DEPARTMENT OF THE AIR FORCE
AIR FORCE CIVIL ENGINEER CENTER

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30 October 2013

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and

Mr. Wayne Miller, P.E., R.G.
Arizona Department of Environmental Quality
1110 West Washington Street, 4415B-1
Phoenix, Arizona 85007

Subject: Submission of "Final Record of Decision Amendment 2, Groundwater, Operable Unit 2 (OU-2), Site ST012, Former Williams Air Force Base, Mesa, Arizona"

The Air Force is pleased to submit the attached document, *Record of Decision Amendment 2,* in final format for your records. There are no changes to the Final document issued September 9, 2013 except that Section 1.7, Authorizing Signatures, includes signatures by the Air Force Civil Engineer Center, the U.S. Environmental Protection Agency, Region IX, and Arizona Department of Environmental Quality. This signed copy of the Final *Record of Decision Amendment 2* has been uploaded to the Administrative Record online at http://afrpaar.lackland.af.mil/ar as document number 1633. A copy is being provided by this distribution to the Arizona State University Library.

This RODA represents another milestone in the successful clean-up of the former Williams AFB and is a result of our partnership with the State of Arizona and U. S. Environmental Protection Agency.

Sincerely,

CATHERINE JERRARD, PE
BRAC Environmental Coordinator

Attachment:

Final Record of Decision Amendment 2, Groundwater, Operable Unit 2 (OU-2), Site ST012, Former Williams Air Force Base, Mesa, Arizona

c: Addressee (1 CD)
ADEQ - Wayne Miller (1 CD)
Administrative Record – Terie Glaspey (1 and 1 CD)
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FINAL

RECORD OF DECISION AMENDMENT 2
GROUNDWATER, OPERABLE UNIT 2 (OU-2)
SITE ST012
FORMER WILLIAMS AIR FORCE BASE
MESA, ARIZONA

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9 September 2013

Contract Number: FA8903-09-D-8572 - 0002
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LIST OF ACRONYMS AND ABBREVIATIONS

°F	degrees Fahrenheit
µg/L	micrograms per liter
ADEQ	Arizona Department of Environmental Quality
AF	U.S. Air Force
AFB	Air Force Base
AFCEC	Air Force Civil Engineer Center
AFRPA	Air Force Real Property Agency
ARARs	Applicable or Relevant and Appropriate Requirements
AVGAS	aviation gasoline
BEM	Balanced Environmental Management Systems, Inc.
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and xylene
CDM	Camp Dresser McKee
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	contaminant of concern
COPCs	contaminant of potential concern
DCD	demonstration conceptual design
FFS	Focused Feasibility Study
ft	feet, foot
ft/yr	feet per year
HI	Hazard index
IDW	Investigation-derived waste
ILCR	Incremental Lifetime Cancer Risk
IRP	Installation Restoration Program
IT	IT Corporation, Inc.
JP-4	jet propellant grade 4
lb(s)	pound(s)
LFSA	Liquid Fuels Storage Area
LNAPL	light non-aqueous phase liquid
LPZ	Lower Permeability Zone
LSZ	lower saturated zone
mg/L	milligrams per liter
MNA	monitored natural attenuation
NAPL	non-aqueous phase liquid
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priority List
O&M	operation and maintenance
OU	Operable Unit
PHC	petroleum hydrocarbons

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LIST OF ACRONYMS AND ABBREVIATIONS (CONTINUED)

PS/DS	pilot study/demonstration study
RAO	Remedial Action Objectives
RI	Remedial Investigation
ROD	Record of Decision
SEE	steam enhanced extraction
SVE	Soil Vapor Extraction
SVOCs	semi-volatile organic compounds
TEE	Thermal Enhanced Extraction
TPH	total petroleum hydrocarbons
UWBZ	upper water bearing zone
VOCs	volatile organic compounds

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1.0 DECLARATION

1.1 Site Name and Location

The former Williams Air Force Base (AFB), National Priority List (NPL) Site CERCLIS ID AZ7570028582, is located in Maricopa County, Mesa, Arizona (Figure 1-1). Operable Unit (OU)-2 of the former Williams AFB is composed of Installation Restoration Program (IRP) site ST012, the former Liquid Fuels Storage Area (LFSA) (Figure 1-2).

1.2 Statement of Basis and Purpose

This Record of Decision (ROD) Amendment 2 presents a fundamental change to the ST012 groundwater remedy selected in the OU-2 ROD dated December 1992 (IT Corporation, Inc. [IT], 1992). The OU-2 ROD selected a soil vapor extraction remedy for shallow soil (less than 25 feet [ft] below ground surface [bgs]) and a hydraulic extraction remedy for groundwater. Later, soil vapor extraction for the deep soil was included in OU-2 ROD Amendment 1 (IT, 1996). OU-2 ROD Amendment 1 did not affect the groundwater remedy selected in the original OU-2 ROD, however, this ROD Amendment 2 represents a change to the original OU-2 ROD from hydraulic extraction of groundwater to steam enhanced extraction (SEE) and enhanced bioremediation. The revised groundwater Selected Remedy for ST012 at the former Williams AFB in Mesa, Arizona was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended by the Superfund Amendments and Reauthorization Act of 1986, and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). Public participation requirements of CERCLA §117(c) and NCP 300.435(c)(2)(ii) were implemented in support of the ROD Amendment and revised remedy selection.

The U.S. Environmental Protection Agency (EPA) and the State of Arizona concur with the revised groundwater Selected Remedy for ST012. Information supporting this decision is contained in the Administrative Record file for ST012, and ROD Amendment 2 will become part of the Administrative Record file. The Administrative Record is available at all hours online at http://afrpaar.lackland.af.mil/ar/. Documents comprising the Administrative Record can also be accessed at the former McClellan AFB, located at 3411 Olson Street, McClellan, CA 95652. An information repository is available at the Government Documents Section of Arizona State University Library, 300 East Orange Mall, Tempe, Arizona.

1.3 Assessment of the Site

The revised groundwater response action selected in ROD Amendment 2 is necessary to protect public health or welfare, or the environment, from actual or threatened releases into the environment of hazardous substances, and pollutants or contaminants from ST012 which may present an imminent and substantial endangerment to public health or welfare.

The OU-2 ROD, signed in December 1992 (IT, 1992d), selected a ST012 groundwater remedy that included extraction of light non-aqueous phase liquid (LNAPL, see below) and groundwater by horizontal or vertical extraction wells; separation of LNAPL for reuse or disposal; treatment of extracted groundwater as needed to remove solids and achieve action levels (cleanup levels are referred to as action levels in the OU-2 ROD) for metals, semi-volatile organic compounds (SVOCs) and volatile organic compounds (VOCs) identified as contaminants of potential

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concern (COPCs); and either injection of treated groundwater back into the aquifer or discharge of the treated groundwater to the wastewater treatment plant. [LNAPL, referred to as free-phase product in the OU-2 ROD and hereafter referred to as LNAPL in this ROD Amendment 2, is generally defined as a liquid that is present as a separate phase and less dense than water. Petroleum hydrocarbon based LNAPL at OU-2 contributes to dissolved phase groundwater contamination and may be found floating at the surface of groundwater but is also trapped in soil above and below the groundwater level.]

Installation of vertical and horizontal wells during remedial design established that aquifer yields were too low to achieve hydraulic control of the contaminated groundwater plume area and rising groundwater levels diminished effectiveness of the remedy to achieve hydraulic control and LNAPL recovery (Camp Dresser McKee [CDM], 1995). EPA and Arizona Department of Environmental Quality (ADEQ) concurred with suspending implementation of the original remedy (EPA, 1995) and by 2000, EPA, ADEQ and the U.S. Air Force (AF) had agreed that the original OU-2 groundwater extraction remedy would not be effective at achieving remediation goals at ST012 (EPA and ADEQ, 2005). This OU-2 ROD Amendment 2 addresses the ST012 revised groundwater remedy.

A Thermal Enhanced Extraction (TEE) pilot test was performed in 2008 and 2009 to evaluate the effectiveness of TEE technology to enhance LNAPL recovery and remediation of the groundwater contaminant plume at ST012. The TEE pilot test established that it was a possible effective technology for the site. Subsequently, the OU-2 Focused Feasibility Study (FFS) evaluated groundwater remediation alternatives for ST012, including one alternative based on SEE, a technology similar to TEE, and enhanced bioremediation. The Amended Proposed Plan identified FFS Alternative ST012-3, Steam Enhanced Extraction and Enhanced Bioremediation, as the preferred groundwater alternative for ST012.

The OU-2 ROD selected bioenhanced Soil Vapor Extraction (SVE) as the remedy for shallow soil (less than 25 ft bgs) and included institutional controls to impose restrictions on installation of new groundwater wells and limit soil excavation to 10 ft in depth at the ST012 site. OU-2 ROD Amendment 1, signed in August 1996 (IT, 1996), selected SVE as the remedy for deep soil (from 25 ft bgs to groundwater). The SVE remedy has been effectively implemented for soil at ST012, achieving OU-2 ROD cleanup levels for shallow soil, and continuing remediation in the deep soil. Institutional controls have been implemented via deed restrictions and an Arizona Declaration of Environmental Use Restrictions. Operation of a small scale groundwater containment system and recovery of LNAPL that accumulates in groundwater monitoring wells continues to be a part of the site cleanup strategy pending selection of the revised groundwater remedy. The ROD Amendment 2 does not revise or alter the existing OU-2 ROD and ROD Amendment 1 with the exception of what is discussed and presented in Sections 1.4, Description of the Revised Selected Remedy, and 5.0, Description of Existing and Revised Remedies.

1.4 Description of the Revised Selected Remedy

The revised Selected Remedy for ST012 groundwater is FFS Alternative ST012-3: Steam Enhanced Extraction and Enhanced Bioremediation. SEE involves the installation of a network of steam injection, liquid extraction, and vapor extraction wells; installation of temperature monitoring equipment; injection of steam into the wells; and extraction of fluids (LNAPL and groundwater) and vapor. The original groundwater remedy components that provided for

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separation of LNAPL, treatment of groundwater to achieve OU-2 ROD action levels, and institutional controls are largely the same for the revised groundwater remedy, while also providing for updates to the groundwater action levels and the addition of extracted vapor treatment to the groundwater remedy. SEE is similar to the technology successfully demonstrated by the TEE pilot test. For ST012, one or two steam generation systems will be used. The fuel source for steam generation can be natural gas, propane, diesel, or recovered LNAPL.

When the effectiveness of contaminant mass removal by SEE has diminished, the remedial action will transition to enhanced bioremediation. The criteria that will be evaluated for this transition will be developed jointly by the AF, EPA, and ADEQ as part of the Remedial Design/Remedial Action Work Plan. Enhanced bioremediation is the process of modifying existing conditions to promote biological activity among bacteria that feed off of contamination present at the site. The residual increase in temperature at the site after the cessation of SEE is anticipated to enhance biological activity. Further modifications to enhance biological activity may include introducing food sources to promote activity, or modifying physical or chemical characteristics (e.g., pH, temperature) to create an environment that is more hospitable to bacterial growth. The specific methods for enhanced bioremediation will be established in consultation with EPA and ADEQ based on biological and contaminant conditions after SEE implementation. After enhanced bioremediation, a period of monitored natural attenuation (MNA) may be necessary until cleanup levels have been achieved. The estimated timeframe to achieve cleanup levels is twenty (20) years (including Remedial Design/Remedial Action Work Plan, remedial system construction, remedial action operation and maintenance (O&M), and remedy completion).

The revised groundwater Selected Remedy does not alter the existing SVE remedy for vadose zone soil. Existing institutional controls prohibiting installation of wells or extraction of groundwater except for remediation and/or monitoring will remain in effect. Five-year reviews will be conducted until cleanup levels have been achieved.

1.5 Statutory Determinations

The revised Selected Remedy is protective of human health and the environment, complies with federal and state requirements that are applicable or relevant and appropriate to the remedial action, is cost-effective, and utilizes permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable. This remedy also satisfies the statutory preference for treatment as a principal element of the remedy (i.e., reduces the toxicity, mobility, or volume of hazardous substances, pollutants, or contaminants as a principal element through treatment). Because this remedy will result in hazardous substances, pollutants, or contaminants remaining on-site for more than five years until cleanup levels have been achieved that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within five years after initiation of remedial action and every five years thereafter until cleanup levels are achieved to ensure that the remedy is, or will be, protective of human health and the environment.

1.6 Data Certification Checklist

The following information is included in the Decision Summary section of ROD Amendment 2. Additional information can be found in the Administrative Record.

- Contaminants of concern (COCs), COPCs, and their respective concentrations.
- Baseline risk represented by the COCs/COPCs.
- Cleanup levels established for COCs/COPCs and the basis for cleanup levels.
- How source materials constituting principal threats are addressed.
- Current and reasonably anticipated future land use assumptions and current and potential future beneficial uses of groundwater assumed in the baseline risk assessment and ROD Amendment 2.
- Potential land and groundwater use that will be available at ST012 as a result of the Selected Remedy.
- Estimated capital, annual O&M, and total present worth costs, and number of years over which the remedy cost estimates are projected.
- Key factor(s) that led to selecting the remedy (i.e., describe how the Selected Remedy provides the best balance among tradeoffs with respect to the balancing and modifying criteria, highlighting criteria key to the decision).

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1.7 Authorizing Signatures

The AF and EPA approve and select the remedy as stated in ROD Amendment 2, and the ADEQ, representative of the State of the Arizona, concurs.

Connie M. Lotti — 17 Sep 13

CONNIE M. LOTTI, GS-15, DAF — Date
Deputy Director
Installations Directorate
Air Force Civil Engineer Center

28, September 2013

MICHAEL MONTGOMERY — Date
Assistant Director, Federal Facilities and Site Cleanup Branch
U.S. Environmental Protection Agency, Region IX

TINA L. LEPAGE — Date
Remedial Projects Section Manager
Arizona Department of Environmental Quality

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1.7 Authorizing Signatures

The AF and EPA approve and select the remedy as stated in ROD Amendment 2, and the ADEQ, representative of the State of the Arizona, concurs.

Connie M. Lotti

CONNIE M. LOTTI, GS-15, DAF
Deputy Director
Installations Directorate
Air Force Civil Engineer Center

17 Sep 13
Date

MICHAEL MONTGOMERY
Assistant Director, Federal Facilities and Site Cleanup Branch
U.S. Environmental Protection Agency, Region IX

Date

Tina LePage

TINA L. LEPAGE
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Arizona Department of Environmental Quality

9/24/13
Date

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2.0 INTRODUCTION TO THE SITE AND STATEMENT OF PURPOSE

The former Williams AFB is located in Maricopa County and lies within the boundaries of the City of Mesa, adjacent to the towns of Gilbert and Queen Creek and portions of unincorporated Maricopa County. The former Williams AFB was an AF flight-training base that was first activated in 1941. In 1989, Williams AFB was placed on the EPA NPL (Williams AFB, CERCLIS ID, AZ7570028582). The Base officially closed in 1993.

Since 1989, the AF has been cleaning up hazardous substance releases at Williams AFB as the lead agency under CERCLA with regulatory oversight from the EPA, ADEQ, and Arizona Department of Water Resources. Regulatory authority for the former Williams AFB is defined in the Williams AFB Federal Facility Agreement (FFA) (EPA, 1990). The primary purpose of the FFA is to ensure that the environmental impacts associated with past activities at the former Williams AFB are thoroughly investigated and appropriate remedial actions are taken as necessary to protect the public health, welfare and the environment. The State agencies speak with one voice in regard to FFA implementation, and ADEQ presents positions on behalf of the State.

The OU-2 ROD, signed in December 1992 (IT Corporation [IT], 1992d), selected a ST012 groundwater remedy that included extraction of LNAPL and groundwater by horizontal or vertical extraction wells; separation of LNAPL for reuse or disposal; treatment of extracted groundwater as needed to remove solids and achieve action levels for metals, SVOCs and VOCs identified as COPCs; and either injection of treated groundwater back into the aquifer or discharge of the treated groundwater to the wastewater treatment plant. Installation of vertical and horizontal wells during remedial design established that aquifer yields were too low to achieve hydraulic control of the contaminated groundwater plume area and rising groundwater levels diminished effectiveness of the remedy to achieve hydraulic control and LNAPL recovery (CDM, 1995). EPA and ADEQ concurred with suspending implementation of the original remedy (EPA, 1995) and by 2000, EPA, ADEQ and the AF had agreed that the original OU-2 groundwater extraction remedy would not be effective at achieving remediation goals at ST012 (EPA and ADEQ, 2005). This OU-2 ROD Amendment 2 addresses the ST012 revised groundwater remedy. Public participation requirements of CERCLA §117(c) and NCP 300.435(c)(2)(ii) were implemented in support of the ROD Amendment and revised remedy selection.

Information supporting the OU-2 ROD Amendment 2 is contained in the Administrative Record file for ST012 and ROD Amendment 2 will become part of the Administrative Record file. The Administrative Record is available at all hours online at http://afrpaar.lackland.af.mil/ar/.

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3.0 SITE HISTORY, CONTAMINATION, AND SELECTED REMEDY

ST012 is the location of the former LFSA where fuel storage and distribution operations involving aboveground and underground tanks and lines were conducted from 1941 until the fuel storage and distribution system was decommissioned in 1991. The AF-owned aboveground and underground equipment and structures relating to the fuel storage and distribution operations within ST012 were removed in 1990 and 1991. Releases of jet propellant grade 4 (JP-4) and aviation gasoline (AVGAS) from the former fuel facilities have impacted soil and groundwater at ST012. Multiple documented and undocumented fuel releases during the 50-year Base operations period account for the soil and groundwater impacts. Remaining contamination is in the form of dissolved phase groundwater contamination, LNAPL floating on top of the water table, and residual LNAPL and associated contaminants that are retained in soil both above and below the water table.

3.1 Site History

The AF has conducted RIs, pilot studies, and remedial actions at ST012 since the discovery of fuel contamination in 1984. RIs defined the nature and extent of contamination. Pilot studies evaluated the feasibility of proposed remedies. Remedial actions addressed and continue to remediate contamination in soil and groundwater. Table 3-1 presents the investigations and actions that have occurred on site to date.

Table 3-1 Summary of Previous Investigations/Remediation Conducted at ST012

Contractor	Activities	Dates	Reference[1]
Engineering-Science	Phase 1 Records Search	1984	Engineering-Science, 1984, *Installation Restoration Program, Phase 1 – Records Search.*
AeroVironment, Inc.	Advanced eight borings to 45 ft	October 1984	AeroVironment Inc., 1986, *Installation Restoration Program, Phase II Confirmation/Quantification, Stage 2 Report.*
	Installed Wells LI-01 through LI-08	1986	
	Advanced 30 borings to 210 ft	August 1986 – June 1987	
	Performed soil organic vapor surveys	November 1986 – June 1987	
IT	Installed wells W01 through W17	August 1989 – November 1989	IT, 1992a, *Remedial Investigation Report, Liquid Fuels Storage Area, Operable Unit 2.*
	Installed wells W18 through W25	July 1990 – September 1990	
	Installed wells W26 and W27	May 1991 – June 1991	
	Installed wells W28 and W29	September 1991	IT, 1994, *Remedial Investigation Report, Operable Unit 3.*
	Performed soil vapor survey	March and November 1989	
	Advanced soil borings SB01 through SB15 (soil samples collected at 10-ft intervals from 25-125 ft bgs	September 1993 – November 1993	
CDM Federal Programs, Inc.	Installed wells W30 and W31 and two extraction wells (EX-01 and EX-02)	January 1992 – February 1992	CDM, 1995, *Pilot Study/Demonstration Study Report*
	Installed wells INJ-01 through INJ-04	February 1992 – March 1992	
	Installed horizontal well HW-1	July 1992	

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Table 3-1 Summary of Previous Investigations/Remediation Conducted at ST012 (Continued)

Contractor	Activities	Dates	Reference[1]
	Installed eight piezometers (PA, PB, PC-s, PC-d, PD-s, PD-d, PE-s, and PE-d)	October 1993	
	Installed wells W32 and W33	March 1994	
	Installed horizontal well HW-2	April 1994 – May 1994	
Earth Tech	SVE remediation and confirmatory sampling of top 25 ft of impacted soil at ST012	March 1994 – January 1996	Earth Tech, 1996, *Operable Unit 2 (Shallow) Soil Cleanup and Confirmatory Sampling Results.*
Battelle	Bioslurping, skimming, and SVE pilot testing	October 1996 – April 1997	Battelle, 1997, *Draft Site-Specific Technical Report (A003) for Free Product Recovery Testing at Site ST-12, Williams AFB, Arizona*
Geo/Resource Consultants, Inc.	SVE O&M	October 1997 – April 1999	IT, 1999, *Draft Focused Feasibility Study, Operable Unit 2.*
Balanced Environmental Management Systems, Inc. (BEM)	Installed wells N01 through N08 and DPE-1	August 1996 – September 1996	BEM, 1998b, *Treatability Study in Support of Remediation by Natural Attenuation.*
	Installed wells N09 through N15, DPE-2, and monitoring points MPA-2 through MPC-2	October 1997 – December 1997	BEM, 1999a, *Groundwater Monitoring Well, Dual Phase Extraction Well, and Soil Vapor Monitoring Point Installation*
	Decommissioned 27 wells	January 1999	BEM, 1999b, *Well Closure Report*
	Presented CSM for site physical and contamination conditions	May 2003 – June 2003	BEM, 2007, *Phase 1, Thermal Enhanced Extraction (TEE) Pilot Test Work Plan*
	Installed well clusters LSZ-1/UWB-1 and LSZ-2/UWB-2		
	Installed SVE well nest SVE01		
	Installed SVE well nests SVE02 through SVE07	May 2004 – June 2004	
	Operated deep soil SVE system	April 2005 – December 2009	BEM, 2010a, *SVE System Operation and Maintenance Quarterly Performance Report 01 October through 31 December 2009* (only latest report listed)
	Installed Thermal Enhanced Extraction (TEE) treatment cell injection, extraction, and monitoring wells	July 2004 – October 2004	BEM, 2010b, *Construction Completion/Inspection Report*
	Conducted aquifer testing at TEE treatment cell	December 2006	BEM, 2011, *Phase 1, Thermal Enhanced Extraction (TEE) Pilot Test Performance Evaluation Report.*
	Installed TEE treatment cell system	July 2004 – August 2008	BEM, 2010b, *Construction Completion/Inspection Report.*
	Installed reference boundary well RB-1A, RB-1C, RB-2A, and RB-2C	November 2008	
	Installed SVE wells SVE08 and SVE09	December 2008	
	Conducted TEE Pilot Test	August 2008 – January 2010	BEM, 2011, *Phase 1, Thermal Enhanced Extraction (TEE) Pilot Test Performance Evaluation Report.*
	Installed wells U02, U11 through U13, U36 through U38, and W34 through W38	December 2009 – March 2010	BEM, 2010c, *Well Installation, Abandonment, Sampling, and Groundwater Optimization Report.*

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Table 3-1 Summary of Previous Investigations/Remediation Conducted at ST012 (Continued)

Contractor	Activities	Dates	Reference[1]
	Decommissioned wells N01 through N05, N08, N09, N11, N12, N14, N15, and INJ003	January 2010 – March 2010	
URS Corporation (URS)	Installed Cobble Zone wells C01, C02, C03, C04, C05, and reference boundary well RB3A; Decommissioned well N10	October 2008 – November 2008	URS, 2009b, *Sites ST012, ST035, and LF004 Monitoring Well Replacement, Abandonment, and Installation Report.*
	Monitored groundwater quarterly and annually	July 2008 – January 2009	URS, 2009a, *Annual 2008 Groundwater Monitoring Report*
		February 2009 – November 2009	URS, 2010, *Annual 2009 Groundwater Monitoring Report.*
		March 2010 – November 2010	URS, 2011a, *Annual 2010 Groundwater Monitoring Report.*
		February 2011 – November 2011	URS, 2012a, *Annual 2011 Groundwater Monitoring Report.*
	Operated deep soil SVE system quarterly	January 2010 – December 2011	URS, 2012b, *SVE System Operation and Maintenance 2011 Annual Performance Report* (only latest report listed)
	Implemented Groundwater Containment Study	June 2011 – July 2012	URS, 2011b, *Containment Study Work Plan Addendum*
AMEC	Completed OU-2 FFS with focus on groundwater	November 2011 – November 2012	AMEC, 2012, *Final Focused Feasibility Study, Remedial Alternatives for Operable Unit, Site ST012, Former Williams Air Force Base, Mesa, Arizona*
	Operated deep soil SVE system quarterly	January 2012 – present	AMEC, 2013a, *Soil Vapor Extraction System Operation and Maintenance Report, Former Liquid Fuels Storage Area, Site ST012, Former Williams Air Force Base, Mesa, Arizona*
	Operated Groundwater Containment System	September 2012 - present	AMEC, 2013b, *2012 Annual Containment System Status Report, Former Liquid Fuels Storage Area, Site ST012, Former Williams Air Force Base, Mesa, Arizona*
	Monitored groundwater annually	November 2012	AMEC, 2013c, *Annual 2012 Groundwater Monitoring Report, Former Liquid Fuels Storage Area, Site ST012, Former Williams Air Force Base, Mesa, Arizona*

[1]Review, comment, and concurrence have been provided by EPA and ADEQ throughout these investigation/remediation activities.

3.2 Summary of Site Characteristics

This section provides an overview of the assessments conducted during the Remedial Investigation (RI) to characterize contamination in groundwater at ST012. This summary presents the following information:

- Site Hydrogeology
- Quantity, types, and concentrations of hazardous substances
- Estimated volumes of contaminants
- Lateral and vertical extents of contamination
- Mobility of identified contaminants
- Potential surface and subsurface pathways of contaminant migration

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3.2.1 Site Hydrogeology

The hydrogeology of ST012 is described in the OU-2 RI report (IT, 1992a) and the FFS (AMEC, 2012), and can be summarized as a complex stratified system with local vertical interconnections. Two main aquifers can be distinguished: a shallow unconfined aquifer referred to as the upper aquifer and a deep confined aquifer. The deep aquifer is the main source of groundwater used regionally.

At ST012, all LNAPL and contaminated groundwater is contained within the upper aquifer. The upper aquifer extends from the water table (approximately 156 ft bgs) to approximately 245 ft bgs. Within the upper aquifer, saturated conditions exist at ST012 primarily within four intervals that are characterized by different soil types and hydraulic properties within each interval. These intervals, or zones, are (from highest to lowest): the Cobble Zone, Upper Water Bearing Zone (UWBZ), Lower Permeability Zone (LPZ), and Lower Saturated Zone (LSZ). The groundwater is now rising into the lower portions of the Cobble Zone.

Groundwater within the LSZ, once apparently unconfined, now appears to be under semi-confined conditions. In the 1970s, groundwater elevations began to rise and by 1993 fully saturated the LSZ. Water elevations in well clusters screened discretely above and below the LPZ indicate a downward vertical gradient.

Underlying the upper aquifer is a fine-grained aquitard approximately 15 ft in thickness. Below the aquitard lies the deep aquifer of undetermined thickness. The AF has concluded that the aquitard forms an effective barrier to migration of contaminated groundwater to the underlying deep aquifer (IT, 1999); no contamination of the deep confined aquifer beneath ST012 has ever been demonstrated.

3.2.2 Groundwater Contamination at ST012

Contaminated groundwater at ST012 is defined in the OU-2 ROD (IT, 1992a) as groundwater containing benzene in amounts of 5 micrograms per liter (µg/L) (the drinking water standard established as the action/cleanup level for benzene) or more. Benzene was chosen as an indicator because it poses the greatest danger to human health and the environment of the OU-2 ROD COPCs detected in groundwater at ST012. The volume of contaminated groundwater contained within the 5 µg/L benzene plume based on July 1991 sampling data was defined in the OU-2 ROD (IT, 1992a) as 170 million gallons. Dynamic site conditions such as rising groundwater, smeared LNAPL, changes in monitoring well network, and attenuation mechanisms have affected this estimate. Using the November 2011 estimated benzene concentrations contours (Figures 3-1 and 3-2), the current estimated volume within the 5 µg/L benzene plume is 67.5 million gallons.

An extensive network of groundwater monitoring wells has been installed at ST012 (Figure 3-3). Groundwater sampling conducted semiannually at ST012 since 1990 has documented the presence of a JP-4 and/or AVGAS LNAPL plume and a dissolved component (i.e., benzene, toluene, ethylbenzene, and xylene [BTEX]) plume. These plumes were defined in the OU-2 ROD, and have been further characterized in semiannual groundwater sampling reports. The most recent groundwater sampling report documents sampling conducted by URS in 2011 (URS, 2012a), and includes an analysis of the current state of the dissolved plume. The

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monitoring network does not include a well in the UWBZ within the middle of the historic release area so the contours for the UWBZ may under-represent actual benzene contours in that area.

Appendix A-1 (Table A-1) summarizes groundwater contaminant characteristics from the historic groundwater monitoring data presented in Table 4-4 of the OU-2 ROD and includes updated groundwater contaminant characteristics from the November 2011 annual groundwater monitoring event (URS, 2012a). November 2011 groundwater monitoring data were used as the basis for evaluation of remedial alternatives in the OU-2 Focused Feasibility Study and are the basis for groundwater contaminant distribution maps provided in Figures 3-1 and 3-2. Appendix A-2 includes historical analytical summary tables for total petroleum hydrocarbons (TPH), VOCs, SVOCs and metals from the ST012 2011 Annual Groundwater Monitoring Report (URS, 2012a). As discussed above, in accordance with the OU-2 ROD, groundwater monitoring has been conducted and presented in groundwater monitoring reports, the most recent of which is for the sampling completed in November 2011. Consistent with the COPCs identified in the OU-2 ROD, ST012 groundwater sample analyses are conducted for VOCs, SVOCs, metals and TPH in order to monitor groundwater conditions including contaminant concentrations, concentration trends, contaminant distribution, and potential contaminant migration. Recommendations are provided in the groundwater monitoring reports for additions or modifications to the monitoring program as needed. Based on the groundwater monitoring and reports completed for ST012, the contaminants detected remain consistent with those identified during the original site characterization activities; concentrations of the primary fuel-related contaminants, such as benzene, toluene, ethyl benzene, xylenes, and naphthalene have remained within the ranges originally identified in the OU-2 ROD (see Appendix A-1 Table A-1 and Appendix A-2), and benzene remains as the contaminant most representative of ST012 groundwater impacts due to its wide distribution and potential threat to human health and the environment. The maximum contaminant detections reported at ST012 were detected and reported in the early site investigations and RI, as summarized from OU-2 ROD Table 4-4 in Appendix A-1 Table A-1.

Groundwater elevations have risen more than 60 ft beneath ST012 since the late 1980s. The groundwater table currently resides at approximately 156 ft bgs. Rates of rise in recent years are in the range of 2.5 to 3.0 feet per year (ft/yr) and averaged less than 1 ft between November 2011 and November 2012 (AMEC, 2013c). The effect of the rising groundwater is to "smear" the LNAPL.

3.2.3 LNAPL at ST012

The volume of the LNAPL plume beneath ST012 was estimated in the OU-2 RI report (IT, 1992a) to be between 650,000 and 1,400,000 gallons. This volume did not take into account LNAPL that was occupying pore spaces in vadose zone soil above the groundwater. At that time, groundwater elevations reflected only seasonal variations, and the LNAPL was assumed to be floating on the groundwater. The groundwater rise has altered the distribution of LNAPL in wells. The most recent estimate of LNAPL volume in the saturated zone of 2,200,000 gallons was established in 2008 prior to the TEE Pilot Test (BEM, 2011).

The behavior of LNAPL in the subsurface is complicated and depends on site-specific and heterogeneous factors such as porosity, permeability, degree of water wetting compared to hydrocarbon wetting, and vertical groundwater gradient. There is not a simple correlation

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between the thickness of LNAPL present in a given monitoring well and the volume of LNAPL in the adjacent subsurface sediments. At ST012, LNAPL has exhibited different behavior at different monitoring wells over time. While this behavior can be correlated to the rise in groundwater across ST012, the exact cause of the different behavior could be related to such diverse factors as formation and contamination heterogeneity, trapping and removal of LNAPL, and submergence of well screens.

Although a precise distribution and volume of LNAPL beneath ST012 will never be known, it is clear that LNAPL has moved from saturated soil into wells within the most contaminated area. Treatability studies of LNAPL removal indicated the rate of LNAPL flow to the wells was slow, yielding an average of less than 2,000 gallons per year at that time. More recently, LNAPL recovery efforts conducted quarterly yielded much lower volumes (17.7 gallons in 2010 [URS, 2011c]).

3.2.4 Contaminant Removal

Since 1990, pilot studies, treatability studies, remedial actions, etc. have been performed, as well as continuation of successful technologies. Each action has resulted in the removal of some amount of contamination; these actions are summarized in Table 3-2. A total of approximately 671,000 gallons of fuel have been removed from the site by these actions.

Table 3-2 Summary of Groundwater Contaminant Removal

Media	Contamination Removed	Dates	Method of Removal
Shallow Soil	76,400 lbs TVH (11,800 gallons hydrocarbons [as JP-4])	4/94 – 3/95 (Site 538) & 7/95 – 1/96 (Site 514)	SVE[1]
Shallow Soil	5,500 lbs TPH (850 gallons hydrocarbons [as JP-4])	4/94 – 3/95 (Site 538) & 7/95 – 1/96 (Site 514)	Bioventing[1]
Deep Soil	2,230,000 lbs TVH (343,000 gallons hydrocarbons [as JP-4])	2/97 – 7/02	SVE[2]
Groundwater	20,282 gallons "BTEX-saturated water"	10/90 – 4/97	Skimming/bioslurping[4]
LNAPL source in groundwater	38,900 lbs (5,980 gallons hydrocarbons [as JP-4])	1969 – 2011	Natural attenuation[4] (926 lbs/year)
LNAPL	10,564 gallons	10/90 – 12/96	Skimming/bioslurping[4]
Deep Soil	1,637,000 lbs TVH (252,000 gallons hydrocarbons [as JP-4])	4/05 – 12/11	SVE
Deep Soil	188,000 lbs TPH (28,900 gallons hydrocarbons [as JP-4])	2/97 – 7/03, 4/05 – 6/11	Bioventing[3]
Groundwater	117,902 lbs TPH (18,140 gallons hydrocarbons [as JP-4])	10/08 – 5/09	TEE

[1] Calculated mass removal using Earth Tech data (see Appendix A of FFS [AMEC, 2012])
[2] Source: GeoResource Consultants, Inc, Williams AFB Technical Working Group meeting, 3/24/99 (IT, 1999a)
[3] Estimated assuming 5% bioventing removal per pound of SVE removal
[4] Source: BEM, 1998b

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3.2.5 Contaminant Fate and Transport

Once deposited in the unsaturated zone, organic compounds that compose the LNAPL will partition among four phases: gas, solid, water, and LNAPL. The fate of components in these phases is determined by volatilization, dissolution, sorption, and degradation (Newell, et al., 1995). All four processes will be active in the vadose zone. Dissolution will occur within the pore-space water, and degradation can only occur within this pore-water environment.

In the saturated zone, the effects of volatilization become inconsequential, and the processes of dissolution and degradation have the greatest impacts on source life. Dissolution occurs as the individual components at the LNAPL-water interface disperse from the LNAPL phase to the water phase (Testa and Winegardner, 1991). This is largely controlled by solubility, molecular size, and the rate of water flow across the interface. If no flow exists, then an equilibrium concentration will develop between them and no further dispersion will occur across the interface. With groundwater moving past the interface, the LNAPL has additional potential to release its components to the water phase.

Once in the water phase, the dissolved components will migrate according to the groundwater flow direction and rate, their sorption potential (retardation factor), and degradation potential. Literature sources discuss the mechanisms for biologically-mediated degradation in the saturated zone (Wiedemeier, et al., 1995; Norris, et al., 1994). In short, aerobic and anaerobic microorganisms are present throughout the subsurface environment. Work at petroleum contaminated sites has demonstrated that a wide variety of bacteria are metabolically active in reducing contaminant concentrations.

Migration of LNAPL in the vadose zone is dependent on the degree of water saturation and LNAPL saturation in the soil column. When water and LNAPL are both equally saturated in soil pore space, the mobility of each liquid decreases. With increasing saturation of one of the liquids, the mobility of the other liquid decreases substantially. As the SVE system continues to operate, the saturation of both water and LNAPL is expected to decrease, thereby further reducing the potential for downward migration of the LNAPL.

In the saturated zone, LNAPL may continue to move in the direction of pressure heads associated with either LNAPL thickness in the formation, or groundwater gradients. LNAPL that was deposited in the lower sections of the upper aquifer has become trapped and is essentially immobile beneath the water, although site evidence suggests that sufficient pressure gradients have been created by the increasing groundwater elevations to mobilize some of the submerged LNAPL into wells. Trapped LNAPL will also undergo dissolution as groundwater continues to move past the LNAPL-water interface. Soluble constituents (e.g., BTEX) will enter the groundwater system. Once dissolved, additional mechanisms such as dispersion and degradation will act on these components to limit their transport potential.

3.2.6 Existing Groundwater Selected Remedy

The OU-2 ROD (IT, 1992d) was signed in December 1992, following the publication of the RI (IT, 1992a), the Feasibility Study (IT, 1992b), and the OU-2 Proposed Plan (IT, 1992c). The major actions of the original groundwater selected remedy were as follows:

- Extraction of LNAPL and groundwater using an estimated series of up to 2 horizontal or 16 vertical extraction wells. The exact number, type, and location of wells were to be determined during the remedial design phase as a result of aquifer tests conducted after well installations.
- Pass extracted fluids through an oil/water separator in order to capture all LNAPL prior to treatment of the water. LNAPL was either to be reused by an approved vendor or disposed of at an authorized off-site disposal facility.
- Conduct pretreatment, as needed, of the extracted groundwater (e.g., precipitation, flocculation, clarification, filtration, acid treatment, etc.) to remove solids that may potentially interfere with the treatment for contaminants. The system specifications were to be developed from treatability studies conducted during the remedial design phase, if required.
- Conduct pretreatment, as needed, of the extracted groundwater (e.g., precipitation, flocculation, clarification, filtration, ion exchange, etc) to reduce the concentration of metals to action levels identified in the OU-2 ROD, The OU-2 ROD provided details for including this treatment contingency.
- Provide treatment of the extracted groundwater by twin air stripping columns in series to reduce volatile contaminant concentrations to action levels identified in the OU-2 ROD. Treatment will achieve greater than 99 percent removal of volatile contaminants.
- Conduct post-treatment, as needed, of the extracted groundwater (e.g., liquid-phase carbon adsorption) to reduce semi-volatile organic concentrations to action levels identified in the OU-2 ROD. The OU-2 ROD provided details for including this treatment contingency.
- Injection of treated groundwater back into the shallow aquifer to assist in maintaining hydraulic control and to avoid depletion of the aquifer or discharge of treated groundwater to the Base wastewater treatment plant. A number of factors were to be evaluated to yield a decision by Parties to the FFA to inject treated groundwater back into the aquifer and/or to discharge the treated groundwater into the Base sanitary sewer. These factors included, but were not limited to the following: (1) the results of aquifer measurements made during a given remediation period; (2) the ability of injection wells to accommodate the extraction rate; (3) the minimum volume of water needed at the Base wastewater treatment plant to remain in operation; and (4) identified Base treated wastewater reuse needs, such as irrigation of the Base golf course. Based on current estimates, four injection wells were planned. Their exact number, type, and location were to be determined during the remedial design phase.

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4.0 BASIS FOR THE ROD AMENDMENT

This section summarizes the information that prompted and supports the fundamental change to the groundwater remedy selected in the OU-2 ROD. Implementation of the studies to verify the optimum design for the original groundwater remedy at ST012 began with a demonstration conceptual design (DCD) (CDM, 1992). The DCD resulted in a pilot study/demonstration study (PS/DS), which involved: (1) the design, construction, and operation of groundwater extraction systems; (2) a monitoring system to assess the groundwater depression caused by the extraction systems; (3) a treatment system to remove dissolved contaminants from extracted groundwater; and (4) a reinjection system for discharge of treated groundwater. Concurrent with and following the PS/DS, activities and studies including LNAPL recovery, groundwater monitoring, natural attenuation studies, a bioslurping evaluation (vacuum extraction of LNAPL/groundwater that also promotes biodegradation of petroleum contaminants), and a TEE pilot test were conducted in support of the original remedy and alternative technologies potentially applicable to groundwater remediation at ST012.

4.1 Pilot Study/Demonstration Study

The purpose of the PS/DS was to compare the effectiveness of horizontal and vertical well recovery of LNAPL and contaminated groundwater. Fieldwork for the PS/DS was completed between 1992 and 1994. During the PS/DS, which was summarized in a PS/DS report (CDM, 1995), two horizontal and two vertical extraction wells and four injection wells were installed. The PS/DS included pumping tests of the horizontal and vertical extraction wells, and infiltration testing of the injection wells. The conclusions of the PS/DS report were as follows:

- Strong aquifer anisotrophy (aquifer properties that vary with direction) and rising groundwater rendered horizontal wells ineffective for hydraulic control.
- The contaminated aquifer is a low-yield aquifer.
- Successful groundwater remediation is technically impractical by pump and treatment methods using the design and methods set forth in the DCD and the OU-2 ROD.

EPA agreed with the conclusions of the PS/DS report, including suspending installation of a full-scale pump-and treat system, premised on the following: 1) deep vadose zone remedial action is implemented; 2) an evaluation of natural attenuation in groundwater is conducted; 3) operation of the LNAPL removal system is continued; and 4) groundwater data indicates that the plume is not moving off-base and does not appear to be migrating at a significant rate (EPA, 1995). ADEQ provided a letter that indicated they had no comments on the report (ADEQ, 1995).

4.2 LNAPL Recovery

LNAPL recovery began in August of 1990 with the installation of a dedicated skimmer pump recovery system, which was operated until 1996. Over this period, the LNAPL recovery declined from as much as 80 percent of the fluids removed to almost zero, so a decision was made to use a portable recovery system. The portable system was operated for 10 months on a monthly basis. Over the course of the recovery efforts, a total of 10,564 gallons of LNAPL and about 20,000 gallons of contaminated groundwater were removed.

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4.3 Groundwater Monitoring

Following groundwater characterization sampling from August 1989 to October 1991, groundwater monitoring at ST012 began on a quarterly basis in 1992. Monitoring continued quarterly through 1993, when it decreased to semiannually through 1996. Monitoring has continued annually since that date, with additional events added during and following the TEE pilot test as discussed in Section 4.6, Thermal Enhanced Extraction Pilot Test. The objective of groundwater monitoring is to quantify and report groundwater conditions and contaminant plume characterization beneath ST012 and to monitor the plume for potential migration. Groundwater contaminant analyses are conducted for VOCs, SVOCs, TPH, and metals in order to address the COPCs identified in the OU-2 ROD.

For each groundwater sampling event, a complete round of water level and LNAPL thickness measurements from all accessible wells was followed by groundwater sampling in accordance with the latest version of the groundwater monitoring work plan. Results to date indicate the presence of a plume of contaminated groundwater (Figure 4-1), indicated primarily by benzene, with varying amounts of LNAPL present in the core of the plume (URS, 2011a and URS, 2012).

4.4 Groundwater Natural Attenuation Study

A natural attenuation study was initiated in February 1995 to measure compounds that would indicate ongoing biodegradation. The study was designed with guidance from Air Force Civil Engineer Center (AFCEC) (AFCEC was formerly known as Air Force Center for Engineering and the Environment, for consistency the current name is used in this document) and the EPA Robert S. Kerr Environmental Laboratory in Ada, Oklahoma.

The study was performed in conjunction with annual groundwater monitoring activities and used field and laboratory analyses to identify evidence of biodegradation byproducts. The objective of the natural attenuation study at ST012 was to document lines of evidence that point to the occurrence of natural attenuation and intrinsic remediation: loss of contaminants at the field scale, geochemical evidence, and bacterial metabolic residues. The samples collected and analyzed during the February 1995 monitoring activities were intended to document geochemical evidence and the presence of organic acids; the loss of contaminants was documented by compilation of historical evidence. Natural attenuation analytes and measurements were dissolved oxygen (DO), oxidation reduction potential, sulfate, sulfide, nitrate, ferric iron, carbon dioxide, and methane. BTEX analysis was performed to document dissolved contamination. Sampling and analysis during the February 1995 groundwater monitoring event established a baseline for comparison of later sampling data; the sampling is documented in the groundwater sampling report (IT, 1995b).

Additional sampling and analysis for natural attenuation parameters was performed throughout the late 1990s and in isolated instances in the 2000s (before and after the TEE pilot), but is no longer a routine part of the groundwater monitoring program. The latest sampling information is included in the TEE evaluation report (BEM, 2011).

A 1998 natural attenuation treatability study concluded that the natural attenuation process is occurring in groundwater at ST012, has limited benzene plume migration, and will ultimately result in groundwater clean-up (BEM, 1998b). Comparison of upgradient, within-plume, cross-gradient, and downgradient natural attenuation parameters provides evidence of microbial

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activity. An overlay of natural attenuation parameters and BTEX concentrations shows a strong correlation between the location of the plume and relatively low values of DO (Figure 4-2), nitrate (Figure 4-3), and sulfate (Figure 4-4). The location of the BTEX plume correlates with relatively high values of methane and sulfide, as well. Measurement of bioactivity-derived carbon dioxide in groundwater is complicated by the presence of carbonate (as alkalinity), which acts as both a source and a sink for carbon dioxide. Comparison of carbon dioxide values and ferrous iron values outside of the plume to those within the plume are inconclusive.

Groundwater samples collected for analysis by the EPA Kerr Laboratory were analyzed for organic acids. The results showed the presence of intermediate microbial respiration compounds such as benzoic acid and phenylacetic acid, which are solely attributable to the biodegradation of fuel hydrocarbons. In addition, field testing by Hach™ test kits documented the presence of sulfate-reducing bacteria, iron-reducing bacteria, and denitrifying bacteria.

Results of further groundwater sampling and analysis for natural attenuation parameters have continued to provide evidence of the containment and reduction of the dissolved benzene plume by natural attenuation although some redistribution is observed. A comparison of benzene values in groundwater over the period of sampling from October 1990 to November 2010 (Figure 4-1) shows a decrease in length of the dissolved benzene plume (as defined by the 5 µg/L boundary), despite groundwater movement at the rate of at least 120 ft/yr. This suggests that plume migration is influenced by the documented bioactivity.

4.5 Bioslurping Initiative

The AFCEC bioslurper initiative was designed to develop procedures for evaluating the potential for recovery of LNAPL at petroleum-contaminated sites within the IRP. The objective at ST012, as at similar sites nationwide, was to evaluate applicability, cost, and performance of bioslurping as a technology for removal of LNAPL, and to identify site parameters that are reliable predictors of successful LNAPL recovery and site remediation. A bioslurping study was performed at ST012 by Battelle in 1996 (Battelle, 1997).

Bioslurper pilot test activities were conducted at monitoring wells N-6 and ST012-MW05. Site characterization activities, such as baildown testing of LNAPL mobility, were performed first. Pilot tests for skimmer pumping, bioslurping, and SVE were then conducted, using various configurations of drop tube diameters, pump types, and pump vacuums. Measurements of extracted soil gas composition, LNAPL thickness, and groundwater elevations were collected throughout the testing.

Bioslurping testing at ST012 demonstrated the ability of liquid-ring pumps to extract liquids from depths exceeding 200 ft, but LNAPL recovery was low relative to groundwater extraction totals (Battelle, 1997). Tests on both wells produced similar results, and drop tube diameter was observed to have little effect on LNAPL recovery. The initiative was, therefore, abandoned.

4.6 Thermal Enhanced Extraction Pilot Test

BEM performed a pilot test between 2004 and 2010 to evaluate the use of TEE as a source reduction technology for ST012. Three reports document the TEE Pilot Test: the Pilot Test Work Plan (BEM, 2007); the Construction Completion/Inspection Report (BEM, 2010); and the Pilot

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Test Performance Evaluation Report (BEM, 2011). The summaries presented here are from these reports. The implementation of the TEE Pilot Test followed the steps in the Table 4-1.

Table 4-1 Steps for the TEE Pilot Test Implementation

Lower Saturated Zone (LSZ) (~210-245 ft bgs)	Upper Water Bearing Zone (UWBZ) (~160-195 ft bgs)
Pre-Test	
LSZ – Pre-test Soil, Groundwater, and non-aqueous phase liquid (NAPL) Sampling	UWBZ – Pre-test Soil and Groundwater Sampling
Operation	
LSZ-Step 1 – Groundwater and NAPL Extraction	UWBZ-Step 1 – Groundwater and SVE
LSZ-Step 2 – Pre-treatment Mass Transfer Test	UWBZ-Step 2 – Pre-treatment Mass Transfer Test
LSZ-Step 3 – Steam Injection	UWBZ-Step 3 – Steam Injection
LSZ-Step 4 – Co-Steam/Air Injection	UWBZ-Step 4 – Co-Steam/Air Injection
LSZ-Step 5 – Water Injection	UWBZ-Step 5 – Air Injection
Post-Test	
LSZ – Post-treatment Mass Transfer Test	UWBZ – Post-treatment Mass Transfer Test
LSZ – Post-test Soil and Groundwater Sampling, Monitoring, and Evaluation	UWBZ – Post-test Soil and Groundwater Sampling, Monitoring, and Evaluation

4.6.1 Thermal Enhanced Extraction Cell Installation

The pilot test cell was located within the eastern portion of ST012 (Figure 4-5). This location was selected because it was known to contain substantial accumulations of LNAPL in monitoring wells (from several ft up to nearly 20 ft of thickness) in the saturated zone, thereby providing a suitable setting for evaluation of the effectiveness of TEE in treating heavily contaminated areas.

The pilot test was conducted within a single treatment cell having a diameter of 140 ft. The cell contained a single central injection well pair surrounded by six perimeter extraction well pairs. The TEE Pilot Test cell contained six monitoring well locations within the cell interior and an existing overlying vadose zone SVE well nest completed within the cell. The interior monitoring wells provided groundwater and/or vapor samples along with temperature measurements for assessing the performance of the pilot test.

Each injection/extraction well pair consisted of a shallow well (total depth approximately 200 ft bgs) screened across the UWBZ, and a deep well (total depth approximately 245 ft bgs) screened across the LSZ. Each monitoring well location consisted of three wells, with one well completed within the UWBZ and the other two completed at two depth intervals within the LSZ. The middle-depth well was screened across the upper portion of the LSZ, and the deep well was screened across the lower portion of the LSZ just above the aquitard. Thermocouples were installed within each deep borehole to monitor subsurface temperature changes as the treatment proceeded.

4.6.2 Results and Conclusions

BEM judged the effectiveness of the TEE Pilot Test based on mass removal as determined by process samples of extracted fluids and gasses and mass reduction based on comparison of the pre- and post-test soil and groundwater analytical results. Concentrations of benzene and

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lighter hydrocarbon chain COPCs were reduced in post-test soil samples (BEM, 2011) and concentrations of all COPCs in groundwater were measurably reduced, with greater reduction nearer to the injection wells (BEM, 2011).

Extracted fluids and vapors were analyzed for contaminant concentration and the results were used to generate an estimate of mass removal on a contaminant by contaminant basis. An estimated total of 4,000 pounds (lbs) of benzene was removed during the pilot test, primarily in the dissolved phase; less than 4 percent of the cumulative mass of extracted benzene was attributed to vapor recovery in the LSZ, and roughly 20 percent was extracted as a vapor in the UWBZ. The recharge rate of outside groundwater was high enough to condense the steam in both lithologic units, resulting in the relatively low recovery percentage.

Conversely, of the roughly 118,000 lbs of petroleum hydrocarbons (PHC) extracted, approximately 60 percent of the mass extracted from the LSZ was as a vapor, and more than 90 percent of the mass extracted from the UWBZ was extracted as a vapor. Almost half of the overall mass was attributed to extraction of LNAPL. Volatilized LNAPL in the presence of steam condenses as it reaches the extraction wells, leaving LNAPL floating on hot water. When sufficient drawdown was achieved to uncover the top portion of the well screen, soil vapor was immediately drawn past the LNAPL and quickly volatilized it. The total masses extracted of other COPCs can be found in Table 4-2.

Table 4-2 Total Masses Extracted of Individual Compounds During the TEE Pilot Test

Compound	Mass Extracted (lbs)			
	LSZ	UWBZ	NAPL	Total
Benzene	2,787	896	294	3,977
Toluene	1,646	815	1,016	3,477
Ethylbenzene	645	410	663	1,718
m&p-Xylenes	933	620	1,100	2,653
o-Xylene	658	500	406	1,564
<=C6	10,434	9,153	5,806	25,393
C7-C8	11,544	14,696	21,090	47,330
C9-C10	1,512	3,370	17,743	22,625
C11-C12	377	507	5,568	6,452
C13-C14	174	23	2,278	2,474
>=C15	227	12	0	239
Total PHC	30,936	31,002	55,964	117,902

Using the extracted volume of groundwater over the duration of the TEE pilot and the contaminant concentrations monitored before the pilot was installed, an estimate of contaminant removal in a purely groundwater extraction scenario was compared to the observed extracted masses over the course of the pilot in order to quantitatively analyze the benefit of TEE. The results of the comparison are presented in Table 4-3.

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Table 4-3 Estimated Masses Extracted for Groundwater/LNAPL Extraction and Comparison to TEE

	Zone and NAPL	Benzene (lbs)	Toluene (lbs)	Ethylbenzene (lbs)	m&p-Xylenes (lbs)	o-Xylene (lbs)	PHC (lbs)
Groundwater/NAPL Extraction Scenario (GW)	LSZ	1,340	998	356	572	243	7,281
	UWBZ	409	416	145	286	115	2,413
	NAPL	0	0	0	0	0	0
	Total	1,749	1,414	501	858	358	9,694
TEE Pilot Test Total (TEE)	LSZ	2,787	1,646	645	933	658	30,936
	UWBZ	896	815	410	620	500	31,002
	NAPL	294	1,016	663	1,100	406	55,964
	Total	3,977	2,477	1,718	2,653	1,564	117,902
Thermal Enhancement over P&T Scenario (=TEE-GW)	LSZ	1,447	648	289	361	415	23,655
	UWBZ	487	399	265	334	385	28,589
	NAPL	294	1,016	663	1,100	406	55,964
	Total	2,228	2,063	1,217	1,795	1,206	108,208
(TEE-GW) / (GW)		1.27	1.46	2.43	2.09	3.36	11.16

As shown by the mass removal comparison, BEM concluded that TEE provides an increased rate of extraction for all of the observed contaminants, ranging from a factor of roughly 1.25 more effective to 11 times more effective.

4.7 ST012 Dispute

In October 2005, EPA and ADEQ invoked formal dispute in accordance with the FFA over progress in establishing a revised groundwater remedy for ST012 (EPA and ADEQ, 2005). Prior to the dispute, the AF and regulatory agencies had reached consensus on augmenting the OU-2 groundwater remedy with the TEE technology. The EPA and ADEQ invoked formal dispute because, after partial construction of the first phase of a TEE pilot treatment system, further work was terminated by the AF due to a change in program funding criteria. In February through May 2006, the AF, EPA and ADEQ exchanged dispute resolution letters in which the AF agreed to proceed with a TEE pilot test at ST012 (AFRPA, 2006a; EPA and ADEQ, 2006a; AFRPA, 2006b; EPA and ADEQ, 2006b). As described in Section 4.6, Thermal Enhanced Extraction Pilot Test, the AF implemented the TEE Pilot Test to evaluate TEE as a component technology for a revised ST012 groundwater remedy. Based on the results of the TEE Pilot Test, the AF concluded that potential remedial alternatives, including the TEE technology, should be evaluated in a ST012 FFS that would lead to this ROD Amendment 2 for a revised groundwater remedy (AFRPA, 2010). During the interim period while the ST012 FFS and OU-2 ROD Amendment were being completed, the AF continued implementation of the OU-2 ROD remedy as follows:

- Operated and optimized the deep soil SVE system.
- Continued LNAPL removal activity.
- Restarted and operated the existing groundwater extraction wells – The most functional of the TEE pilot study extraction wells were operated to extract and treat contaminated groundwater. Operation of the extraction wells removed benzene mass from the source area and provided an element of hydraulic containment within the source area.

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- Continued groundwater monitoring – Annual groundwater monitoring is ongoing in order to monitor the ST012 contaminant plume and ensure protectiveness of human health and the environment.

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5.0 DESCRIPTION OF EXISTING AND REVISED REMEDIES

In response to the determination that the originally selected remedy was impractical and ineffective, the OU-2 FFS was completed to evaluate additional groundwater alternatives (AMEC, 2012). The FFS identified and evaluated four groundwater alternatives for OU-2 as follows:

- Alternative ST012-1 – No Action
- Alternative ST012-2 – MNA with LNAPL Removal and Treatment
- Alternative ST012-3 – Steam Enhanced Extraction and Enhanced Bioremediation
- Alternative ST012-4 – Enhanced Bioremediation and Ozonation

Based on the FFS evaluation, Alternative ST012-3 was identified in the Amended Proposed Plan as the preferred alternative and is the revised groundwater Selected Remedy in this ROD Amendment 2. Alternative ST012-3 is selected because it will achieve Applicable or Relevant and Appropriate Requirements (ARARs) in the shortest amount of time and uses the technology with the most certainty of achieving the predicted results at the site. It is implementable and poses manageable risks to workers and visitors to the site for the shortest period of time. It is a permanent solution that allows unrestricted use of the site in the future, and the technology is the most suited to the scale and conditions of the site. Alternatives ST012-1 and ST012-2 would not have achieved ARARs at ST012 for hundreds of years. Alternative ST012-4 was estimated to require up to 60 years to achieve ARARs and would require additional pilot testing to demonstrate its effectiveness. In contrast, Alternative ST012-3 has the highest cost of the alternatives, but is estimated to achieve ARARs in the shortest time (about 20 years) and the SEE component has been demonstrated as effective at ST012 by the TEE pilot test. Additional details on the alternatives are available in the FFS (AMEC, 2012) and Amended Proposed Plan (AF, 2013).

The remainder of this section describes the amended groundwater selected remedy (Alternative ST012-3: Steam Enhanced Extraction and Enhanced Bioremediation), provides the remedial action objectives (RAOs) for the site and describes changes to the expected outcome of the groundwater remedy as a result of OU-2 ROD Amendment 2. The original groundwater selected remedy was described in Section 3.2.6, Existing Groundwater Selected Remedy. Table 5-1 provides a side by side comparison of the existing and revised groundwater remedy components for treatment, containment or storage, and institutional controls. Key ARARs in terms of the original and revised groundwater selected remedies are provided in Appendix B.

Table 5-1 OU-2 ST012 Groundwater Remedy Comparison of Existing and Revised Selected Remedy Components

Component	Existing Groundwater Remedy 1992 ROD	Revised Groundwater Remedy ROD Amendment 2
Treatment Components	LNAPL and groundwater extraction using horizontal or vertical extraction wells.	SEE involving steam injection and extraction of LNAPL and groundwater using vertical multi-phase extraction wells.
	LNAPL separation in an oil/water separator prior to treatment of the water. LNAPL to be reused by an approved vendor or disposed of at an authorized off-site disposal facility.	Retained. Recovered LNAPL may also be used as a supplemental fuel to generate steam for the SEE system.

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Component	Existing Groundwater Remedy 1992 ROD	Revised Groundwater Remedy ROD Amendment 2
	Extracted groundwater pretreatment, as needed, to remove solids that may potentially interfere with the treatment for contaminants.	Retained.
	Extracted groundwater pretreatment, as needed, to reduce the concentration of metals to action levels identified in the OU-2 ROD. The detection of certain metals during the remedial investigation may have been erroneous and additional sampling during the remedial design phase was to confirm or eliminate the need for this treatment.	Discharge limits and actual influent conditions will dictate need for pretreatment. The Remedial Design/ Remedial Action Work Plan may include optional pre-treatment. Implementation will be determined during preparation of the Remedial Design/Remedial Action Work Plan or actual operations.
	Extracted groundwater treatment by twin air stripping columns in series to reduce volatile contaminant concentrations to action levels identified in the OU-2 ROD. Treatment to achieve greater than 99 percent removal of volatile contaminants.	Retained. The design for air stripping units will be established in the Remedial Design/Remedial Action Work Plan and may be a different configuration than twin columns.
	Extracted groundwater post-treatment, as needed, to reduce semi-volatile organic concentrations to action levels identified in the OU-2 ROD. The detection of certain phthalate compounds during the remedial investigation may have been erroneous and additional sampling during the remedial design phase will confirm or eliminate the need for this treatment.	Discharge limits and actual influent conditions will dictate need for post treatment (e.g., activated carbon). The Remedial Design/ Remedial Action Work Plan may include optional post-treatment. Implementation will be determined during preparation of the Remedial Design/Remedial Action Work Plan or actual operations.
	Treated groundwater will either be injected back into the shallow aquifer to assist in maintaining hydraulic control and to avoid depletion of the aquifer or will be discharged to the Base wastewater treatment plant.	Treated groundwater will be discharged to the municipal wastewater treatment plant.
	Not applicable.	After SEE activities conclude, enhanced bioremediation will reduce remaining contamination by modifying soil and groundwater conditions to promote biological activity among bacteria that feed off of site contamination. The specific methods for enhanced bioremediation will be established based on biological and contaminant conditions after SEE implementation.
	Not applicable.	Monitored Natural Attenuation (end phase monitoring as needed for achieving cleanup levels)
Containment or storage components	Not applicable.	Not applicable.
Institutional Controls	Institutional controls will be implemented to impose restrictions on installation of new wells at the ST-12 site.	Retained. Institutional controls have been implemented via deed restrictions and an Arizona Declaration of Environmental Use Restriction that limits property uses and prohibits groundwater extraction or installation of groundwater wells for other than monitoring or remediation.
ARARs	See Appendix B	See Appendix B

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5.1 Description of Revised Remedy: Alternative ST012-3: Steam Enhanced Extraction and Enhanced Bioremediation

The Selected Remedy for groundwater at ST012 is Alternative ST012-3: Steam Enhanced Extraction and Enhanced Bioremediation, as described in the OU-2 FFS and the OU-2 Amended Proposed Plan. The specific components of this alternative were presented in summary form in Section 1.4, Description of the Revised Selected Remedy, and are fully described in this section.

Alternative ST012-3 will achieve cleanup levels by combining SEE of groundwater and LNAPL with enhanced bioremediation of the remaining contaminant plume. Individual processes will be applied in a sequential approach in the treatment area as follows:

- Existing institutional controls will prohibit extraction/pumping of groundwater or installation of new wells at the site for purposes other than remediation or monitoring until cleanup levels are achieved and the existing controls (deed restrictions and Declaration of Environmental Use Restriction) are removed.
- Steam will be generated on-site using one or two boilers and provide steam to injection wells. The fuel source for steam generation will be natural gas, propane, diesel, or recovered LNAPL. Recovered LNAPL may be used as fuel for the boilers if determined feasible during the remedial design. Steam injection will heat the treatment area, increasing the mobility of LNAPL and volatilizing contaminants from the groundwater and soil. Steam injection wells screened in the three zones (UWBZ, LPZ, LSZ) will be collocated with temperature monitoring points.
- Multi-phase extraction will extract LNAPL, contaminated groundwater, and soil vapor from the three aquifer zones. Multi-phase extraction wells will be collocated with temperature monitoring points. Captured LNAPL will be separated and recovered to the extent feasible to power steam generation. Contaminated groundwater will be treated using on-site air stripping and, if necessary, granular activated carbon, and treated water will be discharged to the municipal wastewater treatment plant. Soil vapor will be treated by thermal oxidation or potentially burned in the steam boiler(s).
- Where it is feasible to do so (i.e., SVE wells that are screened outside the SEE footprint), the existing deep soil SVE system will continue to operate and collect vapor from contaminated soil to assist in capture of any additional soil vapor contamination as a result of steam injection. Enhanced bioremediation will proceed after the cessation of SEE activities. The criteria to cease SEE activities and proceed with enhanced bioremediation will be developed jointly by the AF, EPA, and ADEQ as part of the Remedial Design/Remedial Action Work Plan. Existing site conditions will be enhanced to promote biological activity among bacteria that feed off of contamination present at the site. Residual heat in the treatment area following cessation of steam injection is anticipated to enhance biological activity. Further modifications to enhance biological activity may include introducing food sources to promote activity, or modifying physical or chemical characteristics (e.g., dissolved oxygen, pH, temperature) to create an environment that is more hospitable to bacterial growth. The specific methods for enhanced bioremediation will be established in consultation with EPA and ADEQ based on biological and contaminant conditions after SEE implementation.

- Subsequent to all active remediation processes, monitoring of natural attenuation processes will proceed. Monitoring will track the progress of contaminant attenuation and remedy effectiveness until cleanup levels are achieved.
- Throughout the duration of the remedy, groundwater monitoring will be conducted in accordance with the ST012 Groundwater Monitoring Work Plan which will be updated and submitted for EPA and ADEQ review and approval as needed. One objective of monitoring during the injection of steam will be to verify that the dissolved contaminants and LNAPL are not being driven beyond the extraction system zone of capture by the injection of steam. Groundwater monitoring reports will evaluate remedy effectiveness and include recommendations for changes to remedy implementation, the monitoring network, analytical methods, and sampling methods or frequency. The number of available wells will decrease during steam injection due to the presence of heated and pressurized steam in the subsurface.

The TEE pilot study results have already indicated the effectiveness of TEE technologies such as SEE with respect to site-specific conditions. The revised groundwater remedial action at ST012 will substantially reduce the mass of JP-4 and AVGAS that impacts groundwater and will thereby reduce the time required to clean up the groundwater at ST012.

The active components (SEE and Enhanced Bioremediation) of the Selected Remedy for groundwater will be implemented until the chemical-specific cleanup levels are reached, or analysis of biological and natural attenuation related degradation suggest that contaminants will naturally degrade to the desired concentration within an overall remedial timeframe of approximately 20 years. Monitoring of groundwater will continue until attainment of all cleanup levels has been demonstrated. It is expected that cleanup levels will be attained for portions of the groundwater contaminant plume area as remedial action progresses and that the area exceeding cleanup levels will diminish over time. In the absence of alternative mutual agreement between the AF, EPA and ADEQ, cleanup levels will have been attained when monitoring results throughout the plume reach concentrations at or below the cleanup levels and remain below cleanup levels throughout a two year period of continued groundwater monitoring after cleanup levels were initially achieved. The AF, EPA and ADEQ may agree to termination of monitoring at specific locations or for the overall plume area based on a shorter duration or other criteria upon mutual agreement. No institutional or engineering controls will be required after the remedy has achieved RAOs.

5.1.1 Compliance and In-Process Measurement

Influent and effluent sampling will be conducted routinely during the operation of SEE. Groundwater monitoring outside of the active steam zone will occur during SEE and throughout the ST012 site during enhanced bioremediation treatment to evaluate the effectiveness of the remedy and determine cleanup progress. The details of this compliance and in-process measurement program, including methods to compare monitoring data over time to evaluate remedial progress, will be specified in the OU-2 Remedial Design/Remedial Action Work Plan. The Work Plan will be updated for the transition from SEE to Enhanced Bioremediation. The ST012 Groundwater Monitoring Work Plan will be updated in coordination with EPA and ADEQ review and approval as needed throughout the remedial timeframe. The OU-2 O&M Manual will describe operations, maintenance, monitoring and procedures for the remedial systems.

5.1.2 Cost

The total present worth of Alternative ST012-3 is $20.8 million. Appendix C presents a cost summary table and estimate for Alternative ST012-3, the ROD Amendment 2 revised groundwater selected remedy. The cost is an order-of-magnitude engineering estimate that is expected to be within +50 to -30 percent of the actual project cost. The information in the cost estimate summary table is based on the best available information regarding the anticipated scope of the remedy. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedy. Major changes may be documented in the form of a memorandum in the Administrative Record file, an ESD, or a ROD amendment.

5.2 Remedial Action Objectives

The RAOs for groundwater at OU-2 were not specifically described in the OU-2 ROD and are as follows:

- to prevent exposure to contaminants in water exceeding drinking water standards,
- to prevent exposure to contaminants in water at concentrations exceeding $1x10^{-6}$ to 10^{-4} Incremental Lifetime Cancer Risk (ILCR) or a Hazard Index (HI) greater than 1 when a drinking water standard is not established, and
- to restore the aquifer to drinking water and aquifer water quality standards.

The purpose of the first two RAOs is to prevent exposures to contaminants that pose a potential human health risk. Chemical-specific health-based ARARs, where available, were selected over calculated risk-based actions levels. The objective of these two RAOs is currently met by existing institutional controls that limit the site to non-residential use and prevent future exposure to groundwater by restricting the extraction of groundwater and installation of wells at the site except for investigation and remediation purposes. The purpose of the third RAO is to restore groundwater to concentrations that comply with applicable chemical-specific ARARs. Because these ARARs are based on protection of human health, restoration to these concentrations will address the risks identified in the baseline human health risk assessment.

The identification of groundwater cleanup levels based on the groundwater RAOs is documented in Table B-2 of Appendix B and summarized in Table 5-2. These cleanup levels were identified in the OU-2 ROD and have been updated based on current standards as presented in Table B-2. The OU-2 ROD identifies only COPCs. Based on the November 2012 groundwater sampling event (AMEC, 2013c), benzene, toluene, naphthalene, chromium, and nickel were detected above the OU-2 ROD action levels. Chromium and nickel have been associated with well construction materials. The only compounds related to site contamination that exceed the OU-2 ROD Amendment 2 cleanup levels are benzene, toluene, and naphthalene. Therefore, benzene, toluene, and naphthalene have been identified as COCs. The remaining ST012 compounds identified for groundwater in the OU-2 ROD remain as COPCs as presented in the OU-2 ROD.

Table 5-2 List of Contaminants of Concern and Contaminants of Potential Concern in Groundwater and Associated Action or Cleanup Level

Contaminant	OU-2-ROD Action Level (mg/L)	Basis of Action Level	OU-2 ROD Amendment 2 Cleanup Level (mg/L)	Basis of Cleanup Level
Contaminant of Concern				
Benzene	0.005	Federal MCL	0.005	Federal MCL
Toluene	1.0	Federal MCL	1.0	Federal MCL
Naphthalene	0.028	Arizona HBGL	0.028	Arizona HBGL
Contaminant of Potential Concern				
Bis(2-exylhexyl)phthalate	0.006	Federal MCL, Effective January 1994	0.006	Federal MCL
1,2-Dichloroethane	0.005	Federal MCL	0.005	Federal MCL
Ethylbenzene	0.7	Federal MCL	0.7	Federal MCL
Methylene chloride	0.005	Federal MCL, Effective January 1994	0.005	Federal MCL
2-Methylnaphthalene	N/A	No EPA approved toxicity information available.	0.027	EPA Regional Screening Level for tap water
2-Methylphenol	0.87	AF risk-based allowable concentration	0.72	EPA Regional Screening Level for tap water
4-Methylphenol	0.87	AF risk-based allowable concentration	1.4	EPA Regional Screening Level for tap water
Phenol	4.2	Arizona HBGL	4.2	Arizona HBGL
Tetrachloroethene	0.005	Federal MCL	0.005	Federal MCL
Trichlorofluoromethane	2.1	Arizona HBGL	1.1	EPA Regional Screening Level for tap water
Xylenes	10	Federal MCL	10.0	Federal MCL
Antimony	0.006	Federal MCL, Effective January 1994	0.006	Federal MCL
Chromium III	0.1	Federal MCL	0.1	Federal MCL
Chromium VI	0.1	Federal MCL	0.1	Federal MCL
Copper	1.3	EPA OSWER June 24, 1990	1.3	Federal MCL
Lead	0.015	EPA OSWER June 24, 1990	0.015	Federal MCL
Nickel	0.1	Federal MCL, Effective January 1994	0.1	AZ Aquifer Water Quality Standard
Silver	0.05	Federal MCL	0.1	Federal MCL
Zinc	1.4	Arizona HBGL	1.4	Arizona HBGL

AZ - Arizona
ADEQ - Arizona Department of Environmental Quality
HBGL – health-based guidance level
MCL - Maximum Containment Level
MCLG - Maximum Containment Level Goal
OSWER – Office of Solid Waste and Emergency Response
mg/L - milligrams per liter

5.3 Expected Outcome

As for the original remedy, the expected outcome of the revised groundwater remedy is that concentrations of residual LNAPL in saturated soil and dissolved contaminants in groundwater will be reduced to levels that will no longer result in contaminant concentrations in groundwater exceeding cleanup levels. The revised groundwater remedy will achieve groundwater cleanup levels in an estimated 20 years. The cleanup levels presented in Appendix B have changed since the issuance of the OU-2 ROD, but are still based on federal and state water quality standards or risk-based screening levels. Table 5-2 compares the OU-2 ROD action levels to the OU-2 ROD Amendment 2 cleanup levels. No further changes are anticipated as a result of ROD Amendment 2.

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6.0 EVALUATION OF EXISTING AND REVISED REMEDIES

This section provides an evaluation of the nine CERCLA criteria to compare Alternative C, the original selected remedy (described in Section 3.2.6, Existing Groundwater Selected Remedy, and the 1992 ROD [IT, 1992d]), and Alternative ST012-3, the revised selected remedy (described in Section 5.1, Description of Revised Remedy, and the OU-2 FFS [AMEC, 2012]).

6.1 Overall Protection of Human Health and the Environment

Alternative ST012-3 will be protective of human health and the environment because there is no current use of groundwater at ST012 and institutional controls will prevent future use of groundwater until cleanup levels are achieved. This cleanup will successfully remediate OU-2 groundwater. Groundwater monitoring and five-year reviews will evaluate the behavior of the contaminant plume, the progress of the dissolved contaminant biological attenuation, the effectiveness of the remedy, and confirm that the remedy remains protective until cleanup levels are achieved.

Alternative C, the original selected remedy, is not protective of human health and the environment. Pre-design studies to evaluate the effectiveness of groundwater extraction at ST012 indicated that groundwater extraction was an inefficient technology for removing contaminant mass and the original selected remedy was abandoned. Although institutional controls would prevent exposure to contaminated media, Alternative C, the original selected remedy, requires that the controls remain in place to provide long-term protection of human health and the environment until contaminant concentrations drop below cleanup levels (a process estimated to take between 300 and 700 years [HGL, 2005]).

6.2 Compliance with Applicable or Relevant and Appropriate Requirements

Alternative ST012-3 will be designed and implemented to meet all applicable ARARs (see Appendix B).

Alternative C, the original selected remedy, would only comply with location-specific and action-specific ARARs as well as chemical-specific ARARs (see Appendix B) after sufficient treatment time has elapsed, although the necessary treatment time is anticipated to be hundreds of years longer than the treatment time of Alternative ST012-3.

6.3 Long-Term Effectiveness and Permanence

Residual risk from Alternative ST012-3 is related to the time to achieve cleanup, which would be shortened by source removal. It is estimated that Alternative ST012-3 would achieve groundwater cleanup levels in approximately 20 years including the Remedial Design/Remedial Action Work Plan, remedial system construction, remedial action maintenance O&M, and remedy completion (See Appendix D of the OU-2 FFS [AMEC, 2012]). The TEE Pilot Test demonstrated that SEE is an effective remedial technology at ST012. Based on the completed remedy achieving RAOs, institutional controls would no longer be necessary.

Alternative C, the original selected remedy, does not effectively remove LNAPL and dissolved groundwater contamination so long-term effectiveness and permanence is questionable. Institutional controls would provide for protection of human health but the controls would

effectively be in place on a permanent basis, thereby requiring long-term management and potential enforcement.

Both ST012-3 and Alternative C, the original selected remedy, represent permanent remedies once cleanup is achieved.

6.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Both alternatives satisfy the CERCLA preference for reduction of toxicity, mobility, or volume through treatment. Alternative ST012-3 will satisfy this preference through direct removal and destruction of mobilized LNAPL and dissolved contamination, and the processes of enhanced and natural biodegradation. Alternative C, the original selected remedy, would satisfy this preference to a limited degree through groundwater extraction and treatment, and subsequent desorption of contaminants from soil into groundwater. However, Alternative C, the original selected remedy, is not an efficient approach for the site and is less effective than Alternative ST012-3.

6.5 Short-Term Effectiveness

Both Alternative ST012-3 and Alternative C, the original selected remedy, use institutional controls and safety procedures to protect the community and environment from short-term risks. These controls and procedures prevent exposure to contaminants via existing exposure pathways and new exposure pathways created by remedial actions. Long-term management and monitoring of Alternative C, the original selected remedy, would require operation of the groundwater extraction and treatment system for at least 100 years, and groundwater monitoring and institutional controls would be necessary to prevent use of groundwater in the area prior to achieving cleanup levels. Alternative ST012-3 has a shorter time frame until cleanup levels are achieved (about 20 years) than Alternative C, the original selected remedy (hundreds of years).

Risks to the community and the environment during the completion of Alternative ST012-3 are primarily related to the steam injection activities. Steam injection activities would occur for approximately two years; the remainder of the 20-year cleanup time frame would involve enhanced biodegradation activities and MNA. Risk to site workers performing steam injection would be minimized by proper procedures and training. Risks to site workers and the public associated with the unintended surfacing of injected steam would be addressed by abandonment of unused wells and potential conduits, temporary street closures, site fencing, and safety buffer zones. Steam injection will initially be progressively implemented to ensure site and perimeter safety. Trained site workers will monitor steam injection and the design will incorporate access restrictions within 100 ft of the steam treatment zone. Risks to the community and environment will be minimal after steam injection activities conclude and enhanced biodegradation and MNA activities begin.

Alternative ST012-3 and Alternative C, the original selected remedy, pose risks to workers due to boring in contaminated soil and a minor potential risk during operation due to temporary volatile emissions if the vapor treatment system malfunctions. The alternatives could also pose risks due to the potential temporary release of volatiles if the thermal oxidizer or the vapor-phase carbon adsorption system on the air stripper exhaust malfunctioned, and due to potential fire or explosion related to storage and handling of recovered hydrocarbons or fuel for the

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thermal oxidizer. These risks are manageable but would continue to exist as long as the system was in operation, which for Alternative C is an estimated duration of hundreds of years.

6.6 Implementability

The TEE Pilot Test has proven that the SEE technology is effective at ST012 despite the low-yield nature of contaminated soil demonstrated during the PS/DS. The technology, skills, and material to implement Alternative ST012-3 are readily available; however, the safeguards required for steam and the proximity of several streets would make implementation more complex than Alternative C, the original selected remedy.

Implementability of Alternative C, the original selected remedy, has proven to be difficult and ineffective. The technical feasibility of installing a groundwater extraction well network and treatment system is moderate because there are no known site or waste characteristics that represent significant installation problems; however, pre-design studies of the effectiveness of groundwater extraction revealed that soil anisotropy and low aquifer transmissivity, among other conditions, make it difficult to design a groundwater extraction system capable of capturing sufficient groundwater over the entirety of the treatment area to constitute an efficient treatment system. The conclusions of the studies are presented in the "Pilot Study/Demonstration Study Report" (CDM, 1995).

6.7 Cost

Costs associated with Alternative ST012-3 relate to groundwater monitoring and reporting, remedial design, system installation, O&M of the steam injection system, LNAPL and contaminated groundwater treatment/disposal, enhanced biodegradation, MNA, and five-year reviews. The initial capital cost for Alternative ST012-3 is estimated to be $19.1 million. O&M of the SEE treatment has been included in the capital cost due to its relatively short duration. The non-discounted cost for 20 years of O&M including groundwater monitoring and five-year reviews is $1.96 million, with a present value of $1.65 million. This includes 15 years of monitoring after SEE. A more detailed cost summary for Alternative ST012-3 is presented in Appendix C. The total present worth of Alternative ST012-3 is $20.8 million.

The initial Alternative C, original selected remedy, cost estimate was between $7.9 and $21.1 million dollars. The range of costs is due to the variations in cost for vertical and horizontal extraction wells and the cost for thermal oxidization and vapor-phase carbon adsorption. An updated cost estimate was not prepared due to the ineffectiveness of the technology as a remedy at the site.

6.8 Support Agency Acceptance

EPA Region IX and ADEQ have been involved in the technical review of the OU-2 FFS and the development of the Amended Proposed Plan and ROD Amendment 2. The EPA and the ADEQ supported Alternative ST012-3 as the preferred alternative presented in the Amended Proposed Plan. EPA and ADEQ agreed that Alternative C, the original selected remedy, was ineffective for the ST012 and that a different technology should be pursued. This agreement was based on discussions after review of the PS/DS report.

6.9 Community Acceptance

Mailings, a public notice, a public comment period and a public meeting occurred in April 2013 (see Section 9.0) to solicit input on the preferred alternative, Alternative ST012-3 from the FFS. No oral or written public comments, in favor or against the preferred alternative, were received during the public meeting or comment period. Therefore, the community acceptance of the amended remedy presented in this ROD Amendment 2 is inferred.

Community reaction to Alternative C, the original selected remedy, was positive. During the public comment period, several comment letters were received. The comments, along with questions raised during the public meeting, primarily addressed cleanup extent and methods. The community seemed most concerned about:

- The use of bioremediation to remediate the soils.
- Limiting soil cleanup to 25 ft.
- The selection or elimination of certain technologies or processes.
- The extraction process to be employed for groundwater removal from the aquifer.
- The role that the public will play in the remedial action process.

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7.0 SUPPORT AGENCY COMMENTS

EPA and ADEQ have reviewed this ROD Amendment 2 and provided comments on the draft and draft final versions of this document. Their comments and the AF responses are documented in Appendix D.

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8.0 STATUTORY DETERMINATIONS

Under section 121 of CERCLA, and the NCP, the lead agency must select remedies that are protective of human health and the environment, comply with ARARs (unless a statutory waiver is justified), are cost-effective, and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, CERCLA includes 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 for Site ST012.

8.1 Protection of Human Health and the Environment

The Selected Remedy is protective of human health and the environment because the existing institutional controls will remain in place to prevent exposure to contaminated groundwater until cleanup levels are met, LNAPL source materials will be reduced through enhanced mobilization and recovery, and dissolved phase contamination will be treated to the ARAR and risk-based cleanup levels identified in Appendix B. Achievement of these cleanup levels is anticipated to result in an ILCR within or below the risk management range of 10^{-6} to 10^{-4} and an HI of less than 1. There is no current exposure to contaminants and institutional controls will control future exposure until cleanup levels are achieved. Groundwater monitoring will evaluate the behavior of the contaminant plume and the progress of the dissolved contaminant biological attenuation. Groundwater monitoring reports will evaluate remedy effectiveness and include recommendations for changes to remedy implementation, the monitoring network, analytical methods, and sampling methods or frequency. Five-year reviews will ensure the Selected Remedy is and will continue to be protective of human health and the environment.

The upper 25 ft of the site have been successfully remediated in accordance with the OU-2 ROD (IT, 1992d), eliminating the primary exposure pathway for soil. The only remaining pathway for exposure to contaminated soil is through cuttings generated during well installation. This exposure pathway can also be eliminated by proper work and waste disposal practices.

8.2 Compliance with Applicable or Relevant and Appropriate Requirements

The Selected Remedy will comply with chemical-, location-, and action-specific ARARs, which are presented in more detail in Appendix B.

8.2.1 Chemical-Specific ARARs

Chemical-specific ARARs are presented in Table B-1 of Appendix B and cleanup levels are presented in Table B-2. Applicable guidance on allowable contaminant concentrations are drawn largely from the federal MCLs. For contaminants that are not regulated by the federal MCLs, Arizona Aquifer Water Quality Standards, Arizona Health-Based Guidance Levels, and EPA risk-based Regional Screening Level concentrations were consulted to establish an updated cleanup level. For consistency with CERCLA guidance, the basis of the cleanup levels presented in the FFS was changed in this ROD Amendment 2 to cite the federal MCL rather than the state standard where the state standard is numerically equivalent to the federal MCL. In addition, cleanup levels presented in the FFS based on the AF risk assessment were updated

to use the EPA risk-based Regional Screening Levels to incorporate updates in toxicity values that have occurred since the OU-2 risk assessment.

The Selected Remedy will comply with chemical specific ARARs through removal of LNAPL, SEE and treatment, enhanced bioremediation, and MNA.

8.2.2 Location-Specific ARARs

Location-specific ARARs are presented in Table B-3 of Appendix B.

Location-specific ARARs will be addressed by complying with the Programmatic Agreement (AF, 1995) for Base Realignment and Closure Act at Williams AFB, as needed, to avoid irreparable harm, loss or destruction of discovered significant artifacts and to preserve or provide respectful disposition of Native American human remains.

8.2.3 Action-Specific ARARs

Action-specific ARARs are presented in Table B-4 of Appendix B.

Action-specific ARARs will be complied with during installation of wells or activities generating investigation-derived waste (IDW) (e.g., groundwater sampling) through proper management and characterization of IDW. Dust control measures will be implemented during well construction. Air and water discharges will comply with applicable permits or permit equivalents.

8.3 Cost Effectiveness

The present worth cost of Selected Remedy is estimated to be $20.8 million. The Selected Remedy is cost-effective and represents a reasonable value for the cost. In making this determination, the following definition was used: “A remedy shall be cost-effective if its costs are proportional to its overall effectiveness.” (NCP §300.430(f)(1)(ii)(D)). Although the range of costs for the original groundwater remedy is less than the range of costs for the Selected Remedy, the infeasibility of the original remedy and the Selected Remedy’s ability to satisfy applicable criteria make the Selected Remedy the more cost-effective alternative.

8.4 Utilization of Permanent Solution and Alternative Treatment Technologies (or Resource Recovery Technologies) to the Maximum Extent Practical

The Selected Remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a practical manner at the site. It is considered to provide the best balance of trade-offs with respect to the balancing criteria set out in the NCP (40 CFR 300.430(f)(1)(i)(B)), i.e., (1) long-term effectiveness and permanence, (2) reduction of toxicity, mobility, or volume through treatment, (3) short-term effectiveness, (4) implementability, and (5) cost. The proposed remediation provides effective source removal and groundwater treatment at the site without being too disruptive to surrounding roads and properties. In comparison to the original remedy, the revised groundwater Selected Remedy provides a reduction in time frame from hundreds of years to decades to achieve a permanent solution.

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8.5 Preference for Treatment as a Principal Element

The Selected Remedy satisfies the statutory preference for treatment as a principal element of the remedy by incorporating SEE of contamination, destruction of recoverable LNAPL, and groundwater treatment. The Selected Remedy satisfies the regulatory requirements set forth in Section 121 of CERCLA.

8.6 Five Year Reviews

Because this remedy will result in hazardous substances, pollutants, or contaminants remaining on-site for more than five years until cleanup levels have been achieved that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within five years after initiation of remedial action and every five years thereafter until cleanup levels are achieved to ensure that the remedy is, or will be, protective of human health and the environment.

ED_005025_00013684-00044

9.0 PUBLIC PARTICIPATION COMPLIANCE

The Amended Proposed Plan and the associated Administrative Record file for OU-2 groundwater at the former Williams AFB, in Mesa, Arizona, was made available to the public in April 2013. The notice of the availability was published in the East Valley Tribune and Mesa Independent on April 10, 2013. A public comment period was held from April 10, 2013, to May 9, 2013. In addition, a public meeting was held on April 18, 2013 on the former Williams AFB to present the Amended Proposed Plan. At this meeting, the AF answered questions about problems at the site and the remedial alternatives. The AF also used this meeting to solicit a cross-section of community input on the OU-2 revised groundwater preferred alternative. . The AF received no comments during the public comment period so no transcript or responsiveness summary was necessary.

Upon completion of authorizing signatures for the OU-2 ROD Amendment 2, a notice of the amendment's availability will be published in the East Valley Tribune and Mesa Independent newspapers. An administrative record that contains the documents relating to investigation and cleanup activities performed at or proposed for former Williams AFB is available for public inspection online. The completed OU-2 ROD Amendment 2 will be available in the administrative record prior to commencement of revised groundwater remedial action. The administrative record can be accessed by the public at all hours at the following URL: https://afrpaar.lackland.af.mil/ar/. In addition, an information repository is available in the Government Documents Section at the Arizona State University Library, 300 East Orange Mall, Tempe, Arizona, 85287.

The activities described above meet the public participation requirements in CERCLA §§113(k) and 117(c) (42 U.S. Code §§ 9613(k) and 9617(c)) and of the NCP (40 CFR § 300.435(c)(2)(ii)) during the remedy selection process.

ED_005025_00013684-00045

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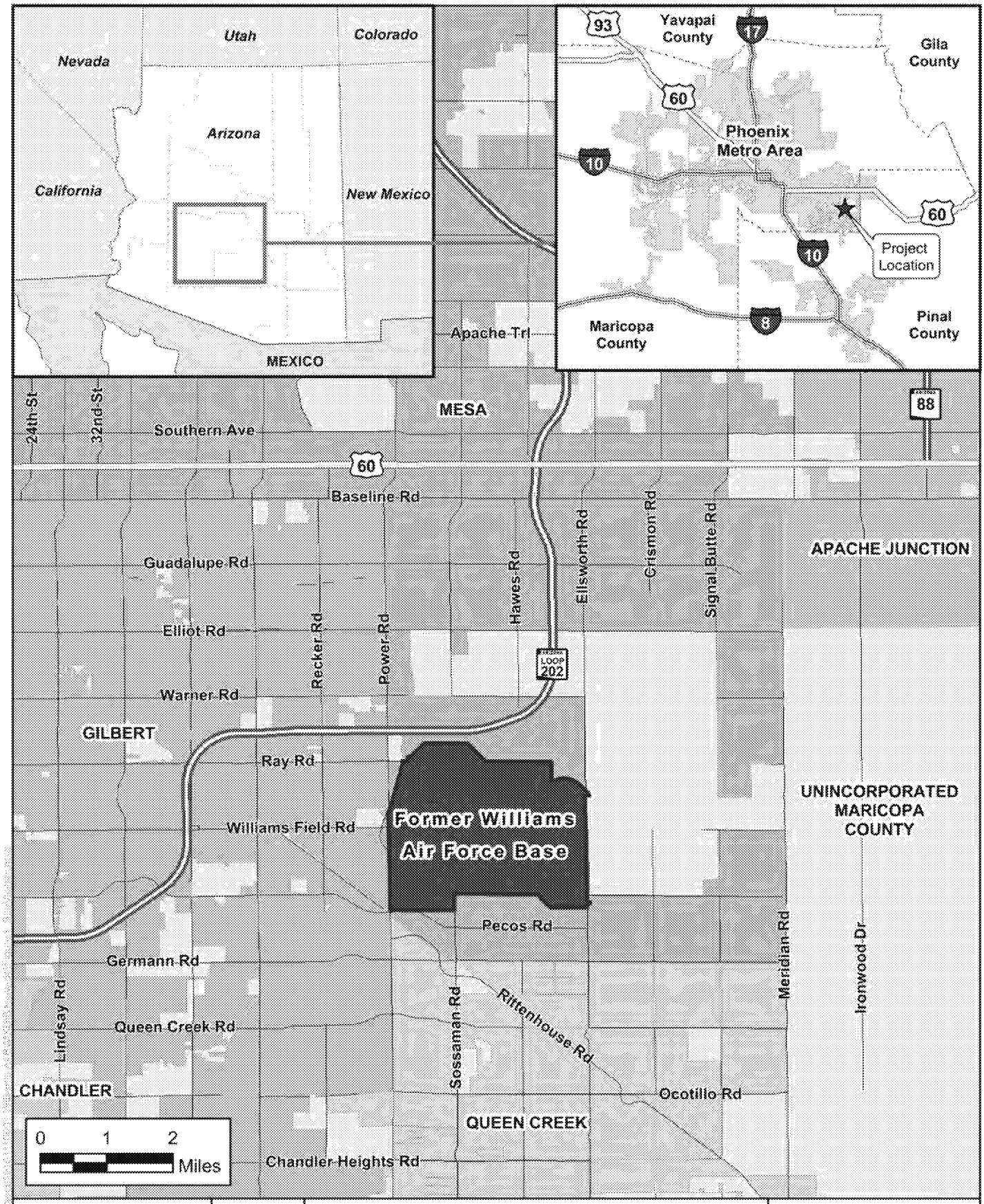
FIGURES



Job No.	9101110001
PM:	EW
Date:	10/2/2012
Scale:	1" = 2 miles

N

Former Williams Air Force Base
Mesa, Arizona

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Location of Former Williams Air Force Base

FIGURE **1-1**

Job No.	9101110001
PM:	EW
Date:	05/09/2012
Scale:	1" = 0.5 mile

N

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Former Williams Air Force Base
Mesa, Arizona

ST012 Site Location Map

FIGURE
1-2

Legend

Lower Saturated Zone Treatment Area

Benzene - LSZ - (Nov. 2011)

Source: URS, 2011a

0 50 100 Feet

N

Final
ROD Amendment 2, OU-2 (ST012)
Former Williams Air Force Base
Mesa, Arizona

Lower Saturated Zone Treatment Area

FIGURE **3-1**

Job No.	9101110001
PM:	EW
Date:	9/3/2013
Scale:	1" = 100 feet

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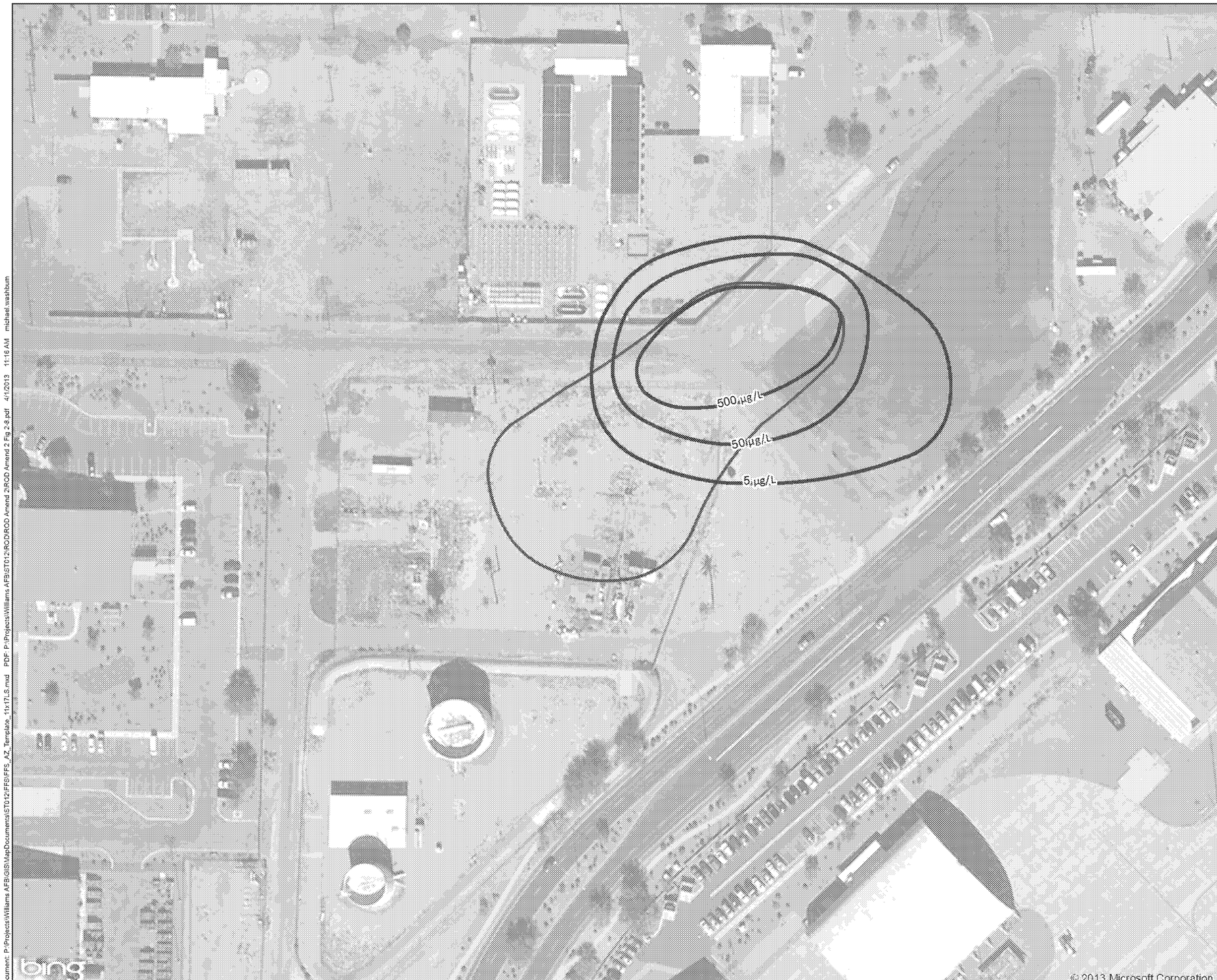

Legend

Upper Water Bearing Zone Treatment Area

Benzene - UWBZ - (Nov. 2011)

Source: URS, 2011a

0 50 100 Feet

N

Final
ROD Amendment 2, OU-2 (ST012)
Former Williams Air Force Base
Mesa, Arizona

Upper Water Bearing Zone Treatment Area

FIGURE **3-2**

Job No.	9101110001
PM:	EW
Date:	9/3/2013
Scale:	1" = 100 feet

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Legend

ST012 Wells:

- Monitoring
- Extraction
- DPE
- SVE
- Borings
- Abandoned
- Horizontal Well
- Horizontal Well Screen

0 125 250 Feet

N

Final
ROD Amendment 2, OU-2 (ST012)
Former Williams Air Force Base
Mesa, Arizona

Location of Former and Current Wells and Borings

FIGURE 3-3

Job No. 9101110001
PM: EW
Date: 9/3/2013
Scale: 1" = 250 feet

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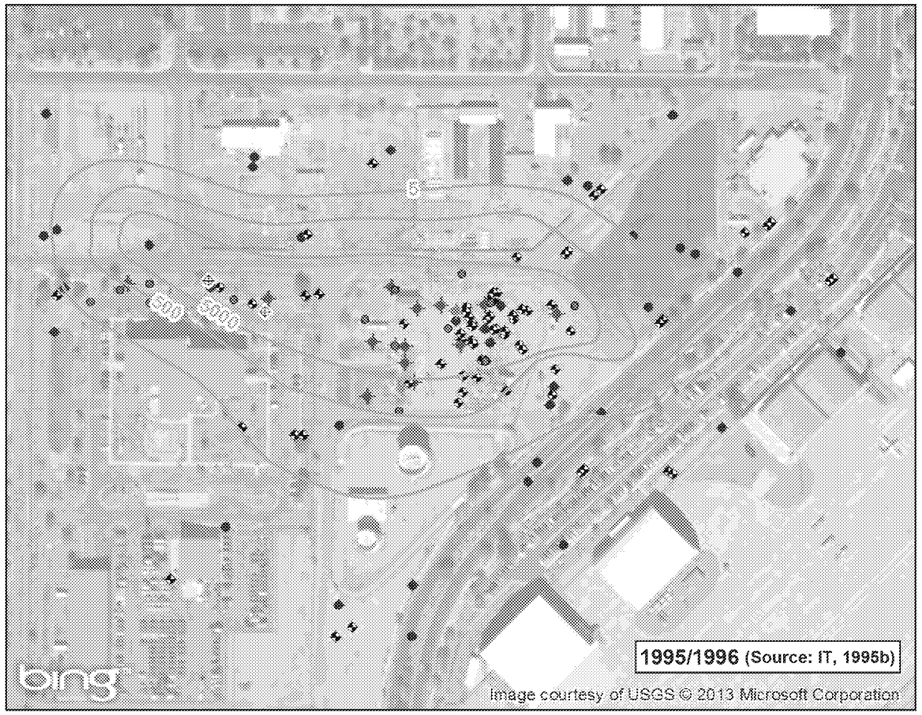
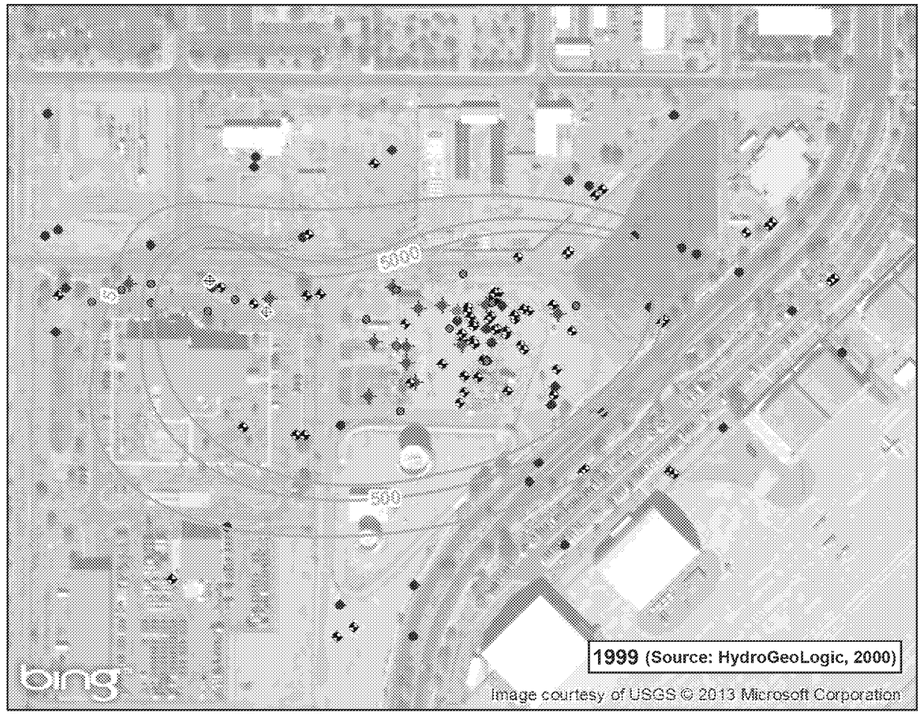
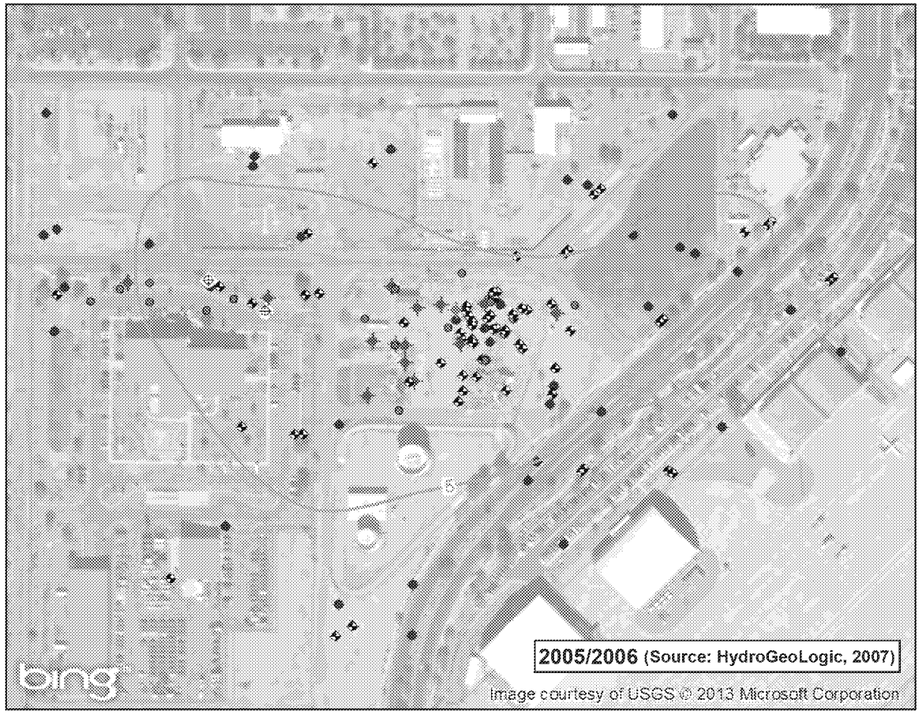


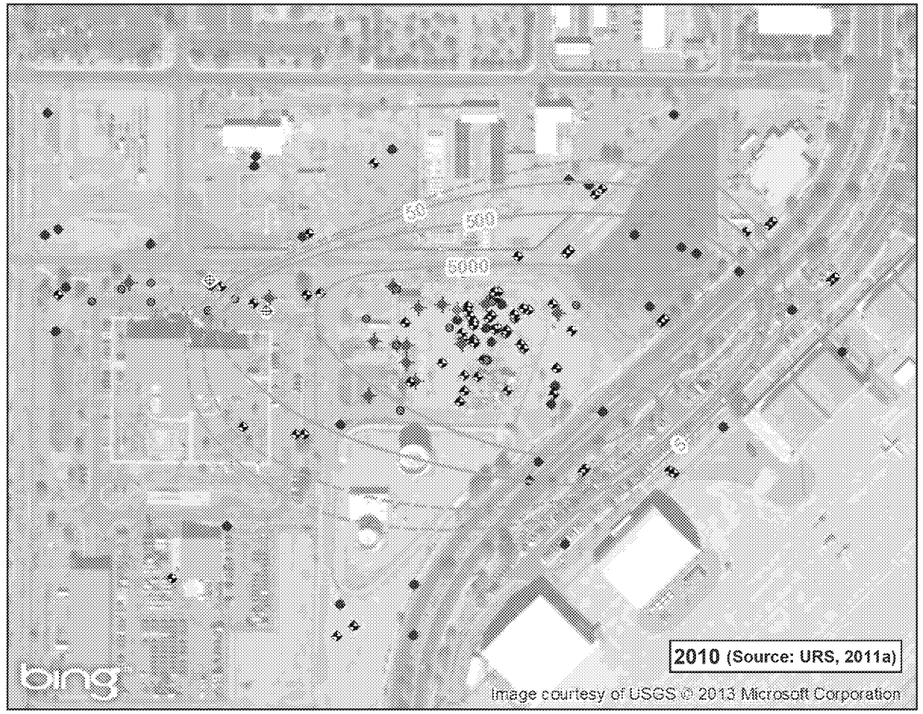
Benzene is plotted across UWBZ and LSZ.



Benzene is plotted across UWBZ and LSZ.



Benzene contour represents estimated extent of benzene plume based on 2005 annual monitoring report.
Individual well data unavailable. Benzene is plotted across UWBZ and LSZ.



Benzene is plotted in the LSZ.

Legend

- Benzene (µg/L)

ST012 Wells:

- Monitoring
- Extraction
- DPE
- SVE
- Borings
- Abandoned

0 150 300 Feet

N

Final
ROD Amendment 2, OU-2 (ST012)
Former Williams Air Force Base
Mesa, Arizona

Benzene Plume Concentrations Over Time

FIGURE 4-1

Job No. 9101110001
PM: EW
Date: 9/3/2013
Scale: 1" = 300 feet

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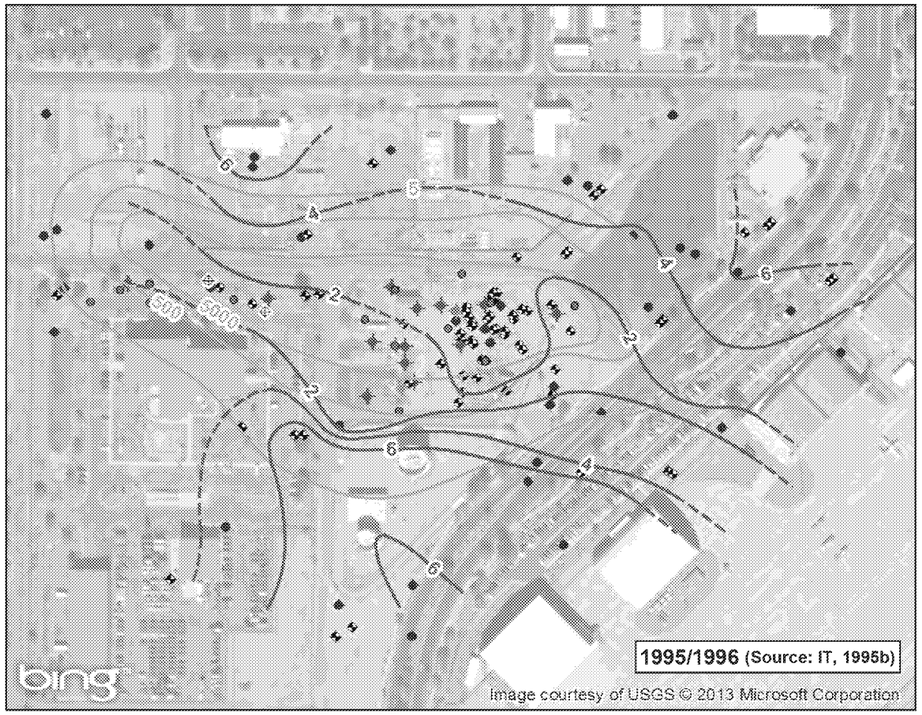
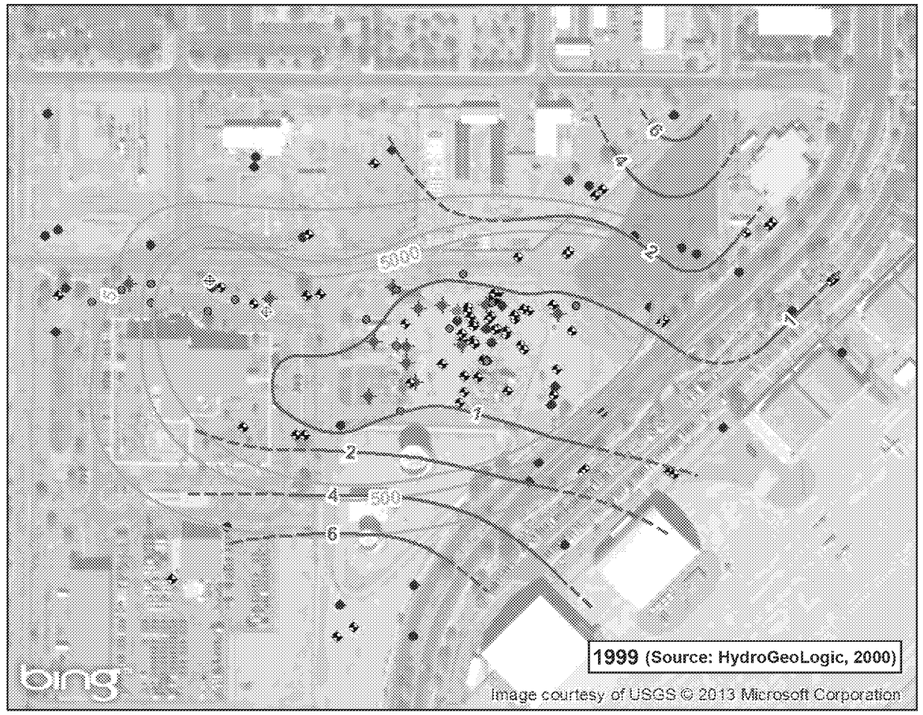
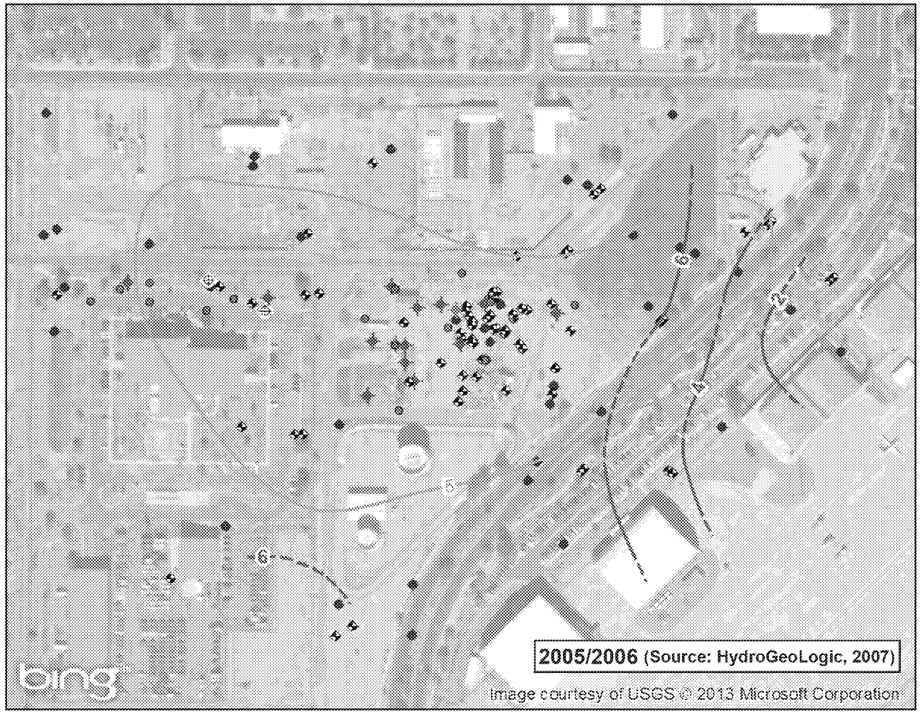


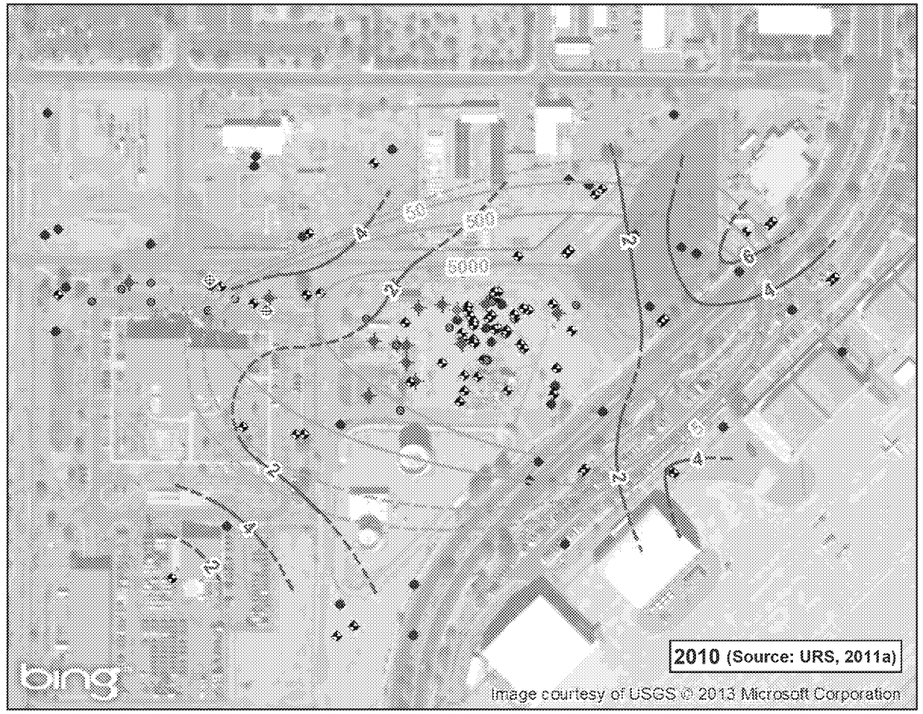
Benzene and DO are plotted across UWBZ and LSZ.



Benzene and DO are plotted across UWBZ and LSZ.



Benzene contour represents estimated extent of benzene plume based on 2005 annual monitoring report.
Individual well data unavailable. Benzene and DO are plotted across UWBZ and LSZ.



Benzene is plotted in the LSZ. DO is plotted across LSZ and UMBZ.

Legend

- DO (mg/L)
- Benzene (µg/L)

ST012 Wells:

- Monitoring
- Extraction
- DPE
- SVE
- Borings
- Abandoned

0 150 300 Feet

N

Final
ROD Amendment 2, OU-2 (ST012)
Former Williams Air Force Base
Mesa, Arizona

Benzene Plume and DO Concentrations

FIGURE **4-2**

Job No. 9101110001
PM: EW
Date: 9/3/2013
Scale: 1" = 300 feet

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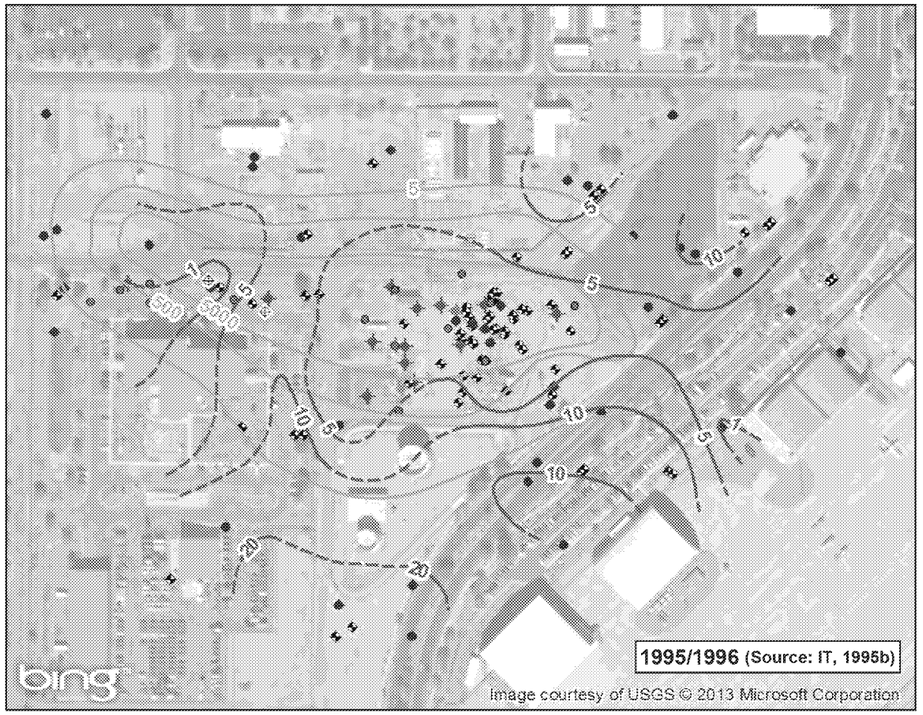
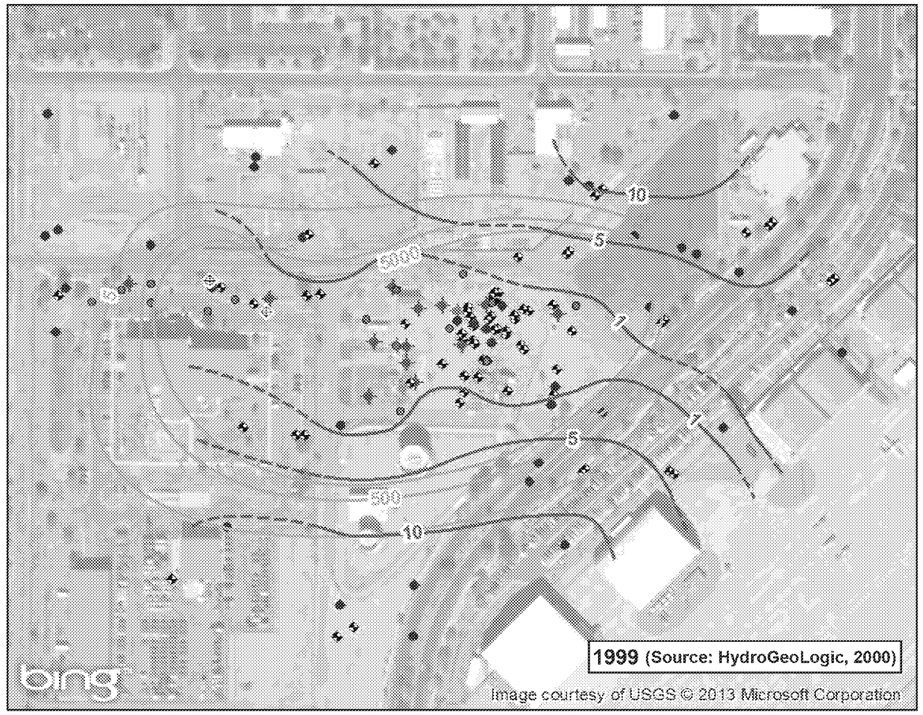
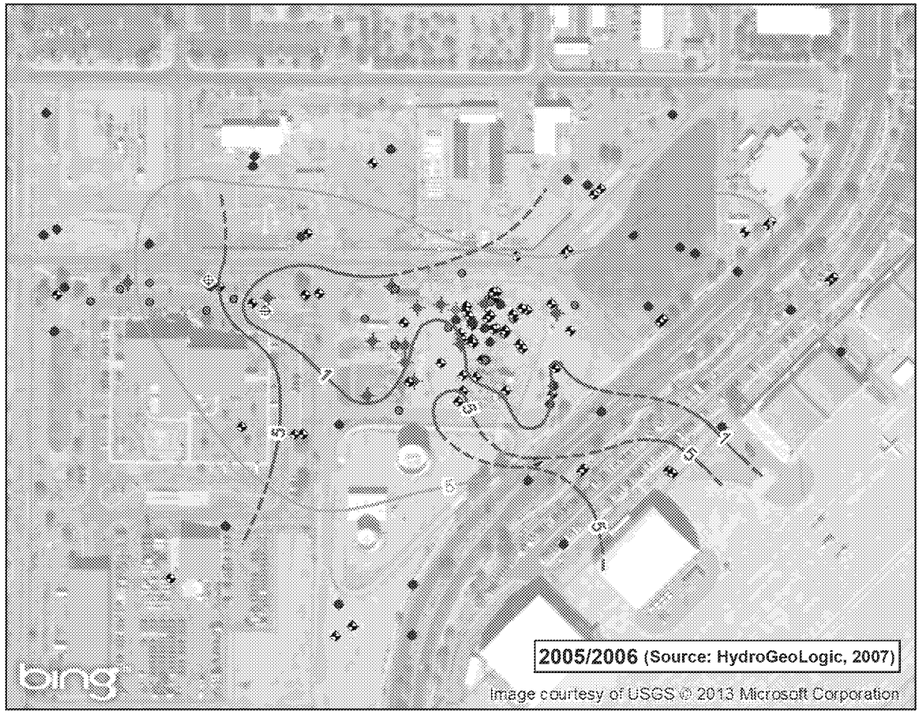


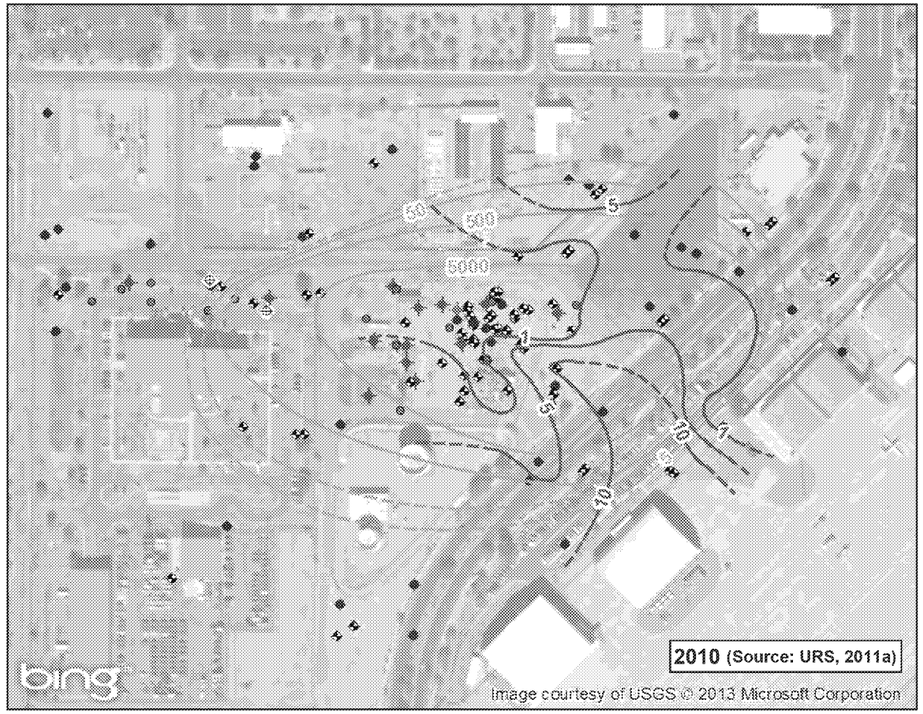
Benzene and Nitrate are plotted across UWBZ and LSZ.



Benzene and Nitrate are plotted across UWBZ and LSZ.



Benzene contour represents estimated extent of benzene plume based on 2005 annual monitoring report.
Individual well data unavailable. Benzene and Nitrate are plotted across UWBZ and LSZ.



Benzene is plotted in the LSZ. Nitrate is plotted across LSZ and UMBZ.

Legend

- Benzene (µg/L)
- Nitrate (mg/L)

ST012 Wells:

- Monitoring
- Extraction
- DPE
- SVE
- Borings
- Abandoned

0 150 300 Feet

N

Final
ROD Amendment 2, OU-2 (ST012)
Former Williams Air Force Base
Mesa, Arizona

Benzene Plume and Nitrate Concentrations

FIGURE **4-3**

Job No. 9101110001
PM: EW
Date: 9/3/2013
Scale: 1" = 300 feet

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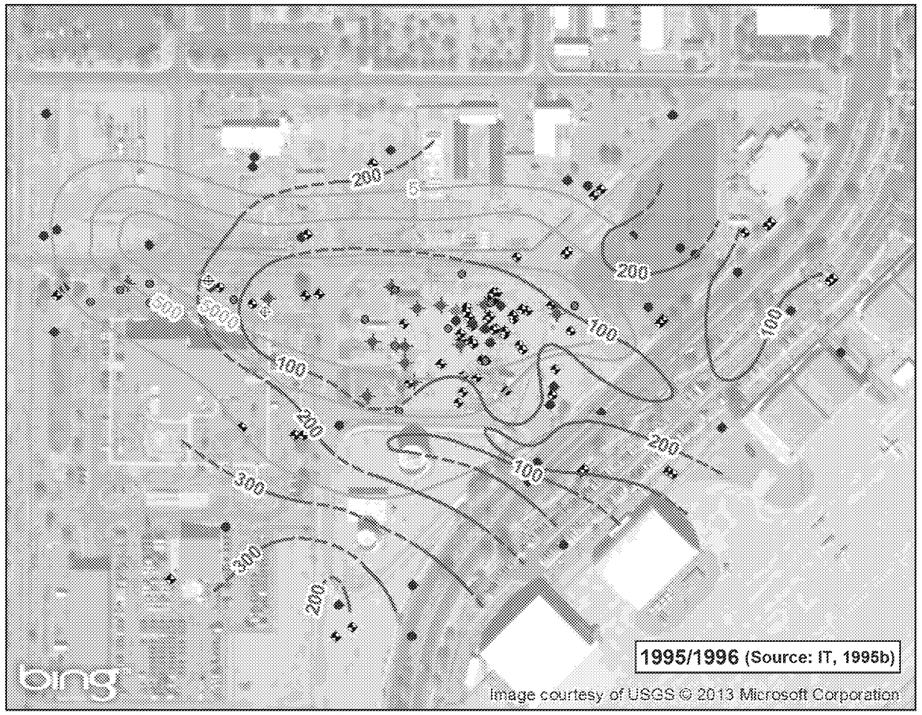
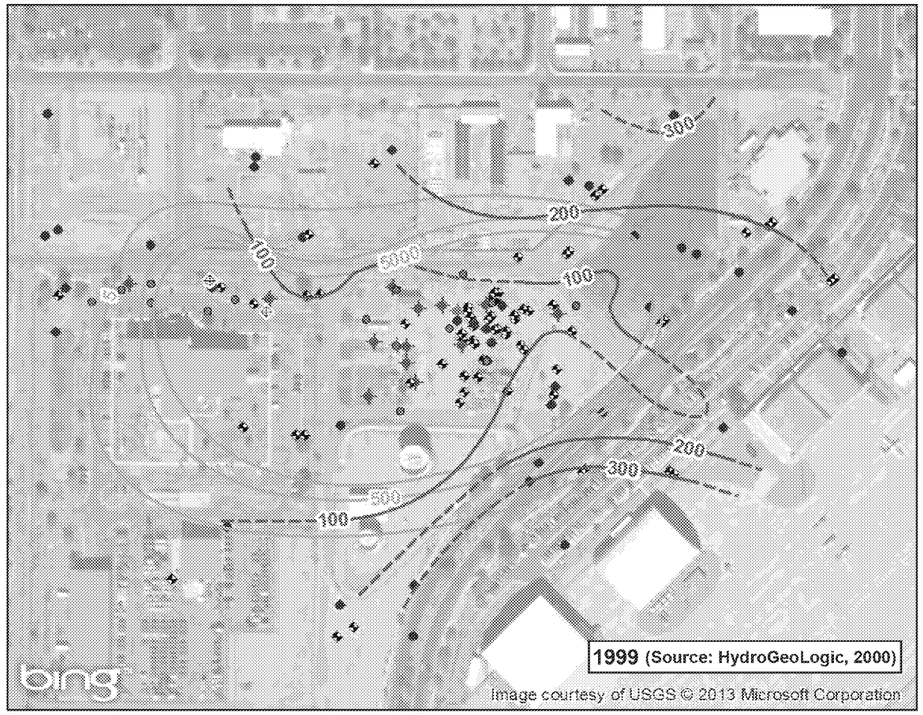
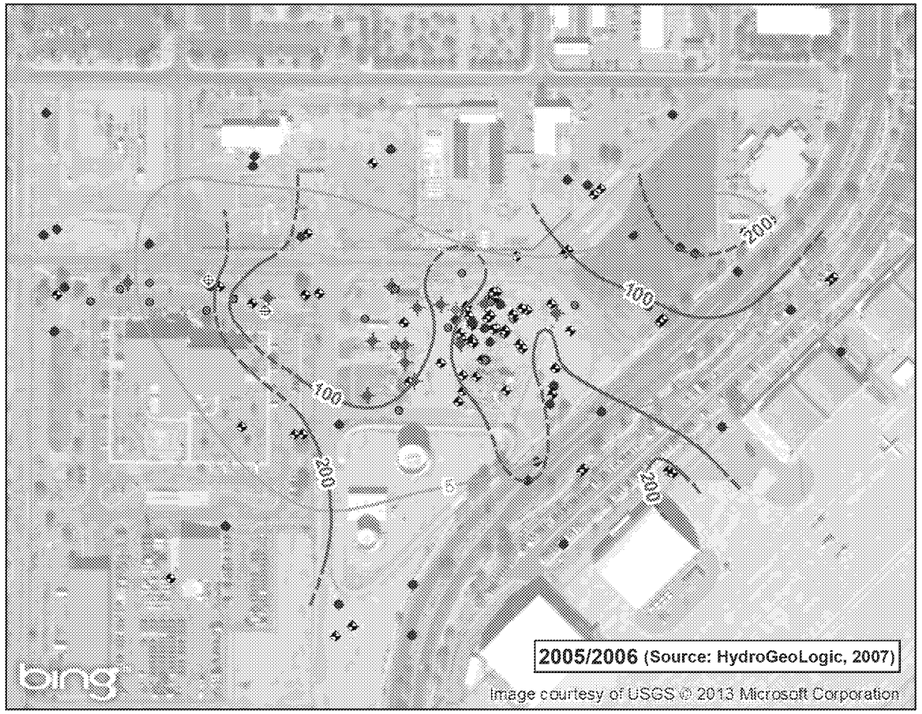
Document: P:\Projects\Williams AFB\GIS\MapDocuments\ST012\FFS\Benzene_4frame_AZ_Template_11x17LS.mxd PDF: P:\Projects\Williams AFB\ST012\ROD\ROD Amend 2\ROD Amend 2 Fig 2-4.pdf 4/1/2013 10:30 AM michael washburn



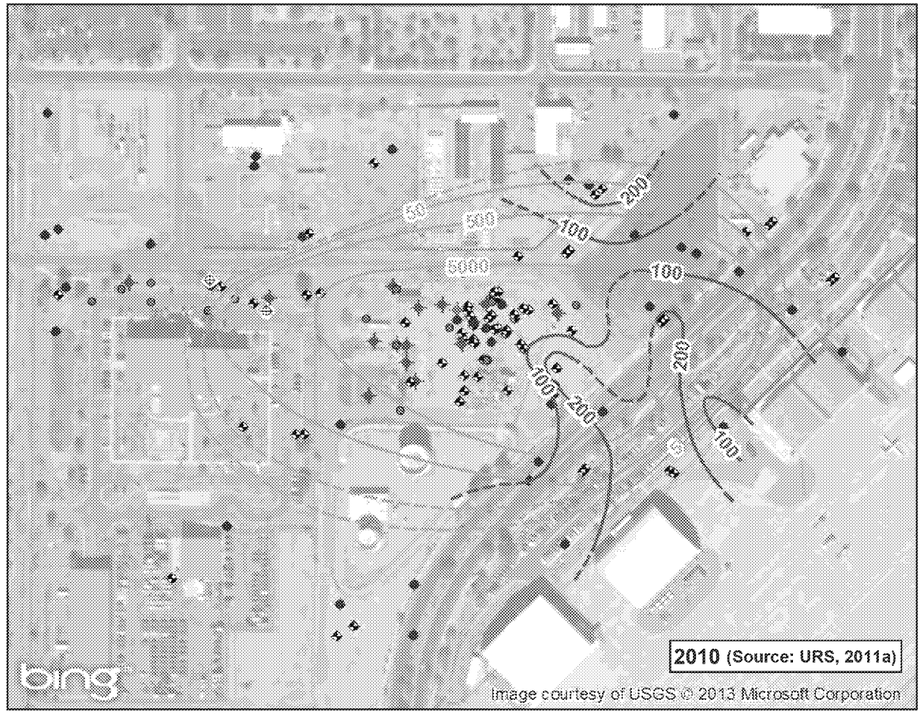
Benzene and Sulfate are plotted across UWBZ and LSZ.



Benzene and Sulfate are plotted across UWBZ and LSZ.



Benzene contour represents estimated extent of benzene plume based on 2005 annual monitoring report.
Individual well data unavailable. Benzene and Sulfate are plotted across UWBZ and LSZ.



Benzene is plotted in the LSZ. Sulfate is plotted across LSZ and UMBZ.

Legend

- Benzene (µg/L)
- Sulfate (mg/L)

ST012 Wells:

- Monitoring
- Extraction
- DPE
- SVE
- Borings
- Abandoned

0 150 300 Feet

N

Final
ROD Amendment 2, OU-2 (ST012)
Former Williams Air Force Base
Mesa, Arizona

Benzene Plume and Sulfate Concentrations

FIGURE 4-4

Job No. 9101110001
PM: EW
Date: 9/3/2013
Scale: 1" = 300 feet

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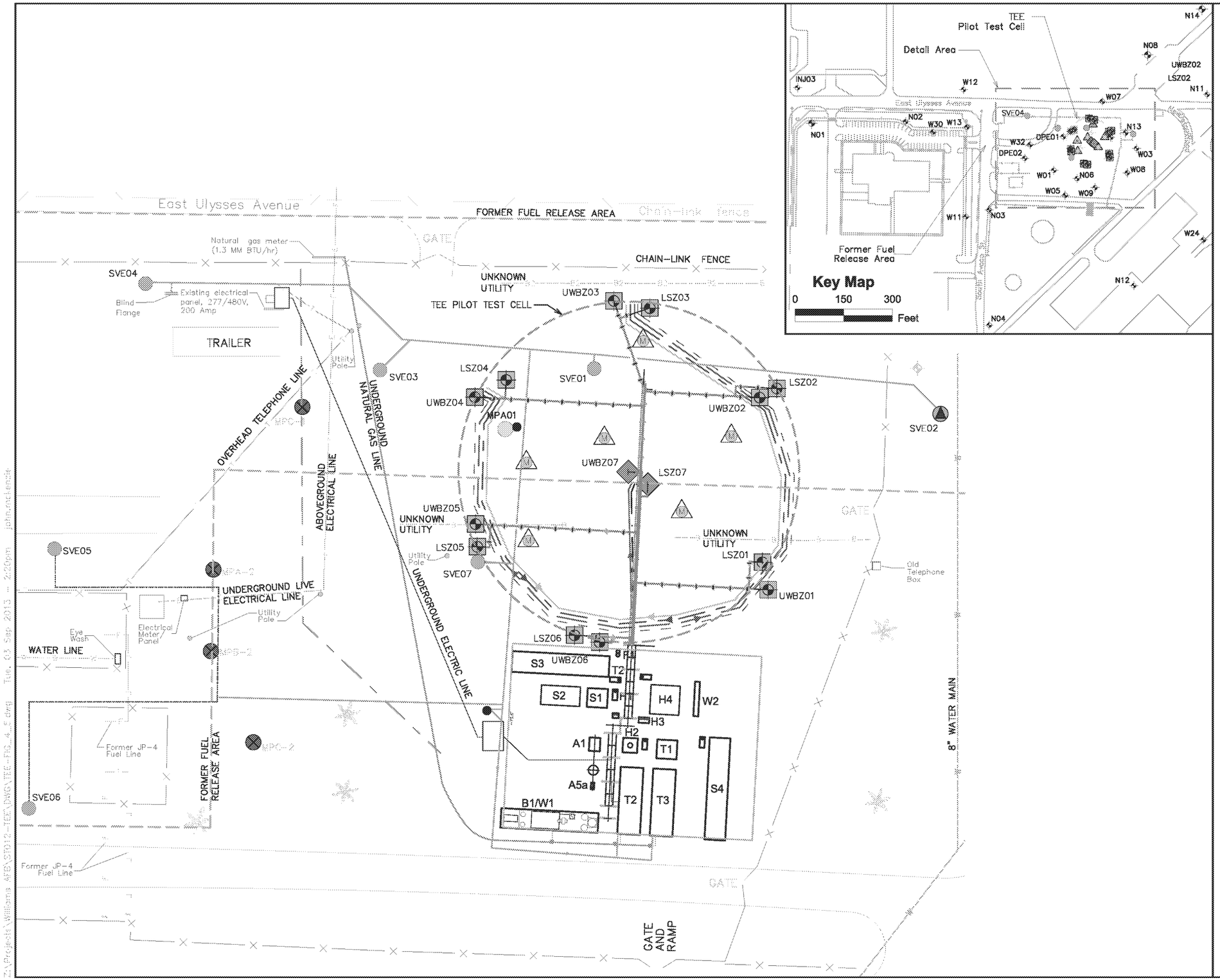
Document: P:\Projects\Williams AFB\GIS\MapDocuments\ST012\FFS\Benzene_4frame_AZ_Template_11x17LS.mxd PDF: P:\Projects\Williams AFB\ST012\ROD\ROD Amend 2\ROD Amend 2 Fig 2-5.pdf 4/1/2013 10:35 AM michael.washburn



Legend

- Existing Well
- Decommissioned Well
- TEE Pilot Test Monitoring Well Cluster/Nest
- Existing TEE Pilot Test Extraction Well
- Existing SVE Well
- Existing Monitoring Point
- Decommisioned Monitoring Point
- Tee Pilot Test Injection Well

A1	Air Compressor
A5	Positive Displacement Blower
B1	Boiler
F1	Water Filter
H1, H3	Heat Exchanger
H2	Direct Contact Condenser
H4	Cooling Tower
S1	Oil/water Separator
S2	NAPL Storage Tank
S3	Accumulation Tank
S4	Effluent Water Retention Tank
T1	Air Stripper
T2	Flame Oxidizer
T3	Thermal Oxidizer
W1	Water Softener
W2	Water Softener

Notes:

1. Wells MPA01, MPB01, N07, and W33 have been decommissioned.
2. Well MPB01 (decommissioned) corresponds in location with TEE system well MWN01C.

0 20 40 Feet

Source: BEM, 2007

N

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Mesa, Arizona

Pilot Test Layout

FIGURE 4-5

Job No.	9101110001
PM:	EW
Date:	08/30/2013
Scale:	1"=40 Feet

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APPENDIX A

CHEMICALS IDENTIFIED IN GROUNDWATER MONITORING WELLS AT OU-2

APPENDIX A-1

TABLE A-1: CHEMICALS IDENTIFIED IN GROUNDWATER MONITORING WELLS AT OU-2

Table A-1 Chemicals Identified in Groundwater Monitoring Wells at OU-2

Constituent	From OU-2 ROD, Table 4-4[7]				November 2011 Groundwater Monitoring[8]			
	IT Investigations		AV Investigations					
	Frequency of Detection[1]	Range of Detected Concentrations (mg/L)	Frequency of Detection[1]	Range of Detected Concentrations (mg/L)	Frequency of Detection	Range of Detected Concentrations (mg/L)	Monitoring Well Location of Highest Concentration	Average Concentration[9] (mg/L)
Organics								
Acetone	1/69	0.033	--[6]	--[6]	--[5]	--[5]	--[5]	--[5]
Benzene	104/133	0.0006-24.0	5/9	0.0014-12.0	15/28	0.000133F-8.69	ST012-RB-2C	1.3
Bis(2-ethylhexyl)phthalate	8/76	0.002-0.028	--[6]	--[6]	1/28	0.00412F	ST012-C05	0.004
Bis(2-chloroethyl)ether	1/76	0.140	--[6]	--[6]	--[5]	--[5]	--[5]	--[5]
Chlorobenzene	--[6]	--[6]	1/9	0.0006	--[5]	--[5]	--[5]	--[5]
Dibenzofuran	1/76	0.300	--[6]	--[6]	--[5]	--[5]	--[5]	--[5]
1,4-Dichlorobenzene	--[6]	--[6]	1/9	0.0036	--[5]	--[5]	--[5]	--[5]
1,2-Dichloroethane	3/77	0.0008-0.016	--[6]	--[6]	1/28	0.000263F	ST012-W38	0.0003
2,4-Dimethylphenol	4/76	0.002-0.015	--[6]	--[6]	--[5]	--[5]	--[5]	--[5]
Ethyl Benzene	55/133	0.0005-3.5	4/9	0.0011-2.8	11/28	0.000374F-1.04	ST012-W13	0.4
Methylene Chloride	3/77	0.260-0.282	--[6]	--[6]	--[5]	--[5]	--[5]	--[5]
2-Methylnaphthalene	10/76	0.006-10.0	--[6]	--[6]	6/28	0.006B-0.030	ST012-W13	0.02
2-Methylphenol	6/76	0.002-0.14	--[6]	--[6]	--[5]	--[5]	--[5]	--[5]
4-Methylphenol	4/76	0.006-0.073	--[6]	--[6]	1/28	0.00301F	ST012-RB-2C	0.003
Naphthalene	15/77	0.004-7.2	--[6]	--[6]	9/28	0.000367F-0.103	ST012-W13	0.4
2-Nitrophenol	1/76	0.017	--[6]	--[6]	--[5]	--[5]	--[5]	--[5]
4-Nitrophenol	2/76	0.008-0.018	--[6]	--[6]	--[5]	--[5]	--[5]	--[5]
Phenol	13/76	0.011-0.18	--[6]	--[6]	5/28	0.00281-0.017	ST012-RB-1A	0.008
Tetrachloroethene	3/70	0.005-0.0012	--[6]	--[6]	4/28	0.000257F-0.000574F	ST012-U38	0.0005
Toluene	24/133	0.086-24.0	4/9	0.048-21.0	8/28	0.000379F-5.02	ST012-RB-2C	0.8
1,1,1-Trichloroethane	1/77	0.0008	--[6]	--[6]	--[5]	--[5]	--[5]	--[5]
Trichlorofluoromethane	4/77	0.0007-0.0022	--[6]	--[6]	--[5]	--[5]	--[5]	--[5]
Xylenes (total)	78/133	0.0006-9.8	4/9	0.016-5.9	11/28	0.000938F-1.646[4]	ST012-W37	0.5
Total Petroleum Hydrocarbons								
TPH	71/175	0.6-80,000.0	--[6]	--[6]	12/28	0.0525F-31.0[3]	ST012-RB-2C	9.0
Metals								
Antimony	5/75	0.012-0.433	--[6]	--[6]	1/28	0.000559F	ST012-W12	0.0006
Arsenic	4/75	0.0013-0.0015	--[6]	--[6]	--[5]	--[5]	--[5]	--[5]
Beryllium	1/75	0.0085	--[6]	--[6]	--[5]	--[5]	--[5]	--[5]
Cadmium	3/75	0.018-0.030	--[6]	--[6]	--[5]	--[5]	--[5]	--[5]
Chromium	21/75	0.0042-54.5	--[6]	--[6]	11/28	0.00132F-0.41	ST012-W26	0.05
Copper	14/75	0.0085-0.5	--[6]	--[6]	5/28	0.00159F-0.011	ST012-W26	0.004
Lead	17/75	0.0011-0.079	6/10	0.004-0.017	3/28	0.000526F-0.00063F	ST012-W26	0.0006
Mercury	6/76	0.00012-0.17[2]	--[6]	--[6]	--[5]	--[5]	--[5]	--[5]

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Constituent	From OU-2 ROD, Table 4-4[7]				November 2011 Groundwater Monitoring[8]			
	IT Investigations		AV Investigations					
	Frequency of Detection[1]	Range of Detected Concentrations (mg/L)	Frequency of Detection[1]	Range of Detected Concentrations (mg/L)	Frequency of Detection	Range of Detected Concentrations (mg/L)	Monitoring Well Location of Highest Concentration	Average Concentration[9] (mg/L)
Nickel	20/75	0.010-4.99	--[6]	--[6]	25/28	0.00375F-0.416	ST012-W29	0.04
Selenium	5/76	0.02-0.04	--[6]	--[6]	--[5]	--[5]	--[5]	--[5]
Silver	7/75	0.0029-0.111	--[6]	--[6]	--[5]	--[5]	--[5]	--[5]
Uranium	--[6]	--[6]	4/10	0.002-0.005	--[5]	--[5]	--[5]	--[5]
Zinc	50/75	0.0059-3.969	--[6]	--[6]	6/28	0.0131F-0.0308	ST012-U13	0.02

Notes:
[1]If the concentration of the detected chemical is less than ten (for common laboratory contaminants) or five times the concentration found in any blank, the chemical was not considered a detection.
[2]Mercury was also detected in an associated blank for this sample. The highest concentration detected in a sample without blank contamination was 0.0018 mg/L.
[3]Results listed are the sum of gasoline range organics (GRO) and diesel range organics (DRO). If GRO or DRO was not detected, the sum was calculated using a value of zero.
[4]Results listed are the sum of analytical results for meta- and para-xylenes plus analytical results for ortho-xylene. If either xylene analysis was reported as not detected, the sum was calculated using a value of zero.
[5]Analyte is not part of the routine annual groundwater monitoring program based on recommendations from past monitoring events, generally due to limit detections or associated risk.
[6]Analyte was not evaluated as part of investigation.
[7]Source: IT, 1992d.
[8]Source: URS, 2012a
[9]Average concentrations from the November 2011 sampling event include detected concentrations only.
B - Sample concentration is similar to that found in an associated blank.
F - The analyte was positively identified, but the associated concentration is an estimation above the detection limit and below the reporting limit.

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APPENDIX A-2

HISTORICAL ANALYTICAL SUMMARY TABLES
TABLES 3-7 THROUGH 3-10 OF THE ST012 ANNUAL GROUNDWATER MONITORING REPORT (URS, APRIL 2012)

Table 3-7. Site ST012 Historical TPH Analytical Summary

Well ID	Analyte (Units)	TPH-GRO (mg/L)	TPH-DRO [b] (mg/L)
	OU-2 ROD Action Level [a]	--	--
	Sample Date	Result (mg/L)	Result (mg/L)
ST012-C01	Jan-09	<0.0450 U	<0.278 U
	Nov-09	**0.123**	<0.250 U
	Nov-10	**0.0940 FB**	<0.0200 U
	Nov-11	<0.0450 UML	<0.269 U
ST012-C02	Jan-09	**1.11**	**13.7**
	Nov-09	**0.825**	**8.74 MH**
	Nov-10	**0.613 JH**	**9.02 JL**
	Nov-11	**0.234**	**12.2**
ST012-C03	Jan-09	<0.0450 U	<0.278 U
	Nov-09	**0.182**	<0.269 U
	Nov-10	**0.0920 FB**	<0.0200 U
	Nov-11	<0.0450 UML	<0.250 U
ST012-C04	Jan-09	<0.0450 U	<0.265 U
	Nov-09	**0.0634 F**	<0.0200 U
	Nov-10	**0.0800 FB**	<0.0200 U
	Nov-11	<0.0450 U	<0.269 U
ST012-C05	Jan-09	<0.0450 U	<0.255 U
	Nov-09	<0.0450 U	<0.250 U
	Nov-10	**0.124 FB**	**0.0509 F**
	Nov-11	<0.0450 UML	<0.272 U
ST012-N01[c]	Jul-06	**0.0110 FB**	<0.030 U
	Jan-08	<0.00490 U	<0.0330 U
	Jan-09	NS	NS
	Nov-09	NS	NS
ST012-N02[c]	Jan-08	**0.00640 FB**	<0.0330 U
	Jan-09	NS	NS
	Nov-09	NS	NS
ST012-N03[c]	Jan-08	**1.20**	**6.60**
	Jan-09	**1.54**	**4.68**
	Nov-09	<0.0450 U	<0.250 U
ST012-N04[c]	Jul-06	**0.00860 FB**	<0.030 U
	Jan-08	**0.00780 FB**	<0.0330 U
	Jan-09	NS	NS
	Nov-09	NS	NS
ST012-N05[c]	Jul-06	**2.50**	**12.0**
	Jan-08	**1.10 JH**	**11.0**
	Jan-09	**0.626**	**6.99**
	Nov-09	<0.0450 U	<0.250 U
ST012-N06	Jan-08	**15.0**	**11.0**
	Jan-09	**13.5**	**14.0**
	Nov-09	**8.80**	**50.7 MH**
	Nov-10	NS	NS
	Nov-11	NS	NS
ST012-N08[c]	Jul-06	**0.0110 FB**	<0.030 U
	Jan-08	**0.00820 FB**	<0.0330 U
	Jan-09	<0.0450 U	<0.255 U
	Nov-09	<0.0450 U	<0.250 U
ST012-N09[c]	Jul-06	**0.0140 FB**	--
	Jan-08	<0.00490 U	<0.0340 U

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Table 3-7. Site ST012 Historical TPH Analytical Summary (Continued)

Well ID	Analyte (Units)	TPH-GRO (mg/L)	TPH-DRO [b] (mg/L)
	OU-2 ROD Action Level [a]	--	--
	Sample Date	Result (mg/L)	Result (mg/L)
ST012-N09[c] (Continued)	Jan-09	<0.0450 U	<0.270 U
	Nov-09	<0.250 U	<0.250 U
ST012-N10[d]	Jul-06	**0.0220 FB**	<0.030 U
	Jan-08	NS	NS
ST012-N11[c]	Jan-08	**5.00**	**17.0**
	Jan-09	**4.00**	**20.4**
	Nov-09	**1.89**	**11.0 MH**
ST012-N12[c]	Jul-06	**0.0120 FB**	<0.030 U
	Jan-08	**0.0280 FB**	<0.0330 U
	Jan-09	<0.0450 U	<0.275 U
	Nov-09	<0.0450 U	<0.250 U
ST012-N13	Jan-08	**13.0**	**18.0**
	Jan-09	**15.5**	**38.3**
	Nov-09	**12.2**	**20.8 MH**
	Nov-10	NS	NS
	Nov-11	NS	NS
ST012-N14[c]	Jan-08	**0.00950 FB**	<0.0360 U
	Jan-09	<0.0450 U	<0.255 U
	Nov-09	**0.0973 FJH**	<0.255 U
ST012-N15[c]	Jul-06	**1.60**	**6.80**
	Jan-08	**1.20**	**8.40**
	Jan-09	**1.45**	**12.3**
	Nov-09	**1.52**	**12.3 MH**
ST012-RB-1A	Nov-10	**5.22**	**12.3**
	Nov-11	**1.76 B**	**2.51**
ST012-RB-2A	Nov-10	**1.24 JH**	**24.8**
	Nov-11	**0.673**	**9.56**
ST012-RB-2C	Nov-10	**34.7**	**5.05 JL**
	Nov-11	**27.3**	**3.66**
ST012-RB-3A	Nov-10	**0.0810 FB**	**0.112**
	Nov-11	<0.0450 UML	<0.266 U
ST012-U02	Nov-10	**0.133 FB**	**5.22**
	Nov-11	**0.758 ML**	**15.6**
ST012-U11	Nov-10	**0.0900 FB**	<0.0200 U
	Nov-11	<0.0450 U	<0.255 U
ST012-U12	Nov-10	**0.139 FB**	<0.0200 U
	Nov-11	<0.0450 UML	<0.250 U
ST012-U13	Nov-10	**0.266 B**	**0.0838**
	Nov-11	<0.0450 U	<0.250 U
ST012-U36	Nov-10	**0.0820 FB**	**0.315**
	Nov-11	<0.0450 U	<0.260 U
ST012-U37	Nov-10	**0.0630 FB**	**0.128**
	Nov-11	<0.0450 U	<0.255 U
ST012-U38	Nov-10	**0.0930 FB**	**0.0495 F**
	Nov-11	<0.0450 UML	<0.250 U
ST012-W05	Jan-08	**45.0**	**2.10**
	Jan-09	**38.0**	**3.38**
	Nov-09	**23.3**	**2.41 MH**
	Nov-10	NS	NS
	Nov-11	NS	NS

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Table 3-7. Site ST012 Historical TPH Analytical Summary (Continued)

Well ID	Analyte (Units)	TPH-GRO (mg/L)	TPH-DRO [b] (mg/L)
	OU-2 ROD Action Level [a]	--	--
	Sample Date	Result (mg/L)	Result (mg/L)
ST012-W07	Nov-10	**10.3**	**1.43**
	Nov-11	**4.54**	**0.825**
ST012-W11	Nov-10	**8.02**	**0.610**
	Nov-11	**2.97 B**	**0.343 F**
ST012-W12	Jan-08	**0.0940 FB**	<0.0330 U
	Jan-09	**0.947**	<0.241 U
	Nov-09	**0.325**	<0.250 U
	Nov-10	**0.0920 FB**	<0.0200 U
	Nov-11	**0.0528 F**	<0.272 U
ST012-W13	Nov-10	**7.32**	**1.22**
	Nov-11	**5.55**	**0.669**
ST012-W24	Nov-10	**0.0820 FB**	**0.0228 F**
	Nov-11	<0.0450 U	<0.255 U
ST012-W26	Nov-10	NS	NS
	Nov-11	<0.0450 U	<0.250 U
ST012-W27	Jul-06	**0.0190 FB**	**0.0330 F**
	Jan-08	**0.0260 FB**	<0.0330 U
	Jan-09	NS	NS
	Nov-09	NS	NS
	Nov-10	NS	NS
	Nov-11	NS	NS
ST012-W29	Nov-10	**0.0790 FB**	<0.0200 U
	Nov-11	<0.0450 U	<0.250 U
ST012-W34	Nov-10	**0.102 FB**	<0.0200 U
	Nov-11	<0.0450 U	<0.260 U
ST012-W35	Nov-10	**0.0730 FB**	<0.0200 U
	Nov-11	**0.0525 F**	<0.255 U
ST012-W36	Nov-10	**3.67**	**0.345**
	Nov-11	**4.82**	<0.255 U
ST012-W37	Nov-10	**14.8**	**1.09**
	Nov-11	**14.0**	**0.414 F**
ST012-W38	Nov-10	**0.0860 FB**	**0.208**
	Nov-11	<0.0450 UML	<0.269 U

[a] Source: ***Final Record of Decision*** (ROD) ***Operable Unit*** (OU)-*2* (IT Corporation [IT], December 1992).
[b] The carbon series C_{10}-C_{22} are reported as the diesel range organics (DRO) results for January 2009, November 2009, and November 2010. In November 2011, the carbon series C_{10}-C_{32} are reported as the DRO results. The analytical laboratory did not specify the carbon series for the DRO results in July 2006 and January 2008.
[c] Well was decommissioned between January to March 2010.
[d] Well was decommissioned in November 2008.
Results with positive detections are **bolded**.
-- Data not available.
B - Sample concentration is similar to that found in an associated blank.
F - The analyte was positively identified, but the associated concentration is an estimation above the detection limit and below the reporting limit.
H - The result is biased high.
J - The analyte was positively identified, but the quantitation is an estimation.
L - The result is biased low.
M - The concentration is estimated because of a matrix effect.
U - The analyte was analyzed for, but not detected above the detection limit shown.
DRO - Diesel range organics.
GRO - Gasoline range organics.
ID - Identification.
mg/L - Milligrams per liter.
NS - Not sampled.
TPH - Total petroleum hydrocarbons.

ED_005025_00013684-00070

Table 3-8. Site ST012 Historical VOC Analytical Summary

Well ID	Analyte (Units)	1,2-Dichloroethane (µg/L)	Benzene (µg/L)	Ethylbenzene (µg/L)	Methylene Chloride (µg/L)	Naphthalene (µg/L)	Tetrachloroethene (µg/L)	Toluene (µg/L)	TFM (µg/L)	Total Xylenes (µg/L)
	OU-2 ROD Action Level [a]	5	5	700	5	28	5	1,000	2,100	10,000
	Sample Date	Result	Result	Result	Result	Result	Result	Result	Result	Result
ST012-C01	Jan-09	NR	<0.125 U	<0.250 U	<0.250 U	<0.200 U	<0.250 U	<0.250 U	NR	<0.500 U
	Nov-09	<0.250 U	**2.34**	**0.339 F**	<0.250 U	**0.447 F**	<0.250 U	<0.250 U	NR	<0.500 U
	Nov-10	<0.100 U	**0.270 F**	<0.0900 U	NR	<0.200 U	**0.0800 F**	**0.180 FB**	NR	**1.27 F**
	Nov-11	<0.250 U	<0.125 U	<0.250 U	NR	<0.200 U	<0.250 U	<0.250 U	NR	<0.500 U
ST012-C02	Jan-09	NR	**1.07**	**12.3**	<0.250 U	**6.31**	<0.250 U	**0.797 F**	NR	**17.2**
	Nov-09	<0.250 U	**1.02**	**1.05**	<0.250 U	<0.200 U	<0.250 U	<0.250 U	NR	**0.715 F**
	Nov-10	**0.290 F**	**0.720**	<0.0900 U	NR	<0.200 U	**0.130 F**	**0.160 F**	NR	**0.860 F**
	Nov-11	<0.250 U	**0.143 F**	<0.250 U	NR	<0.200 U	<0.250 U	<0.250 U	NR	<0.500 U
ST012-C03	Jan-09	NR	<0.125 U	<0.250 U	<0.250 U	<0.200 U	<0.250 U	**0.357 F**	NR	<0.500 U
	Nov-09	<0.250 U	**6.65**	**0.943 F**	<0.250 U	**0.782 F**	<0.250 U	<0.250 U	NR	**0.632 F**
	Nov-10	<0.100 U	**0.170 F**	<0.0900 U	NR	<0.200 U	<0.0800 U	**0.170 FB**	NR	**0.960 F**
	Nov-11	<0.250 U	<0.125 U	<0.250 U	NR	<0.200 U	<0.250 U	<0.250 U	NR	<0.500 U
ST012-C04	Jan-09	NR	<0.125 U	<0.250 U	<0.250 U	<0.200 U	<0.250 U	<0.250 U	NR	<0.500 U
	Nov-09	<0.250 U	**0.223 F**	**1.08**	<0.250 U	**0.225 F**	<0.250 U	<0.250 U	NR	<0.500 U
	Nov-10	<0.100 U	<0.100 U	<0.0900 U	NR	<0.200 U	<0.0800 U	<0.0700 U	NR	**0.380 F**
	Nov-11	<0.250 U	<0.125 U	<0.250 U	NR	<0.200 U	**0.539 F**	<0.250 U	NR	<0.500 U
ST012-C05	Jan-09	NR	<0.125 U	<0.250 U	<0.250 U	<0.200 U	<0.250 U	<0.250 U	NR	<0.500 U
	Nov-09	<0.250 U	<0.125 U	<0.250 U	<0.250 U	<0.200 U	**0.348 F**	<0.250 U	NR	<0.500 U
	Nov-10	<0.100 U	**0.460 F**	<0.0900 U	NR	<0.200 U	<0.0800 U	**0.190 FB**	NR	**2.44**
	Nov-11	<0.250 U	<0.125 U	<0.250 U	NR	<0.200 U	<0.250 U	<0.250 U	NR	<0.500 U
ST012-N01[b]	Jul-06	NR	<0.130 U	<0.010 U	<0.210 U	NR	<0.140 U	<0.070 U	NR	<0.100 U
	Jan-08	<0.0680 U	<0.130 U	<0.0990 U	<0.210 U	<0.250 U	<0.140 U	<0.0680 U	NR	<0.100 U
	Jan-09	NS	NS	NS	NS	NS	NS	NS	NS	NS
	Nov-09	NS	NS	NS	NS	NS	NS	NS	NS	NS
ST012-N02[b]	Jan-08	<0.0680 U	<0.130 U	<0.0990 U	<0.210 U	<0.250 U	<0.140 U	<0.0680 U	NR	<0.100 U
	Jan-09	NS	NS	NS	NS	NS	NS	NS	NS	NS
	Nov-09	NS	NS	NS	NS	NS	NS	NS	NS	NS
ST012-N03[b]	Jan-08	<0.0680 U	**140**	**0.930 F**	**0.340 F**	**4.99 MH**	<0.140 U	**0.250 F**	NR	**8.50**
	Jan-09	NR	**223**	**31.3**	<0.250 U	**38.1**	<0.250 U	**1.60**	NR	**22.0**
	Nov-09	<0.250 U	**0.552**	<0.250 U	<0.250 U	<0.200 U	<0.250 U	<0.250 U	NR	<0.500 U
ST012-N04[b]	Jul-06	NR	<0.130 U	<0.010 U	**0.220 FB**	NR	<0.140 U	<0.070 U	NR	<0.100 U
	Jan-08	<0.0680 U	**0.790**	**0.250 F**	<0.210 U	<0.250 U	<0.140 U	<0.0680 U	NR	**0.550 F**
	Jan-09	NS	NS	NS	NS	NS	NS	NS	NS	NS
	Nov-09	NS	NS	NS	NS	NS	NS	NS	NS	NS
ST012-N05[b]	Jul-06	NR	**3.60**	**0.630 F**	**0.390 FB**	NR	<0.140 U	**0.410 F**	NR	**3.90**
	Jan-08	<0.0680 U	**1.70**	**0.320 F**	<0.210 U	<0.250 UM	<0.140 U	**0.420 F**	NR	**0.650 F**
	Jan-09	NR	**0.674**	<0.250 U	<0.250 U	<0.200 U	<0.250 U	**0.487 F**	NR	<0.500 U

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Table 3-8. Site ST012 Historical VOC Analytical Summary (Continued)

Well ID	Analyte (Units)	1,2-Dichloroethane (µg/L)	Benzene (µg/L)	Ethylbenzene (µg/L)	Methylene Chloride (µg/L)	Naphthalene (µg/L)	Tetrachloroethene (µg/L)	Toluene (µg/L)	TFM (µg/L)	Total Xylenes (µg/L)
	OU-2 ROD Action Level [a]	5	5	700	5	28	5	1,000	2,100	10,000
	Sample Date	Result	Result	Result	Result	Result	Result	Result	Result	Result
ST012-N05[b] (Continued)	Nov-09	<0.250 U	<0.125 U	<0.250 U	<0.250 U	<0.200 U	<0.250 U	<0.250 U	NR	<0.500 U
ST012-N06	Jan-08	**54.0**	**1,700**	**670**	**1.50 F**	**193**	<0.720 U	<0.340 U	NR	**2,360**
	Jan-09	NR	**1,010**	**586**	<0.250 U	**242**	<0.250 U	**207**	NR	**1,780**
	Nov-09	<1.25 U	**652**	**457**	**1.64 FB**	**84.3**	<1.25 U	**530**	NR	**780**
	Nov-10	NS	NS	NS	NS	NS	NS	NS	NS	NS
	Nov-11	NS	NS	NS	NS	NS	NS	NS	NS	NS
ST012-N08[b]	Jul-06	NR	<0.130 U	<0.010 U	<0.210 U	NR	**0.240 F**	<0.070 U	NR	<0.100 U
	Jan-08	<0.0680 U	<0.130 U	<0.0990 U	**0.350 F**	<0.250 UM	**0.460 F**	**0.190 F**	NR	<0.100 U
	Jan-09	NR	<0.125 U	<0.250 U	<0.250 U	<0.200 U	**0.470 F**	<0.250 U	NR	<0.500 U
	Nov-09	<0.250 U	**0.184 F**	<0.250 U	<0.250 U	<0.200 U	**0.518 F**	<0.250 U	NR	<0.500 U
ST012-N09[b]	Jul-06	NR	<0.130 U	<0.010 U	**0.290 FB**	NR	<0.140 U	<0.070 U	NR	<0.100 U
	Jan-08	<0.0680 U	<0.130 U	<0.0990 U	<0.210 U	<0.250 U	<0.140 U	<0.0680 U	NR	<0.100 U
	Jan-09	NR	<0.125 U	<0.250 U	<0.250 U	<0.200 U	**0.295 F**	**0.312 F**	NR	<0.500 U
	Nov-09	<0.250 U	<0.125 U	<0.250 U	<0.250 U	<0.200 U	**1.29**	<0.250 U	NR	<0.500 U
ST012-N10[c]	Jul-06	NR	<0.130 U	<0.010 U	**0.290 FB**	NR	<0.140 U	<0.070 U	NR	<0.100 U
	Jan-08	NS	NS	NS	NS	NS	NS	NS	NS	NS
ST012-N11[b]	Jan-08	<0.340 U	**1,200**	**8.90**	<1.10 U	**97.0 MH**	<0.720 U	<0.340 U	NR	**6.90**
	Jan-09	NR	**1,290**	**19.9**	<2.50 U	**165**	<2.50 U	<2.50 U	NR	<5.00 U
	Nov-09	<0.500 U	**319**	**5.17**	**0.662 FB**	**4.18**	<0.500 U	**0.883 F**	NR	**3.89**
ST012-N12[b]	Jul-06	NR	<0.130 U	<0.010 U	**0.290 FB**	NR	<0.140 U	<0.070 U	NR	<0.100 U
	Jan-08	<0.0680 U	<0.130 U	<0.0990 U	<0.210 U	<0.250 U	<0.140 U	<0.0680 U	NR	<0.100 U
	Jan-09	NR	<0.125 U	<0.250 U	<0.250 U	<0.200 U	<0.250 U	<0.250 U	NR	<0.500 U
	Nov-09	<0.250 U	<0.125 U	<0.250 U	<0.250 U	<0.200 U	<0.250 U	<0.250 U	NR	<0.500 U
ST012-N13	Jan-08	<0.340 U	**1,400**	**88.0**	**1.30 F**	**203 MH**	<0.720 U	**410**	NR	**1,510**
	Jan-09	NR	**1,700**	**185**	<2.50 U	**400**	<2.50 U	**809**	NR	**2,180**
	Nov-09	<2.50 U	**2,560**	**671**	**3.91 F**	**149 J**	<2.50 U	**623**	NR	**1,160**
	Nov-10	NS	NS	NS	NS	NS	NS	NS	NS	NS
	Nov-11	NS	NS	NS	NS	NS	NS	NS	NS	NS
ST012-N14[b]	Jan-08	<0.0680 U	**0.180 F**	<0.0990 U	<0.210 U	<0.250 U	<0.140 U	<0.0680 U	NR	**0.380 F**
	Jan-09	NR	<0.125 U	<0.250 U	<0.250 U	<0.200 U	<0.250 U	<0.250 U	NR	<0.500 U
	Nov-09	<0.250 U	**1.39**	<0.250 U	<0.250 U	<0.200 U	<0.250 U	<0.250 U	NR	<0.500 U
ST012-N15[b]	Jul-06	NR	**5.90**	**1.10**	**0.380 FB**	NR	<0.140 U	**0.380 F**	NR	**25.4**
	Jan-08	<0.0680 U	**1.90**	**0.370 F**	**0.420 F**	<0.250 UM	<0.140 U	**0.420 F**	NR	**14.0**
	Jan-09	NR	**1.67 JH**	**0.299 F**	<0.250 U	**0.818 F**	<0.250 U	**1.17**	NR	**9.73**
	Nov-09	**0.434 F**	**1.66**	**0.751 F**	<0.250 U	<0.200 U	<0.250 U	<0.250 U	NR	**5.97**

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Table 3-8. Site ST012 Historical VOC Analytical Summary (Continued)

Well ID	Analyte (Units)	1,2-Dichloroethane (µg/L)	Benzene (µg/L)	Ethylbenzene (µg/L)	Methylene Chloride (µg/L)	Naphthalene (µg/L)	Tetrachloroethene (µg/L)	Toluene (µg/L)	TFM (µg/L)	Total Xylenes (µg/L)
	OU-2 ROD Action Level [a]	5	5	700	5	28	5	1,000	2,100	10,000
	Sample Date	Result	Result	Result	Result	Result	Result	Result	Result	Result
ST012-RB-1A	Nov-10	<0.100 U	1,090	111	NR	26.9 J	<0.0800 U	60.1	NR	323
	Nov-11	<2.50 U	1,230	59.3 B	NR	11.3 B	<2.50 U	<2.50 U	NR	84.7
ST012-RB-2A	Nov-10	<0.100 U	137	56.9	NR	7.37 J	0.190 F	117	NR	120
	Nov-11	<0.250 U	4.43	20.2	NR	0.367 F	<0.250 U	0.462 F	NR	1.21 F
ST012-RB-2C	Nov-10	<0.100 UJL	>8,000	1,360	NR	96.7 J	0.420 F	6,690	NR	2,030
	Nov-11	<12.5 U	8,690	919	NR	62.0	<12.5 U	5,020	NR	1,420
ST012-RB-3A	Nov-10	<0.100 U	<0.100 U	<0.0900 U	NR	<0.200 U	<0.0800 U	0.0900 F	NR	0.430 F
	Nov-11	<0.250 U	<0.125 U	<0.250 U	NR	<0.200 U	<0.250 U	<0.250 U	NR	<0.500 U
ST012-U02	Nov-10	<0.100 U	0.570	<0.0900 U	NR	<0.200 U	<0.0800 U	0.100 FB	NR	0.370 F
	Nov-11	<0.250 U	1.01	0.374 F	NR	<0.200 U	<0.250 U	0.444 F	NR	1.45 F
ST012-U11	Nov-10	<0.100 U	0.150 F	<0.0900 U	NR	<0.200 U	<0.0800 U	0.100 FB	NR	0.750 F
	Nov-11	<0.250 U	<0.125 U	<0.250 U	NR	<0.200 U	<0.250 U	<0.250 U	NR	<0.500 U
ST012-U12	Nov-10	<0.100 U	0.130 F	<0.0900 U	NR	<0.200 U	0.880	<0.0700 U	NR	0.630 F
	Nov-11	<0.250 U	<0.125 U	<0.250 U	NR	<0.200 U	0.540 F	<0.250 U	NR	<0.500 U
ST012-U13	Nov-10	<0.100 U	49.3 MH	13.2	NR	2.50 J	0.300 F	19.9	NR	33.2
	Nov-11	<0.250 U	<0.125 U	0.804 F	NR	<0.200 U	<0.250 U	<0.250 U	NR	0.938 F
ST012-U36	Nov-10	<0.100 U	2.56	<0.0900 U	NR	<0.200 U	0.120 F	0.100 FB	NR	0.420 F
	Nov-11	<0.250 U	0.133 F	<0.250 U	NR	<0.200 U	0.257 F	<0.250 U	NR	<0.500 U
ST012-U37	Nov-10	<0.100 U	0.220 F	<0.0900 U	NR	<0.200 U	0.190 F	<0.0700 U	NR	0.460 F
	Nov-11	<0.250 U	<0.125 U	<0.250 U	NR	<0.200 U	<0.250 U	<0.250 U	NR	<0.500 U
ST012-U38	Nov-10	<0.100 U	0.490 F	<0.0900 U	NR	<0.200 U	0.190 F	<0.0700 U	NR	0.680 F
	Nov-11	<0.250 U	<0.125 U	<0.250 U	NR	<0.200 U	0.574 F	<0.250 U	NR	<0.500 U
ST012-W05	Jan-08	<3.40 U	16,000	1,600	16.0 F	116	<7.20 U	<3.40 U	NR	667
	Jan-09	NR	18,800	1,590	2.21	191	<0.250 U	287	NR	951
	Nov-09	<25.0 U	12,100	804	39.4 F	64.7 FJ	<25.0 U	256	NR	377
	Nov-10	NS	NS	NS	NS	NS	NS	NS	NS	NS
	Nov-11	NS	NS	NS	NS	NS	NS	NS	NS	NS
ST012-W07	Nov-10	<0.100 U	2,710	565	NR	52.8 J	<0.0800 U	163	NR	281
	Nov-11	<2.50 U	2,860	608	NR	42.6	<2.50 U	42.1	NR	147
ST012-W11	Nov-10	<0.100 U	381	454	NR	56.0 J	<0.0800 U	24.3	NR	232
	Nov-11	<1.25 U	198 B	531 B	NR	56.9	<1.25 U	<1.25 U	NR	199 B
ST012-W12	Jan-08	<0.0680 U	4.70	10.0	<0.210 U	1.28 MH	0.370 F	3.20	NR	4.50
	Jan-09	NR	5.61	32.4	<0.250 U	4.26	<0.250 U	11.2 J	NR	43.1 J
	Nov-09	<0.250 U	2.82	18.9	<0.250 U	2.21	<0.250 U	4.14	NR	17.1
	Nov-10	<0.100 U	1.32	5.12	NR	0.540 F	0.0900 F	0.520 F	NR	1.80 F
	Nov-11	<0.250 U	0.450	3.80	NR	0.367 F	<0.250 U	0.379 F	NR	2.01

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Table 3-8. Site ST012 Historical VOC Analytical Summary (Continued)

Well ID	Analyte (Units)	1,2-Dichloroethane (µg/L)	Benzene (µg/L)	Ethylbenzene (µg/L)	Methylene Chloride (µg/L)	Naphthalene (µg/L)	Tetrachloroethene (µg/L)	Toluene (µg/L)	TFM (µg/L)	Total Xylenes (µg/L)
	OU-2 ROD Action Level [a]	5	5	700	5	28	5	1,000	2,100	10,000
	Sample Date	Result	Result	Result	Result	Result	Result	Result	Result	Result
ST012-W13	Nov-10	<0.100 UJL	**4,650**	**1,020**	NR	**104 J**	<0.0800 U	**33.3**	NR	**719**
	Nov-11	<6.25 U	**4,290**	**1,040**	NR	**103**	<6.25 U	**7.18 F**	NR	**395**
ST012-W24	Nov-10	<0.100 U	**0.430 F**	<0.0900 U	NR	<0.200 U	<0.0800 U	<0.0700 U	NR	**0.300 F**
	Nov-11	<0.250 U	**0.590**	<0.250 U	NR	<0.200 U	<0.250 U	<0.250 U	NR	<0.500 U
ST012-W26	Nov-10	NS	NS	NS	NS	NS	NS	NS	NS	NS
	Nov-11	<0.250 U	<0.125 U	<0.250 U	NR	<0.200 U	<0.250 U	<0.250 U	NR	<0.500 U
ST012-W27	Jul-06	NR	<0.130 U	<0.010 U	**0.320 FB**	NR	**1.40**	<0.070 U	NR	<0.100 U
	Jan-08	<0.0680 U	<0.130 U	<0.0990 U	<0.210 U	<0.250 U	**1.50**	<0.0680 U	NR	<0.100 U
	Jan-09	NS	NS	NS	NS	NS	NS	NS	NS	NS
	Nov-09	NS	NS	NS	NS	NS	NS	NS	NS	NS
	Nov-10	NS	NS	NS	NS	NS	NS	NS	NS	NS
	Nov-11	NS	NS	NS	NS	NS	NS	NS	NS	NS
ST012-W29	Nov-10	<0.100 U	<0.100 U	<0.0900 U	NR	<0.200 U	**0.0800 F**	<0.0700 U	NR	<0.200 U
	Nov-11	<0.250 U	<0.125 U	<0.250 U	NR	<0.200 U	<0.250 U	<0.250 U	NR	<0.500 U
ST012-W34	Nov-10	<0.100 U	**1.56**	<0.0900 U	NR	<0.200 U	<0.0800 U	**0.0900 FB**	NR	**0.470 F**
	Nov-11	<0.250 U	**0.360 F**	<0.250 U	NR	<0.200 U	<0.250 U	<0.250 U	NR	<0.500 U
ST012-W35	Nov-10	<0.100 U	<0.100 U	<0.0900 U	NR	<0.200 U	<0.0800 U	<0.0700 U	NR	**0.340 F**
	Nov-11	<0.250 U	<0.125 U	<0.250 U	NR	<0.200 U	<0.250 U	<0.250 U	NR	<0.500 U
ST012-W36	Nov-10	<0.100 U	**138**	**431**	NR	**17.9**	<0.0800 U	**69.9**	NR	**723**
	Nov-11	<1.25 U	**362**	**564**	NR	**14.2**	<1.25 U	**144**	NR	**1,100**
ST012-W37	Nov-10	<5.00 U	**2,810 MH**	**640**	NR	**47.5 FJ**	<4.00 U	**2,050**	NR	**1,540**
	Nov-11	<5.00 U	**2,360**	**755**	NR	**57.1**	<5.00 U	**1,520**	NR	**1,650**
ST012-W38	Nov-10	**0.340 F**	**0.280 F**	<0.0900 U	NR	<0.200 U	<0.0800 U	<0.0700 U	NR	**0.550 F**
	Nov-11	**0.263 F**	**0.242 F**	<0.250 U	NR	<0.200 U	<0.250 U	<0.250 U	NR	<0.500 U

[a] Source: ***Final Record of Decision*** (ROD) ***Operable Unit*** (OU)-*2* (IT Corporation [IT], December 1992).
[b] Well was decommissioned between January to March 2010.
[c] Well was decommissioned in November 2008.
Results with positive detections are **bolded**.
Bolded/shaded results exceed the OU-2 ROD action level.
> - Result was greater than numerical value shown.
< - Result was less than numerical value shown.
B - Sample concentration is similar to that found in an associated blank.
F - The analyte was positively identified, but the associated concentration is an estimation above the detection limit and below the reporting limit.
H - The result is biased high.
J - The analyte was positively identified, but the quantitation is an estimation.
L - The result is biased low.
M - The concentration is estimated because of a matrix effect.
U - The analyte was analyzed for, but not detected above the detection limit shown.

µg/L - Micrograms per liter.
ID - Identification.
NR - There were no detections for this compound in this sampling round.
NS - Not sampled.
TFM - Trichlorofluoromethane.
VOC - Volatile organic compound.

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Table 3-9. Site ST012 Historical SVOC Analytical Summary

Well ID	Analyte (Units)	2-Methylnaphthalene (µg/L)	2-Methylphenol (µg/L)	4-Methylphenol (p-cresol) (µg/L)	bis(2-Ethylhexyl)-phthalate (µg/L)	Phenol (µg/L)
	OU-2 ROD Action Level [a]	--	870	870	6	4,200
	Sample Date	Result	Result	Result	Result	Result
ST012-C01	Jan-09	<2.76 U	NR	NR	<2.76 U	<2.76 U
	Nov-09	<2.55 UJL	<2.55 UJL	NR	<2.55 UJL	<2.55 UJL
	Nov-10	<2.70 U	NR	NR	NR	NR
	Nov-11	<2.55 UML	NR	<2.55 UM	<2.55 U	<2.55 UM
ST012-C02	Jan-09	**19.1**	NR	NR	<2.55 U	<2.55 U
	Nov-09	<2.55 U	<2.55 U	NR	<2.55 U	<2.55 U
	Nov-10	<27.0 U	NR	NR	NR	NR
	Nov-11	<2.72 U	NR	<2.72 U	<2.72 U	<2.72 U
ST012-C03	Jan-09	<2.73 U	NR	NR	<2.73 U	<2.73 U
	Nov-09	<2.55 UJL	<2.55 UJL	NR	<2.55 UJL	<2.55 UJL
	Nov-10	<2.70 U	NR	NR	NR	NR
	Nov-11	<2.50 UML	NR	<2.50 UM	<2.50 U	<2.50 UM
ST012-C04	Jan-09	<2.69 U	NR	NR	<2.69 U	<2.69 U
	Nov-09	<2.50 U	<2.50 U	NR	<2.50 U	<2.50 U
	Nov-10	<2.70 U	NR	NR	NR	NR
	Nov-11	<2.72 UM	NR	<2.72 UM	<2.72 U	<2.72 UM
ST012-C05	Jan-09	<2.55 U	NR	NR	<2.55 U	<2.55 U
	Nov-09	<2.50 U	<2.50 U	NR	<2.50 U	<2.50 U
	Nov-10	<2.70 U	NR	NR	NR	NR
	Nov-11	<2.69 UML	NR	<2.69 UM	**4.12 F**	<2.69 UM
ST012-N01[b]	Jul-06	NR	NR	NR	NR	NR
	Jan-08	<0.300 U	NR	<0.770 U	<0.580 U	<0.320 U
	Jan-09	NS	NS	NS	NS	NS
	Nov-09	NS	NS	NS	NS	NS
ST012-N02[b]	Jan-08	<0.290 U	NR	<0.740 U	<0.560 U	<0.310 U
	Jan-09	NS	NS	NS	NS	NS
	Nov-09	NS	NS	NS	NS	NS
ST012-N03[b]	Jan-08	<0.280 U	NR	<0.710 U	<0.540 U	**47.0**
	Jan-09	**18.4**	NR	NR	<2.50 U	**4.69 F**
	Nov-09	<2.55 U	<2.55 U	NR	<2.55 U	<2.55 U
ST012-N04[b]	Jul-06	NR	NR	NR	NR	NR
	Jan-08	<0.300 U	NR	<0.750 U	<0.570 U	<0.320 U
	Jan-09	NS	NS	NS	NS	NS
	Nov-09	NS	NS	NS	NS	NS
ST012-N05[b]	Jul-06	NR	NR	NR	NR	NR
	Jan-08	<0.290 U	NR	<0.740 U	**1.00 F**	<0.310 U
	Jan-09	<2.75 U	NR	NR	<2.75 U	<2.75 U
	Nov-09	<2.50 U	<2.50 U	NR	<2.50 U	<2.50 U
ST012-N06	Jan-08	**150**	NR	<0.750 U	**1.80 F**	<0.310 U
	Jan-09	**146**	NR	NR	**2.89 F**	<5.00 U
	Nov-09	**34.6 FJL**	<25.0 UJL	NR	<25.0 UJL	**33.8 FJL**
	Nov-10	NS	NS	NS	NS	NS
	Nov-11	NS	NS	NS	NS	NS
ST012-N08[b]	Jul-06	NR	NR	NR	NR	NR
	Jan-08	<0.290 U	NR	<0.740 U	<0.560 U	<0.310 U
	Jan-09	<2.66 U	NR	NR	<2.66 U	<2.66 U
	Nov-09	<2.55 UJL	<2.55 UJL	NR	<2.55 UJL	<2.55 UJL

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Table 3-9. Site ST012 Historical SVOC Analytical Summary (Continued)

Well ID	Analyte (Units)	2-Methylnaphthalene (µg/L)	2-Methylphenol (µg/L)	4-Methylphenol (p-cresol) (µg/L)	bis(2-Ethylhexyl)-phthalate (µg/L)	Phenol (µg/L)
	OU-2 ROD Action Level [a]	--	870	870	6	4,200
	Sample Date	Result	Result	Result	Result	Result
ST012-N09[b]	Jul-06	NR	NR	NR	NR	NR
	Jan-08	<0.270 U	NR	<0.700 U	<0.530 U	<0.290 U
	Jan-09	<2.69 U	NR	NR	<2.69 U	<2.69 U
	Nov-09	<2.55 U	<2.55 U	NR	<2.55 U	<2.55 U
ST012-N10[c]	Jul-06	NR	NR	NR	NR	NR
	Jan-08	NS	NS	NS	NS	NS
ST012-N11[b]	Jan-08	**45.0**	NR	<0.730 U	**1.10 F**	<0.310 U
	Jan-09	**73.1 JL**	NR	NR	<2.69 U	R
	Nov-09	<5.21 UJL	<5.21 UJL	NR	<5.21 UJL	<5.21 UJL
ST012-N12[b]	Jul-06	NR	NR	NR	NR	NR
	Jan-08	<0.300 U	NR	<0.750 U	<0.570 U	<0.320 U
	Jan-09	<2.72 U	NR	NR	<2.72 U	<2.72 U
	Nov-09	<2.50 U	<2.50 U	NR	**7.77**	<2.50 U
ST012-N13	Jan-08	**130**	NR	<0.730 U	**5.30 F**	**12.0**
	Jan-09	**187 JL**	NR	NR	<5.00 U	R
	Nov-09	**44.8**	**21.1**	NR	<2.50 U	<2.50 U
	Nov-10	NS	NS	NS	NS	NS
	Nov-11	NS	NS	NS	NS	NS
ST012-N14[b]	Jan-08	<0.300 U	NR	<0.780 U	<0.590 U	<0.330 U
	Jan-09	<2.55 U	NR	NR	<2.55 U	<2.55 U
	Nov-09	<2.58 UJL	<2.58 UJL	NR	<2.58 UJL	<2.58 UJL
ST012-N15[b]	Jul-06	NR	NR	NR	NR	NR
	Jan-08	<0.290 U	NR	<0.740 U	<0.560 U	<0.310 U
	Jan-09	R	NR	NR	<2.66 U	R
	Nov-09	<2.50 U	<2.50 U	NR	**6.58**	<2.50 U
ST012-RB-1A	Nov-10	<27.0 U	NR	NR	NR	R
	Nov-11	<2.75 U	NR	<2.75 U	<2.75 U	**17.0**
ST012-RB-2A	Nov-10	<27.0 U	NR	NR	NR	NR
	Nov-11	<2.50 U	NR	<2.50 U	<2.50 U	<2.50 U
ST012-RB-2C	Nov-10	**30.5**	NR	NR	NR	NR
	Nov-11	**15.3 BJL**	NR	**3.01 F**	<2.69 UJL	**12.9**
ST012-RB-3A	Nov-10	<2.70 U	NR	NR	NR	NR
	Nov-11	<2.78 UML	NR	<2.78 UM	<2.78 U	<2.78 UM
ST012-U02	Nov-10	<14.0 U	NR	NR	NR	NR
	Nov-11	<2.50 UML	NR	<2.50 UM	<2.50 U	<2.50 UM
ST012-U11	Nov-10	<2.70 U	NR	NR	NR	NR
	Nov-11	<2.55 UM	NR	<2.55 UM	<2.55 U	<2.55 UM
ST012-U12	Nov-10	<2.70 U	NR	NR	NR	NR
	Nov-11	<2.55 UML	NR	<2.55 UM	<2.55 U	<2.55 UM
ST012-U13	Nov-10	<2.70 U	NR	NR	NR	NR
	Nov-11	<2.55 U	NR	<2.55 U	<2.55 U	<2.55 U
ST012-U36	Nov-10	<2.70 U	NR	NR	NR	NR
	Nov-11	<2.63 U	NR	<2.63 U	<2.63 U	<2.63 U
ST012-U37	Nov-10	<2.70 U	NR	NR	NR	NR
	Nov-11	<2.69 UM	NR	<2.69 UM	<2.69 U	<2.69 UM
ST012-U38	Nov-10	<2.70 U	NR	NR	NR	NR
	Nov-11	<2.50 UML	NR	<2.50 UM	<2.50 U	<2.50 UM

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Table 3-9. Site ST012 Historical SVOC Analytical Summary (Continued)

Well ID	Analyte (Units)	2-Methylnaphthalene (µg/L)	2-Methylphenol (µg/L)	4-Methylphenol (p-cresol) (µg/L)	bis(2-Ethylhexyl)-phthalate (µg/L)	Phenol (µg/L)
	OU-2 ROD Action Level [(a)]	--	870	870	6	4,200
	Sample Date	Result	Result	Result	Result	Result
ST012-W05	Jan-08	**68.0**	NR	**3.40 F**	**12.0**	**34.0**
	Jan-09	**82.2**	NR	NR	**7.48**	**12.7**
	Nov-09	**18.3 JL**	<2.50 UJL	NR	**14.1**	**11.7 JL**
	Nov-10	NS	NS	NS	NS	NS
	Nov-11	NS	NS	NS	NS	NS
ST012-W07	Nov-10	**14.0**	NR	NR	NR	NR
	Nov-11	**10.8 BJL**	NR	<2.60 U	<2.60 UJL	**3.42 F**
ST012-W11	Nov-10	**16.8**	NR	NR	NR	NR
	Nov-11	**18.2 B**	NR	<2.69 U	<2.69 U	<2.69 U
ST012-W12	Jan-08	<0.300 U	NR	<0.770 U	<0.580 U	<0.320 U
	Jan-09	<2.40 UJ	NR	NR	<2.40 U	<2.40 U
	Nov-09	<2.94 U	<2.94 U	NR	<2.94 U	<2.94 U
	Nov-10	<2.70 U	NR	NR	NR	NR
	Nov-11	<2.72 U	NR	<2.72 U	<2.72 U	<2.72 U
ST012-W13	Nov-10	**35.3**	NR	NR	NR	NR
	Nov-11	**30.0**	NR	<2.75 U	<2.75 U	**4.68 F**
ST012-W24	Nov-10	<2.70 U	NR	NR	NR	NR
	Nov-11	<2.55 UM	NR	<2.55 UM	<2.55 U	<2.55 UM
ST012-W26	Nov-10	NS	NS	NS	NS	NS
	Nov-11	<2.50 U	NR	<2.50 U	<2.50 U	<2.50 U
ST012-W27	Jul-06	NR	NR	NR	NR	NR
	Jan-08	<0.290 U	NR	<0.740 U	<0.560 U	<0.310 U
	Jan-09	NS	NS	NS	NS	NS
	Nov-09	NS	NS	NS	NS	NS
	Nov-10	NS	NS	NS	NS	NS
	Nov-11	NS	NS	NS	NS	NS
ST012-W29	Nov-10	<2.70 U	NR	NR	NR	NR
	Nov-11	<2.55 U	NR	<2.55 U	<2.55 U	<2.55 U
ST012-W34	Nov-10	<2.70 U	NR	NR	NR	NR
	Nov-11	<2.50 U	NR	<2.50 U	<2.50 U	<2.50 U
ST012-W35	Nov-10	<2.70 U	NR	NR	NR	NR
	Nov-11	<2.55 UM	NR	<2.55 UM	<2.55 U	<2.55 UM
ST012-W36	Nov-10	**5.80 F**	NR	NR	NR	NR
	Nov-11	**6.00 B**	NR	<2.72 U	<2.72 U	<2.72 U
ST012-W37	Nov-10	**15.7**	NR	NR	NR	NR
	Nov-11	**13.0 B**	NR	<2.66 U	<2.66 U	**2.81 F**
ST012-W38	Nov-10	<5.40 U	NR	NR	NR	NR
	Nov-11	<2.69 UJL	NR	<2.69 UM	<2.69 UJL	<2.69 UM

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Table 3-9. Site ST012 Historical SVOC Analytical Summary (Continued)

[a] Source: ***Final Record of Decision*** (ROD) ***Operable Unit*** (OU)-*2* (IT Corporation [IT], December 1992).
[b] Well was decommissioned between January and March 2010.
[c] Well was decommissioned in November 2008.
Results with positive detections are **bolded**.
Bolded/shaded results exceed the OU-2 ROD action level.
-- Data not available.
B - Sample concentration is similar to that found in an associated blank.
F - The analyte was positively identified, but the associated concentration is an estimation above the detection limit and below the reporting limit.
J - The analyte was positively identified, but the quantitation is an estimation.
L - The result is biased low.
M - The concentration is estimated because of a matrix effect.
R - The data are rejected because of deficiencies in meeting quality control (QC) criteria and may not be used for decision making.
U - The analyte was analyzed for, but not detected above the detection limit shown.
UJL - The analyte was not detected; however, the result is estimated because of discrepancies in meeting certain analyte-specific QC criteria; the result is biased low.

µg/L - Micrograms per liter.
ID - Identification.
NR - There were no detections for this compound in this sampling round.
NS - Not sampled.
SVOC - Semivolatile organic compound.

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Table 3-10. Site ST012 Historical Metals Analytical Summary

Well ID	Analyte (Units)	Antimony (mg/L)	Chromium (total) (mg/L)	Copper (mg/L)	Lead (mg/L)	Nickel (mg/L)	Silver (mg/L)	Zinc (mg/L)
	OU-2 ROD Action Level [a]	0.006	0.1	1.3	0.015	0.1	0.05	1.4
	Sample Date	Result	Result	Result	Result	Result	Result	Result
ST012-C01	Jan-09	<0.000250 U	**0.00652**	**0.00164 F**	<0.000250 U	**0.0178**	NR	**0.00660 F**
	Nov-09	NR	**0.00752 J**	**0.00878 J**	**0.00165 J**	**0.0258**	NR	**0.0200 FML**
	Nov-10	**0.000100 F**	**0.00220 F**	**0.00440 B**	**0.00170 F**	**0.0109 ML**	NR	**0.00550 F**
	Nov-11	<0.00250 U	<0.00500 U	<0.00500 U	<0.00250 U	**0.0222**	NR	<0.0625 UM
ST012-C02	Jan-09	<0.000250 U	**0.00592**	**0.00126 F**	<0.000250 U	**0.0163**	NR	**0.0125 F**
	Nov-09	NR	**0.00579**	**0.00567**	**0.000975 F**	**0.0200**	NR	**0.0160 FML**
	Nov-10	**0.000200 F**	**0.00250 F**	**0.00430 B**	**0.000800 F**	**0.00860 ML**	NR	**0.0146 F**
	Nov-11	<0.00250 U	<0.00500 U	<0.00500 U	<0.00250 U	<0.0100 U	NR	<0.0625 UM
ST012-C03	Jan-09	<0.000250 U	**0.00507**	**0.000935 F**	<0.000250 U	**0.00893**	NR	**0.00648 F**
	Nov-09	NR	**0.00355 J**	**0.00717 J**	**0.00239 J**	**0.0290**	NR	**0.0241 FML**
	Nov-10	**0.000100 F**	**0.00360 F**	**0.00510**	**0.00160 F**	**0.0136 ML**	NR	**0.00480 F**
	Nov-11	<0.00250 U	<0.00500 U	<0.00500 U	<0.00250 U	**0.0264**	NR	<0.0625 UM
ST012-C04	Jan-09	<0.000250 U	**0.00678 MH**	**0.00216**	<0.000250 U	**0.0276**	NR	**0.00883 F**
	Nov-09	NR	**0.00445 B**	**0.00710 B**	**0.000964 F**	**0.0254 B**	NR	**0.0220 FB**
	Nov-10	**0.000100 F**	**0.00240 F**	**0.00340 B**	**0.000900 F**	**0.00900 ML**	NR	**0.00360 F**
	Nov-11	<0.00250 U	<0.00500 U	<0.00500 U	<0.00250 U	**0.0142 F**	NR	<0.0625 U
ST012-C05	Jan-09	<0.000250 U	**0.0135**	**0.00113 F**	<0.000250 U	**0.0132**	NR	**0.0236 F**
	Nov-09	NR	**0.00449 B**	**0.00248 B**	<0.000250 U	**0.0141 B**	NR	**0.0109 FB**
	Nov-10	**0.000100 FB**	**0.00390 F**	**0.00400 B**	**0.00130 FB**	**0.00610 B**	NR	**0.0146 F**
	Nov-11	<0.00250 U	<0.00500 U	<0.00500 U	<0.00250 U	**0.0133 F**	NR	<0.0625 UM
ST012-N01[b]	Jul-06	<0.0000700 U	**0.130**	**0.00670**	<0.000200 U	**0.0380**	<0.000200 U	**0.0170 F**
	Jan-08	<0.0000700 U	**0.0490**	**0.000820 F**	<0.000180 U	**0.0180**	NR	<0.00200 U
	Jan-09	NS	NS	NS	NS	NS	NS	NS
	Nov-09	NS	NS	NS	NS	NS	NS	NS
ST012-N02[b]	Jan-08	<0.0000700 U	**0.0640**	**0.00110 F**	<0.000180 U	**0.0200**	NR	<0.00200 U
	Jan-09	NS	NS	NS	NS	NS	NS	NS
	Nov-09	NS	NS	NS	NS	NS	NS	NS
ST012-N03[b]	Jan-08	<0.0000700 U	**0.00350 F**	<0.000560 U	**0.000200 F**	**0.00810**	NR	**0.00320 F**
	Jan-09	<0.000500 U	**0.00457 MH**	**0.00104 F**	<0.000250 U	**0.00859**	NR	**0.00617 F**
	Nov-09	NR	**0.0730**	**0.00865**	<0.000250 U	**0.0833**	NR	**0.0151 FML**
ST012-N04[b]	Jul-06	**0.0000900 FB**	**0.00640**	**0.00260 F**	**0.000380 F**	**0.0200**	<0.000200 U	**0.0140 F**
	Jan-08	**0.0000760 F**	**0.100**	**0.00230 F**	**0.000190 F**	**0.240**	NR	**0.00550 FB**
	Jan-09	NS	NS	NS	NS	NS	NS	NS
	Nov-09	NS	NS	NS	NS	NS	NS	NS

Table 3-10. Site ST012 Historical Metals Analytical Summary (Continued)

Well ID	Analyte (Units)	Antimony (mg/L)	Chromium (total) (mg/L)	Copper (mg/L)	Lead (mg/L)	Nickel (mg/L)	Silver (mg/L)	Zinc (mg/L)
	OU-2 ROD Action Level [a]	0.006	0.1	1.3	0.015	0.1	0.05	1.4
	Sample Date	Result	Result	Result	Result	Result	Result	Result
ST012-N05[b]	Jul-06	0.000410 FB	0.00140 FB	0.00160 F	0.000190 F	0.0250	<0.000200 U	0.0120 FB
	Jan-08	<0.0000700 U	0.00430	0.00150 F	0.000180 F	0.00950	NR	0.00260 F
	Jan-09	<0.000500 U	0.00421 MH	0.00146 F	<0.000250 U	0.0184	NR	0.00631 F
	Nov-09	NR	0.00210	0.000927 F	<0.000250 U	0.00875	NR	0.00668 FML
ST012-N06	Jan-08	<0.0000700 U	<0.000500 U	0.00220 F	0.000920 F	0.00590	NR	0.0260
	Jan-09	<0.000250 U	0.00297	0.00126 F	0.000281 F	0.0101	NR	0.00719 F
	Nov-09	NR	0.00384 J	0.000933 FJ	0.000534 FJ	0.00454	NR	0.0121 FML
	Nov-10	NS	NS	NS	NS	NS	NS	NS
	Nov-11	NS	NS	NS	NS	NS	NS	NS
ST012-N08[b]	Jul-06	<0.0000700 U	0.430	0.0110	0.000250 F	0.0510	<0.000200 U	0.0250
	Jan-08	<0.0000700 U	0.160	0.00210 F	0.000220 F	0.0840	NR	0.00230 F
	Jan-09	<0.000250 U	0.124	0.00291	<0.000250 U	0.0409	NR	<0.00500 U
	Nov-09	NR	0.0139	0.00997	0.00217	0.0747	NR	0.0234 FML
ST012-N09[b]	Jul-06	0.000730 F	6.50	0.0850	0.000870 F	0.240	0.000200 F	0.0310
	Jul-06*	0.000071*	0.00330 FB*	0.00320*	<0.000200 U*	0.0430*	<0.000200 U*	0.0190*
	Jan-08	0.000210 F	1.30	0.0110	<0.000180 U	0.110	NR	<0.00200 U
	Jan-09	<0.000250 U	0.439	0.00886	<0.000250 U	0.399	NR	0.00841 F
	Nov-09	NR	0.0756	0.00829 B	0.000336 FB	0.216	NR	0.0136 FB
ST012-N10[c]	Jul-06	<0.0000700 U	0.250	0.00470 F	<0.000200 U	0.0340	<0.000200 U	0.0130 FB
	Jan-08	NS	NS	NS	NS	NS	NS	NS
ST012-N11[b]	Jan-08	<0.0000700 U	0.00560	<0.000560 U	<0.000180 U	0.0110	NR	<0.00200 U
	Jan-09	<0.000250 U	0.00806	0.00110 F	<0.000250 U	0.0146	NR	<0.00500 U
	Nov-09	NR	0.00661	0.00144 F	0.000374 F	0.0181	NR	0.0163 FML
ST012-N12[b]	Jul-06	0.000710 F	4.10	0.0430	<0.000200 U	0.0950	<0.000200 U	0.0150 F
	Jan-08	0.000110 F	0.530	0.00630	<0.000180 U	0.140	NR	<0.00200 U
	Jan-09	0.000260 FB	0.433	0.00774	<0.000250 U	0.125	NR	0.00600 F
	Jan-09*	0.000300 F*	0.0128 MH*	0.00222*	NR*	0.117*	NR*	0.00835 F*
	Nov-09	NR	0.231	0.00811	<0.000250 U	0.236	NR	0.0236 FML
ST012-N13	Jan-08	<0.0000700 U	0.00290 F	0.00190 F	0.00130 F	0.00800	NR	<0.00200 U
	Jan-09	<0.000250 U	0.00785 B	0.00263	0.000646 F	0.0177	NR	0.0235 F
	Nov-09	NR	0.00796 J	0.00638	0.00436	0.00745	NR	0.00841 FML
	Nov-10	NS	NS	NS	NS	NS	NS	NS
	Nov-11	NS	NS	NS	NS	NS	NS	NS
ST012-N14[b]	Jan-08	<0.0000700 U	0.330	0.00380 F	<0.000180 U	0.0980	NR	<0.00200 U
	Jan-09	<0.000250 U	0.316 MH	0.00576	<0.000250 U	0.0897	NR	0.00547 F
	Nov-09	NR	0.0526 J	0.0179 J	0.00111 J	0.0830	NR	0.0389 ML

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Table 3-10. Site ST012 Historical Metals Analytical Summary (Continued)

Well ID	Analyte (Units)	Antimony (mg/L)	Chromium (total) (mg/L)	Copper (mg/L)	Lead (mg/L)	Nickel (mg/L)	Silver (mg/L)	Zinc (mg/L)
	OU-2 ROD Action Level [a]	0.006	0.1	1.3	0.015	0.1	0.05	1.4
	Sample Date	Result	Result	Result	Result	Result	Result	Result
ST012-N15[b]	Jul-06	<0.0000700 U	**0.00390 F**	**0.000680 F**	<0.000200 U	**0.0150**	<0.000200 U	**0.0110 FB**
	Jan-08	<0.0000700 U	**0.00540**	<0.000560 U	<0.000180 U	**0.0110**	NR	<0.00200 U
	Jan-09	<0.000250 U	**0.0101**	**0.000854 F**	<0.000250 U	**0.0174**	NR	<0.00500 U
	Nov-09	NR	**0.0132**	**0.00482**	**0.000622 F**	**0.0193**	NR	**0.115 FML**
ST012-RB-1A	Nov-10	<0.000100 U	<0.00200 U	**0.0552**	**0.00100 F**	**0.00970**	NR	<0.00300 U
	Nov-11	<0.000500 U	**0.0194**	**0.00196 F**	**0.000536 F**	**0.019**	NR	**0.0131 F**
ST012-RB-2A	Nov-10	**0.000200 F**	**0.00550 F**	**0.0989**	**0.00130 F**	**0.0149**	NR	**0.0120 B**
	Nov-11	<0.000500 U	**0.00493**	**0.00327**	<0.000500 U	**0.0176**	NR	**0.0203 F**
ST012-RB-2C	Nov-10	**0.000100 F**	**0.00310 F**	**0.00180 F**	<0.000500 U	**0.00610**	NR	**0.0136 B**
	Nov-11	<0.000500 U	**0.00152 F**	<0.00100 U	<0.000500 U	**0.00711**	NR	<0.0125 U
ST012-RB-3A	Nov-10	**0.000100 F**	**0.00330 F**	**0.00510 B**	**0.00120 F**	**0.0105 ML**	NR	**0.00900 F**
	Nov-11	<0.00250 U	<0.00500 U	<0.00500 U	<0.00250 U	**0.0271**	NR	<0.0625 UM
ST012-U02	Nov-10	**0.000100 F**	**0.00230 F**	**0.00400 B**	**0.000900**	**0.00850 ML**	NR	**0.00730 F**
	Nov-11	<0.000500 U	**0.00571**	**0.00159 F**	<0.000500 U	**0.0139**	NR	<0.0125 U
ST012-U11	Nov-10	<0.000100 U	<0.00200 U	**0.00240 B**	<0.000500 U	**0.00480 B**	NR	**0.00720 F**
	Nov-11	<0.00250 U	<0.00500 U	<0.00500 U	<0.00250 U	<0.0100 U	NR	<0.0625 U
ST012-U12	Nov-10	**0.000100 F**	<0.00200 U	**0.00430 B**	<0.000500 U	**0.00730 B**	NR	**0.0147 F**
	Nov-11	<0.00250 U	<0.00500 U	<0.00500 U	<0.00250 U	**0.0152 F**	NR	<0.0625 UM
ST012-U13	Nov-10	**0.000100 F**	**0.0278**	**0.00710**	**0.000700 F**	**0.0267**	NR	**0.00760 B**
	Nov-11	<0.000500 U	**0.00318**	**0.00227**	**0.000526 F**	**0.0237**	NR	**0.0308**
ST012-U36	Nov-10	**0.000100 F**	**0.00340 F**	**0.00370 FB**	**0.000800 F**	**0.0103 ML**	NR	**0.00410 F**
	Nov-11	<0.00250 U	<0.00500 U	<0.00500 U	<0.00250 U	**0.0312**	NR	<0.0625 UM
ST012-U37	Nov-10	**0.000100 F**	**0.00320 F**	**0.00440 B**	<0.000500 U	**0.0100 ML**	NR	**0.00990 F**
	Nov-11	<0.00250 U	<0.00500 U	<0.00500 U	<0.00250 U	**0.0244**	NR	<0.0625 U
ST012-U38	Nov-10	**0.000100 F**	<0.00200 U	**0.00240 B**	<0.000500 U	**0.00520 B**	NR	**0.0123 F**
	Nov-11	<0.00250 U	<0.00500 U	<0.00500 U	<0.00250 U	**0.0208**	NR	<0.0625 UM
ST012-W05	Jan-08	**0.000140 F**	**0.000500 F**	**0.00370 F**	**0.000820 F**	**0.00680**	NR	**0.0690**
	Jan-09	<0.000250 U	**0.00277**	**0.00127 F**	**0.000278 F**	**0.00499**	NR	**0.0192 F**
	Nov-09	NR	**0.00426 J**	**0.00250**	**0.000307 F**	**0.0117**	NR	**0.0157 FML**
	Nov-10	NS	NS	NS	NS	NS	NS	NS
	Nov-11	NS	NS	NS	NS	NS	NS	NS
ST012-W07	Nov-10	<0.000100 U	<0.00200 U	**0.00230**	<0.000500 U	**0.00610**	NR	**0.00340 B**
	Nov-11	<0.000500 U	<0.00100 U	<0.00100 U	<0.000500 U	**0.00769**	NR	**0.0162 F**
	Nov-11*	NR	**0.00132 F**	NR	NR	**0.0084**	NR	<0.0125 U

Table 3-10. Site ST012 Historical Metals Analytical Summary (Continued)

Well ID	Analyte (Units)	Antimony (mg/L)	Chromium (total) (mg/L)	Copper (mg/L)	Lead (mg/L)	Nickel (mg/L)	Silver (mg/L)	Zinc (mg/L)
	OU-2 ROD Action Level [(a)]	0.006	0.1	1.3	0.015	0.1	0.05	1.4
	Sample Date	Result	Result	Result	Result	Result	Result	Result
ST012-W11	Nov-10	<0.000100 U	**0.00930 F**	**0.00260**	<0.000500 U	**0.00640**	NR	**0.00630 B**
	Nov-11	<0.000500 U	**0.00308**	<0.00100 U	<0.000500 U	**0.00563**	NR	<0.0125 U
ST012-W12	Jan-08	**0.000110 F**	<0.000500 U	<0.000560 U	<0.000180 U	**0.00510**	NR	**0.00200 F**
	Jan-09	<0.000250 U	**0.00840 B**	**0.00113 F**	<0.000250 U	**0.0118 J**	NR	<0.00500 U
	Nov-09	NR	**0.00236 B**	**0.00125 FB**	<0.000250 U	**0.0159 B**	NR	<0.00500 UML
	Nov-09*	NR*	**0.00214 B***	**0.00196 FB***	NR*	**0.0159 B***	NR*	**0.00619 FB***
	Nov-10	**0.000600 F**	<0.00200 U	**0.00160 BF**	<0.000500 U	**0.00710 B**	NR	<0.00300 U
	Nov-11	**0.000559 F**	<0.00100 U	<0.00100 U	<0.000500 U	**0.0094**	NR	<0.0125 U
ST012-W13	Nov-10	<0.000100 U	<0.00200 U	**0.00190 F**	<0.000500 U	**0.00630**	NR	<0.00300 U
	Nov-11	<0.000500 U	**0.00132 F**	<0.00100 U	<0.000500 U	**0.00588**	NR	<0.0125 U
ST012-W24	Nov-10	<0.000100 U	**0.0233**	**0.00610 B**	**0.000700 F**	**0.0169 ML**	NR	**0.00860 F**
	Nov-11	<0.00250 U	**0.00961 FMH**	<0.00500 U	<0.00250 U	**0.037**	NR	<0.0625 U
ST012-W26	Nov-10	NS	NS	NS	NS	NS	NS	NS
	Nov-11	<0.000500 U	**0.410**	**0.011**	**0.00063 F**	**0.115**	NR	**0.0173 F**
	Nov-11*	NR	**0.00322**	NR	NR	**0.0991**	NR	**0.0549**
ST012-W27	Jul-06	<0.0000700 U	**0.180**	**0.00670**	**0.000380 F**	**0.0370**	<0.000200 U	**0.0160 F**
	Jan-08	<0.0000700 U	**0.330**	**0.00610**	<0.000180 U	**0.0840**	NR	**0.00210 F**
	Jan-09	NS	NS	NS	NS	NS	NS	NS
	Nov-09	NS	NS	NS	NS	NS	NS	NS
	Nov-10	NS	NS	NS	NS	NS	NS	NS
	Nov-11	NS	NS	NS	NS	NS	NS	NS
ST012-W29	Nov-10	**0.000100 F**	**0.0515**	**0.00350 B**	<0.000500 U	**0.165**	NR	<0.0150 U
	Nov-10*	**0.000200 F***	<0.00200 U*	**0.00320 B***	<0.000500 U*	**0.153***	NR*	**0.00510 F***
	Nov-11	<0.00250 U	**0.0632**	<0.00500 U	<0.00250 U	**0.416**	NR	<0.0625 UM
ST012-W34	Nov-10	**0.000100 F**	**0.00250 F**	**0.00250 B**	**0.000600 F**	**0.00580 B**	NR	**0.00390 F**
	Nov-11	<0.00250 U	<0.00500 U	<0.00500 U	<0.00250 U	**0.0109 F**	NR	<0.0625 UM
ST012-W35	Nov-10	**0.000100 F**	**0.00420 F**	**0.00240 B**	**0.000600 F**	**0.00520 B**	NR	<0.00300 U
	Nov-11	<0.00250 U	**0.00526 FMH**	<0.00500 U	<0.00250 U	<0.0100 U	NR	<0.0625 U
ST012-W36	Nov-10	**0.000100 F**	<0.00200 U	**0.00160 BF**	<0.000500 U	**0.00540 B**	NR	<0.00300 U
	Nov-11	<0.000500 U	<0.00100 U	<0.00100 U	<0.000500 U	**0.00635**	NR	**0.0134 F**
ST012-W37	Nov-10	<0.000100 U	**0.0179**	**0.00160 F**	<0.000500 U	**0.00700**	NR	**0.00970 B**
	Nov-11	<0.000500 U	<0.00100 U	<0.00100 U	<0.000500 U	**0.00375 F**	NR	<0.0125 U
ST012-W38	Nov-10	**0.000100 F**	<0.00200 U	**0.00310 B**	<0.000500 U	**0.00930 ML**	NR	**0.0120 F**
	Nov-11	<0.00250 U	<0.00500 U	<0.00500 U	<0.00250 U	**0.0153 F**	NR	<0.0625 UM

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Table 3-10. Site ST012 Historical Metals Analytical Summary (Continued)

[a] Source: ***Final Record of Decision*** (ROD) ***Operable Unit*** (OU)-*2* (IT Corporation [IT], December 1992).
[b] Well was decommissioned between January to March 2010.
[c] Well was decommissioned in November 2008.
* Result is for dissolved metals.
Results with positive detections are **bolded**.
Bolded/shaded results exceed the OU-2 ROD action level.
B - Sample concentration is similar to that found in an associated blank.
F - The analyte was positively identified, but the associated concentration is an estimation above the detection limit and below the reporting limit.
H - The result is biased high.
J - The analyte was positively identified, but the quantitation is an estimation.
L - The result is biased low.
M - The concentration is estimated because of a matrix effect.
U - The analyte was analyzed for, but not detected above the detection limit shown.

ID - Identification.
mg/L - Milligrams per liter.
NR - There were no detections for this compound in this sampling round.
NS - Not sampled.

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APPENDIX B

IDENTIFICATION OF APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Identification of Applicable or Relevant and Appropriate Requirements

In 1980, Congress enacted the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. Section 9601 *et seq.*, establishing the Superfund program to address remediation of National Priority List (NPL) sites. CERCLA was amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986. Promulgated regulations to implement the program are found in Title 40 of the Code of Federal Regulations (CFR), Part 300, also known as the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). Compliance with applicable or relevant and appropriate requirements (ARARs) is one of nine criteria for remedial alternative evaluations [40 CFR 430(e)(9)(iii)(B)]. Accordingly, this appendix identifies the ARARs for ST012 at the former Williams Air Force Base (AFB).

The terms applicable requirements and relevant and appropriate requirements are defined in 40 CFR Section 300.5 as follows:

> *Applicable requirements* means those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility citing laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Only those state standards that are identified by a state in a timely manner and that are more stringent than federal requirements may be applicable.
>
> *Relevant and appropriate requirements* means those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility citing laws that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site. Only those state standards that are identified in a timely manner and are more stringent than federal requirements may be relevant and appropriate.

ARARs may be federal or state requirements. The requirement must be legally enforceable for evaluation as a potential ARAR. Guidelines and voluntary standards are not legally enforceable and are evaluated separately as potential "to be considered" guidelines (TBCs) [40 CFR 300.400(g)(3)]. TBCs are not legally enforceable, but become enforceable when included in an approved record of decision (ROD). Identification of TBCs is not mandatory, but TBCs are typically identified when useful in developing CERCLA remedies (e.g., when ARARs do not exist or are not fully protective).

ARARs are typically divided into three categories: chemical, location, and action.

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- Chemical-specific ARARs are typically risk-based standards, requirements, criteria, or limitations which when applied to the site yield numerical limitations for acceptable amounts of a particular chemical that may be present in an environmental media.
- Location-specific ARARs are typically standards, requirements, criteria, or limitations that are placed on activities conducted at certain locations due to the unique nature of the location.
- Action-specific ARARs are typically standards, requirements, criteria, or limitations that are placed on remedial actions that affect hazardous substances.

Tables B-1 through B-4 summarize the identification process. Citations and identification of specific requirements have been performed for the Selected Remedy and the previous remedy identified in the original ROD (IT, 1992d). The analysis of alternatives evaluates each alternative's ability to comply with the federal and state ARARs identified in Tables B-1, B-3, and B-4. Table B-2 presents an update to the numerical standards originally presented in the ROD (IT, 1992d) associated with the chemical-specific ARARs along with the revised cleanup levels. Where ARARs do not exist for a specific compound, the risk-based EPA regional screening level concentration was considered.

The identification of groundwater cleanup levels based on the groundwater RAOs is documented in Table B-2 of Appendix B and summarized in Table 5-2. These cleanup levels were identified in the OU-2 ROD and have been updated based on current standards as presented in Table B-2. The OU-2 ROD identifies only COPCs. Based on the November 2012 groundwater sampling event (AMEC, 2013c), benzene, toluene, naphthalene, chromium, and nickel were detected above the OU-2 ROD action levels. Chromium and nickel have been associated with well construction materials. The only compounds related to site contamination that exceed the OU-2 ROD Amendment 2 cleanup levels are benzene, toluene, and naphthalene. Therefore, benzene, toluene, and naphthalene have been identified as COCs. The remaining ST012 compounds identified for groundwater in the OU-2 ROD remain as COPCs as presented in the OU-2 ROD.

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Table B-1
Groundwater Chemical-Specific Applicable or Relevant and Appropriate Requirements
Liquid Fuels Storage Area (ST012), Operable Unit 2
Williams Air Force Base, Arizona

Scope	Citation	Description	Requirement(s)	Applicable[a]	Relevant and Appropriate[b]
Federal	40 CFR Part 141 (SDWA - 42 USC § 300)	National Primary Drinking Water Standards	These regulations establish MCLs and MCLGs, which are used as drinking water standards for public water systems. MCLs are specified for a wide range of organic and inorganic analytes. Of particular note is the MCL for benzene (5 micrograms per liter).		Previous Remedy Selected Remedy
State	AAC, Title 18, Chapter 11, Article 4	Aquifer Water Quality Standards	State regulations providing numerical standards for protection of aquifer water quality. Domestic water source standards for contaminants of potential concern are the same as Federal MCLs (40 CFR Part 141) except for nickel which does not have a federal MCL.	Previous Remedy Selected Remedy	

[a] Criteria is applicable for alternative(s) listed.
[b] Criteria is relevant and appropriate for alternatives listed.
AAC = Arizona Administrative Code
CFR = Code of Federal Regulations
MCL = maximum contaminant level
MCLG = maximum contaminant level goal
SDWA = Safe Drinking Water Act
USC = United States Code

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Table B-2
List of Contaminants of Concern/Potential Concern in Groundwater and Cleanup Levels
(all values are mg/L)
Liquid Fuels Storage Area (ST012), Operable Unit 2
Williams Air Force Base, Arizona

Contaminant	Selection of Cleanup Level			
	Cleanup Level[1]			Citation
	Applicable (mg/L)	Relevant and Appropriate (mg/L)	Criteria To Be Considered (mg/L)	
Contaminant of Concern				
Benzene		0.005		Federal MCL
Toluene		1.0		
Naphthalene			0.028	Arizona HBGL
Contaminant of Potential Concern				
bis(2-ethylhexyl)phthalate		0.006		Federal MCL
1,2-Dichloroethane		0.005		Federal MCL
Ethylbenzene		0.7		Federal MCL
Methylene chloride		0.005		Federal MCL
2-Methylnaphthalene			0.027	EPA Regional Screening Level for tap water
2-Methylphenol			0.72	EPA Regional Screening Level for tap water
4-Methylphenol			1.4	EPA Regional Screening Level for tap water
Phenol			4.2	Arizona HBGL
Tetrachloroethene		0.005		
Trichlorofluoromethane			1.1	EPA Regional Screening Level for tap water
Xylenes		10.0		Federal MCL
Antimony		0.006		Federal MCL
Chromium III		0.1		Federal MCL
Chromium VI		0.1		Federal MCL
Copper		1.3		Federal MCL
Lead		0.015		Federal MCL
Nickel		0.1		AZ Aquifer Water Quality Standard
Silver		0.1		Federal MCL
Zinc			1.4	Arizona HBGL

[1]Cleanup levels are selected based on a hierarchy of federal/state MCLs (relevant and appropriate), Arizona Aquifer Water Quality Standards if more stringent than federal MCLs (applicable), and Arizona Health Based Guidance Level (to be considered where no standard exists under other ARARs), and EPA Regional Screening Levels (to be considered where no standard exists under the other ARARs or no Arizona HBGL exists).
HBGL – Health Based Guidance Level
MCL - Maximum Containment Level
mg/L – milligrams per liter

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Table B-3
Location-Specific Applicable or Relevant and Appropriate Requirements
Liquid Fuels Storage Area (ST012), Operable Unit 2
Williams Air Force Base, Arizona

Scope	Citation	Description	Requirement(s)	Comments	Applicable[a]	Relevant and Appropriate[b]
Federal	National Historical Preservation Act (16 USC Section 490); 36 CFR Part 800	Within area where action may cause irreparable harm, loss, or destruction of significant artifacts	Action to recover and preserve artifacts	No designated historic structures/artifacts are known in the area of the remediation	Selected Remedy[c]	
Federal	Archaeological Resources Protection Act (16 USC Section 470)	Within area where action may cause irreparable harm, loss, or destruction of significant artifacts	Action to recover and preserve artifacts	No archeological sites are known to exist in the area of remediation	Previous Remedy Selected Remedy[c]	
Federal	Native American Graves Protection and Repatriation Act (25 USC Part 3001); 43 CFR Part 10	Within area where action may uncover Native American human remains, funerary objects, sacred objects, and objects of cultural patrimony	Action to preserve in place or provide respectful and dignified disposition of human remains, funerary objects, sacred objects, and objects of cultural patrimony	No Native American use of the immediate ST012 area is known.	Selected Remedy[c]	

[a] Criteria is applicable for alternative(s) listed.
[b] Criteria is relevant and appropriate for alternatives listed.
[c] Although no known historical structures/artifacts, archeological sites, or historical native American use are associated with the immediate ST012 site, such features exist in the vicinity. This citation is applicable for such artifacts/sites encountered during the course of remedial action implementation.
CFR = Code of Federal Regulations
USC = United States Code

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Table B-4
Action-Specific Applicable or Relevant and Appropriate Requirements
Liquid Fuels Storage Area (ST012), Operable Unit 2
Williams Air Force Base, Arizona

Scope	Citation	Description	Requirement(s)	Comments	Applicable[a]	Relevant and Appropriate[b]
Federal	40 CFR Part 403 (CWA- 33 USC §§ 1251-1376)	Discharge to Publically-Owned Treatment Works	A national pretreatment program designed to protect municipal wastewater treatment plants and the environment from damage that may occur when hazardous, toxic, or other non-domestic wastes are discharged to a sewer system. Sets the requirements for discharges and permitting of discharges to publically-owned treatment works.	Discharges to a sewer are considered an off-site activity and require a permit. Extracted groundwater discharged to the sewer would require treatment to meet substantive permit requirements.	Selected Remedy	
Federal	40 CFR Parts 144-147 (SDWA - 42 USC § 300)	Underground Injection Control Standards	Establishes regulations for subsurface injections. Regulations are designed to provide for protection of groundwater used for drinking water. Requires registration of injection wells.	Applicable for injection of treated water or steam.	Previous Remedy Selected Remedy	
Federal	40 CFR Part 63, Subparts AA and IIII	National Emission Standards for Hazardous Air Pollutants	RCRA Standards for control of emissions of volatile organics	The standard requires reduction from "production accumulator vessels", leak detection, and repair programs. Product accumulator vessels include air strippers.	Previous Remedy Selected Remedy	
Federal	40 CFR 264.273 (c) (d)	Surface Water Control	Requirements for run-on prevention and run-off control and collection for a 24-hour, 25-year storm. Follow RCRA standards for treatment as a hazardous waste.			Previous Remedy Selected Remedy

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Scope	Citation	Description	Requirement(s)	Comments	Applicable[a]	Relevant and Appropriate[b]
Federal	40 CFR 264.111 40 CFR 264.178 40 CFR 264.197 40 CFR 264.288 (o)(1) 40 CFR 264.258 40 CFR 244.111	Closure with No Post-Closure Care (i.e., Clean Closure)	General performance standard requires elimination of need for further maintenance and control. Elimination of post-closure escape of hazardous waste, hazardous constituents, leachate, contaminated run-off, or hazardous waste decomposition. Applicable to all RCRA hazardous waste placed at the site after the effective date of the requirements, or placed into another unit.	Includes disposal and decontamination of equipment, structures, and soils. Removal or decontamination of all waste residues, contaminated containment system components, subsoils, and structures and management of them as hazardous waste.	Previous Remedy Selected Remedy	
Federal	40 CFR 122	Storm Water Permitting	Operations as defined in the regulations that discharge storm water must perform sampling, submit a permit application, and comply with all permit requirements, water quality standards, and effluent limitations set by Best Achievable Technology.	Applicable for discharge of storm water from industrial facilities and large construction sites (greater than 5 acres in area)		Previous Remedy Selected Remedy
Federal	40 CFR 264 and 265	Treatment of hazardous waste in units as regulated under RCRA	Design and operating standards for all hazardous waste treatment units, including miscellaneous units (long term retrievable storage, thermal treatment other than incineration, open burning, open detonation, chemical, physical, and biological treatment units using other than tanks, surface impoundments, or land treatment units) require new miscellaneous units to satisfy environmental performance standards by protection of groundwater, surface water, and air quality, and by limiting surface and subsurface migration.	The substantive portions of these requirements will be relevant and appropriate to the construction, operation, maintenance, and closure of any miscellaneous treatment unit constructed on-site for treatment or disposal of hazardous site wastes		Previous Remedy Selected Remedy

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Scope	Citation	Description	Requirement(s)	Comments	Applicable[a]	Relevant and Appropriate[b]
County	Maricopa County Air Quality Standards (Rules 200, 210, 220, 320) as dictated by the Clean Air Act; Arizona Administrative Code (AAC) R18-2-201, R18-2-206, R18-2-210, & R18-2-218	Air Emissions Control During Remediation	Control of air emissions of volatile organics, particulates, and gaseous contaminants.		Previous Remedy Selected Remedy	
State (Federal)	AAC R18-8-264 (40 CFR 264.171); (40 CFR 264.172); (40 CFR 264.173); (40 CFR 264.174); (40 CFR 264.175); (40 CFR 264.176); (40 CFR 264.177): (40 CFR 264.178); (40 CFR 268.50)	Container Storage (On Site)	Containers of hazardous waste must be: • Maintained in good condition • Compatible with hazardous waste to be stored • Closed during storage (except to add or remove waste) Inspect container storage areas weekly for deterioration. Place containers which contain free liquid on sloped, crack-free base, and protect from contact with accumulated liquid. Provide containment system with a capacity of 10 percent of the volume of containers of free liquid of the volume of the largest container, whichever is greater. Remove spilled or leaked waste in a timely manner to prevent overflow of the containment system. Keep containers of ignitable or reactive waste at least 50 feet from the facility's property line. Keep incompatible materials separate. Separate incompatible materials stored near each other by a dike or other barrier. At closure, remove all hazardous waste and residues from the containment system, and	If waste fails to meet TCLP criteria, waste is characterized as RCRA hazardous waste. These requirements are applicable for any contaminated soil, groundwater, or treatment system waste that might be containerized and stored on site prior to treatment or final disposal. Soil containing a listed waste must be managed as if it were a hazardous waste so long as it contains a constituent of the listed waste.	Previous Remedy[c] Selected Remedy[c]	

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Scope	Citation	Description	Requirement(s)	Comments	Applicable[a]	Relevant and Appropriate[b]
			decontaminate or remove all containers and liners. Storage of banned wastes must be in accordance with 40 CFR 268. When such storage occurs beyond 1 year, the owner/operator bears the burden of proving that such storage is solely for the purpose of accumulating sufficient quantities to allow for proper recover, treatment, and disposal.			
State (Federal)	ARS 49-802 (40 CFR Part 279)	Federal Used Oil Program	Standards for used oil burners who burn off-specification used oil for energy recovery.	Recovered fuels burned for energy will not be categorized as a hazardous waste or as used oil but will approximate an off-specification fuel to be used in the selected remedy's steam generation boilers.		Selected Remedy
State (Federal)	AAC R18-8-261 (40 CFR Part 261)	Characterization of Waste	Generator must characterize waste for parameters that the off-site TSDF requires for proper treatment, storage, disposal, and compliance with LDR. If waste fails to meet TCLP criteria, waste is characterized as RCRA hazardous waste.	Waste must be characterized for off-site disposal, and to meet the requirement of the off-site disposal facility for LDR.	Previous Remedy[c] Selected Remedy[c]	
State (Federal)	AAC R18-8-262 (40 CFR Part 262)	Generation of RCRA Hazardous Waste	Full requirements must be met for off-site disposal.	If waste fails to meet TCLP criteria, waste is characterized as RCRA hazardous waste. This includes packaging, labeling, manifesting, etc. On-site storage requirements are addressed separately.	Previous Remedy[c] Selected Remedy[c]	

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Scope	Citation	Description	Requirement(s)	Comments	Applicable[a]	Relevant and Appropriate[b]
State (Federal)	AAC R18-8-263 (40 CFR 263) ; (49 CFR 171 through 179)	Transportation of RCRA Hazardous Waste	RCRA hazardous waste shipped off-site for recycle of to a TSDF must meet full RCRA and DOT requirements based on type of carriage.	If waste fails to meet TCLP criteria, waste is characterized as RCRA hazardous waste.	Previous Remedy[c] Selected Remedy[c]	
State (Federal)	AAC R18-8-268 (40 CFR 268)	Disposal of RCRA Hazardous Waste	The waste will have to be characterized to provide information suitable for certification that land disposal criteria are met in full.	If waste fails to meet TCLP criteria, waste is characterized as RCRA hazardous waste and full requirements relative to off-site disposal must be met.	Previous Remedy[c] Selected Remedy[c]	
State	AAC, R18-11-405	Narrative Aquifer Water Quality Standards	A discharge shall not cause a pollutant to be present in an aquifer classified for a drinking water protected use in a concentration which endangers human health.			Selected Remedy
State	AAC R18-2-401, 402, 404 through 407, and 410	Emissions from nonpoint sources	Requirements for controlling emissions from nonpoint sources			Previous Remedy Selected Remedy
State	Arizona Groundwater Management Act ARS 45-454.01	Installation of wells and withdrawal of groundwater	Requirements for treatment and reinjection of groundwater into the aquifer that occurs as part of and on the site of a superfund remedial action			Previous Remedy Selected Remedy
State	49 ARS §282	Remedial Action Requirements	Incorporate best management practices during remedial actions to (a) assure the protection of public health and welfare and the environment, and (b) provide for the control and management of clean-up of the hazardous substance so as to allow the maximum beneficial use of the waters of the state, to the extent possible.		Previous Remedy Selected Remedy	

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Scope	Citation	Description	Requirement(s)	Comments	Applicable[a]	Relevant and Appropriate[b]
State	ARS 49-243 and ARS 49 224	Aquifer Protection Requirement and Water Quality Standards	ADEQ requirements for injection of groundwater in drinking water aquifers. All aquifers in the state are classified as drinking water aquifers. As such, remediation must restore the affected aquifer to drinking water quality with regard to chemical contamination.	Injection activities would have to be conducted in accordance with this standard.	Previous Remedy Selected Remedy	
State	ARS 49-152 and AAC R18-7-208	Recordation of a DEUR	Under a nonresidential scenario, if a remediation results in contamination being left on site above a residential SRL, but equal to or below a nonresidential SRL, the recordation of a DEUR is required.	DEUR is currently in effect.	Previous Remedy Selected Remedy	

[a] Criteria is applicable for alternatives listed.
[b] Criteria is relevant and appropriate for alternatives listed.
[c] Criteria is applicable only if confirmed by analytical results.
AAC = Arizona Administrative Code
ADEQ = Arizona Department of Environmental Quality
ARS = Arizona Revised Statutes
CFR = Code of Federal Regulations
DOT = U.S. Department of Transportation
DEUR = declaration of environmental use restriction
LDR = land disposal regulations
RCRA = Resource Conservation and Recovery Act
SRL = health based guidance level
TCLP = toxicity characteristic leaching procedure
TSDF = transportation, storage, and disposal facility

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APPENDIX C

ST012 COST ESTIMATE

Cost Summary Table

Description	Capital Cost		O&M Cost					Totals
	Description	Cost	Description	Cost	Period	Annual Equivalent	Present Value[3]	
Steam Enhanced Extraction and Enhanced Biodegradation	SEE[1,2]	$ 19,138,959	Long Term Management (5-Year Reviews and Semiannual Monitoring)	$ 1,959,231	20	$ 97,962	$1,649,169.85	
Subtotal		$ 19,138,959		$ 1,959,231			$ 1,649,170	
Total Alternative Cost (Non-discounted)								$ 21,098,190
Total Present Value Alternative Cost								$ 20,788,129

Notes:

[1]SEE capital includes design, construction, and operation for approximately 1 year

[2]SEE construction/operation includes existing SVE system operation costs for years 1-2 as a necessary component of SEE. Otherwise the costs shown exclude O&M of the SVE system.

[3]Real Discount Rates (from Appendix C of White House Office of Management and Budget Circular A-94, December 2011)
20-Year 1.7%

Estimate Documentation Report

System:

RACER Version: 10.4.0
Database Location: C:\Users\rob.singer\Documents\001.Projects\MISC RACER\Williams\First Run\Williams AFB Rev 1.mdb

Folder:

Folder Name: Williams AFB

Project:

Project ID: ST012 - Steam Injection Rev. 2
Project Name: ST012 - Steam Injection Rev. 2
Project Category: None

Location
State / Country: ARIZONA
City: WILLIAMS AFB

Location Modifier	Default	User
	0.994	0.994

Options
Database: System Costs
Cost Database Date: 2011
Report Option: Fiscal

Description: Former Williams Air Force Base, located in Mesa, Arizona. Treatment occurs in 3 partially isolated aquifers - Lower Saturated Zone (LSZ), Upper Water Bearing Zone (UWBZ), and Cobble Zone with a low permeability zone between the LSZ and UWBZ and a caliche layer in the top 10 ft of the UWBZ. Total range of treatment spans 155 ft bgs to 245 ft bgs. Water table occurs at 155, rising roughly 4 ft per year for the last 20 years. Primary contaminants are jet propellant grade 4 (JP-4) and aviation gasoline. The LNAPL plume is estimated to contain 650,000 to 1,400,000 gallons of NAPL. SVE systems operating since 1996 are estimated to have removed 575,000 gallons of hydrocarbons.

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Estimate Documentation Report

Site Documentation:

Site ID: ST012 - Steam Injection
Site Name: ST012 - Steam Injection
Site Type: None

Media/Waste Type
Primary: Groundwater
Secondary: Soil

Contaminant
Primary: Fuels
Secondary: None

Phase Names
Pre-Study: ☐
Study: ☐
Design: ☑
Removal/Interim Action: ☐
Remedial Action: ☑
Operations & Maintenance: ☑
Long Term Monitoring: ☑
Site Closeout: ☐

Documentation
Description:
Support Team:
References:

Estimator Information
Estimator Name: Robert Singer, P.E.
Estimator Title: Sr. Engineer
Agency/Org./Office: AMEC Environment & Infrastructure
Business Address: 511 Congress St.
Portland, ME 04101
Telephone Number: 207-828-2643
Email Address: rob.singer@amec.com
Estimate Prepared Date: 01/13/2012

Estimator Signature: _____ Date: _____

Reviewer Information
Reviewer Name:
Reviewer Title:
Agency/Org./Office:
Business Address:

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Estimate Documentation Report

Telephone Number:
Email Address:
Date Reviewed:

Reviewer Signature: _____ Date: _____

Estimated Costs:

Phase Names		Direct Cost	Marked-up Cost
Steam Enhanced Vapor Recovery		$13,107,054	$19,138,959
Long Term Management		$1,143,109	$1,959,231
	Total Cost:	$14,250,163	$21,098,190

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Estimate Documentation Report

Phase Documentation:

Phase Type: Remedial Action
Phase Name: Steam Enhanced Vapor Recovery
Description: See Feasibility Study
Assume:
-Costs inclusive of POTW sewer connection for treated water disposal
-Stated costs are sufficient for carbon disposal and LNAPL

Approach: In Situ
Start Date: January, 2013
Labor Rate Group: System Labor Rate
Analysis Rate Group: System Analysis Rate

Phase Markups: System Defaults

Technology Markups	Markup	% Prime	% Sub.
Heat Enhanced Vapor Extraction	Yes	100	0
Carbon Adsorption (Gas)	Yes	100	0
Overhead Electrical Distribution	Yes	100	0
Carbon Adsorption (Liquid)	Yes	100	0
Air Stripping	Yes	100	0
Professional Labor Management	Yes	100	0
Well Abandonment	Yes	100	0
Groundwater Monitoring Well	Yes	100	0
Residual Waste Management	Yes	100	0

Total Marked-up Cost: $19,138,959

Technologies:

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Estimate Documentation Report

Technology Name: Heat Enhanced Vapor Extraction (# 1)

Description	Default	Value	UOM
System Definition			
Required Parameters			
Soil Type		Gravel/Gravel Sand Mixture	n/a
Soil Permeability		40	darcies
Contamination Area		30,000	SF
Contamination Depth to Top		150	FT
Contamination Thickness		35	FT
Contract Startup		4	weeks
Contract Operation		13	months
Injection Well Configuration		Double Set	n/a
Safety Level		D	n/a
Wells			
Secondary Parameters			
Injection Well Set 1: Depth to Top of Screen	150	154.4	FT
Injection Well Set 1: Screen Length	11.67	11.6655	FT
Injection Well Set 2: Depth to Top of Screen	173	210	FT
Injection Well Set 2: Screen Length	11.67	11.6655	FT
Steam Injection Pressure Per Well	66.79	66.79	PSIA
Injection Well: Diameter	4	4	IN
Number of Injection Wells	8	31	EA
Vapor Extraction Points			
Secondary Parameters			
Vapor Extraction Points: Depth to Top of Screen	150	179.7	FT
Vapor Extraction Points: Screen Length	35	30.1	FT
Extraction Pressure Per VEP	13.72	13.72	PSIA
Vapor Extraction Points: Diameter	4	4	IN
Number of VEPs	1	45	EA
Pumps/Boilers			
Secondary Parameters			
Total Air Flow	20,995	n/a	SCFM
Steam Injection	400,000	n/a	PPH
Breakthrough Time	1	n/a	days
Steam Boiler: Size/Capacity	12,000 PPH	12,000 PPH	PPH

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Estimate Documentation Report

Technology Name: Heat Enhanced Vapor Extraction (# 1)

Description	Default	Value	UOM
Pumps/Boilers			
Secondary Parameters			
Steam Boiler: Quantity	34	4	EA
Condenser: Size/Capacity	10,000 PPH	10,000 PPH	PPH
Condenser: Quantity	20	20	EA
Vacuum: Pump Size/Capacity	30 HP, 580 SCFM	30 HP, 580 SCFM	SCFM
Vacuum: Pump Quantity	37	7	EA
Well Drilling			
Secondary Parameters			
Drilling Method	Water/Mud Rotary	Hollow Stem Auger	n/a
Drum Drill Cuttings	Yes	No	n/a
Soil Sample Collection	Yes	No	n/a

Comments: RACER LIMITATIONS:
1) 150 ft maximum for contamination depth. Manually adjust the drilling depths.

2) RACER only allows two sets of injection wells. The Depths and Screen Lengths for Set 1 have been manually adjusted to reflect the weighted average of the 6 Cobble Zone injection wells (145 ft casing and 11.7 ft screen) and the 10 UWBZ wells (160 ft casing and 11.7 ft screen). Set 2 represents the parameters for the 15 LWBZ wells (210 ft casing and 11.7 ft screen).

3) RACER only allows one set of extraction wells. The Depths and Screen Lengths for the VEPs have been manually adjusted to reflect the weighted average of the 11 Cobble Zone extraction wells (145 ft casing and 15 ft screen), the 13 UWBZ extraction wells (160 ft casing and 35 ft screen), and the 21 LWBZ extraction wells (210 ft casing and 35 ft screen).

4) Assume that area of treatment is not a variable.

5) Manually adust number of blowers, boilers, condensors to reflect TerraTherm configuration.

6) Limits treatment area to 1 acre. Scale up the piping legnths to reflect larger areas.

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Estimate Documentation Report

Technology Name: Carbon Adsorption (Gas) (# 1)

Description	Default	Value	UOM
System Definition			
Required Parameters			
Influent Flow Rate		543	CFM
Adsorption System		Modular Carbon Adsorbers (Permanent)	n/a
Know Total Organic Concentration		No	n/a
Influent Total Organic Concentration (for O&M)		0	ppm
System Redundancy		Two Adsorbers in Series	n/a
Blower		No	n/a
Heater		No	n/a
Safety Level		D	n/a

Comments:

Technology Name: Overhead Electrical Distribution (# 1)

Description	Default	Value	UOM
System Definition			
Required Parameters			
Type of Distribution		5 KV 3 Phase Primary	n/a
Distance		200	LF
Safety Level		D	n/a
Specification			
Secondary Parameters			
Pole Spacing	200	200	LF
Electric Wire Type	160 AMP Service	160 AMP Service	n/a
Electric Pole Length	10.67 m (35 FT) Pole	10.67 m (35 FT) Pole	n/a

Comments:

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Estimate Documentation Report

Technology Name: Carbon Adsorption (Liquid) (# 1)

Description	Default	Value	UOM
System Definition			
Required Parameters			
Influent Flow Rate		250	GPM
Adsorption System		Dual Bed Carbon Adsorption Units	n/a
System Redundancy		Two Adsorbers in Series	n/a
Know Total Organic Concentration (for O&M)		No	n/a
Total Organics		0	ppm
Total Chlorinated Organics		0	ppm
Safety Level		D	n/a

Comments:

Technology Name: Air Stripping (# 1)

Description	Default	Value	UOM
System Definition			
Required Parameters			
Type of Air Stripper		Low Profile Tray Stack	n/a
Removal Percentage		95	%
Influent Flow Rate		250	GPM
Volatility of Contaminants		Moderate	n/a
Safety Level		D	n/a
Configuration			
Secondary Parameters			
Number of Strippers	1	1	EA
Low Profile Stripper - Number of Trays	3	3	EA

Comments:

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Estimate Documentation Report

Technology Name: Professional Labor Management (# 1)

Description	Default	Value	UOM
System Definition			
Required Parameters			
Markedup Construction Cost ($)		18,654,520	$
Percentage	10	2.5	%
Dollar Amount		466,363	$

Comments: Scale down from 10 to 2.5% give that contractor will provide substantial oversight. Assume that this includes all analyitcal and field oversight.

Technology Name: Well Abandonment (# 1)

Description	Default	Value	UOM
System Definition			
Required Parameters			
Safety Level		D	n/a
Abandon Wells			
Required Parameters			
Technology/Group Name		Existing Wells	n/a
Number of Wells		34	EA
Well Depth		200	FT
Well Diameter		4	IN
Well Abandonment Method		Overdrill / Removal	n/a
Formation Type		Unconsolidated	n/a
Technology/Group Name		Two Horizontal Wells (1250ft)	n/a
Number of Wells		4	EA
Well Depth		625	FT
Well Diameter		6	IN
Well Abandonment Method		Abandon In-Place	n/a
Formation Type		Unconsolidated	n/a

Comments: 1. The vertical well depths and diameters are average values.

2. The maximum length for a well in RACER is 1000 ft. the two horizontal wells have a total length of 2500 feet. To account for the entire length, use 4 wells at 625 ft each.

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Estimate Documentation Report

Technology Name: Groundwater Monitoring Well (# 1)

Description	Default	Value	UOM
System Definition			
Required Parameters			
Number of Aquifers		One	n/a
Include Guard Posts		No	n/a
Depth to Groundwater to Aquifer One		150	FT
Number of Wells to Aquifer One		15	EA
Safety Level		D	n/a
Aquifer One			
Required Parameters			
Aquifer One: Average Well Depth		245	LF
Aquifer One: Formation Type		Unconsolidated	n/a
Aquifer One: Drilling Method		Sonic Drilling	n/a
Aquifer One: Well Diameter		2 Inch	n/a
Aquifer One: Sonic Casing Size		5" - 6"	n/a
Aquifer One: Well Construction Material		Stainless Steel	n/a
Aquifer One: Split Spoon Sample Collection		No	n/a
Aquifer One: Average Number of Soil Samples per Well		0	EA
Aquifer One: Soil Analytical Template		None	n/a
Aquifer One: Safety Level		D	n/a

Comments:
1. These wells represnt the Temperature Monitoring Points.
2. Air Rotary and Sonic drilling are the only choices for installation method. Sonic drilling costs are more representative.
3. Manually add three Thermocouples per well with wire leads

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Estimate Documentation Report

Technology Name: Residual Waste Management (# 1)

Description	Default	Value	UOM
System Definition			
Required Parameters			
Safety Level		D	n/a
Non-Rad Disposal			
Required Parameters			
Waste Type / Condition		Non-Hazardous Bulk Solid	n/a
Total Quantity		496	CY
Transportation Type		Truck	n/a
Truck Distance (One-way)		30	Miles

Comments: Assume $30/CY for drill cutting disposal
Change the quantity of Temp Monitoring Point Cuttings to reflect expected volume

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Estimate Documentation Report

Phase Documentation:

Phase Type: Long Term Monitoring
Phase Name: Long Term Management
Description: Five-year reviews for years 2016, 2021, 2026, 2031, 2036, 2041, including cost for site visits and reporting.

Costs for long-term anual monitoring in years 1 thorugh 5. and semiannual monitoring for VOCs in years 6 though 20.

Start Date: January, 2012
Labor Rate Group: System Labor Rate
Analysis Rate Group: System Analysis Rate

Phase Markups: System Defaults

Technology Markups	Markup	% Prime	% Sub.
MONITORING YEARS 1-5	Yes	100	0
Five-Year Review	Yes	100	0
MONITORING YEARS 6-20	Yes	100	0

Total Marked-up Cost: $1,959,231

Technologies:

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Estimate Documentation Report

Technology Name: Monitoring (# 1)
User Name: MONITORING YEARS 1-5

Description	Default	Value	UOM
System Definition			
Required Parameters			
Model Name		MONITORING YEARS 1-5	n/a
Groundwater		Yes	n/a
Surface Soil		No	n/a
Surface Water		No	n/a
Subsurface Soil		No	n/a
Sediment		No	n/a
Soil Gas		No	n/a
Air		No	n/a
Site Distance (One-way)		30	MI
Safety Level		D	n/a
Groundwater			
Required Parameters			
Average Sample Depth		200	FT
Samples per Event (First Year)		25	n/a
Samples per Event (Out Years)		25	n/a
Number of Events (First Year)		1	n/a
Number of Events (Out Years)		1	n/a
Number of Years (Out Years)		4	n/a
Secondary Parameters			
Primary Analytical Template	System Water - VOCs	System Water - Fuels	n/a
Secondary Analytical Template	None	None	n/a
Turnaround Time	Standard (21 Days)	14 Day	n/a
Data Package/QC	Stage 1	Stage 1	n/a
Sampling Method	Existing Wells - Low Flow Pump	Existing Wells - Low Flow Pump	n/a
Number of Wells/Day	4	4	EA
Contain Purge Water	Yes	Yes	n/a
QA/QC			
Secondary Parameters			
Split Samples	1: 10	1: 10	EA
Field Duplicate Samples	1: 10	1: 10	EA

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Estimate Documentation Report

Technology Name: Monitoring (# 1)
User Name: MONITORING YEARS 1-5

Description	Default	Value	UOM
QA/QC			
Secondary Parameters			
Rinse Blanks (per Round)	1	1	EA
Trip Blanks (per Day)	1	1	EA
Matrix Spikes/Matrix Spike Duplicates	1: 20	1: 20	EA
Data Management			
Secondary Parameters			
Monitoring Plan	Standard	Standard	n/a
Lab Data Review	Stage 1	Stage 1	n/a
Submit Data Electronically	Yes	Yes	n/a
Monitoring Reports	Abbreviated	Abbreviated	n/a

Comments:

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Estimate Documentation Report

Technology Name: Five-Year Review (# 1)

Description	Default	Value	UOM
System Definition			
Required Parameters			
Site Complexity		Low	n/a
Document Review		Yes	n/a
Interviews		Yes	n/a
Site Inspection		Yes	n/a
Report		Yes	n/a
Travel		No	n/a
Rebound Study		No	n/a
Start Date		January-2017	n/a
No. Reviews		4	EA
Document Review			
Required Parameters			
5-Year Review Check List		Yes	n/a
Record of Decision		Yes	n/a
Remedial Action Design & Construction		Yes	n/a
Close-Out Report		No	n/a
Operations & Maintenance Manuals & Reports		Yes	n/a
Consent Decree or Settlement Records		No	n/a
Groundwater Monitoring & Reports		Yes	n/a
Remedial Action Required		Yes	n/a
Previous 5-Year Review Reports		Yes	n/a
Interviews			
Required Parameters			
Current and Previous Staff Management		Yes	n/a
Community Groups		No	n/a
State Contacts		No	n/a
Local Government Contacts		No	n/a
Operations & Maintenance Contractors		Yes	n/a
PRPs		No	n/a
Remedial Design Consultant		No	n/a
Site Inspection			
Required Parameters			

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Estimate Documentation Report

Technology Name: Five-Year Review (# 1)

Description	Default	Value	UOM
Site Inspection			
Required Parameters			
General Site Inspection		Yes	n/a
Containment System Inspection		No	n/a
Monitoring Systems Inspection		Yes	n/a
Treatment Systems Inspection		Yes	n/a
Regulatory Compliance		Yes	n/a
Site Visit Documentation (Photos, Diagrams, etc.)		Yes	n/a
Report			
Required Parameters			
Introduction		Yes	n/a
Remedial Objectives		Yes	n/a
ARARs Review		Yes	n/a
Summary of Site Visit		Yes	n/a
Areas of Non Compliance		Yes	n/a
Technology Recommendations		Yes	n/a
Statement of Protectiveness		Yes	n/a
Next Review		Yes	n/a
Implementation Requirements		Yes	n/a

Comments:

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Estimate Documentation Report

Technology Name: Monitoring (# 2)
User Name: MONITORING YEARS 6-20

Description	Default	Value	UOM
System Definition			
Required Parameters			
Model Name		MONITORING YEARS 6-20	n/a
Groundwater		Yes	n/a
Surface Soil		No	n/a
Surface Water		No	n/a
Subsurface Soil		No	n/a
Sediment		No	n/a
Soil Gas		No	n/a
Air		No	n/a
Site Distance (One-way)		30	MI
Safety Level		D	n/a
Groundwater			
Required Parameters			
Average Sample Depth		200	FT
Samples per Event (First Year)		25	n/a
Samples per Event (Out Years)		25	n/a
Number of Events (First Year)		2	n/a
Number of Events (Out Years)		2	n/a
Number of Years (Out Years)		14	n/a
Secondary Parameters			
Primary Analytical Template	System Water - VOCs	System Water - Fuels	n/a
Secondary Analytical Template	None	None	n/a
Turnaround Time	Standard (21 Days)	14 Day	n/a
Data Package/QC	Stage 1	Stage 1	n/a
Sampling Method	Existing Wells - Low Flow Pump	Existing Wells - Low Flow Pump	n/a
Number of Wells/Day	4	4	EA
Contain Purge Water	Yes	Yes	n/a
QA/QC			
Secondary Parameters			
Split Samples	1: 10	1: 10	EA
Field Duplicate Samples	1: 10	1: 10	EA

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Estimate Documentation Report

Technology Name: Monitoring (# 2)
User Name: MONITORING YEARS 6-20

Description	Default	Value	UOM
QA/QC			
Secondary Parameters			
Rinse Blanks (per Round)	1	1	EA
Trip Blanks (per Day)	1	1	EA
Matrix Spikes/Matrix Spike Duplicates	1: 20	1: 20	EA
Data Management			
Secondary Parameters			
Monitoring Plan	Standard	None	n/a
Lab Data Review	Stage 1	Stage 1	n/a
Submit Data Electronically	Yes	Yes	n/a
Monitoring Reports	Abbreviated	Abbreviated	n/a

Comments:

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APPENDIX D

RESPONSE TO EPA AND ADEQ COMMENTS

Item	Page	Section	Line(s)	EPA Comment	Air Force (AF) Response to Comment (RTC)
General Comments					
1		Section 6		Section 6 discussing the evaluation of existing and revised remedies is confusing and should be revised. It would be less confusing to refer to the original selected remedy as simply the "original selected remedy" rather than "Alternative C" as so many years has passed since the original proposed plan and the identification with "Alternative C" has not been used elsewhere in the current ROD amendment or proposed plan that went to the public. There also appears to be some confusion between the originally selected remedy which was for pumping and treating groundwater and the interim measure of passive recovery of floating product as it accumulated in wells, which has not been selected in any decision document. Some of the discussion in this section appears to pertain to monitored natural attenuation (MNA), which was not part of the original pump and treat remedy. The original selected remedy was abandoned and not implemented after it failed to meet performance objectives. The failure of the remedy should be explained in the text, and the text discussing the original selected remedy should be revised to at it [*sic*] pertain to the failed pump and treat remedy.	Replaced "Alternative C" with "Alternative C, the original selected remedy," throughout Section 6. The original select remedy included LNAPL and groundwater extraction and treatment. It is the AF's interpretation that continued recovery of LNAPL that accumulated in wells implemented the LNAPL extraction portion of the selected remedy to the extent practical given the limitations of groundwater extraction and treatment. The discussion of MNA in Section 6 pertains to Alternative ST012-3, the Revised Selected Remedy. Section 1.3, paragraph three identifies that the original selected remedy was abandoned and not implemented and explains the reasons. In addition Section 6 includes text related to the failure of the remedy (e.g., Section 6.1, second paragraph, Section 6.6, second paragraph).

Item	Page	Section	Line(s)	EPA Comment	Air Force (AF) Response to Comment (RTC)
Specific Comments					
1	1-2		214-215	Lines 214 and 215 (page 1-2) state, "When the effectiveness of contaminant mass removal by SEE has diminished, the remedial action will transition to enhanced bioremediation." This statement is adequate for the RODA; however, the criteria for transition from SEE to enhanced bioremediation will require further definition during remedial design.	The operational parameters that will be evaluated to guide the timing of the transition from SEE to enhanced bioremediation will be presented in the Remedial Design/Remedial Action Work Plan. A clarification sentence has also been added to the Section 1.4 text (see response to ADEQ specific comment number 4).
2	3-6		417	The sentence beginning "The groundwater elevation…" contains superfluous words that should be deleted.	The text "rise has" has been deleted.
3	5-4		833-836	Lines 833 to 836 (page 5-4) state, "In the absence of alternative mutual agreement between the AF, EPA and ADEQ, cleanup levels will have been attained when monitoring results from no more than a two year period have demonstrated that cleanup levels were not exceeded." Since the final step in the remedial process is monitored natural attenuation (MNA), which can be a slow process, careful consideration should be given to the time period required to demonstrate that the cleanup levels have been attained. This, also, can be addressed during the Remedial Design stage.	The intent was for two years of sampling once MNA has achieved the cleanup levels. The text has been revised for clarification (see response to ADEQ comment number 18).

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Item	Page	Section	Line(s)	EPA Comment	Air Force (AF) Response to Comment (RTC)
4	5-5		885	Please explain the statement regarding the Arizona Health-Based Guidance Level for naphthalene which is "no longer in effect".	See response to ADEQ specific comment number 25.
5	6-2	Section 6.5		Page 6-2, Section 6.5, which discusses the short-term effectiveness of the chosen alternative, states that Alternative ST012-3 has a time frame of approximately 20 years, and that the risks to the community and the environment of this alternative are primarily due to the steam injection activities. This section should make it clear that the steam injection portion of the remedy will only require approximately a two year period, and the remainder of the 20 year time frame, during which enhanced biodegradation and MNA are occurring, will involve much less risk to the community and the environment.	Added the following as the second sentence of Section 6.5 paragraph two: "Steam injection activities would occur for approximately two years; the remainder of the 20-year cleanup time frame would involve enhanced biodegradation activities and MNA. Added the following sentence at the end of paragraph two: "Risks to the community and environment will be minimal after steam injection activities conclude and enhanced biodegradation and MNA activities begin."
6	6-2		986 and 988	Lines 986 and 988 (page 6-2) mention a 'fume incinerator'. The vapor treatment equipment that will be used for the SEE portion of the remediation is more properly called a thermal oxidizer, and this term should be used in this document to avoid confusing the public.	The term "fume incinerator" has been changed to "thermal oxidizer" in two places in last paragraph of Section 6.5. In Section 6.7 second paragraph text was changed from "fume incineration" to "thermal oxidation"

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Item	Page	Section	Line(s)	EPA Comment	Air Force (AF) Response to Comment (RTC)
7	6-3	Section 6.9		The first paragraph of this section states, "Upon completion of the public comment period…". However, the public comment period closed in May, before the draft RODA was submitted. This section should be updated to include any comments from the community that were received.	The first paragraph of this section has been updated as follows: "Mailings, a public notice, a public comment period and a public meeting occurred in April 2013 (see Section 9.0) to solicit input on the preferred alternative, Alternative ST012-3 from the FFS. No oral or written public comments, in favor or against the preferred alternative, were received during the public meeting or comment period. Therefore, the community acceptance of the amended remedy presented in this ROD Amendment 2 is inferred."

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Item	Page	Section	Line(s)	ADEQ Comment	Air Force (AF) Response to Comment (RTC)
General Comments					
1				To avoid confusion among public viewers of the ROD Amendment 2, please review the document for consistency regarding the terms used to describe non-aqueous phase hydrocarbons. Although the relationship between the terms "LNAPL" and "free-phase product" is discussed in Line 165, the additional terms "free product", "free-phase LNAPL", and "free-phase organics" are also used. Throughout the text, the term "LNAPL" is generally used when referring to the ROD Amendment 2 Revised Remedy, however, the term "free-phase product" is used in Table 5-1 and Section 5.1 when referring to the Revised Remedy.	Text has been revised to apply “LNAPL” consistently throughout the document and replace other terms such as “free-phase product”, "free product", "free-phase LNAPL", and "free-phase organics". Clarification has been added to Section 1.3, second paragraph, that while the OU-2 ROD uses the term “free-phase product” that “LNAPL” would be used thereafter in ROD Amendment 2.
2				Document should include a contaminant record table presenting each contaminant's high-to-low concentration range, average concentration, contaminant-detected quantity compared to total samples analyzed quantity, etc.	Table 4-4 from the OU-2 ROD has been provided as Appendix A to ROD Amendment 2. This table includes a list of detected constituents in OU-2 groundwater monitoring wells, frequencies of detection, and ranges of detected concentrations. Reference to this new Appendix has been added to the end of Section 3.2.2 as follows: “Table 4-4 from the OU-2 ROD, provided in Appendix A, summarizes groundwater contaminant characteristics from historical groundwater monitoring. It includes a list of detected constituents in OU-2 groundwater

Item	Page	Section	Line(s)	ADEQ Comment	Air Force (AF) Response to Comment (RTC)
					monitoring wells, frequencies of detection, and ranges of detected concentrations." Previous Appendices A, B, and C have been renamed B, C, and D, respectively.
3				The 1992 ROD stated ST-012 would be addressed in the RODs for OU-I and OU-3. Section 1.2 should include text making absolutely clear, based upon this RODA, which ROD(s) is(are) applicable or no longer applicable.	The following text has been added to Section 1.2: "The OU-2 ROD selected a remedy for shallow soil (less than 25 feet [ft] below ground surface [bgs]) and groundwater and indicated that deep soil (greater than 25 ft bgs to the water table) would be addressed in the OU-3 ROD. Later, the deep soil was included in OU-2 ROD Amendment 1 (IT, 1996) rather than included in the OU-3 ROD. OU-2 ROD Amendment 1 did not affect the groundwater remedy selected in the original OU-2 ROD. Therefore, this ROD Amendment 2 represents a change to the original OU-2 ROD." The acronym definition of "ft bgs" has been removed in Section 1.3, last paragraph.
4				In several instances, the discussion of cleanup levels and chemical-specific ARARs is inconsistent with the Final Focused Feasibility Study. Table B-2 of the FFS cites the Arizona Aquifer Water Quality Standard as the Applicable requirement for the majority of the listed contaminants, whereas the ROD Amendment 2 (Tables 5-2 and A-2) cites	The following text has been added to the end of the first paragraph in Section 8.2.1: "For consistency with CERCLA guidance, the basis of the cleanup levels presented in the FFS was changed in this ROD Amendment 2 to cite the federal MCL rather than the state standard where the state standard is numerically equivalent to the federal MCL. In

Item	Page	Section	Line(s)	ADEQ Comment	Air Force (AF) Response to Comment (RTC)
				the EPA MCL for those constituents. In addition, the FFS cites the USAF risk-based allowable concentration as the Applicable requirement for trichlorofluoromethane, 2methylphenol, and 4-methylphenol, whereas the amended ROD cites the EPA Region 9 Tap Water Risk Screening Level. Section 8.2.1 should include a brief discussion in explaining the reason or reasons for changing the references cited in the FFS to those cited in the ROD Amendment 2.	addition, cleanup levels presented in the FFS based on the AF risk assessment were updated to use the EPA risk-based Regional Screening Levels to incorporate updates in toxicity values that have occurred since the OU-2 risk assessment."
Specific Comments					
1	ii	Table of Contents	90	In the section title, the closing parenthesis following the word "Recovery" should be removed and placed after the word "Technologies".	The parenthesis has been relocated.
2	1-2	Section 1.3 Assessment of the Site	199-200	Clarify and specify items not revised or altered. If appropriate, revise sentence beginning "The ROD Amendment 2..." to "The ROD Amendment 2 does not revise or alter the existing OU-2 ROD and OU-2 RODA #1 with the exception of what is discussed and presented in Sections 1.4 and 4.0."	Change made as suggested except that reference to Section 4.0 has been changed to Section 5.0 and Section titles have been added after the section numbers.
3	1-2	Section 1.4 Description of the Revised Selected Remedy	207	Add "ROD" after the term "OU-2".	Addition made.

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Item	Page	Section	Line(s)	ADEQ Comment	Air Force (AF) Response to Comment (RTC)
4	1-2	Section 1.4 Description of the Revised Selected Remedy	214-215	"When the effectiveness of contaminant mass removal by SEE has diminished" is an extremely vague criterion for transitioning from steam injection to enhanced bioremediation. It should be established (prior to publishing the RODA) that the criteria for transitioning from steam injection to enhanced bioremediation and from enhanced bioremediation to monitored natural attenuation will be developed jointly by the USAF team, EPA, and ADEQ.	A sentence has been added immediately after the sentence indicated that reads: "The criteria that will be evaluated for this transition will be developed jointly by the AF, EPA, and ADEQ as part of the Remedial Design/Remedial Action Work Plan." A similar sentence was added to the fourth bullet in Section 5.1: "The criteria to cease SEE activities and proceed with enhanced bioremediation will be developed jointly by the AF, EPA, and ADEQ as part of the Remedial Design/Remedial Action Work Plan."
5	1-4	Section 1.7 Authorizing Signatures	284+	Please change ADEQ signatory to: Tina L. LePage Remedial Projects Section Manager Arizona Department of Environmental Quality	Change made.
6	2-1	Section 2.0 Introduction to the Site and Statement of Purpose	289	The former Williams AFB is not located adjacent to any portion of Pinal County. The reference to Pinal County should be removed.	Text referencing Pinal County has been removed.
7	2-1	Section 2.0 Introduction to the Site and Statement of Purpose	296	Add an appropriate citation and include the FFA in the References section of the ROD Amendment 2.	Citation added and FFA added to references list.

ED_005025_00013684-00124

Item	Page	Section	Line(s)	ADEQ Comment	Air Force (AF) Response to Comment (RTC)
8	3-2 thru 3-4	Table 3-1		EPA and ADEQ concurrence documents should be included/referenced to demonstrate regulatory agencies' concurrence.	The purpose of the table is to document historical activities at the site. EPA and ADEQ have been involved throughout these investigations. EPA and ADEQ involvement is documented for many, but not all, of these documents through response to comments and regulatory correspondence. A note has been added at the end of the table that reads: "[1]Review, comment, and concurrence has been provided by EPA and ADEQ throughout these investigation/remediation activities." The note is referenced in the column heading for "References".
9	3-5	Section 3.2.1 Site Hydrogeology -	371	For consistency, capitalize the first letter of the term "lower saturated zone".	Correction made.
10	3-6	Section 3.2.3 LNAPL at ST012	417	The sentence starting with "The groundwater elevation...." is confusing. The two words "has rise" immediately following "ST012" should be deleted.	The text "rise has" has been deleted.
11	3-6	Section 3.2.3 LNAPL at ST012	418	The sentence containing the partial phrase "certain wells" should be altered, with the specific wells listed.	The word, "certain" has been deleted.
12	3-6	Section 3.2.3 LNAPL at ST012	419	The second instance of the word "was" should be removed.	The first instance of "was about" has been replaced with "of".
13	4-2	Section 4.3 Groundwater Monitoring	581-582	The sentence refers to a "large, slowly changing plume". Please clarify the meaning of this term.	The adjectives, "large, slowly changing" have been deleted.

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Item	Page	Section	Line(s)	ADEQ Comment	Air Force (AF) Response to Comment (RTC)
14	4-6	Section 4.7 ST012 Dispute	733+	Section should leave reader with perception that dispute parties have resolved issues and are moving forward. Although this section is appropriate, important and should be discussed, the message to the reader may leave unanswered questions, i.e., was the dispute resolved. Section text could clarify dispute resolution purpose. Timeline events could be elaborated upon to show responsible party, stakeholder, and regulatory agency group progress milestones like TEE re-engagement, etc.	Text has been updated in accordance with ADEQ suggestions. Sentences have been added to Section 4.7 to describe the purpose of the dispute and clarify that the dispute was resolved based on correspondence between the AF and EPA/ADEQ in 2006. Additional information was also added to describe activities implemented at ST012 during completion of the ST012 FFS and OU-2 ROD Amendment 2. Additional detail regarding TEE pilot test implementation was not added since it is already summarized in Section 4.6. The relevant dispute and dispute resolution letters are referenced in Section 4.7 and provide additional information for interested parties as needed. The following text has been added after the first sentence in Section 4.7: "Prior to the dispute, the AF and regulatory agencies had reached consensus on augmenting the OU-2 groundwater remedy with the TEE technology. The EPA and ADEQ invoked formal dispute because, after partial construction of the first phase of a TEE pilot treatment system, further work was terminated by the AF due to a change in program funding criteria. In February through May 2006, the AF, EPA and ADEQ exchanged dispute resolution letters in which the AF agreed to proceed with a TEE pilot test at ST012 (AFRPA, 2006a; EPA and ADEQ, 2006a; AFRPA, 2006b; EPA and

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Item	Page	Section	Line(s)	ADEQ Comment	Air Force (AF) Response to Comment (RTC)
					ADEQ, 2006b)." The following was added at the end of the paragraph: "During the interim period while the ST012 FFS and OU-2 ROD Amendment were being completed, the AF continued implementation of the OU-2 ROD remedy as follows: • Operated and optimized the deep soil SVE system. • Continued LNAPL removal activity. • Restarted and operated the existing groundwater extraction wells – The most functional of the TEE pilot study extraction wells were operated to extract and treat contaminated groundwater. Operation of the extraction wells removed benzene mass from the source area and provided an element of hydraulic containment within the source area. • Continued groundwater monitoring – Annual groundwater monitoring is ongoing in order to monitor the ST012 contaminant plume and ensure protectiveness of human health and the environment."

Item	Page	Section	Line(s)	ADEQ Comment	Air Force (AF) Response to Comment (RTC)
15	5-3	Section 5.1 Description of Revised Remedy: Alternative ST012-3: Steam Enhanced Extraction and Enhanced Bioremediation	789	The phrase "screened between the three aquifers" should state "screened in the three aquifers".	The phrase has been changed to “screened in the three zones”. “Zones,” was used for consistency with the hydrogeology described in Section 3.2.1 (all three zones are part of the upper aquifer).
16	5-3	Section 5.1 Description of Revised Remedy: Alternative ST012-3: Steam Enhanced Extraction and Enhanced Bioremediation	803-804	The phrase "residual increase in temperature" should be replaced with "residual heat in the treatment area following steam injection".	The sentence has been revised as follows: “Residual heat in the treatment area following cessation of steam injection is anticipated to enhance biological activity.”
17	5-4	Section 5.1 Description of Revised Remedy: Alternative ST012-3: Steam Enhanced Extraction and Enhanced Bioremediation	814-820	This section on groundwater monitoring should explain that one objective of monitoring during the injection of steam is to verify that the dissolved plume and contaminants mobilized by the injection of steam are not being driven beyond the zone of capture of the extraction system.	The following has been added as the second sentence in the bullet: “One objective of monitoring during the injection of steam will be to verify that the dissolved contaminants and LNAPL are not being driven beyond the extraction system zone of capture by the injection of steam.”

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Item	Page	Section	Line(s)	ADEQ Comment	Air Force (AF) Response to Comment (RTC)
18	5-4	Section 5.1 Description of Revised Remedy: Alternative ST012-3: Steam Enhanced Extraction and Enhanced Bioremediation	833-836	The USAF has developed "fallback" criteria for determining when cleanup levels have been attained. If such criteria are to be included in the RODA they should be negotiated between the USAF team, EPA, and ADEQ prior to finalizing the RODA.	To clarify the intent, the sentence has been revised to read: "In the absence of alternative mutual agreement between the AF, EPA and ADEQ, cleanup levels will have been attained when monitoring results throughout the plume reach concentrations at or below the cleanup levels and remain below cleanup levels throughout a two year period of continued groundwater monitoring after cleanup levels were initially achieved."
19	5-5	Section 5.2 Remedial Action Objectives	865	If the intent is to show "1 x 10-6 to 10-4" as an exponential range, use word processing superscript utility and change text to expand the exponent ("1 x 10^{-6} to 1 x 10^{-4}").	Superscript has been added.
20	5-5	Section 5.2 Remedial Action Objectives	865	It is suggested that Remedial Action Objectives "1x 10-6 to 10-4" be replaced with the phrase "an acceptable" or that if specific criteria are to be included in the RODA that criteria should be accepted by the USAF team, EPA, and ADEQ prior to finalizing the RODA.	Specific standards (drinking water standards) are covered by the first RAO bullet. As indicated at the end of the second RAO bullet, the risk-based criteria apply only where specific drinking water standards are not established. The range $1x10^{-6}$ to $1x10^{-4}$ is the established CERCLA risk management range. No change has been made to the text.
21	5-5	Section 5.2 Remedial Action Objectives, Table 5-2		The term "OU-ROD" should be changed to "OU-2 ROD".	Correction has been made.
22	5-7	Section 5.3 Expected Outcome	909	The term "cleanup levels" should be changed to "action levels" in reference to the OU-2 ROD.	Change has been made.

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Item	Page	Section	Line(s)	ADEQ Comment	Air Force (AF) Response to Comment (RTC)
23	8-2	Section 8.4		In the section title, the closing parenthesis following the word "Recovery" should be removed and placed after the word "Technologies".	The parenthesis has been relocated.
24	A-2	Appendix A		Because of the abundance of prehistoric Hohokam features and artifacts found on and around the former Williams AFB, the National Historical Preservation Act (16 USC Section 490); 36 CFR Part 800, the Archeological Resources Protection Act (16 USC Section 470), and the Native American Graves Protection and Repatriation Act (25 USC Part 3001); 43 CFR Part 10 should be added as site specific ARARs.	Although regionally such features and artifacts are known to exist, no such findings have occurred at ST012 or in close proximity to ST012. The AF has concluded that it is not appropriate to identify these citations as ARARs based on a possibility rather than known evidence of prehistoric or archeologically findings at ST012. Recognizing the possibility that such features and artifacts could be discovered, Section 8.2.2, Location-Specific ARARs identifies the contingency actions that will be taken which would include review and compliance with these citations. No change has been made to the text.
25	A-2	Appendix A		Clarify the phrase intent associating Arizona Health Based Guidance Levels (HBGLs) with "no longer in effect". Naphthalene has clean up standards. With respect to soil, effective May 5, 2007 the State of Arizona adopted Soil Remediation Levels (SRLs). The SRLs replaced the HBGLs. The text should clarify the specific contaminant concentration clean up standards: HBGLs (memorialized); SRLs for appropriate media (see Arizona Administrative Code, Title 18, Chapter 7, Article 2, Supplement 09-1); or, detail	The naphthalene SRL is a soil standard not relevant to OU-2 groundwater. Table A-2 (now B-2) memorializes the specific cleanup standard for naphthalene and the basis. In addition the text has been revised to read: “The original OU-2 ROD naphthalene action level was based on an Arizona Health-Based Guidance Level (HBGL). Arizona now has a regulatory standard for naphthalene in surface water that is used as a drinking water source. This naphthalene standard was not in place at the time of the OU-2 ROD (promulgated in 2002 [8 Arizona

Item	Page	Section	Line(s)	ADEQ Comment	Air Force (AF) Response to Comment (RTC)
				other media-specific criteria accepted by the USAF team, EPA, and ADEQ.	Administrative Register 1264]). The naphthalene surface water standard is part of a promulgated regulation that is considered to be a relevant and appropriate requirement. The HBGL is a risk-based guidance level developed for drinking water (ADHS, 1992) and is not part of a promulgated standard. Under CERCLA, chemical-specific ARARs are typically selected as cleanup levels, where available and risk-based values are typically used for cleanup levels where a chemical-specific ARAR is not available. On this basis, the surface water standard for use as a drinking water source is the basis of the naphthalene cleanup level in this ROD Amendment 2. The November 2012 naphthalene results are below the cleanup level in this ROD Amendment 2." The same text revisions have been made in Section 5.2 (second paragraph after bullets)
26		Appendix A, Table A-3		Correct Declaration of Environmental Use Restriction acronym to "DEUR".	Correction made.

RESPONSE TO EPA COMMENTS DATED 16 AUGUST 2013
DRAFT FINAL RECORD OF DECISION AMENDMENT 2, GROUNDWATER, OPERABLE UNIT 2, ST012
FORMER WILLIAMS AFB, MESA, ARIZONA

Item	Page	Section	Line(s)	EPA Comment	Air Force (AF) Response to Comment (RTC)
Specific Comments					
1	1-1	1.2	136	Insert "soil vapor extraction" before "remedy for shallow soil"	The change has been made.
2	1-1	1.2	137	Insert "hydraulic extraction remedy for" before "groundwater". Insert period after "groundwater" and strike the rest of the sentence regarding OU3 ROD.	The changes have been made.
3	1-1	1.2	138	Insert "soil vapor extraction for" after "Later" and before "the deep soil", striking the rest of the sentence after OU2 ROD amendment.	The changes have been made.
4	1-1	1.2	140	Change period to comma after OU2 ROD, change "therefore" to "however".	The changes have been made.
5	1-1	1.2	141	Add "from hydraulic extraction of groundwater to Steam Enhanced Extraction".	The following has been added, "from hydraulic extraction of groundwater to steam enhanced extraction (SEE) and enhanced bioremediation."
6	1-1	1.2	142	Unnecessary comma after "Arizona".	The change has been made.
7	3-6	3.2.3	441	Change to: The groundwater rise has "altered the distribution of LNAPL in wells".	The change has been made.
8	6-1	6.2	995	Insert "only" between "would" and "comply".	The change has been made.

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Item	Page	Section	Line(s)	ADEQ Comment	Air Force (AF) Response to Comment (RTC)
General Comments					
2				Document should include a contaminant record table presenting each contaminant's high-to-low concentration range, average concentration, contaminant-detected quantity compared to total samples analyzed quantity, etc. The revised Draft Final RODA 2 includes a copy of Table 4-4 from the December 1992 Final ROD in Appendix A. Because the 2013 RODA document amends a much older document, and this 2013 public document will define a final remedy for the site, it is important that the public be provided an inclusive, stand-alone document. The table should be updated to include all contaminant concentration data collected since 1992. Additional columns should be added to the table to indicate the well(s) that contained the highest concentration of each particular contaminant and the date on which that concentration was reported	A revised version of Table 4-4 from the December 1992 Final ROD is provided in Appendix A (Table A-1) that includes the low-to-high concentration range, average concentration, contaminant-detected quantity compared to total samples analyzed quantity (referred to as frequency of detection), and the well location of the maximum detected concentration for each contaminant of potential concern reported for the November 2011 annual groundwater monitoring event. Presentation of the information requested in the comment is provided for November 2011 since it is the most current published data for ST012. November 2011 groundwater monitoring data are appropriate and sufficient to support remedy selection since they were used as the basis for evaluation of remedial alternatives in the OU-2 Focused Feasibility Study and are the basis for groundwater contaminant distribution maps provided in the OU-2 ROD Amendment (Figures 3-1 and 3-2). As additional supporting information, the historical analytical summary tables for TPH, VOCs, SVOCs and metals that were presented in the ST012 2011 Annual Groundwater Monitoring Report have been included in Appendix A-2. Text at line 431 of the Draft Final OU-2 ROD Amendment 2 was revised as follows:

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					"Appendix A-1 (Table A-1) summarizes groundwater contaminant characteristics from the historic groundwater monitoring data presented in Table 4-4 of the OU-2 ROD and includes updated groundwater contaminant characteristics from the November 2011 annual groundwater monitoring event (URS, 2012a). November 2011 groundwater monitoring data were used as the basis for evaluation of remedial alternatives in the OU-2 Focused Feasibility Study and are the basis for groundwater contaminant distribution maps provided in Figures 3-1 and 3-2. Appendix A-2 includes historical analytical summary tables for total petroleum hydrocarbons (TPH), VOCs, SVOCs and metals from the ST012 2011 Annual Groundwater Monitoring Report (URS, 2012a). As discussed above, in accordance with the OU-2 ROD, groundwater monitoring has been conducted and presented in groundwater monitoring reports, the most recent of which is for the sampling completed in November 2011. Consistent with the COPCs identified in the OU-2 ROD, ST012 groundwater sample analyses are conducted for VOCs, SVOCs, metals and TPH in order to monitor groundwater conditions including contaminant concentrations, concentration trends, contaminant distribution, and potential contaminant migration. Recommendations are provided in the groundwater monitoring reports for additions or modifications to the monitoring program as needed. Based on the

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					groundwater monitoring and reports completed for ST012, the contaminants detected remain consistent with those identified during the original site characterization activities; concentrations of the primary fuel-related contaminants, such as benzene, toluene, ethyl benzene, xylenes, and naphthalene have remained within the ranges originally identified in the OU-2 ROD (see Appendix A-1 table and Appendix A-2), and benzene remains as the contaminant most representative of ST012 groundwater impacts due to its wide distribution and potential threat to human health and the environment. The maximum contaminant detections reported at ST012 were detected and reported in the early site investigations and RI, as summarized from OU-2 ROD Table 4-4 in Appendix A-1 (Table A-1)."
Specific Comments					
8	3-2 thru 3-4	Table 3-1		EPA and ADEQ concurrence documents should be included/referenced to demonstrate regulatory agencies' concurrence. Because the 2013 RODA is a public document that defines a final remedy for the site, it is important that the public is assured of the regulatory agencies' concurrence with the methods used and the technologies implemented to arrive at the final decision ADEQ acknowledges that Table 3-1 (within the Draft Final	The AF agrees with ADEQ's comment that the public be assured of the regulatory agencies' concurrence with the methods used and the technologies implemented in regard to the ST012 remedy decision. It is the AF's interpretation that such assurance is provided by the AF's compliance with CERCLA including the following: 1) The AF's and agencies' fulfillment of their respective roles and responsibilities as established in the Federal Facility Agreement (FFA) referenced in Section 2.0 of the OU-2

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				RODA 2) includes notation at the bottom of the table. However, the note is not sufficient indication of the regulatory agencies' concurrence. Table 3-1 should include a column that references, at a minimum, the ADEX concurrence documents associated with listed Final investigation reports. The public should be able to track the investigative basis and corresponding regulatory concurrence used to arrive at the ROD amendment decisions.	Record of Decision (ROD) Amendment 2. Under Section 7 of the FFA, the AF prepares plans, reports and other documents, such as those listed in Table 3-1, for agency review and comment. Documents under the FFA are finalized with agency concurrence after completion of review and resolution of comments unless a dispute is invoked on a primary document. In practice, regulatory agency concurrence on comment resolution and final documents are often performed through submitted responses, telephone conference calls, email correspondence, and BRAC Cleanup or technical meetings. There is no requirement under the FFA to document confirmation of regulatory concurrence or that regulatory agency concurrence letters be issued in order to finalize a document. In many cases, EPA and ADEQ have not issued concurrence letters on final documents, instead, the documents have been finalized in accordance with the FFA process. Therefore, the documents are final, but concurrence letters may not be available for all documents listed in Table 3-1. 2) AF compliance and regulatory agency involvement in fulfilling the Public Participation requirements of CERCLA discussed in Section 9 of the OU-2 ROD Amendment 2. As described in Section 9, the AF notified the public of the Proposed Plan and preferred alternative for revising the ST012 groundwater remedy and completed a

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					public comment period including a public meeting for presenting the Proposed Plan and preferred alternative. The Proposed Plan presented the site information, remedy selection process and supporting documentation for the preferred alternative and made all supporting documentation available to the public on the Administrative Record. The Proposed Plan established that the EPA and ADEQ expressed support for the ST012 preferred alternative. Regulatory agency acceptance of the revised groundwater remedy is also described in Section 6.8 of the OU-2 ROD Amendment 2. 3) Resolution of agency review comments on the Draft and Draft Final versions of the OU-2 ROD Amendment 2 as addressed in Section 7 and Appendix D of the OU-2 ROD Amendment 2. No agency comments have been received that indicate nonconcurrence with the supporting documentation for the OU-2 ROD Amendment 2. 4) Regulatory agency signature of the OU-2 ROD Amendment 2 indicating that, as stated in the Declaration, the EPA approves of and the ADEQ concurs with the remedy selected by the OU-2 ROD Amendment 2. By virtue of regulatory agency approval or concurrence with the remedy selected in the OU-2 ROD Amendment, the public is assured of the regulatory agencies' concurrence with the methods used and technologies implemented

Item	Page	Section	Line(s)	ADEQ Comment	Air Force (AF) Response to Comment (RTC)
					in regard to the ST012 remedy decision. No revisions have been made to the text or tables in the Final RODA 2.
17	5-4	Section 5.1	859-862	This section on groundwater monitoring should explain that one objective of monitoring during the injection of steam is to verify that the dissolved plume and contaminants mobilized by the injection of steam are not being driven beyond the zone of capture of the extraction system. ADEQ concurs with the response to this comment. The requested phrase has been added to the text.	No additional changes have been made to the Final RODA 2.
20	5-5	Section 5.2	911	It is suggested that Remedial Action Objectives "1x 10-6 to 10-4" be replaced with the phrase "an acceptable" or that if specific criteria are to be included in the RODA that criteria should be accepted by the USAF team, EPA, and ADEQ prior to finalizing the RODA. ADEQ concurs with the response to this comment. No changes have been made to the text.	No additional changes have been made to the Final RODA 2.
24	B-10	Appendix B (was Appendix A in the Draft RODA 2)		Because of the abundance of prehistoric Hohokam features and artifacts found on and around the former Williams AFB, the National Historical Preservation Act (16 USC Section 490); 36 CFR Part 800, the Archeological Resources Protection Act (16 USC Section 470), and the Native	AF has added Table B-3 to include the location specific ARARs that are associated with prehistoric Hohokam features and artifacts found in the area. The previous Table B-3 has been relabeled as Table B-4. The first three sentences of the 2nd to last paragraph in Appendix B have been revised

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				American Graves Protection and Repatriation Act (25 USC Part 3001); 43 CFR Part 10 should be added as site specific ARARs. Despite the fact that prehistoric Hohokam features and artifacts have not been found at the Site ST012, those historical features have been found at nearby sites. During the course of the proposed remediation program, it may become necessary to drill additional soil borings and wells outside of the current site boundaries. Therefore, the National Historical Preservation Act (16 USC Section 490); 36 CFR Part 800, the Archeological Resources Protection Act (16 USC Section 470), and the Native American Graves Protection and Repatriation Act (25 USC Part 3001); 43 CFR Part 10 are all applicable regulatory requirements, and should be added to Appendix A.	to read: "Tables B-1 through B-4 summarize the identification process. Citations and identification of specific requirements have been performed for the Selected Remedy and the previous remedy identified in the original ROD (IT, 1992d). The analysis of alternatives evaluates each alternative's ability to comply with the federal and state ARARs identified in Tables B-1, B-3, and B-4." The text in Section 8.2.2 has been revised to read: "Location-specific ARARs are presented in Table B-3 of Appendix B. Location-specific ARARs will be addressed by complying with the Programmatic Agreement (AF, 1995) for Base Realignment and Closure Act at Williams AFB, as needed, to avoid irreparable harm, loss or destruction of discovered significant artifacts and to preserve or provide respectful disposition of Native American human remains."
25	B-2	Appendix B (was Appendix A in the Draft RODA 2)		Clarify the phrase intent associating Arizona Health Based Guidance Levels (HBGLs) with "no longer in effect". Naphthalene has clean up standards. With respect to soil, effective May 5, 2007 the State of Arizona adopted Soil Remediation Levels (SRLs). The SRLs replaced the	The action level established for naphthalene in the OU-2 ROD will be retained as the OU-2 ROD Amendment 2 cleanup level. Table B-2 (Appendix B) and Table 5-2 have been revised accordingly. Recent groundwater monitoring results

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				HBGLs. The text should clarify the specific contaminant concentration clean up standards: HBGLs (memorialized); SRLs for appropriate media (see Arizona Administrative Code, Title 18, Chapter 7, Article 2, Supplement 09-1); or, detail other media-specific criteria accepted by the USAF team, EPA, and ADEQ. The AF has provided a more detailed discussion of the Remedial Action Objective for napththalene; however it is inappropriate in this case to use the referenced surface water standard. Although neither the EPA nor the State of Arizona have promulgated a numeric groundwater quality standard for naphthalene in groundwater, Arizona Administrative Code R18-11-405, Narrative Aquifer Water Quality Standards is a promulgated standard that is relevant and appropriate. R18-11-405(A) states "A discharge shall not cause a pollutant to be present in an aquifer classified for a drinking water protected use in a concentration which endangers human health." The Arizona Department of Health Services developed the Human Health-Based Guidance Levels (HBGLs) as a risk-based approach to determine representative concentrations of contaminants in drinking water that are	(November 2012) have indicated that naphthalene concentrations exceed the cleanup level, thus, naphthalene has been re-categorized as a COC. The last paragraph in Appendix B and Section 5.2 have been revised to read: "The identification of groundwater cleanup levels based on the groundwater RAOs is documented in Table B-2 of Appendix B and summarized in Table 5-2. These cleanup levels were identified in the OU-2 ROD and have been updated based on current standards as presented in Table B-2. The OU-2 ROD identifies only COPCs. Based on the November 2012 groundwater sampling event (AMEC, 2013c), benzene, toluene, naphthalene, chromium, and nickel were detected above the OU-2 ROD action levels. Chromium and nickel have been associated with well construction materials. The only compounds related to site contamination that exceed the OU-2 ROD Amendment 2 cleanup levels are benzene, toluene, and naphthalene. Therefore, benzene, toluene, and naphthalene have been identified as COCs. The remaining ST012 compounds identified for groundwater in the OU-2 ROD remain as COPCs as presented in the OU-2 ROD." The surface water standards have also been removed as relevant and appropriate requirements in Table B-1 and footnote 1 has

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				protective of public health. As such, the napththalene HBGL is an appropriate standard to reference as a remediation standard in the RODA 2. Alternatively, the AF can propose a site-specific risk-based standard for regulatory approval.	been updated in Table B-2. The reference to surface water standards in Section 8.2.1 was replaced with a reference to HBGLs. Arizona Administrative Code R18-11-405 was added as relevant and appropriate to the action–specific requirements in Table B-4.

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