuel (RP-1), PAHs and dioxins (combustion byproducts), pentaborane, HEFs, and fluorine. The last three compounds are highly energetic rocket fuels, evaluated in the 1950s and 1960s, but not widely used due to the extreme danger they posed. All three compounds are acutely toxic, highly corrosive, and can explode spontaneously when exposed to air. The residues from the combustion of these compounds are also toxic. However, given that the fuel cylinders were detonated at great depth (at least 200 feet), it is unlikely that either the surface soil or near-surface bedrock was contaminated in the process. Instead, it is likely that the site hazards are located at depth, near the bottom of the shafts.

Buried Debris

The debris buried in the mine shafts poses a potential explosive hazard in that there are no means of verifying that all propellants detonated during the burn following disposal. Additionally, the toxicities of the propellants (and possible combustion byproducts) are unknown, but may pose a risk to human health. Therefore, contact with the buried debris by all potential receptors must be prevented.

Groundwater

Based on groundwater flow directions inferred from topography, Wells 6-MW01 and 113-MW01 were installed immediately down gradient of each mine shaft in 2001; groundwater was encountered at depths of 250 feet and 260 feet, respectively. Groundwater samples from the Site 6 and 113 wells were analyzed for VOCs, SVOCs, NDMA, 1,4-dioxane, hydrazine, perchlorate, and general inorganic parameters (elements including metals, common anions, TDS, hardness, and alkalinity). No VOCs or SVOCs were detected above the reporting limit in either well. However, as shown on Figure 2.6-1, several VOCs and two SVOCs (phenol and benzoic acid) were detected at estimated concentrations

below the RL in Well 113-MW01; no MCLs were exceeded. Perchlorate was not detected, and none of the general inorganic parameters exceeded both their MCL (or NL) and background concentrations established for the AFRL (Earth Tech 2000b).

As shown on Figure 2.6-1, NDMA has been inconsistently detected at Sites 6 and 113 between 2001 and 2007. During the initial sampling in November 2001, NDMA was detected in both wells at concentrations below the NL of 0.01 μg/L. The June 2002 results showed that NDMA was still present (below the NL) in Well 6-MW01, but was not detected above the reporting limit (RL) of 0.002 μg/L in Well 113-MW01. In January 2003, the concentration in both wells increased, to a level (0.09 μg/L) above its NL in Well 6-MW01 and to a level at the NL (0.011 μg/L) in Well 113-MW01. In July 2003, the NDMA concentration in Well 6-MW01 returned to below the NL, but the concentration in Well 113-MW01 remained slightly above the NL (0.013 μg/L). Samples collected in September 2005 and August 2007 show that NDMA concentrations were below the NL in Well 6-MW01 and below the RL of 0.002 μg/L in Well 113-MW01.

Interim Remedial Actions

Other than the backfilling and capping of the mine shafts, no IRAs have been conducted at Sites 6 and 113.

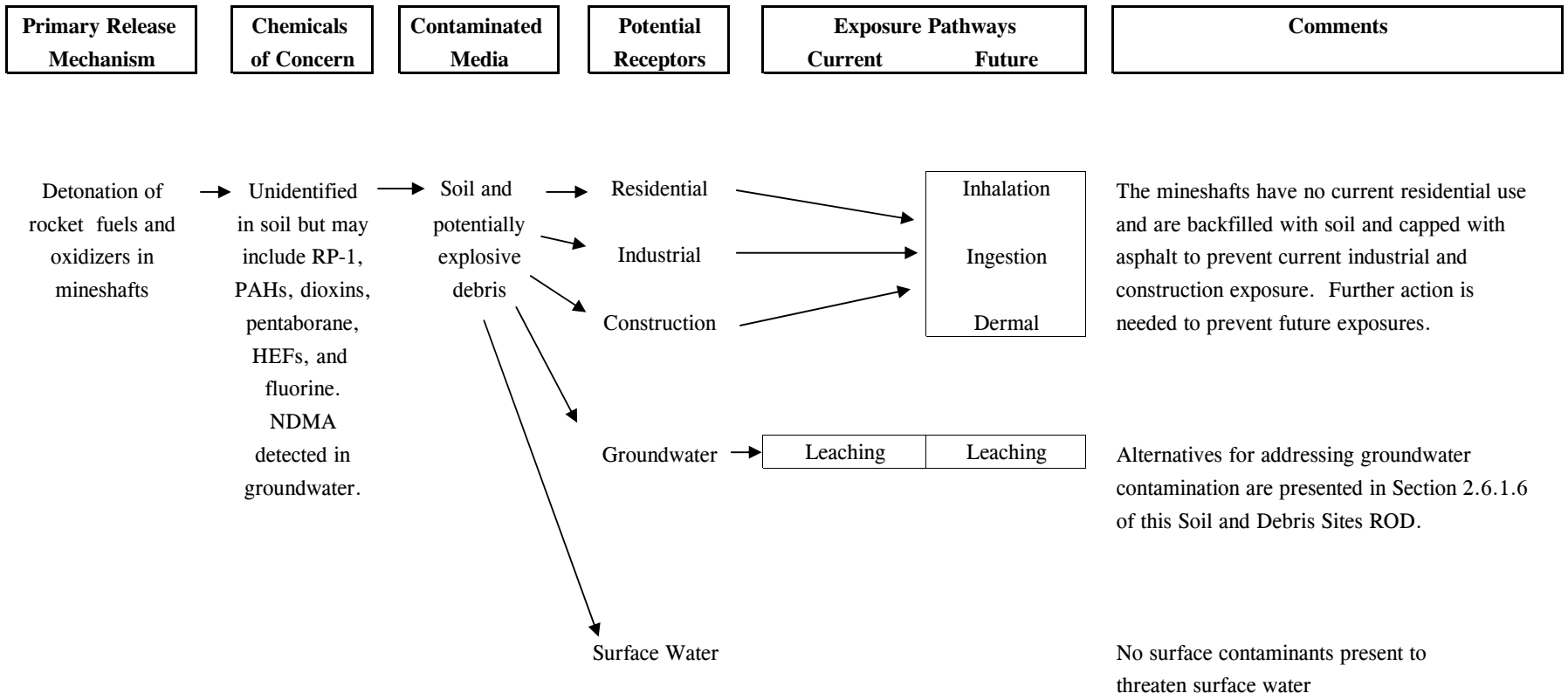
Nature and Extent of Residual Site Contamination

No cleanup has been performed at Site 6 and 113. Please see Site Characterization Sampling above for the nature and extent of site contamination.

Conceptual Site Model

The conceptual site model illustrating the potential exposure pathways for Sites 6 and 113 is shown on Figure 2.6-2. The mineshafts are backfilled and capped, preventing current exposures by residential (hypothetical), industrial, and construction receptors to the potentially hazardous soil and debris. However, further action is needed (i.e., maintenance of the engineering controls and LUCs) to prevent future exposures via the inhalation, ingestion, and/or dermal pathways. Additionally, there is a potentially complete exposure pathway for groundwater (as a receptor) through the leaching of contaminants from debris in the mineshafts. The past detection of NDMA in the Sites 6 and 113 wells

FIGURE 2.6-2. SITES 6 AND 113 CONCEPTUAL SITE MODEL - EXPOSURE PATHWAYS



Notes:

→	potentially complete pathway	PAHs	polycyclic aromatic hydrocarbons
HEFs	high energy fuels	ROD	record of decision
LUC	land use control	RP-1	Rocket Propellant-1
NDMA	N-nitrosodimethylamine		

indicates that this pathway may have resulted in groundwater impact. Because there are no surface contaminants present, there is no potential for surface water impact.

2.6.1.3 Current and Potential Future Land and Resource Uses

According to the *EAFB GP*, the current and anticipated future land uses at Sites 6 and 113 are test and research; there are no residential land uses planned. These land uses are considered industrial for risk assessment purposes.

2.6.1.4 Summary of Site Risks

Human Health Risk

No soil samples could be safely collected from the vicinity of the mine shafts. Therefore, no risk assessment for exposure to soil, or exposure to indoor air, could be conducted. However, as supported in Section 2.6.1.2, it is unlikely that the surface soil, or near-surface bedrock, pose health risks to any potential receptors. Given the depth of debris burial, only construction crews (i.e., those drilling for soil sampling or well installation) would potentially be at risk. Also, the depth of burial ensures that there is little likelihood for vapor intrusion from the potential site contaminants in the mine shafts.

In Earth Tech (2004), a preliminary evaluation of risk (under a hypothetical residential exposure to groundwater) was conducted for Sites 6 and 113 by taking the ratio of the maximum concentrations of chemicals detected (in samples available at the time) to the 2002 tap water PRGs. A cancer risk of 4×10^{-6} was estimated for Site 6, driven by an NDMA detection of 0.00513 μg/L (the HI was not applicable at this site). Site 113 exhibited a cancer risk of 3×10^{-5} (driven by a TCE detection of 0.815 μg/L and an NDMA detection of 0.00670 μg/L), and an HI of 0.06. It should be noted that more recent sampling results indicate lower concentrations of NDMA (i.e., less than 0.01 μg/L in Well 6-MW01 and less than 0.002 μg/L in Well 113-MW01 in 2005 and 2007); TCE was not detected above an RL of 1 μg/L (when last measured in 2003). Therefore, the cancer risk based on current levels of contaminants are likely lower that those calculated in 2002.

Ecological Risk

The OU9 ERA (USGS 2004b) identified no complete ecological exposure pathways to be present at Sites 6 and 113. Therefore, NFEI was recommended, and the site did not proceed to the SERA phase (USGS 2004c).

Threat to Groundwater and Surface Water

The sporadic detection of NDMA (including concentrations in 2003 that exceeded its NL in Wells 6-MW01 and 113-MW01) suggests that groundwater quality at Sites 6 and 113 may have been impacted by the contents of the mineshafts. However, groundwater samples collected in 2001, 2002, 2005, and 2007 exhibited NDMA concentrations below the NL or not detected (below the RL). This trend suggests that NDMA impact to groundwater from the mineshafts, if any, is limited and concentrations may continue to decline. The asphalt caps placed over the mine shafts prevent rain water infiltration through the backfill, providing protection from infiltration of rain water. Because the site contaminants are located deep within the mineshafts, ephemeral surface water (storm runoff) is not threatened; there is no permanent standing water on site.

2.6.1.5 Remedial Action Objectives

The RAOs for Sites 6 and 113 are:

1. Prevent all exposures by any potential receptors to the hazardous soil and debris contained in the mineshafts.
2. Limit surface access to authorized and trained industrial or construction personnel.
3. Detect and track any future releases of site contaminants to the groundwater.
4. Limit the potential for leaching of the mineshafts contents to the underlying groundwater.

2.6.1.6 Description of Alternatives

As described in the *Soil and Debris Sites FS*, the Air Force evaluated numerous remedial strategies to manage and/or clean up potentially explosive debris at Sites 6 and 113. After an initial screening of available technologies, two remedial alternatives were developed for detailed evaluation. Estimated

costs for both alternatives are presented in Table 2.6-1. Due to the depths of the mineshafts and the potential explosive hazards, active treatment or removal of the debris was considered infeasible.

Table 2.6-1. Sites 6 and 113 Remedial Alternatives Cost Breakdown

Remedial Alternatives (Selected Remedy Shown in Bold)	Unadjusted Cost	Escalated Cost	Present Value Cost
Alternative 1 – No Action Scenario	$0	$0	$0
Alternative 2 – Expand LUCs			
Replace Fences and Signs (capital cost in Year 1)	$12,000	$12,000	$12,000
Install Wells (capital cost in Year 1)	$200,000	$209,000	$200,000
LTM (recurring costs in Years 1 to 30)	$463,000	$626,000	$346,000
Administrative Controls (recurring annual costs in Years 1 to 30)	$69,000	$100,000	$46,000
	$744,000	**$947,000**	**$604,000**
Annual Cost Beyond Year 30 (LUCs)	$2,000	-	-
Annual Cost Beyond Year 30 (LTM)	$13,000	-	-
	$15,000		

Notes:

Escalation factors from RACER Software. Present value based on a 3% discount factor. All costs rounded to nearest $1,000. Costs for well installation and LTM assume four new wells (two at each site) and sampling of all six wells semiannually for the first 2 years, then once every 5 years thereafter. Sampling parameters include VOCs, NDMA, and elements, including metals. These assumptions and the costs will be revised when the details of the program are finalized in the forthcoming RAWP. Cost backup provided in Table C-4, Appendix C.

Alternative 1 – No Action

As required by the NCP, the no action alternative is listed only to compare to other alternatives. No remedial action would be taken at Sites 6 and 113.

Alternative 2 – Land Use Controls Only (Selected Remedy)

The following engineering and administrative LUCs will be instituted at Site 6 and 113:

Engineering Controls

The design of the existing four-strand, barbed-wire fences surrounding the mine shafts is not adequate to properly limit site access. The fences can easily be bypassed, and there are no locked gates. Moreover, the fences have fallen into disrepair and portions of the barbed-wire have been removed.

Consistent with RAO Nos. 1 and 2, new chain-link fences with locking gates will be installed around each mine shaft, and signs warning of the potential explosive hazard and providing a point of contact telephone number will be posted on all four sides of each compound. Annual inspection and maintenance of the fences, gates, and signs will be conducted to ensure long-term protectiveness of the remedy.

Consistent with RAO No. 4, the asphalt caps (currently intact and in good condition) limit the potential for infiltration of rain water through the mineshafts to the groundwater. These engineering controls will be augmented with stormwater diversion measures (to be detailed in the forthcoming RAWP). Annual inspection and maintenance of the asphalt caps and stormwater diversion measures will be conducted to ensure long-term protectiveness of the remedy.

Long-Term Groundwater Monitoring

Consistent with RAO No. 3, a groundwater action component for Sites 6 and 113 is included in this ROD because these sites are not located within any of the groundwater management areas listed in Section 1.3.4. LTM is the preferred ground water action for these sites primarily because: (1) NDMA concentrations are low and have been declining over the last three years, (2) current NDMA concentrations are less than the State NL, (3) the area of degraded groundwater is likely small and localized, and (4) the sites are in a remote location with no potential groundwater users affected.

The following lists the general components of the Sites 6 and 113 LTM program; specific details will be presented in the forthcoming post-ROD RAWP:

1. Installation of additional groundwater monitoring points as necessary to establish the local groundwater flow gradient and provide data to establish background concentrations.

2. Periodic sampling for VOCs, NDMA, and elements (including metals) in existing Wells 6-MW01 and 113-MW01, as well as any future wells installed for that purpose. The sampling frequency will be specified in the RAWP.

3. If the groundwater sampling shows the NL for NDMA (currently 0.01 μg/L) has been exceeded, the RAWP will be modified and implemented for enhanced groundwater monitoring; and will include a process to consider whether further action is warranted.

Administrative LUCs

Because potentially hazardous debris remains in the mine shafts, LUCs will be needed to ensure that access to the site is strictly regulated. To ensure that no unauthorized digging could encounter a mineshaft regardless of its orientation below ground, the LUCs boundaries (Figure 2.6-1) encompass circular areas extending 300 feet from each mineshaft. The vertical component of the LUC boundaries extends from the surface to the first occurrence of groundwater at a depth of approximately 250 feet to 260 feet (it is unlikely the mineshafts extend below the groundwater-bearing fractures).

The specific LUC objectives for Sites 6 and 113 under this remedy are as follows:

1. Consistent with RAO No. 1, the land within the LUC boundaries is to remain unused and will not be cleared for any residential, industrial, agricultural, or commercial purposes; access to the site by residential receptors and most Base personnel will be prohibited.

2. Consistent with RAO No. 2, access by site workers (i.e., for cap and fence maintenance) will be permitted only with prior authorization from Environmental Management; and only for those with current training in hazardous waste operations and supplemental instruction related to construction in the vicinity of munitions and explosives of concern (MEC) or other potentially explosive and/or hazardous materials. Intrusive work (excavation or drilling) will be prohibited except as needed for cap maintenance. No buildings or other inhabited structures are to be constructed within the LUC boundaries.

3. Discharges of water to the surface and/or subsurface at Sites 6 and 113 will be prohibited (RAO No. 4).

4. Currently, both sites are located within an active range area, and are not being considered for Military Munitions Response Program (MMRP) activities (which are reserved for closed ranges). However, if the range is closed in the future, the mine shafts which potentially contain explosive debris may be added to the program.

Further discussion of these LUCs, including the means for implementation and documentation, is presented in Section 2.8.1 – LUCs General Provisions.

2.6.1.7 Comparative Analysis of Alternatives

The comparative analysis of the alternatives for Sites 6 and 113 is presented in Table 2.6-2.

Table 2.6-2. Comparative Analysis of Alternatives – Sites 6 and 113

KEY L – Low M – Medium H – High NA – Not applicable NPC – No public comments received	Threshold Criteria		Balancing Criteria					Modifying Criteria	
Evaluation Criteria	Overall protection of human health and the environment	Compliance with ARARs	Long-term effectiveness and permanence	Reduction of toxicity, mobility, or volume through treatment	Short-term effectiveness	Implementability	Escalated cost (Years 1 through 30)	Public acceptance	State/Support Agency acceptance
1. No Action	L	NA	NA	NA	NA	NA	NA	NA	NA
2. LUCs (Selected Remedy)	H	H	M	M	H	H	$**947**K	NPC	H

Alternative 1 does not meet the threshold criterion of being protective of human health and the environment and was therefore eliminated from further consideration. Alternative 2 meets both threshold criteria (see Section 2.6.1.10) and was therefore evaluated against the five balancing criteria as follows.

Alternative 2 rates high on implementability and short-term effectiveness because it requires only minor construction, which will not expose construction workers to the hazardous debris in the mineshafts during implementation. However, because the future effectiveness of the remedy relies on LUCs, long-term effectiveness and permanence are rated at medium. Moreover, reduction of toxicity, mobility, or volume of contaminants through treatment are rated medium; although there will be reduction in mobility to groundwater through stormwater diversion measures and cap maintenance, potentially explosive debris will remain untreated in the mineshafts.

2.6.1.8 Principal Threat Wastes

The potentially explosive debris buried within the mineshafts represents a principal threat waste in that any exposure could pose a danger to life or health.

2.6.1.9 Selected Remedy

The Air Force and USEPA, with concurrence from Cal/EPA DTSC and the Water Board, selected Alternative 2 as the remedy for Sites 6 and 113.

2.6.1.10 Statutory Determinations

Under CERCLA Section 121 and the NCP, the lead agency must select remedies that meet the threshold criteria of being protective of human health and the environment, and complying with ARARs (unless a statutory waiver is justified). As balancing criteria, the remedies should also be cost effective, and should utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, CERCLA asserts a preference for remedies that employ treatment that permanently and significantly reduces the volume, toxicity, or mobility of hazardous wastes as a principal element, and a bias against off-site disposal of untreated wastes. The following sections discuss how the selected remedy meets these statutory requirements.

Protection of Human Health and the Environment

The mineshafts at Sites 6 and 113 contain potentially explosive debris that poses an unacceptable risk to all receptors. Alternative 2 offers adequate protection by restricting site access through LUCs, and by ensuring that the mineshaft caps are maintained. The asphalt caps and stormwater diversion measures provide adequate protection for the underlying groundwater by preventing rain water infiltration through the mine shafts. LUCs ensure that no exposure to the groundwater will occur and the LTM program will detect and track future releases of COC (if any).

Compliance with ARARs

Section 121(e) of CERCLA, USC Section 9621(e), states that no federal, state, or local permit is required for remedial actions conducted entirely on site; these actions must meet the substantive but not administrative requirements of ARARs.

Chemical-Specific ARARs. The following chemical-specific ARARs were identified as relevant and appropriate for Sites 6 and 113:

- Federal and State primary drinking water standards (non-zero maximum contaminant level goals [MCLGs] and MCLs) (see Appendix B, Table B-1, Item 1).

- The beneficial uses designated in the *Water Quality Control Plan, South Lahontan Basin* (Basin Plan) for minor surface waters in the Antelope Hydrologic Unit and North Muroc Hydrologic Area and for groundwater in the Antelope Valley (see Table B-1, Item 2).

Location-Specific ARARs. Because Sites 6 and 113 have already been heavily disturbed, most state and federal regulations governing protection of wildlife resources are not ARARs. However, endangered or threatened species are present at the AFRL, and the mineshafts have historical significance as part of the Kramer Mining District. Therefore, the following are listed as RARs for Sites 6 and 113:

- California Endangered Species Act (Table B-1, Item No. 4);
- Federal Endangered Species Act (Table B-1, Item No. 5); and
- National Historical Preservation Act (Table B-1, Item No. 7).

Field activities associated with the selected remedy will be coordinated with Base biologists to ensure the protection of sensitive wildlife species and with base archeologists to ensure the historical significance of the mineshafts is not impacted.

Action-Specific ARARs. The following requirements are relevant and appropriate for Sites 6 and 113:

- Sources of Drinking Water Policy (Table B-1, Item 9).
- 22 CCR, Div. 4.5, Ch. 39, Section 67391.1 and Civil Code Section 1471a and b (Table B-1, Item No. 12). As discussed in Section 2.6.1.6, LUCs are included as part of the selected remedy because potentially hazardous debris will be left in the mineshafts. In the event of transfer of property that includes the Sites 6 and 113 LUC boundary to a non-federal entity, a land use covenant with DTSC would be required. Therefore, the cited requirements are relevant and appropriate to the selected remedy.
- CIWMB post-closure care requirements, to the extent feasible, for closed, abandoned, and inactive (CAI) units - 27 CCR Sections 20080 (g), 20090 (d), 20385, 20390, 20395, 20400, and 20420 (a – i) (Table B-2).

Disagreement on ARARs. The Air Force and Water Board do not agree on whether the following Water Board requirements are ARARs for Sites 6 and 113:

- Specific sections of the *Basin Plan*, including but not limited to:

- WQOs for non-degradation (page 3-2) and certain of the WQOs for surface waters (page 3-3) and groundwater (page 3-11).

- Region-wide prohibitions 1 and 2 (found on page 4.1-1), which prohibit discharging a waste which causes a violation of narrative (including non-degradation) or numeric WQOs.

- Soil Cleanup Levels (page 4.2-4): "The Regional Board will determine soil cleanup levels for the unsaturated zone based upon threat to water quality… If it is unreasonable to clean up soils to background concentration levels,…site-specific recommendations for soil cleanup levels [may [be] consider[ed]] provided that applicable groundwater quality objectives are met and health risks from surface or subsurface exposure meet current guidelines."

Please see Section 2.8.2 for the individual positions held by the Air Force, the USEPA, and the Water Board regarding analysis of whether these requirements are ARARs.

Notwithstanding the Air Force position that these Water Board requirements are not ARARs for this action, the selected remedy for Sites 6 and 113 meets the technical requirements of California water quality law, plans, and policies for protection of surface waters and groundwater in that the asphalt cap prevents surface water intrusion, surface water diversion measures will be implemented, and surface water discharges will be prohibited. The underlying groundwater currently meets primary MCLs and is only marginally degraded by NDMA. Moreover, the selected remedy meets the following five exemption criteria cited (on page 4.1-2) by the *Basin Plan* for restoration projects:

- The storm water diversion measures and the asphalt mine shaft caps will reduce or mitigate existing sources of soil erosion, water pollution, or impairment of beneficial uses;

- There is no feasible alternative to the project (i.e., it is technically impractical to remove or treat in place the potentially explosive debris);

- Land disturbance will be minimized to the area immediately surrounding each mine shaft and new monitoring well site;

- The asphalt mine shaft caps minimize potential adverse environmental impacts; and

- The selected remedy complies with the ARARs identified in Appendix B.

Cost Effectiveness

Because the selected remedy is the only alternative that meets the statutory requirements, the moderately high projected cost is justified. It should be noted that the cost estimates presented in this ROD include only the first 30 years of remedy implementation. Given the indefinite duration of the selected remedy, the total lifecycle costs of the remedy cannot be calculated, but will likely be far greater than the 30-year costs shown. Table 2.6-1 lists an estimate of the unadjusted annual cost of implementing the remedy beyond Year 30.

Utilization of Permanent Solutions and Alternative Treatment Technologies

Excavation of the mines to remove the debris would prove technically infeasible and dangerous. Therefore, the selected remedy does not incorporate permanent solutions or alternative treatment technologies. However, the protection afforded by the remedy is expected to be effective over the long term provided routine maintenance of the asphalt caps, stormwater diversion measures, fencing, and signs is performed; the LUCs are enforced; and the LTM program is implemented.

Preference for Treatment as a Principal Element

The selected remedy does not satisfy the statutory preference for treatment as a principal element of the remedy. As discussed in Section 2.6.1.6, excavation of the mines to remove the debris would be dangerous and technically infeasible.

Five-Year Review Requirements

Because the selected remedy will result in hazardous substances, pollutants, or contaminants (potentially explosive debris in mineshafts) remaining on-site above levels that allow for unrestricted use and unrestricted exposure (i.e., residential levels), a statutory review will be conducted within 5 years after initiation of the remedial action to satisfy NCP Section 300.430(f)(4)(ii), and at 5-year intervals thereafter, as long as hazardous substances remain at the site at levels that do not allow for unrestricted (residential) uses. Five-year reviews will be conducted in accordance with CERCLA Section 121(c) and are required to determine whether the remedy continues to be protective of human health and the environment.

2.6.1.11 Documentation of Significant Changes from Proposed Plan

Significant changes from the *Soil and Debris Sites PP* include the addition of LTM at Sites 6 and 113 as part of the LUCs. Also, as discussed in Section 2.5.1.11, the present value cost for implementing long-term LUCs at Sites 6 and 113 was recalculated using a 3 percent discount factor rather than 7 percent. These two changes (especially the addition of LTM) resulted in significant cost increases for Alternative 2.

2.6.2 SITE 115 – TEST AREA 1-100 MISSILE SILOS 1 AND 2

2.6.2.1 Site Name, Location, and Description

Site 115 is located in Test Area 1-100, at the northeast terminus of Gemini Road (Figure 2.1-2). The test area was constructed in 1959 and was used during the 1960s for test launches of tethered Minuteman I and II intercontinental ballistic missiles (ICBMs) from Missile Silo 1 (Building 8959) and Missile Silo 2 (Building 8960) (Figure 2.6-3). Test Area 1-100 has been largely inactive since the 1970s with the exception of ongoing periodic solid propellant burns at Site 39. As described in the *Sites 270 and 39 RI Site Summary Report* (Earth Tech 2003c), Site 39 is an active Open Burn Area operating under a RCRA permit, and is therefore not being evaluated as part of this CERCLA ROD.

As documented in the *OU 9 RI Summary Report* (Earth Tech 2006d), which can be found in the administrative record file and information repositories, Site 115 includes Missile Silos 1 and 2, two former sanitary leachfields, an open pit, and an open trench (see Section 2.6.2.2). Figure 2.6-4 shows a diagram of Silo 2 in plan view; although not shown on the figure, Silo 1 shares similar construction details. Each silo consists of a concrete and steel-lined vertical shaft measuring approximately 27 feet in diameter and 86 feet in depth; the walls of the shaft extend approximately 2 feet above the ground surface. Inside each shaft is a steel launch tube into which the missiles were loaded; service walkways are installed at various levels around each launch tube. The silo shafts are ringed by concentric circular concrete pads and asphalt access roads. Because only limited construction details are available, it must be conservatively assumed that the silos are not sealed against water (or contaminant) seepage. Each silo is fitted with a horizontal box-framed protective cover that rolls away from the silo on steel guide rails. Each cover measures 30 feet square and 3 feet tall, and is enclosed by steel plates on the top and on all sides except one, left open so that the cover clears the above-ground portion of the silo when

115-MW04	10/02	1/03	7/03
NDMA	-	0.0586	-

(0',25',40',45') 115-B08	0'	25'	25'*	40'	45'
BIS(2-ETHYLHEXYL)PHTHALATE	<0.35	<0.38	<0.35	0.387	0.169 J
DIESEL FUEL #2	3.77 J	<12	<11	<10	<10

115-MW03	10/01	6/02	1/03	8/03	8/03	9/05
CIS-1,2-DCE	0.95 J	8.5	7.0	6.8	-	2.1
PERCHLORATE	<4.0	<4.0	9.6	-	<8.0 G	-
TCE	15.9	<1.0	1.1	1.7	-	1.9

(0',5',25',45') 115-B07	0'	5'	25'	45'
BIS(2-ETHYLHEXYL)PHTHALATE	<0.36	0.118 J	<0.35	<0.34
DIESEL FUEL #2	<11	10.7	<11	<10

SEE INSET A

OPEN TRENCH

OPEN PIT

(0') 115-TSS08

(0',30',45') 115-B01

(5',20',40') 115-B03

(0') 115-TSS06

(0') 115-TSS07

(0',25',45') 115-B02

MANHOLE

P034

8950

TANKS

REVETMENT

FORMER LEACHFIELD 1 (FIELD-DETERMINED LOCATION)

(0',15',25') 115-B06	0'	15'	25'
METHYLENE CHLORIDE	0.00200 J	0.00259 J	0.00264 J
DIESEL FUEL #2	<11	<11	4.70 J

115-MW02	10/01	6/02	1/03	7/03	8/03	9/05
NDMA	-	-	0.00376	-	-	<0.002
PERCHLORATE	<4.0	7.1	<8.0	-	<8.0 G	<2.0
PCE	2.98	2.5	2.0	1.9	-	1.6

8959 SILO NO. 1

115-MW01 ND

SITE 115

GEMINI ROAD

6,664,700 E

2,168,500 N

(5',20',45') 115-B05

BIS(2-ETHYLHEXYL)PHTHALATE	5' <0.38	20' <0.35	45' 0.940

115-TSS04	0'
BENZO(A)ANTHRACENE	0.0052 J PG
BENZO(A)PYRENE	0.0061 J
BENZO(B)FLUORANTHENE	0.0060 J
BENZO(G,H,I)PERYLENE	0.0054 J
BENZO(K)FLUORANTHENE	0.0030 J
FLUORANTHENE	0.0070 J
INDENO(1,2,3-CD)PYRENE	0.0046 J

39-MW01	7/02	1/03	8/03	9/05
PCE	<1.0	0.44 J	0.41 J	<1.0

115-TSS03

115-TSS05

FORMER LEACHFIELD 2 (FIELD-DETERMINED LOCATION)

OPEN BURN AREA

MANHOLE

8953

P035

P036

8955

39-MW02 ND

(0',20',35') 115-B04	0'	20'	35'
METHYLENE CHLORIDE	0.00408 J	<0.0054	0.00269 J
TRICHLOROFLUOROMETHANE	0.00233 J	<0.0054	<0.0053
BENZO(A)ANTHRACENE	0.180 J	<0.36	<0.35
BENZO(A)PYRENE	0.205 J	<0.36	<0.35
BENZO(B)FLUORANTHENE	0.217 J	<0.36	<0.35
BENZO(G,H,I)PERYLENE	0.259 J	<0.36	<0.35
BENZO(K)FLUORANTHENE	0.180 J	<0.36	<0.35
CHRYSENE	0.214 J	<0.36	<0.35
FLUORANTHENE	0.357 J	<0.36	<0.35
INDENO(1,2,3-CD)PYRENE	0.223 J	<0.36	<0.35
PHENANTHRENE	0.184 J	<0.36	<0.35
PYRENE	0.335 J	<0.36	<0.35

SITE 39

2,171,000 N

6,670,700 E

115-MW07	7/94	8/99	8/99	8/00	8/02	1/03	7/03	9/05
CIS-1,2-DCE	<1.0	<1.0	-	<1.0	0.47 J	0.61 J	0.77 J	<1.0
TRANS-1,2-DCE	<1.0	<1.0	-	<1.0	<1.0	0.23 J	0.26 J	<1.0
TCE	21	14	-	27	46	42	41	47

(0',3') 115-HB06	0'	3'
FLUORANTHENE	0.014 J PG	<0.055
PHENANTHRENE	0.0062 J	<0.11

(0,2.5') 115-HB05

(0, 20', 45') 115-MW06 (SOIL)	0'	0'*	20'	45'
ANTHRACENE	0.72	<0.35	<0.35	<0.34

115-HB07	0'	0'*	3'
FLUORANTHENE	0.026 J PG	0.015 J	<0.052
PHENANTHRENE	0.022 J	0.021 J	<0.10

8960 SILO NO. 2

LIMITS OF LAND USE CONTROLS

SITE 338

FORMER TEST STAND

BURN PIT

338-MW01	1/01	12/01	6/02	1/03	7/03	9/04	9/05
CIS-1,2-DCE	1.9 J	8.4	10	12	17	6.0	7.7
TRANS-1,2-DCE	<5.0	2.0	2.4	2.8	2.8	<1.0	<1.0
NDMA	0.0159	0.0639	0.0241	0.0290	0.0988	<0.002	<0.002
TCE	76	48	39	41	39	77	59

338-MW02 ND

INSET A
SCALE: 1"= 30'

(0') 115-TSS02

115-HB04 (0.5,3.0,5.0)

115-HB03 (0.5',3.0',6.0')

115-B08

115-B07

OPEN PIT

115-HB02 (0.5',2.0')

(0') 115-TSS01

115-HB01 (0.5,2.0)

EXPLANATION

- MONITORING WELL
- BOREHOLE
- APPROXIMATE HAND-AUGERED LOCATION
- HAND-AUGERED BOREHOLE LOCATION
- SURFACE SOIL SAMPLE LOCATION
- (R) REMOVED UNDERGROUND STORAGE TANK
- * DUPLICATE SAMPLE
- SURFACE DRAINAGE
- GENERALIZED GROUNDWATER FLOW DIRECTION
- —x— CHAINLINK FENCE (PROPOSED)
- LOCKED GATE (PROPOSED)

DCE DICHLOROETHENE
J ESTIMATED CONCENTRATION DETECTED BELOW THE REPORTING LIMIT
NDMA N-NITROSODIMETHYLAMINE
PCE TETRACHLOROETHENE
PG DIFFERENCE BETWEEN ORIGINAL AND CONFIRMATION ANALYSES IS >40%
TCE TRICHLOROETHENE
UEH UNKNOWN EXTRACTABLE HYDROCARBONS

(DEPTHS SAMPLED)
LOCATION NAME — SAMPLE DEPTH/DATE
PARAMETER NAME — VALUE DETECTED
SOIL (mg/Kg)
GROUNDWATER (µg/L)

NORTH

0 200 400 FEET

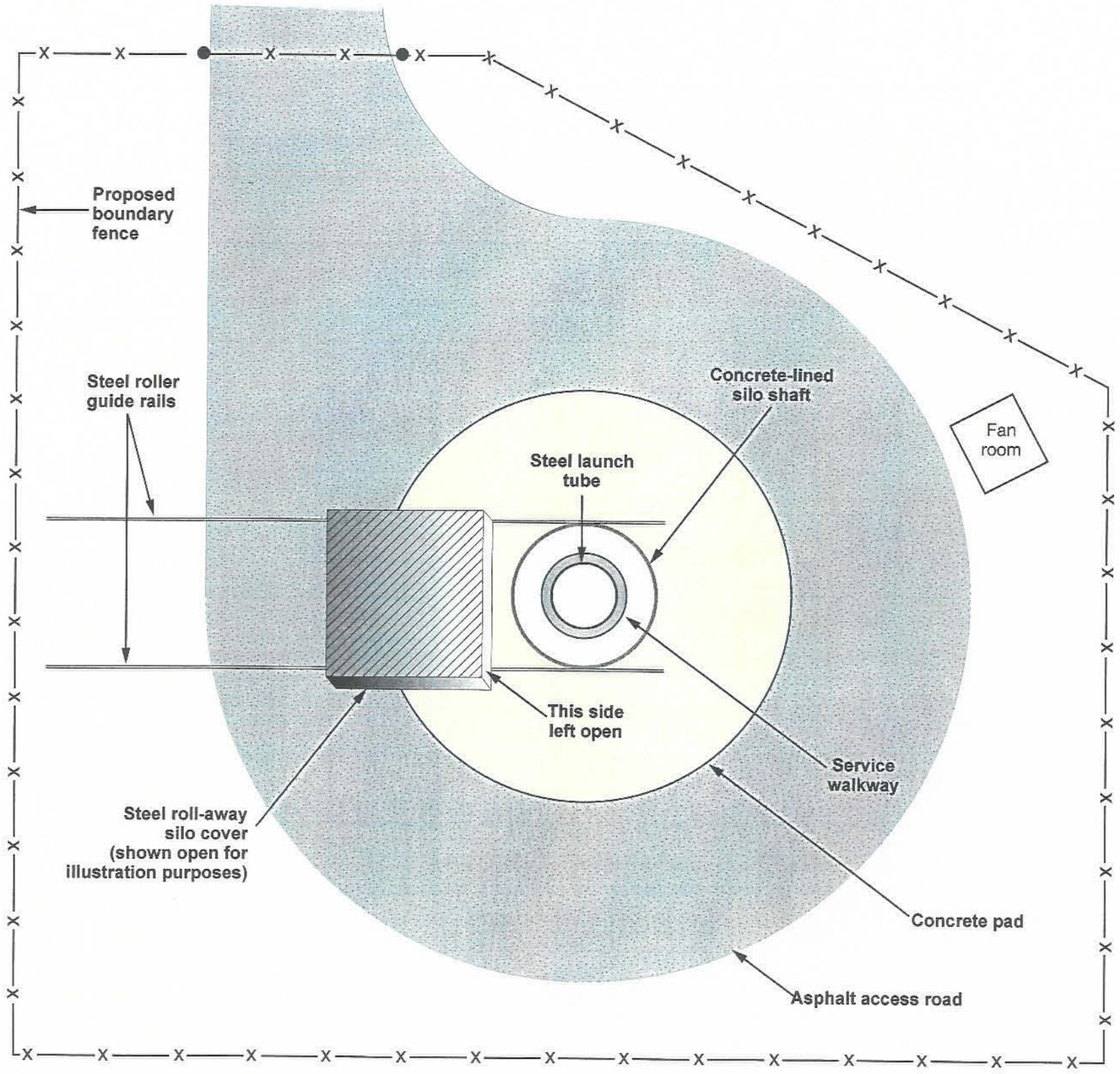
SCALE: 1"= 400'

OUs 4 and 9 Soil and Debris Sites ROD

Site 115 Map Showing Soil and Groundwater Sampling Results

Date 5-08	Air Force Research Laboratory Edwards AFB	Figure 2.6-3
Project No. 87503		

EDWARDS\87503\B6592FGA.A01



North

0 25 Feet

(Approximate)
Scale 1" = 25'

87503.10.04.17.01 Fig 2.6-4

OUs 4 and 9 Soil and Debris Sites ROD

Site 115 Diagram Showing Silo 2 in Plan View

Date 05-08	Air Force Research Laboratory	Figure
Project No. 87503	Edwards AFB	**2.6-4**

being opened. Although the covers are now welded in the closed position, the open sides allow entry to the silos and are not adequate access controls. However, the covers are effective in preventing rainwater infiltration through the silos. Because the silos were used only for test launches, they do not include the underground support facilities (i.e., launch control center and living quarters) typically included in the design of fully functional missile silo complexes.

2.6.2.2 Site History and Enforcement Activities

Site History

The missile tests conducted at Site 115 were performed to prove and refine the concept of below-ground silo launches of the Minuteman I and II ICBM systems. Because the scope of the test program was limited to the first few moments of flight, the missiles were tethered to the ground by a data cable only about 500 feet long, and likely carried only enough perchlorate-based solid fuel to clear the silos before motor cutoff. It is also likely that the upper stages of the test missiles were non-functional mockups used only to provide realistic weight and balance.

During the test program, solid propellant residues from the perchlorate fuels were likely deposited in the silos. Additionally, in the mid-1960s, a missile (likely a Minuteman II) exploded inside Silo 1, damaging it beyond repair. Details of the accident are sparse, but the remnants of the missile were reportedly left in place and the silo was backfilled with debris, including fill soil, roofing material, and other construction materials. Collectively, the materials used to fill the silo (including the fill soil) are referred to as debris and are distinct from native soil on site. Although Silo 2 was also deactivated in the 1960s, it was reportedly not filled in with debris. In 1988, approximately twenty 1- and 5-gallon containers of X-ray developing fluids (acetic acid and aluminum chloride) were discarded into Silo 2. The unauthorized disposal was reported to the AFRL Safety and Health Office, which recovered several containers from the silo's first level (at a depth of 20 feet). However, most of the containers were broken and their contents released. Three broken containers were visible on the bottom of the silo during the initial site visit and were not recovered.

Building 8950 was a missile assembly building where solid rocket engines were combined with their components into complete missile systems ready for testing. In the early 1960s, Building 8950 was used to test a pentaborane transfer system. After each test, the plumbing system was flushed with

RP-1, reportedly to an open pit (10 feet in diameter) located 200 feet northwest of the building. The open pit has a 2-inch diameter inlet pipe and an ignition wire leading from Building 8950. An overflow pipe drains from the open pit into an open trench, approximately 50 feet long. Building 8955 was built in 1959 and was used as a control station for the silo test firings. Building 8953, provided shop and office space. Two former leachfields were apparently used for disposal of septic wastes generated in Buildings 8950 and 8953.

Site Characterization Sampling

Soil

Samples were collected from the native soil (excludes fill soil in Silo 1) present at Site 115 in 1994, 2001, and 2002; estimated concentrations (detected below laboratory reporting limits) of PAHs, possibly attributed to burn activities at nearby Site 39, were detected. However, only the surface sample from Borehole 115-B04 exhibited a PAH [benzo(a)pyrene] above its residential PRG of 0.062 mg/kg; the industrial PRG of 0.21 mg/kg was not exceeded. Results for samples collected in 2005 indicated that only trace concentrations of PAHs (well below residential PRGs) were present; therefore, PAHs in soil are not considered COCs at this site. No other organic COCs were detected in soil at Site 115.

In samples collected in 2005, only iron (among the elements including metals detected at Site 115), in a single sample, was found at a concentration that exceeded both its residential PRG and background levels. Due to its limited distribution, and because the industrial PRG was not exceeded, iron is not considered a COC at Site 115. Although perchlorate was detected in soil at nearby Site 39, a full remedial investigation cannot be completed until active use of this unit is discontinued at a future (undetermined) date. The Site 39 remedial investigation, and possible remedy selection, will be conducted independent of this ROD.

Buried Debris

The debris filling Silo 1 has not been analyzed due to the potential risks involved with sampling potentially explosive solid fuels. However, based on historical reports, it is likely that the debris consists of the remnants of the destroyed missile, unburned fragments of solid perchlorate fuel,

potential combustion byproducts from the burned fuel, and inert backfill (including soil, roofing material, and other construction debris).

Groundwater

Impacts to the groundwater at Site 115 are demonstrated by the presence of TCE, cis-1,2-DCE, and NDMA above their respective MCL or NLs. Groundwater sampling of all wells in the immediate vicinity of Site 115 (Figure 2.6-3) suggests that these organic compounds may originate from activities at an upgradient former Test Stand (formerly identified as Site 338). Perchlorate has been inconsistently detected at low concentrations in Wells 115-MW02 and 115-MW03. The perchlorate contamination likely originates from the missile launches and related activities at Site 115. The groundwater contamination at Site 115 will be addressed in the ROD for Northeast AFRL area.

Interim Remedial Actions

No IRA or treatability study has been performed at Site 115.

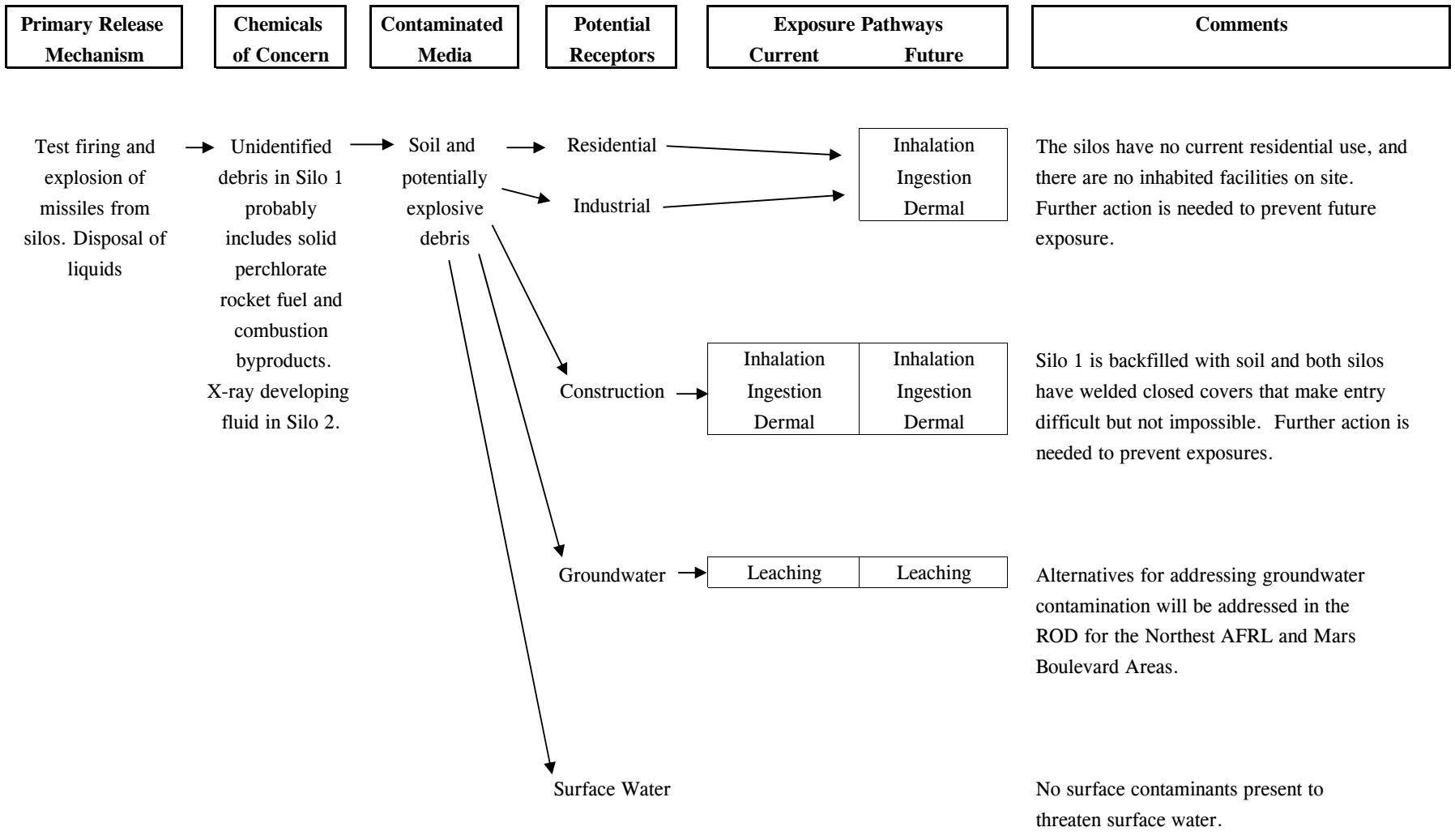
Nature and Extent of Residual Site Contamination

Please see discussion of site characterization sampling above. No COCs were retained for native soil at Site 115, and the debris filling Silo 1 was not characterized for specific COCs. However, as discussed above, the debris may contain unburned perchlorate and burned perchlorate fuel residues.

Conceptual Site Model

The conceptual site model illustrating the potential exposure pathways for Site 115 is shown on Figure 2.6-5. There are no potentially complete exposure pathways to current residential (hypothetical) or industrial receptors; however, further action is required to prevent future exposures to potentially hazardous debris via the inhalation, ingestion, or dermal pathways. Similar exposures are possible by current or future construction workers. Additionally, there is a potentially complete exposure pathway for groundwater (as a receptor) through the leaching of contaminants from debris inside the missile silos (see Section 2.6.2.4 – Threat to Groundwater and Surface Water). Because there are no surface contaminants present, there is no potential for surface water impact.

FIGURE 2.6-5. SITE 115 CONCEPTUAL SITE MODEL - EXPOSURE PATHWAYS



Notes:

→ potentially complete pathway
AFRL Air Force Research Laboratory
ROD record of decision

2.6.2.3 Current and Potential Future Land and Resource Uses

According to the *EAFB GP*, the current and anticipated future land uses at Site 115 are test and research; there are no residential land uses planned. These land uses are considered industrial for risk assessment purposes.

2.6.2.4 Summary of Site Risks

Human Health Risk

Results of the risk assessment for soil are shown in Table 2.6-3. The estimated cancer risks from exposure to soils under all exposure scenarios are less than 1×10^{-6}. The hypothetical residential scenario exhibits a non-carcinogenic HI at 6.3 driven primarily by the maximum detected concentrations of iron and manganese (note that elevated concentrations of manganese were not confirmed in 2005 sampling results; iron was elevated in only one sample as discussed in Section 2.6.2.2 – Site Characterization Sampling). The HIs for the industrial and construction scenarios are near or below 1. It should be noted that the risks and HIs may be underestimated if propellant residues (i.e., perchlorate) or other wastes have seeped through the silo walls into the adjacent soil. However, given that the areas surrounding the silos are paved with both concrete and asphalt, it is unlikely (but not impossible) that humans would be exposed to the soil. Because no VOCs were detected in the Site 115 soil above residential PRGs (Appendix D), no evaluation of risk via the VIP into indoor air from soil was conducted. The forthcoming Northeast AFRL ROD will include an evaluation of risk via the VIP associated with the Site 115 groundwater plume, and the selected remedial response.

Although the debris filling Silo 1 has not been sampled, it may pose a potential physical hazard (risk of explosion) in that there are no means of verifying that all propellants were burned off during the missile explosion. Additionally, the toxicities of the rocket propellants, including potential by-products of incomplete combustion, are unknown but are likely to pose risk to human health. The waste liquids disposed in Silo 2 also may pose a threat to human health. Therefore, it is conservatively assumed that physical contact with the debris (or inhalation/ingestion of dust from the debris) would pose an unacceptable hazard to all receptors.

TABLE 2.6-3. QUANTIFICATION OF RISKS AND HAZARDS IN SOIL - SITE 115

(Page 1 of 2)

Analyte	Maximum Detected Concentration	Residential PRG[(1)]	Industrial PRG[(1)]	Residential Risk and Hazard Index		Industrial Risk and Hazard Index	
				Carcinogens	Noncarcinogens	Carcinogens	Noncarcinogens
Inorganic Analytes (mg/kg)							
antimony	2.49E+01	3.13E+01	4.09E+02		0.796		0.061
beryllium	9.76E-01	1.54E+02	1.94E+03 c		0.006	5.03E-10	
cadmium	1.50E+00	3.70E+01	4.51E+02		0.041		0.003
chromium, total	5.34E+01	2.11E+02 c	4.48E+02 c	2.53E-07		1.19E-07	
cobalt	9.58E+00	9.03E+02 c	1.92E+03 c	1.06E-08		4.99E-09	
copper	6.91E+01	3.13E+03	4.09E+04		0.022		0.002
iron	8.56E+04	2.35E+04	1.00E+05		3.648		0.856
lead	2.31E+01	1.50E+02	7.50E+02		0.154		0.031
manganese	2.17E+03	1.76E+03	1.95E+04		1.231		0.112
molybdenum	6.00E+00	3.91E+02	5.11E+03		0.015		0.001
nickel	6.01E+02	1.56E+03	2.04E+04		0.384		0.029
nitrogen, nitrate (as N)	3.22E+00	NA	NA		NA		NA
selenium	2.60E+00	3.91E+02	5.11E+03		0.007		<0.001
zinc	1.52E+02	2.35E+04	1.00E+05		0.006		0.002
Organic Analytes (mg/kg)							
benzo(a)anthracene	5.20E-03	6.21E-01 c	2.11E+00 c	8.37E-09		2.46E-09	
benzo(a)pyrene	6.10E-03	6.21E-02 c	2.11E-01 c	9.82E-08		2.89E-08	
benzo(b)fluoranthene	6.00E-03	6.21E-01 c	2.11E+00 c	9.65E-09		2.84E-09	
benzo(g,h,i)perylene	5.40E-03	2.32E+03 s	2.91E+04 s				
benzo(k)fluoranthene	3.00E-03	3.78E-01 c	1.28E+00 c	7.94E-09		2.34E-09	
bis(2-ethylhexyl) phthalate	9.40E-01	3.47E+01 c	1.23E+02 c	2.71E-08		7.63E-09	
fluoranthene	2.62E-01	2.29E+03	2.20E+04		<0.001		<0.001

TABLE 2.6-3. QUANTIFICATION OF RISKS AND HAZARDS IN SOIL - SITE 115
(Page 2 of 2)

Analyte	Maximum Detected Concentration	Residential PRG[1]		Industrial PRG[1]		Residential Risk and Hazard Index: Carcinogens	Residential Risk and Hazard Index: Noncarcinogens	Industrial Risk and Hazard Index: Carcinogens	Industrial Risk and Hazard Index: Noncarcinogens
indeno(1,2,3-c,d)pyrene	4.60E-03	6.21E-01	c	2.11E+00	c	7.40E-09		2.18E-09	
methylene chloride	4.08E-03	9.11E+00	c	2.05E+01	c	4.48E-10		1.99E-10	
phenanthrene	2.20E-02	2.19E+04	s	1.00E+05	s		<0.001		<0.001
trichlorofluoromethane (Freon 11)	2.33E-03	3.86E+02		2.00E+03			<0.001		<0.001
Total Risk and Hazard Index Quantification for Constituents in Soil[2]						2.48E-07	6.311	8.19E-08	1.097

	Carcinogens	Noncarcinogens
Total Construction Worker Risk and Hazard Index Quantification for Constituents in Soil[3]	1.37E-09	0.421

Notes:

[1] United States Environmental Protection Agency Region 9 preliminary remediation goal (USEPA 2004)

[2] 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.

[3] Calculated as the product of 0.015 and the industrial risk, and 0.384 and the industrial hazard (Earth Tech 2004).

c Indicates that chemical is evaluated based on its carcinogenic potential.

s Surrogate. PRGs for these chemicals have not been established. The following surrogates are substituted:

Chemical	Surrogate
benzo(g,h,i)perylene	pyrene
phenanthrene	anthracene

mg/kg milligrams per kilogram
NA not applicable

Ecological Risk

Results of the PERA identified eight chemicals of potential ecological concern in the soil at Site 115 (antimony, cadmium, total chromium, lead, molybdenum, nickel, selenium, and zinc) that pose potential risks to certain receptor groups. The ecological risks were primarily driven by the results from a single sampling location located near Silo 2. In June 2005, additional soil samples were analyzed for metals to confirm the previous sampling results. The samples were collected from three shallow boreholes drilled adjacent to the suspect location. Results indicate that only four of the potential ecological risk drivers (total chromium, lead, molybdenum, and nickel) were detected above background limits. The other four metals were either not detected, or were present at levels below background limits. Because half of the potential risk drivers were not confirmed, it is likely that the PERA overestimated the ecological risk at Site 115. Moreover, given that the high concentrations of total chromium, lead, molybdenum, and nickel are limited in distribution to a single locale, it is unlikely that plant or wildlife populations would be negatively impacted. Therefore, it was recommended that these metals be eliminated as chemicals of potential ecological concern at Site 115.

Threat to Groundwater and Surface Water

The inconsistent detection of perchlorate in Wells 115-MW02 and 115-MW03 may indicate limited impact to groundwater from the missile silos; it is not clear whether any other contaminants detected in low concentrations in groundwater at Site 115 are related to disposal into the missile silos, or activities at upgradient sites (e.g., the former test stand identified as Site 338). A remedial action for groundwater contamination below Site 115 will be selected in the forthcoming ROD for the Northeast AFRL. The silo covers effectively prevent rain water from entering the silos at the surface. Because the site contaminants are located within the missile silos, there is no threat to ephemeral surface water (storm runoff); there is no permanent standing water on site.

2.6.2.5 Remedial Action Objectives

The RAOs for Site 115 are:

1. Prevent all exposures by any potential receptors to the hazardous soil and/or debris contained in the missile silos.

2. Limit surface access to authorized and trained industrial or construction personnel.

3. Limit the potential for leaching of the silos contents to the underlying groundwater.

2.6.2.6 Description of Alternatives

As described in the *Soil and Debris Sites FS*, the Air Force evaluated numerous remedial strategies to manage and/or clean up the potentially explosive debris at Site 115. After an initial screening of available technologies, three remedial alternatives were developed for detailed evaluation. However, in response to written comments on the *Soil and Debris Sites PP* received during the public review period (see Part 3), Alternative 2 has been modified for this ROD. Estimated costs for the alternatives are presented in Table 2.6-4. Due to the depths of the silos and the potential explosive hazards, active treatment or removal of the debris was considered infeasible.

Alternative 1 – No Action

As required by the NCP, the no action alternative is listed only to compare to other alternatives. No remedial action would be taken at Site 115.

Alternative 2 – Modify Existing Silo Covers and Institute Administrative LUCs

The following describes Alternative 2 as presented in the *Soil and Debris Sites PP*; changes made in response to public comments (see Part 3 and revised Alternative 2 below) are not reflected.

Engineering Controls

Although physical access controls in the form of roll-away silo covers are already in place, they need modifications to be effective. Both covers lack steel plates on one side, leaving open access to the top of the silo. The modifications include welding new steel side plates to each cover, and adding signs that warn of potential chemical and explosive hazards, and provide a point of contact and telephone number. Because the covers are already welded in the closed position, there would be no opportunities to access the silos once the modifications are complete. The silo covers would provide continued protection from rainwater infiltration.

Table 2.6-4. Site 115 Remedial Alternatives Cost Breakdown

Remedial Alternatives (Selected Remedy Shown in Bold)	Unadjusted Cost	Escalated Cost	Present Value Cost
Alternative 1 – No Action Scenario	$0	$0	$0
Alternative 2 – Modify Silo Covers and Institute Administrative LUCs			
Administrative Controls (recurring annual costs in Years 1 to 30)	$69,000	$100,000	$46,000
Modify Silo Covers (capital cost in Year 1)	$5,000	$5,000	$5,000
	$74,000	$105,000	$51,000
Revised Alternative 2 – Fences, Gates, Signs, and Administrative LUCs			
Administrative Controls (recurring annual costs in Years 1 to 30)	$69,000	$100,000	$46,000
Install Fences and Signs (capital cost in Year 1)*	$48,000	$48,000	$48,000
	$117,000	**$148,000**	**$94,000**
Alternative 3 – Backfill and Cap Silos, and Institute Administrative LUCs			
Administrative Controls (recurring annual costs in Years 1 to 30)	$69,000	$100,000	$46,000
Backfill Silo 2 and Cap Both Silos with Concrete (capital cost in Year 1)	$86,000	$86,000	$86,000
	$155,000	$186,000	$132,000
Annual Cost Beyond Year 30 (LUCs)	$2,000	-	-

Notes:

Escalation factors from RACER Software. Present value based on a 3% discount factor. All costs rounded to nearest $1,000.
* Cost backup provided in Table C-5, Appendix C.

Administrative LUCS

The administrative LUCs that would be instituted under this alternative are detailed in the discussion of Revised Alternative 2 (below).

Revised Alternative 2 –Fences, Locked Gates, Warning Signs, and Administrative LUCs (selected remedy)

In response to public concerns (detailed in Part 3), Alternative 2 was revised and was identified as the selected alternative; the revisions are as follows.

Engineering Controls

Significant modifications to the silo covers would negatively impact the historical value of the site, and international treaties require that the silos remain in a state such that they can be opened for visual inspection by surveillance satellites. Therefore, the modifications to the silo covers detailed in the original version of Alternative 2 are not feasible, and alternate access controls are needed. As with

Sites 6 and 113; chain-link fences (6 feet high), locked gates, and warning signs will prevent unauthorized access to the site. As shown on Figures 2.6-3 and 2.6.4, the fences will surround each silo, completely enclosing the circular asphalt access roads, the steel roller guide rails, and the fan rooms. The fence lines provide adequate access controls while also retaining the ability to open the silo covers as required by the 1991 Strategic Arms Reduction Treaty (START). The silo covers would provide continued protection from rainwater infiltration. Annual inspection and maintenance of the covers and fences will be conducted to ensure long-term protectiveness of the remedy and continued prevention of rainwater infiltration through the silos.

Administrative LUCS

As shown on Figure 2.6-3, the boundaries of the LUCs coincide with the fence lines to be constructed for each silo. The vertical component of the LUC boundaries extends from the surface to the first occurrence of groundwater at a depth of approximately 90 feet. It is anticipated that the groundwater below Site 115 will be subject to LUCs as part of the forthcoming remedy for the Northeast AFRL area.

The specific LUCs for Site 115 under this remedy are as follows:

1. Consistent with RAO No. 1, the land within the LUC boundaries is to remain unused and will not be cleared for any residential, industrial, agricultural, or commercial purposes; access to the site by residential receptors and most Base personnel will be prohibited.

2. Consistent with RAO No. 2, access by site workers (i.e., for cover and fence maintenance) will be permitted only with prior authorization from Environmental Management; and only for those with current training in hazardous waste operations and supplemental instruction related to construction in the vicinity of MEC or other potentially explosive and/or hazardous materials. Intrusive work (excavation or drilling) will be prohibited except as needed for fence maintenance. No buildings or other inhabited structures are to be constructed within the LUC boundaries.

3. Discharges of water to the surface and/or subsurface at Site 115 will be prohibited (RAO No. 3).

4. Currently, the site is located within an active range area and is not being considered for MMRP activities (which are reserved for closed ranges). However, if the range is closed in the future, Silo 1 (which potentially contains explosive debris) may be added to the program.

Further discussion of these LUCs, including the means for implementation and documentation, is presented in Section 2.8.1 – LUCs General Provisions.

Alternative 3 – Backfill and Cap the Silos; Institute Administrative LUCs

Although Alternative 3 was identified as the recommended remedy in the *Soil and Debris Sites PP*, the identified need to preserve the silos in their present state (see Part 3 and revised Alternative 2, above) makes this alternative infeasible.

Alternative 3 would involve dismantling the existing roll-away steel silo covers and hauling them to a scrap yard for recycling. Silo 2 would then be backfilled with clean soil and if necessary additional clean soil would be used to top off Silo 1 (which has already been backfilled). Because no disturbance of the existing backfill in Silo 1 is proposed, there would be no complete pathway for exposure by construction workers to potentially explosive debris. A 12-inch cap of reinforced concrete would be placed over each silo, flush with the ground surface. The caps would permanently seal off the silos and would rainwater infiltration. Signs will be posted that warn of the explosive hazard, and provide a point of contact organization and telephone number. LUCs, similar to those detailed in the discussion of Revised Alternative 2 (above), would be instituted under this alternative.

2.6.2.7 Comparative Analysis of Alternatives

The comparative analysis of the alternatives for Sites 115 is presented in Table 2.6-5.

Table 2.6-5. Comparative Analysis of Alternatives – Site 115

KEY L – Low M – Medium H – High NA – Not applicable NPC – No public comments received	Threshold Criteria		Balancing Criteria					Modifying Criteria	
Evaluation Criteria	Overall protection of human health and the environment	Compliance with ARARs	Long-term effectiveness and permanence	Reduction of toxicity, mobility, or volume through treatment	Short-term effectiveness	Implementability	Escalated cost (Years 1 through 30)	Public acceptance	State/Support Agency acceptance
1. No Action	L	NA	NA	NA	NA	NA	NA	NA	NA
2. Modify Silo Doors and LUCs	H	M	M	L	H	H	$105K	L	H
2. (Revised) Fences, Gates, Signs, and LUCs	H	H	M	L	H	H	$148K	H	H
3. Backfill/Cap Silos and LUCs	H	M	M-H	L	H	M-H	$186K	L	H

Alternative 1 does not meet the threshold criterion of being protective of human health and the environment and was therefore eliminated from further consideration; Alternative 2, Revised Alternative 2, and Alternative 3 meet this threshold criterion (see Section 2.6.2.10). Revised Alternative 2 complies with all ARARs, but Alternatives 2 and 3 do not fully comply with the National Historical Preservation Act in that their implementation would negatively impact the historical value of the site.

Alternative 2 and revised Alternative 2 rate high on implementability, requiring only minor construction for silo cover modifications or fences. Additionally, short-term effectiveness is rated as high for both alternatives because there would/will be no exposure to the missile silo contents during implementation. However, because the future effectiveness of the alternatives relies on LUCs, long-term effectiveness and permanence are rated at medium. Reduction of toxicity, mobility, or volume of contaminants through treatment are rated low because potentially hazardous debris would/will remain in the silos, untreated, with reduced mobility to groundwater through cover maintenance. Public acceptance of Alternative 2 is low because it would negatively impact the historical value of the site, and would potentially violate terms of the START Treaty. Revised Alternative 2 rates high for public acceptance because there will be no negative impact to the site's historical significance, or to the START treaty obligations.

Alternative 3 rates medium to high on implementability, requiring significant construction to backfill and cap the silos. Short-term effectiveness is rated as high because there would be no exposure to the missile silo contents during implementation. However, although the engineering controls would be durable, the long-term effectiveness and permanence of the alternative would rely on LUCs, and are therefore rated as medium to high. Reduction of toxicity, mobility, or volume of contaminants through treatment are rated low because potentially hazardous debris would remain in the silos, untreated, with only limited reduction in mobility to groundwater through capping. Public acceptance of Alternative 3 is low because it would negatively impact the historical value of the site, and would potentially violate terms of the START Treaty.

2.6.2.8 Principal Threat Wastes

The potentially explosive debris buried within Silo 1 represents a principal threat waste in that any exposure could pose a danger to life or health.

2.6.2.9 Selected Remedy

The Air Force and USEPA, with concurrence from Cal/EPA DTSC and the Water Board, selected Revised Alternative 2.

2.6.2.10 Statutory Determinations

Under CERCLA Section 121 and the NCP, the lead agency must select remedies that meet the threshold criteria of being protective of human health and the environment, and complying with ARARs (unless a statutory waiver is justified). As balancing criteria, the remedies should also be cost effective, and should utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, CERCLA asserts a preference for remedies that employ treatment that permanently and significantly reduces the volume, toxicity, or mobility of hazardous wastes as a principal element, and a bias against off-site disposal of untreated wastes. The following sections discuss how the selected remedy meets these statutory requirements.

Protection of Human Health and the Environment

Silo 1 at Site 115 contains potentially explosive debris that poses an unacceptable risk to all receptors. Alternative 2 (revised) offers adequate protection by restricting site access through fences, locked gates, warning signs, and LUCs.

Compliance with ARARs

Section 121(e) of CERCLA, USC Section 9621(e), states that no federal, state, or local permit is required for remedial actions conducted entirely on site; these actions must meet the substantive but not administrative requirements of ARARs.

Chemical-Specific ARARs. The beneficial uses designated in the *Basin Plan* for minor surface waters in the Antelope Hydrologic Unit and North Muroc Hydrologic Area are relevant and appropriate to the remedy selected for Site 115 (see Appendix B, Table B-1, Item 2); removal of impacted soil from the site and maintenance of the existing drainage swales will support these beneficial uses.

Location-Specific ARARs. Because Site 115 has already been moderately disturbed, most state and federal regulations governing the protection of wildlife or archeological resources are not ARARs.

However, endangered or threatened species are present at the AFRL, and there is a possibility that migrating birds may be present at Site 115. Also, the missile silos are eligible for listing with the National Register of Historic Places. Therefore, the following are listed as RARs:

- California Endangered Species Act (Table B-1, Item No. 4);
- Federal Endangered Species Act (Table B-1, Item No. 5);
- Migratory Bird Treaty Act (Table B-1, Item No. 6); and
- National Historical Preservation Act (Table B-1, Item No. 7).

Field activities associated with the selected Site 115 remedy will be coordinated with Base biologists to ensure the protection of sensitive wildlife species, and with Base archeologists to ensure the historic value of the silos is not impacted.

Action-Specific ARARs. The following requirement is relevant and appropriate for Site 115:

- 22 CCR, Div. 4.5, Ch. 39, Section 67391.1 and Civil Code Section 1471a and b (Table B-1, Item No. 12). As discussed in Section 2.6.2.6, LUCs are included as part of the selected remedy because potentially hazardous debris will be left in the mineshafts. In the event of transfer of property that includes the Site 115 LUC boundary to a non-federal entity, a land use covenant with DTSC would be required. Therefore, the cited requirements are relevant and appropriate to the selected remedy.
- CIWMB post-closure care requirements, to the extent feasible, for CAI units - 27 CCR Sections 20080 (g) and 20090 (d) (Table B-2).

Disagreement on ARARs. The Air Force and the Water Board do not agree on whether the following Water Board requirements are ARARs for Site 115:

- Specific sections of the *Basin Plan*, including but not limited to:
  - Water quality objectives (WQOs) for non-degradation (page 3-2) and certain of the WQOs for surface waters (page 3-3).
  - Region-wide prohibitions 1 through 3 (found on page 4.1-1). Items 1 and 2 prohibit discharging waste which causes a violation of narrative (including non-degradation) or numeric WQOs while Item 3 prohibits discharging waste which causes further degradation or pollution where a narrative or numeric WQO is already being violated.

- Soil Cleanup Levels (Page 4.2-4): "The Regional Board will determine soil cleanup levels for the unsaturated zone based upon threat to water quality… If it is unreasonable to clean up soils to background concentration levels,…site-specific recommendations for soil cleanup levels [may [be] consider[ed]] provided that applicable groundwater quality objectives are met and health risks from surface or subsurface exposure meet current guidelines."

Please see Section 2.8.2 for the individual positions held by the Air Force, the USEPA, and the Water Board regarding analysis of whether these requirements are ARARs.

Notwithstanding the Air Force position that these Water Board requirements are not ARARs for this action, the selected remedy for Site 115 meets the technical requirements of California water quality law, plans, and policies for protection of surface waters (and groundwater) by maintenance of the existing silo covers (which prevent rainwater intrusion), and by prohibiting discharges of surface water. Moreover, the selected remedy meets the following five exemption criteria cited (on page 4.1-2) by the *Basin Plan* for restoration projects:

- The silo covers will reduce or mitigate existing sources of soil erosion, water pollution, or impairment of beneficial uses;
- There is no feasible alternative to the project (i.e., it is technically impractical to remove or treat in place the potentially explosive debris in a historically significant missile silo structure);
- Land disturbance will be limited to the installation of fences surrounding the silos;
- The silo covers minimize potential adverse environmental impacts; and
- The selected remedy complies with the ARARs identified in Appendix B.

Cost Effectiveness

The selected remedy is a low-cost alternative that meets the statutory requirements. However, it should be noted that the cost estimates presented in this ROD include only the first 30 years of remedy implementation. Given the indefinite duration of the selected remedy, the total lifecycle costs of the remedy cannot be calculated, but will likely be far greater than the 30-year costs shown. Table 2.6-4 lists an estimate of the unadjusted annual cost of implementing the remedy beyond Year 30.

Utilization of Permanent Solutions and Alternative Treatment Technologies

Excavation of the soil and debris in Silo 1 would prove technically infeasible and dangerous. Moreover, Alternative 3 (backfill and cap silos) was rejected because it conflicts with the goals to preserve the historical significance and treaty obligations associated with the silos. Therefore, the selected remedy does not incorporate permanent solutions or alternative treatment technologies. However, the protection afforded by the remedy is expected to be effective over the long term provided routine maintenance of the fencing and signs is performed, and the LUCs are enforced.

Preference for Treatment as a Principal Element

The selected remedy does not satisfy the statutory preference for treatment as a principal element of the remedy.

Five-Year Review Requirements

Because the selected remedy will result in hazardous substances, pollutants, or contaminants (potentially explosive debris in missile silos) remaining on-site above levels that allow for unrestricted use and unrestricted exposure (i.e., residential levels), a statutory review will be conducted within 5 years after initiation of the remedial action to satisfy NCP Section 300.430(f)(4)(ii), and at 5-year intervals thereafter, as long as hazardous substances remain at the site at levels that do not allow for unrestricted (residential) uses. Five-year reviews will be conducted in accordance with CERCLA Section 121(c) and are required to determine whether the remedy continues to be protective of human health and the environment.

2.6.2.11 Documentation of Significant Changes from Proposed Plan

The *Soil and Debris Sites PP* identified Alternative 3 as the recommended remedy. However, in response to public concerns over historical significance and treaty obligations, a modified version of Alternative 2 was selected as the remedy for Site 115. Additionally, as discussed in Section 2.5.1.11, the present value cost for implementing long-term LUCs at Site 115 was recalculated using a 3 percent discount factor rather than 7 percent, resulting in a present value increase of $15,000 for each alternative that includes LUCs (see Table C-2, Appendix C).

2.7 DECISION SUMMARY - NO FURTHER ACTION SITES

2.7.1 SITE 7 – TEST AREA 1-46 BERYLLIUM-CONTAMINATED EARTH PILES

2.7.1.1 Site Name, Location, and Brief Description

Site 7 is located in Test Area 1-46 along Mars Boulevard approximately 4 miles southeast of its intersection with Mercury Boulevard (Figure 2.1-2). Site 7 is located within the Site 167 boundary but is considered a separate, though closely related, site. The beryllium-contaminated earth piles were located in two clusters in a disturbed area (Figures 2.7-1 and 2.7-2).

2.7.1.2 Site History and Enforcement Activities

Site History

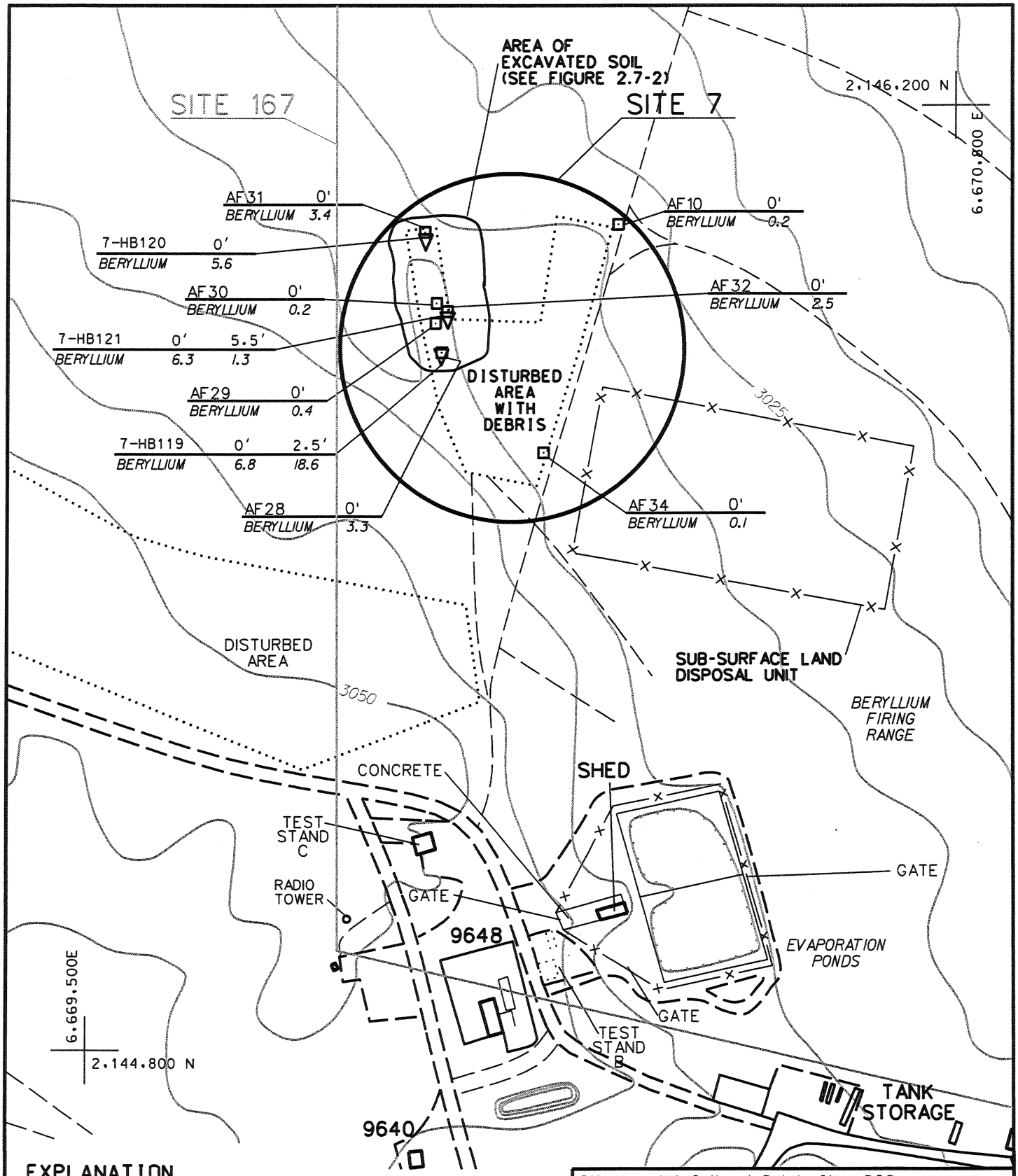
Miscellaneous hardware, piping, and components from beryllium tests were disposed in the piles. Contaminated metal, wood, and other debris from an explosion that destroyed a building storing beryllium during the 1960s were added to the piles in 1970. Also, contaminated soils removed from the Site 167 Beryllium Firing Range were moved to this area in 1972. Based on the known history of activities at Site 7, beryllium was identified as the only COC.

Site Characterization Sampling

The following is a summary of site characterization sampling conducted at Site 7; a more comprehensive discussion of these activities is presented in the *OU4 RI Summary Report*.

Soil

Concentrations of beryllium in soil samples collected between 1993 and 1995 ranged from not detected (at a reporting limit of 0.20 mg/kg) to 219 mg/kg, exceeding the background concentration for the AFRL (0.9 mg/kg), and the then-current PRGs (residential 0.14 mg/kg and industrial 1.1 mg/kg). Note, however, that the USEPA has since incrementally raised the residential and industrial PRGs for beryllium to their current levels of 150 mg/kg and 1,900 mg/kg, respectively.



OUs 4 and 9 Soil and Debris Sites ROD

Site 7 Map Showing 1993 Soil Sampling Results

Date 5-08	Air Force Research Laboratory Edwards AFB	Figure 2.7-1
Project No. 87503		

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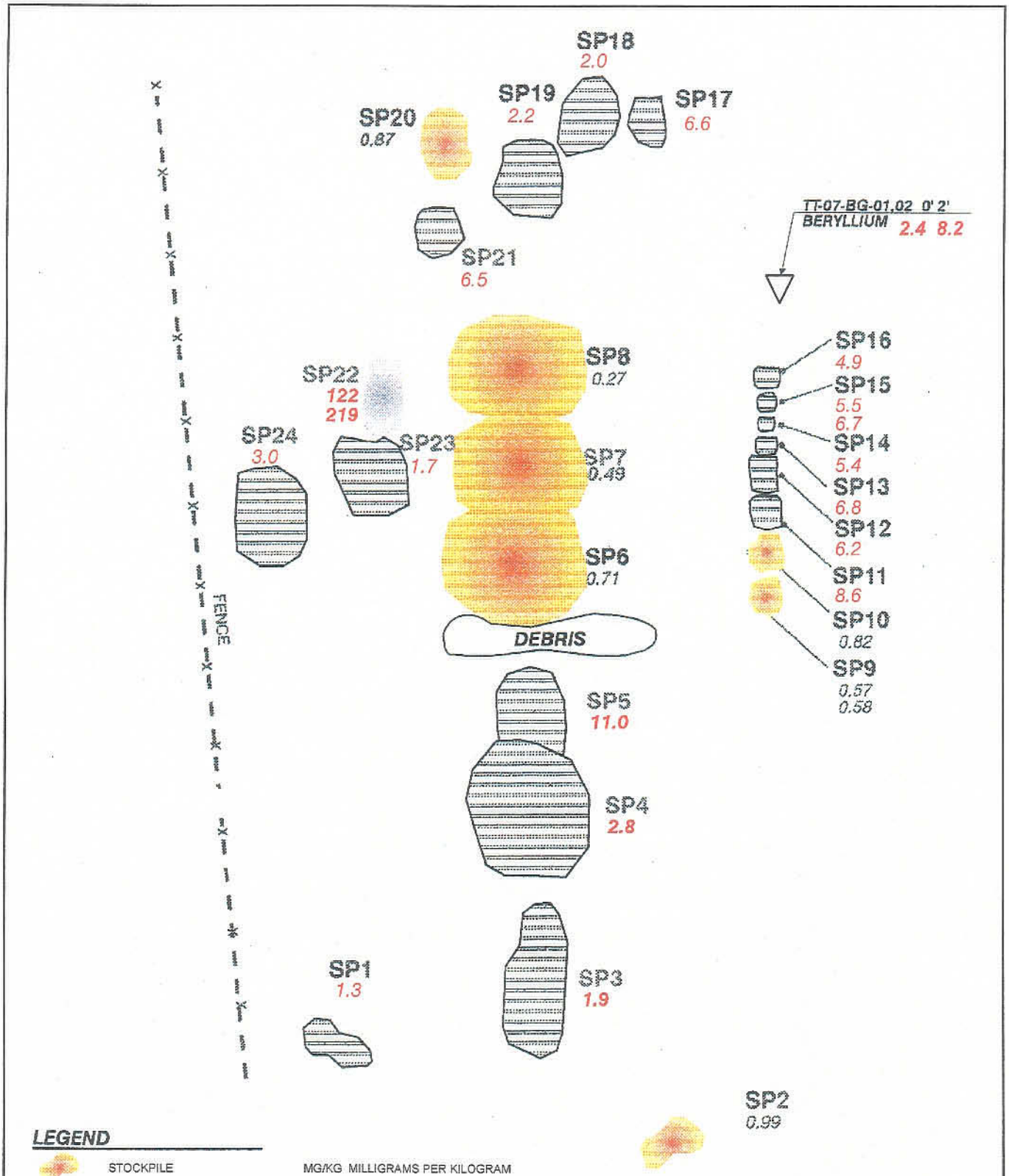


LEGEND

- STOCKPILE
- STOCKPILE TO BE REMOVED AND DISPOSED
- STOCKPILE WITH BERYLLIUM CONCENTRATIONS EXCEEDING PRG (1995) AND STLC
- EXISTING HAND AUGER SAMPLE LOCATION

MG/KG MILLIGRAMS PER KILOGRAM

PRG PRELIMINARY REMEDIATION GOAL

STLC SOLUBLE THRESHOLD LIMIT CONCENTRATION

NOTE: RESULTS ARE REPORTED IN MG/KG. VALUES IN RED EXCEED INDUSTRIAL PRG. SEE FIGURE 2.7-1 FOR APPROXIMATE MAP LOCATION. ADAPTED FROM TETRA TECH (1998)

OUs 4 and 9 Soil and Debris Sites ROD

Site 7 Map Showing 1995 Soil Sampling Results

Date 05-08	Air Force Research Laboratory Edwards AFB	Figure 2.7-2
Project No. 87503		

87503.10.04.17.01 Fig. 2.7-2

Debris

Samples of wood, concrete, and metal debris were collected in 1995. Beryllium was detected at concentrations up to 3.7 mg/kg in the wood and up to 0.26 mg/kg in the concrete. Beryllium was not detected in the metal samples. There are no regulatory standards for beryllium in debris.

Groundwater

Because groundwater underlying the site is estimated to occur at 300 feet bgs (based on depth to water in wells installed at adjacent Site 167), and beryllium exhibits low mobility in soil, beryllium migration into groundwater was not likely, and no groundwater investigations were conducted.

Interim Remedial Actions

An IRA conducted in 1996 included the excavation of beryllium-contaminated soils and debris and re-burial within the Site 167 SLDU (see Section 2.5.3.2). The SLDU is capped, and LUCs will be used to ensure its long-term integrity. Confirmation samples, collected after excavation was complete, showed that beryllium concentrations in the soil left behind were all below the 1.1 mg/kg compliance standard (the industrial PRG current at that time) and well below the current residential PRG of 150 mg/kg. The excavated area was then backfilled and revegetated.

Nature and Extent of Residual Site Contamination

No residual contaminants remain at Site 7 that would limit exposure or restrict use, and no soil COCs were retained.

2.7.1.3 Summary of Site Risks

Human Health Risk

Because the beryllium-contaminated soil and debris were removed from Site 7, and the remaining soil contains beryllium at far lower concentrations than is allowed by the revised residential PRG, the potential risks to human health posed by this site are considered to be acceptable. Therefore, no quantitative HHRA was performed for soil.

Ecological Risk

The OU4 ERA identified no ecological exposure pathways to be present at Site 7. Therefore, no NFEI was recommended, and the site did not proceed to the SERA phase.

Threat to Groundwater and Surface Water

Because beryllium exhibits low mobility in soil, the beryllium remaining in the soil at Site 7 after the IRA (less that 1.1 mg/kg) is not likely to migrate into the groundwater at 300 feet bgs, or into ephemeral surface water (storm runoff). There is permanent standing water on site.

2.7.1.4 Selected Remedy

Because the IRA conducted at Site 7 effectively removed the contaminated soil and debris, the site now qualifies for unrestricted land use. Therefore, the Air Force and USEPA, with concurrence from Cal/EPA DTSC and the Water Board, selected NFA for soil at Site 7. However, the soil and debris removed from Site 7 will continue to be managed as part of the final remedy for Site 167.

2.7.1.5 Documentation of Significant Changes from Proposed Plan

There are no significant changes from the *Soil and Debris Sites PP*.

2.7.2 SITE 26 – FORMER FIRE TRAINING AREA

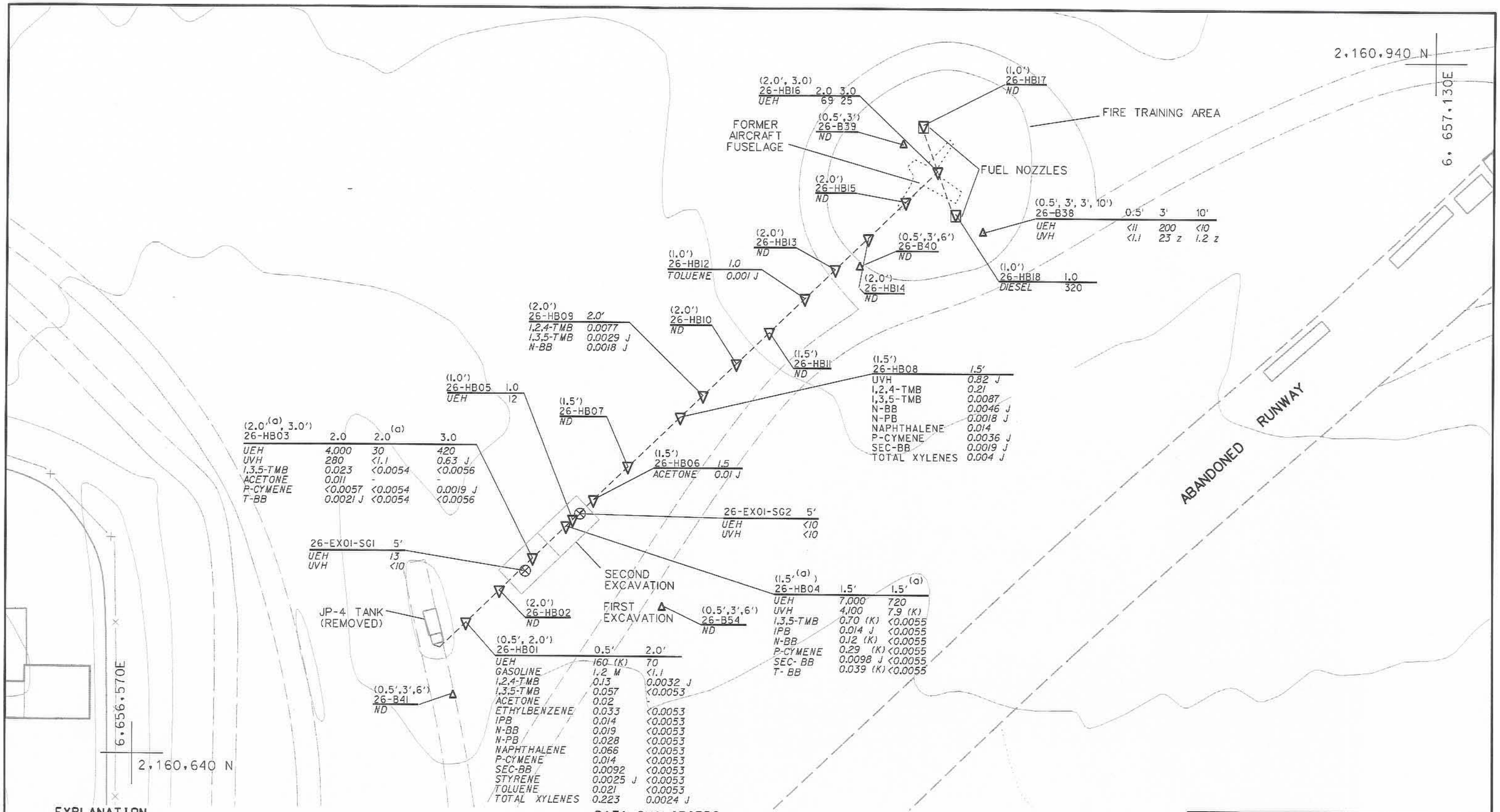
2.7.2.1 Site Name, Location, and Brief Description

Site 26 is located east of the AFRL Civil Engineering yard near the AFRL abandoned runway (Figure 2.1-2). The site consists of a former fire training area (FTA), a removed aboveground storage tank, and its associated underground pipeline (Figure 2.7-3).

2.7.2.2 Site History and Enforcement Activities

Site History

The FTA was used in the early 1970s to train personnel to fight aircraft fires, but has been inactive since 1975. During training exercises, jet fuel and/or gasoline were sprayed onto a small decommissioned jet aircraft, ignited, and then extinguished using water and chemical foam. The fuel was supplied by an aboveground storage tank, underground pipeline, and two aboveground nozzles.



EXPLANATION

- ▽ HAND-AUGERED BOREHOLE (2000)
- ⊗ CONFIRMATION SAMPLE LOCATION (2001)
- Δ BOREHOLE LOCATION (1993)
- -- REMOVED UNDERGROUND PIPELINE
- ROADS

(DEPTHS SAMPLED)
LOCATION NAME SAMPLE DEPTH
PARAMETER NAME VALUE DETECTED (mg/kg)

BB BUTYLBENZENE
IPB ISOPROPYLBENZENE
mg/kg MILLIGRAMS PER KILOGRAM
ND NON DETECT
PB PROPYLBENZENE
TMB TRIMETHYLBENZENE
UEH UNKNOWN EXTRACTABLE HYDROCARBONS
UVH UNKNOWN VOLATILE HYDROCARBONS
(a) REPLICATE SAMPLE COLLECTED AT THIS DEPTH

DATA QUALIFIERS

J ESTIMATED RESULT, RESULT IS LESS THAN THE REPORTING LIMIT
M SAMPLE HAS GC/FID CHARACTERISTICS THAT ARE SIMILAR TO WEATHERED GASOLINE
(K) VALUES MAY BE BIASED HIGH BECAUSE ONE OR MORE SURROGATES ARE OUT HIGH.
z CHROMATOGRAPHIC PROFILE IS NOT CONSISTENT WITH PATTERN(S) EXHIBITED BY REFERENCE FUEL STANDARDS. QUANTITATION OF UNKNOWN HYDROCARBON IN SAMPLE IS BASED ON GASOLINE.

NORTH
0 20 40 FEET
SCALE: 1"= 40'

OUs 4 and 9 Soil and Debris Sites ROD

Site 26 Map Showing Soil Sampling Results

Date 5-08
Project No. 87503
Air Force Research Laboratory Edwards AFB
Figure 2.7-3

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Site Characterization Sampling

The following is a summary of site characterization sampling conducted at Site 26; a more comprehensive discussion of these activities is presented in the *OU4 RI Summary Report*.

Soil

Soil samples collected between 1993 and 2000 in and around the FTA exhibited contamination by unidentified extractable and volatile hydrocarbons (UEH and UVH), most likely components of weathered jet fuel, diesel fuel, and gasoline. Concentrations of these petroleum hydrocarbons generally did not exceed action limits of 1,000 mg/kg for UEH and 100 mg/kg for UVH, derived from the *LUFT Field Manual*. A small area of soil near the underground pipeline exhibited contamination at concentrations above these action levels; that area was excavated in 2001 (see below). A number of other compounds associated with petroleum fuel were detected at trace concentrations.

Groundwater

Based on groundwater sampling results, the former FTA is one of several source areas contributing chlorinated solvent contaminants (primarily PCE) to the Site 133 groundwater plume. However, based on low to non-detected concentrations of petroleum fuel components in groundwater samples collected immediately below the FTA, it can be concluded that petroleum hydrocarbons released directly to the soil did not migrate to, or did not persist in, groundwater. The chlorinated solvent contamination in groundwater at Site 26 is addressed in the ROD for the South AFRL area.

Interim Remedial Actions

In 2001, the aboveground tank, the underground fuel pipeline, and the fuel nozzles were removed, cleaned, and disposed of as scrap metal. Also, approximately 120 cubic yards of petroleum contaminated soil and bedrock were excavated and disposed of as a non-hazardous waste at a licensed soil recycling TSDF. Confirmation samples were collected following excavation to verify that soil concentrations remaining at the site were below the groundwater-protective LUFT-derived action levels. Subsequently, the KCEHSD regulator noted that a 10-fold lower compliance standard of 100 mg/kg for UEH and 10 mg/kg for UVH would have been more appropriate due to the shallow depth to groundwater in this area. The concentrations in confirmation samples were also below these more restrictive compliance standards.

Nature and Extent of Residual Site Contamination

Following the IRA, no soil COCs remain at Site 26 that would limit human exposure or restrict land use.

2.7.2.3 Summary of Site Risks

Human Health Risk

The results of the HHRA, summarized in Table 2.7-1, indicate that the potential cancer risk from exposure to soil under all scenarios was acceptable (less than 1×10^{-6}). The non-cancer HI calculated for Site 26 for hypothetical residential receptors was 1.2 driven by high concentrations of manganese in the soil. However, a review of soil data collected at Site 26 suggested that the high manganese concentrations are naturally occurring (rather than from site impact). For all other exposure scenarios evaluated, the HI was less than 1, indicating the hazard to human health is acceptable.

Because no VOCs were detected in the Site 26 soil at concentrations above residential PRGs (Appendix D), the VIP into indoor air from soil is incomplete and no evaluation of risk via this pathway was conducted. However, the South AFRL ROD details the VIP associated with the underlying Site 133 groundwater plume, and the selected remedial response.

Ecological Risk

In 2004, the OU4 SERA identified potential risks from various metals and VOCs to several potential wildlife receptors at Site 26. The PERA (Tetra Tech 2004) confirmed these risks, but found that the compaction of the soil and low density of vegetation across most of the site makes it unlikely that Site 26 will serve as a valuable refuge for either flora or fauna in its present form, even after 30 years of inactivity. Moreover, the ecological risks are considered acceptable because no threatened or endangered species have been identified at Site 26, and (as stated in the PERA):

> …It is important to note that past physical disturbance contributes in part to this conclusion [potential risk to certain receptor groups], and chemical contamination is not the sole justification… Results for the terrestrial receptors at Site 26 did not show any systematic trend (e.g., a consistent and substantial risk for all receptors for a certain suite of constituents) that would indicate the potential for impact to the community as a whole.

TABLE 2.7-1. QUANTIFICATION OF RISKS FOR CHEMICALS DETECTED IN SOIL - SITE 26

(Page 1 of 2)

Analyte	Maximum Detected Concentration	Residential PRG[1]	Industrial PRG[1]	Residential Risk and Hazard Index		Industrial Risk and Hazard Index	
				Carcinogens	Noncarcinogens	Carcinogens	Noncarcinogens
Inorganic Analytes (mg/kg)							
chromium, total	8.52E+01	2.11E+02 c	4.48E+02 c	4.04E-07		1.90E-07	
cobalt	7.40E+00	4.69E+03	1.00E+05		0.002		<0.001
copper	7.36E+01	2.91E+03	7.59E+04		0.025		<0.001
lead	2.27E+01	4.00E+02	7.50E+02		0.057		0.030
manganese	1.91E+03	1.76E+03	3.23E+04		1.084		0.059
mercury	1.50E-01	2.35E+01	6.13E+02		0.006		<0.001
molybdenum	1.82E+01	3.91E+02	1.02E+04		0.047		0.002
nickel	1.12E+01	1.50E+02 c	4.09E+04	7.47E-08			<0.001
selenium	9.90E-01	3.91E+02	1.02E+04		0.003		<0.001
Organic Analytes (mg/kg)							
1,2,4-trimethylbenzene	1.30E-01	5.20E+01	1.70E+02		0.003		<0.001
1,3,5-trimethylbenzene	5.70E-02	2.13E+01	6.98E+01		0.003		<0.001
acetone	2.00E-02	1.57E+03	6.22E+03		<0.001		<0.001
ethylbenzene	3.30E-02	2.30E+02	2.30E+02		<0.001		<0.001
isopropylbenzene (cumene)	1.40E-02 [2]	1.57E+02	5.22E+02		<0.001		<0.001
naphthalene	6.60E-02	5.59E+01	1.89E+02		0.001		<0.001
n-butylbenzene	1.90E-02	1.45E+02	2.40E+02		<0.001		<0.001
n-propylbenzene	2.80E-02	1.45E+02	2.40E+02		<0.001		<0.001
p-cymene (p-isopropyltoluene)	1.40E-02	1.57E+02	5.22E+02		<0.001		<0.001
sec-butylbenzene	9.20E-03	1.11E+02	2.20E+02		<0.001		<0.001
styrene	2.50E-03	1.70E+03	1.70E+03		<0.001		<0.001
toluene	1.20E-02	5.20E+02	5.20E+02		<0.001		<0.001
xylene (m,p)	1.50E-01	2.10E+02	2.10E+02		<0.001		<0.001
xylene (o)	7.30E-02	2.10E+03	2.10E+02		<0.001		<0.001

TABLE 2.7-1. QUANTIFICATION OF RISKS FOR CHEMICALS DETECTED IN SOIL - SITE 26

Analyte	Maximum Detected Concentration	Residential PRG[1]	Industrial PRG[1]	Residential Risk and Hazard Index		Industrial Risk and Hazard Index	
				Carcinogens	Noncarcinogens	Carcinogens	Noncarcinogens
Total Risk and Hazard Index Quantification for Constituents in Soil[3]				4.79E-07	1.231	1.90E-07	0.096
						Carcinogens	Noncarcinogens
Total Construction Worker Risk and Hazard Index Quantification for Constituents in Soil[4]						2.92E-09	0.037

Notes:

[1] United States Environmental Protection Agency Region 9 preliminary remediation goal (USEPA 2000).

[2] The PRGs for isopropylbenzene were used as surrogate criteria for isopropyltoluene.

[3] Calculated as the ratio of the maximum detected concentration to the PRG for noncarcinogens. This ratio is multiplied by 1×10^{-6} for carcinogens.

[4] Calculated as the product of 0.015 and the industrial risk, and 0.384 and the industrial hazard (Earth Tech 2004).

c Indicates that chemical is evaluated based on its carcinogenic potential.

mg/kg milligrams per kilogram

Threat to Groundwater and Surface Water

Because the IRA removed petroleum-contaminated soil to levels below the groundwater-protective LUFT-derived action levels, the remaining soil at Site 26 poses little threat to groundwater. Existing VOC contamination in the groundwater is addressed in the South AFRL ROD. Because most of the surface contaminants were removed, there is little threat to ephemeral surface water (storm runoff); there is no permanent standing water on site.

2.7.2.4 Selected Remedy

Because the IRA conducted at Site 26 effectively removed the contaminated soil, the site now qualifies for unrestricted land use. Therefore, the Air Force and USEPA, with concurrence from Cal/EPA DTSC and the Water Board, selected NFA for soil at Site 26. The groundwater below the site will continue to be managed as part of the final remedy for the South AFRL area.

2.7.2.5 Documentation of Significant Changes from Proposed Plan

There are no significant changes from the *Soil and Debris Sites PP*.

2.7.3 SITE 150 – BUILDING 8451 FORMER WASTE EVAPORATION PONDS

2.7.3.1 Site Name, Location, and Brief Description

Site 150 is located on Saturn Boulevard southeast of its intersection with Mercury Boulevard (Figure 2.1-2) and encompasses a former beryllium/organic waste evaporation pond and a former inorganic waste evaporation pond associated with Building 8451, the Laboratory Services facility (Figure 2.7-4).

2.7.3.2 Site History and Enforcement Activities

Site History

Wastes discharged into the two ponds reportedly included beryllium, acids, solvents, alcohol, hydrazine, acetone, and waste containers. Drainage lines from Building 8451 also discharged to the organic waste pond. By 1968, the drain lines were capped off and re-routed to the inorganic waste pond, which was active from the 1950s to the early 1970s. This pond was filled with clean soil when deactivated, and there is no current surface evidence of the pond.

150-MW02

2,162,200 N

6,656,130E

3025

6000 PSI GN2 PIPE

3020

3015

3030

LO2 TANK

P020

GN2 TANK

8451

SATURN BOULEVARD

P064

UST

P019 (ABANDONED IN PLACE)

SEE INSET 'A'

8457

8454

8456

P018

TANK

8455

FORMER BERYLLIUM/ORGANIC WASTE EVAPORATION POND

3010

INDUS STREET

SITE 150

GN2 TANK

3005

3000

(10', 15', 20', 40')
150-B59
ND

FORMER INORGANIC WASTE EVAPORATION POND

ANTARES ROAD

INSET 'A'
SCALE: 1"= 50'

6000 PSI GN2 PIPE

AREA 1-60

8457 BUNKER

8424

8456 BUNKER

8454

8455 BUNKER

TANK

(0')
150-TSS46
ND

(0')
150-TSS42
ND

(0')
150-TSS45
ND

(0')
150-TSS47
ND

(0')
150-TSS43
ND

(0')
150-TSS40
ND

(0')
150-TSS44
ND

(0', 6', 10')
150-B23
ND

(0')
150-TSS41
ND

(0', 3', 10')
150-B22
ND

(6', 15', 20')
150-B58
ND

(0', 3', 6')
150-B21
ND

150-TSS10 THROUGH 150-TSS29 NOT SHOWN (ALL ND)

8423

2990

INDUS STREET

6,657,040E

2,160,880 N

EXPLANATION

- SURFACE SOIL SAMPLE LOCATION
- BOREHOLE LOCATION
- (R) REMOVED UST
- (UST) UNDERGROUND STORAGE TANK
- ND NON DETECT

(DEPTHS SAMPLED)
LOCATION NAME
PARAMETER NAME *VALUE DETECTED*

NORTH

0 50 100 FEET

SCALE: 1'= 100'

OUs 4 and 9 Soil and Debris Sites ROD

Site 150 Map Showing Soil Sampling Results

Date 5-08	Air Force Research Laboratory Edwards AFB	Figure 2.7-4
Project No. 87503		

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Site Characterization Sampling

The following is a summary of site characterization sampling conducted at Site 150; a more comprehensive discussion of these activities is presented in the *OU4 RI Summary Report*.

Soil

Soil samples collected between 1993 and 1996 at the waste ponds show that no organic compounds were detected and no inorganic compounds were detected in excess of both background levels and residential PRGs. Therefore, no COCs were identified.

Groundwater

Groundwater sampling results indicate past releases of TCE, PCE, cis-1,2-DCE, 1,4-dioxane, and NDMA to groundwater underlying Building 8451. Site 150 is considered a source area for the Site 133 groundwater plume, which is addressed in the ROD for the South AFRL area.

Interim Remedial Actions

Because no COCs were identified in the soil at Site 150, no IRA was conducted.

Nature and Extent of Residual Site Contamination

Please see discussion of site sampling above. No COCs were identified for soil at Site 150.

2.7.3.3 Summary of Site Risks

Human Health Risk

No carcinogenic chemicals were detected at concentrations that exceeded background; therefore, there is no potential cancer risk due to exposure to Site 150 soil (Table 2.7-2). The cumulative HI of 1.3 under the hypothetical residential scenario was due to the maximum concentrations of manganese and mercury (both individually below residential PRGs). The HIs for both the industrial and construction scenarios are well below 1.

Because no VOCs were detected in the Site 150 soil, the VIP into indoor air from soil is incomplete and no evaluation of risk via this pathway was conducted. However, the South AFRL ROD details the VIP associated with the underlying Site 133 groundwater plume, and the selected remedial response.

TABLE 2.7-2. QUANTIFICATION OF RISKS FOR CHEMICALS DETECTED IN SOIL - SITE 150

Analyte	Maximum Detected Concentration	Residential PRG[1]	Industrial PRG[1]	Residential Risk and Hazard Index		Industrial Risk and Hazard Index	
				Carcinogens	Noncarcinogens	Carcinogens	Noncarcinogens
Inorganic Analytes (mg/kg)							
cobalt	1.01E+01	4.69E+03	1.00E+05		0.002		<0.001
copper	1.23E+02	2.91E+03	7.59E+04		0.042		0.002
lead	1.14E+01	4.00E+02	7.50E+02		0.029		0.015
manganese	1.32E+03	1.76E+03	3.23E+04		0.749		0.041
mercury	1.03E+01	2.35E+01	6.13E+02		0.439		0.017
molybdenum	6.10E+00	3.91E+02	1.02E+04		0.016		<0.001
silver	1.70E+00	3.91E+02	1.02E+04		0.004		<0.001
Total Risk and Hazard Index Quantification for Constituents in Soil[2]					1.281		0.075

	Carcinogens	Noncarcinogens
Total Construction Worker Risk and Hazard Index Quantification for Constituents in Soil[3]		0.029

Notes:

[1] United States Environmental Protection Agency Region 9 preliminary remediation goal (USEPA 2000).

[2] 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.

[3] Calculated as the product of 0.015 and the industrial risk, and 0.384 and the industrial hazard (Earth Tech 2004).

mg/kg milligrams per kilogram

Ecological Risk

The OU4 SERA identified potentially complete exposure pathways to ecological receptors. Additionally, the PERA (Tetra Tech 2004) suggested risk to certain receptor groups. However, because the property is heavily developed for industrial use, it is unlikely that Site 150 will serve as a practical or valuable refuge for plants or animals now or in the future. Moreover, the ecological risks are considered acceptable because no threatened or endangered species have been identified at Site 150, and (as stated in the PERA):

> Potential risks to some of these receptor groups may by of limited ecological significance given the low attractiveness of the habitat, the surrounding Air Force facilities and activity, and the uncertain potential for recovery at this highly disturbed industrial site... It is important to note that past physical disturbance contributes in part to this conclusion [potential risk to certain receptor groups], and chemical contamination is not the sole justification… Results for the terrestrial receptors at Site 150 did not show any systematic trend (e.g., a consistent and substantial risk for all receptors for a certain suite of constituents) that would indicate the potential for impact to the community as a whole.

Threat to Groundwater and Surface Water

Because no organic compounds were detected and no inorganic compounds are identified as COCs, the soil at Site 150 poses little threat to groundwater or ephemeral surface water (storm runoff); there is permanent standing water on site. Existing contamination in the groundwater is addressed in the South AFRL ROD.

2.7.3.4 Selected Remedy

Because no COCs were identified, the Air Force and USEPA, with concurrence from Cal/EPA DTSC and the Water Board, selected NFA for soil at Site 150. The groundwater below the site will continue to be managed as part of the final remedy for the South AFRL area.

2.7.3.5 Documentation of Significant Changes from Proposed Plan

There are no significant changes from the *Soil and Debris Sites PP*.

2.7.4 SITES 153 AND 396 – DRY WELLS ASSOCIATED WITH BUILDINGS 8419, 8421, 8423, 8425, AND 8431

2.7.4.1 Site Name, Location, and Brief Description

Sites 153 and 396 are located north of the AFRL Civil Engineering Yard and east of Mercury Boulevard (Figure 2.1-2). As shown on Figure 2.7-5, Site 153 includes a former waste discharge area, former Dry Well A (associated with Building 8421), former Dry Well D (Building 8419), former Dry Well E (Building 8431), and former Dry Well F (Building 8423); Site 396 includes Dry Well G (Building 8425). Dry Wells B and C (reportedly associated with Building 8421) could not be located (and are therefore not shown on Figure 2.7-5); it is assumed these two dry wells were destroyed prior to 1993.

2.7.4.2 Site History and Enforcement Activities

Site History

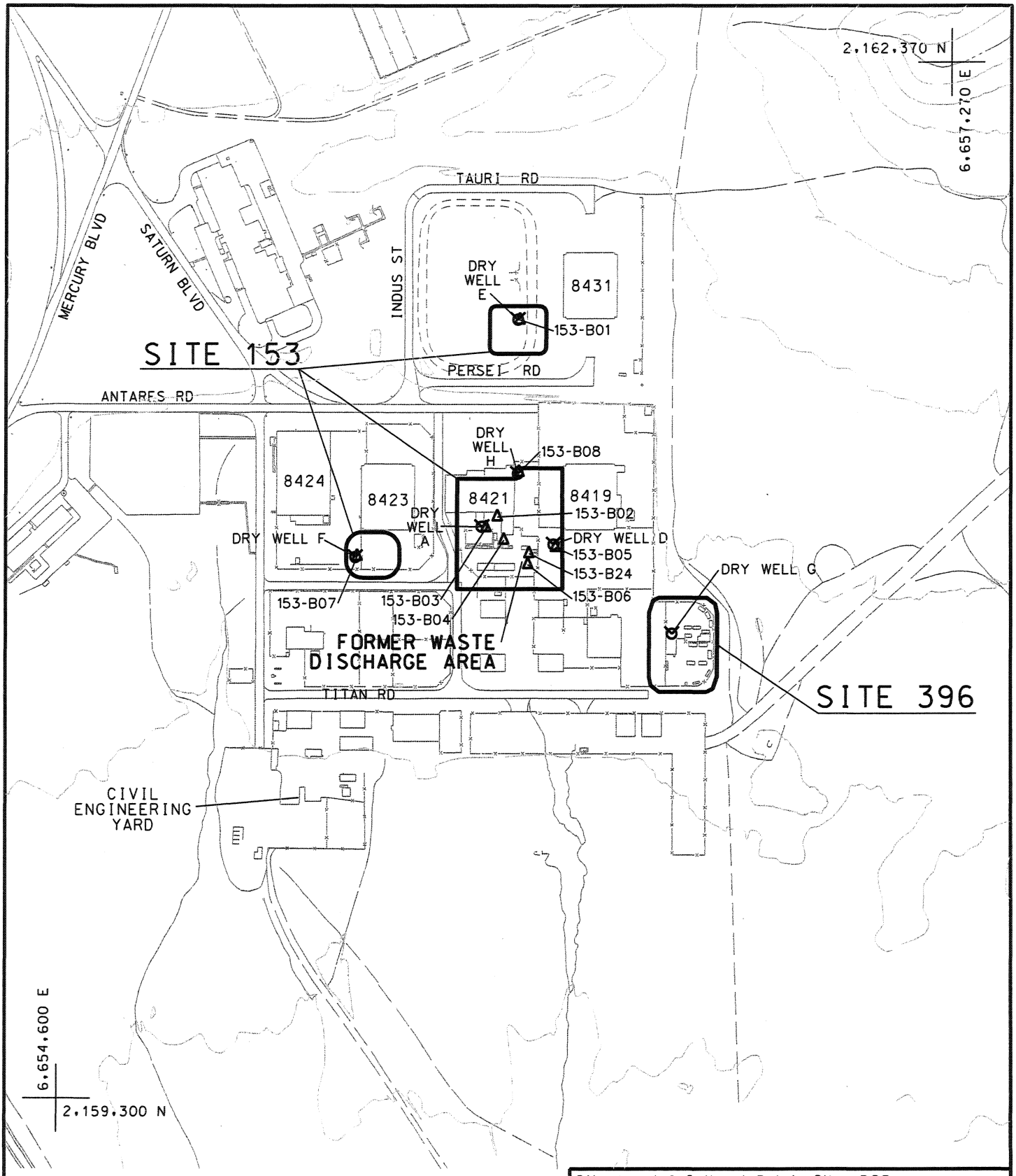
The former waste discharge area reportedly received hundreds of gallons of wastes from Building 8421, which was used as a machine shop from the early 1960s through mid-1997. A visual inspection of the site in June 1993 found evidence of soil discoloration in convergent drainage channels that originate at the southern extent of the asphalt surface southeast of Building 8421. The dry wells were formerly connected to floor drains, grease interceptor pits, cesspools, and/or air conditioning systems inside their associated buildings. Prior to 2001, the dry wells were isolated from all inlet sources except the air conditioning systems which discharge only clean water from the condensers.

Site Characterization Sampling

The following is a summary of site characterization sampling conducted at Sites 153 and 396; a more comprehensive discussion of these activities is presented in the *OU4 RI Summary Report*.

Soil

Soil samples were collected at the waste discharge area and adjacent to each dry well. No organic compounds were detected at concentrations that exceed residential or industrial PRGs, and no inorganic compound exceeded both PRGs and background limits. Therefore, no COCs were identified for soil.



OUs 4 and 9 Soil and Debris Sites ROD

Sites 153 and 396 Map Showing Soil Sampling Locations

Date 5-08 Project No. 87503	Air Force Research Laboratory Edwards AFB	Figure 2.7-5

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Sludge and Standing Water

Sludge from the bottom of Dry Well E and standing water from Dry Wells A and D were sampled in 1999. The sludge contained TEPH above the *LUFT*-derived action level of 1,000 mg/kg. The elements arsenic and chromium exceeded both their industrial PRGs and AFRL background limits. Only lead (in standing water from Dry Well A) was detected above its MCL and AFRL background level.

Groundwater

It is likely that organic wastes, including the solvent TCE, entered the groundwater through use of the dry wells. Sites 153 and 396 are considered source areas for the Site 133 groundwater plume, and the groundwater contamination below the sites is addressed in the ROD for the South AFRL area. TEPH was not detected in the well drilled adjacent to Dry Well E.

Interim Remedial Actions

An IRA was conducted in 2001 to destroy the dry wells at Sites 153 and 396. Dry well destruction consisted of the following field tasks:

1. The dry well inlet lines were redirected to discharge clean water from the air conditioning systems to the sanitary sewer.
2. The standing water was pumped from Dry Well A and was disposed on-site after treatment.
3. At the request of the Water Board; the sludge, soil, and gravel in Dry Well E was excavated past the bottom of the dry well, to the bedrock contact. The remaining bedrock was too hard to collect confirmation samples. The removed material was disposed as a non-RCRA hazardous waste, at a licensed off-site TSDF.
4. The aboveground portions of all dry well surface monuments were removed.
5. The dry well casings were filled to the surface with a cement slurry to prevent future use and to safeguard the groundwater from further leaching of contaminants into the groundwater.

Following dry well destruction, a closure letter from KCEHSD was issued stating, "The Department concurs that these wells are no longer a potential source for soil or groundwater contamination."

Nature and Extent of Residual Site Contamination

No residual contaminants remain in soil at Sites 153 and 396 that would limit exposure or restrict use, and no soil COCs were retained.

2.7.4.3 Summary of Site Risks

Human Health Risk

The results of the 2004 risk assessments, included in Tables 2.7-3 and 2.7-4, show that estimated cancer risks from exposure to Site 153 soil under all scenarios are less than or equal to 1 x 10^{-6}, within the acceptable range. No carcinogenic compounds were detected above background in soil at Site 396. The HI calculated for Site 153 is less than 1 for the industrial and construction scenarios suggesting no hazard to human health. The HI for the hypothetical residential scenario is 2.7, driven by the maximum concentrations of iron and manganese (possibly due to site activity) detected in the soil next to Dry Wells F and A, respectively. However, given the limited extent of the metals, and the fact that the dry wells have been destroyed, iron and manganese were not listed as COCs for Site 153. The HIs for Site 396 are all below 1.

Because no VOCs were detected in soil at Sites 153 and 396 at concentrations above residential PRGs (Appendix D), the VIP into indoor air from soil is incomplete and no evaluation of risk via this pathway was conducted. However, the South AFRL ROD details the VIP associated with the underlying Site 133 groundwater plume, and the selected remedial response.

Ecological Risk

No complete pathways to ecological receptors at Site 153 were found in the OU4 SERA due to the industrial nature of the site, the limited amount of vegetation, and the fact that the ground at the dry wells has been graded and/or paved. In addition, the dry wells have been destroyed, and sampling results for soil boreholes indicate there is no continuing source of soil contamination at the site. Therefore, NFEI was recommended at Site 153.

Because no contaminants were detected in soil between 0 and 2 feet bgs, the OU4 ERA identified no ecological exposure pathways to be present at Site 396. Therefore, NFEI was recommended, and the site did not proceed to the SERA phase.

TABLE 2.7-3. QUANTIFICATION OF RISKS FOR CHEMICALS DETECTED IN SOIL - SITE 153

Analyte	Maximum Detected Concentration	Residential PRG[1]	Industrial PRG[1]	Residential Risk and Hazard Index		Industrial Risk and Hazard Index	
				Carcinogens	Noncarcinogens	Carcinogens	Noncarcinogens
Inorganic Analytes (mg/kg)							
chromium, total	2.21E+02	2.11E+02 c	4.48E+02 c	1.05E-06		4.93E-07	
cobalt	9.66E+01	4.69E+03	1.00E+05		0.021		<0.001
copper	1.20E+02	2.91E+03	7.59E+04		0.041		0.002
cyanide	8.00E-01	1.08E+01	3.54E+01		0.074		0.023
iron	3.49E+04	2.35E+04	1.00E+05		1.487		0.349
lead	1.90E+01	4.00E+02	7.50E+02		0.048		0.025
manganese	1.53E+03	1.76E+03	3.23E+04		0.868		0.047
molybdenum	4.40E+00	3.91E+02	1.02E+04		0.011		<0.001
nickel	4.07E+01	1.50E+02 c	4.09E+04	2.71E-07			<0.001
selenium	1.60E+00	3.91E+02	1.02E+04		0.004		<0.001
vanadium	7.71E+01	5.47E+02	1.43E+04		0.141		0.005
zinc	1.05E+02	2.35E+04	1.00E+05		0.004		0.001
Organic Analytes (mg/kg)							
1,2-dichloroethane	2.10E-02	3.46E-01 c	7.65E-01 c	6.07E-08		2.75E-08	
bis(2-ethylhexyl) phthalate	1.80E+00	3.47E+01 c	1.76E+02 c	5.18E-08		1.02E-08	
Dioxins/Furans (ng/g)							
OCDD[2]	1.30E+00	3.90E+01 c	2.70E+02 c	3.33E-08		4.81E-09	
Total Risk and Hazard Index Quantification for Constituents in Soil[3]				1.47E-06	2.700	5.35E-07	0.455

	Carcinogens	Noncarcinogens
Total Construction Worker Risk and Hazard Index Quantification for Constituents in Soil[4]	8.22E-09	0.175

Notes:

[1] United States Environmental Protection Agency Region 9 preliminary remediation goal (USEPA 2000).

[2] The PRG for 2,3,7,8-tetrachlorodibenzo-p-dioxin was used divided by the toxicity equivalency factor for OCDD (0.0001).

[3] 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.

[4] Calculated as the product of 0.015 and the industrial risk, and 0.384 and the industrial hazard (Earth Tech 2004).

c Indicates that chemical is evaluated based on its carcinogenic potential.

mg/kg milligrams per kilogram

ng/g nanograms per gram

OCDD octachlorodibenzo-p-dioxin

TABLE 2.7-4. QUANTIFICATION OF RISKS FOR CHEMICALS DETECTED IN SOIL - SITE 396

Analyte	Maximum Detected Concentration	Residential PRG[1]	Industrial PRG[1]	Residential Risk and Hazard Index		Industrial Risk and Hazard Index	
				Carcinogens	Noncarcinogens	Carcinogens	Noncarcinogens
Inorganic Analytes (mg/kg)							
copper	7.47E+01	2.91E+03	7.59E+04		0.026		<0.001
manganese	7.98E+02	1.76E+03	3.23E+04		0.453		0.025
mercury	6.10E-01	2.35E+01	6.13E+02		0.026		<0.001
Total Risk and Hazard Index Quantification for Constituents in Soil[2]					0.505		0.027

	Carcinogens	Noncarcinogens
Total Construction Worker Risk and Hazard Index Quantification for Constituents in Soil[3]		0.010

Notes:

[1] United States Environmental Protection Agency Region 9 preliminary remediation goal (USEPA 2000).

[2] Calculated as the ratio of the maximum detected concentration to the PRG for noncarcinogens. This ratio is multiplied by 1×10^{-6} for carcinogens.

[3] Calculated as the product of 0.015 and the industrial risk, and 0.384 and the industrial hazard (Earth Tech 2004).

mg/kg milligrams per kilogram

Threat to Groundwater and Surface Water

Because the IRA conducted at Sites 153 and 396 removed the contaminated water and sludge from the dry wells prior to destruction, the sites pose little threat to groundwater. Existing VOC contamination in the groundwater is addressed in the South AFRL ROD. Because there are no identified surface contaminants, there is no threat to ephemeral surface water (storm runoff); there is permanent standing water on site.

2.7.4.4 Selected Remedy

Because no COCs were identified in the soil at Sites 153 and 396, and the dry wells have been destroyed, the site now qualifies for risk-based closure with no restrictions on land use. Therefore, the Air Force and USEPA, with concurrence from Cal/EPA DTSC and the Water Board, selected NFA for soil at Sites 153 and 396. The groundwater below the sites will continue to be managed as part of the final remedy for the South AFRL area.

2.7.4.5 Documentation of Significant Changes from Proposed Plan

There are no significant changes from the *Soil and Debris Sites PP*.

2.7.5 SITE 166 – BUILDING 8240 FORMER WASTE DISCHARGE AREA AND REMOVED WASTE OIL UST

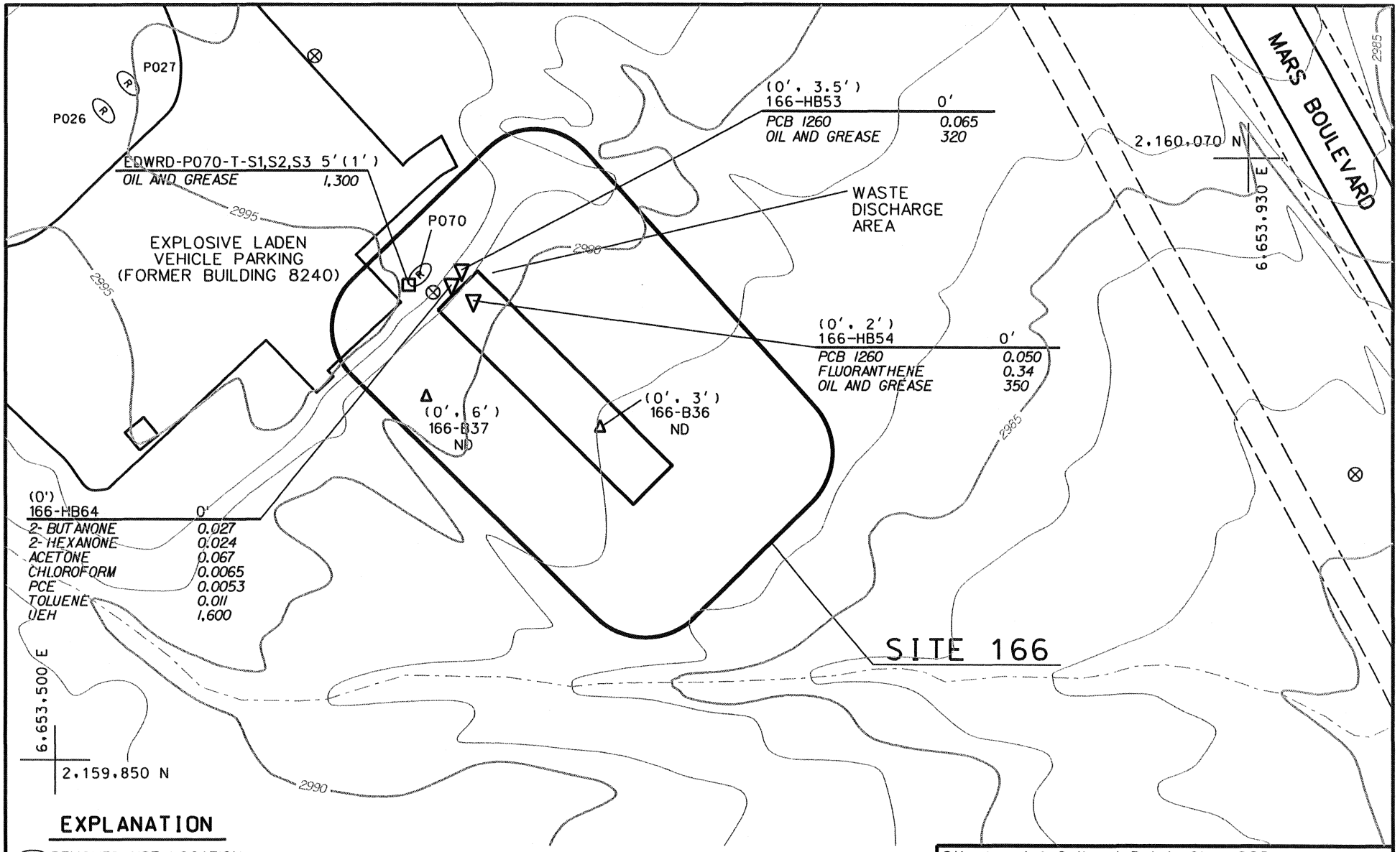
2.7.5.1 Site Name, Location, and Brief Description

Site 166 includes a former waste discharge area and a removed waste oil UST associated with Building 8240, located on the southeastern side of Mercury Boulevard (Figure 2.1-2). Building 8240 was a service garage that was constructed in the late 1950s and deactivated in the mid-1960s (Figure 2.7-6); the building has since been demolished.

2.7.5.2 Site History and Enforcement Activities

Site History

The service station formerly included four fuel dispenser islands that were supplied by two 10,000-gallon USTs. The fuel dispensers and the tanks were removed in 1992 with no contaminants detected. The Site 166 waste oil UST had a 300-gallon capacity and was connected to the service



OUs 4 and 9 Soil and Debris Sites ROD

Site 166 Map Showing Soil Sampling Results

Date 5-08	Air Force Research Laboratory Edwards AFB	Figure 2.7-6
Project No. 87503		

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station via an underground drain pipe. A second drainpipe originated at Building 8240 and discharged to the surface soil at the waste discharge area. This area extended southeast from the former UST and was located near an electrical utility pole. A transformer unit mounted on the utility pole leaked oil to the waste discharge area.

Site Characterization Sampling

The following is a summary of site characterization sampling conducted at Site 166; a more comprehensive discussion of these activities is presented in the *OU4 RI Summary Report*.

Soil

Results of soil sampling conducted at Site 166 between 1992 and 1997 revealed contamination by UEH (probably diesel fuel), oil and grease, and PCBs. The PCBs ranged in concentration from 0.050 mg/kg to 0.16 mg/kg, all below the residential PRG of 0.22 mg/kg and the TSCA limit of 1 mg/kg for residential use. The UEH and oil and grease concentrations were above the *LUFT*-derived action level of 1,000 mg/kg.

Groundwater

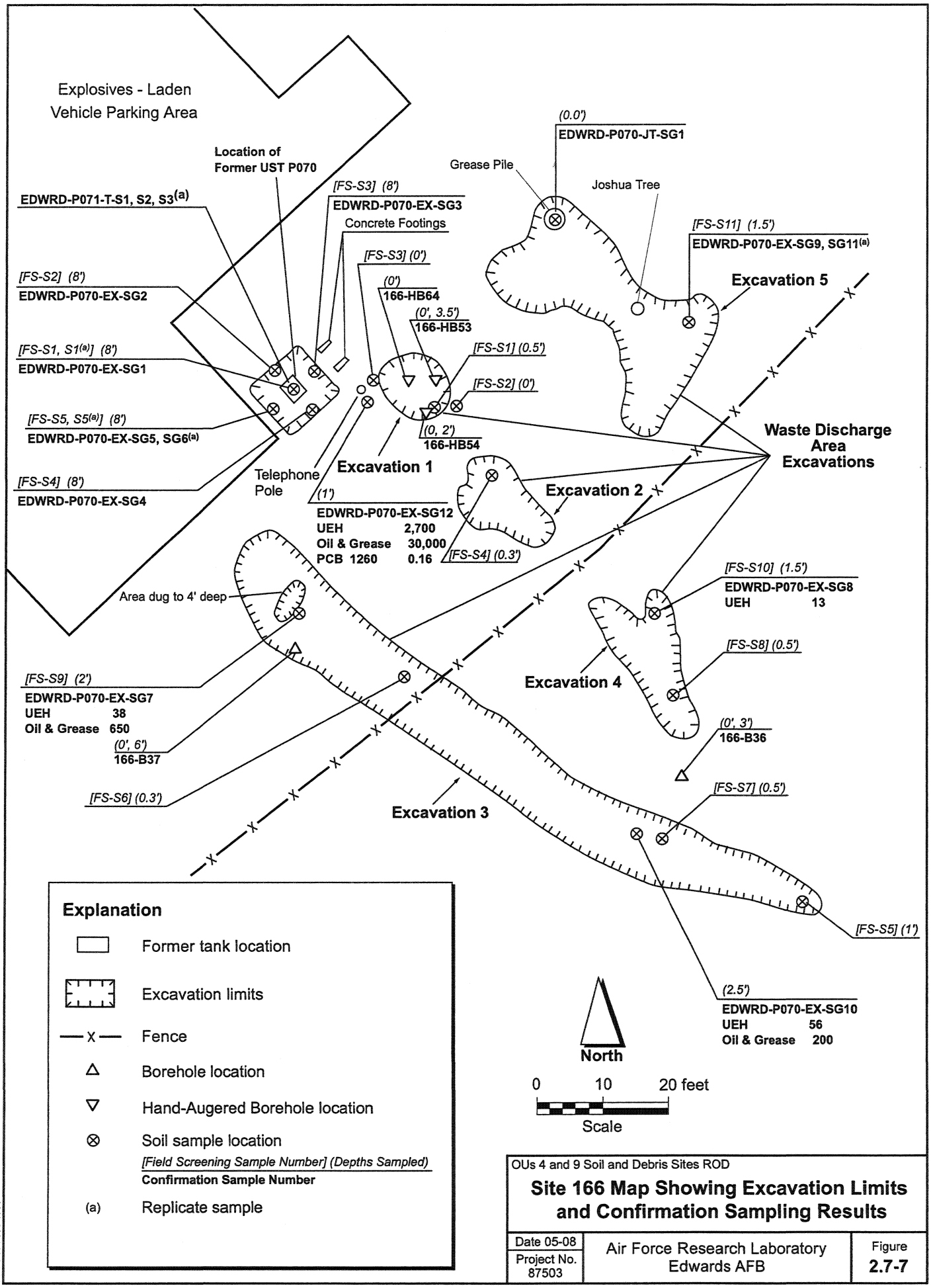
Due to the low mobility of the soil contaminants, migration into groundwater was not considered likely; therefore, no groundwater investigations were conducted. However, the groundwater under Site 166 is contaminated as part of the Site 37 groundwater plume and is addressed in the ROD for the South AFRL area.

Interim Remedial Actions

The waste oil UST was removed in 1992 and the electric transformer was removed in 1994. In 1997, a total of 75 tons of contaminated soil was excavated from the former site of the waste oil UST and from the waste discharge area (Figure 2.7-7). The soil was remediated ex-situ at a treatment facility (land farm) located on Edwards AFB, near South Base.

Nature and Extent of Residual Site Contamination

No COCs were retained for soil at Site 166. Except for one sample (from a small area too close to the utility pole to excavate), petroleum hydrocarbon concentrations in confirmation samples collected



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OUs 4 and 9 Soil and Debris Sites ROD

Site 166 Map Showing Excavation Limits and Confirmation Sampling Results

Date 05-08	Air Force Research Laboratory	Figure
Project No. 87503	Edwards AFB	2.7-7

following the IRA were below the *LUFT*-derived action level of 1,000 mg/kg. The concentrations of UEH, oil and grease, and PCBs in the sample collected near the utility pole were 2,700 mg/kg, 30,000 mg/kg, and 0.16 mg/kg, respectively. However, due to the limited extent of these contaminants and the low risk exhibited (see below), the RPMs agreed that they should not be retained as soil COCs (Earth Tech 2005a).

2.7.5.3 Summary of Site Risks

Human Health Risk

Using the confirmation soil data collected at Site 166 following the 1997 excavations, a screening-level HHRA was completed in 2004. The HHRA compared maximum detections of chemicals against their background concentrations (inorganics only) and their residential and industrial PRGs. The results, presented in Table 2.7-5, show that the potential cancer risk from exposure to soil under all scenarios evaluated is acceptable, i.e., less than 1×10^{-6}. The non-cancer HI calculated for the hypothetical residential exposure scenario was slightly greater than 1 due to the combined effects of iron and manganese (neither of which was detected individually at a concentration above its residential PRG); the HI was less than 1 for the industrial and construction exposure scenarios.

Because no VOCs were detected in the Site 166 soil, the VIP into indoor air from soil is incomplete and no evaluation of risk via this pathway was conducted. However, the South AFRL ROD details the VIP associated with the underlying Site 133 groundwater plume, and the selected remedial response.

Ecological Risk

A PERA was completed in 2004 using the confirmation soil data collected at Site 166 following the 1997 excavations. Results of the PERA (Tetra Tech 2004) indicate that PCBs at Site 166 may pose a limited potential risk to plant-feeding birds (house finch) as a receptor group. No risks to other avian receptors were identified and no chemicals of potential ecological concern were identified for the other receptor communities evaluated (terrestrial plant, terrestrial invertebrates, reptiles, other birds, and mammals). The PERA concluded that the ecological risks at Site 166 are not significant because (1) no threatened or endangered species have been identified at Site 166, (2) the small site provides only limited habitat for plant feeding birds, and (3) results for the terrestrial receptors at Site 166 did not show any systematic trend that would indicate the potential for impact to the community as a whole.

TABLE 2.7-5. QUANTIFICATION OF RISKS FOR CHEMICALS DETECTED IN SOIL - SITE 166

Analyte	Maximum Detected Concentration	Residential PRG[1]	Industrial PRG[1]	Residential Risk and Hazard Index		Industrial Risk and Hazard Index	
				Carcinogens	Noncarcinogens	Carcinogens	Noncarcinogens
Inorganic Analytes (mg/kg)							
chromium, total	1.30E+01	2.11E+02 c	4.48E+02 c	6.17E-08		2.90E-08	
iron	1.99E+04	2.35E+04	1.00E+05		0.848		0.199
manganese	7.25E+02	1.76E+03	3.23E+04		0.411		0.022
nickel	1.02E+01	1.50E+02 c	4.09E+04	6.80E-08			<0.001
Organic Analytes (mg/kg)							
PCB-1260 (Aroclor 1260)	1.60E-01	2.22E-01 c	1.00E+00 c	7.21E-07		1.59E-07	
Total Risk and Hazard Index Quantification for Constituents in Soil[2]				8.51E-07	1.260	1.88E-07	0.222

	Carcinogens	Noncarcinogens
Total Construction Worker Risk and Hazard Index Quantification for Constituents in Soil[3]	2.89E-09	0.085

Notes:

[1] United States Environmental Protection Agency Region 9 preliminary remediation goal (USEPA 2000).

[2] 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.

[3] Calculated as the product of 0.015 and the industrial risk, and 0.384 and the industrial hazard (Earth Tech 2004).

c Indicates that chemical is evaluated based on its carcinogenic potential.

mg/kg milligrams per kilogram

PCB polychlorinated biphenyl

Threat to Groundwater and Surface Water

The Site 166 IRA removed petroleum-contaminated soil to levels below the groundwater-protective LUFT-derived action levels in all but a very small area. Additionally, the PCBs remaining on site exhibit low mobility in soil. Therefore, the remaining soil at Site 166 poses little threat to groundwater. Existing VOC contamination in the groundwater is addressed in the South AFRL ROD. Because most of the surface contaminants were removed, there is little threat to ephemeral surface water (storm runoff); there is no permanent standing water on site.

2.7.5.4 Selected Remedy

Because the IRA conducted at Site 166 removed most of the contaminated soil and sources of further contamination, the site now qualifies for risk-based closure with no restrictions on land use. Therefore, the Air Force and USEPA, with concurrence from Cal/EPA DTSC and the Water Board, selected NFA for soil at Site 166. The groundwater below the site will continue to be managed as part of the final remedy for the South AFRL area.

2.7.5.5 Documentation of Significant Changes from Proposed Plan

There are no significant changes from the *Soil and Debris Sites PP*.

2.7.6 AOCs 170 AND 171 – BUILDING 8595 INDOOR VAPOR DEGREASER PIT AND INDOOR SUMP

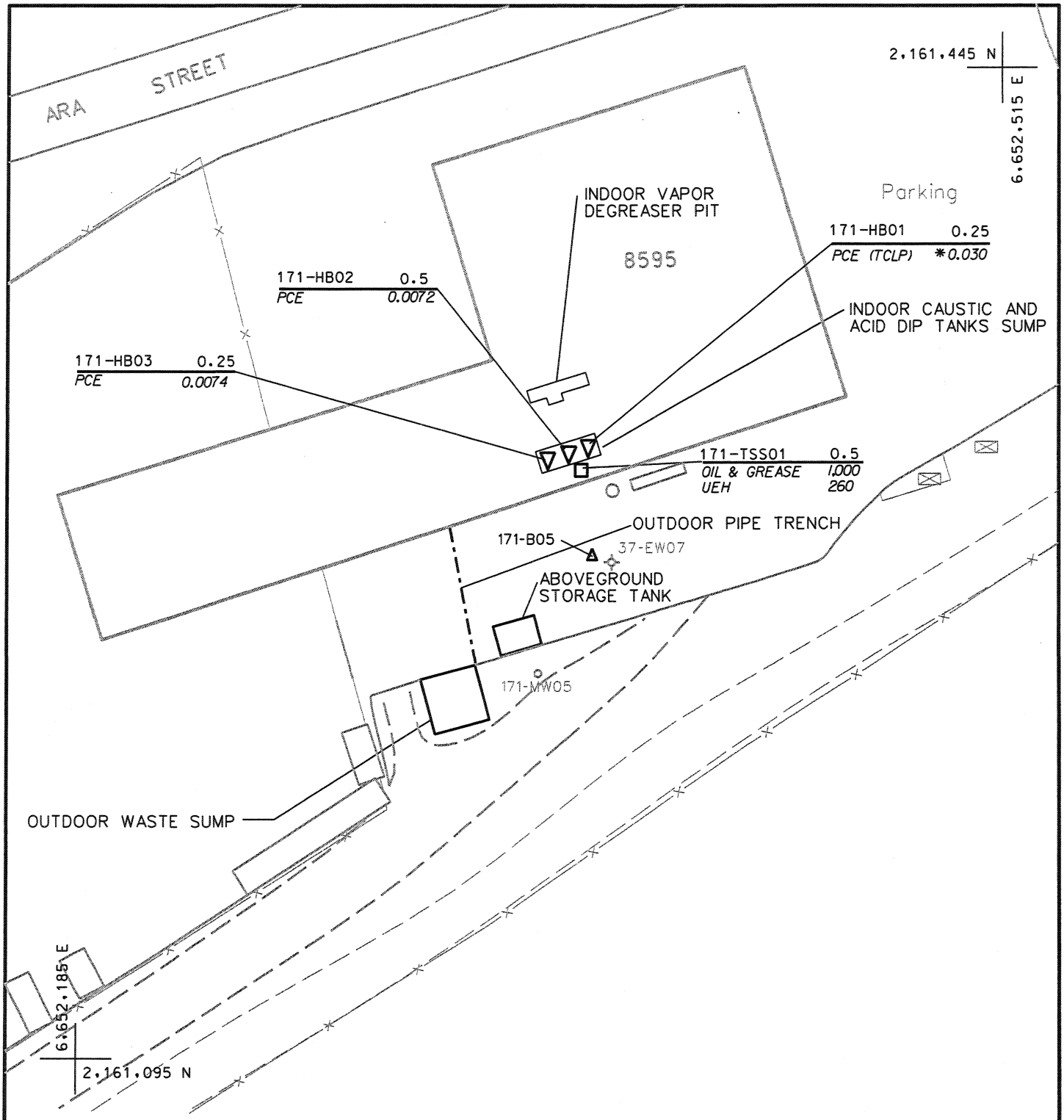
2.7.6.1 Site Name, Location, and Brief Description

AOCs 170 and 171 are associated with indoor degreasing and acid/caustic dip-cleaning operations formerly conducted at Building 8595, located at the intersection of Mars Boulevard and Ara Street (Figure 2.1-2). The indoor vapor degreaser pit and indoor sump were located in the southwestern portion of Building 8595 (Figure 2.7-8).

2.7.6.2 Site History and Enforcement Activities

Site History

The solvent PCE was used in the vapor degreaser to clean rocket nozzles and components. From approximately 1963 to 1970, the unit was in use for up to 8 hours per day. Two drain lines from the



EXPLANATION

- SURFACE SAMPLE LOCATION
- HAND AUGER SAMPLE LOCATION
- MONITORING WELL LOCATION
- EXTRACTION WELL LOCATION
- BOREHOLE LOCATION

PCE TETRACHLOROETHENE
TCLP TOXICITY CHARACTERISTIC LEACHING POTENTIAL
UEH UNKNOWN EXTRACTABLE HYDROCARBON

LOCATION NAME SAMPLE DEPTH (FT)
PARAMETER NAME
VALUE DETECTED
SOIL-mg/kg
**-mg/L*

NORTH

0 25 50 FEET
SCALE: 1" = 50'

OUs 4 and 9 Soil and Debris Sites ROD

AOCs 170 and 171 Map Showing Soil Sampling Results

Date 5-08	Air Force Research Laboratory Edwards AFB	Figure 2.7-8
Project No. 87503		

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vapor degreaser pit discharged directly into the indoor sump. Alkali and acids were used to clean parts in dip tanks located on a grate above the indoor sump.

Site Characterization Sampling

The following is a summary of site characterization sampling conducted at AOCs 170 and 171; a more comprehensive discussion of these activities is presented in the *OU4 RI Summary Report*.

Soil

During a 1993 investigation, soil samples were collected from a borehole (171-B05) drilled 30 feet south of Building 8595. PCE was detected below its residential PRG in samples from the surface (0.014 mg/kg) and from a depth of 3 feet (0.074 mg/kg). In 1997, as part of activities to decommission the units, three samples were collected from beneath the indoor waste sump (AOC 171) and one was collected through a crack in the floor adjacent to the sump. PCE was detected at concentrations below its residential PRG. Petroleum hydrocarbons (UEH at 260 mg/kg and oil and grease at 1,000 mg/kg) were also detected. Among the inorganic elements, only cadmium (at 10.7 mg/kg) exceeded both its residential PRG and AFRL background limit. Because, the walls and floor of the vapor degreaser pit (AOC 170) were found to be intact, no soil samples were collected beneath this unit.

Groundwater

Groundwater below AOCs 170 and 171 was found to be contaminated (at concentrations well above MCLs) by PCE. This contamination is part of the Site 37 groundwater plume and is addressed in the ROD for the South AFRL area.

Interim Remedial Actions

In November 1997, the sludge inside the indoor sump was removed and disposed of as a hazardous waste at an off-site, licensed TSDF. The pit and sump were then steam cleaned and inspected. The vapor degreaser pit was found to be in good condition. The drain from this unit, and all drains and holes in the indoor sump, were plugged with concrete. Both units were then backfilled with gravel to 6 inches below grade and capped with reinforced concrete. In addition, 180 square feet of damaged concrete flooring to the west, south, and east of the indoor sump were replaced.

Nature and Extent of Residual Site Contamination

No residual contaminants remain in soil at AOCs 170 and 171 that would limit exposure or restrict use, and no soil COCs were identified.

2.7.6.3 Summary of Site Risks

Human Health Risk

A screening-level HHRA was completed for AOC 171 in 2004. The HHRA consisted of comparing maximum detections of chemicals against their background concentrations (for inorganics only) and their residential and industrial PRGs. The results indicate acceptable cancer risks of 1.4×10^{-6} from exposure to soil under a hypothetical residential exposure scenario, and less than 1×10^{-6} under the industrial and construction exposure scenarios (Table 2.7-6). The non-cancer HIs calculated for all three exposure scenarios were less than 1. Because no soil samples were collected from the vapor degreaser pit, no HHRA was performed for AOC 170.

Ecological Risk

The OU4 ERA identified no ecological exposure pathways to be present at either of AOCs 170 or 171. Therefore, NFEI was recommended for both AOCs, and neither AOC proceeded to the SERA phase.

Threat to Groundwater and Surface Water

Because the 1997 IRA removed the contaminated sludge from the indoor sump, and both units were cleaned prior to decommissioning, no source remains that poses a threat to groundwater. Existing VOC contamination in the groundwater is addressed in the South AFRL ROD. Because the AOCs are located indoors, there is no surface water present.

2.7.6.4 Selected Remedy

Because the IRA conducted at AOCs 170 and 171 effectively removed these units as sources of further contamination, the Air Force and USEPA, with concurrence from Cal/EPA DTSC and the Water Board, selected NFA for soil at AOCs 170 and 171. The groundwater and soil vapor below Building 8595 will continue to be managed as part of the final remedy for the South AFRL area.

TABLE 2.7-6. QUANTIFICATION OF RISKS FOR CHEMICALS DETECTED IN SOIL - AOC 171

Analyte	Maximum Detected Concentration	Residential PRG[1]	Industrial PRG[1]	Residential Risk and Hazard Index		Industrial Risk and Hazard Index	
				Carcinogens	Noncarcinogens	Carcinogens	Noncarcinogens
Inorganic Analytes (mg/kg)							
cadmium	1.07E+01	9.00E+00 c	8.09E+02	1.19E-06			0.013
chromium, total	1.72E+01	2.11E+02 c	4.48E+02 c	8.16E-08		3.84E-08	
cobalt	4.24E+01	4.69E+03	1.00E+05		0.009		<0.001
copper	5.37E+01	2.91E+03	7.59E+04		0.018		<0.001
lead	2.33E+01	4.00E+02	7.50E+02		0.058		0.031
nickel	1.68E+01	1.50E+02 c	4.09E+04	1.12E-07			<0.001
nitrogen, nitrate (as N)	3.90E+00	NE	NE				
zinc	1.13E+02	2.35E+04	1.00E+05		0.005		0.001
Organic Analytes (mg/kg)							
bis(2-ethylhexyl) phthalate	7.00E-01	3.47E+01 c	1.76E+02 c	2.01E-08		3.97E-09	
di-n-butyl phthalate	3.70E-01	6.11E+03	8.81E+04		<0.001		<0.001
naphthalene	1.10E-03	5.59E+01	1.89E+02		<0.001		<0.001
tetrachloroethene (PCE)	7.40E-03	5.69E+00 c	1.87E+01 c	1.30E-09		3.96E-10	
Total Risk and Hazard Index Quantification for Constituents in Soil[2]				1.40E-06	0.091	4.27E-08	0.045

	Carcinogens	Noncarcinogens
Total Construction Worker Risk and Hazard Index Quantification for Constituents in Soil[3]	6.56E-10	0.017

Notes:

[1] United States Environmental Protection Agency Region 9 preliminary remediation goal (USEPA 2000).

[2] 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.

[3] Calculated as the product of 0.015 and the industrial risk, and 0.384 and the industrial hazard (Earth Tech 2004).

c Indicates that chemical is evaluated based on its carcinogenic potential.

AOC area of concern

mg/kg milligrams per kilogram

NE not established

2.7.6.5 Documentation of Significant Changes from Proposed Plan

There are no significant changes from the *Soil and Debris Sites PP*.

2.7.7 SITE 172 – BUILDING 8595 OUTDOOR SUMP

2.7.7.1 Site Name, Location, and Brief Description

Site 172, the Building 8595 outdoor waste sump (Figure 2.7-9), is located on the southeast-facing side of Leuhman Ridge, at the intersection of Mars Boulevard and Ara Street (Figure 2.1-2). At the time the waste sump was active, Building 8595 was used for the repair, rebuilding, and maintenance of rocket motor components. The outdoor waste sump was constructed in 1972 approximately 50 feet south of Building 8595 and was connected to the indoor sump (AOC 171) via a discharge line routed through the building and into a collection box on its northeastern corner. Two valved lines exited the collection box, one discharging into the sump and the other discharging to the ground surface southeast of the sump.

2.7.7.2 Site History and Enforcement Activities

Site History

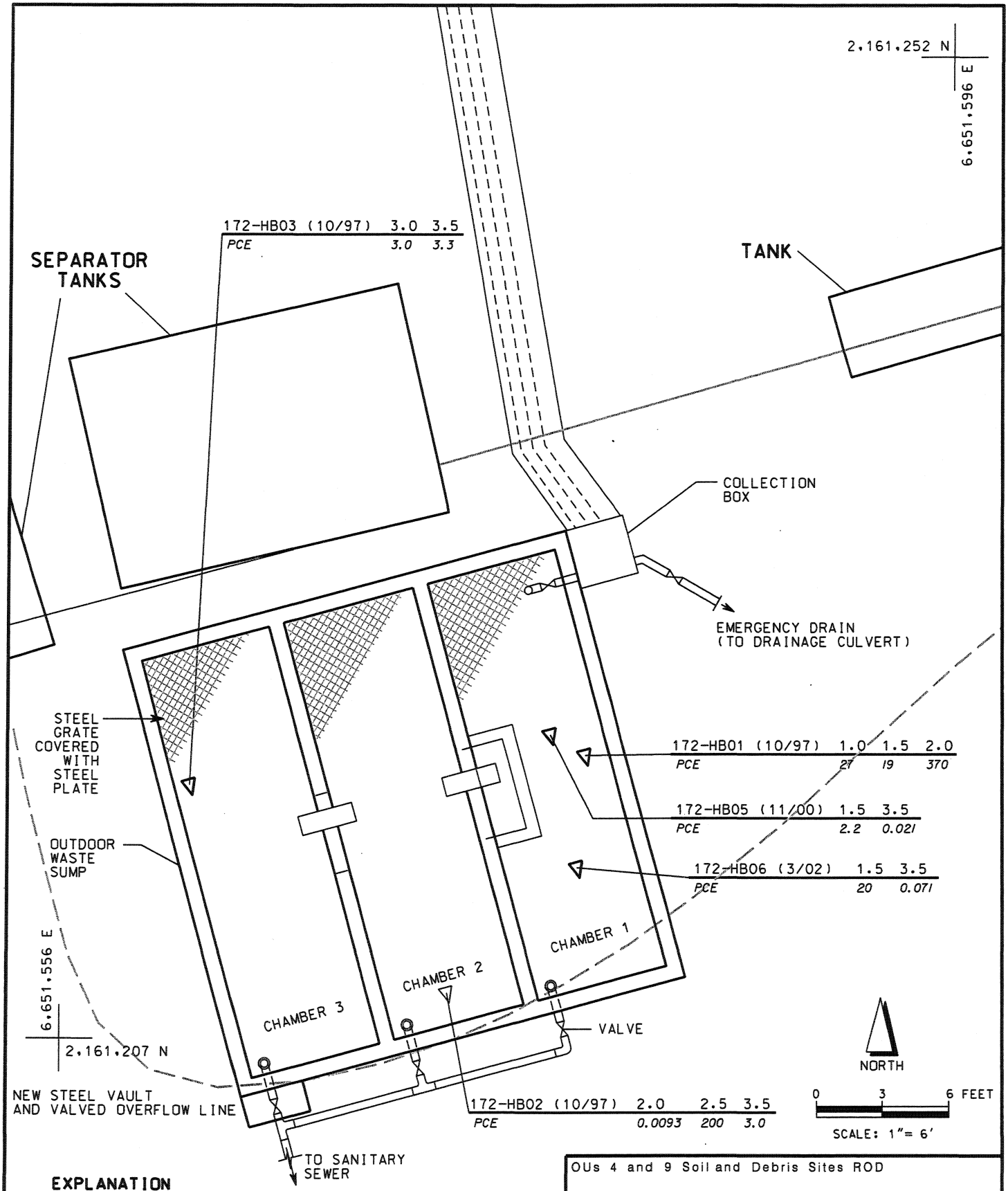
Wastewater discharged to the outdoor waste sump was potentially contaminated with bases, acids, chlorinated solvents, heavy metals, paints, and waste petroleum products. In the mid 1980s, it was discovered that fluids were released from the sump due to leakage; repairs to the unit included installation of a fiberglass liner. Maintenance and cleaning of rocket components at Building 8595 were discontinued in mid-1997. The building is now used as an electric propulsion laboratory.

Site Characterization Sampling

The following is a summary of site characterization sampling conducted at Site 172; a more comprehensive discussion of these activities is presented in the *OU4 RI Summary Report*.

Soil

Soil samples were collected in 1993 and 1994 from boreholes located down slope from the outdoor sump. No organic compounds were detected in these samples, none of which extended below a depth of 1.6 feet bgs due to the presence of shallow bedrock. During activities conducted to decommission



EXPLANATION

- - - - - PIPING (ABOVE GROUND)
▽ HAND AUGERED BOREHOLE LOCATION
mg/kg MILLIGRAMS PER KILOGRAM
PCE TETRACHLOROETHENE

LOCATION NAME SAMPLE DEPTH(FEET BELOW BOTTOM OF SUMP)
PARAMETER NAME *VALUE DETECTED SOIL - mg/kg*

OUs 4 and 9 Soil and Debris Sites ROD

Site 172 Map Showing Soil Sampling Locations

Date 5-08	Air Force Research Laboratory Edwards AFB	Figure 2.7-9
Project No. 87503		

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the outdoor sump (see below), samples were collected of the fill sand below the sump's floor in 1997 and again in 2000. The samples indicated that, prior to treatment (see IRA below), PCE was present at a maximum concentration of 1,200 mg/kg, exceeding its residential and industrial PRGs of 0.48 mg/kg and 1.3 mg/kg, respectively.

Groundwater

The Site 172 sump was formerly a source of PCE contamination that contributed to the Site 37 groundwater plume, which is addressed in the ROD for the South AFRL area.

Interim Remedial Actions

Cleaning, Inspection, and Backfilling of the Waste Sump

In 1997, the liquids and sludge from the outdoor waste sump, the sump's fiberglass liner, and the underlying bed of sand were removed and disposed of as a RCRA hazardous waste at a licensed, off-site TSDF. The sump chambers were then steam-cleaned and all inlet pipes were removed. In 2002, the sump was filled with a concrete slurry and was capped by a reinforced concrete pad.

Soil Vapor Extraction System

A soil vapor extraction (SVE) system, using activated carbon to treat vapors extracted from three shallow vapor extraction wells, was installed at Site 172 in 2000. This temporary system was initially designed to clean up PCE contamination only in the soil below the Site 172 sump. However, in 2002 the system was upgraded to a permanent installation, and expanded to include four additional extraction wells that targeted PCE contamination in soil from nearby Site 37. The cumulative mass of contaminants removed by the SVE system through December 2007 is approximately 7,500 pounds. Confirmation sampling of the fill sand beneath the sump in 2002 showed that PCE concentrations had dropped from 1,200 mg/kg (prior to treatment) to only 20 mg/kg. In a risk management meeting held on 20 January 2005, the AFRL RPMs concurred that the Site 172 SVE had achieved it's original goal of reducing contaminant mass below the sump and that Site 172 should be administratively closed. Also, it was agreed that any remaining soil contaminants in the vicinity of Building 8595 would be addressed in the final remedy for Site 37 (see the South AFRL ROD). Currently the SVE system is online pending development of the South AFRL RAWP to address long-term management of the VIP at Building 8595 in Site 37.

Nature and Extent of Residual Site Contamination

PCE (the only COC) contamination remains in the soil vapor surrounding the Site 172 sump. This soil vapor contamination is addressed as part of the remedy for Site 37 in the South AFRL ROD.

2.7.7.3 Summary of Site Risks

Human Health Risk

A screening-level HHRA, which consisted of comparing maximum detections of chemicals against their background concentrations (for inorganics only) and their residential and industrial PRGs, was completed for Site 172 in 2004. The HHRA used soil data collected through August 2001; however, the samples collected beneath the sump in 1997 and January 2000 (prior to initiation of SVE) were excluded. Instead, the HHRA used sampling results (PCE at 2.2 mg/kg) for a progress borehole drilled below the floor of the sump in November 2000, following 19 days of SVE system downtime. A March 2002 sample indicating PCE at 20 mg/kg was collected after the risk assessment had been completed. Results of the risk assessment, presented in Table 2.7-7, indicate the potential cancer risk under all three exposure scenarios is less than 1×10^{-6} and the non-cancer HI for all three exposure scenarios is less than 1. Although the risk would likely be higher if the March 2002 sample was included, it is important to note that residual contamination in soil vapor below (and surrounding) the Site 172 sump will be addressed as part of Site 37.

The risk from the VIP at Building 8595 is addressed as part of the Site 37 remedy (see the South AFRL ROD).

Ecological Risk

The OU4 ERA noted that this site was actively undergoing remediation with an SVE system, and groundwater contamination in the area would be addressed as part of Site 37. No habitat was identified on site. Therefore, NFEI was recommended pending results of the *Validation Study* (USGS 2002b). Because this study indicated very little accumulation of chlorinated solvent chemicals in the vapor phase inside artificial burrows, even above areas of shallow groundwater with high concentrations of PCE or TCE, the NFEI recommendation was unchanged, and Site 172 did not proceed to the SERA phase.

TABLE 2.7-7. QUANTIFICATION OF RISKS FOR CHEMICALS DETECTED IN SOIL - SITE 172

Analyte	Maximum Detected Concentration	Residential PRG[1]	Industrial PRG[1]	Residential Risk and Hazard Index		Industrial Risk and Hazard Index	
				Carcinogens	Noncarcinogens	Carcinogens	Noncarcinogens
Inorganic Analytes (mg/kg)							
cadmium	7.60E-01	9.00E+00 c	8.09E+02	8.44E-08			<0.001
chromium, total	1.72E+01	2.11E+02 c	4.48E+02 c	8.16E-08		3.84E-08	
lead	2.21E+01	4.00E+02	7.50E+02		0.055		0.029
mercury	6.70E-01	2.35E+01	6.13E+02		0.029		0.001
Organic Analytes (mg/kg)							
tetrachloroethene (PCE)	2.20E+00	5.69E+00 c	1.87E+01 c	3.87E-07		1.18E-07	
Total Risk and Hazard Index Quantification for Constituents in Soil[2]				5.53E-07	0.084	1.56E-07	0.030

	Carcinogens	Noncarcinogens
Total Construction Worker Risk and Hazard Index Quantification for Constituents in Soil[3]	2.40E-09	0.011

Notes:

[1] United States Environmental Protection Agency Region 9 preliminary remediation goal (USEPA 2000).

[2] 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.

[3] Calculated as the product of 0.015 and the industrial risk, and 0.384 and the industrial hazard (Earth Tech 2004).

c Indicates that chemical is evaluated based on its carcinogenic potential.

mg/kg milligrams per kilogram

Threat to Groundwater and Surface Water

Because the outdoor sump has been decommissioned, this unit is no longer a source for further groundwater contamination. The residual PCE in soil vapor beneath and around Site 172 may pose a threat to groundwater. This threat and existing VOC contamination in the groundwater is addressed in the South AFRL ROD. The cap over the outdoor sump and the pavement around Building 8595 protects ephemeral surface water (storm runoff) from impact; there is no permanent standing water on site.

2.7.7.4 Selected Remedy

Because the IRA conducted at Site 172 removed the outdoor waste sump and 7,500 pounds of soil vapor contaminants as sources of further contamination, the Air Force and USEPA, with concurrence from Cal/EPA DTSC and the Water Board, selected NFA for Site 172. However, because the soil vapor surrounding Site 172 continues to be contaminated by PCE and will be addressed as part of Site 37, the closure of Site 172 is largely for administrative purposes. The land surrounding Building 8595 (including that on which Site 172 lies), and the groundwater below the building will continue to be managed as part of the final remedy presented in the ROD for the South AFRL area.

2.7.7.5 Documentation of Significant Changes from Proposed Plan

There are no significant changes from the *Soil and Debris Sites PP*.

2.7.8 SITE 329 – TEST AREA 1-46 FORMER WASH RACK AND OXIDATION POND

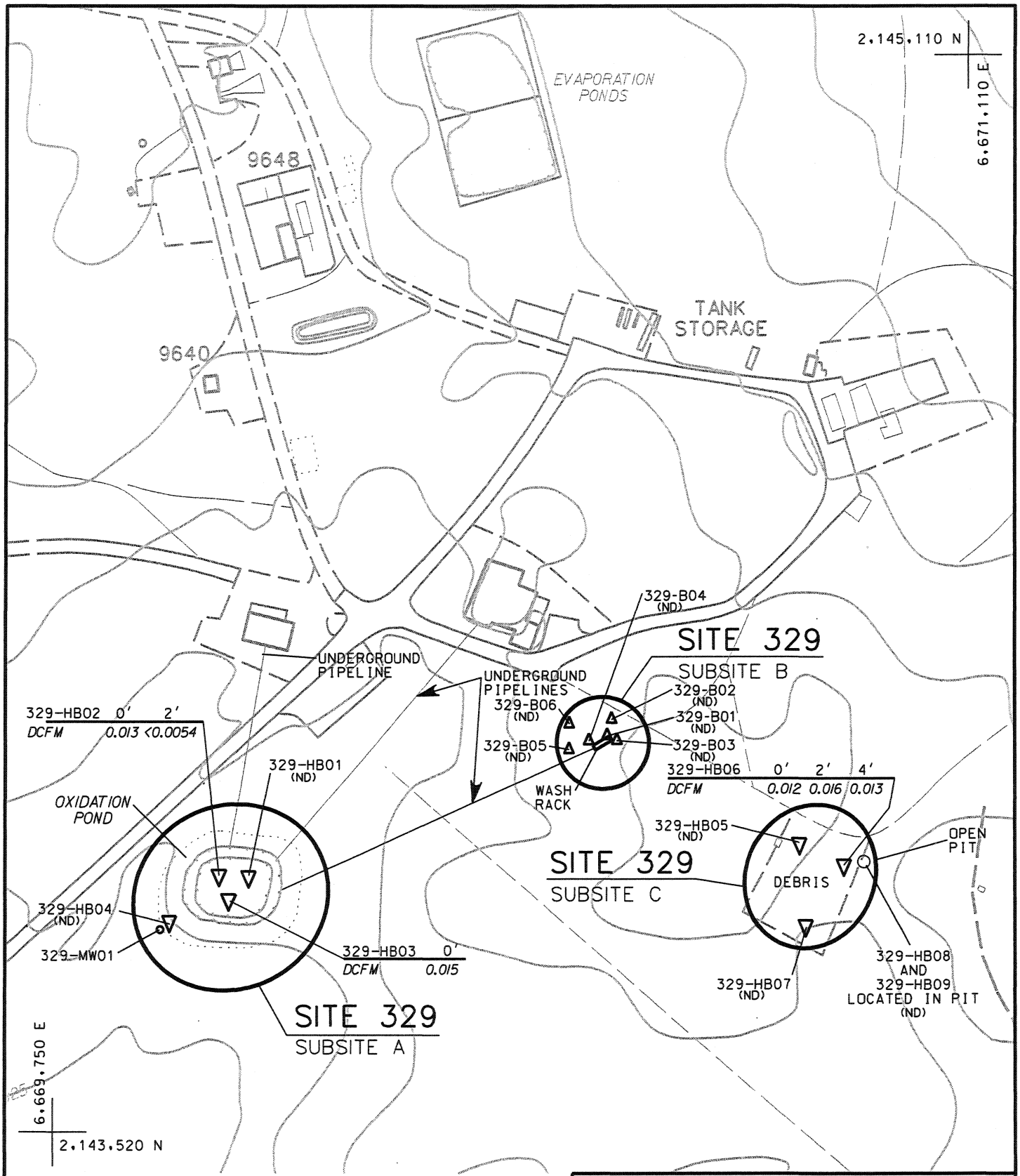
2.7.8.1 Site Name, Location, and Brief Description

Site 329 is located in Test Area 1-46 near Sites 7 and 167 (Figure 2.1-2). The site includes a wash rack and an oxidation pond associated with the test area's main shop and instrumentation/control station (Figure 2.7-10).

2.7.8.2 Site History and Enforcement Activities

Site History

Between the early 1960 and early 1970s, the wash rack was reportedly used to rinse vehicles that may have become contaminated during tests of beryllium-fueled rocket engines. Wastewater from the wash



EXPLANATION

- MONITORING WELL LOCATION
- BOREHOLE LOCATION
- HAND-AUGER BOREHOLE LOCATION
- ND NON DETECT
- DCFM DICHLORODIFLUOROMETHANE

NORTH

0 100 200 FEET

SCALE 1" = 200'

OUs 4 and 9 Soil and Debris Sites ROD

Site 329 Map Showing Soil Sampling Results

Date 5-08	Air Force Research Laboratory Edwards AFB	Figure 2.7-10
Project No. 87503		

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rack, potentially containing waste oil and beryllium, formerly drained to the unlined oxidation pond or soaked into the ground next to the wash rack. Also, the oxidation pond likely received septic wastes. There is an outlet pipe on the southwestern end of the pond. Southeast of the wash rack, and east of the oxidation pond, is a cleared area with scattered metal debris.

Site Characterization Sampling

The following is a summary of site characterization sampling conducted at Site 329; a more comprehensive discussion of these activities is presented in the *OU4 RI Summary Report*.

Soil

Soil samples were collected at Site 329 from nine shallow hand-augered boreholes in 1999, and from six drilled boreholes in 2000. No organic compounds were detected in excess of residential PRGs. Furthermore, the only inorganic analyte detected above both its residential PRG and background concentration for AFRL was iron. Based on the site history (no suspected sources of iron contamination) and sampling results, no soil COCs were identified at Site 329.

Groundwater

Groundwater samples were collected from a single monitoring well installed at Site 329 in 2000. The only contaminant detected was NDMA (at concentrations below its NL). Therefore, no COCs were identified in the groundwater.

Interim Remedial Actions

Because no COCs were identified at Site 329, no IRA was conducted.

Nature and Extent of Residual Site Contamination

Please see discussion of site characterization sampling above. No COCs were identified for soil at Site 329.

2.7.8.3 Summary of Site Risks

Human Health Risk

A screening-level HHRA, which consisted of comparing maximum detections of chemicals against their background concentrations (for inorganics only) and their residential and industrial PRGs, was completed for Site 329 in 2004. The HHRA utilized the soil sampling data from the nine hand-augered boreholes and six boreholes drilled at Site 329. The results, presented in Table 2.7-8, indicate the cancer risks from exposure to soil under all scenarios are less than 1×10^{-6}. The non-cancer HI calculated for Site 329 was less than 1 for the industrial and construction scenarios, but slightly greater than 1 for the hypothetical residential scenario, driven by the maximum detected concentration of iron in the soil.

Because no VOCs were detected in the Site 329 soil at concentrations that exceed residential PRGs (Appendix D), the VIP into indoor air from soil is incomplete and no evaluation of risk via this pathway was conducted.

The risk from exposure to groundwater was estimated for the residential (tap water) scenario only (Table 2.7-9). The estimated risk (driven by the presence NDMA) is 4×10^{-6}, within the range considered generally acceptable. The HI for groundwater exposure is less that 1. Please note that there are no plans to use Site 329 for residential purposes, and there are no complete exposure pathways to groundwater.

Ecological Risk

Results of the PERA identified total chromium and zinc as risk drivers posing a limited risk to some receptor groups via soil at Site 329. However, these potential risks may be of limited ecological significance given the poor quality of the habitat, the minimally attractive nature of the habitat, and the slow potential for recovery at this moderately disturbed industrial site.

Threat to Groundwater and Surface Water

Because no soil COCs were identified, there is no threat to groundwater or surface water from the soil at Site 329. Impacts to the groundwater underlying the site will be evaluated in the ROD for the Northeast AFRL and Mars Boulevard areas.

TABLE 2.7-8. QUANTIFICATION OF RISKS FOR CHEMICALS DETECTED IN SOIL - SITE 329

Analyte	Maximum Detected Concentration	Residential PRG[1]	Industrial PRG[1]	Residential Risk and Hazard Index		Industrial Risk and Hazard Index	
				Carcinogens	Noncarcinogens	Carcinogens	Noncarcinogens
Inorganic Analytes (mg/kg)							
beryllium	1.20E+00	1.54E+02	2.24E+03 c		0.008	5.35E-10	
chromium, total	2.13E+01	2.11E+02 c	4.48E+02 c	1.01E-07		4.75E-08	
cobalt	1.13E+01	4.69E+03	1.00E+05		0.002		<0.001
copper	7.78E+01	2.91E+03	7.59E+04		0.027		0.001
fluoride	7.80E+00	3.67E+03	5.29E+04		0.002		<0.001
iron	2.51E+04	2.35E+04	1.00E+05		1.070		0.251
nickel	1.96E+01	1.50E+02 c	4.09E+04	1.31E-07			<0.001
nitrogen, nitrate (as N)	1.32E+01	NE	NE				
zinc	1.68E+02	2.35E+04	1.00E+05		0.007		0.002
Organic Analytes (mg/kg)							
acetone	1.70E-02	1.57E+03	6.22E+03		<0.001		<0.001
dichlorodifluoromethane (Freon 12)	1.60E-02	9.39E+01	3.08E+02		<0.001		<0.001
methylene chloride	1.30E-03	8.88E+00 c	2.05E+01 c	1.46E-10		6.33E-11	
toluene	1.20E-03	5.20E+02	5.20E+02		<0.001		<0.001
Total Risk and Hazard Index Quantification for Constituents in Soil[2]				2.32E-07	1.116	4.81E-08	0.255

	Carcinogens	Noncarcinogens
Total Construction Worker Risk and Hazard Index Quantification for Constituents in Soil[3]	7.39E-10	0.098

Notes:

[1] United States Environmental Protection Agency Region 9 preliminary remediation goal (USEPA 2000).

[2] 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.

[3] Calculated as the product of 0.015 and the industrial risk, and 0.384 and the industrial hazard (Earth Tech 2004).

c Indicates that chemical is evaluated based on its carcinogenic potential.

mg/kg milligrams per kilogram

NE not established

TABLE 2.7-9. QUANTIFICATION OF RISKS FOR CHEMICALS DETECTED IN GROUNDWATER - SITE 329

Analyte	Maximum Detected Concentration	Tap Water PRG[1]		Residential Risk and Hazard Index	
				Carcinogens	Noncarcinogens
Inorganic Analytes (mg/L)					
aluminum	1.05E+01	3.65E+01			0.288
lead	9.70E-03	1.50E-02	a		
zinc	4.30E+00	1.09E+01			0.393
Organic Analytes (μg/L)					
acetone	7.50E+00	6.08E+02			0.012
bis(2-ethylhexyl) phthalate	4.50E+00	4.80E+00	c	9.37E-07	
N-nitrosodimethylamine (NDMA)	4.00E-03	1.32E-03	c	3.03E-06	
toluene	5.10E-01	7.23E+02			<0.001
Total Risk and Hazard Index Quantification for Constituents in Groundwater[2]				3.97E-06	0.693

Notes:

[1] United States Environmental Protection Agency Region 9 preliminary remediation goal (USEPA 2000).

[2] 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.

a A PRG for lead has not been established. The value shown is the California Drinking Water Action Level (see 22 CCR 64672.3).

c Indicates that chemical is evaluated based on its carcinogenic potential.

μg/L micrograms per liter
CCR California Code of Regulations
mg/L milligrams per liter

2.7.8.4 Selected Remedy

The Air Force and USEPA, with concurrence from Cal/EPA DTSC and the Water Board, selected NFA for soil at Site 329. Groundwater quality at the site will be addressed in the ROD for the Northeast AFRL and Mars Boulevard areas.

2.7.8.5 Documentation of Significant Changes from Proposed Plan

There are no significant changes from the *Soil and Debris Sites PP*.

2.8 DECISION SUMMARY – KEY DECISIONS APPLICABLE TO MULTIPLE SITES

2.8.1 LUCs GENERAL PROVISIONS

Administrative LUC measures to be used at the soil and debris sites are in accordance with specific provisions of 22 CCR Section 67391.1 that were determined by the Air Force (with USEPA and State concurrence) to be relevant and appropriate requirements. Subsections (e)(1) and (e)(2) of 22 CCR Section 67391.1 provide that if a remedy at property owned by the federal government will result in levels of hazardous substances remaining on property at levels not suitable for unlimited use and unrestricted exposure, and it is not feasible to record a land use covenant (as is the case with the soil and debris sites subject to LUCs), then the government may use other mechanisms (such as the *EAFB GP*) to clearly define and include limitations on current and future land uses to ensure that they are compatible with the levels of hazardous substances remaining on the property. Components of and requirements for the LUCs are as follows:

1. The Air Force will include in the *EAFB GP* by reference in the geographic information system (GIS) database: (1) any specific restrictions required at each site; (2) a statement that restrictions are required due to the presence of pollutants or contaminants; (3) a list of the current site land users and land uses; (4) the site geographic control boundaries; and (5) the objectives of the land use restrictions. Unless a site is cleaned up to levels appropriate for unlimited use and unrestricted exposure, the *EAFB GP* will prohibit the development and use of property for agriculture, residential housing, elementary and secondary schools, child care facilities, and playgrounds. Upon completion of any future remedial action at a site, the *EAFB GP* will be updated to modify the site-specific use restrictions as appropriate. The *EAFB GP* will contain a map depicting the geographic boundaries of all ERP sites where LUCs are in effect.

2. LUCs will be maintained until the concentration of hazardous substances in the soil/debris is at such a level to allow for unrestricted use and exposure. Where applicable, the Air Force anticipates maintaining other LUCs for groundwater until the concentrations of hazardous substances in the groundwater are at such a level to allow for unrestricted use and exposure. These other LUCs have been selected in the South AFRL ROD (signed in September 2007) and similar LUCs are anticipated for groundwater to be addressed by two forthcoming RODs for the AFRL Arroyos and Northeast AFRL/Mars Boulevard areas.

3. The Air Force shall not modify or terminate LUCs, implementation actions, or modify land use without USEPA and State approval. The Air Force shall seek prior concurrence (at least 45 days) 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. Whenever the Air Force transfers real property that is subject to LUCs to another federal agency, the transfer documents shall require that the federal transferee include the LUCs, and any 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.

5. Whenever the Air Force proposes to transfer real property subject to 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 California Land Use Covenant and this ROD. The Air Force policy regarding costs associated with the California Land Use Covenant is presented as Appendix A.

6. The Air Force will provide notice to USEPA and the State at least 6 months prior to any transfer or sale of property with LUC restrictions so that USEPA and the State 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 USEPA and the State at least 6 months prior to any transfer or sale, then the facility will notify USEPA and the State 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 USEPA and the State with similar notice, within the same time frames, as federal-to-federal transfer of property. The Air Force shall provide a copy of the executed deed or transfer assembly to USEPA and the State.

7. The Air Force shall notify the USEPA and the State at least 30 days in advance of any proposed land use changes that are inconsistent with LUC objectives or the selected remedy and any changes to the *EAFB GP* that would affect the LUCs.

8. The Air Force will notify USEPA and the State as soon a practicable but no longer than 10 days after discovery of any activity that is inconsistent with the LUC objectives or use restrictions, or any other action that may interfere with the effectiveness of the LUCs. The Air Force will notify USEPA and the State regarding how the Air Force has addressed or will address the breach within 10 days of sending USEPA and the State notification of the breach.

9. 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 breach.

10. 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 and the State. The annual monitoring reports will be used in preparation of the Five Year Review to evaluate the effectiveness of the remedy.

11. The annual monitoring report, submitted to the regulatory agencies by the Air Force, will evaluate the status of the LUCs and how any LUC 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 with such restrictions and controls.

The Air Force shall provide additional details regarding the engineered LUCs (e.g., fences and signs) and health and safety procedures in the RAWP. The RAWP is an enforceable primary document under Section 7.3 of the FFA.

The Air Force is responsible for implementing, monitoring, maintaining, reporting on, and enforcing LUCs in accordance with CERCLA and the NCP. 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. 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.

The *EAFB GP* resides in the office of the Base community planner. Accordingly, the *EAFB GP* will be revised to include any specific restrictions required at each site, 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.

Any project requiring change in land use designation and/or construction requires approval by the appropriate Environmental Management Office to ensure compliance with the *EAFB GP*.

The administrative measures are conducted as part of the Environmental Impact Assessment Process (EIAP) 32 CFR 989.27, which ensures that potential environmental concerns are considered as early as possible in the planning process. Only Air Force-approved projects are allowed on base and they must be covered by one of the following documents: Form 5926 (Civil Engineering [CE] Work Clearance Request), Form 332 (CE Work Request), or Form 813 (Request for Environmental Impact Analysis). 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. The permit process involves submitting and securing approval from the Environmental Management office and other support offices that review the excavation plans. The procedures by which work clearance requests are evaluated include review of the GIS database to determine if a worksite falls within any ERP site boundary; this process will be modified to also evaluate if the proposed worksite is within a site boundary where LUCs are in effect. If constraints involving soil disturbance or worker safety exist at the excavation area, the permit describes the appropriate procedures that will prevent unknowing exposure to groundwater contamination and measures the workers must implement before the start of excavation. Any intrusive work conducted at an ERP site, where contaminants remain at levels not suitable for unrestricted land use, must be performed by workers trained and certified for hazardous waste operations.

Form 332, the CE Work Request, must be submitted and approved before the start of any building project on Edwards AFB. Approval of this form involves the comparison of the building site with the constraints in the *EAFB GP*. 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.

Work Request forms are subject to an EIAP review conducted pursuant to the National Environmental Policy Act (NEPA), as promulgated in 40 CFR Parts 1500-1508. The EIAP analysis is initiated when a proponent of a proposed action fills out a Form 813, Request for Environmental Impact Analysis. A proponent of an action is required to submit the Form 332 and/or Form 5926 with Form 813 to Environmental Management so that the appropriate environmental analysis of the proposed action and alternatives to the proposed action is accomplished prior to any construction activities. The environmental staff (air, water, cultural and natural resources, restoration, and others) and the Community Planner review Forms 332 and 813 in cases that involve facilities construction. Major new construction may result in a determination that a formal publicized Environmental Assessment is necessary. The EIAP process works to ensure proposed construction sites are reviewed in accordance with the *EAFB GP*. The process also ensures that all environmental factors, as well as the Base's ROD LUCs, are considered in siting construction projects.

Consistent with the notification requirement in Item 3 (above), the Air Force shall notify USEPA and the State in advance if changes to the *EAFB GP* (or other internal administrative procedures) are proposed that would impact the LUCs.

2.8.2 DISAGREEMENT ON ARARS

The Air Force, the USEPA, and the Water Board do not agree on whether the Basin-wide Prohibitions (pages 4.1-1 and 4.1-2), the Soil Cleanup Levels (page 4.2-4), and certain of the WQOs (pages 3-2, 3-3, and 3-11) in the *Basin Plan*, portions of CCR Title 27, and SWRQCB Resolution 92-49 Section III.G, are ARARs for the final remedies selected at the soil and debris sites (refer to Section 2.5).

Air Force's 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 further be appropriate and relevant to the circumstances of a site release per (42 United States Code [USC] Section 9621(a)(1) and (d)(1)). Both CERCLA and the NCP focus on cleaning up contaminated groundwater, where practicable and achievable within a reasonable timeframe, to a level that will restore the designated uses of the groundwater, not to the lowest level

achievable regardless of risk (42 USC Section 9621(d)(2)(B)(i) and 40 CFR Section 300.430(a)(1)(iii)(F)). Accordingly, California non-degradation provisions (to include SWRQCB Resolutions 68-16, 92-49 and the narrative and numeric criteria in Sections 3 and 4 of the *Basin Plan*) that are based on maintaining high quality waters with maximal beneficial uses or achieving background or the lowest cleanup level that is technically and economically achievable, are not risk-based, necessary, appropriate or relevant to returning contaminated groundwater to a drinking water level of service; and, therefore, they are not eligible to be considered as potential ARARs.

Without prejudice to the Air Force's position above, the California non-degradation provisions are not applicable because they 1) 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 2) apply to current discharges as opposed to historic releases or further migration of such releases.

The non-risk-based narrative and numerical goals and objectives (e.g., the Basin Plan WQOs, which include secondary MCLs and NLs) in Section 3, and soil cleanup criteria and waste discharge Prohibitions 1-4 in Section 4 of the State non-degradation provisions, also are not relevant and appropriate requirements because: (1) MCL goals that are set at zero are categorically not relevant and appropriate (40 CFR Section 300.430(e)(2)(i)(C)) and as background for many of the hazardous substances in issue at Edwards AFB would be zero, such background provisions in California non-degradation provisions are similarly not relevant and appropriate; and (2) the NCP [40 CFR Section 300.430(e)(2)(i)(C) and 40 CFR Section 300.400(g)(2)(viii)] requires that groundwater cleanup standards be based on beneficial uses, whereas the California non-degradation provisions, including the Basin Plan WQOs, require cleanup levels be set at zero or the lowest level technically and economically feasible, regardless of beneficial uses.

In summary, the only provisions of the California cleanup regulations that are ARARs are those that are substantive, more stringent than federal standards, and consistent with CERCLA groundwater cleanups (see 42 USC Section 9621(d)(2)(A)(ii)): namely (1) risk-based concentrations protective of human health and the environment and (2) standards tied to beneficial uses. Since groundwater has been designated by the Water Board as municipal water supply, the relevant standards are federal and state primary drinking water standards (i.e., federal and state primary MCLs).

USEPA's Position Regarding State Requirements as ARARs for the Soil and Debris Sites

The State of California has identified certain provisions of the Porter-Cologne Water Quality Act (Water Code Section 13000 et seq.), SWRQCB Resolutions 68-16 and 92-49, and Chapter 15 of Title 23 and Title 27 as proposed ARARs for this Soil and Debris ROD.

USEPA stated its position in the South AFRL ROD regarding the limited application of the Basin Plan, Resolutions 68-16, 92-49 and Chapter 15 of Title 23, as ARARs for CERCLA groundwater cleanups. In brief: USEPA recognizes only those parts of the Basin Plan which set out the designated uses and the water quality criteria based upon such uses as potential ARARs for CERCLA groundwater cleanups. Resolution 68-16 is only an ARAR when setting limits for discharge or reinjection into groundwater. Only Section III.G of Resolution 92-49 is potentially relevant and appropriate in setting cleanup levels for groundwater being cleaned up pursuant to CERCLA, depending on technical and economic factors. USEPA's position regarding CCR Title 23 Chapter 15 is that it has limited applicability to CERCLA cleanups because of the exemption language in Section 2511(d) which generally exempts cleanups taken by or at the direction of public agencies.

Aside from these reasons, and more importantly for this ROD, these State requirements are neither applicable nor relevant and appropriate where no groundwater cleanup is being undertaken as is the case here. With the exception of Sites 6 and 113, (where the remedial action selected in this ROD requires groundwater monitoring) none of the remedies selected for the sites in this ROD require groundwater remedial action. There are a number of the sites addressed in this ROD that have groundwater contamination underneath. However, this contaminated groundwater is being addressed in the South AFRL groundwater ROD which was signed in September 2007, or will be addressed in either the upcoming Northeast AFRL groundwater ROD or the upcoming AFRL Arroyos groundwater ROD. The South AFRL ROD provided for a waiver of the water quality standards for the contaminated groundwater based on technical impracticability.

The State of California has listed Title 27 requirements as ARARs for the following sites in this ROD: Sites 13, 6 and 113, and 115. Title 27 consists of the consolidated regulations of the SWRQCB and CIWMB to regulate the treatment, storage, processing, or disposal of solid waste. The standards promulgated in Title 27 by the CIWMB regulate disposal sites; the standards promulgated in Title 27 by

the SWRQCB regulate the water quality aspects of discharges of solid waste to land for treatment, storage or disposal.

Site 13 is a closed landfill. There are requirements in Title 27 for closure and post-closure maintenance standards for disposal sites and landfills. These closure and post-closure maintenance standards ensure that the waste in the landfill is contained and there is no exposure to the public from this waste. These requirements are relevant and appropriate requirements for Site 13 and are identified as ARARs for this site in this ROD. There are also requirements in Title 27 for groundwater detection, evaluation, monitoring and sampling of closed landfills. However, the groundwater underneath Site 13 is already being monitored as part of the groundwater plume addressed in the South AFRL groundwater ROD. Therefore, the groundwater detection, evaluation, monitoring and sampling requirements in Title 27 will not be identified as ARARs for Site 13 in this ROD.

Sites 6 and 113 are abandoned mine shafts where solid waste was disposed. Aside from preventing exposing the public to this waste, there is also concern regarding the impact of this waste on water quality. Therefore, aside from the closure and post-closure maintenance standards for landfills and disposal sites in Title 27, the groundwater detection, evaluation, monitoring and sampling requirements in Title 27 are relevant and appropriate requirements for Sites 6 and 113 in this ROD.

Site 115 is Test Area 1-100 and missile Silos 1 and 2. Solid waste was disposed at this site. Like the abandoned mine shafts, it is necessary to protect the public from exposure to this waste. The closure and post-closure management standards for disposal sites in Title 27 are relevant and appropriate requirements for Site 115 in this ROD. There is also concern regarding the impact of the waste from this site on water quality. However, the regulatory agencies agree that the groundwater underneath Site 115 will be addressed pursuant to the Northeast AFRL groundwater ROD. Therefore, the groundwater detection, evaluation, monitoring and sampling requirement in Title 27 are not ARARs for this site in this ROD.

State of California's Position Regarding State Requirements

The State of California has identified certain provisions of the Porter-Cologne Water Quality Act (Water Code section 13000 et seq.), SWRQCB Resolutions 68-16 and 92-49, CCR Title 23 Chapter 15, and CCR Title 27 as proposed ARARs for determining cleanup levels in the groundwater and response

actions at waste management units at Edwards AFB. The Air Force and the State disagree about whether these state requirements are ARARs for this cleanup.

First of all, there are numerous provisions of the Porter-Cologne Water Quality Act that are ARARs, namely, Water Code Sections 13000, 13172, 13240, 13241, 13242, 13243, 13267, and 13304. These statutes do provide authority for other ARARs (e.g., the Basin Plan) and these statutes do impose requirements in and of themselves and are therefore ARARs.

Pertaining to SWRQCB Resolution 68-16, Resolution 68-16 is an ARAR for the injection or 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). Pursuant to Water Code Section 13050 Subdivision (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."

A discharge also occurs where polluted or degraded groundwater migrates to areas of higher or high quality groundwater. Discharges subject to Resolution 68-16 include the continuing migration of any *in-situ* treatment reagents or other waste as defined in Water Code Section 13050 Subdivision (d) from the injection wells to groundwater. Under Resolution 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 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 Subdivision (e). This Resolution is applicable or relevant and appropriate with regard to the migration of waste in groundwater at Sites 6 and 113.

With respect to SWRQCB Resolution 92-49, the State asserts that this resolution is an applicable requirement for remedial actions at Sites 6 and 113 of the contaminated groundwater and complies with CCR Title 23 Section 2550.4. Furthermore, the State does not believe that the application of SWRQCB Resolution 92-49 is strictly limited to Section III.G. In this case, SWRQCB Resolution 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 respect to CCR Title 23 Division 3 Chapter 15 and Title 27, the State asserts that these provisions are ARARs because they regulate all discharges of hazardous waste and non-hazardous waste to land that may affect water quality. A "waste management unit" is defined in CCR Title 23 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 and CCR Title 27 Section 20164). Pursuant to Water Code Section 13050 Subdivision (d), the definition of "waste" is extremely broad.

For the Soil and Debris ROD, the State asserts that CCR Title 23 Section 2511(d) and CCR Title 27 Section 20090(d) apply to the extent "feasible" for Sites 6, 113, 115, and 167. The groundwater requirements of these regulations are also applicable for Sites 6 and 113 because groundwater is addressed in this ROD for these two sites. The CCR Title 23 and Title 27 sections identified below for closure apply to all four sites:

- Engineered Alternatives;
- CAI units;
- Exemptions;
- General Engineered Alternative; and
- Gas Monitoring and Control During Closure and Post-Closure.

CCR Title 23 Section 2550.4 and CCR Title 27 Section 20400 requires the consideration of beneficial uses when establishing cleanup levels above background. The factors that are to be considered by Edwards AFB in performing a technical and economic feasibility analysis (TEFA) for groundwater are listed under CCR Title 23 Section 2550.4 Subdivision (d) and CCR Title 27 Section 20400 Subdivision (d). CCR Title 23 Section 2550.6 and CCR Title 27 Section 20140 requires monitoring for compliance with remedial action objectives for 3 years from the date of achieving cleanup levels. To allow for in-situ natural attenuation of contaminants detected at Sites 6 and 113, some further degradation of waters of the state will occur. It is necessary to first establish that some degradation is appropriate under SWRCB Resolution No. 68-16 and then to determine the allowed concentrations for each constituent of concern after compliance with SWRCB Resolution No. 92-49. CCR Title 23 Section 2550.10 and CCR Title 27 Section 20430 require implementation of corrective action measures

that ensure cleanup levels are achieved through the zone affected by the release by removing waste constituents or by treating them in place.

In addition, the SWRQCB has promulgated regulations pertaining to the treatment, storage, processing, and disposal of solid waste (non-hazardous solid waste and designated waste). Although Title 27 provisions are similar to those found in Title 23, the applicability of certain sections within either title will depend on the characterization of the waste.

Consistent with CCR Title 23 Section 2550.3 and CCR Title 27 Section 20395, constituents of concern (CoCs) encompass all constituents that are in, or expected to be derived from the waste. The Water Board disagrees that CoCs are limited to the CERCLA definition which considers COCs to be only constituents above some human risk threshold level.

The responses to Water Board comments, page 11 of 13 (No. 49) indicates the Air Force will submit an Unauthorized Release Form for a leaking petroleum storage tank only if the release is from a "active" tank. The Water Board disagrees that an Unauthorized Release Form is required only for active tanks. Consistent with Title 23 Chapter 16 Section 2560 (b and e) the owner/operator of a UST ***with a release - not all USTs*** - shall report any unauthorized release to the local agency (Kern County - or in the case of a Department of Defense site subject to the ERP - the Water Board.)

With respect to the Basin Plan, the State asserts that Chapter 2 – *Beneficial Uses,* Chapter 3 – *Water Quality Objectives,* and the sections in Chapter 4 – *Implementation* entitled "Requirements for Site Investigation and Remediation" and "Cleanup Levels" are ARARs and apply to determine the appropriate cleanup level in groundwater to protect beneficial uses and to meet the water quality objectives.

With respect to secondary MCLs, the State asserts that the taste and odor Water Quality Objective specified in the Water Quality Control Plan for the Lahontan Region, which incorporates State primary and secondary drinking water standards specified in CCR Title 22, are ARARs that apply to the establishment of cleanup levels. In particular, secondary MCLs for taste and odor based on drinking water standards specified in CCR Title 22 Section 64449 Table 64449-A (Secondary Maximum Contaminant Levels – Consumer Acceptance Limits) and Table 64449-B (Secondary Maximum Contaminant Levels – Ranges) of the Water Quality Control Plan for the Lahontan are ARARs.

In summary, the following are applicable requirements because they specifically address remedial actions taken in order to protect the quality of the waters of the State, are substantive requirements that are legally enforceable, of general applicability, and more stringent than federal requirements:

1. Certain provisions of the Porter-Cologne Water Quality Control Act (noted above).
2. SWRCB Resolution 92-49.
3. SWRCB Resolution 68-16.
4. Chapter 2, *Beneficial Uses*, Chapter 3, *Water Quality Objectives*, and the Sections "Requirements for Site Investigation and Remediation" and "Cleanup Levels" from Chapter 4, *Implementation,* of the Water Quality Control Plan for the Lahontan Region.
5. CCR Title 23 Division 3 Chapter 15.
6. CCR Title 27.
7. Secondary MCLs.

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 soil and debris sites submitted during the public comment period for the *Soil and Debris Sites PP*. Copies of the *Soil and Debris Sites PP* and a brief (four-page) *Fact Sheet* were posted to the repositories listed in Section 2.3.3 on 30 March 2007, and notices of the document's availability were published in the Antelope Valley Press (01 April 2007), the Mojave Desert News (05 April 2007), and Desert Wings (06 April 2007). A public comment period was held from 01 April through 15 May 2007, during which, the *OUs 4 and 9 RI Summary Reports*, the *Soil and Debris Sites FS*, and the *Soil and Debris Sites PP* were made available to the public.

Two public availability sessions were held at different times and locations on 01 May 2007 to present the *Soil and Debris Sites PP* to a broader community audience than those that had already been involved. At each meeting, posters explaining the site backgrounds and presenting the remedial alternatives were made available. Representatives from Edwards AFB and the Cal/EPA DTSC were available to answer questions from the community about problems at the soil and debris sites and the proposed remedial alternatives. At the first meeting (held in the AFRL lunchroom from 11 am to 12 pm), approximately 5 AFRL workers attended. The second public availability was held at West Boron Elementary School from 5:30 pm to 7:30 pm; however, there was no public attendance.

One set of written comments, followed by an e-mail were received from Mr. Ranney Adams (AFRL Public Affairs) regarding the proposed remedy for Site 115 as follows:.

Written comments from Mr. Ranney Adams dated 01 May 2007:

> Very concerned regarding Site 115 action and spending of $182,000. This is a historic site - the first launch of Minuteman I Ballistic Missile, the validation of the silo concept for launching and [*unreadable*], and proof of proper silo diameter. Colonel Sam Phillips, later four-star General Phillips, was the project leader for the Boeing project. John Marshal of the AFRPL, our predecessor, was the concept developer and proponent. Additionally, the site is "START Treaty" compliant with the ability to move the silo covers to indicate the status. If needed, I can engage the AF Missileers organization and their horsepower. Request no action be taken as proposed!

Comments received via e-mail from Mr. Ranney Adams on 03 May 2007

> Thank you for taking my comment and considering it. Additional information developed at the gathering and potential remedies included repair of extant or replacement silo covers, clearing of brush on the silo pads, ability to chain and padlock the silo covers so they could be moved for 'START Treaty Compliance Inspection', and fencing around the area to prevent access by a casual unauthorized visitor. The considerations might include the clearing of debris from the silos which are intact and because of their construction, I am told that they don't provide a pathway for rainwater, etc, into the surrounding terrain. It is one thing to contest a recommendation, but without constructive suggestions for a solution, it has less value. I would appreciate the opportunity to work with your team in finding the best solutions while preserving the Lab's and nation's aerospace legacy.

In response to these comments, the Air Force researched the historical significance of the two missile silos at Site 115, and the Air Force's obligations under the 1991 START Treaty.

Historical Significance of Test Area 1-100

The *Phase II Cultural Resource Evaluation of the AFRL at Edwards AFB, CA* (Jones & Stokes Associates, Inc. 1998) confirms the historical significance of the silos stating that Test Area 1-100 played an exceptionally important role in developing the ICBM "hot firing" technology, bringing the Cold War-era United States on par with Soviet launch capabilities. Test Area 1-100 is eligible for listing on the National Register of Historic Places (NRHP), and any actions that impact a character-defining feature of the site must be first evaluated under a NRHP Section 106 Review. The character-defining features of Test Area 1-100 include the underground silos, the landscaping around the silos (including the circular drive and the rolling silo covers), the missile impact area, and the control instrumentation and equipment. Under these criteria, Alternatives 2 and 3 for Site 115 (as originally proposed) would negatively impact a one or more character-defining features and are therefore considered infeasible.

International Treaty Obligations Relating to Test Missile Silos

The provisions of the 1991 START Treaty as they pertain to inspection and elimination of test ICBM silos are too complex to be properly analyzed in the context of this ROD. However, according to the *Protocol on Procedures Governing the Conversion or Elimination of the Items Subject to the Treaty Between the United States of America and the Union of Soviet Socialist Republics on the Reduction and*

Limitation of Strategic Offensive Arms (U.S. Department of State 2001), Section II - *Procedures for Elimination of Silo Launchers of ICBMs, Silo Training Launchers, and Silo Test Launchers*:

> A Party shall be considered to have initiated the elimination process for silo launchers of ICBMs, silo training launchers, and silo test launchers as soon as the silo doors have been opened, removed, or eliminated. Notification thereof shall be provided in accordance with paragraph 2 of Section IV of the Notification Protocol.

Therefore, to ensure that the ROD activities in no way violate arms controls treaties, no modifications to the silos or silo doors will be made as described in Alternatives 2 and 3 for Site 115.

Development of an Acceptable Remedy for Site 115

Both Alternatives 2 and 3 developed for Site 115 are considered infeasible because they incorporate significant modifications to character-defining features of an historic site, and they possibly would be in violation of international treaties. Therefore, Alternative 2 was modified to include only fences, locked gates, and warning signs as access controls for the silos (see Section 2.6.2.6), and was identified as the selected remedy. These measures will be protective of human health and the environment, while not impacting the historical significance of the site or violating treaty obligations.

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Appendices and Attachments for this Record of Decision are available by placing a request using the Customized CERCLIS/RODS Report Order Form.

http://www.epa.gov/superfund/sites/phonefax/rods.htm