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29 January 2014

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and

Mr. Wayne Miller, P.E., R.G.
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Subject: Submission of "Draft Final Remedial Design and Remedial Action Work Plan, Former Liquid Fuels Storage Area, Site ST012, Former Williams Air Force Base, Mesa, Arizona"

The Air Force is pleased to submit the attached document, *Remedial Design and Remedial Action Work Plan,* in draft final format for your review. This work plan was prepared for implementation of the groundwater remedy for Operable Unit 2 at the former Williams Air Force Base in Mesa, Arizona. Comments received by the Air Force Civil Engineer Center from USEPA and ADEQ have been addressed and are included as an appendix to the draft final report.

We would appreciate receiving your comments or concurrence on the attached report within 30 days of receiving these materials.

Please contact me at (315) 356-0810 or catherine.jerrard@us.af.mil if you have any questions regarding this report.

Sincerely,

CATHERINE JERRARD, PE
BRAC Environmental Coordinator

Attachment:

Draft Final Remedial Design and Remedial Action Work Plan, Former Liquid Fuels Storage Area, Site ST012, Former Williams Air Force Base, Mesa, Arizona

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DRAFT FINAL
REMEDIAL DESIGN AND REMEDIAL ACTION WORK PLAN
FOR OPERABLE UNIT 2
REVISED GROUNDWATER REMEDY
SITE ST012
FORMER WILLIAMS AIR FORCE BASE, MESA, ARIZONA

Prepared for:
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AFCEC/CIBW
2261 Hughes Avenue, Suite 155
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29 January 2014

Contract Number: FA8903-09-D-8572 - 0002
AMEC Project No. 9101110001
CDRL No. A001

SIGNATURE PAGE

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ED_005025_00013386-00004

TABLE OF CONTENTS

1.0 INTRODUCTION 1-1
1.1 Purpose and Organization of Report 1-1
1.2 Background 1-2

2.0 REMEDIAL ACTION DESCRIPTION 2-1
2.1 Conceptual Site Model 2-1
2.2 Selected Remedy 2-2
2.3 Remedial Action Objectives and Cleanup Levels 2-4

3.0 REMEDIAL DESIGN 3-1
3.1 Design Components 3-1
3.2 Design Criteria 3-1
3.2.1 Basis of Design – Contaminant Distribution 3-1
3.2.2 Remediation Performance and Technology Transitions 3-3
3.2.3 Permit Limits/Codes/Standards 3-6
3.3 Steam Enhanced Extraction Design 3-8
3.4 SVE Enhancements during SEE 3-11
3.5 Enhanced Bioremediation Design 3-12

4.0 REMEDIAL ACTION IMPLEMENTATION 4-1
4.1 Overview of Implementation 4-1
4.2 SEE Implementation 4-1
4.2.1 Construction 4-2
4.2.2 Operation 4-5
4.2.3 SVE Operation During SEE 4-6
4.2.4 Transition to Enhanced Bioremediation 4-7
4.2.5 SEE System Decommissioning 4-10
4.3 Enhanced Bioremediation Implementation 4-10
4.3.1 Construction 4-11
4.3.2 Operation 4-12
4.3.3 Transition to Monitoring 4-13
4.4 Groundwater Monitoring Implementation 4-13
4.4.1 Transition to Closure 4-14

5.0 PROJECT REQUIREMENTS 5-1
5.1 Health and Safety Plan 5-1
5.2 Site Management Plan 5-1
5.3 Operation and Maintenance Plan 5-2
5.4 Waste Management Plan 5-3
5.5 Quality Assurance Project Plan 5-3
5.6 Sampling and Analysis Plan 5-4
5.6.1 Soil Characterization for LNAPL 5-4
5.6.2 Pre-SEE Groundwater Sampling 5-4
5.6.3 SEE Operational Sampling and Analysis 5-5
5.6.4 Annual Groundwater Monitoring 5-11
5.6.5 Groundwater Characterization for Enhanced Bioremediation 5-12
5.7 Reporting 5-13

ED_005025_00013386-00005

5.8 Contingency Plan 5-13
5.9 Community Relations Plan 5-14
5.10 Permits and Permit Equivalency Evaluations 5-15
5.10.1 Well Abandonment and Installation 5-15
5.10.2 Road Access and Closure Permits 5-16
5.10.3 Electrical Construction Permit 5-16
5.10.4 Utility Connection Permits 5-16
5.10.5 Air Emissions Permit Equivalency 5-16
5.10.6 Wastewater Discharge Permit 5-19
5.10.7 Injection Requirements 5-20

6.0 PROJECT ORGANIZATION AND SCHEDULE 6-1

7.0 REFERENCES 7-1

LIST OF TABLES

Table 1-1 Summary of Previous Investigations/Remediation Conducted at ST012 1-3
Table 2-1 List of Contaminants of Concern and Contaminants of Potential Concern in Groundwater and Associated Cleanup Level 2-5
Table 3-1 Results of LNAPL Quantity Calculations (Saturated Zones) 3-3
Table 3-2 Results of LNAPL Quantity Calculations (Saturated Zones) 3-5
Table 3-3 Effluent Concentration Limits in Existing Permit 3-7
Table 3-4 Predicted Peak Steam Injection Rates for the Three Treatment Zones 3-8
Table 3-5 Predicted Peak Liquid Extraction Rates from the Three Treatment Zones 3-9
Table 3-6 Predicted EBR Injection and Extraction Rates by Zone 3-14
Table 3-7 Predicted TEA Travel and Mixing Times by Zone 3-15
Table 3-8 Advantages and Disadvantages of TEA Candidates 3-15
Table 3-8 Advantages and Disadvantages of TEA Candidates 3-16
Table 4-1 Summary of SEE Well Installation 4-4
Table 4-2 Example Aerobic EBR Phases 4-12
Table 5-1 Proposed Well Replacement for Annual Groundwater Monitoring 5-12

LIST OF FIGURES

Figure 1-1 Location of Former Williams Air Force Base
Figure 1-2 ST012 Site Location Map
Figure 1-3 Location of Former and Current Wells and Borings
Figure 2-1 CSM Boundary and Fuel Release Map
Figure 2-2 CSM Cross Section A-A'
Figure 2-3 CSM Cross Section B-B'
Figure 3-1 CZ/UWBZ LNAPL Distributions and TTZs
Figure 3-2 LSZ LNAPL Distributions and TTZs
Figure 3-3 Conceptual Enhanced Bioremediation Well Field Layout
Figure 3-4 Cobble Zone Recirculation System Pathlines
Figure 3-5 Upper Water Bearing Zone Recirculation System Pathlines
Figure 3-6 Lower Saturated Zone Recirculation System Pathlines
Figure 6-1 ST012 Remedial Action Implementation Schedule

ED_005025_00013386-00006

172 **APPENDICES**

Appendix A Pre-Design Investigation Results
Appendix B LNAPL Volume Calculations
Appendix C Design Drawings
Appendix D SEE Design Report
Appendix E Enhanced Bioremediation and SEE Containment Modeling Report
Appendix F Permit Documentation
Appendix G Well Installation and Abandonment Table
Appendix H QAPP/SAP Worksheets
Appendix I Sample TerraTherm Weekly Report
Appendix J Response to EPA and ADEQ Comments

173

ED_005025_00013386-00007

LIST OF ACRONYMS AND ABBREVIATIONS

%	percent
§	Section
°C	degrees Celsius
°F	degrees Fahrenheit
3D	three-dimensional
AAC	Arizona Administrative Code
ADEQ	Arizona Department of Environmental Quality
ADOT	Arizona Department of Transportation
ADWR	Arizona Department of Water Resources
AF	United States Air Force
AFB	Air Force Base
AFCEC	Air Force Civil Engineer Center
AMEC	AMEC Environment & Infrastructure, Inc.
ARAR	applicable or relevant and appropriate requirement
ASME	American Society of Mechanical Engineers
ASTM	American Standard Test Method
AVGAS	aviation gasoline
BEM	Balanced Environmental Management Systems, Inc.
bgs	below ground surface
CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
CO	carbon monoxide
COC	contaminant of concern
COPC	contaminant of potential concern
CPVC	chlorinated polyvinyl chloride
CSM	conceptual site model
CZ	cobble zone
DEUR	Declaration of Environmental Use Restriction
DO	dissolved oxygen
DRE	destruction and removal efficiency
DRO	diesel range organics
EBR	enhanced bioremediation
EPA	United States Environmental Protection Agency
FFA	Federal Facility Agreement
FFS	focused feasibility study
FID	Flame Ionization Detector
ft	Feet, foot
ft/ft	feet per foot
GAC	granular activated carbon
GC/FID	Gas Chromatography/Flame Ionization Detector
gpd	gallon(s) per day
gpm	gallons per minute

ED_005025_00013386-00008

175 **LIST OF ACRONYMS AND ABBREVIATIONS (Continued)**

GRO	gasoline range organics
HAP	Hazardous Air Pollutant
HASP	Health and Safety Plan
IEC	International Electrotechnical Commission
IRP	Installation Restoration Program
IT	IT Corporation
JP-4	jet petroleum grade 4
lbs	Pounds
lbs/hr	pounds per hour
lbs/MMBTU	pounds per million British Thermal Units
LNAPL	light non-aqueous phase liquid
LPZ	Low Permeability Zone
LSZ	Lower Saturated Zone
MCAPC	Maricopa County Air Pollution Control
mg/L	milligrams per liter
MMBTU/hr	million British Thermal Units per hour
MPE	Multi-phase extraction
NAPL	non-aqueous phase liquid
NCP	National Contingency Plan
NOI	Notice of Intent
NOx	nitrogen oxide(s)
O&M	operation and maintenance
OM&M	operation, maintenance, and monitoring
OU	Operable Unit
PE	polyethylene
PID	photoionization detector
PLC	programmable logic controller
PM	particulate matter
PMGAA	Phoenix-Mesa Gateway Airport Authority
PPE	personal protective equipment
ppm	parts per million
Program QAPP	Performance Based Remediation Program Quality Assurance Project Plan and Standard Operating Procedures, Former Williams AFB, Mesa, Arizona. (AMEC, July 2012)
PVC	polyvinyl chloride
QAPP	Quality Assurance Project Plan
RA	remedial action
RAB	Restoration Advisory Board
RAO	remedial action objective
RD	remedial design
RD/RAWP	Remedial Design and Remedial Action Work Plan
ROD	Record of Decision

176

ED_005025_00013386-00009

LIST OF ACRONYMS AND ABBREVIATIONS (Continued)

SAP	Sampling and Analysis Plan
SCADA	supervisory control and data acquisition system
scfm	standard cubic feet per minute
SEE	steam enhanced extraction
SRP	Salt River Project ®
ST012	Site ST012, the former Liquid Fuels Storage Area
SVE	soil vapor extraction
TEA	terminal electron acceptor
TEE	thermal enhanced extraction
TOX	thermal oxidation
TMP	temperature monitoring point
TPH	total petroleum hydrocarbons
TPH-GRO	total petroleum hydrocarbons as gasoline range organics
tpy	ton(s) per year
TTZ	thermal treatment zone
URS	URS Corporation
USARC	United States Army Reserve Center
UWBZ	Upper Water Bearing Zone
VOC	volatile organic compound

ED_005025_00013386-00010

1.0 INTRODUCTION

This combined Remedial Design (RD) and Remedial Action (RA) Work Plan (RD/RAWP) was prepared for implementation of the revised groundwater remedy for Operable Unit (OU) 2 at the former Williams Air Force Base (AFB), Mesa, Arizona (Figure 1-1). OU-2 is composed of the Installation Restoration Program (IRP) Site ST012, the former Liquid Fuels Storage Area (ST012) (Figure 1-2), where historic releases of jet petroleum grade 4 (JP-4) and/or aviation gasoline (AVGAS) have resulted in contaminated soil and groundwater. A record of decision (ROD) that specified a remedy for groundwater and shallow soil (i.e., one to 25 feet [ft] below ground surface [bgs]) at OU-2 was signed in 1992 (IT Corporation [IT], 1992a). An OU-2 ROD Amendment that specified a remedy for deep soil (25 ft bgs to top of groundwater) was signed in 1996 (IT, 1996).

Shallow soil (one to 25 ft bgs) contaminants at ST012 have been successfully remediated by soil vapor extraction (SVE) to levels set forth in the OU-2 ROD (Earth Tech, 1996), and source removal is ongoing in deep soil in accordance with the remedy set forth in the OU-2 ROD Amendment using SVE.

Results of post-ROD pilot studies, demonstration studies, and groundwater studies indicated that the OU-2 ROD Selected Remedy for groundwater cleanup will not achieve cleanup goals. The initially selected remedy of pumping, treating, and reinjection for cleanup of the trapped light non-aqueous-phase liquid (LNAPL) and affected groundwater has been rendered ineffective by site-wide groundwater levels that have risen more than 60 ft since the late 1980s. A focused feasibility study (FFS) was completed in November 2012 to evaluate alternatives for achieving groundwater cleanup. An OU-2 ROD Amendment 2 that revised the groundwater remedy based on one of the FFS alternatives was signed in 2013 (Air Force Civil Engineer Center [AFCEC], 2013). This RD/RAWP was prepared for the OU-2 Amendment 2 groundwater remedy.

1.1 Purpose and Organization of Report

The purpose of this RD/RAWP is to provide the design and implementation details for the revised groundwater remedy at ST012. The revised groundwater remedy includes installation and operation of a steam enhanced extraction (SEE) system followed by in-situ enhanced bioremediation (EBR). The design of the SEE system incorporates continued use of the existing deep soil SVE system for ongoing contaminant mass removal in the vadose zone.

This report consists of seven sections, plus appendices. Section 1.0 presents an introduction and background. Section 2.0 describes the background and history of OU-2 and presents a summary of the groundwater remedy. Section 3.0 presents the RD including the design basis and details on the major remedy components. Section 4.0 describes the implementation plan for the RA. Section 5.0 presents the supplemental project planning documents for health and safety, site management, operation and maintenance (O&M), waste management, quality assurance, sampling and analysis, reporting, contingencies, community relations, and permits. Section 6.0 provides the detailed project organization and schedule for implementation. Section 7.0 presents references cited in the body of the text. Appendix A presents results from the

ED_005025_00013386-00011

ST012 Pre-Design Investigation, Appendix B presents design calculations of LNAPL volume, Appendix C presents Design Drawings, Appendix D presents the SEE Design Report supplied by TerraTherm, Appendix E presents the EBR Design Report, Appendix F presents applicable permitting or permit equivalency documents, Appendix G presents a table of new wells and wells to be abandoned, and Appendix H presents Quality Assurance Project Plan (QAPP)/ Sampling and Analysis Plan (SAP) project-specific worksheets.

1.2 Background

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. Williams AFB was a United States Air Force (AF) flight-training base that was first activated in 1941. In 1989, Williams AFB was placed on the United States Environmental Protection Agency (EPA) National Priorities List. The base officially closed in 1993. Since 1989, the AF has been cleaning up contamination caused by historic hazardous substance releases at the former Williams AFB under Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) with oversight from the EPA, the Arizona Department of Environmental Quality (ADEQ), and the Arizona Department of Water Resources (ADWR). Regulatory authority for the former Williams AFB has been defined and agreed upon in accordance with a Federal Facility Agreement (FFA). The primary purpose of the FFA is to ensure that the environmental impacts associated with the former Williams AFB are thoroughly investigated and appropriate RAs are taken as necessary to protect the public health, welfare and the environment. The primary regulatory agencies overseeing the FFA include EPA, ADEQ, and ADWR. The State agencies speak with one voice in regard to FFA implementation and ADEQ has been functioning as the agency presenting positions on behalf of the State. RAs at ST012 are being conducted in accordance with CERCLA and the FFA.

ST012 is the location of the former Liquid Fuels Storage Area 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 transmission operations within ST012 have been removed. Soil and groundwater at ST012 have been affected by documented and undocumented releases of JP-4 and AVGAS from the former fuel facilities during the 50-year base operations period.

ST012 has been the focus of Remedial Investigations, pilot studies, and RAs since the discovery in 1984 of site contamination by fuel hydrocarbons. Remedial Investigations were designed to define the nature and extent of contamination; pilot studies were designed to evaluate the feasibility of proposed remedies; RAs have been implemented, and are ongoing, to address contamination in soil and groundwater. Table 1-1 presents the investigations and actions that have occurred on site to date. Previous investigations and associated RAs are described further in the FFS (AMEC Environment & Infrastructure, Inc. [AMEC], 2012a). Locations of investigation borings and former or current wells are shown on Figure 1-3.

ED_005025_00013386-00012

264 **Table 1-1 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, 1992b, *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	
	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, 1998a, *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		

265

ED_005025_00013386-00013

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

Contractor	Activities	Dates	Reference[1]
BEM	Installed SVE well nest SVE01	May 2003-June 2003	BEM, 2007, *Phase 1, Thermal Enhanced Extraction (TEE) Pilot Test Work Plan*
	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.*
	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, 2009a, *Sites ST012, ST035, and LF004 Monitoring Well Replacement, Abandonment, and Installation Report.*
	Monitored groundwater quarterly and annually	July 2008 – January 2009	URS, 2009b, *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*

ED_005025_00013386-00014

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

Contractor	Activities	Dates	Reference[1]
AMEC	Completed OU-2 FFS with focus on groundwater	November 2011 – November 2012	AMEC, 2012a, *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.
BEM – Balanced Environmental Management Systems, Inc.
bgs – below ground surface
FFS – focused feasibility study
ft – feet, foot
O&M – operation and maintenance
OU – operable unit
SVE – soil vapor extraction
TEE – thermal enhanced extraction
URS – URS Corporation

The AF transferred the property including ST012 to the Phoenix-Mesa Gateway Airport Authority (PMGAA) in 2008. The transfer deed for ST012 reserves the right of access for the AF, EPA, and State of Arizona for purposes consistent with the IRP and FFA including inspections, investigations, RAs, and monitoring. The deed and a Declaration of Environmental Use Restriction (DEUR), both recorded in 2008, restrict the property to non-residential use, prohibit the installation of wells for uses other than remediation or monitoring, and require soil management procedures for excavations greater than 10 ft bgs.

ED_005025_00013386-00015

2.0 REMEDIAL ACTION DESCRIPTION

This section describes the conceptual site model (CSM), the ST012 groundwater RA and how the RA will be implemented.

2.1 Conceptual Site Model

This CSM presents the current conceptual understanding of site physical and fuel contamination conditions at the level of detail necessary to select and evaluate the remedy for contaminated groundwater at ST012. It is recognized that heterogeneous physical conditions at ST012 and the limited information on fuel releases and occurrence in the subsurface limit the CSM's ability to represent the ST012 system in detail. However, this CSM serves as a useful and necessary tool to guide development of design and implementation. Figure 2-1 shows the CSM boundary and former fuel release areas at ST012.

The ST012 conceptual site physical model incorporates the following:

- Five main hydrostratigraphic units (Figures 2-2 and 2-3):
  1. The Vadose Zone extending from the ground surface to a current depth of about 155-160 ft bgs. The Vadose Zone is heterogeneous, consisting of interbedded coarse- and fine-grained layers. The Cobble Zone (CZ), a coarse-grained and permeable layer containing substantial fuel contamination is present near the base of the Vadose Zone.
  2. The Upper Water Bearing Zone (UWBZ) extending from the capillary fringe at about 160 ft bgs to the top of the silty clay layer comprising the Low Permeability Zone (LPZ) at about 195 ft bgs. The UWBZ is heterogeneous, consisting of interbedded coarse- and fine-grained layers. The UWBZ is the uppermost saturated unit at ST012, is unconfined, and contains and can transmit groundwater at low yields.
  3. The LPZ extending from about 195 to about 210 ft bgs. The LPZ consists of a laterally continuous silty clay layer that hydraulically separates the UWBZ from the Lower Saturated Zone (LSZ).
  4. The LSZ extending from about 210 to about 245 ft bgs. The LSZ is heterogeneous, consisting of interbedded coarse- and fine-grained layers. The LSZ, which is semi-confined by the overlying LPZ, is the coarsest and most permeable saturated unit at ST012, capable of transmitting groundwater at rates of 10 to 20 gallons per minute (gpm) or greater (Balanced Environmental Management Systems, Inc. [BEM], 2011). The estimated hydraulic conductivity of the LSZ is in the range of 15 - 40 ft per day, and the seepage velocity is estimated at 110 – 290 ft per year (BEM, 2011).
  5. The aquitard extending from about 245 to 260 ft bgs. The top of the aquitard represents the base of the CSM. The aquitard has low permeability and acts as a flow and contaminant migration boundary, effectively limiting the contamination to the Upper Unit at ST012.
- A dynamic groundwater system:
  - The water table at ST012 has been rising.

ED_005025_00013386-00016

- The deepest water table during the time of the fuel releases was approximately 232 ft bgs.
- Groundwater flow direction in both the UWBZ and LSZ is to the east-northeast with a hydraulic gradient of about 0.004 feet per foot (ft/ft) (URS Corporation, 2011c).
- Hydraulic communication between the UWBZ and LSZ across the LPZ is minimal. A downward vertical hydraulic gradient of 0.1 ft/ft exists across the LPZ.

A detailed CSM including regional and site-specific geology, surface features, geotechnical information, regional and site-specific hydrogeology, the water level rise, volumes of LNAPL and contaminated soil and groundwater, contaminant fate and transport, and results of computer modeling efforts were described in detail in the November 2012 FFS, and these site characteristics were described again in ROD Amendment 2. In summary, it is known that significant amounts of LNAPL remain in the vadose and saturated zones. Migration of LNAPL in the vadose zone is dependent on the degree of water saturation and non-aqueous phase liquid (NAPL) saturation in the soil column. 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 toward lower potentiometric heads associated with either LNAPL thickness in the formation, or groundwater elevation. LNAPL that was deposited in the lower sections of the upper aquifer has become trapped and essentially immobilized beneath the water, although site evidence suggests that some of the submerged LNAPL has been mobilized by the increasing water level. Trapped LNAPL will undergo partial dissolution as groundwater continues to move past the LNAPL-water interface. Soluble constituents (e.g., benzene, toluene, ethylbenzene and xylenes) will enter the groundwater system. Once dissolved, additional mechanisms such as dispersion and degradation will act on these components to limit their transport potential.

2.2 Selected Remedy

The OU-2 ROD Amendment 2 Selected Remedy for groundwater at ST012 is Steam Enhanced Extraction and Enhanced Bioremediation. The Selected Remedy will achieve cleanup levels by combining SEE of groundwater and LNAPL with EBR 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 ST012 for purposes other than remediation or monitoring until cleanup levels are achieved and the existing controls (deed restrictions and DEUR) 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 RD. 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 aquifer zones (UWBZ, LPZ, LSZ) will be co-located with temperature monitoring points (TMPs).

ED_005025_00013386-00017

- Multi-phase extraction (MPE) wells will extract LNAPL, contaminated groundwater, and soil vapor from the three aquifer zones. MPE wells will be co-located with TMPs. 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 (GAC), and treated water will be discharged to the municipal wastewater treatment plant. Soil vapor will be treated by thermal oxidation (TOX) 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 generated or mobilized as a result of steam injection. EBR will proceed after the cessation of SEE activities. Existing site conditions will be enhanced to promote biological activity among bacteria that feed off of contamination present at ST012. The residual increase in temperature at ST012 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., dissolved oxygen [DO], pH, temperature) to create an environment that is more hospitable to bacterial growth. The specific methods for EBR 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 (AMEC, 2013d) which will be updated and submitted for EPA and ADEQ review and approval as needed. 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 wells available for conventional water-quality sampling will decrease during steam injection due to the presence of heated and pressurized steam in the subsurface.

The Thermal Enhanced Extraction (TEE) pilot study results have indicated the effectiveness of TEE technologies such as SEE with respect to site-specific conditions. The revised groundwater RA 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 EBR) 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 RA progresses and that the area exceeding cleanup levels will diminish over time. In the absence of alternative mutual agreement between the AF, EPA and

ED_005025_00013386-00018

ADEQ, cleanup levels will be attained when monitoring results throughout the plume reach concentrations at or below the cleanup levels for a two year period of continued groundwater monitoring after the 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 remedial action objectives (RAOs).

2.3 Remedial Action Objectives and Cleanup Levels

The RAOs for groundwater at OU-2 were identified in the OU-2 ROD Amendment 2 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 or a Hazard Index 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 applicable or relevant and appropriate requirements (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 ST012 to non-residential use and prevent future exposure to groundwater by restricting the extraction of groundwater and installation of wells at ST012 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 above is documented in OU-2 ROD Amendment 2 and summarized in Table 2-1.

ED_005025_00013386-00019

Table 2-1 List of Contaminants of Concern and Contaminants of Potential Concern in Groundwater and Associated Cleanup Level

Contaminant	OU-2 ROD Amendment 2 Cleanup Level (mg/L)	Basis of Cleanup Level
Contaminant of Concern		
Benzene	0.005	Federal MCL
Toluene	1.0	Federal MCL
Naphthalene	0.028	OU-2 ROD (Arizona HBGL)
Contaminant of Potential Concern		
Bis(2-exylhexyl)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	OU-2 ROD (Arizona HBGL)
Tetrachloroethene	0.005	Federal MCL
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	Arizona Aquifer Water Quality Standard
Silver	0.1	Federal MCL
Zinc	1.4	OU-2 ROD (Arizona HBGL)

Notes:
EPA – United States Environmental Protection Agency
HBGL – Health Based Guidance Level
MCL – Maximum Contaminant Level
mg/L – milligrams per liter
OU – Operable Unit
ROD – Record of Decision

ED_005025_00013386-00020

3.0 REMEDIAL DESIGN

This section provides an overview of the RD for the ST012 groundwater remedy.

3.1 Design Components

The RD components, described further below and in Appendices D and E, include the following:

1. The SEE system which includes steam injection, MPE and separation, groundwater treatment, and vapor and LNAPL treatment;
2. Required SVE enhancements to enable continued operation during SEE operations; and
3. EBR to treat contamination outside the SEE treatment areas.
4. Groundwater monitoring following SEE/EBR operations.

3.2 Design Criteria

The major design criteria that govern the RD are the distribution of contaminants (LNAPL and dissolved phase), site conditions and expected technology performance, the basis for transitions of the remedy from SEE to EBR and from EBR to groundwater monitoring, and the regulatory limits for discharges of air and liquid waste streams along with applicable codes/standards. Each of these [redacted] described further in the following sections.

3.2.1 Basis of Design – Contaminant Distribution

A review of the historical development of the CSM was included in the FFS for ST012 (AMEC, 2012a). The 1992 IT OU-2 Remedial Investigation Report estimated the volume of LNAPL at ST012 to be between 650,000 and 1,400,000 gallons but did not account for residual LNAPL in the vadose zone (IT, 1992b). In 1999, EPA estimated the total volume of LNAPL present at ST012 in the saturated zone to range from 800,000 to 3,800,000 gallons (EPA, 1999). A more recent estimate performed by BEM in the *Final Phase I Thermal Enhanced Extraction Pilot Test Performance Evaluation Report* calculated 2,200,000 gallons in the saturated zone (BEM, 2011). In accordance with the Pre-Design Investigation Work Plan (AMEC, 2013e), additional groundwater and soil analytical samples were taken to develop a better understanding of contaminant distribution beneath ST012 and update the estimate of LNAPL present at ST012 and within the proposed treatment zone.

The Pre-Design Investigation consisted of monitoring the installation of 11 remediation wells, vadose zone soil sampling, groundwater sampling, and well slug testing. Remediation well borings were logged, screened with photoionization detector (PIDs), visually inspected, tested with LNAPL partitioning dye kits, and sampled for off-site analysis of volatile organic compounds (VOCs) and total petroleum hydrocarbons (TPH). Groundwater samples were taken from all of the newly installed remediation wells and from existing wells within the remediation area for off-site analysis for VOCs and TPH. Slug tests were performed on two existing and four of the newly installed wells; however, accurate results were only obtained for the newly installed wells indicating redevelopment of the existing wells is needed. Results of the Pre-Design Investigation are presented in Appendix A.

ED_005025_00013386-00021

In order to update the contaminant distribution conceptual model, a review of historical boring logs and Pre-Design Investigation boring logs was performed to identify soils that exhibit evidence of the presence of LNAPL and to better understand the three-dimensional (3D) distribution of contaminants in the subsurface. Borings were reviewed for: PID readings, observations of visible staining and odor, soil analytical data for benzene and TPH, positive results on LNAPL partitioning dye kits, and visual observations of the presence of LNAPL. A scoring system was developed to weigh both the degree to which the evidence points to the presence of LNAPL and the subjectivity of the evidence (conclusions based on PID, odor, and staining were considered to be weaker than lab analytical data and dye kit results). Inconsistencies between LNAPL detection in the same boring log (isolated evidence of LNAPL in borings that were otherwise clean or vice versa) were identified and evaluated

The resulting score at 1-ft intervals correlated with the corresponding elevation data was entered into a 3D representation of the interpreted data (see Appendix B). In order to develop a 3D extent of LNAPL contaminated soils, the sum of the LNAPL scoring results were compiled for 10-ft depth intervals, and a demarcation contour was manually interpreted to identify the estimated extent of contamination for each depth. Two sets of contours were developed; the first, referred to as the base distribution, focused on scoring from the Pre-Design Investigation and additionally considering dissolved phase contaminant distribution and where LNAPL has been observed in monitoring wells and the second, a more conservative interpretation that considered scoring results for both historical and Pre-Design Investigation borings. These contours were then imported to the 3D model, which could then interpolate a surface between the contours to create a 3D representation of the extent of LNAPL contamination (See Appendix B). Interpreted elevations of the interface between lithologic units were also entered into the 3D model to develop surfaces between the CZ, UWBZ, LPZ, and LSZ.

Based on these interpretations, the software generated volumes of LNAPL contaminated soil in each lithologic unit. These volumes were used in conjunction with two methods of calculating residual LNAPL in pore space to estimate the amount of LNAPL present. . One method used the TPH concentrations and a correlation between TPH data and residual LNAPL concentration developed by Hawthorne and Kirkman; the other used literature values for NAPL saturation based on soil type. The second method had been used previously by BEM for the TEE pilot test. A detailed explanation of these calculations is provided in Appendix B.

It should be noted that homogeneous conditions within the interpreted zone of residual LNAPL presence were initially assumed. In reality, review of boring data has indicated some locations within this interpreted zone do not have strong evidence of LNAPL while other borings in close proximity do. This indicates that LNAPL residual has a heterogeneous distribution within the interpreted zone and calculations assuming homogeneous distribution may overestimate the volume present. To account for this potential, a range of LNAPL volumes was estimated from 50 to 100 percent with the base distribution and 75 to 100 percent for the conservative distribution of the calculated volume using the homogeneous assumption. The results are summarized in Table 3-1.

ED_005025_00013386-00022

Table 3-1 Results of LNAPL Quantity Calculations (Saturated Zones)

Calculation Method	Geologic Zone	Range of LNAPL - Base Distribution (gallons)	Range of LNAPL – Conservative Distribution (gallons)
Hawthorne & Kirkman Method	CZ	7,800 – 11,000	20,000 – 26,000
	UWBZ	270,000 – 430,000	480,000 – 640,000
	LPZ	40,000 – 60,000	29,000 – 38,000
	LSZ	250,000 – 350,000	330,000 – 450,000
	Total	570,000 – 850,000	860,000 – 1,150,000
Literature Saturation Values	CZ	5,100 – 7,400	13,000 – 17,000
	UWBZ	170,000 – 280,000	360,000 – 480,000
	LPZ	94,000 – 140,000	70,000 – 90,000
	LSZ	580,000 – 810,000	750,000 – 1,000,000
	Total	850,000 – 1,230,000	1,190,000 – 1,590,000

Notes:
CZ – cobble zone
LNAPL – light non-aqueous phase liquid
LPZ – Low Permeability Zone
LSZ – Lower Saturated Zone
UPBZ – Upper Water Bearing Zone

3.2.2 Remediation Performance and Technology Transitions

The Selected Remedy for ST012 groundwater involves two phases of active remediation, SEE and EBR, followed by groundwater monitoring to track the progress of contaminant attenuation and remedy effectiveness until cleanup levels are achieved. The project will begin with SEE to remove and treat a mass of LNAPL contamination in the main area of ST012. EBR will be used to treat contamination around the perimeter of the SEE thermal treatment zones (TTZs) and, if necessary, to address residual contamination within the TTZs after SEE. The initial TTZs were developed for the conceptual SEE design in the FFS based on a combination of dissolved-phase benzene distribution and observed LNAPL in monitoring wells (AMEC, 2012a). The conceptual LSZ TTZ remained primarily within the boundaries created by the adjacent roads, only crossing over East Ulysses Avenue, and encompassed the majority of the 5,000 µg/L concentration contour. The portion of the plume beneath South Sossaman Road was deemed inaccessible because it would be infeasible to interrupt traffic in this area. The conceptual CZ and UWBZ TTZs encompassed the likely remaining source material near the historic release in the area of the TEE Pilot Test. The TTZs for the CZ and the UWBZ have a similar footprint and are referred to collectively as the CZ/UWBZ TTZ.

ED_005025_00013386-00023

The Pre-Design Investigation installed 11 SEE wells at locations along the perimeter of TTZs from the FFS conceptual design (see Figures 3-1 and 3-2). Most of the installed wells were positioned around the LSZ TTZ perimeter. Soil boring logs, LNAPL dye kit testing results, soil analytical results and groundwater results were reviewed relative to the conceptual TTZs. Figures 3-1 and 3-2 show the Pre-Design Investigation wells and the revised TTZs relative to the two interpretations of LNAPL distribution in the saturated zone. The following observations and adjustments to the conceptual design TTZs were made:

- Along Sossaman Road, three wells (ST012-LSZ12, ST012-LSZ13, and ST012-LSZ14) were installed. Wells ST012-LSZ12 and ST012-LSZ14 had soil results of TPH less than 1,000 mg/kg and benzene less than 5 mg/kg in isolated 10-ft intervals within the LSZ. ST012-LSZ13 had higher results (TPH up to 9,600 mg/kg and benzene up to 22 mg/kg); For drilling logistic reasons, this well was installed about 40 ft northwest of Sossaman Road and may not represent conditions closer to the roadway. This well did indicate that LNAPL may be present in the UWBZ at this location. Although the UWBZ TTZ does not extend as far east as this location, an UWBZ extraction well would be positioned in proximity to this location to recover contaminants that may migrate upwards during treatment of the LSZ. This extraction well can also capture contamination in the UWBZ however, lower mass removal is expected and follow-on EBR may be required in this area. In the LSZ, the TTZ is constrained by Sossaman Road and extension of the TTZ to the east is not feasible given the public use of this road and its importance to the airport and surrounding community. Contamination under Sossaman Road, to the extent present, will be addressed using EBR, which will have less impact on the use of Sossaman Road and poses less risk to the public during implementation.

- Along the northern side of the site, four wells (ST012-LSZ08, ST012-LSZ16, ST012-LSZ17, and ST012-UWBZ09) were installed. Benzene and TPH concentrations in ST012-UWBZ09 were low and no indications of LNAPL were observed. ST012-LSZ08 had TPH and benzene contamination from 219 to 225 ft bgs. ST012-LSZ16 had TPH and benzene contamination throughout most of the boring indicating this boring was likely close to a release area. ST012-LSZ16 is within both the CZ/UWBZ and LSZ TTZs. ST012-LSZ17 had TPH and benzene contamination from about 168 to 230 ft bgs; however, LNAPL dye test kits were mostly positive in the LSZ. No adjustments to the TTZs were made along the northern side of the site as a result of these findings.

- Along the west and southwestern side of the site, three wells (ST012-LSZ09, ST012-LSZ10, and ST012-LSZ11) were installed. All three had benzene soil results greater than 10 mg/kg and had several zones of positive LNAPL dye test kit results. ST012-LSZ09 and ST012-LSZ-10 had TPH soil results greater than 10,000 mg/kg. In response to these results, the conceptual design LSZ TTZ was extended to the west to capture additional LNAPL that may be present in these areas. Although monitoring well ST012-W11 to the southwest of the TTZ has historically had measureable LNAPL, benzene concentrations in this well have been around 100 µg/L for several monitoring events and further treatment in this area can be more efficiently addressed through EBR and/or natural attenuation. Monitoring well ST012-W13, located just to the west, has also historically had measureable LNAPL and benzene concentrations have been higher (typically 2,000-3,000 µg/L). For this reason the revised TTZ has been expanded to this well.

ED_005025_00013386-00024

- Well ST012-LSZ15 was installed in the interior of the conceptual design LSZ TTZ for evaluation of contamination in the UWBZ. This well location had strong indicators of LNAPL presence through much of the vertical soil column and is likely positioned close to a former release location. For this reason, the UWBZ and CZ conceptual design TTZs were extended to the west to include this area.

Locations where adjustments were made to the TTZs are unobstructed and relatively simple to include in the treatment volume by modifying locations of the additional planned treatment wells. As can be noted in Figure 3-1, the interpretations of the LNAPL in the UWBZ extend beyond the TTZ; however, there is uncertainty with these extents based on limited recent boring data between the LSZ and UWBZ TTZ perimeters. Boring logs will be reviewed closely in these areas to evaluate if further adjustments to the TTZs would be beneficial. The conceptual treatment volume from the FFS was approximately 371,000 cubic yards; the expanded TTZs included another 39,000 cubic yards for a total of 410,000 cubic yards. The mass of LNAPL within (addressed by SEE) and outside (addressed by EBR and natural attenuation) the TTZs was estimated (see Appendix B) and is summarized in Table 3-2 for the two LNAPL distribution interpretations.

Table 3-2 Results of LNAPL Quantity Calculations (Saturated Zones)

LNAPL Distribution Interpretation	Calculation Method	TTZ	Range of LNAPL Within TTZ (gallons)	Range of LNAPL Outside the TTZ (gallons)
Base Distribution (focus on recent data [Pre-Design Investigation borings supported by dissolved concentration distribution, and measured LNAPL in wells])	Hawthorne & Kirkman Method	CZ/UWBZ	190,000 – 250,000	110,000 – 220,000
		LSZ	240,000 – 330,000	30,000 – 60,000
		Total	430,000 – 580,000	140,000 – 270,000
	Literature Saturation Values	CZ/UWBZ	150,000 – 200,000	80,000 – 160,000
		LSZ	560,000 – 740,000	66,000 – 130,000
		Total	710,000 – 940,000	140,000 – 290,000
Conservative Distribution (includes historical borings and measure LNAPL in wells)	Hawthorne & Kirkman Method	CZ/UWBZ	230,000 – 300,000	270,000 – 360,000
		LSZ	270,000 – 360,000	90,000 – 120,000
		Total	500,000 – 660,000	360,000 – 480,000
	Literature Saturation Values	CZ/UWBZ	170,000 – 230,000	200,000 – 260,000
		LSZ	620,000 – 830,000	200,000 – 270,000
		Total	790,000 – 1,050,000	400,000 – 530,000

Notes:
CZ - cobble zone
LNAPL - light non-aqueous phase liquid
LSZ - Lower Saturated Zone
UWBZ - Upper Water Bearing Zone
TTZ - thermal treatment zone

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Monitoring of SEE treatment progress will be ongoing with the expectation that the mass removal rate from ST012 will increase, reach a peak, and then diminish. The general basis for transition of ST012 to EBR will be achieving and maintaining temperatures in the TTZ as well as reaching a point in mass removal rates by SEE that are significantly below the peak mass removal rates. This situation will represent a condition where the thermal heating has been achieved and mass removal from ST012 is becoming less efficient with respect to energy input. Several factors will be considered when evaluating the appropriate time for transition and additional details on the specific parameters are described further in Section 4.2.4.

It is anticipated that a better than 99 percent (%) mass reduction of the VOC constituents such as benzene will occur within the TTZs as a result of SEE (Appendix D). The removal in the low-permeability zones will be lower, and it is difficult to predict exactly what average reduction will be achieved. However, at least a 90% reduction in these zones is expected, and thereby an overall mass reduction for benzene of 95% or higher is anticipated for the SEE treatment within the TTZs.

Once the decision to terminate steam injection is made, the remedy will fully transition to EBR to promote biodegradation. EBR is intended to treat areas outside the TTZ and, to a lesser extent, treat residual contamination within the TTZ until conditions across ST012 are established such that natural attenuation can further degrade contaminants to achieve the cleanup levels within the projected remedial timeframe (i.e., about 20 years).

Based on the predicted mass reduction and contaminant removal to be achieved by SEE, conceptual EBR remediation designs have been developed (see Section 3.5). Modeling was used (Appendix E) to evaluate conceptual EBR designs, estimate design requirements to achieve cleanup levels within the projected remedial timeframe, and predict groundwater concentrations at the conclusion of active EBR and during further degradation by natural attenuation. Additional details on the specific parameters are described further in Section 4.3.3. Because of the uncertainty of remaining LNAPL mass, especially the extent outside the SEE TTZs, the EBR conceptual design is based on the conservative LNAPL distribution. This allows evaluation of a worse case in the modeling to verify that cleanup levels can be achieved within the projected remedial timeframe.

Progress toward attainment of the cleanup levels will be monitored after EBR is completed. Some increase in dissolved phase contamination is anticipated following termination of active EBR and remaining amendments are consumed, followed by declining concentrations until the cleanup levels are achieved. The transition to closure of the groundwater remedy will occur following demonstration that the groundwater cleanup levels have been achieved for several monitoring events spanning a period up to two years.

3.2.3 Permit Limits/Codes/Standards

The primary standards that form the basis of the RA include the cleanup levels identified in OU-2 ROD Amendment 2 and the discharge requirements for air and water for active RAs. The cleanup levels are the target endpoint of the RA. Interim criteria for transitions from SEE and EBR are discussed in Sections 3.2.2, 4.2.4 and 4.3.3.

ED_005025_00013386-00026

Air emissions during SEE will occur from the steam boilers and the vapor treatment system. Section 5.10.5 details the air emissions regulations/requirements. The primary requirements that form the design basis of the RA are a required 90 percent destruction of VOCs in thermal oxidizer systems and best management practices for burner tuning and maintenance for steam boilers to control nitrogen oxides (NOx) and carbon dioxide.

The existing sewer discharge permit for the ST012 containment pumping system (see Appendix F) is the basis for liquid treatment requirements for discharge to the sanitary sewer system. The permitted effluent limits are listed in Table 3-3 below.

Table 3-3 Effluent Concentration Limits in Existing Permit

Parameter	Daily Maximum	Units
pH	5 – 10.5	S.U.
Arsenic, total	0.13	mg/L
Benzene	35	µg/L
Cadmium, total	0.047	mg/L
Chloroform	2,000	µg/L
Copper, total	1.5	mg/L
Cyanide, total	2.0	mg/L
Lead, total	0.41	mg/L
Mercury, total	0.0023	mg/L
Selenium, total	0.10	mg/L
Silver, total	1.2	mg/L
Zinc, total	3.5	mg/L

Notes:
S.U. - standard units
mg/L - milligrams per liter
µg/L - micrograms per liter

The current discharge permit has a limit of 100,000 gallons per day (gpd). As part of the permit renewal a limit of 250 gpm (360,000 gpd) will be requested. The design includes up to 227 gpm of extracted groundwater plus an additional 10 gpm for other miscellaneous flows (e.g., boiler blowdowns). Current sewer capacity is available to handle this flow and preliminary discussions with the City of Mesa have indicated that discharges would be permitted to 250 gpm. However, if other user requests in the vicinity are submitted, the flow limit could be reduced to 200 gpm.

Key industrial standards that also form the basis of the SEE system design include the National Electric Code (National Fire Protection Association 70), International Electrotechnical Commission (IEC) Explosive Atmospheres standard (IEC 60079), and American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code and the ASME Pressure Piping Code (ASME B31).

ED_005025_00013386-00027

3.3 Steam Enhanced Extraction Design

TerraTherm's detailed design report is included in Appendix D and associated drawings are included in Appendix C. SEE will be used to thermally treat the TTZ with a network of vertical steam injection and MPE wells over the approximate 199,000 square ft footprint. The layout of the steam injection and MPE wells along with the footprints of the LSZ and combined CZ/UWBZ TTZs are shown on Drawing C103 in Appendix C. These locations along with the anticipated steam injection and water extraction rates described below were used for hydraulic containment modeling as detailed in Appendix E.

The injection wells will be spaced approximately 80 ft apart in the CZ and in the UWBZ and approximately 100 ft apart in the LSZ. The well spacing is derived from the data collected in the TEE pilot test. The TEE pilot test was performed using two injection wells in the center of a 70-ft radius circle, surrounded by six extraction well clusters. The radius of influence of the steam was close to 70 ft during the pilot test (steam from the center injection cluster reached locations near the perimeter extraction wells, with maximum calculated radii of 72 and 79 ft, respectively for the LSZ and UWBZ). For full-scale SEE treatment, extraction wells will be influenced by several injection wells and receive steam from more than one side. The SEE design includes well spacings in the range of 80 to 100 ft (lower spacing in the less permeable UWBZ), assuming that the longer duration of steam injection will be sufficient to get steam breakthrough.

Steam injection wells will be installed in each TTZ to propagate a steam front throughout the treatment footprints. An estimated 48,800 pounds per hour (lbs/hr) of steam will be generated during peak operations and delivered to the TTZ via 34 steam injection wells to heat the TTZ to up to 284 degrees Fahrenheit (°F). Table 3-4 shows the predicted peak injection rates in each of the three treatment zones.

Table 3-4 Predicted Peak Steam Injection Rates for the Three Treatment Zones

Zone	Predicted Peak Injection Rate (lbs/hr)	Predicted Peak Injection Rate (gpm)	Number of Injection Wells	Predicted Average Injection Rate per Well at Peak Overall Injection (lbs/hr)	Predicted Average Injection Rate per Well at Peak Overall Injection (gpm)
CZ	6,300	12.6	6	1,050	2.10
UWBZ	8,750	17.5	10	875	1.75
LSZ	33,750	67.4	18	1,875	3.75
Total	48,800	97.5	34		

Notes:
CZ – cobble zone
lbs/hr – pounds per hour
LSZ – Lower Saturated Zone
UWBZ – Upper Water Bearing Zone

Extraction well placement has been designed to capture the injected steam, draw volatilized contaminants to the surface for treatment and/or destruction, and to prevent the migration of contaminants off site due to the increased subsurface pressures caused by the steam injection. A total of 51 MPE wells, screened at the same intervals as the steam injection wells, with a total

ED_005025_00013386-00028

estimated extraction rate of 227 gpm will be installed. The anticipated overall peak liquid extraction rate from the MPE wells is approximately 2.3 times the expected peak steam liquid injection rate. Table 3-5 summarizes the MPE wells in the three treatment zones.

Table 3-5 Predicted Peak Liquid Extraction Rates from the Three Treatment Zones

Zone	Peak Extraction Rate (gpm)	Overall Ratio of Extraction to Injection	Number of Extraction Wells	Predicted Average Extraction Rate per Well at Peak Overall Extraction (gpm)
CZ	30	2.4	13	2.3
UWBZ	45	2.6	14	3.2
LSZ	151	2.2	24	6.3
Total	227	2.3	51	

Notes:
CZ – cobble zone
gpm – gallons per minute
LSZ – Lower Saturated Zone
UWBZ – Upper Water Bearing Zone

The construction of the wells will be the same for both the steam injection and MPE wells within each of the three aquifer zones to enable layout changes as needed pending findings during drilling operations. All of the wells will have fittings for injection and extraction. A steam injection well can be converted to an MPE well by addition of an eductor system and connection to the extraction manifold. An MPE well can be converted to a steam injection well by connection to the steam manifold. The design currently designates each well as either an injection or extraction well. The distribution of injection and extraction wells was developed to provide alternating wells and promote a steam sweep throughout the TTZ. Lacking evidence of LNAPL presence at the perimeter, there is a preference for injection at the perimeter so that LNAPL is mobilized toward the center of the site. However, in some areas of the site, the pre-design investigation identified potential LNAPL presence at the perimeter of the TTZs. As a result, the injection/extraction well layout includes more extraction along the perimeter to limit mobilization of LNAPL away from the TTZs. This is particularly the case along the western and southern sides of the LSZ TTZ and the southwestern side of the UWBZ TTZ. The layout of injection and extraction wells will be reviewed based on findings during drilling of the wells and modifications will be made as necessary. If needed, based on observations of LNAPL at perimeter wells during drilling operations, select wells may be equipped to serve as both an extraction and injection well to avoid spreading contamination by injecting steam in a highly contaminated area. In such a well, following initial extraction to remove recoverable LNAPL, steam will be injected for a short period to preheat the area surrounding the steam well prior to returning the well to an extraction well to further recover the LNAPL surrounding the well. This method is called cyclic steam injection. Currently, the design does not include any wells designated as both injection and extraction, however, this approach will be evaluated further upon completion of the well drilling.

ED_005025_00013386-00029

Vapors and liquids extracted from the well field will be treated prior to discharge. A process flow diagram (Drawing P101) and mechanical equipment layout (Drawing M101), which are provided in Appendix C, depict the primary treatment system components and flow paths described below.

Vapor Treatment:

The vapors will be extracted from the MPE wells at a total maximum rate of 3,200 standard cubic ft per minute (scfm) and will follow the following treatment path:

1. Vapors will first enter a horizontal moisture separator (S-101);
    - Condensate from the moisture separator will be pumped to the sediment tank (S-104) to be treated with the liquid stream described below.
2. Vapors from the moisture separator will then flow through a set of parallel heat exchangers to cool down to approximately 49 degrees Celsius (°C) (120°F) (E-101);
    - The heat exchangers will use 500 gpm of non-contact water from the cooling towers (W-101).
3. Following the heat exchanger, vapors will flow through a second moisture separator (S-102) to remove additional moisture formed during the cooling process;
    - Liquid from the moisture separator will be pumped to the gravity separator (S-105) to separate liquid from LNAPL described further below.
4. Vapors will be pulled through the primary vacuum blower (B-101 A/B);
5. Finally the vapors will enter the thermal accelerators (F-101 and F-102) for TOX prior to being exhausted to the atmosphere.

Liquid will be extracted from the TTZs via the MPE wells at an estimated peak flow rate of up to 227 gpm. Groundwater extraction will occur using eductor pumps which were selected because of their robust design and limited susceptibility to fouling and high temperatures. If the permitted discharge is reduced to 200 gpm due to the City of Mesa receiving additional sewer connection requests, extraction rates will be maintained below this limit and steam injection rates will also be reduced. The effect of reduced flow rates will be to increase the time required to achieve the SEE treatment objectives. An additional 273 gpm of water will be circulated to operate the eductor pumps installed in the MPE wells. Therefore, up to 470 gpm will be extracted from the MPE wells and treated through the following treatment train as depicted on the PFD in Appendix C (Drawing P101). First, water extracted from the MPE wells will be delivered to two 20,000 gallon sediment tanks (S-104) equipped with oil skimmers to allow sediments to drop out and to segregate LNAPL from the water. Treatment paths for the water and the LNAPL are described below:

Water Treatment:

1. Water will then be pumped from the sediment tanks to a set of filter bags (FX-102);
2. From the filter bags water will pass through a heat exchanger (E-102) to reduce the temperature of the liquid to 120°F;

ED_005025_00013386-00030

3. Water will then pass through the gravity separator to remove any further LNAPL which will be transferred to the LNAPL tank (T-101);
4. Water treatment chemical will be metered in from a storage tank (Z-104) to iron fouling, carbonate scaling, and bio-fouling in downstream treatment units and then discharged to the discharge tank (T-102);
5. From the discharge tank water will be split into two streams. Approximately half the stream will feed back to the eductor pump skids to continue pumping operations. The other half of the stream will pass through the air stripper (Z-103) to remove volatile compounds. The vapor stream from the air stripper will pass through a moisture separator (S-103) prior to joining up with the other vapor streams at the thermal accelerators.
6. Water from the air stripper will pass through another set of bag filters (FX-104) and then through two GAC units (C-101 & C-102) for final polishing prior to discharge. The long-term need for GAC polishing to meet discharge limits will be evaluated during operations and may be discontinued if unnecessary.

LNAPL Treatment:

1. LNAPL from the sediment tanks (S-104) will first pass through a set of bag filters (FX-103) to remove grit;
2. From the bag filters the LNAPL will pass through a heat exchanger (E-103) to cool the LNAPL to 120°F;
3. Following the heat exchanger, the LNAPL will go through a LNAPL conditioning system (S-106) to purify the LNAPL for reuse and remove remaining water that will be redirected back to the liquid treatment system;
4. The purified LNAPL/JP-4 will be delivered to 20,000 gallon LNAPL holding tanks (T-103) which will feed the fuel to the steam boilers and the oxidizers.

Additional design details including equipment capabilities, materials of construction, steam generation and associated water softeners are included in TerraTherm's design report in Appendix D.

3.4 SVE Enhancements during SEE

The existing deep soil SVE well network at ST012 consists of a series of nine nested wells with three screened intervals per well location. The SVE extraction wells have Schedule 40 steel casings and stainless steel wire-wrapped well screens. Screened intervals for each of the shallow (S), middle (M), and deep (D) wells generally extend from 34 to 79 ft bgs, 87 to 127 ft bgs, and 135 to 165 ft bgs, respectively. Soil vapors extracted from the SVE well network are routed through SVE collector piping and directed to vapor treatment equipment for destruction of hydrocarbon vapors prior to release into the atmosphere. Two sub-grade collection sumps are installed in-line with the SVE piping for collection of condensate. Currently, the SVE system is operated using a 1,000-scfm thermal oxidizer with an installed catalyst manufactured by Catalytic Combustion Corporation for vapor abatement. As of the beginning of 2013, nine of the 27 SVE wells were actively extracting soil vapor. The existing SVE system will continue to

ED_005025_00013386-00031

operate during construction and operation of the SEE system. However, some changes will be made:

- Some of the conveyance piping for the SVE system will be relocated to accommodate piping and equipment for the SEE system (see Drawing CS-105 in Appendix C).
- The deep screens on the SVE wells (135-165 ft bgs) within the TTZs (ST012-SVE01 through ST012-SVE07) will not operate during SEE operations because they would extract steam, but will be turned back on after SEE operations are complete.
- High pressure / high temperature valves will be installed at the header of the deep SVE well screens within the TTZs (ST012-SVE01 through ST012-SVE07) to ensure that steam is not released from them.
- Five new SVE wells (SVE10 through SVE14) will be installed and will be co-located with TMPs (TMP04, 05, 12, 14, and 15) installed as part of the SEE (see Drawings CS-105 and CS-302 in Appendix C). Installation of the TMPs provides an opportunity to co-locate SVE screens to supplement the existing SVE well network. TMP locations were reviewed and those locations in proximity to Pre-Design Investigation wells ST012-LSZ15 and ST012-LSZ16 were selected. The borings for these two wells indicated higher remaining vadose zone contamination than other borings (see Appendix A) and are also close to existing SVE wells that typically have higher VOC concentrations, especially in the shallow or medium screened intervals (ST012-SVE01 and ST012-SVE05) Each well will have one screened interval which will vary based on field observations, but will be no deeper than 105 ft, so that there is a 30-ft buffer between the screen and the upper TTZ.
- The four existing vapor monitoring points including all probe depths, currently used to monitor vacuum, will be abandoned because they are constructed of polyvinyl chloride (PVC) and extend into the TTZ, where they would not withstand the temperature and would provide a pathway for steam to escape.
- Commissioning of the new/modified systems will be conducted and the Operation, Maintenance, and Monitoring (OM&M) Manual will be updated prior to SEE startup.

3.5 Enhanced Bioremediation Design

The approach to remediating the LNAPL impacted zones outside the TTZ combines the technologies of groundwater recirculation with the addition of terminal electron acceptor (TEA), and plume containment. At this juncture AMEC is employing an observational approach to selection, and delivery of TEA for the EBR system. The data generated by installation of the SEE system wells and operation of the SEE system will provide an improved understanding of subsurface flow and pressure responses and refinement, or, at a minimum confirmation of equipment and process selection for the final design of the EBR system. Additionally, single well inject-withdraw tests will be conducted in each hydrostratigraphic zone to assess TEA selection and delivery.

The final RD for the EBR system will be presented in an addendum to this document following the initiation of SEE treatment and completion of the EBR Field Test. The EBR Field Test Plan will detail the procedures, analysis, utilization, and data quality objectives of single-well inject-

ED_005025_00013386-00032

withdraw tracer and TEA dosing tests in the three hydrostratigraphic units. The EBR field test will be conducted outside of the SEE TTZs before SEE startup.

Conceptually, the EBR system will consist of an interlaced network of injection and extraction wells screened in the three water-bearing, LNAPL-impacted hydrostratigraphic zones outside the TTZs and, potentially, within the TTZs based on post-SEE conditions. An example of what the EBR well field might look like after initiating SEE and completion of the EBR Field Test Plan is shown in Figure 3-3. Layout of this conceptual EBR well field was performed using a refined version of the 3D groundwater flow model presented in the ST012 FFS (AMEC, 2012a). The model was updated using additional data and 3D geologic modeling performed by AMEC in 2013 using visualization software. The major upgrades to the 3D groundwater flow model include adjustment of the model layers from uniform thickness to honor the spatial variations in the 3D geologic model and update to the boundary conditions to calibrate to recent groundwater fluid pressures, including the filling of the CZ. A detailed description of the 3D groundwater flow model used for conceptual EBR design is provided in Appendix E.

Remediation well spacing and positioning; well design, specifically screen placement; and injection and injection/extraction rates for the conceptual EBR system (Figure 3-3) were designed using the refined 3D groundwater flow model. A typical five-point pattern, a square treatment cell consisting of a centrally located injection well surrounded by four extraction wells, on 60-ft spacing was used for the conceptual layout of the UWBZ and LSZ well fields. Although these units have different hydrogeologic properties, the 60-ft spacing was determined to yield a sufficient mixing time and dispersion between injection and extraction in each zone and allow for the collocation of wells within single boreholes thereby minimizing the cost and impact of drilling. In the CZ, because of the high conductivity, the five-spot pattern was not effective; instead a sweeping injection front generated using three injection wells upgradient and two extraction wells downgradient of the LNAPL-impacted zone outside the TTZ was designed. The conceptual spacing and layout shown in Figure 3-3 is based on available information. Well spacing and layout will be reevaluated based on observed hydraulic performance during the Field Test and SEE and will also depend on the final selected TEA.

The remediation-well screen sections; both injection and extraction, located in the LSZ and CZ, are designed to span the entire LNAPL-impacted zone outside the TTZ. The remediation well screen sections in the UWBZ were refined based on particle tracking analysis conducted using the 3D groundwater flow model. Initially the remediation well screens were positioned across the entire thickness of the UWBZ (similar to wells in other zones); however, due to the high conductivity of the overlying CZ a large portion of injected liquids traveled rapidly upwards exiting into the CZ. Using an iterative process with the 3D groundwater flow model the injection well screens and flow rates in the UWBZ were adjusted until particle traces of flow from injection wells were contained in the UWBZ. Ultimately, the top of the well screen section for each UWBZ injection well is set 20 ft below the top of the CZ/UWBZ interface. The bottom of the UWBZ injection wells extend to the bottom of the hydrostratigraphic unit.

Extraction well screen sections in the UWBZ extend from 10 ft below the CZ/UWBZ interface to the bottom of the unit. Injection and extraction flow rates for each conceptual EBR well were also designed considering the following:

ED_005025_00013386-00033

- The combined extraction rates from a given hydrostratigraphic zone exceed the injection rate to facilitate containment of the injected treatment solutions;
- The rates of injection or extraction to/from a given well are divided equally over the hydrostratigraphic unit but are weighted based on the transmissivity of the formation across the remediation-well screen interval;
- The average travel time from injection to extraction well (metric for evaluating mixing and diffusion of TEA in recirculation setting) and distribution of injected liquids is sufficient to deliver TEA to react with the impacted area within a reasonable timeframe.

Table 3-6 provides a summary of the conceptual EBR well design and injection and extraction flow rates.

Table 3-6 Predicted EBR Injection and Extraction Rates by Zone

Zone	Number of Injection Wells	Total Injection Rate (gpm)	Injection Rate Range per Well (gpm)	Number of Extraction Wells (gpm)	Total Extraction Rate (gpm)	Extraction. Rate Range per Well (gpm)	Ratio of Extraction to Injection Rate
CZ	3	9	2.61 - 3.45	2	15	6.37 - 8.63	1.67
UWBZ	12	60	3.60 - 7.67	16	90	4.33 - 7.04	1.50
LSZ	13	45	1.50 - 10.31	15	55	1.76 - 11.11	1.22
TOTAL	28	114	1.50 - 10.31	33	160	1.76 - 11.11	1.40

Notes:
CZ – cobble zone
EBR – enhanced bioremediation
gpm – gallons per minute
LSZ – Lower Saturated Zone
UWBZ – Upper Water Bearing Zone

The average and standard deviation of the travel and mixing time for TEA administered to each zone was estimated using the 3D groundwater flow model with particle tracking, the flow rates in Table 3-6, and the remediation well field layout shown in Figure 3-3. The results of particle tracking from injection well to extraction well for the CZ, UWBZ, and LSZ are shown in Figures 3-4, 3-5, and 3-6, respectively. The average and standard deviation of the estimated TEA travel and mixing times for each zone are summarized in Table 3-7 below.

ED_005025_00013386-00034

Table 3-7 Predicted TEA Travel and Mixing Times by Zone

Zone	Average Travel Time (days)	Standard Deviation (days)
CZ	26	5.5
UWBZ	235	170
LSZ	185	77

Notes:
CZ – cobble zone
LSZ – Lower Saturated Zone
TEA – terminal electron acceptor
UWBZ – Upper Water Bearing Zone

The two TEAs considered for application at ST012 are oxygen and sulfate. The advantages and disadvantages for each of these TEAs are presented in Table 3-8.

Table 3-8 Advantages and Disadvantages of TEA Candidates

TEA	Advantages	Disadvantages
Sulfate	**High Solubility** - An aqueous sulfate solution (considering a sodium sulfate solution) at standard temperature and pressure can contain as much as 27.7 percent sulfate by weight. This can greatly improve the implementablilty of storage and delivery of TEA as well as target TEA concentrations in the formation. The utilization factor for sulfate and JP-4 is estimated at approximately 5 pounds of sulfate per pound of JP-4 degraded. Therefore, based on the estimated volume of LNAPL to be treated outside the TTZ, approximately 7,600 tons of sulfate are required[1].	**Low Utilization Rate** – Estimated maximum specific benzene utilization rates for sulfate processes in the UWBZ and LSZ range between $8.75X10^{-4}$ and $1.75X10^{-2}$ per day. *It should be noted that these rates are estimated considering the natural flux of sulfate into the system; adding sulfate to the system may positively influence the sulfate reducing bacteria to utilize petroleum hydrocarbon as a substrate thereby altering the kinetic constants including maximum specific utilization rates, half-velocity coefficients, and maximum yield.*
	Complement Current Subsurface Conditions - The current subsurface conditions are reduced and amendable to sulfate reduction.	**Potential for Groundwater Contamination by Sulfate**: Sulfate is a secondary groundwater contaminant, therefore careful consideration to the injected mass and residual sulfate need to be incorporated into the final design if sulfate is selected as the preferred TEA.
	Longevity - The high solubility of sulfate will allow for leaving behind a sulfate residual concentration in the system following active treatment.	**Potential for Generation of Excess Hydrogen Sulfide:** sulfate reduction of petroleum hydrocarbons can produce hydrogen sulfide gas. However, the relatively deep vadose zone and site hydrogeology along with careful attention to dosing mass and distribution can limit the potential for hydrogen sulfide gas accumulation at unsafe levels.

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Table 3-8 Advantages and Disadvantages of TEA Candidates (Continued)

TEA	Advantages	Disadvantages
Oxygen	**High Utilization Rate** - Maximum specific benzene utilization rates[2] for oxygen processes in the UWBZ and LSZ range between 0.15 and 0.20 per day (BEM, 2011, Appendix M). The utilization factor for oxygen and JP-4 is estimated at approximately 3.5 pounds of oxygen per pound of JP-4 degraded (BEM, 2011, Appendix M). Therefore, based on the estimated volume of LNAPL to be treated outside the TTZ using the conservative LNAPL interpretation, approximately 5,300 tons of oxygen are required[1]. *It should be noted that these rates are estimated considering the natural flux of oxygen into the system; adding oxygen to the system may positively influence the aerobic bacteria utilizing petroleum hydrocarbon as a substrate thereby altering the kinetic constants including maximum specific utilization rates, half-velocity coefficients, and maximum yield.*	**Counter to Current Site Conditions** - Raising the oxygen level in the system will require a period of adjustment or lag phase and some loss of added oxygen to abiotic processes.
	Benign Byproducts - Complete mineralization of petroleum hydrocarbons by aerobic biodegradation yields carbon dioxide and water.	**High Potential for Biofouling and Abiotic Clogging** - The calcium rich sediments at ST012 and biomass increase at injection points will likely require robust injection well rehabilitation during system operations.

Notes:
[1]Based on 465,000 gallons of LNAPL/JP-4 at a density of 6.57 pounds per gallon (middle of the literature-based range of estimated LNAPL outside the TTZs in the conservative LNAPL interpretation – see Table 3-2).
[2]Specific utilization rate represents the ratio of mass of TEA used to a specific compound degraded (benzene in this case) per day.
JP-4 – jet propulsion fuel, grade 4
LNAPL – light non-aqueous phase liquid
LSZ – Lower Saturated Zone
ST012 – former Liquid Fuels Storage Area
TEA – terminal electron acceptor
TTZ – thermal treatment zone
UWBZ – Upper Water Bearing Zone

Based on oxygen and sulfate biodegradation kinetic constants and LNAPL fractions and solubilities published in Appendix M of the TEE Pilot Test Report (BEM, 2011), the travel and mixing times estimated using the 3D groundwater flow model are sufficient to deliver TEA to the mixing/treatment zone.

ED_005025_00013386-00036

Considering the design injection flow rates, the distribution and mass of the LNAPL outside the SEE TTZ, and the solubility of sulfate, the required mass of sulfate could be added to the CZ, UWBZ, and LSZ over a 30-day period of recirculation utilizing a stock solution at 20 percent of the solubility limit of sulfate. Once the sulfate is added, the system recirculation would be operated to distribute the sulfate throughout the treatment area. Sulfate distribution in the UWBZ and LSZ would be accomplished by recirculating the system for approximately 1.5 to 3 years. Portions of the system in thinner LNAPL-impacted zones and/or higher permeability zones would be shut down earlier than areas of thicker LNAPL impact and/or lower conductivity. Sulfate in the CZ would be administered in smaller more frequent doses to maximize in-situ utilization and minimize loss of TEA mass to diverted extracted water. Additional sulfate doses would be considered based on feedback from process-flow and monitoring-well sampling and analysis results. The initial design of sulfate doses would be by zone and area of ST012 based on the results of the EBR Field Test.

Because oxygen is less soluble than sulfate and the oxygen utilization rates are significantly higher than those of sulfate, the delivery of oxygen using recirculation would be different than sulfate. Considering the design injection flow rates, the distribution and mass of the LNAPL outside the SEE TTZ, and hydrogen peroxide as the oxygen source, the required mass of oxygen could be added to the CZ, UWBZ, and LSZ over an approximate 1.5 to 3 year period of recirculation utilizing a stock solution of 10 percent hydrogen peroxide and target in-situ DO levels just below saturation. Hydrogen peroxide solution would be administered to the recirculation system on a more continuous feed as compared with the sulfate dosing process. Again, this is due to the relatively high utilization rates compared with the solubility limit of oxygen. Oxygen addition in the UWBZ and LSZ would be accomplished by recirculating the system for up to 3 years. Similar to the sulfate addition, portions of the system in thinner LNAPL-impacted zones and/or higher permeability zones would be shut down earlier than areas of thicker LNAPL impact and/or lower conductivity. Oxygen in the CZ would be administered in smaller more frequent doses to maximize in-situ utilization and minimize loss of TEA mass to diverted extracted water. Additional oxygen doses would be considered based on feedback from process-flow and monitoring-well sampling and analysis results. The initial design of oxygen doses would be by zone and area of ST012 based on the results of the EBR Field Test.

The conceptual design to the TEA dosing described above is affected by assumptions for sustainable biomass concentrations, maximum yield, and maximum utilization rates. Biodegradation kinetic constants were taken from Appendix M of the TEE Pilot Test Report (BEM, 2011). Since these constants are based on natural conditions, the biomass and maximum yield will likely be enhanced by the SEE process. Results of the EBR Field Test Plan will be used to refine and model kinetics with higher confidence to select the appropriate TEA and refine the delivery and dosing.

Process equipment will be installed for integrated operations for active remediation and containment of the three hydrostratigraphic zones (CZ, UWBZ and LSZ). The system components will operate in conjunction for an optimized and energy efficient remedy. Groundwater and LNAPL will be recovered by downhole pumps in extraction wells and separated by an oil/water separator at the surface. The separated LNAPL will be either recycled or disposed off site. The recovered groundwater will be amended with mineral nutrients, a concentrated TEA source (e.g. ozone, hydrogen peroxide for oxygen or powdered agricultural

ED_005025_00013386-00037

grade sodium sulfate salts for sulfate) and possibly cosolvent carbon sources (e.g. ethanol or ethyl lactate) and injected back into the subsurface. The combined physical and biological removal techniques are complementary and will augment each other for an optimized and efficient approach for remediation of ST012.

The overall system will be hydraulically designed to capture and maintain the plume geometry. A portion of the recovered water will be treated and will be available for beneficial use or discharged to the sanitary sewer. The system will be monitored in real-time with a supervisory control and data acquisition system (SCADA) and human-machine interface and will provide opportunities for system modifications. Flexible system hydraulics will allow quick modification of pumping and injection rates so that remediation can focus on higher concentrations. As the residual contamination decreases, the focus of the system will be directed toward higher concentration areas thereby maintaining optimum hydrocarbon recovery throughout the life cycle of the project.

Hydrocarbon recovery will be routinely checked with data collection and evaluation to identify opportunities for system improvements. Mass removal rates, dosing rates, TEA utilization, and hydraulic capture will be evaluated to quickly identify opportunities for system improvements.

ED_005025_00013386-00038

4.0 REMEDIAL ACTION IMPLEMENTATION

4.1 Overview of Implementation

Implementation of the remedial alternative will generally include the following:

- abandon monitoring wells within the TTZ that have materials incompatible with SEE (some will be rebuilt as SEE injection or MPE wells)
- install steam injection and MPE wells
- install TMPs and co-located SVE wells
- modify SVE system for compatibility with SEE
- upgrade utilities to accommodate SEE requirements
- construct conveyance lines for steam, water and LNAPL
- construct the SEE treatment facility
- operate, maintain, and monitor the SEE injection, extraction, and treatment systems
- monitor hydraulic control, thermal conditions, LNAPL distribution, and dissolved contaminant concentrations during and post SEE treatment
- conduct an EBR field test
- complete EBR design and update RD/RAWP
- install supplemental wells for EBR
- install recirculation and treatment equipment for EBR
- operate, maintain, and monitor EBR system for approximately 1.5 to 3 years
- monitor hydraulic control, TEA distribution and utilization, LNAPL distribution, and dissolved contaminant concentrations during and post EBR treatment.
- develop post SEE and EBR groundwater monitoring work plan
- conduct groundwater monitoring until cleanup levels are achieved

Details of implementation are covered in Sections 4.2 (SEE Implementation), 4.3 (EBR Implementation, and 4.4 (Groundwater Monitoring Implementation) although details for EBR and groundwater monitoring are limited at this time.

4.2 SEE Implementation

The following sections describe the construction and operation of the SEE system. Design Drawings are provided in Appendix C. Additional details are contained in Appendix D.

ED_005025_00013386-00039

4.2.1 Construction

Construction activities are anticipated to occur over several months. Initially utility service upgrades and wells will be installed followed by well field piping, mechanical equipment, and electrical/instrumentation.

4.2.1.1 Utilities / Civil

Modifications to existing on-site utilities (See Drawing CS-103) will be required to support the SEE system. Utility services necessary to operate the SEE system include electric, water, natural gas, and wastewater. Utility services currently existing at the Site to include the following:

- Underground electric line, transformer pad, and meters (2)
- 2-inch PVC water service line
- 2-inch polyethylene (PE) gas service line
- 4- inch chlorinated polyvinyl chloride (CPVC) sanitary sewer service line

Electric service to the Site is currently provided by Salt River Project (SRP®) through a drop down transformer and meter(s) located just south of Ulysses Avenue. The three phase electrical line is then routed via underground conduit to an electric panel located adjacent to the SVE process equipment. The proposed SEE system will require a 2,000 Kilovolt Amps transformer located in the vicinity of the existing transformer pad. From the transformer, electric service will be carried above grade through mining cables to three separate electric panels and ultimately to the required process components.

The existing 2-inch PVC water service line is fed from an 8-inch water main owned by the City of Mesa and located along the east side of the Site. A portion of this service line will be maintained including the shut off valve and backflow preventer. A connection to the existing service line will be completed on site and the 2-inch PVC service line will be extended to provide the necessary water for steam generation. Operation of the SEE system will require a water flow rate of 150 gpm.

Gas service is currently provided by Southwest Gas Corporation through a 2-inch gas line running along Ulysses Avenue. This gas line connects with a meter vault located at the north edge of ST012 adjacent to the existing transformer pad. From the meter a 2-inch PE gas line continues underground to the existing SVE process equipment. A valve pit will be installed along the existing on-site 2-inch PE gas line to allow for the connection and underground routing of new 2-inch PE gas lines to service the boilers and oxidizers.

Implementation of the SEE process will require a significant increase in the gas consumption to support steam generation and vapor treatment. The current system presently draws less than 1 million British Thermal Units (MMBTU) per hour (MMBTU/hr) and during initial operations the proposed SEE system will require approximately 88 MMBTU/hr with a delivery pressure of 5 to 7 pounds (lbs) per square inch absolute. It is anticipated that as the system becomes operational there will be large volumes of LNAPL/JP-4 extracted from the treatment area and

ED_005025_00013386-00040

separated from vapor and water that will be suitable for reuse to fuel the boilers and thermal accelerators, thereby reducing the natural gas consumption.

Communications have been initiated with Southwest Gas regarding the significant increase in gas demand during the initial phase of the remediation process. Preliminary engineering evaluations have determined the existing 2-inch gas line is capable of providing the required gas demand; however evaluations on required delivery pressure still need to be performed.

The SEE system will generate a significant volume of wastewater during MPE. After pre-treatment to remove sediments and separate LNAPL, the wastewater will be split into two streams (see Drawing P101) with approximately 273 gpm being recirculated to operate the extraction well eductor pumps and a remaining flow of up to 227 gpm will be directed to the City of Mesa's sanitary sewer system following additional treatment to meet discharge requirements.

Wastewater discharge from the SEE process will be directed to an existing 12-inch sanitary sewer line located along Sossaman Drive located just south of ST012. The existing 4-inch CPVC service line located on the Site does not provide adequate capacity to convey the anticipated flows and will be abandoned in-place or removed as required. A proposed 6-inch CPVC sewer line with associated clean-outs and manholes will be installed to convey flows from the wastewater treatment equipment to a proposed manhole to be installed on the existing 12-inch sewer main.

The City of Mesa recently (June 2013) completed a flow study on the entire system to evaluate downstream capacity and establish discharge limits from the Site. The study revealed the receiving system currently conveys 220 gpm and has an available additional capacity of 350 gpm. The City has expressed concerns with the proposed discharge from the Site but has agreed to permit 250 gpm of capacity with the provision that if future developments along the system are requested during SEE operation, the City will reduce the allowable discharge rate for the SEE system to 200 gpm.

All utility services will be installed in accordance with the permits identified in Section 5.10 Permits and Permit Equivalency Evaluations. The proposed below grade utilities will be installed with adequate setbacks from the proposed Injection and Extraction Wells to eliminate any detrimental temperature effects on the proposed utility lines.

4.2.1.2 Drilling

Existing wells from the TEE pilot test and from the Pre-Design Investigation will be used as steam injection or MPE wells. These will be supplemented with additional steam injection wells, MPE wells, and TMPs installed at ST012 as shown on Drawing C-103. Drilling activities will include well abandonment and well installation, which will take place concurrently. New wells will be drilled in accordance with SOPs 4D and 4F and well abandonment will be in accordance with SOP 5 (updated procedures will be provided in the Draft Final version of this RD/RAWP). There are several monitoring wells, extraction wells, injection wells, and vapor monitoring points located in the TTZ and within 30 ft of the TTZ perimeter that will need to be abandoned to prevent high pressure steam from escaping the treatment zone (see Drawing CS-101). These

ED_005025_00013386-00041

wells are summarized in Appendix G. Abandonment of monitoring wells constructed of PVC will consists of first over drilling the existing well and then filling in the hole with cement grout that is able to withstand the high temperature of the steam (high-temperature grout). Abandonment of monitoring wells constructed of steel will include filling in the well and the annular space around the well screen with high-temperature grout, and removing the upper 5-ft of the steel casing. The two existing horizontal wells will also be filled with high-temperature grout and a procedure will be developed (to be incorporated into Draft Final RD/RAWP) to ensure that the sloped approaches will be successfully abandoned so that high pressure steam does not escape outside of the TTZ. Selected well abandonment locations, identified in Appendix G, will be used as TMPs, where a temperature probe will be installed and surrounded by the high-temperature grout. TMP details are shown on Drawing C106. In some instances, a new vapor extraction well will be installed above a TMP (in the vadose zone) to enhance the SVE system (see Detail J, Drawing CS-302). Additionally, select wells abandoned via over-drilling will be replaced with a steam injection or MPE well. Permitting for the well closure operations will be conducted in accordance with the procedure outlined in Article 8, Section (§) R12-15-816 of the Arizona Administrative Code (AAC) and a Notice of Intent (NOI) form to abandon a well will be completed for each well and will be submitted to the ADWR.

New steam injection wells and MPE wells in the LSZ will be installed using Rotosonic Drill Rigs to provide detailed lithological data throughout the site and to the depth of treatment. Air rotary rigs will be used for new CZ and UWBZ wells. As previously mentioned, steam injection wells and MPE wells will be constructed in the same manner within each treatment zone so that changes can be made as needed based on field investigations (see Drawing C-104). Each steam injection and MPE well will be equipped with three thermocouples to monitor the temperature and the top, middle and bottom of the treatment zone. An additional 17 TMPs will be installed to monitor temperature throughout the TTZ. Of the 17 TMPs, 16 will be located in the LSZ and will each have 24 thermocouples, while the remaining TMP will be located in the CZ and will have 15 thermocouples (Drawing C106). Wells will be completed aboveground for ease of O&M. Table 4-1 provides a summary of steam injection and MPE wells to be installed. Additional details for the proposed wells are included in Appendix G.

Table 4-1 Summary of SEE Well Installation

Zone	Number of Steam Injection Wells	Number of Multi-Phase Extraction Wells	Screened Interval (ft bgs)
CZ	6	13	145 – 160
UWBZ	10	14	170 – 195
LSZ	18	24	210 – 245
Total	34	51	

Notes:
CZ – cobble zone
ft bgs – feet below ground surface
LSZ – Lower Saturated Zone
SEE – steam enhanced extraction
UWBZ – Upper Water Bearing Zone

Additional characterization of soil contamination, potential LNAPL distribution, and groundwater concentrations will be evaluated following well installation and baseline groundwater sampling.

ED_005025_00013386-00042

This data will be summarized and evaluated to establish the intial injection and extraction operational strategy for SEE and identify implications for the EBR design. These results and analysis will be summarized in an addendum to the Final RD/RAWP for Air Force and regulatory agency review prior to system startup.

4.2.1.3 System Installation

Vapor, liquid and steam manifold piping (Drawings M101 and M102) will be installed on the ground and/or on pipe stands. Steam and liquid piping will consist of welded steel pipe. Steam piping will also be insulated for personnel protection and to minimize heat losses. Vapor conveyance piping will consists of fiberglass pipe, and connections to the individual wells will be made with temperature and chemical rated hose connections to allow for sufficient flexibility for thermal expansion during operation.

Much of the treatment equipment will be delivered to ST012 as pre-assembled skids that will need to be plumbed together once delivered. Additional information regarding system installation is contained in Appendix D.

4.2.2 Operation

Operation of the SEE system will last for approximately [redacted] days, during which an estimated [redacted],000,000 lbs of steam will be injected into the subsurface. It is anticipated that up to a 99 percent reduction of benzene concentrations and up to 90 percent reduction in LNAPL in the treatment zones can be achieved by the end of active SEE remediation. These removals are higher than were achieved during the TEE Pilot Test due to more aggressive operating conditions (see Appendix D). Contaminants in the treatment area will be removed by pushing LNAPL towards the extraction wells, vaporization, and vapor extraction. When extracted, influent will undergo phase separation; contaminated groundwater will undergo air stripping and GAC polishing, vapor will be treated with TOX, and recovered fuel will be used to power one of the two boilers used to generate steam for the SEE system.

SEE is focused on removal of source material and is expected to result in a significant decrease (>90%) in dissolved-phase concentrations. The EBR component of the remedy followed by natural attenuation will address the remaining LNAPL outside the SEE TTZs and the dissolved-phase plume to the extent that cleanup levels will be achieved within the estimated remedial timeframe of 20 years. There is a net extraction of groundwater from ST012 during SEE to provide hydraulic containment and groundwater monitoring outside the limits of treatment to verify containment. Injection strategies will be refined during the RD/RA phase to address potential LNAPL migration. Where injection wells bound LNAPL, injections will occur with an outside in approach. Where LNAPL may exist at the perimeter of the treatment zone, initial extraction is anticipated. Monitoring of temperature within and at the perimeter of SEE, groundwater elevations and LNAPL accumulation outside the TTZ, and perimeter groundwater benzene concentrations will be used to demonstrate containment. Should loss of containment occur, steam injection in the area will be adjusted (reduced pressure or terminated). In some cases extraction may be increased in an area or a well may be converted from an injection to an extraction well. Monitoring will be performed to establish that containment has been re-

ED_005025_00013386-00043

established. If loss of containment continues, other actions may be considered in consultation with the Air Force and regulatory agencies.

The existing SVE system would continue operation while the SEE system is operational although at a reduced vacuum to prevent pulling steam toward the surface. The contaminant removal rate for the SVE system is not likely to diminish as the reductions in vacuum intensity will be offset by some degree of thermal enhancement from below. Some of the existing deep zone SVE wells, which are screened in the CZ, will be closed and sealed with high temperature valves to prevent steam migration to the surface. MPE wells will provide vapor extraction in this interval.

A rise in groundwater and soil temperature would stimulate bioactivity, especially around the perimeter of the SEE treatment. This would result in accelerated natural attenuation outside of the treatment zone. Following the end of steam activities, monitoring would commence to determine the degree to which biological activity had been stimulated and what additional substrate, if any, would be needed to supplement the bacterial activity and complete remediation. An evaluation of biological degradation activity after completion of SEE treatment is included in Appendix E, which indicates that natural attenuation mechanisms will reduce benzene concentrations to the cleanup goal within a 20-year remediation timeframe. Five-year reviews will be conducted in accordance with CERCLA to evaluate the implementation and performance of the remedy in order to determine if the remedy is or will be protective of human health and the environment.

During steam injection activities, the increased pressure and temperature in the subsurface will make groundwater sample collection in or near the injection area hazardous. As such, regular groundwater monitoring activities will be temporarily modified during the active injection portion of this remedy. Sampling will continue around the perimeter of the SEE treatment to monitor plume migration and ensure contaminant containment. Remediation progress will be monitored through tracking of LNAPL volume removed and analyses of samples from individual extraction wells and influent to the treatment system (see Section 5.6).

4.2.3 SVE Operation During SEE

The deep screened interval SVE wells will be shut off and disconnected from the SVE system during SEE. The shallow and middle screened interval SVE wells will continue to be connected to the SVE system and the single screen intervals for the five new SVE wells will be connected to the system network (see Drawings CS-105 and CS-302). Vapor concentrations in all connected wells will be monitored and the system operated to optimize contaminant extraction. Influent concentrations to the oxidizer will also be monitored and, if necessary due to increasing concentrations during SEE, the catalyst may be removed from the currently operating thermal oxidizer or the flame oxidizer unit, which can handle higher concentrations, will be brought on line. It is anticipated that the SVE system would remain operational after SEE until contaminant cleanup levels and RAOs are achieved for the deep soil SVE remedy.

ED_005025_00013386-00044

4.2.4 Transition to Enhanced Bioremediation

The overall strategy for the selected groundwater remedy is presented in Section 3.2.2. Multiple lines of evidence will be used to support the discussion to terminate steam injection and transition to EBR. The primary factors for making the determination to transition from SEE to EBR are achieving target subsurface temperatures and diminishing mass removal rates. Throughout steam injection, AMEC and TerraTherm will closely monitor the performance of the SEE system. Evaluations of thermal operation will be ongoing to determine when the transition to the next phase is warranted. The specific criteria that will be considered in the decision making process for transition are shown in Table 4-2. The criteria will be considered in total with the weight of evidence from these multiple lines being used for decisions. Monitoring associated with achieving the target criteria are presented in Section 5.6.3.

Table 4-2 SEE to EBR Transition Criteria

Parameter	Target Criteria	Basis for Target Criteria	Description
Subsurface Temperature	Varies by Depth (higher boiling temperatures with depth – see Figure 5.3, in Appendix D of the RD/RAWP	Numerical thermal modeling of TTZs supported by depth-specific boiling points.	Efforts will be made during operations to inject steam throughout the TTZ to target achievement of boiling point temperatures for groundwater throughout the TTZ. A steam zone will be generated and maintained where possible with the goal of pushing steam across the TTZ to form a steam zone between injection and extraction wells, with breakthrough of steam demonstrated at extraction wells. It is anticipated that a steam zone will not be able to be created and maintained in the LPZ. Other areas of low permeability may also be discovered during operation that limit achievement of target temperatures. Operational adjustments will be made where possible to increase temperatures in such zones that are slower to reach target temperatures. The energy balance will be used to support evaluation of achieving the temperature goal. Shut-down of steam will only be considered after achieving boiling point temperatures throughout the TTZ with the exception of the LPZ and other potential areas of low permeability and provided that operational adjustments are made to attempt to achieve the temperature goal in areas that are resistant.

ED_005025_00013386-00045

Parameter	Target Criteria	Basis for Target Criteria	Description
Completion of Pressure Cycling	Completion of multiple pressure cycles in each area	Pressure cycling has been demonstrated at other sites to improve mass removal beyond that achieved by uniform heating only.	Once the TTZ temperatures have stabilized, further mass removal improvement can be achieved by releasing steam pressure to cause volatile LNAPL constituents to rapidly vaporize for subsequent collection by MPE wells. The process of building and releasing the pressure is repeated until no additional significant increases in effluent vapor phase concentrations occur when steam pressure is reduced.
Mass removal	Less than 10 percent of peak removal rate	10 percent selected as an indication of significant decline in mass removal by SEE. This target is consistent with removal rate trends observed at other sites and provides some accommodation for the uncertain mass present and the uncertain peak extraction rate.	The rate of contaminant mass removal from the subsurface will play a major factor in determining when SEE is complete or sufficient. The mass removal rate will be closely monitored and will be optimized by using pressure cycling events. Toward the end of the operational period, the mass removal rates will be modest when compared to the peak removal rates (typically less than 10 percent of the rate observed at peak operations). Contaminant mass located around the perimeter of the TTZ may contribute a continuing source of mass for removal by the SEE system, which could mask the progress of mass removal within the TTZs, so the contribution of perimeter/interior extraction wells may be evaluated for mass removal towards the end of operations to identify any perimeter influx. Continued operation below the 10 percent of peak removal rate may be implemented depending on the significance of continued mass removal, the status of COC concentrations (e.g., benzene) in extracted fluids, and the need/ability for EBR to achieve further degradation based on data collected during the EBR field test.

ED_005025_00013386-00046

Parameter	Target Criteria	Basis for Target Criteria	Description
Benzene concentrations:	100 to 500 µg/L	Concentration range where natural attenuation can complete degradation within the remedy time frame.	Benzene concentrations in extracted groundwater provide an indication of the amount of benzene remaining in the TTZ. These concentrations will be monitored against a target benzene concentration in the 100 to 500 µg/L range within the TTZ. This concentration range is predicted to achieve cleanup levels within the 20-year remedial timeframe based on modeling of groundwater contaminant attenuation outside the TTZs after active EBR (Appendix E). Benzene located around the perimeter of the TTZ and the perimeter/interior extraction wells will be evaluated for benzene concentrations to identify any perimeter influx that may mask benzene removal within the TTZ. It is expected that lower benzene concentrations within this range will be achieved in the interior of the TTZs than at the perimeter.
Steam injection	319,357,000 lbs	Numerical thermal modeling of TTZs.	A targeted total of 319,357,000 lbs of steam is expected to be injected into the TTZ over the course of operations. This represents an average flushing of the TTZ pore volume of 1.6 pore volumes of steam as water throughout operation. Actual steam required to achieve the other criteria may be more or less than this estimate.

Notes:
EBR – enhanced bioremediation
lbs – pounds
LNAPL – light nonaqueous phase liquid
LPZ – low permeability zone
MPE – multiphase extraction
TTZ – thermal treatment zone
µg/L – micrograms per liter

Data will be collected to support evaluation of these criteria as described in Section 5.6. These criteria will be tracked and presented as part of routine progress reports particulary as treatment approaches the transition point and some of the data (e.g., subsurface temperatures) will be available via a web page interface. These factors will also be considered in light of the final EBR design including predicted achievement of the cleanup levels within the 20 year remedial timeframe. The evaluation for completion of thermal operations will be made between AMEC

ED_005025_00013386-00047

and TerraTherm and discussed with the AF, EPA, and ADEQ prior to termination of steam injection.

When the determination is made to transition to EBR, steam injection will be discontinued and the steam front will be allowed to collapse. At this point the SEE system will only continue with liquid and vapor extraction to provide additional mass recovery and continued contaminant containment during the initial cool down of the TTZ.

Once steam injection ceases, extraction wells in the PMGAA cell phone lot will be connected by subsurface piping to the extraction system so that use of the original cell phone lot entrance can be restored. Extraction will continue for about 90 days after which the remedy will be in the EBR phase.

4.2.5 SEE System Decommissioning

Once the extraction phase is complete, the SEE system will be shut down completely. SEE elements that are not incorporated into the final EBR design will be decommissioned and TerraTherm will demobilize from the site. The decommissioning and demobilization phase includes removal of the wellheads, meter runs, steam hoses, and monitoring hardware from each well. The downhole pump components will be removed. The wells will be left in place with suitably sealed end caps until such time following EBR that abandonment is justified and agreed to by EPA and ADEQ based on groundwater concentrations. The steam, vapor and liquid conveyance piping and pump skids will be disconnected and decontaminated as required. The process treatment equipment and associated interconnecting piping will be decontaminated and disassembled working from the wellfield inlet toward the process treatment effluent so that decontamination fluid can be processed through the treatment system as much as possible. When it is no longer possible to process the decontamination fluids, they will be containerized and characterized for off-site disposal. Non-hazardous waste and scrap materials will be loaded into dumpsters for off-site disposal or recycling. Rental equipment and temporary facilities will be returned to vendors as appropriate. Purchased equipment will either be left onsite for use during EBR or removed from the site for disposal or reuse.

4.3 Enhanced Bioremediation Implementation

EBR treatment of the LNAPL-impacted zones outside the SEE TTZs, and to the extent necessary, residual contamination within the TTZs will be accomplished in seven steps as follows:

1. Develop and implement an EBR Field Test Plan;
2. Select the TEA for EBR;
3. Analyze SEE treatment operations data (e.g., TEA and contaminant concentrations in groundwater wells and extracted groundwater, temperatures, water chemistry and biological parameters);
4. Refine the EBR system design and document in an RD/RAWP update including well field and process equipment selection and groundwater sampling to evaluate post SEE conditions;

ED_005025_00013386-00048

5. Install EBR system including wells, underground pipes, and process equipment;
6. Operate, maintain, monitor EBR system
7. Shut down and decommission EBR system

The conceptual approach for EBR is presented in Section 3.5 and Appendix E. The development of the EBR Field Test Plan for the selection of TEA and refinement of EBR design will begin following the finalization of the RD/RAWP with implementation of the EBR Field Test planned for just prior to SEE startup. Since the finalization of the EBR RD will occur following the startup of SEE, the schedule allows for a pragmatic approach for development of the final EBR design. At the conclusion of the EBR Field Test, SEE operations will be underway and the EBR RDRA WP update will be completed. Site-specific properties including biotic (e.g., enhanced maximum utilization rates) and abiotic (e.g., dispersivity) parameters will be used to refine the EBR design and implementation.

4.3.1 Construction

To the extent possible, SEE remediation equipment will be reused. Eductor pumps and downhole eductors, some piping, extracted water treatment works, and ancillary materials and equipment may be salvaged from the SEE system. Selection of reusable equipment and materials will be made following the construction of the SEE system. This assessment will be refined in the EBR RD/RAWP update.

Remediation wells will be constructed from conventional 4-inch diameter, Schedule 80 PVC riser pipe and continuous wrap screen. Screen material will depend on final TEA selection and concentration. Wells will be installed using standard or sonic drilling methods and constructed to ensure 1) target zones are screened; 2) filter pack and annular seals are properly installed, and 3) wells are sufficient for installation of pumps or maintenance/well rehabilitation equipment. Continuous logging (cores and cuttings) during installation will support the selection of initial extraction and injection rates and will be used to modify screen placement in the field should the expected impact zone extent vary from design understanding. Final remediation well design will be completed in the EBR RD/RAWP addendum, which will be developed following the completion of the EBR Field Test.

Because the EBR recirculation system will require a longer operation time than SEE and the system footprint will extend into areas actively used by adjacent property owners, pipelines will be installed underground. Wellhead vaults will be installed at each remediation well to allow for access to wells, pumps, instrumentation, and transmission line junctions. Pipelines from each well will be brought to a central remediation compound located within ST012. Bedding sand and compacted trench spoils will be used to backfill transmission line trenches and the site surface will be restored (e.g., grading or asphalt patching).

Flow regulating manifolds for each grouping of wells (e.g., UWBZ injection wells) will be located in a control house at the remediation compound. Operational surge and mixing tanks (if required) and oil/water separators will be placed between extraction and injection manifolds to facilitate control of delivery pressures and conditioning of recirculated liquids. In-well pressure

ED_005025_00013386-00049

transmitters and in-line flow sensors will provide feedback to a SCADA for automated control of extracted and injected liquids. The SCADA will also function to regulate dosing across the various well screened intervals based on well transmissivities. For instance, if the TEA target is to achieve a uniform concentration in the treatment zone; but, the transmissivities across the well field vary over an order of magnitude; the TEA concentrations delivered will vary according to injection well transmissivities. The EBR remediation compound will include storage of TEA, mixing tanks for stock solutions, and air compressors stationed as necessary. The layout and components of the EBR remediation compound and controls will depend on the results of the EBR Field Test and will be finalized in the EBR RD/RAWP addendum.

4.3.2 Operation

AMEC will operate the bioremediation system and will prepare an EBR OM&M manual. AMEC will perform startup, shakedown and troubleshooting of the EBR system as necessary to verify that complete and operational systems are installed. System functionality will be verified before operations commence.

The EBR system operating parameters including pressure, temperature, flow rate and concentration will be recorded for use in system calculations. Hydrocarbon concentration data will be collected from field instrumentation and samples subjected to laboratory analysis. System operating data will be routinely collected and evaluated for performance optimization. The EBR recirculation is anticipated to operate over a period of 1.5 to 3 years. Table 4-3 shows an example of O&M phases of aerobic EBR (i.e., oxygen as the TEA) at ST012.

Table 4-3 Example Aerobic EBR Phases

Phase	Start Time	End Time	Description
Initiate Recirculation	0	1 month	Start and tune groundwater recirculation system to establish flow fields and troubleshoot equipment.
Aquifer Pre-Conditioning	1 month	2 months	Add mineral nutrients (ammonium chloride, disodium phosphate, and potassium phosphate)
Groundwater Recirculation	2 months	Up to 3 years	Following aquifer preconditioning continue to recirculate groundwater.
Oxygen Dose	2 months	Up to 3 years	Add hydrogen peroxide to groundwater recirculation system to provide dose of oxygen for enhanced biodegradation
Option: Cosolvent Carbon Source Dose	When oxygen dose ends	Up to 3 years	Add cosolvent (e.g.: ethanol or ethyl lactate at approximately 2 percent by volume) to groundwater recirculation to support steady-state (zero-order) biodegradation and to enhance bioavailability of petroleum hydrocarbons

Notes:
EBR – enhanced bioremediation

ED_005025_00013386-00050

System adjustments will be made accordingly. Equipment life cycle usefulness will be monitored continuously. In order to maintain optimum performance, manufacturer recommended maintenance programs will be followed as part of routine system operations. System checks, oil changes, lubrications, belt changes, etc. will be recorded on maintenance logs and checked against manufacture maintenance milestones. Equipment will be maintained properly and generated waste will be recycled when possible or disposed of properly.

4.3.3 Transition to Monitoring

As discussed in Section 3.2.2, EBR will achieve conditions (residual contaminant of concern [COC]/contaminant of potential concern [COPC] groundwater concentrations) at ST012 such that contaminants will degrade by natural attenuation to achieve the cleanup levels within the projected remedial timeframe (i.e., about 20 years) after completion of EBR. Natural attenuation modeling has been completed as presented in Appendix E, which predicts that cleanup levels can be achieved within a 20-year remedial timeframe under the following conditions:

- Calibrated Monod kinetic rate constants for simulating biodegradation of the petroleum hydrocarbon contamination as published in Appendix M of the TEE Pilot Test Report (BEM, 2011). These constants are calibrated to the natural flux of TEAs and composition of the LNAPL.
- Depletion of LNAPL is simulated as a coupled two-step process where LNAPL dissolves into groundwater and is then degraded in the dissolved-phase via biodegradation. The dissolution and transport of LNAPL is simulated by the advection and dispersion primarily driven by the flux of clean groundwater into the LNAPL impacted zones.
- Concentrations of dissolved COCs in the TTZ following EBR and SEE were estimated by dividing 1 percent of the estimated mass of LNAPL constituents within each zone by the volume of the treatment zone. This was done to approximate the effects of mixing and the expected contaminant mass reduction within the TTZ as a result of SEE.

The natural attenuation modeling has been completed based on the best available data and reasonable assumptions. Prior to and during EBR, the inputs and assumptions will be updated based on field data, which will enhance the model's ability to predict natural attenuation time frames. Field data collected during EBR will be compared to updated model goals to evaluate when the transition to monitoring is justified.

The transition to monitoring will consist of shutting down active EBR systems including any amendment additions or recirculation systems. The Monitoring Work Plan will be developed prior to shut down of the EBR.

4.4 Groundwater Monitoring Implementation

Groundwater monitoring will be conducted to verify that conditions remain conducive to natural attenuation processes and to track progress toward achieving the cleanup levels. Results will be reported as part of routine monitoring reports and recommendations for modification of the monitoring program will be made as appropriate.

ED_005025_00013386-00051

4.4.1 Transition to Closure

Achievement of the cleanup levels will be evaluated in routine monitoring reports. As presented in ROD Amendment 2 (AFCEC, 2013), in the absence of an alternative mutual agreement between the AF, EPA and ADEQ, cleanup levels will be attained when monitoring results from no more than a two year period do not exceed cleanup levels. The AF, EPA and ADEQ may agree to the termination of monitoring at specific locations or for the overall plume area based on a shorter duration or other criteria upon mutual agreement.

ED_005025_00013386-00052

5.0 PROJECT REQUIREMENTS

5.1 Health and Safety Plan

AMEC has developed a Health and Safety Plan (HASP) for work performed by AMEC personnel at the former Williams AFB and will update the HASP for SEE and EBR operations. Subcontractors, including TerraTherm, potentially exposed to contamination will be required to have their own HASP (or may formally adopt AMEC's HASP) and keep a copy of the HASP on site during construction activities. The AMEC Project Manager will update the HASP if the scope of work changes and as necessary, both prior to and during construction.

AMEC and subcontractor personnel must complete training on site-specific health and safety procedures prior to starting construction.

AMEC's Project Health and Safety Officer will lead a daily safety tailgate meeting with all on-site project personnel to review hazards and safety precautions applicable to the day's specific work tasks.

A copy of the HASP is maintained at the job site.

5.2 Site Management Plan

The majority of the TTZ at ST012 is located on land occupied by existing remediation and monitoring equipment and not used for purposes other than remediation. The remaining area of the TTZ includes several roadways and a portion of a parking lot currently utilized by the airport (See Drawing CS-102). The following areas will be impacted and subject to various forms of closure during remediation activities;

- Upton Avenue (currently not an active road)
- Avoca Street (West)
- Ulysses Avenue (North)
- Ulysses Avenue and Cell Phone Parking Lot (East)

AMEC will work with a subcontractor, the City of Mesa, and adjacent property owners including the PMGAA, Arizona State University, and the United States Army Reserve Center (USARC) to provide necessary controls to secure the Site and prohibit vehicular and pedestrian traffic from entering the work area. Perimeter controls will include the following security measures;

- Installation of wind screen on existing chain link fence (wind screen on USARC fence is subject to coordination with USARC)
- New chain link fence with wind screen
- New chain link fence on concrete Jersey barriers
- Locking construction access gates and informational signage

ED_005025_00013386-00053

- Road closure, parking lot, and detour signage / barriers (See Drawing CS-104)
- Sidewalk warning signage

In addition, yellow caution tape, red danger tape, or orange mesh fencing may be used to further separate bystanders or workers from dangerous or sensitive construction activities or equipment. Concrete barriers will be used around construction areas located adjacent to vehicle traffic areas. Unfinished or unsupervised areas will be secured from trespassing and security for the construction site will be coordinated during non-working hours. Security cameras connected to the internet will be implemented during SEE operations.

The cell phone parking lot is primarily accessed by turning onto Ulysses Avenue from Sossaman Road. This portion of Ulysses Avenue will be closed during remediation and a proposed detour route has been developed for vehicular access to the portion of the parking lot beyond work zone limits (see Drawing CS-104). Entrance modifications will be made to the parking lot and signage provided to detail the detour route.

The automated sliding gates currently located at the northeast corner of the USARC Herrera Hall Facility on Avoca Street will need to be disabled due to these road closures. In coordination with USARC, the currently manually operated sliding gates on Avery Street, between Unger and Union Streets will be modified to have the same functionality as the Avoca Street gate prior to the road closures and disabling of the Avoca Street gate.

5.3 Operation and Maintenance Plan

An O&M Plan will be prepared by TerraTherm for the SEE system, and the system will be operated by TerraTherm. Compliance monitoring and reporting will be conducted by AMEC. The O&M Plan for SEE will be developed toward the end of the SEE construction period so that specific information concerning the actual equipment built into the system can be incorporated into the document. The sampling and analysis requirements are covered in this RD/RAWP (see Section 5.6). Operation is expected to require automated and manual adjustments throughout the operation period. In general, the effluent treatment system operation will be controlled and monitored by the programmable logic controller (PLC) system. Steam injection rates will be monitored and adjusted manually as appropriate (manual adjustment of injection rates).

The existing Operation, Maintenance and Monitoring Manual for the SVE system (AMEC, 2012b) will be updated to include new well locations and any changes to overall operations. Changes in operations are not expected to be significant, however, since there will be new SVE wells in contaminated areas, it is likely that VOC concentrations will increase compared to current conditions. This may require the use of the flame oxidizer and/or use of dilution air until concentrations decrease.

EBR O&M procedures will depend on the final design implemented after SEE is complete and be presented in a separate EBR O&M Plan.

ED_005025_00013386-00054

5.4 Waste Management Plan

Wastes generated during construction and operation of the remedial systems will be managed in accordance with local, state and federal regulations. This shall include labeling all waste containers, waste sampling, preparing waste profiles, and signing waste manifests. Personnel involved in overall management of waste will have appropriate Resource Conservation and Recovery Act and United States Department of Transportation hazardous waste transportation training. The following waste streams are expected to be generated during construction of operation activities:

- Soil from drilling activities will segregated by depth and PID readings and will be placed in roll-off containers. Once a roll-off container is filled, a composite soil sample will be collected and tested for disposal characterization. Based on analytical data, the generated soil will be transported off-site for disposal at a licensed disposal facility as either non-hazardous or hazardous waste.
- Decontamination fluids from construction activities will be processed through the SEE liquid treatment system prior to discharge. Decontamination fluids generated during decommissioning will need to be characterized and shipped off-site for treatment or disposal
- GAC used to treat VOCs as part of the SEE will be transported offsite for regeneration. The GAC will first need to be characterized to determine if it needs to be shipped as non-hazardous or hazardous material.
- Used filter bags will be collected in a satellite accumulation drum and will be sampled and characterized for disposal at a licensed disposal facility as either non-hazardous or hazardous waste.
- Personal protective equipment (PPE) that does not come in contract with Site fluids will be disposed of as construction waste. PPE in contact with Site fluids will be drummed with the used filter bags for characterization and shipped as either non-hazardous or hazardous waste.
- Sediments accumulated from the sediment removal tank will be sampled, characterized and shipped as either non-hazardous or hazardous waste.
- Recovered, excess LNAPL (if any) will be sampled to ensure that it is free of any unsuspected contaminants and may be sold for recycling and reuse. Otherwise the LNAPL will need to be characterized and transported offsite for disposal.

5.5 Quality Assurance Project Plan

This RD/RAWP has been prepared consistent with the Performance Based Remediation *Program Quality Assurance Project Plan and Standard Operating Procedures* (Program QAPP) (AMEC, 2012c) and defines the task-specific sampling and analysis elements associated with the proposed work (see Section 5.6). This RD/RAWP, in combination with the Program QAPP, provides all of the elements of a QAPP and SAP. Task specific elements are included in this RD/RAWP while program-wide elements are referenced in the Program QAPP (AMEC, 2012c).

ED_005025_00013386-00055

Appendix H provides a cross walk of the location of QAPP/SAP information and the task-specific QAPP/SAP worksheets.

5.6 Sampling and Analysis Plan

Sampling and analysis activities will occur throughout RA implementation for a variety of purposes. This section describes the scope of this sampling and analysis during the SEE phase and leading up to the EBR phase. Further details on sampling and analysis during EBR will be presented in an amendment to this RD/RAWP when the EBR design is refined. Finally, groundwater monitoring to be conducted after EBR will be presented in a Groundwater Monitoring Work Plan prior to termination of EBR.

5.6.1 Soil Characterization for LNAPL

During drilling of new remediation wells for SEE, all new LSZ well cores will be screened continuously with a PID for presence of VOCs. Soil will be screened on-site for LNAPL presence using a dye test kit as described in SOP-ST012-05. For other new wells in the CZ and the UWBZ installed by air rotary methods, drill cuttings will be screened with a PID approximately every 5 ft. The dye test kits will be used to confirm LNAPL presence/absence that is suspected based on visual and PID screening. The frequency of dye testing will be selected by the field geologist and will depend on the uncertainty associated with the visual and PID screening methods. It is anticipated that the frequency of dye test kit use will decrease over the investigation period as confidence in visual and PID readings increases. On average one dye test per 10 ft boring interval is anticipated. One soil sample from each new LSZ well boring will be collected from the apparent highest area of contamination based on PID readings and dye test kit results and sent off site for analysis of VOCs by method 8260B and TPH (sum of gasoline range organics [GRO] and diesel range organics [DRO]) by method 8015M. summary of wells to be installed and screened is presented in Table 4-1. Soil characterization will not be possible for the overdrilling of existing wells. Results of the LNAPL characterization sampling will be used to consider the presence of LNAPL throughout the TTZs and inform startup strategies in different areas of ST012.

5.6.2 Pre-SEE Groundwater Sampling

After drilling and well construction activities are complete, AMEC will perform an initial round of groundwater sampling at ST012, including previously existing SEE wells and newly installed wells. Water levels and absence or presence of measurable LNAPL will be recorded for all SEE wells. Approximately 60% of SEE wells will be sampled for VOCs and TPH including roughtly every other well within each TTZ. AMEC will sample the specific wells listed in Worksheet 18. Methods used will generally be consistent with the sampling and analysis used in the annual groundwater monitoring program (AMEC, 2013d). Groundwater samples will be analyzed for VOCs by method 8260B and TPH (sum of GRO and DRO) by method 8015M. VOC COC and COPC results will be compared to the Worksheet 15 project action level. AMEC will collect samples using low-flow sampling methods described in SOP 10D. These sampling methods will require allowing the new wells to rest for at least one week after development so fines and sediment in the well are allowed to settle. During low-flow sampling, flow-through cell instruments will be used to measure water quality parameters.

ED_005025_00013386-00056

Table 5-1 Baseline Groundwater Sampling Summary

Locations	Analysis	Frequency/Timing
All newly installed SEE wells and previously installed SEE wells (PDI or TEE Pilot Test)	Water level and product measurement	One event at least one week after well development
Select newly installed SEE wells and previously installed SEE wells (PDI or TEE Pilot Test) (See Worksheet 18 in Appendix H for complete list)	VOCs (8260B) TPH (8015M)	One event at least one week after well redevelopment

Notes:
PDI – Pre-Design Investigation
SEE – steam enhanced extraction
TEE – Thermal Enhanced Extraction
TPH – total petroleum hydrocarbons
VOCs – volatile organic compounds

5.6.3 SEE Operational Sampling and Analysis

Monitoring of SEE operation will include a combination of process monitoring (e.g., pressures, flow rates) that will be detailed in the SEE OM&M manual, continuous temperature monitoring to confirm heating zones and steam distribution/containment using the thermocouples at injection/extraction wells and TMPs discussed in Section 4.2.1.2, water level monitoring, and analytical monitoring. This section discusses the groundwater level and analytical monitoring specific to the SEE system and groundwater.

Table 5-2 SEE to EBR Transition Criteria Monitoring

Parameter	Target Criteria	Summary of Monitoring or Sampling and Analysis for Evaluation of Progress Toward Transition Criteria
Subsurface Temperature	Varies by Depth (higher boiling temperatures with depth – see Figure 5.3, in Appendix D of the RD/RAWP)	17 individual TMPs will be equipped with 15-24 vertical temperature measurement locations per TMP. In addition, each SIW and MPE well will be equipped with the infrastructure for a co-located TMP to be installed for temperature measurements to be collected. Co-located TMPs will be permanently installed for the 18 deep SIWs in the LSZ and will monitor the temperature at the top, middle and bottom of these wells. Two mobile temperature arrays will be used to monitor temperatures in the remaining deep, intermediate and shallow MPEs and SIWs (top, middle and bottom depths). Temperature monitoring of the SIW/MPE wells, along with extracted fluid and vapor temperatures, will supplement the 17 individual TMPs to monitor temperature distribution at the site.
Completion of Pressure Cycling	Completion of multiple pressure cycles in each area	Because the pressure cycling process results in the volatilization of contaminants upon release of the pressure, extracted vapors will be the primary source for measurement of pressure cycling effectiveness. Vapors will be primarily monitored with hand held devices with the objective to demonstrate diminishing returns from pressure cycles.

ED_005025_00013386-00057

Parameter	Target Criteria	Summary of Monitoring or Sampling and Analysis for Evaluation of Progress Toward Transition Criteria
Mass removal	Less than 10 percent of peak removal rate	Mass removal will be determined from a sum of individual mass removal rates such as: • Recovered LNAPL as measured by flow meters and levels in LNAPL storage tanks • Mass in extracted vapors as measured at vapor collection manifold • Mass in extracted water as measured in air stripper off gas and liquid laboratory samples
Benzene concentrations:	100 to 500 µg/L	Benzene concentrations will be monitored in SEE wells during baseline sampling. Samples of extracted water will be used to evaluate benzene concentrations during SEE operation. Sampling locations during operation will be determined in the field with a sampling strategy that starts at influent to the liquid treatment system and then moves progressively out to individual manifolds and, in some cases individual wells to trace the source of benzene contribution. The locations will also be selected to evaluate the relative contribution of contamination from outside vs. inside the TTZs.
Steam injection	319,357,000 lbs	Steam production will be measured at the boilers.

Notes:
lbs – pounds
LNAPL – light nonaqueous phase liquid
LPZ – low permeability zone
LSZ – lower saturated zone
MPE – multiphase extraction
RD/RAWP – Remedial Design/Remedial Action Work Plan
SIW – steam injection well
TTZ – thermal treatment zone
µg/L – micrograms per liter

During system operation, a handheld Flame Ionization Detector (FID) (Photovac MicroFID or similar) will be used to screen the vapor concentrations at several locations on a daily basis including:

- at the influent to the treatment system;
- at the air stripper effluent;
- at the inlet to the thermal accelerators;
- at the effluent to the thermal accelerators; and
- at the discharge location (effluent stack).

Vapor samples for screening will be collected in Tedlar™ bags using a sample pump. The screening data will be included in the daily data collection sheet completed by the operations team. TerraTherm will also collect monthly vapor samples for screening with the FID from

ED_005025_00013386-00058

individual MPE wells or manifold sections in order to obtain information about the contaminant concentrations in vapors extracted across the Site.

In addition to the screening level vapor samples that will be collected throughout operations, TerraTherm will collect liquid samples from the liquid carbon influent, midfluent and effluent on a weekly basis and will screen the headspace for an indication of contaminant loading of the carbon (procedure will be provided in the OM&M Manual). These headspace readings will be verified through laboratory sampling as discussed below. Similar liquid samples may be collected from individual MPE wells in order to evaluate LNAPL and dissolved contaminant concentrations in the vicinity of the well.

System samples will be collected and sent for laboratory analysis for verification and accurate determination of the COC load in the extracted process streams and permit compliance. It is anticipated that the following analytical sampling will be required:

- Monthly vapor sampling (weekly of influent during peak operations) of [redacted] Influent(s)/Effluent(s) to ensure proper destruction and removal efficiency (DRE) performance of [redacted](s) and to [redacted] the daily FID readings that are collected. These samples will be collected in Summa canisters and will be analyzed for VOCs using EPA method TO-15 and TPH as GRO (TPH-GRO) using a modified EPA method TO-3 (Gas Chromatography [GC]/FID). In addition, sorbent tube samples will be collected and analyzed for DROs (TPH-DRO) using a modified EPA method TO-17. A hydrophobic sorbent (Tenax®) and a dry purge step will be used to eliminate water vapor interference from the sample. If after several rounds of sampling, it is determined that the DRO fraction of mass is not substantially in the vapor phase (i.e., it is knocked out into the liquid phase prior to the thermal accelerators), TerraTherm may choose to discontinue TPH-DRO sampling as a cost saving measure;
- Monthly vapor emissions from the treatment system stack. These samples will be collected in Summa canisters and/or sorbent tubes and will be analyzed for VOCs/TPH-GRO and/or TPH-DRO using the same methods as listed above.
- Monthly dissolved phase contaminants at the GAC influent, midfluent and effluent. Samples will be collected weekly for the first month of operations and monthly thereafter. Samples will be collected in appropriately preserved containers (i.e., VOC vials/amber jars) and will be analyzed for the following:
  - Volatile organics via EPA SW846 8260B (benzene and chloroform will be compared to permit limits, however, all detected VOCs will be evaluated)
  - Pesticide/polychlorinated biphenyls via EPA SW846 8081/8082
  - Oil & Grease (hexane extractable material) via EPA 1664
- Monthly LNAPL storage tank samples [redacted] operations with weekly grab samples collected during [redacted] Additional (and/or less) samples may be collected as needed or as appropriate based on results. Grab samples will be tested for the following parameters:
  - Water and sediment (American Standard Test Method [ASTM] D1796/D2709)
  - Viscosity (kinematic) @ 40°C (ASTM D445)
  - Density (ASTM D1475)

ED_005025_00013386-00059

- Flash point (small scale closed cup: ASTM D3828)
- Heat of combustion by bomb calorimeter (ASTM D4809)
- Carbon/Hydrogen/Nitrogen (ASTM D5291)
- Sulfur by Energy-Dispersive X-Ray Fluorescence Analysis (ASTM D4294)
- Oxygen by pyrolysis/infrared (ASTM D5373)
- Paraffin, Isoparaffin, Aromatic, Naphthene, or Olefin forensic hydrocarbon characterization (GC/FID)

- Extracted groundwater samples will be collected throughout operations to track progress of remediation and progress toward the benzene criteria for transition to EBR. Samples will be analyzed for VOCs by method 8260B. Some samples may also be analyzed for TPH by method 8015M. Samples will primarily be collected from the combined liquid at the inlet to the water treatment system; however, as progress approaches a decision for transition to EBR, samples may be collected from individual extraction manifolds and individual wells to evaluate what areas of the site and what individual wells are contributing the highest VOCs. Decisions on sample locations and frequency will be made by the project team.

A summary of performance monitoring is provided in Table 5-3. Additional samples may be collected at the discretion of TerraTherm.

Table 5-3 Operational Performance Monitoring Summary

Locations	Monitoring/Analysis	Frequency
• Vapor Extraction Blower Discharge	• Vapor Flow Rate	• Logging in PLC
• Well Liquid Manifold Headers	• Totalized flow	• Weekly
• Effluent Discharge	• Liquid Discharge Flow Rate	• Continuous logging
• 17 TMPs (15-24 vertical locations per TMP • Co-located TMPs at LSZ SIWs (3 vertical locations per TMP) • Co-located TMPs at select other SIW/MPE wells (3 vertical locations per TMP). TerraTherm to select locations and move thermocouple arrays around site as needed	• Subsurface temperature	• Continuous for connected arrays. • As needed for mobile arrays as selected by TerraTherm.

ED_005025_00013386-00060

Locations	Monitoring/Analysis	Frequency
• Influent to the vapor treatment system; • Air stripper effluent; • Inlet to the thermal accelerators; • Effluent from the thermal accelerators; and • Discharge location(s) (effluent stack).	• FID	• Daily
• Select manifolds and MPE wells	• FID	• As required to meet additional operational data requirements by project team
• Combined Thermal Accelerator Influent • Thermal Accelerator 1 Effluent • Thermal Accelerator 2 Effluent	• VOCs (TO-15) • TPH-GRO (TO-3) • TPH-DRO (modified TO-17)	• Monthly • Influent weekly during peak operations if needed.
• GAC Influent • GAC Midfluent • GAC Effluent	• FID of liquid headspace	• Weekly
• GAC Influent • GAC Midfluent • GAC Effluent	• VOCs (8260B) • Pesticides/PCBs(8081/8082) (may be discontinued for Influent and/or Midfluent if not beneficial to evaluating breakthrough) • Oil & Grease (1664) (may be discontinued for Influent and/or Midfluent if not beneficial to evaluating breakthrough)	• Weekly for first month • Monthly thereafter
• LNAPL Storage Tank	• Water and sediment (ASTM D1796/D2709) • Viscosity (kinematic) @ 40°C (ASTM D445) • Density (ASTM D1475)	• Monthly when LNAPL is being generated • Weekly during peak operations

ED_005025_00013386-00061

Locations	Monitoring/Analysis	Frequency
	• Flash point (small scale closed cup: ASTM D3828) • Heat of combustion by bomb calorimeter (ASTM D4809) • Carbon/Hydrogen/Nitrogen (ASTM D5291) • Sulfur by Energy-Dispersive X-Ray Fluorescence Analysis (ASTM D4294) • Oxygen by pyrolysis/infrared (ASTM D5373) • Paraffin, Isoparaffin, Aromatic, Naphthene, or Olefin forensic hydrocarbon characterization GC/FID)	
• Influent to water treatment • Extraction Manifolds • Individual MPE Wells	• FID of liquid headspace	• As determined by TerraTherm
• Influent to water treatment • Extraction Manifolds • Individual MPE Wells	• VOCs (8260B) • TPH (8015M) – as determined by TerraTherm	• As determined by TerraTherm (at least one comprehensive round near termination of SEE)

Notes:
ASTM – American Society for Testing Materials
DRO – diesel range organics
FID – flame ionization detector
GAC – granular activated carbon
GC – gas chromatograph
GRO – gasoline range organics
LNAPL – light non-aqueous phase liquid
MPE – multiphase extraction
PCBs – polychlorinated biphenyls
TPH – total petroleum hydrocarbons
SEE – steam enhanced extraction
VOCs – volatile organic compounds

Throughout system operation, groundwater monitoring wells around the perimeter of the treatment area will be gauged for groundwater elevations and LNAPL weekly. The locations are listed in Table 5-4. Up to six of these locations will be selected for installation of pressure transducers to provide a continuous record of groundwater elevations during SEE. Groundwater

ED_005025_00013386-00062

samples will also be collected from the same set of wells monthly and analyzed for VOCs by method 8260B and TPH by method 8015M. VOC COC and COPC concentrations will be compared to the cleanup levels listed in Table 2-1. AMEC will collect samples using low-flow sampling methods described in SOP 10F. The weekly LNAPL gauging and monthly analytical sampling events are intended to observe the potential migration of LNAPL from the treatment zone downgradient.

QAPP/SAP Worksheet 15 provides applicable reporting limits and method detection limits to be used by the laboratory. Quality control samples to be collected during sampling include equipment rinse blanks, field duplicates, and matrix spike/matrix spike duplicates. Quality control samples will be collected at the frequencies specified in QAPP/SAP Worksheet 28.

Table 5-4 Operational Perimeter Groundwater Monitoring Summary

Locations	Monitoring/Analysis	Frequency
• ST012-C02 • ST012-U02 • ST012-W12 • ST012-W34 • ST012-W37 • ST012-U37 • ST012-RB-3A • ST012-RB-3C • ST012-W24 • ST012-W36 • ST012-U38 • ST012-W38 • ST012-U12 • ST012-U11 • ST012-W11 • ST012-W30	VOCs (8260B) TPH (8015M)	Monthly
	Water Levels (up to six locations with pressure transducers)	Weekly
	LNAPL	Weekly

Notes:
LNAPL – light non-aqueous phase liquid
TPH – total petroleum hydrocarbons
VOCs – volatile organic compounds

5.6.4 Annual Groundwater Monitoring

After well installation and implementation of the SEE activities, annual groundwater monitoring will continue at ST012 in general accordance with the Groundwater Monitoring Work Plan (AMEC, 2013d). However, revisions to the Groundwater Monitoring Work Plan will be made to address wells that will be abandoned as part of construction activities. Wells ST012-W07, ST012-RB-1C, ST012-U13, ST012-W13, ST012-U36, ST012-RB-2A, and ST012-RB-2C, which

ED_005025_00013386-00063

were part of the annual groundwater monitoring program, will be decommissioned by directly grouting or over-drilling and grouting during the well drilling and construction activities. Well ST012-RB-1A will be overdrilled and a new well built in the resulting boring. Table 5-1 summarizes the wells to be abandoned, and the proposed wells to use for future monitoring.

Table 5-5 Proposed Well Replacement for Annual Groundwater Monitoring

Current Well to Be Abandoned	Current Well Screened Interval (ft bgs)	Proposed New Well	Screen Interval of New Well (ft bgs)	Location of New Well with Respect to Current
ST023-W07	210-250	ST012-LSZ28	210-245	40 ft SW
ST012-RB-1A	160-195	ST012-UWBZ18	170-195	Same Location
ST012-RC-1C	207-242	ST012-LSZ18	210-245	
ST012-U13	160-195	Will not replace this well		
ST012-W13	209-249	ST012-W30	211-251	100 ft W
ST012-U36	160-195	ST012-UWBZ09	170.2 – 195.2	80 ft S
ST012-RB-2A	160-195	ST012- UWBZ21	170-195	75 ft W
ST012-RB-2C	207-242	ST012-LSZ33	210-245	45 ft SE

Notes:
ft -feet/foot
bgs - below ground surface
SE - southeast
SW - southwest
S - south
W - west

ST012-U13 is a monitoring well in the UWBZ screened from 160-195 ft bgs, while ST012-LSZ37, which will be installed in the same location, will be a MPE well in the LSZ from 210-245 ft bgs. No well in a similar screened interval and in the same area from the SEE system will be available to replace ST012-U13 in the annual groundwater monitoring program after SEE system operation has ceased. Concentrations above cleanup levels are not observed in ST012-U13. For this reason, in addition to the continued availability of ST012-U11 and ST012-U12 for annual groundwater monitoring, this well will not be replaced in the annual groundwater monitoring.

Samples would continue to be monitored for all of the COCs/COPCs by the same methods currently used in the annual monitoring program.

5.6.5 Groundwater Characterization for Enhanced Bioremediation

Both during the initial groundwater monitoring round (see Section 5.6.2) and after the completion of SEE system operation, wells will be sampled to evaluate baseline and post-SEE conditions for the EBR phase of the project. The same wells and parameters will be analyzed for the post-SEE conditions as for the pre-SEE groundwater sampling. In addition, sampling and analysis will be performed during the EBR Field Test. Sampling and analysis for the EBR field test will be detailed in the EBR Field Test Plan.

ED_005025_00013386-00064

5.7 Reporting

Construction progress will be presented as part of routine BRAC Cleanup Team meetings. After completion of the construction and startup/commissioning, a construction completion report will be prepared that will document the construction and include the final O&M Plan.

Real time data collected and logged by the SEE PLC will be available via a web-based portal. The web-based application will be accessible by the AF and by the regulatory agencies. Data available via the web-based application will include subsurface temperatures and aggregate flow rates.

TerraTherm will prepare a weekly progress report during SEE operation to be posted on the AMEC SharePoint site. The weekly report will provide a project summary and graphical presentation of project parameters such as vapor extraction rates, thermal accelerator DRE (based on PID/FID), mass removal, steam injection rate, cumulative steam injection, average temperature, cumulative water balance, and water injection/extraction rate balance. A sample weekly report included in Appendix I provides the typical presentation detail provided in TerraTherm weekly reports. This sample will be tailored to the site-specific parameters for ST012.

Analytical data generated during SEE operations will also be posted on the SharePoint siteupon receipt. In addition, data tables or other interpretive data analysis used to either optimize steam injection or support transition decisions will be posted on the SharePoint site as needed to support these decisions. Validated data will be presented on a quarterly basis along with the current quarterly SVE progress reports. Discharge monitoring reports will be submitted as required by the sewer discharge permit. Copies of these reports will be included in the quarterly reports.

During EBR, monitoring will be reported as defined in the EBR RD/RAWP and the Groundwater Monitoring Work Plan, respectively.

5.8 Contingency Plan

The risk of unplanned releases of contaminants that could threaten human health or the environment is considered moderate due to the mass present at ST012, the volumes of materials being handled, and the flammability of the primary contaminant. The design incorporates measures to mitigate these risks. LNAPL and fuel storage tanks will have dedicated containment systems and a shallow gravel berm will provide containment of overland surface flow in the process area. A hazards and operability review of the entire process was conducted to identify potential process risks so that countermeasures could be incorporated to address potential release scenarios. Site access restrictions around the perimeter of ST012 will be implemented to the extent feasible.

Monitoring of temperature within and at the perimeter of SEE, groundwater elevations and LNAPL accumulation outside the TTZ, and perimeter groundwater benzene concentrations will be used to demonstrate containment. Should loss of containment occur, steam injection in the

ED_005025_00013386-00065

area will be adjusted (reduced pressure or terminated). In some cases extraction may be increased in an area or a well may be converted from an injection to an extraction well. Monitoring will be performed to establish that containment has been re-established. If loss of containment continues, other actions may be considered in consultation with the Air Force and regulatory agencies.

Although the design has included measures to limit risks, spills or vapor/steam releases (from pipes or via unknown pathways to the surface) cannot be ruled out. In case of such emergencies, AMEC and TerraTherm will implement the emergency response measures described in the HASP. AMEC and TerraTherm will also conduct pre-operation and operational reviews with the local fire station to pre-plan and coordinate appropriate responses should an emergency arise.

In addition to contingency planning for unplanned releases, the design incorporates multiple units of key equipment (e.g., steam boilers, thermal accelerators, key pumps/blowers) so that failure of a single piece of equipment will not require a complete shutdown. Emergency backup generators will be installed on site such that critical equipment can continue to be operated in the case of a power outage.

LNAPL volumes present in the subsurface and the rate of removal are uncertain. Contingency plans will be in place for mobilizing additional on-site storage for LNAPL should volumes exceed design capacity as well as plans for shipping excess LNAPL off site as waste oil.

5.9 Community Relations Plan

AMEC and subcontractors will work closely with the following entities prior, during, and after remediation activities to discuss operations and long-term monitoring results:

- PMGAA
- Arizona State University
- USARC
- Chandler Gilbert Community College
- Restoration Advisory Board (RAB)
- EPA
- ADEQ
- Arizona Department of Transportation (ADOT) (to the extent their roads are affected)
- City of Mesa

Decisions and approaches to community relations will be developed though communications with these entities. At a minimum, the following measures will be implemented to allow the public an opportunity to stay informed regarding activities at the Site:

- Public notification of scheduled RAB meetings

ED_005025_00013386-00066

- Informational signs posted along the Site security fencing
- Advance signage regarding scheduled detour routing
- Air quality monitoring results will be available upon request

Site personnel will be required to understand the established community relation policies regarding communications with any public or private individuals. A public relations spokesperson will be identified to personnel and all requests for information will be directed to this individual. Public affairs activities will be coordinated with the AF Base Environmental Coordinator and the AF Public Affairs Office.

5.10 Permits and Permit Equivalency Evaluations

This section presents a review of required permits and anticipated permit requirements. CERCLA § 121(e)(1) provides that no Federal, State, or local permit shall be required for the portion of any removal or RA conducted entirely on-site, where such RA is selected and carried out in compliance with § 121. The 1990 National Contingency Plan (NCP) (§ 300.400(e)(1)) implements this permit exemption for "on-site" actions, defining "on-site" as "the areal extent of contamination and all suitable areas in very close proximity to the contamination necessary for implementation of the response action." The preamble to the NCP (at 55 Federal Register 8689, March 8, 1990) explains that "areal" refers both to the surface areas and the air above the site. EPA policy further defines "on-site" to include the soil and the groundwater plume that are to be remediated. For activities where this CERCLA permit exemption applies, compliance with the substantive requirements is still required and such requirements are reviewed in this section.

Where permits are required they will be obtained during the construction phase of the RA and included in the Construction Completion Report and/or the O&M Plan. Permitting requirements have been evaluated in detail for SEE. Permitting requirements will be reviewed further for EBR in a future RD/RAWP update based on the final EBR RD.

5.10.1 Well Abandonment and Installation

The drilling subcontractor will prepare Form 55-44A, NOI to Drill, Deepen, or Modify a Monitor/Piezometer/Environmental Well, and submit the form to ADWR electronically with the application fee. Drilling may begin as soon as the drilling subcontractor confirms the ADWR has received and filed the NOI; the drilling subcontractor does not need to wait until the ADWR issues a drilling card.

Within 30 days of well completion, the drilling subcontractor will file Form 55-55, Well Driller Report and Well Log.

The Program QAPP (AMEC, 2012c) provides further instructions and information on Arizona's drilling requirements. The subcontractor will be responsible for complying with all applicable requirements.

ED_005025_00013386-00067

5.10.2 Road Access and Closure Permits

Sections of the roadways will require closure to implement the remediation activities. Proposed detour routing has been prepared to provide public access to all existing facilities including the cell phone parking lot. The proposed detour route will also provide necessary access for emergency response vehicles.

A Temporary Traffic Control permit will be obtained with the City of Mesa prior to any road closures. The permit application will include a detailed traffic control plan including all proposed Manual on Uniform Traffic Control Devices signage and traffic barriers. The traffic control plan will be developed with input from affected stakeholders including PMGAA and USARC Herrera Hall Facility. In addition, the traffic control plan will be submitted to ADOT for review and a determination of any additional permits required to implement the road closures and detour routing.

5.10.3 Electrical Construction Permit

Electrical upgrades at the Site will be completed by SRP® and service will continue to be provided under an existing account. Installation of on-site electric panels and cables will be permitted by TerraTherm under their construction permit issued by the City of Mesa.

5.10.4 Utility Connection Permits

Existing water and gas connections at the Site are being evaluated to determine if they are of adequate size to provide the estimated demand flows. Required modifications to the on-site gas line will be completed by Southwest Gas and costs covered by AMEC. Required modifications to the on-site water service line will be completed by a subcontractor upon notification of the City of Mesa Water Resource Department. A permit application will be submitted to the City should any additional connections be required.

The existing 4-inch sanitary sewer service line will not have adequate capacity to convey the anticipated peak discharge rates. A proposed 6-inch CPVC will be connected to the 12-inch sewer main in Sossaman Road and permitted by the City through a Class II Industrial Wastewater Discharge Permit further discussed below in Section 5.10.6.

5.10.5 Air Emissions Permit Equivalency

The SEE treatment will generate emissions during its operation. The RA will be conducted entirely on site and, therefore, as per CERCLA § 121(e), this activity is exempt from having to obtain an air emission permit; however, emissions must comply with the substantive requirements. This section addresses the applicable requirements set forth by the Maricopa County Air Pollution Control (MCAPC) Regulations, the State of Arizona, and the Clean Air Act (CAA). This section addresses the emissions from the SEE system. Emissions from the existing SVE system have been previously evaluated (BEM, 2007). No direct emissions from the EBR are anticipated although area releases of carbon dioxide and/or methane are possible if these off-gas byproducts migrate through the vadose zone from the area of contamination. While the

ED_005025_00013386-00068

SVE system is running, most of these emissions would be processed through the SVE thermal oxidizer.

Section 107 (a) of the CAA gives primary responsibility to the states for assuring air quality within each geographic area of that state. As per AAC, § R-18-2-101 (10), Maricopa County comprises the Maricopa Intrastate Air Quality Control Region (AQCR). Arizona Revised Statutes (ARS) § 49-479 delegates Maricopa County to establish rules and regulations governing emissions within the boundaries of the county. Maricopa County has established the MCAPC Regulations (Maricopa County, 2012) under which the SEE system must meet the substantive requirements.

5.10.5.1 Thermal Accelerators

The SEE system will generate a continuous discharge of air into the atmosphere through the exhaust of the thermal accelerators. The two thermal accelerator units proposed for use at this Site are a nominal 2,500 scfm each with a rated hydrocarbon DRE of 99 percent. The design hydrocarbon input to the units is 501 lbs/hr. This results in a maximum vapor discharge of up to 120 lbs of VOCs per day under maximum loading of the treatment system. Based on the annual emissions of 21.9 tons per year (tpy) of VOCs, the thermal accelerators would be considered a minor source of VOCs because its potential to emit is less than the major source threshold of 100 tpy and is also less than the significant emissions threshold of 40 tpy. Likewise, the emissions of total Hazardous Air Pollutants (HAPs) are less than the 25 tpy major source threshold as are emissions of individual HAPs, each of which is less than 10 tpy (e.g., benzene is expected to make up less the 2 percent of the TPH in extracted vapors based on historical results from the deep soil SVE system).

MCAPC Rule 330 § 301 establishes a discharge threshold of 15 lbs per day VOC emission limitation on operations involving heat, unless an emission control device is used. An incineration control device such as the thermal accelerators must exceed a destruction efficiency of 90 percent as stated in MCAPC Rule 330, § 304.1. Therefore, the thermal accelerators will exceed the emissions control requirements established by Maricopa County.

Rule 241 §301 requires Best Available Control Technology (BACT) to be applied for new stationary sources which emit more than 150 lbs/day or 25 tons/yr of VOC, NO_X, SO_2, or particulate matter (PM); more than 85 lbs/day or 15 tons/yr of PM_{10}; or more than 550 lbs/day or 100 tons/yr of carbon monoxide (CO). Section 302 of the rule requires Reasonably Available Control Technology (RACT) to be applied for new stationary sources that have emissions less than the BACT thresholds. The rule applies to the project as a whole. Based on the calculated potential emissions for the project, the RACT requirements would apply. Consequently, thermal accelerators will be equipped with low NO_x burners.

Inlet and outlet concentrations of VOCs will be monitored monthly using EPA Method TO-15 and TO-3 to confirm the destruction efficiency of this unit and to assure that all substantive requirements and standards are met.

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5.10.5.2 Steam Boilers

Two natural gas/LNAPL fired boilers are components of the steam generation for the SEE system. The maximum steam production rate of the boilers is anticipated to be 48,800 lb/hr at peak design rates; however, the maximum combined capacity of the boilers will be 60,000 lbs/hr at 275 lbs per square inch (approximately 72 MMBTU/hr). The boilers would emit NOx, assuming natural gas as the fuel source, at approximately 2.0 lbs/hr (design) and 2.6 lbs/hr (at capacity), which is calculated to be approximately 8.7 tpy (design) and 11.2 tpy (at capacity) of NOx. Based on the annual emissions of NOx, the boiler would be considered a minor source of NOx because its potential to emit is less than 100 tpy and is also less than the significant emissions threshold of 40 tpy. NOx emissions while burning recovered JP-4 could be higher. Recovered LNAPL was tested for nitrogen content and none was detected; however the detection limit was 0.05 percent. Emissions from the boilers burning JP-4 can be approximated using emission factors for boilers using low sulfur distillate which results in estimated NOx emissions of 5.9 lbs/hr (design) and 7.2 lbs/hr (at capacity). These emissions result in 26 tpy (design) and 32 tpy (at capacity) which remain below the 40 tpy significant emissions threshold.

MCAPC Rule 323 § 301 and § 305 limit PM and CO respectively for steam generating units larger than 100 MMBTU/hr. This rule is not applicable as the capacity of the two boilers is below this threshold. MCAPC Rule 323 § 302 limits opacity for all steam generating units other than uncombined water to less than 20 percent. MCAPC Rule 323 § 303 limits the sulfur content for waste oil liquid fuels for steam generating units to less than 800 milligrams per liter (mg/L). A sample of the LNAPL from ST012 was tested in April 2013 and had a sulfur content of 511 mg/L.

MCAPC Rule 323 § 304 requires steam generating units larger than 10 MMBTU/hr and less than 100 MMBTU/hr to either: establish initial optimum baseline concentrations for NOx and CO and then inspect and maintain the burner to maintain optimum concentrations with handheld instrument monitoring; or limit NOx below 155 parts per million (ppm) when burning gaseous fuel and 230 ppm when burning liquid fuel. The steam boilers for ST012 will be tuned for optimum combustion; burners will be maintained and retuned each time fuel sources are changed.

Rule 241 §301 requires Best Available Control Technology (BACT) to be applied for new stationary sources which emit more than 150 lbs/day or 25 tons/yr of VOC, NO_X, SO_2, or PM; more than 85 lbs/day or 15 tons/yr of PM_{10}; or more than 550 lbs/day or 100 tons/yr of CO. §302 of the rule requires Reasonably Available Control Technology (RACT) to be applied for new stationary sources that have emissions less than the BACT thresholds. The rule applies to the project as a whole. Based on the calculated potential emissions for the project, the RACT requirements would apply and steam boilers will be equipped with low NOx burners.

40 Code of Federal Regulation (CFR) 60 Subpart Dc, Standards of Performance for Small Industrial-Commercial-Institutional Steam Generating Units applies to steam boilers in the 10 MMBTU/hr to 100 MMBTU/hr range limits sulfur dioxide when burning oil to 0.5 lbs/MMBTU or shall limit the sulfur contents of the oil to less than 0.5 weight percent. These standards can be considered relevant to boilers operating on recovered LNAPL. The tested sulfur content of the

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ST012 LNAPL is below this limit. Under these same standards, PM would be limited to less than 0.03 lbs/MMBTU input heat when operating on oil; however, there is a PM exception for facilities that combust only oil containing less than 0.5 weight percent sulfur. 40 CFR 63, Subpart JJJJJJ, National Emission Standards for HAPs for Industrial, Commercial, and Institutional Boilers Area Sources also limits PM for new oil-fired boilers to 0.03 lbs/MMBTU of heat input and does not have a similar applicable exemption based on sulfur content in oil. Therefore, this standard may require stack testing to demonstrate compliance and will be verified with Maricopa County Air Quality Department.

5.10.5.3 Free Product Storage Tanks

The SEE system will have several stationary storage tanks and oil-water separators that will potentially exceed the Non-Title V permit applicability threshold of 250 gallons of organic liquids as per MCAPC Rule 200 Subsection 303.3(c)(2). In accordance with these requirements, each of these tanks has a vent connection to the vapor collection system which collects and destroys VOCs by the thermal accelerators described in Section 5.10.5.1. 40 CFR 60 Subpart Kb, Standards of Performance for Volatile Organic Liquid Storage Vessels (Including Petroleum Liquid Storage Vessels) for Which Construction, Reconstruction, or Modification Commenced after July 23, 1984, applies to storage vessels 75 cubic meters (approximately 19,796 gallons). All tanks containing LNAPL will be limited to a capacity less than this amount.

5.10.5.4 Earth Moving Operations

Construction of the SEE system will require limited earth moving activities such as utility trenching, well drilling and post-hole digging for placement of bollards or support posts. These earth-moving activities may exceed the Non-Title V permit applicability threshold of 0.1 acres of disturbed area as per MCAPC Rule 200 § 305, and therefore, a dust control plan is required. A dust control plan will be developed for ST012 and dust control mitigation measures will be implemented as necessary. Because the activities performed are on site, a local dust control permit will not be required under the CERCLA exemption.

5.10.6 Wastewater Discharge Permit

Extracted groundwater and steam will be treated and discharged to the sanitary sewer. Because the discharge is to a sewer that transports the water off-site to a municipal wastewater treatment plant, the discharge is not covered by the CERCLA permit exemption. Therefore, a permit for the discharge is required.

The SEE system will need an Industrial Wastewater Discharge Permit from the City of Mesa. The new SEE system is expected to discharge up to 237 gpm (341,000 gpd) once in full operation. A discharge permit is currently in place for the ST012 (M-5863-1213, Appendix F) which expires on December 12, 2013. The current discharge flow rate limitation is 100,000 gpd, or 70 gpm. The City of Mesa and AMEC have discussed a new discharge flow limit. Indications from the City are that 250 gpm of flow capacity is available for the project subject to reduction to 200 gpm should additional capacity be required for other users in the vicinity over the next couple of years. Per the requirements of § 8-4-17 of the City of Mesa City Code, a new

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industrial wastewater discharge permit application with a revised flowrate limitation will be submitted to the City for approval a minimum of 60 days prior to expiration of the current permit.

The concentration limits of the existing permit form the basis of the design as described in Section 3.2.3.

5.10.7 Injection Requirements

Potable water in the form of steam will be injected into the subsurface during SEE. Motive water to power the eductor pumps in the MPE wells is recirculated through piping in the wells but is not injected into the subsurface and is therefore not considered injection. Although injection of steam would occur on site and is covered by the CERCLA exemption from obtaining a permit, injection requirements were reviewed for applicability.

EPA Region 9's Underground Injection Control Program governs the injection fluids to be permanently placed underground which could potentially contaminate groundwater; injection of potable water as steam is not a potential contaminant source for groundwater and is not intended to be stored permanently in the aquifer (i.e., there is a net extraction of fluids from ST012 during SEE); therefore, permitting requirements of the Underground Injection Control Program do not apply during SEE. Underground injection requirements may apply during injection of amendments for EBR. Such requirements will be evaluated as part of the RD/RAWP update for EBR.

In accordance with the AAC, Title 12: Natural Resources, Chapter 15, Department of Water Resources, Article 8: Well Construction and Licensing of Well Drillers, injection wells are subject to regulation by the ADEQ, and permitting from the ADWR is therefore not required to inject potable water as steam into the aquifer.

Finally, neither the Water and Waste Management Division of Maricopa County nor the City of Mesa maintain or enforce permitting requirements for the injection of potable water as steam into an aquifer.

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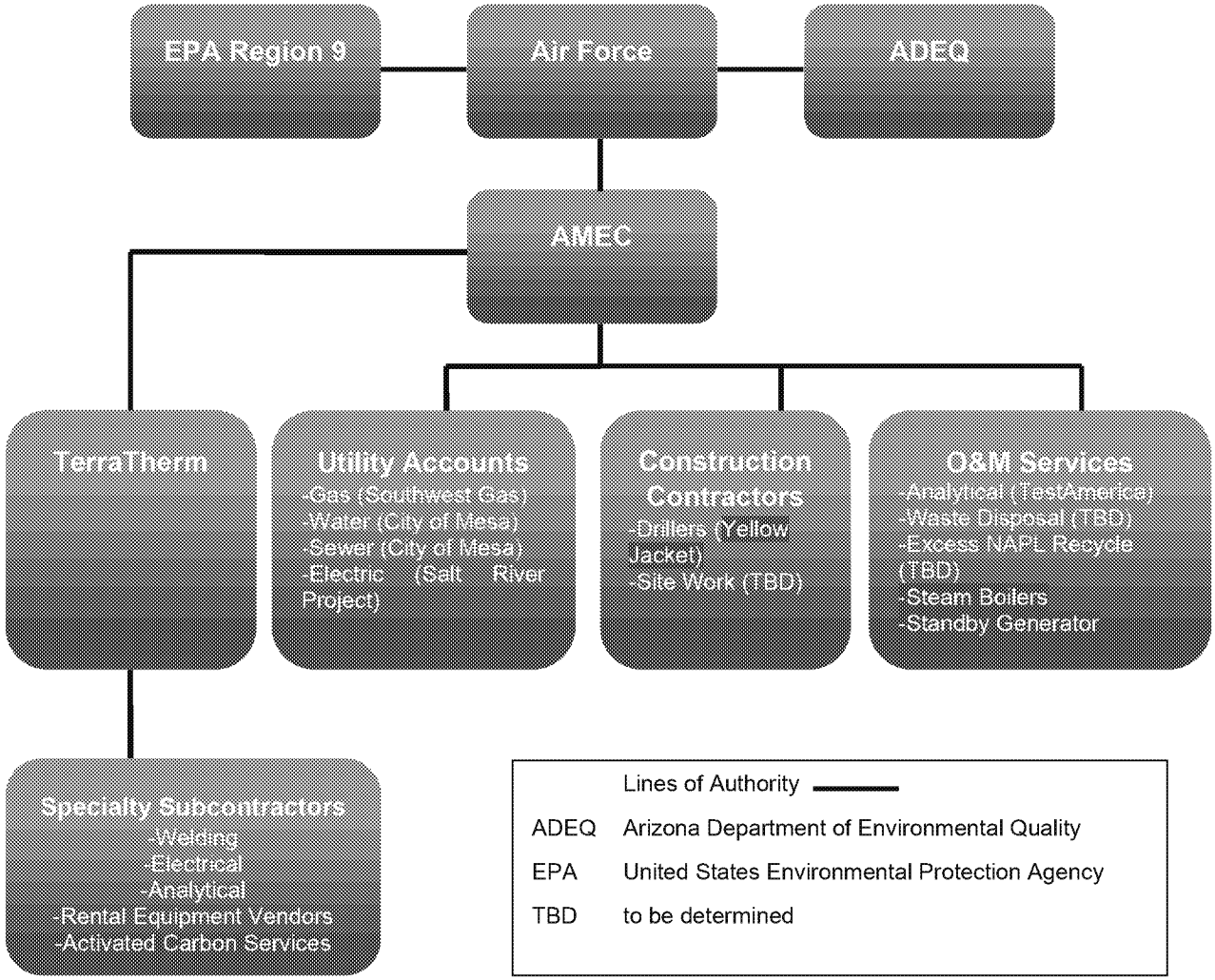
6.0 PROJECT ORGANIZATION AND SCHEDULE

This section provides an overview of the project organization and schedule. A general project organization chart is included below.



As defined in the FFA the AF is the primary party responsible for implementing RAs at the former Williams AFB while EPA and ADEQ provide oversight and review. The AF has contracted AMEC as its remediation contractor for ST012 and AMEC has teamed with TerraTherm for implementation of the SEE technology. AMEC will be directly responsible for site preparation and well drilling activities and TerraTherm will be responsible for SEE system construction and operation. TerraTherm will self perform much of the remedial system construction but will subcontract specialty services, particularly those that require locally licensed contractors such as for electrical and welding work. Treatment equipment will be a combination of leased and TerraTherm-owned equipment. AMEC will oversee construction and operation and will provide waste management, utility management, and analytical services.

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Once the project transitions to the EBR phase, TerraTherm's role will be complete at ST012 and AMEC will implement the EBR activities using subcontractors for construction and OM&M services where appropriate. AMEC will also establish the Groundwater Monitoring Work Plan to be implemented following EBR and will perform initial rounds of monitoring.

A project schedule has been prepared for implementation and is presented in Figure 6-1. SEE implementation has been detailed in this schedule. Once SEE is complete and the transition to EBR commences, further definition of the EBR approach will be available and an updated schedule showing additional detail will be included as part of an EBR addendum to this RD/RAWP.

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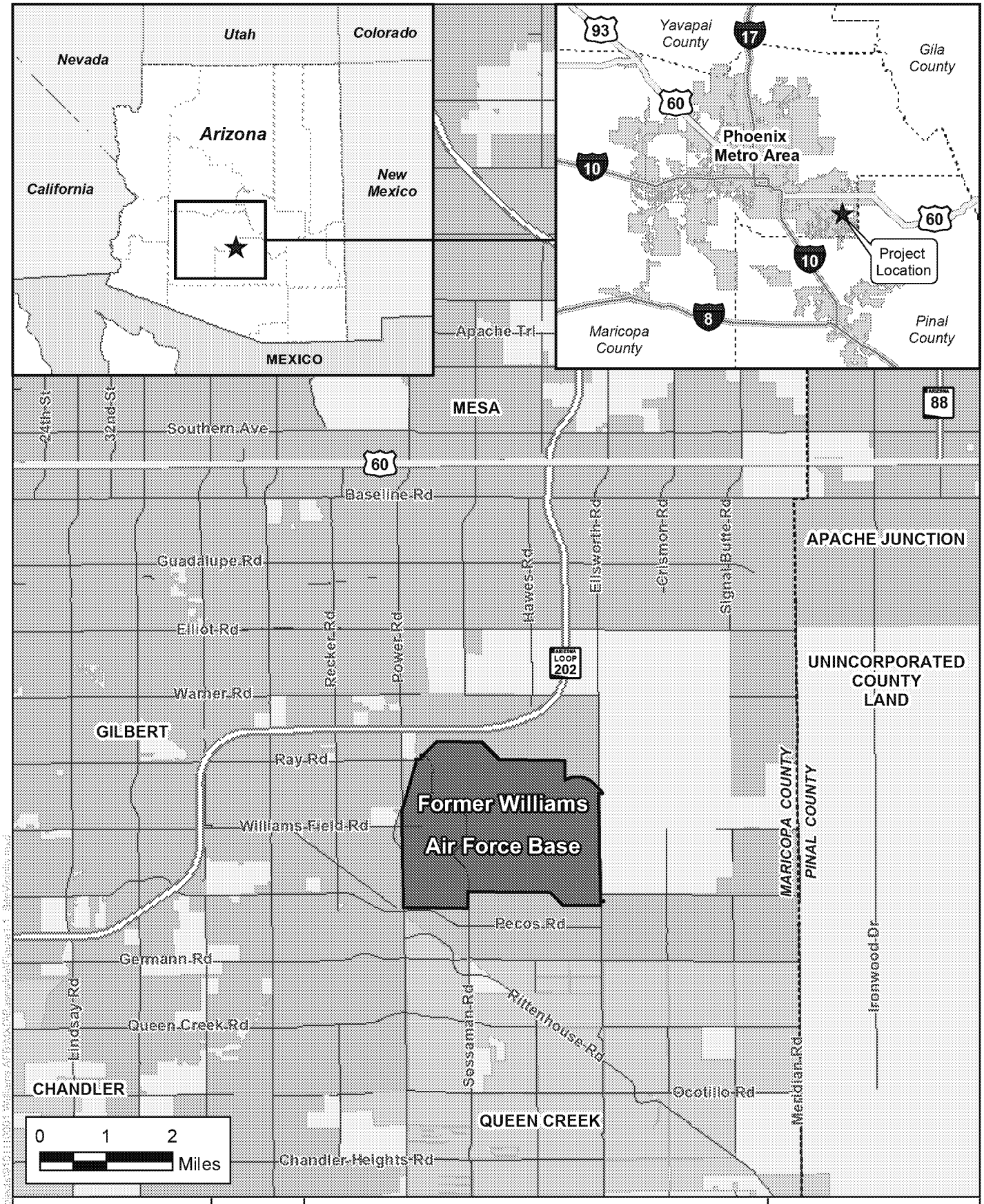
FIGURES



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Date:	10/1/2013
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Former Williams Air Force Base
Mesa, Arizona

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Location of Former Williams Air Force Base

FIGURE **1-1**

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PM:	EW
Date:	10/9/2013
Scale:	1" = 0.5 mile

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Former Williams Air Force Base
Mesa, Arizona

ST012 Site Location Map

FIGURE
1-2

amec

Legend

ST012 Wells:

- Monitoring
- Extraction
- DPE
- SVE
- Borings
- Abandoned
- New SEE Injection/Extraction
- Horizontal Well
- Horizontal Well Screen

0 125 250
Feet

N

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Remedial Design/Remedial Action Work Plan
ST012 - Former Williams Air Force Base
Mesa, Arizona

Location of Former and Current Wells and Borings

FIGURE **1-3**

Job No. 9101-11-0001
PM: EW
Date: 12/20/2013
Scale: 1" = 250 feet

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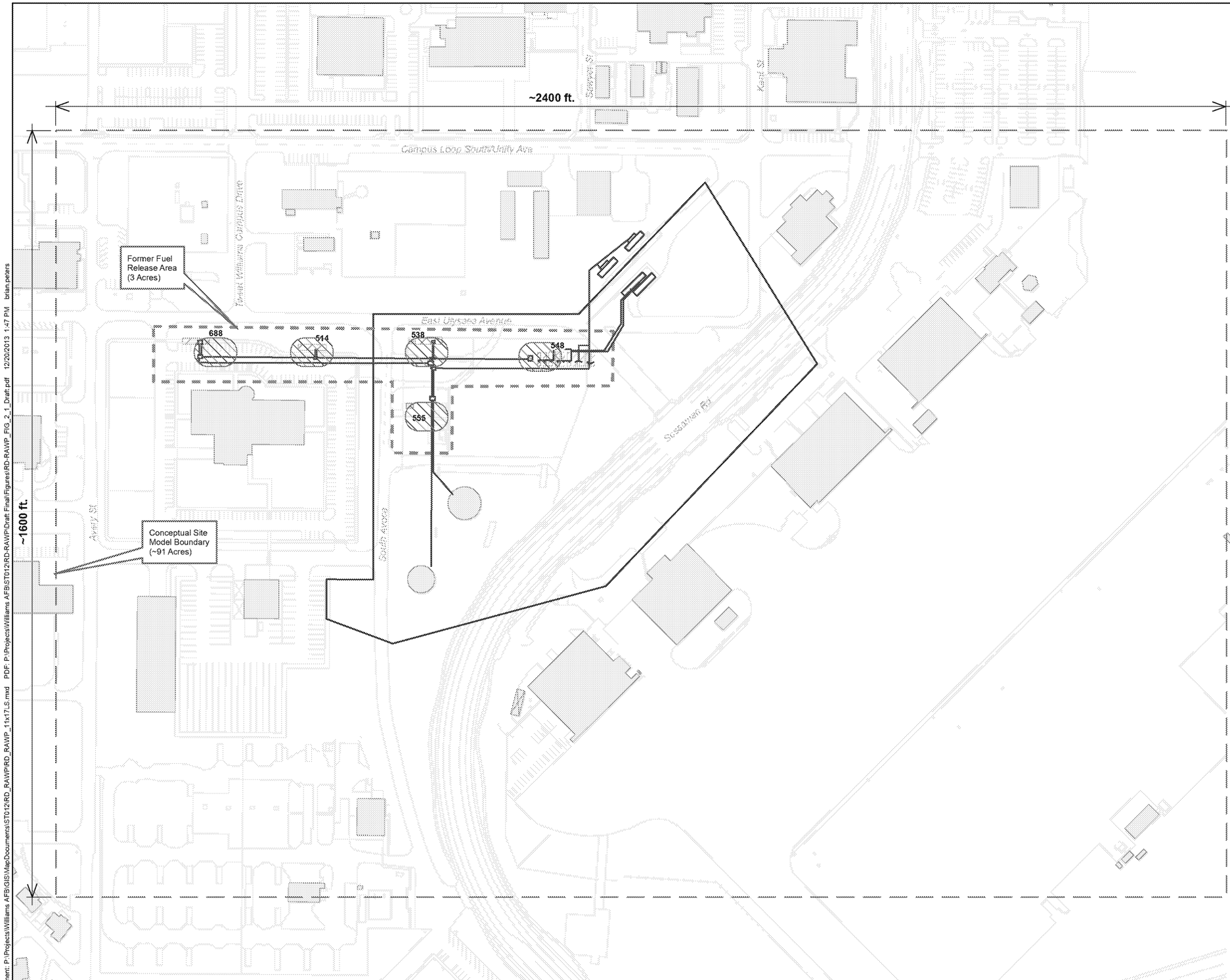

Legend

- Known Former Fuel Release Locations (Approximate)
- Former Fuel Release Area
- Former Fuel Distribution Line
- Former Underground Storage Tank
- 519 Former Facility Number
- Site ST012
- Conceptual Site Model Boundary
- Building/Structure
- Roads, Curbs, Parking, etc.

0 105 210 Feet

N

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ST012 - Former Williams Air Force Base
Mesa, Arizona

CSM Boundary and Fuel Release Map

FIGURE **2-1**

Job No. 9101-11-0001
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Date: 12/20/2013
Scale: 1" = 210 feet

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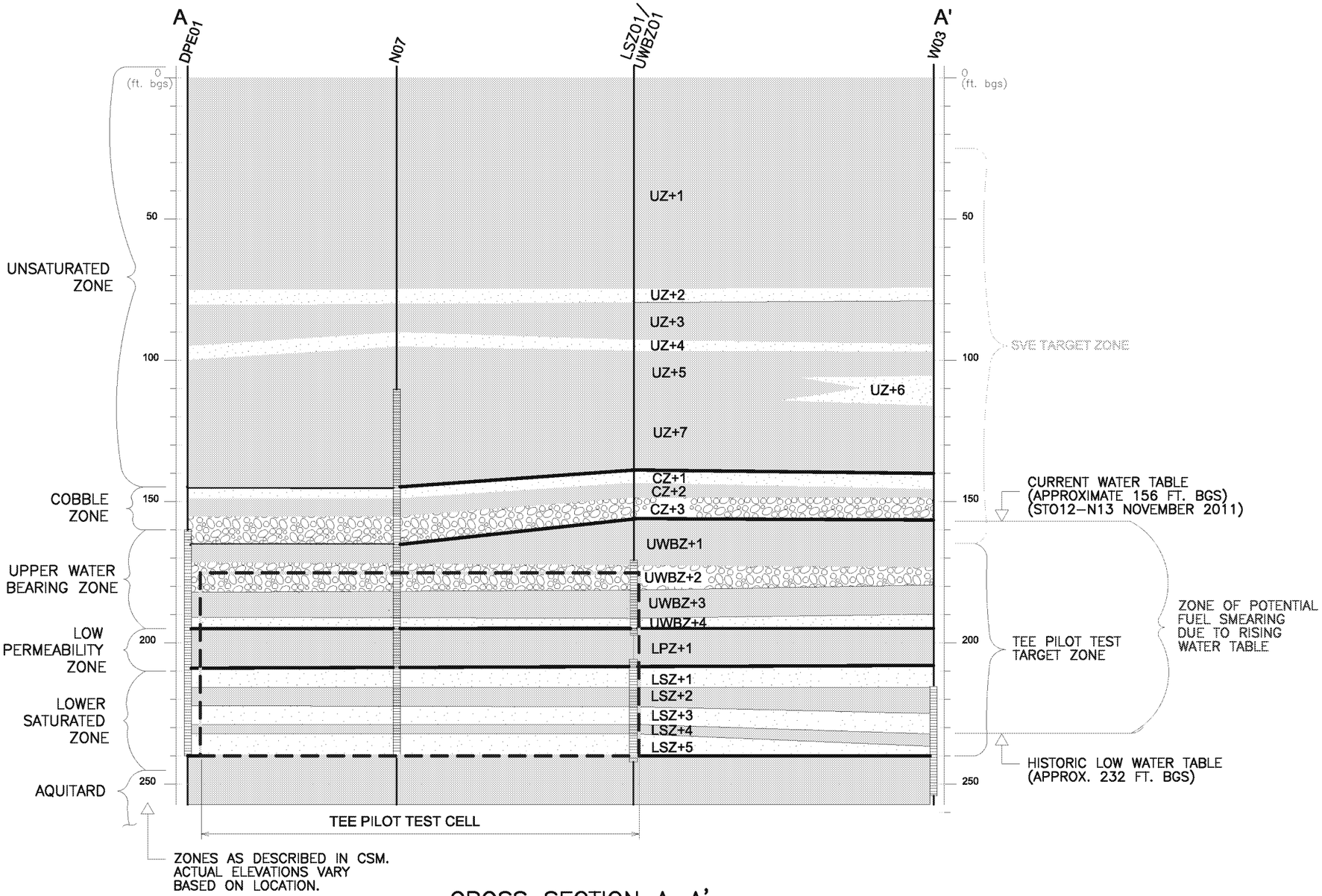
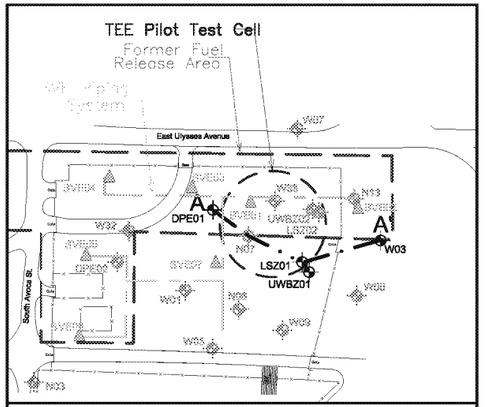


CROSS SECTION A–A'

TARGET SUBSURFACE TREATMENT ZONE



Cross-Section Location Plan

Legend

- Existing Well
- Existing SVE Well
- TEE Pilot Test Cell Location
- Silt/Clay
- Sand
- Gravel
- UWBZ+1 — Hydrostratiographic Layer Designator (corresponds to model layers described in Appendix D)

Source: BEM, 2007

0 20 40 Feet

N

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Remedial Design/Remedial Action Work Plan
ST012 - Former Williams Air Force Base
Mesa, Arizona

CSM Cross-Section A-A'

FIGURE **2-2**

Job No.	9101-11-0001
PM:	EW
Date:	12/20/2013
Scale:	1"=40 Feet

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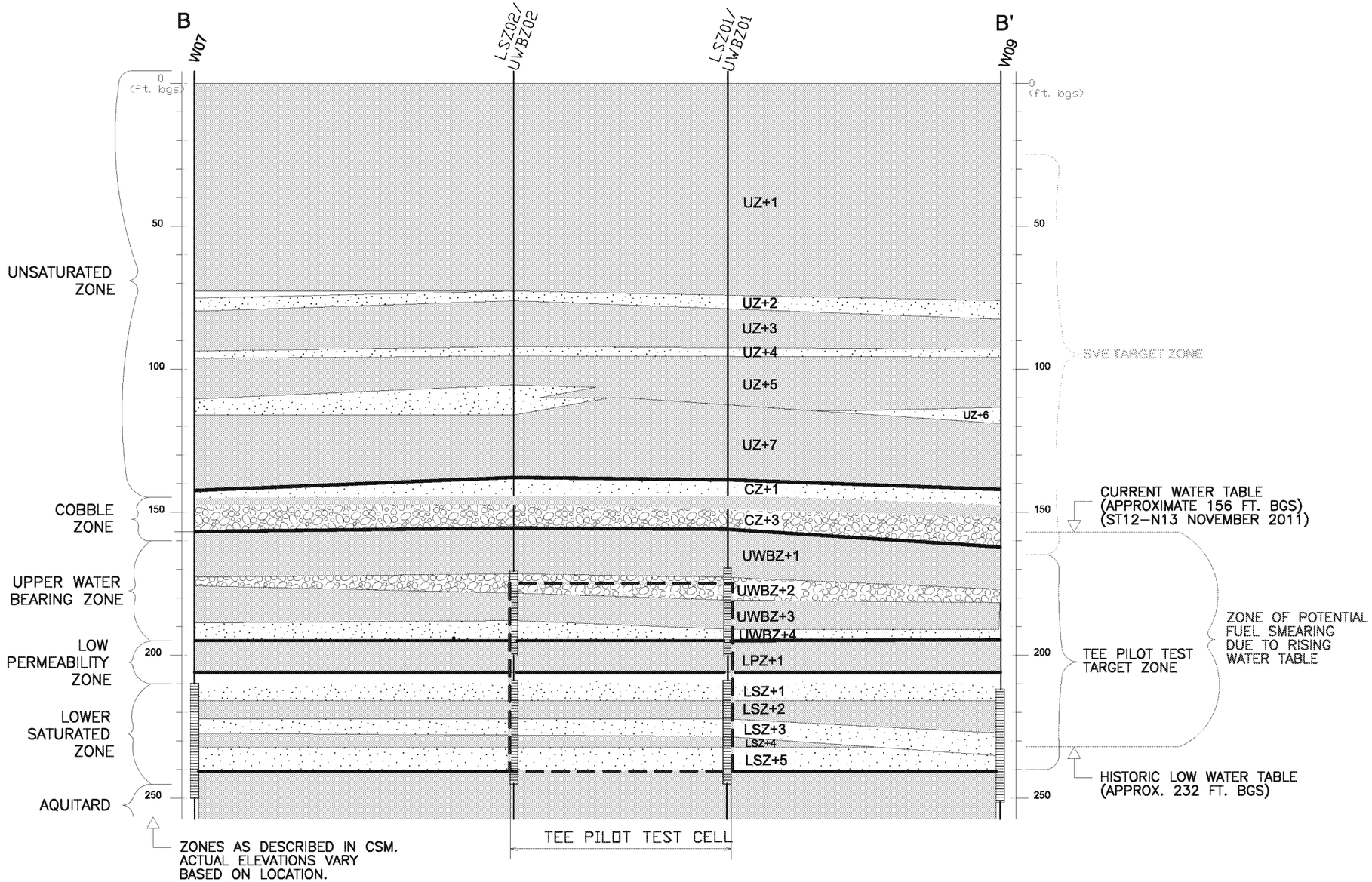
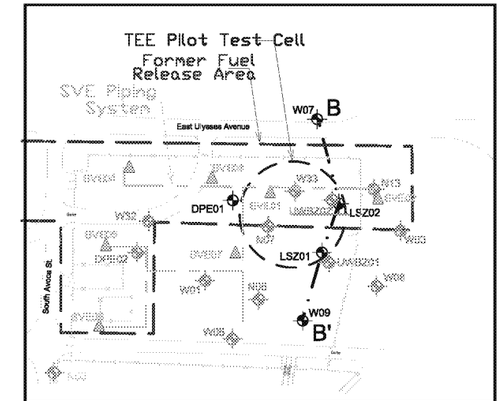


CROSS SECTION B–B'

TARGET SUBSURFACE TREATMENT ZONE



Cross-Section Location Plan

Legend

- Existing Well
- Existing SVE Well
- TEE Pilot Test Cell Location
- Silt/Clay
- Sand
- Gravel
- UWBZ+1 — Hydrostratiographic Layer Designator (corresponds to model layers described in Appendix D)

Source: BEM, 2007

0 20 40 Feet

N

Draft Final
Remedial Design/Remedial Action Work Plan
ST012 - Former Williams Air Force Base
Mesa, Arizona

CSM Cross-Section B-B' — FIGURE **2-3**

Job No.	9101-11-0001
PM:	EW
Date:	12/20/2013
Scale:	1"=40 Feet

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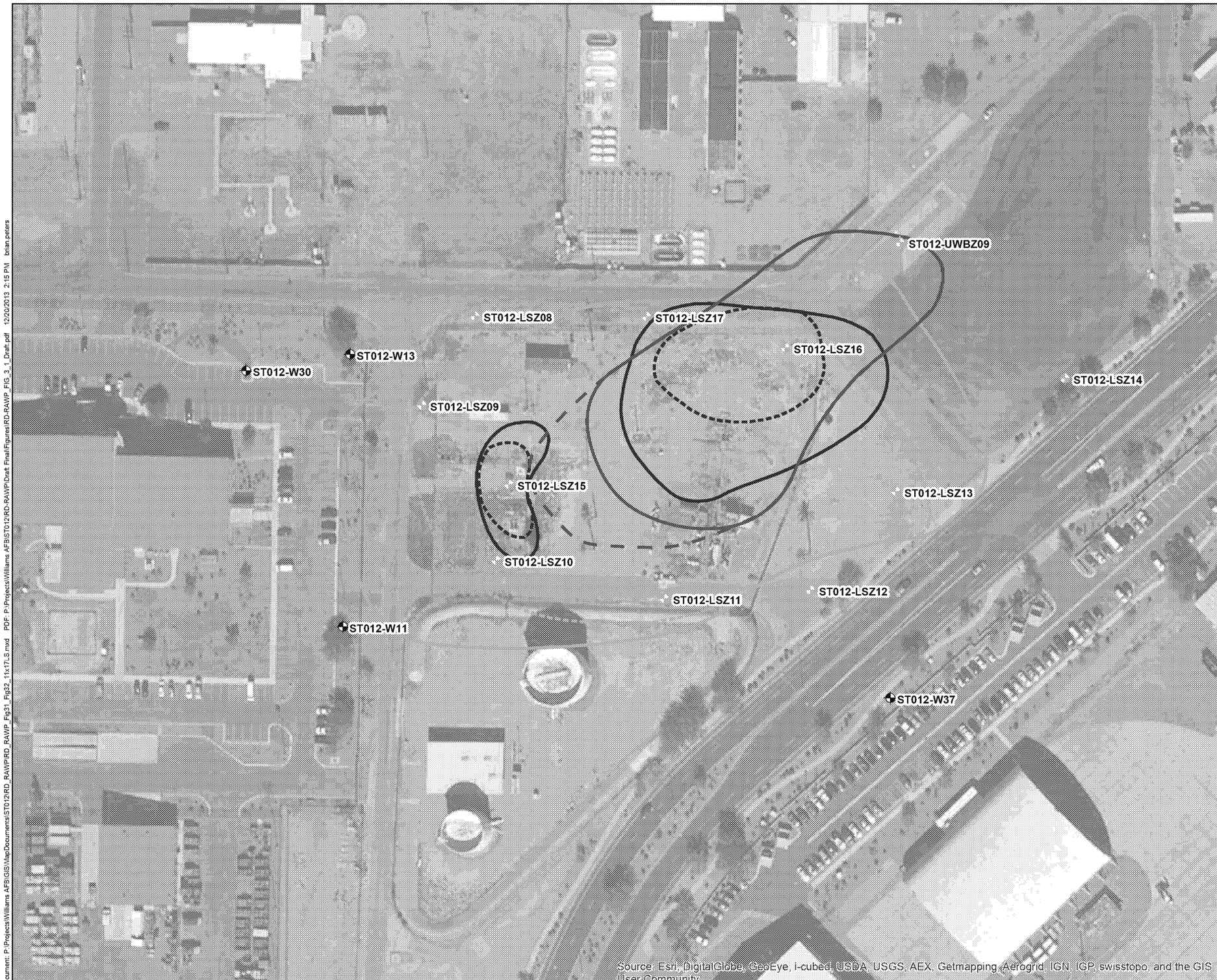

Legend

- Pre-Design Investigation Well Location (Installed 2013)
- Existing Wells Relevant to LNAPL Interpretations
- CZ Base LNAPL Interpretation
- CZ Conservative LNAPL Interpretation
- UWBZ Base LNAPL Interpretation
- UWBZ Conservative LNAPL Interpretation
- CZ/UWBZ FFS SEE TTZ
- CZ/UWBZ RD/RAWP SEE TTZ

Notes:
CZ - Cobble Zone
UWBZ - Upper Water Bearing Zone
LNAPL - Light Non-Aqueous Phase Liquid
SEE - Steam Enhanced Extraction
FFS - Focused Feasibility Study
TTZ - Treatment Zone
RD/RAWP - Remedial Design/Remedial Action Work Plan

0 50 100 Feet

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Remedial Design/Remedial Action Work Plan
Former Williams Air Force Base
Mesa, Arizona

CZ/UWBZ LNAPL Distributions and TTZs

FIGURE 3-1

Job No. 9101110001
PM: EW
Date: 12/20/2013
Scale: 1" = 100 feet

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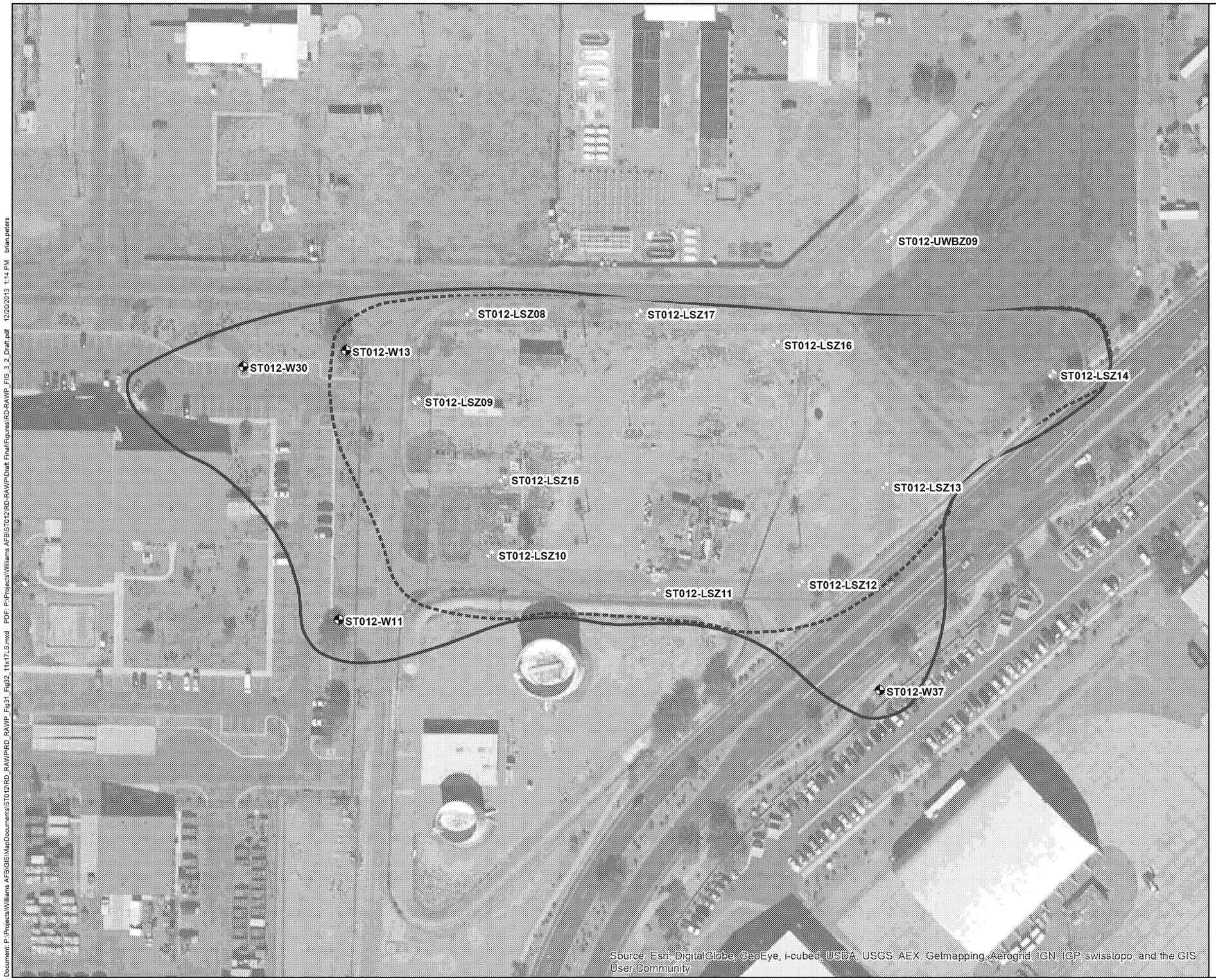

Legend

- Pre-Design Investigation Well Location (Installed 2013)
- Existing Wells Relevant to LNAPL Interpretations
- LSZ Base LNAPL Interpretation
- LSZ Conservative LNAPL Interpretation
- LSZ FFS SEE TTZ
- LSZ RD/RAWP SEE TTZ

Notes:
LSZ - Lower Saturated Zone
LNAPL - Light Non-Aqueous Phase Liquid
SEE - Steam Enhanced Extraction
FFS - Focused Feasibility Study
TTZ - Treatment Zone
RD/RAWP - Remedial Design/Remedial Action Work Plan

0 50 100 Feet

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Remedial Design/Remedial Action Work Plan
Former Williams Air Force Base
Mesa, Arizona

LSZ LNAPL Distributions and TTZs

FIGURE 3-2

Job No. 9101110001
PM: EW
Date: 12/20/2013
Scale: 1" = 100 feet

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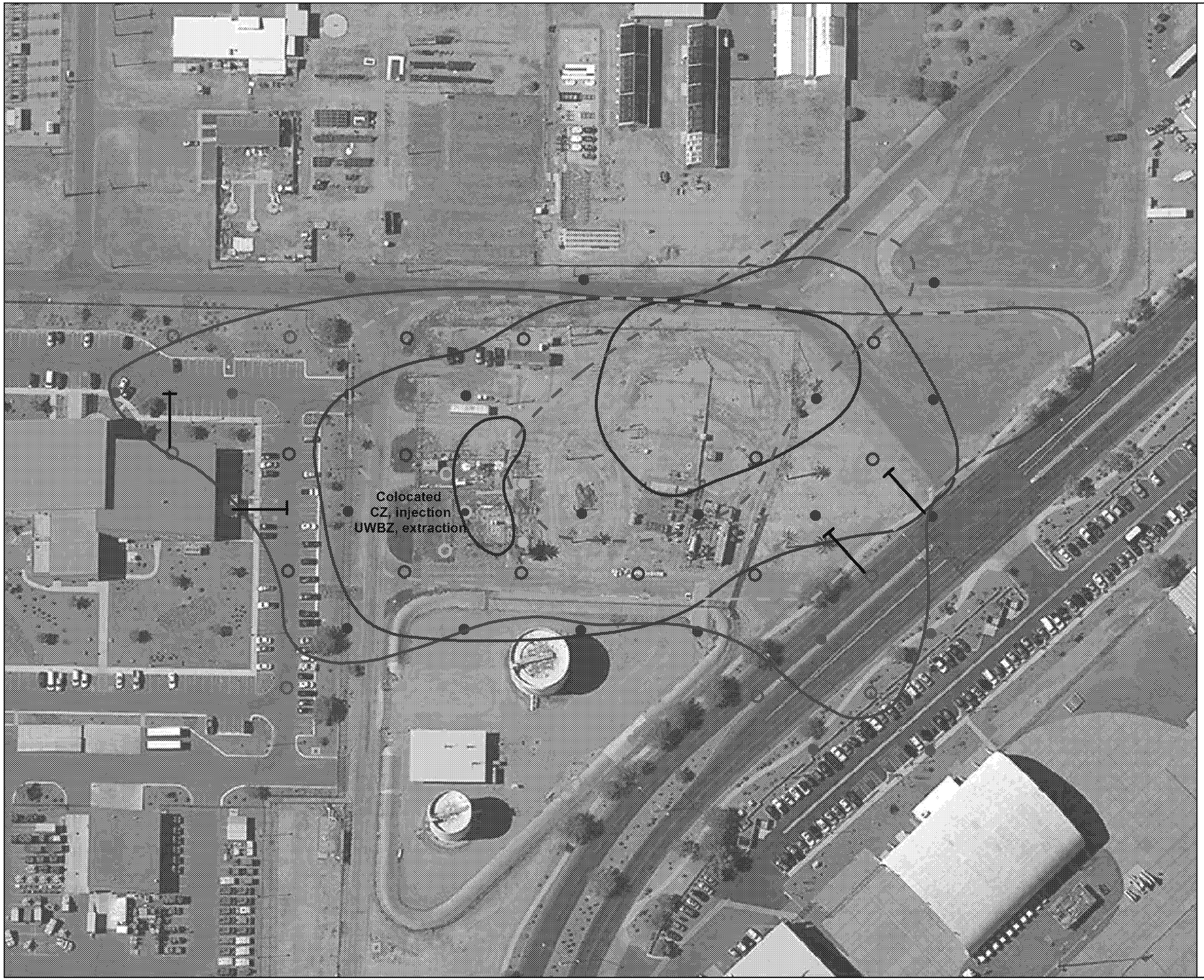

Legend

Remediation Well Zone, Type

- CZ, extraction
- CZ, injection
- LSZ, extraction
- LSZ, injection
- UWBZ and LSZ, extraction
- UWBZ and LSZ, injection
- UWBZ, extraction
- UWBZ, injection
- CZ LNAPL extent
- UWBZ LNAPL extent
- LSZ LNAPL extent
- LSZ SEE Treatment Zone
- CZ/UWBZ SEE Treatment Zone
- Sloped Well

Notes: SEE - Steam Enhanced Extraction
CZ - Cobble Zone
LSZ - Lower Saturated Zone
UWBZ - Upper Water Bearing Zone
LNAPL - Light Non-Aqueous Phase Liquid

0 100 200 Feet

N

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CONCEPTUAL ENHANCED BIOREMEDIATION WELL FIELD LAYOUT

FIGURE 3-3

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Legend

Remediation Well Zone, Type

- CZ, extraction
- CZ, injection
- CZ EBR Recirculation Pathlines
- CZ LNAPL extent
- CZ/UWBZ SEE Treatment Zone

Notes: SEE - Steam Enhanced Extraction
EBR - Enhanced Bio-Remediation
CZ - Cobble Zone
UWBZ - Upper Water Bearing Zone
LNAPL - Light Non-Aqueous Phase Liquid

0 100 200 Feet

N

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COBBLE ZONE RECIRCULATION SYSTEM PATHLINES

FIGURE **3-4**

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Scale: 1" = 100 feet

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Legend

Remediation Well Zone, Type

- UWBZ and LSZ, extraction
- UWBZ and LSZ, injection
- UWBZ, extraction
- UWBZ, injection
- UWBZ EBR Recirculation Pathlines
- UWBZ LNAPL extent
- CZ/UWBZ SEE Treatment Zone
- Sloped Well

Notes: SEE - Steam Enhanced Extraction
EBR - Enhanced Bio-Remediation
CZ - Cobble Zone
LSZ - Lower Saturated Zone
UWBZ - Upper Water Bearing Zone
LNAPL - Light Non-Aqueous Phase Liquid

0 100 200 Feet

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Former Williams Air Force Base
Mesa, Arizona

UPPER WATER BEARING ZONE RECIRCULATION SYSTEM PATHLINES

FIGURE **3-5**

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PM: EW
Date: 12/20/2013
Scale: 1" = 100 feet

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Legend

Remediation Well Zone, Type

- LSZ, extraction
- LSZ, injection
- UWBZ and LSZ, extraction
- UWBZ and LSZ, injection
- LSZ EBR Recirculation Pathlines
- LSZ LNAPL extent
- LSZ SEE Treatment Zone
- Sloped Well

Notes: SEE - Steam Enhanced Extraction
EBR - Enhanced Bio-Remediation
LSZ - Lower Saturated Zone
UWBZ - Upper Water Bearing Zone
LNAPL - Light Non-Aqueous Phase Liquid

0 100 200 Feet

N

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LOWER SATURATED ZONE RECIRCULATION SYSTEM PATHLINES

FIGURE **3-6**

Job No. 9101110001
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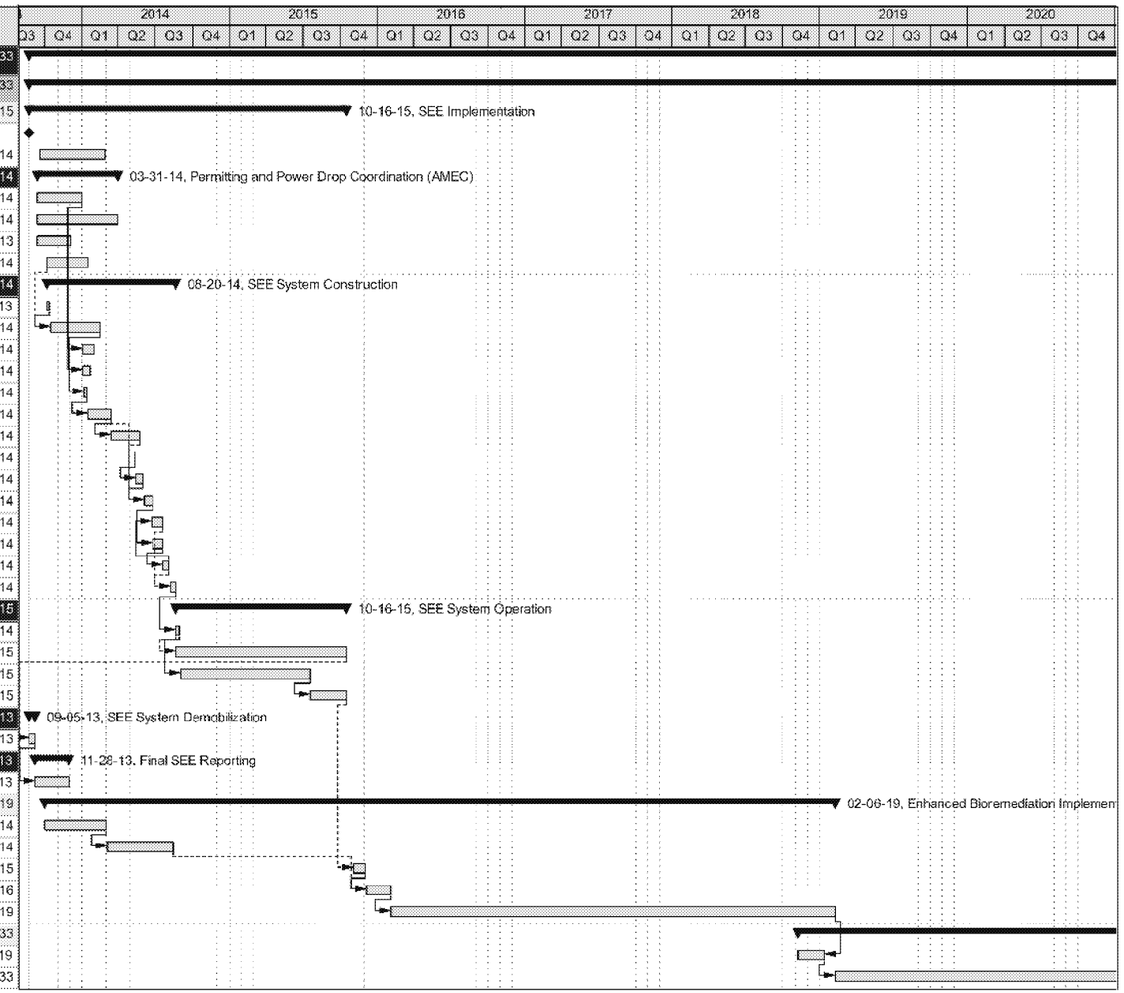
Activity ID	Activity Name	Duration	Start	Finish
ST012 - Remedial Action Implementation		5246	08-23-13	09-30-33
Remedial Action (RA)		5246	08-23-13	09-30-33
SEE Implementation		561	08-23-13	10-16-15
A100	TerraTherm Notice to Proceed (Procurement, Field Implementation)	0	08-23-13	
A105	TerraTherm Equipment/Materials Procurement	161	09-17-13*	02-24-14
Permitting and Power Drop Coordination (AMEC)		201	09-12-13	03-31-14
A101	Local Permits	112	09-12-13*	01-01-14
A104	Water Discharge Permits	201	09-12-13*	03-31-14
A103	Transformer/Power Drop	84	09-12-13*	12-04-13
A102	Well Installation Permits	101	10-07-13*	01-15-14
SEE System Construction		318	10-07-13	08-20-14
A106	Utility Clearance (AMEC)	5	10-07-13*	10-11-13
A108	Drilling and Well Installation (AMEC)	124	10-14-13	02-14-14
A109	Utility Installation/Modification (AMEC)	28	01-02-14	01-29-14
A110	Site Preparation (Fencing Modifications) (AMEC)	21	01-02-14	01-22-14
A111	TerraTherm Mobilization & Site Setup (TerraTherm)	8	01-06-14	01-13-14
A112	Wellhead Assembly and Wellfield Piping (TerraTherm)	59	01-14-14	03-13-14
A114	Treatment System Installation (TerraTherm)	70	03-14-14	05-22-14
A115	Final Road Closures and Change Over Cell Phone Lot Entrance (Amec)	1	05-12-14*	05-12-14
A116	Final Wellfield Piping (Road Closure Areas) (TerraTherm)	21	05-13-14	06-02-14
A117	Electrical installation (Wellfield and Process) (TerraTherm)	21	06-03-14	06-23-14
A118	Submit OM&M Plan	26	06-23-14	07-18-14
A119	Instrumentation and Monitoring System Installation (TerraTherm)	24	06-24-14	07-17-14
A120	Steam Generation System Installation (TerraTherm)	15	07-18-14	08-01-14
A121	Commissioning/Shakedown	14	08-07-14*	08-20-14
SEE System Operation		422	08-21-14	10-16-15
A122	Establish Pneumatic/Hydraulic Control	10	08-21-14	08-30-14
A123	Process Monitoring and Reporting	422	08-21-14	10-16-15
A124	Steam Heating and Extraction	322	08-31-14	07-18-15
A125	Post Treatment Extraction/Air Injection	90	07-19-15	10-16-15
SEE System Demobilization		14	08-23-13	09-05-13
A126	Modify Fencing & Piping/Reopen Remaining Roads	14	08-23-13	09-05-13
Final SEE Reporting		84	09-06-13	11-28-13
A128	Final SEE Reporting	84	09-06-13	11-28-13
Enhanced Bioremediation Implementation		1955	10-01-13	02-06-19
A107	Field Test Work Plan	151	10-01-13*	02-28-14
A113	Field Test	166	03-03-14	08-15-14
A127	RD/RAWP Update for Final Enhancement Bioremediation Approach	31	11-04-15*	12-04-15
A129	Construction for Enhanced Bioremediation	59	12-07-15	02-03-16
A130	Enhanced Bioremediation Attenuation Implementation	1099	02-04-16	02-06-19
Natural Attenuation Groundwater Monitoring		5440	11-09-18	09-30-33
A131	Groundwater Monitoring Work Plan	64	11-09-18*	01-11-19
A132	Groundwater Monitoring Implementation	5350	02-07-19	09-30-33



Legend

- Remaining Work
- Milestone
- Summary

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ST012 - Former Williams Air Force Base
Mesa, Arizona

STO12 Remedial Action Implementation Schedule

FIGURE **6-1**

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Scale: Unknown

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APPENDIX A

PRE-DESIGN INVESTIGATION RESULTS

DRAFT FINAL
PRE-DESIGN INVESTIGATION RESULTS REPORT
OPERABLE UNIT 2, SITE ST012
FORMER WILLIAMS AIR FORCE BASE, MESA, ARIZONA

Prepared for:
Air Force Civil Engineer Center
AFCEC/CIBW
2261 Hughes Avenue, Suite 155
Lackland AFB, Texas 78236-9851

Prepared by:
AMEC Environment & Infrastructure, Inc.
4600 East Washington Street, Suite 600
Phoenix, Arizona 85034

January 2014

AMEC Project No. 9101110001
CDRL No. A008

SIGNATURE PAGE

DRAFT FINAL
PRE-DESIGN INVESTIGATION RESULTS REPORT
OPERABLE UNIT 2, SITE ST012
FORMER WILLIAMS AIR FORCE BASE, MESA, ARIZONA

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January 2014

AMEC Project No. 9101110001
CDRL No. A008

James N. Clarke, PG	Everett Wessner, PMP
Site Investigations Lead	Project Manager

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TABLE OF CONTENTS

1.0 INTRODUCTION 1-1
1.1 Background 1-1
1.2 Site Geology and Hydrogeology 1-2
1.3 Purpose 1-3
2.0 GENERAL WELL INSTALLATION ACTIVITIES 2-1
2.1 Site Preparation and Utility Clearance 2-1
2.2 Well Drilling and Installation Method 2-1
2.3 Well Permitting 2-1
3.0 INSTALLATION OF REMEDIATION WELLS 3-1
3.1 Lithologic Logging 3-1
3.2 Well Development 3-1
3.3 Soil and Groundwater Sampling and Testing 3-1
3.4 Equipment Decontamination 3-3
3.5 Field Documentation 3-3
3.6 Surveying 3-3
3.7 Investigation-Derived Waste Management 3-3
3.7.1 Drill Cuttings 3-3
3.7.2 Well Development Water 3-4
3.8 Divergence from PDI Work Plan 3-4
4.0 REFERENCES 4-1

LIST OF FIGURES

Figure A-1 ST012 Well Location Map
Figure A-2a PDI Benzene Results in Soil - View from the Southeast
Figure A-2b PDI Benzene Results in Soil - View from the North
Figure A-3a PDI TPH Results in Soil - View from the Southeast
Figure A-3b PDI TPH Results in Soil - View from the North
Figure A-4 Upper Water Bearing Zone – Benzene in Groundwater
Figure A-5 Lower Saturated Zone – Benzene in Groundwater

ED_005025_00013386-00096

100 LIST OF ATTACHMENTS

Attachment A.1 Well Construction Diagrams
Attachment A.2 Well Registration and Permit Documents
Attachment A.3 Boring Logs
Attachment A.4 Well Development Logs
Attachment A.5 Soil and Groundwater Test Results
Attachment A.6 Laboratory Test Results and Data Validation Summaries
Attachment A.7 Slug Test Results
Attachment A.8 IDW Management Documents

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101 LIST OF ACRONYMS AND ABBREVIATIONS

ADEQ	Arizona Department of Environmental Quality
ADWR	Arizona Department of Water Resources
AF	Air Force
AFB	Air Force Base
AFCEC	Air Force Civil Engineer Center
AMEC	AMEC Environment & Infrastructure, Inc.
ASTM	American Society for Testing and Materials
ASU	Arizona State University
AVGAS	aviation gasoline
B760	Building 760
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CZ	Cobble Zone
EPA	United States Environmental Protection Agency
FFA	Federal Facility Agreement
ft	foot, feet
ft/day	feet per day
GPS	global positioning system
HASP	Health and Safety Plan
IDW	Investigation-derived waste
IRP	Installation Restoration Program
IWAS	in-well air stripping
JP-4	jet petroleum grade 4
LNAPL	light non-aqueous phase liquid
LSZ	Lower Saturated Zone
MTBE	Methyl-tert-butyl ether
PALs	project action levels
PDI	Pre-Design Investigation
PID	photoionization detector
PMGAA	Phoenix-Mesa Gateway Airport Authority
QAPP	Quality Assurance Project Plan
RAs	Remedial Activities
RD	Remedial Design
ROD	Record of Decision
ST012	Site ST012 (former fuel storage area)
SOP	standard operating procedure
TestAmerica	TestAmerica Laboratories, Inc.
TPH	total petroleum hydrocarbons
URS	URS Corporation
UST	underground storage tank
UWBZ	Upper Water Bearing Zone
VOC	volatile organic compound

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1.0 INTRODUCTION

AMEC Environment & Infrastructure, Inc. (AMEC) prepared this Pre-Design Investigation (PDI) Report for the Air Force Civil Engineer Center (AFCEC) to provide details related to the PDI at Installation Restoration Program (IRP) site ST012, the former Liquid Fuels Storage Area (ST012), at the former Williams Air Force Base (AFB) in Mesa, Arizona. AMEC conducted this investigation to support Remedial Design (RD) for the ST012 groundwater remedy. The primary objectives of the investigation activities were to refine the remedial treatment zone by supplementing existing data on subsurface geology and light non-aqueous phase liquid (LNAPL) distribution, collect information to support future operational strategies for the remedy, and to complete soil borings as remediation wells suitable for monitoring, injection, and/or extraction.

1.1 Background

The former Williams AFB is located in Mesa, Arizona, approximately 30 miles southeast of Phoenix. Williams AFB, constructed on 4,043 acres, was commissioned as a United States Air Force (AF) flight training school in 1941. Pilot training was the primary mission throughout the history of the base.

In 1989, Williams AFB was placed on the United States Environmental Protection Agency (EPA) National Priorities List. As part of the United States Department of Defense-wide Base Realignment and Closure program, the former Williams AFB was closed in 1993. Since 1989, the AF has been cleaning up hazardous substance releases at Williams AFB under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) with oversight from the EPA, the Arizona Department of Environmental Quality (ADEQ), and the Arizona Department of Water Resources (ADWR).

The majority of the base property has since been converted to the Phoenix-Mesa Gateway Airport (formerly Williams Gateway Airport) and related aviation, industrial, and commercial facilities, Arizona State University (ASU) Polytechnic Campus, the Maricopa County Community College Williams Campus, and several other small entities.

ST012, the former Liquid Fuels Storage Area, hosted fuel storage and distribution operations involving aboveground and underground tanks and lines from 1941 until the fuel storage and distribution system was decommissioned in 1991. The AF-owned aboveground and underground equipment and structures relating to fuel storage and distribution operations have been removed. Multiple documented and undocumented releases of jet petroleum grade 4 (JP-4) and aviation gasoline (AVGAS) have contaminated soil and groundwater below ST012 over the 50 years of base operations. The AF transferred the property, including ST012, to the Phoenix-Mesa Gateway Airport Authority (PMGAA) in 2008.

ST012 has been the focus of remedial investigations, pilot studies, and Remedial Activities (RAs) since the discovery of contamination in 1984. RAs at ST012 are being conducted in accordance with CERCLA and the former Williams AFB Federal Facility Agreement (FFA). The FFA ensures the environmental impacts associated with past and present activities at the

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former Williams AFB are thoroughly investigated and necessary RAs are taken to protect the public health, welfare, and the environment. The PMGAA transfer deed reserves right of access for the AF, EPA, and State of Arizona for purposes consistent with the IRP and FFA, including inspections, investigations, RAs, and monitoring.

Results of post-Record of Decision (ROD) pilot studies, demonstration studies, and groundwater studies indicate that portions of the initially selected groundwater remedy in the OU-2 ROD (pumping, treating, and reinjection), will not achieve site cleanup goals under current conditions. Groundwater levels have risen more than 60 feet (ft) since the late 1980s and have rendered this remedy ineffective.

1.2 Site Geology and Hydrogeology

The site geology and hydrogeology was an important consideration in the original design and final installation of the wells documented by this report. The former Williams AFB lies within the Higley Basin, an alluvium-filled structural depression in the Salt River Valley Basin, in the eastern portion of the Basin and Range Physiographic Province of south central Arizona. The topography is characterized by north to northwest trending wide, flat, alluvial-filled basins surrounded by steep, rugged, low-relief mountain ranges. The Higley Basin is bound by the Usery and Goldfield Mountains to the north, the Superstition Mountains to the east, the Santan Mountains to the south, and the South Mountains to the west.

The rocks and sedimentary deposits in the eastern part of the Salt River Valley are divided into six major stratigraphic units. These layers are, from deepest to shallowest, crystalline rocks, extrusive rocks, Red Unit, Lower Unit, Middle Unit, and the Upper Unit. The crystalline and extrusive rocks underlie the basin and outcrop at the surface in the surrounding mountains. These rocks and the surrounding mountains form the vertical and lateral hydrogeologic boundaries of the Higley Basin. The nearby mountains are the source of most of the sedimentary deposits that fill the basin.

The Upper Unit is generally comprised of unconsolidated clay, silt, sand, and gravel associated with stream channel and alluvial fan deposition. Cemented caliche horizons are present within alluvial fan deposits near the margins of the basin and below gravel terraces cut into older basin fill sediments. The Upper Unit does not exhibit coarse to fine lateral gradation from the margins to the basin interior. Instead, grain-size distribution appears to reflect stream flow patterns of the Salt River and Queen Creek drainages. At the former fuel storage area (Site ST012), the upper unit was further described as follows:

- Vadose zone from ground surface to approximately 155 ft below ground surface (bgs), with the base of the vadose zone identified by a layer of gravel and cobbles referred to as the Cobble Zone (CZ);
- Upper Water Bearing Zone (UWBZ) from approximately 165 ft bgs to 190 ft bgs; and,
- Lower Saturated Zone (LSZ) from approximately 210 ft bgs to approximately 240 ft bgs.

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With the rising water table, the CZ described above is now partially or completely saturated. The Middle Unit contains the main water producing aquifer for the region. The base of the Upper Unit, referred to as the "leaky aquitard", is encountered at a depth of about 240 to 245 ft bgs. The lower boundary of the Middle Unit is approximately 1,000 ft bgs. The Middle Unit varies in thickness from less than 100 ft near the mountains to about 1,000 ft near the former Williams AFB. The Middle Unit consists largely of playa, alluvial fan, and fluvial deposits of weakly consolidated silt, siltstone, silty sand, and gravel with locally-occurring moderately to well-cemented siltstone. Portions of the Middle Unit have discontinuous layers and lenses of caliche. The thickest and finest grained parts of the Middle Unit occur in the central part of the basin. The distribution of sand and gravel in the Middle Unit is irregular because the principal sediment source was the Salt River. In the center of the basin, the Middle Unit is composed of silt or clay. Near the margins of the basin, the Middle Unit consists of silt to sand and gravel.

1.3 Purpose

The PDI aimed to further characterize the extent of residual LNAPL on site to refine the perimeter of the treatment areas. The purpose of the well installation is provided as follows:

1. Obtain a continuous log of the lithology, visually inspect for the presence of LNAPL, collect photoionization detector (PID) readings, test suspect soil on site for LNAPL presence using partitioning dye test kits, and collect soil samples for off-site analysis;
2. Collect vadose zone soil samples in well borings;
3. Collect groundwater samples from the new remediation wells and existing monitoring wells at ST012 that are not part of routine annual monitoring but are within the likely area of ST012 remediation; and,
4. Conduct slug tests on five remediation wells.

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2.0 GENERAL WELL INSTALLATION ACTIVITIES

The well installation activities documented by this report were performed in accordance with the PDI Work Plan (AMEC, 2013) and the applicable guidelines described in the former Williams AFB Performance Based Remediation Program Quality Assurance Project Plan (QAPP) and standard operating procedures (SOPs) (collectively referred to as the QAPP/SOP [AMEC, 2012a]). This section describes the drilling and well installation activities conducted at ST012 from 04 February 2013 through 15 March 2013.

2.1 Site Preparation and Utility Clearance

Borehole drilling, soil sampling, and well installation activities were conducted from 04 February 2013 through 15 March 2013 on property owned by PMGAA. Eleven new remediation wells (ST012-LSZ08 through ST012-LSZ17 and ST012-UWBZ09) were installed. All of the new wells are screened in the upper alluvial layer with depth specific screening to isolate sampling in two zones of interest; the UWBZ and the LSZ. The UWBZ well (ST012-UWBZ09) is screened between 170 ft and 197 ft bgs. The LSZ wells (ST012-LSZ08 through ST012-LSZ17, inclusive) are screened between 205 ft and 246 ft bgs.

The borehole locations and new remediation well locations are provided on Figure A-1.

AMEC developed a Health and Safety Plan (HASP) for work performed by AMEC personnel at the former Williams AFB. Boart Longyear also developed a HASP for their employees. Copies of the HASPs remained on site during construction activities. AMEC and subcontractor personnel completed training on site-specific health and safety procedures prior to starting construction. AMEC's Project Health and Safety Officer lead a daily safety tailgate meeting with all on-site project personnel to review hazards and safety precautions applicable to the day's specific work tasks. A copy of the PDI Work Plan also remained on site during drilling, sampling, and well construction activities.

2.2 Well Drilling and Installation Method

The remediation wells were drilled using the 10-inch diameter rotosonic drilling system provided by Boart Longyear. The rotosonic drilling system employs simultaneous high-frequency vibrational and low speed rotational motion coupled with down-pressure to advance the cutting edge of a circular drill string. This action produces a uniform borehole while providing relatively continuous undisturbed core samples of both overburden and most bedrock formations. This technique can be used to obtain large diameter continuous, relatively undisturbed and very accurate core samples of almost any overburden formation. The core is extracted in approximately 2.5 ft intervals into a plastic bag where the lithology can be viewed and logged, soil samples field screened for contamination, and samples collected for laboratory analysis. Well construction diagrams are presented in Attachment A.1.

2.3 Well Permitting

Boart Longyear prepared and submitted Form 55-44A, Notice of Intent to Drill, Deepen, or Modify a Monitor/Piezometer/Environmental Well, to the ADWR for the drilling and installation of

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the wells documented by this report. Boart Longyear submitted the forms electronically with the application fee to ADWR. Boart Longyear subsequently filed Form 55-55, Well Driller Report and Well Log with ADWR after the completion of the well drilling, testing, and installation work. The well registration and permit documents are located in Attachment A.2.

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3.0 INSTALLATION OF REMEDIATION WELLS

The installation of remediation wells was performed, in general accordance with the PDI Work Plan (AMEC, 2013), from 04 February 2013 through 15 March 2013 using the 10-inch diameter rotosonic drilling system provided by Boart Longyear. As the well boring was advanced, continuous core samples were obtained and the soil strata were logged.

The following Sections describe the lithologic logging, well development, soil and groundwater sampling and testing, equipment decontamination, field documentation, surveying, investigation derived waste management, and deviations from the PDI Work Plan associated with installation of the new remediation wells at ST012.

3.1 Lithologic Logging

The continuous cores obtained during drilling were logged by AMEC personnel in accordance with the American Society for Testing and Materials (ASTM) Standard D2488-93, *Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)* (see SOP No. 11, *Borehole Logging*) (AMEC, 2012a). The boring logs for the new remediation wells are included in Attachment A.3.

3.2 Well Development

Well development was performed in accordance with SOP No. 7, *Well Development* (AMEC, 2012a). The monitoring wells were developed by Boart Longyear from 18 March 2013 through 21 March 2013 using a combination of surging, bailing and pumping. The wells were first surged using a surge block, then bailed (1.5 gallon capacity bailer), and finally pumped (12 gallons per minute or less). Pumping continued until a maximum of five well volumes of water were removed or water was observed to be clear or turbidity was measured within the range of 10 to 40 nephelometric turbidity units. The well development logs are included as Attachment A.4. In accordance with SOP No. 7, development of some wells was terminated if the extracted water was not observed to be clearing after more than 5 well volumes of water were removed. This occurred for wells ST012-LSZ09 (1,102 gallons), ST012-LSZ12 (620 gallons), ST012-LSZ13 (500 gallons), and ST012-LSZ14 (380 gallons). Well ST012-UWBZ09 went dry after 14 minutes of pumping. A reduced pump rate of 1.5 to 2 gallons per minute was used for development with a total of 297 gallons of water removed before termination. Additional well development may be conducted prior to SEE startup.

A total of 6,255.5 gallons of water were removed during development of the remediation wells. The development water was temporarily stored in a transfer tank until transport to the ST012 fenced area (if outside the fence limits). The water was then placed in an on-site steel storage tank until discharged to the City of Mesa sewer system via the ST012 pre-treatment system.

3.3 Soil and Groundwater Sampling and Testing

During drilling, cores were screened continuously with a PID for presence of volatile organic compounds (VOCs). Soils were screened on site for LNAPL presence using a dye test kit as described in SOP-ST012-05. The dye test kits were used to confirm LNAPL presence/absence

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that is suspected based on visual and PID screening. On average, approximately one dye test per 10 ft boring interval was performed (same depth ranges indicated for off-site analytical samples).

Approximately one soil sample was collected for off-site analysis every 10 ft in the saturated soil zones for all of the wells, as well as one soil sample every 10 ft in the vadose zone starting at 30 ft bgs for wells ST012-LSZ08, ST012-LSZ09, ST012-LSZ10, ST012-LSZ15, ST012-LSZ16, and ST012-LSZ17. Samples were collected from each 10-ft interval as follows:

1. At the location of the highest PID reading of the drill core; or
2. As selected by the project geologist if PID readings were not elevated or did not correlate with visual and dye test kit results.

Soil samples were analyzed for VOCs by method 8260B and total petroleum hydrocarbons (TPH) by method 8015M. Benzene and TPH were the target analytes during the PDI. Although other VOCs are identified as contaminants at ST012 and may have been present in the samples, benzene is the primary VOC that exceeds cleanup levels and is a primary indicator of the extent of contamination for both the vadose zone and dissolved phase groundwater plume. Benzene and TPH concentrations were compared to project action levels (PALs).

After drilling and construction activities were complete, AMEC performed an initial round of groundwater sampling at ST012, including existing groundwater monitoring wells and the newly installed remediation wells. Groundwater samples were analyzed for VOCs by method 8260B and TPH by method 8015M. Benzene results were compared to the PAL. AMEC collected samples using low-flow sampling methods described in SOP 10F or passive diffusion bags as described in SOP 10E. During low-flow sampling, flow-through cell instruments were used to me quality parameters. The new wells were allowed to rest for at least one week after development so fines and sediment in the well could settle prior to sampling.

Quality control samples were collected during sampling and included equipment rinse blanks, field duplicates, and matrix spike/matrix spike duplicates.

The results of field soil and groundwater testing are summarized in Attachment A.5. The results of laboratory soil and groundwater testing, performed by TestAmerica Laboratories, Inc. (TestAmerica), are summarized in Attachment A.6.

A slug test was performed on two existing remediation wells (ST012-UWBZ07 and ST012-LSZ07) and four newly installed remediation wells (ST012-LSZ08, ST012-LSZ10, ST012-LSZ12, ST012-LSZ14). Accurate water readings could not be obtained for the existing wells indicating that these wells may be partially fouled and are in need of redevelopment. The results of the slug tests are included in Attachment A.7. Estimates of hydraulic conductivity based on the slug tests that were completed in the newly installed wells ranged from 0.4 to 1.7 feet per day (ft/day). These results are on the low end but within the range historically observed at the site (0.1 to 49 ft/day) (AMEC, 2012b).

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The final soil benzene and TPH results from laboratory testing are shown graphically in Figures A-2a, A-2b, A-3a, and A-3b using a three-dimensional model (TecPlot) Groundwater contours that were developed using a combination of PDI groundwater results and results from the November 2012 annual groundwater sampling are presented in Figures A-4 and A-5 for the UWBZ and LSZ respectively.

3.4 Equipment Decontamination

Drilling and sampling equipment was decontaminated in accordance with SOP 01.

3.5 Field Documentation

An AMEC field geologist or project engineer supervised the drilling and sampling activities using field forms and procedures as provided in SOP 02.

3.6 Surveying

An Arizona registered land surveyor surveyed the horizontal location and ground surface elevations of the new remediation wells using a global positioning system (GPS) unit. GPS elevation accuracy was to the nearest 0.01 ft. The surveyed well locations are shown on Figure A-1.

3.7 Investigation-Derived Waste Management

Investigation-derived waste (IDW) was managed in accordance with SOP 16. The IDW that was generated was soil drill cuttings generated during well installation and well development water. Each is described in the below subsections.

3.7.1 Drill Cuttings

Drill cuttings generated during drilling were stored at the drill site in eleven 20 cubic yard roll-off bins until completion of drilling activities. On 10 February 2013, a composite soil sample was collected from the roll-off bins containing the drill cuttings from wells ST012-LSZ16 and ST012-LSZ17. Due to the location of these well borings, the drill cuttings for these well borings were considered representative of the total well installation operation. In accordance with landfill acceptance requirements, this composite soil sample was submitted to the TestAmerica Phoenix laboratory and analyzed for polynuclear aromatic hydrocarbons by EPA Method 8310; the eight Resource Conservation Recovery Act metals (arsenic, cadmium, chromium, lead, mercury, nickel, selenium, and zinc) by EPA Method 6010/7470; and, TPH by EPA Method 8015. This sample was labeled ST012-IDW1-213-SP-N. Two samples were collected from each of the roll-off bins and were methanol extracted in the field in accordance with EPA Method 5035. A composite sample, labeled ST012-IDW1a/1b/1c/1d-213-SP-N, was then composited by TestAmerica and analyzed for VOCs by EPA Method 8260B. The results are included with TestAmerica Analytical Report PWB0697 included in Attachment A.8.

The analytical results were provided to Environmental Response, Inc. and a waste profile was prepared and signed by the AF (Attachment A.8). The soil was disposed as solid waste. The

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disposal documents are also included in Attachment A.8. A total of 109.06 tons of drill cuttings were disposed as solid waste at the Apache Junction Landfill.

3.7.2 Well Development Water

The water purged from the ST012 wells during well development and minimal equipment decontamination fluids were temporarily stored in a polyethylene transfer tank provided by Boart Longyear. At the completion of the development, the purge water was transferred to an on-site steel tank for subsequent processing through the ST012 groundwater containment treatment system in accordance with the Site discharge permit.

3.8 Divergence from PDI Work Plan

The installation of eleven remediation wells was conducted in general accordance with the PDI Work Plan (AMEC, 2013) and applicable guidelines described in the former Williams AFB QAPP/SOPs (AMEC, 2012a). However, there were the following divergences from the PDI Work Plan:

1. The remediation well locations were field adjusted, where necessary, to accommodate drill rig access and to avoid overhead and subsurface utility conflicts.
2. A ½-inch, rather than a 1 ½-inch, Schedule 40 carbon steel casing was installed from depth to 1 ½ ft above ground surface for temperature monitoring in the remediation wells. This change was made to provide greater continuity of sand pack around the well and is compatible with future steam operations.
3. Slug tests locations were adjusted based on discussions with TerraTherm. The work plan included slugs test as ST012-LSZ08, ST012-LSZ10, ST012-LSZ11, ST012-LSZ14, and ST012-UWBZ09. Slug tests were conducted at ST012-UWBZ07, ST012-LSZ07, ST012-LSZ08, ST012-LSZ10, ST012-LSZ12, and ST012-LSZ14. ST012-UWBZ07 replaced ST012-UWBZ09, and ST012-LSZ07 was added added based on TerraTherm's recommendation to provide a comparison to the steam injection wells used during the thermal enhanced extraction pilot test; however, when tested, the behavior of these wells indicated that redevelopment is needed. ST012-LSZ12 replaced ST012-LSZ11 to further distribute the tested wells since the original selection included two adjacent wells (ST012-LSZ10 and ST012-LSZ11).

ED_005025_00013386-00107

4.0 REFERENCES

AMEC Environment & Infrastructure, Inc. (AMEC), January 2013. Final Pre-Design Investigation Work Plan, Operable Unit 2, Site ST012, Former Williams Air Force Base, Mesa, Arizona.

AMEC, July 2012a. Performance Based Remediation Program Quality Assurance Project Plan and Standard Operating Procedures, Former Williams Air Force Base, Mesa, Arizona.

AMEC, November 2012b, *Final Focused Feasibility Study, Remedial Alternatives for Operable Unit, Site ST012, Former Williams Air Force Base, Mesa, Arizona*, prepared for the Air Force Civil Engineer Center (AFCEC), Lackland Air Force Base, Texas.

AMEC, 2012b, Final Focused Feasibility Study, Remedial Alternative for Operable Unit 2, Site ST012, Former Williams Air Force Base, Mesa, Arizona, November 27, 2012.

BEM, April, 1996. Underground Storage Tank Closure Report, Site Characterization Report Form (SCRF), UST No. 760 (ADEQ Nos. 94-99, LUST No. 4715.2069), Williams AFB, Arizona

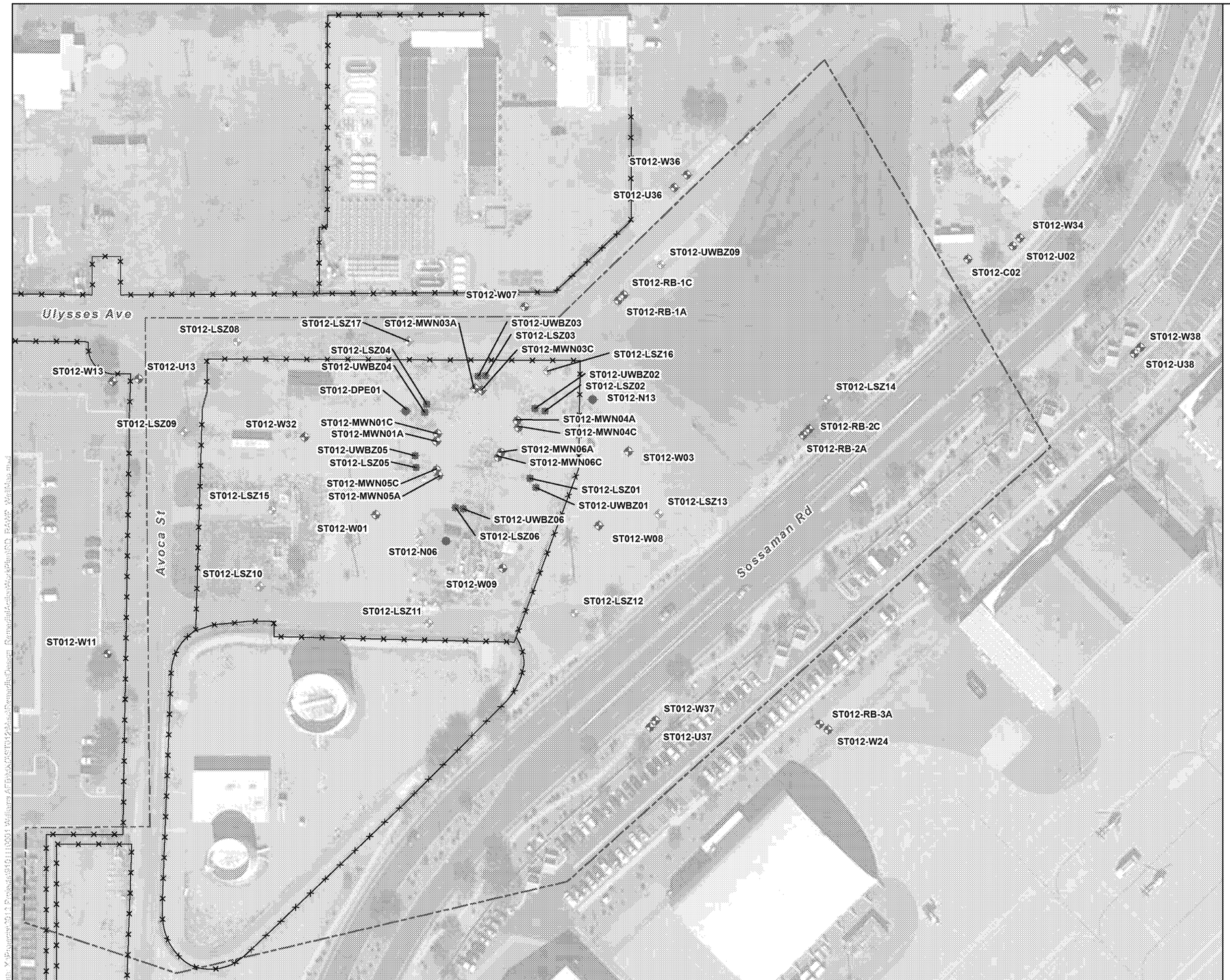
URS Corporation (URS), December 2007. Draft Building 760 Underground Storage Tank, Corrective Action Plan, Former Williams Air Force Base, Mesa, Arizona. Austin, Texas.

URS, February 2009a. Final Site ST035 Former Building 760 Underground Storage Tank Soil Vapor Extraction Construction Work Plan, Former Williams Air Force Base, Mesa, Arizona. Austin, Texas.

URS, May 2009b. Final, Site ST035, Former Building 760 Underground Storage Tank Engineering and Construction Report, Former Williams Air Force Base, Mesa, Arizona.

ED_005025_00013386-00108

FIGURES



Legend

- New Well Location (Installed April 2013)
- Groundwater Containment Monitoring Well Location Screened in UWBZ
- Groundwater Containment Monitoring Well Location Screened in the LSZ
- Groundwater Containment Monitoring Well Location Screened in the UWBZ and LSZ
- Groundwater Extraction Well Location Screened in the UWBZ
- Groundwater Extraction Well Location Screened in the LSZ
- Fenceline
- ST012 Site Boundary

Notes:

ST012-RB-1A	Monitoring Well Identification
LSZ	Lower Saturated Zone
UWBZ	Upper Water Bearing Zone

0 25 50 100 Feet

N

Remedial Design/Remedial Action
Work Plan
Site ST012 - Former Williams Air Force Base
Mesa, Arizona

ST012 Well Location Map

FIGURE **A-1**

Job No. 9101110001
PM: EW
Date: 7/3/2013
Scale: 1" = 100'

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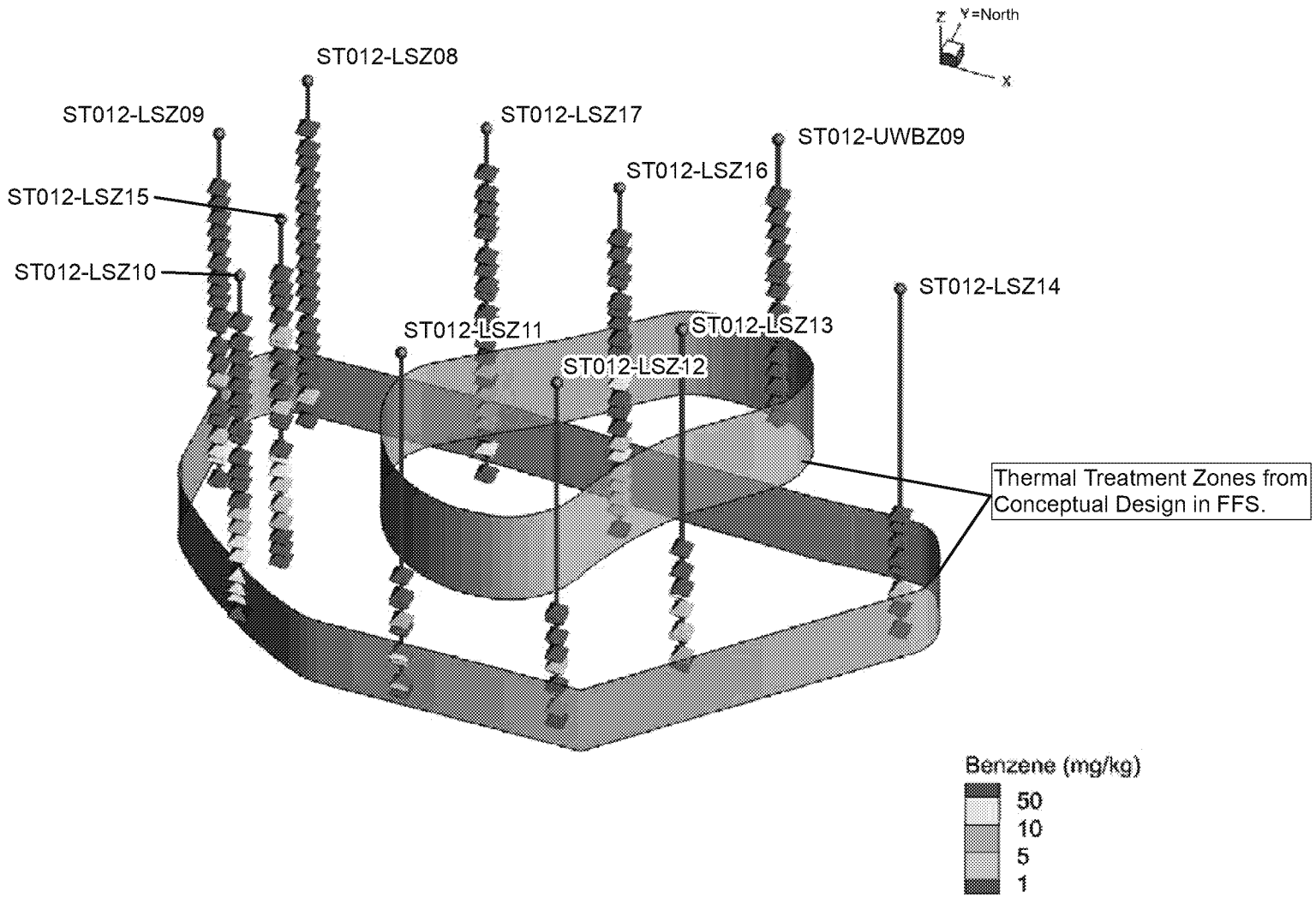

Notes:
1. PDI = Pre-Design Investigation
2. mg/kg = milligram per kilogram

Job No.	9101-11-0001
PM:	EW
Date:	12/20/2013
Scale:	Unknown

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PDI Benzene Results in Soil
View from the Southeast

FIGURE
A-2a

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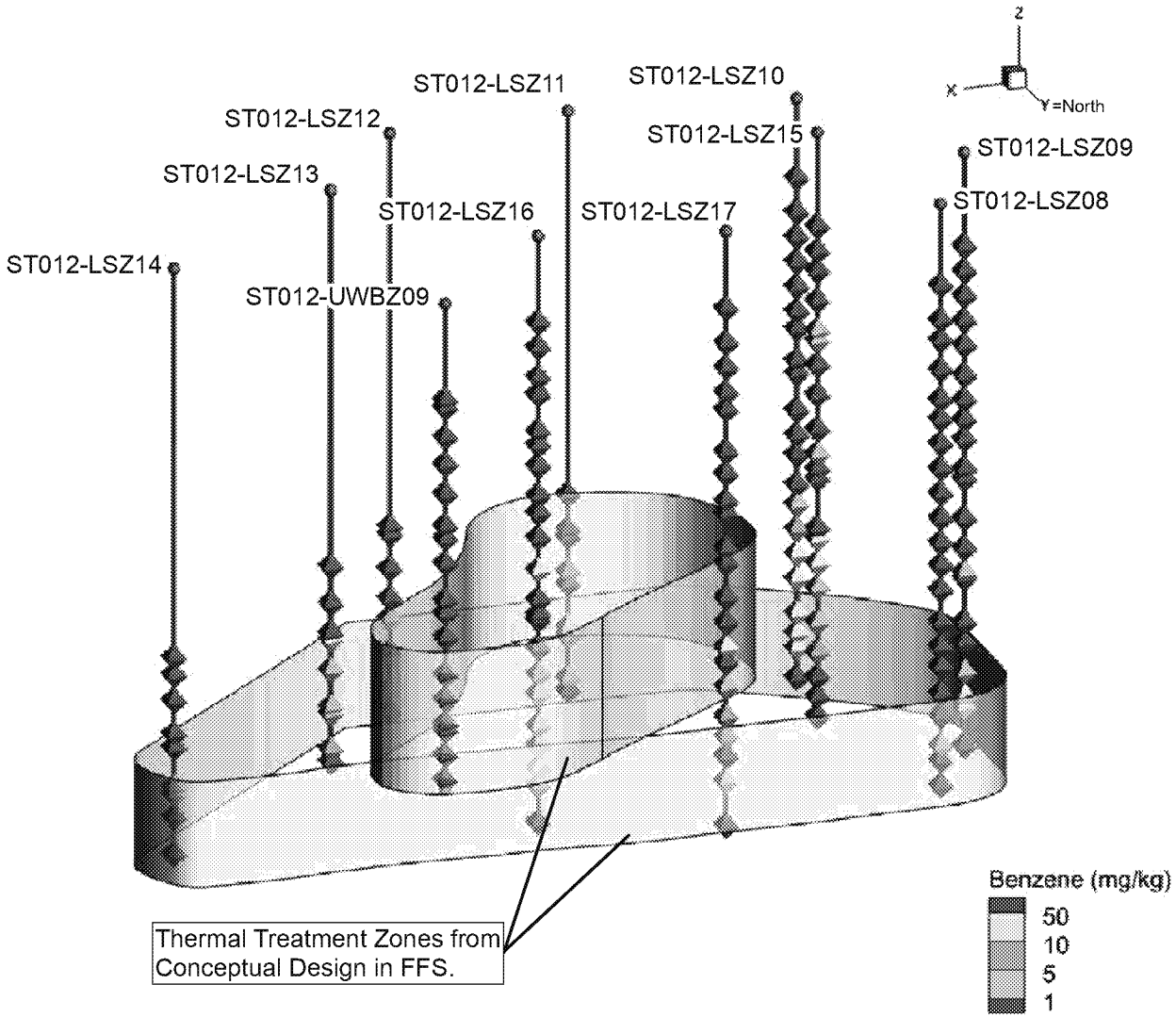

Notes:
1. PDI = Pre-Design Investigation
2. mg/kg = milligram per kilogram

Job No.	9101-11-0001
PM:	EW
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PDI Benzene Results in Soil
View from the North

FIGURE
A-2b

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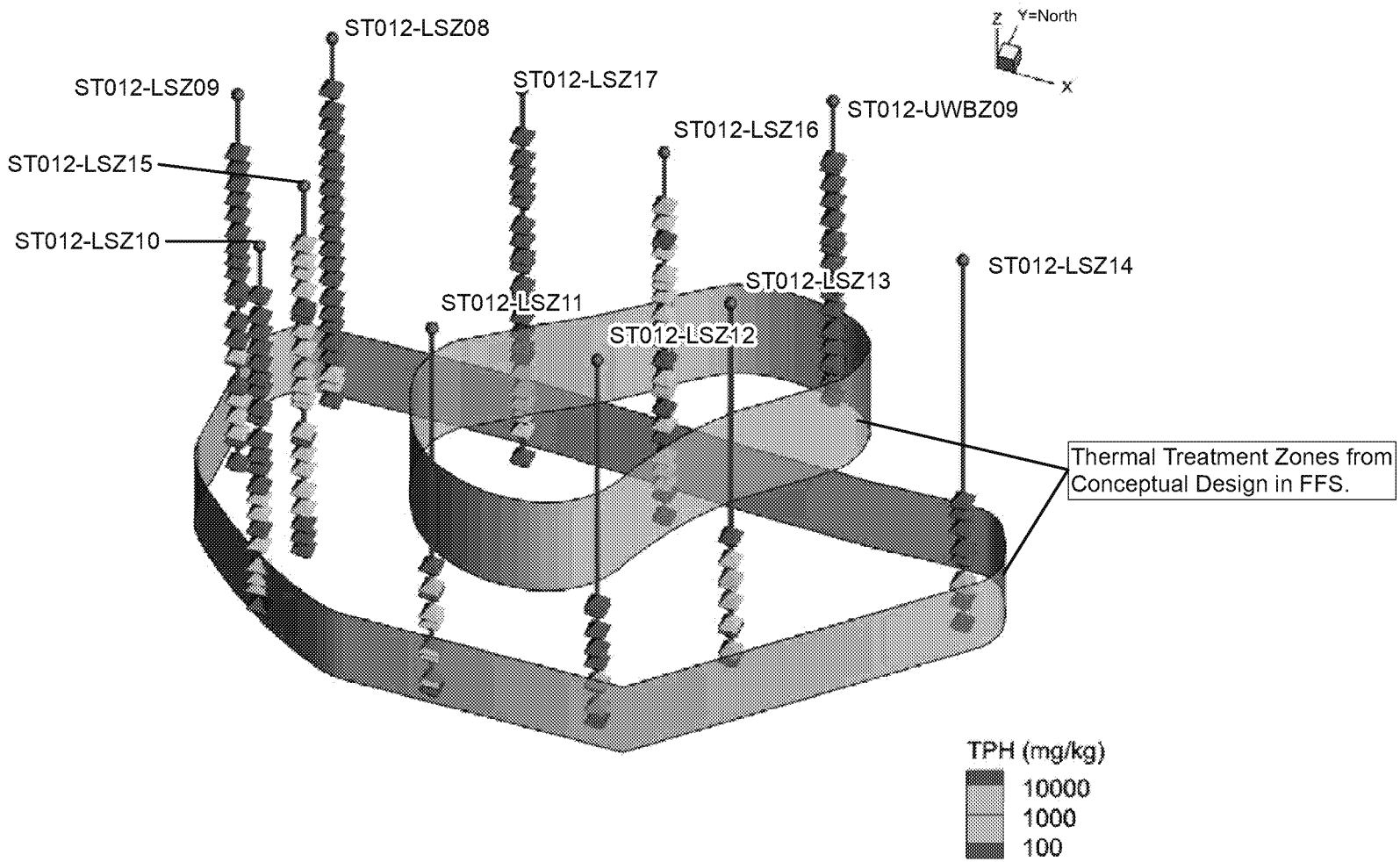

Notes:
1. PDI = Pre-Design Investigation
2. mg/kg = milligram per kilogram
3. TPH = Total Petroleum Hydorcabons (gasolene range organics plus diesel range organics)

Job No.	9101-11-0001
PM:	EW
Date:	12/20/2013
Scale:	Unknown

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PDI TPH Results in Soil
View from the Southeast

FIGURE
A-3a

amec

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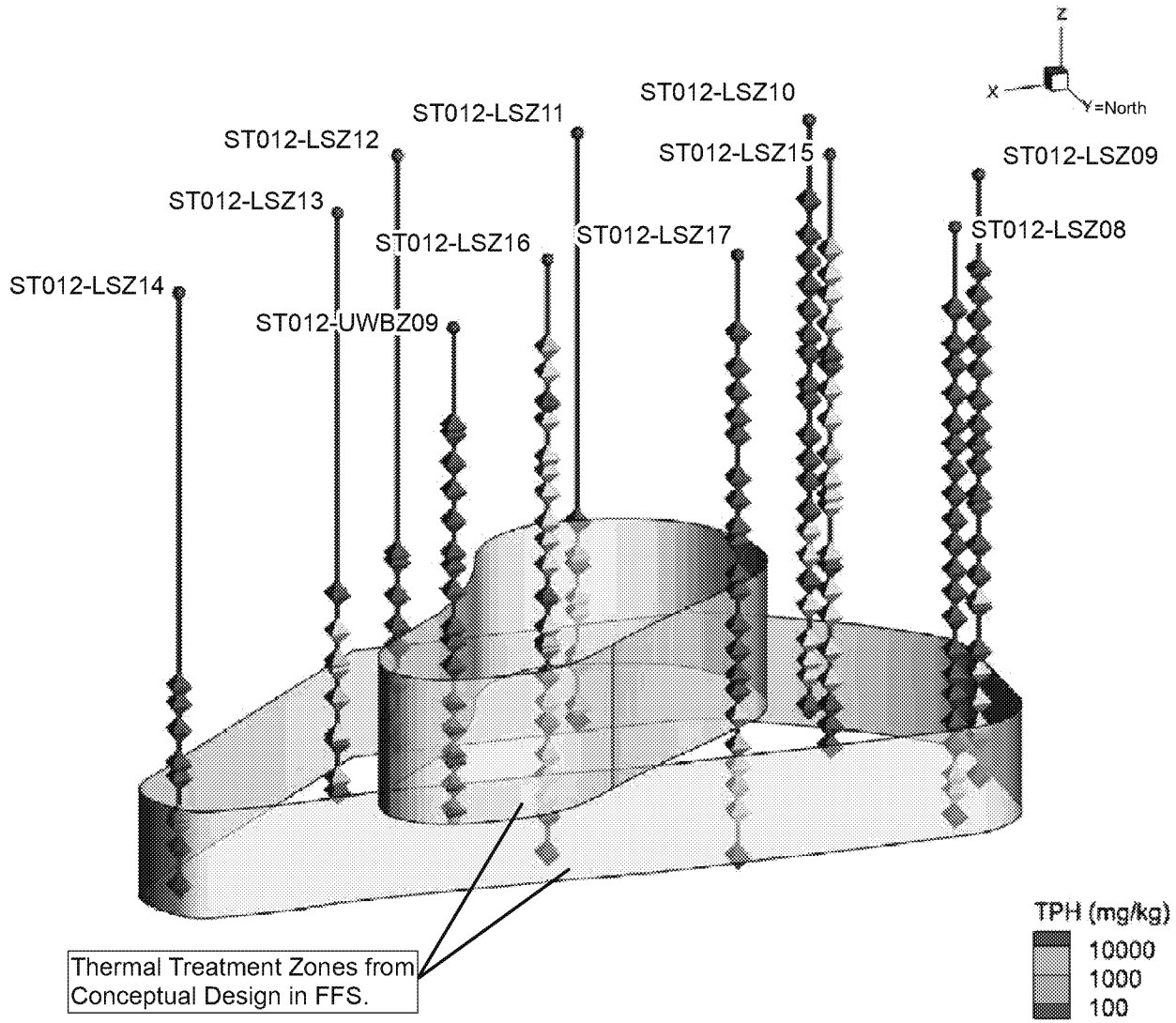

Notes:
1. PDI = Pre-Design Investigation
2. mg/kg = milligram per kilogram
3. TPH = Total Petroleum Hydorcabons (gasolene range organics plus diesel range organics)

Job No.	9101-11-0001
PM:	EW
Date:	12/20/2013
Scale:	Unknown

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PDI TPH Results in Soil
View from the North

FIGURE
A-3b

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Legend

- Monitoring Well
- UWBZ Thermal Treatment Zone (from FFS)
- Benzene Isoconcentration Contour

Pre-Design Investigation results used where available. Supplemented with November 2012 annual groundwater monitoring results.

Note:
Benzene results in µg/L
ND = Not detected

0 100 200 Feet

N

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UPPPER WATER BEARING ZONE BENZENE IN GROUNDWATER

FIGURE **A-4**

Job No.	9101110001
PM:	EW
Date:	12/20/2013
Scale:	1" = 200 feet

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Legend

- Monitoring Well
- LSZ Thermal Treatment Zone (from
- Benzene Isoconcentration Contour

Pre-Design Investigation results used when available. Supplemented with November 2012 annual groundwater monitoring results.

Notes:
Benzene results in µg/L
Wells with two results include the sample duplicate
ND = Not detected

0 87.5 175 Feet

N

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Mesa, Arizona

LOWER SATURATED ZONE BENZENE IN GROUNDWATER

FIGURE **A-5**

Job No. 91011110001
PM: EW
Date: 12/20/2013
Scale: 1" = 175 feet

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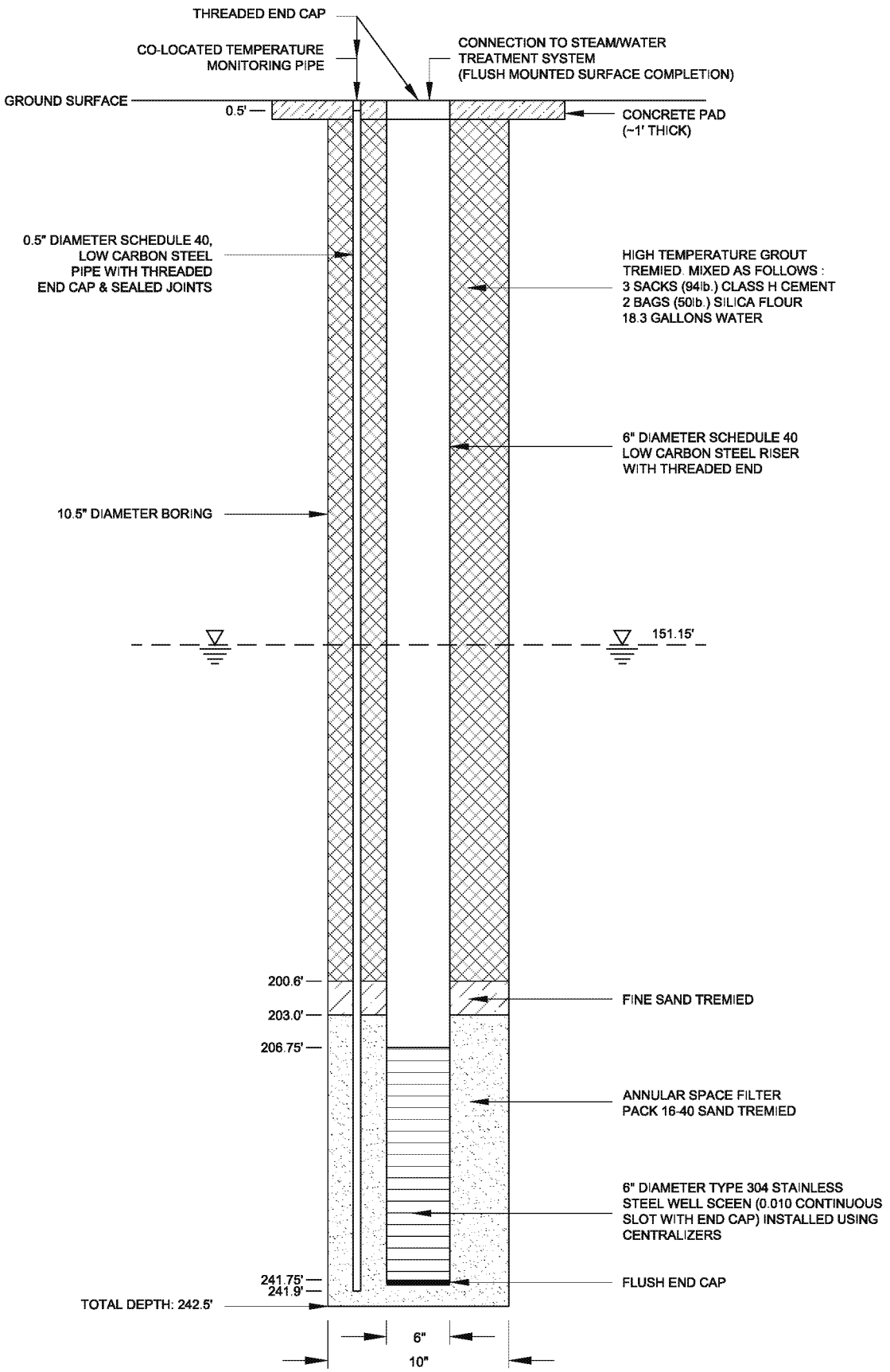
ATTACHMENT A.1

WELL CONSTRUCTION DIAGRAMS



JOB NO.	9101110001
DESIGN:	SW
DRAWN:	GWH
DATE:	5/2013
SCALE:	NOT TO SCALE

FIGURE A.1-1
MONITOR WELL CONSTRUCTION ST012 - LSZ08

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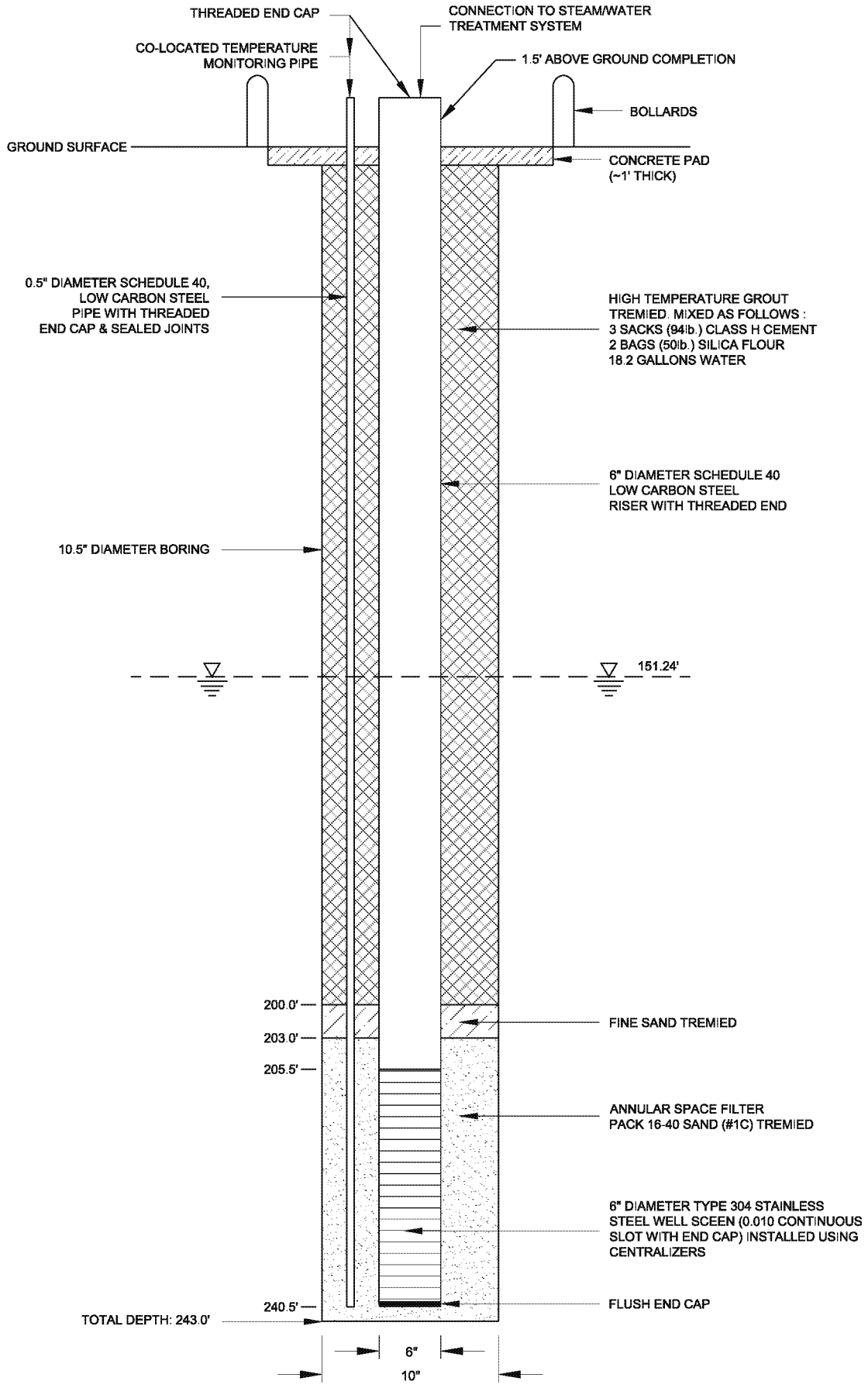

JOB NO.	9101110001
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DATE:	5/2013
SCALE:	NOT TO SCALE

FIGURE A.1-2
MONITOR WELL CONSTRUCTION ST012 - LSZ09

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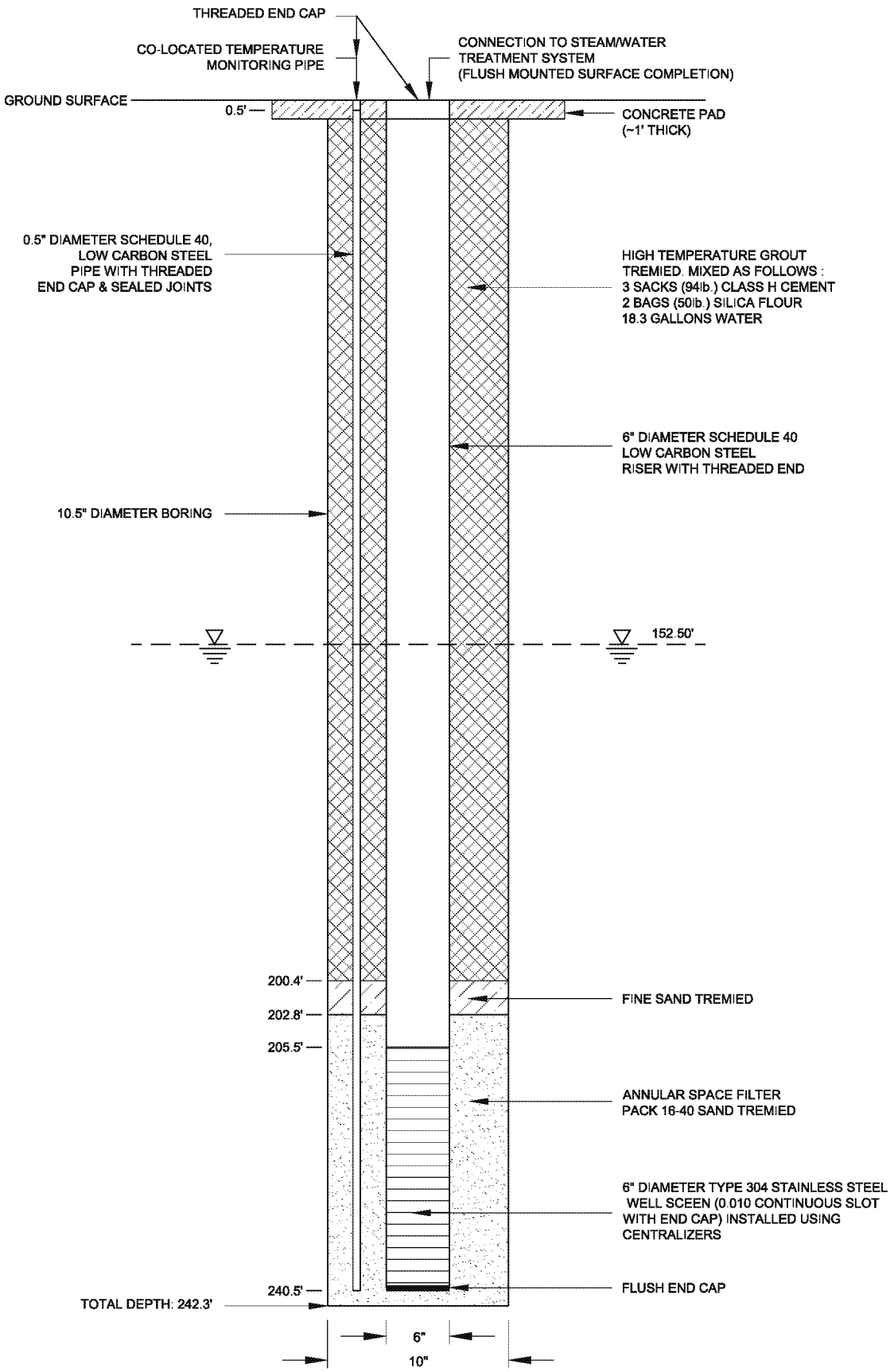

JOB NO.	9101110001
DESIGN:	SW
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SCALE:	NOT TO SCALE

FIGURE A.1-3
MONITOR WELL CONSTRUCTION ST012 - LSZ10

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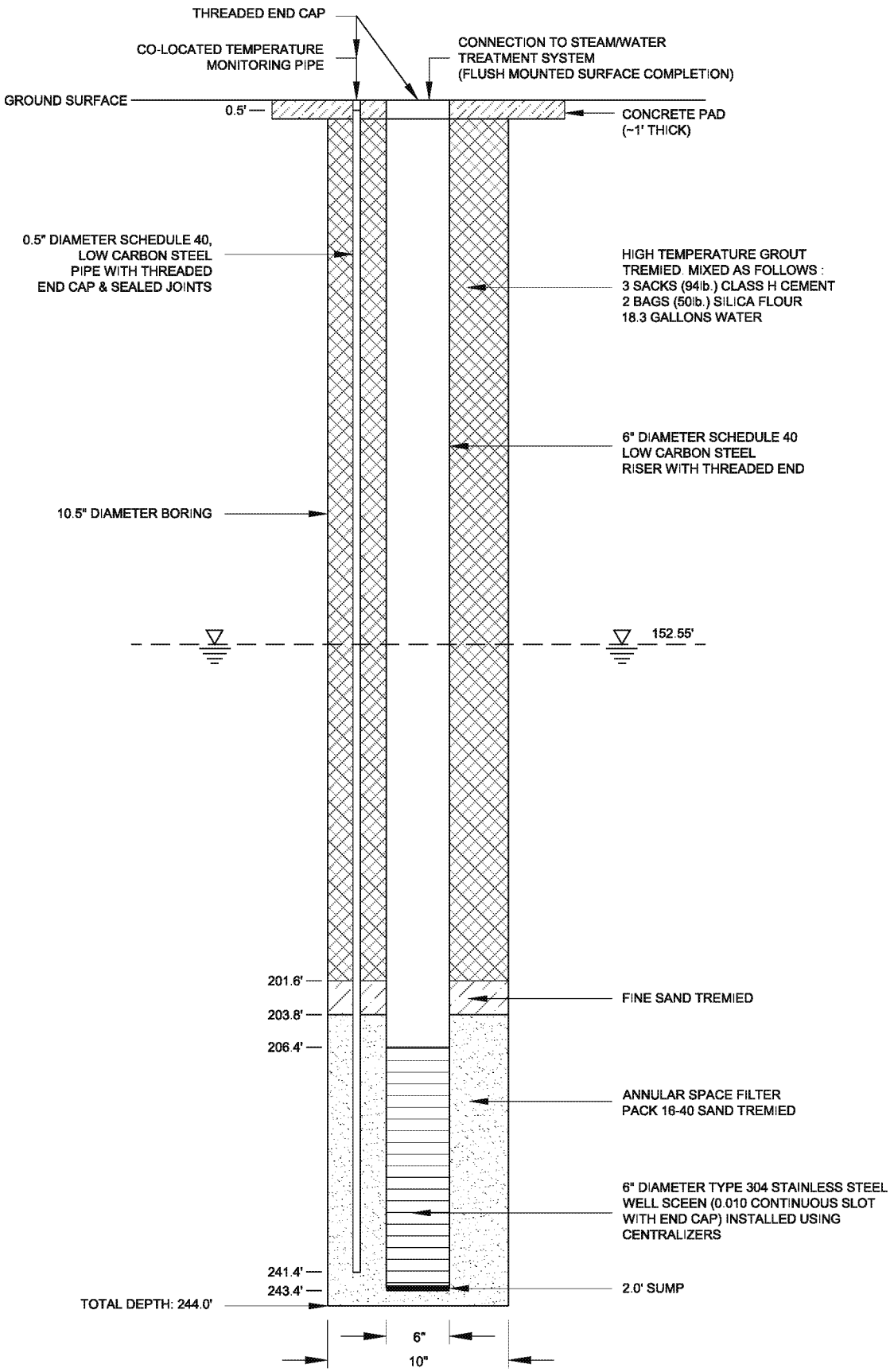

JOB NO.	9101110001
DESIGN:	SW
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DATE:	5/2013
SCALE:	NOT TO SCALE

FIGURE A.1-4
MONITOR WELL CONSTRUCTION ST012 - LSZ11

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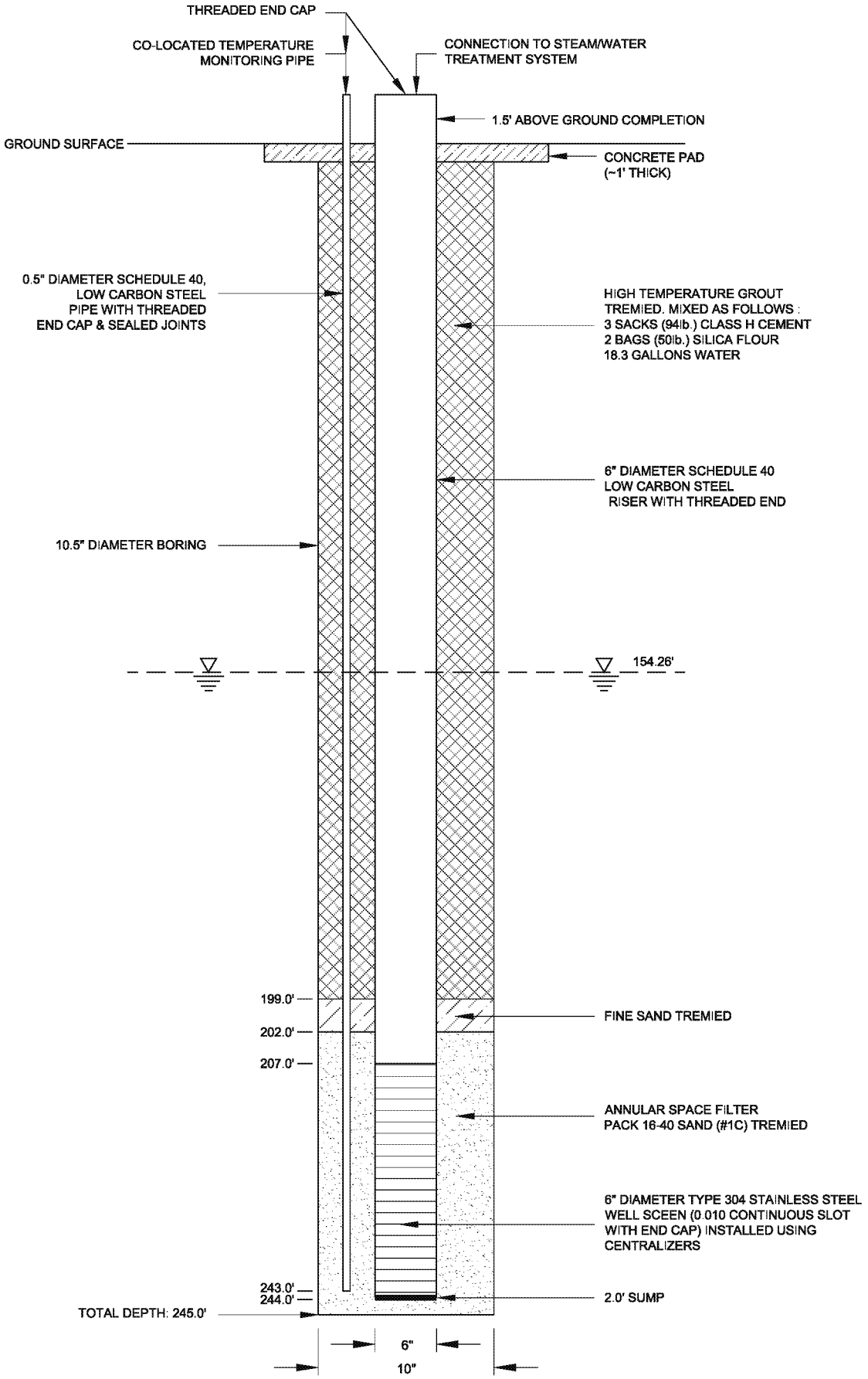

JOB NO.	9101110001
DESIGN:	SW
DRAWN:	GWH
DATE:	5/2013
SCALE:	NOT TO SCALE

FIGURE A.1-5
MONITOR WELL CONSTRUCTION ST012 - LSZ12

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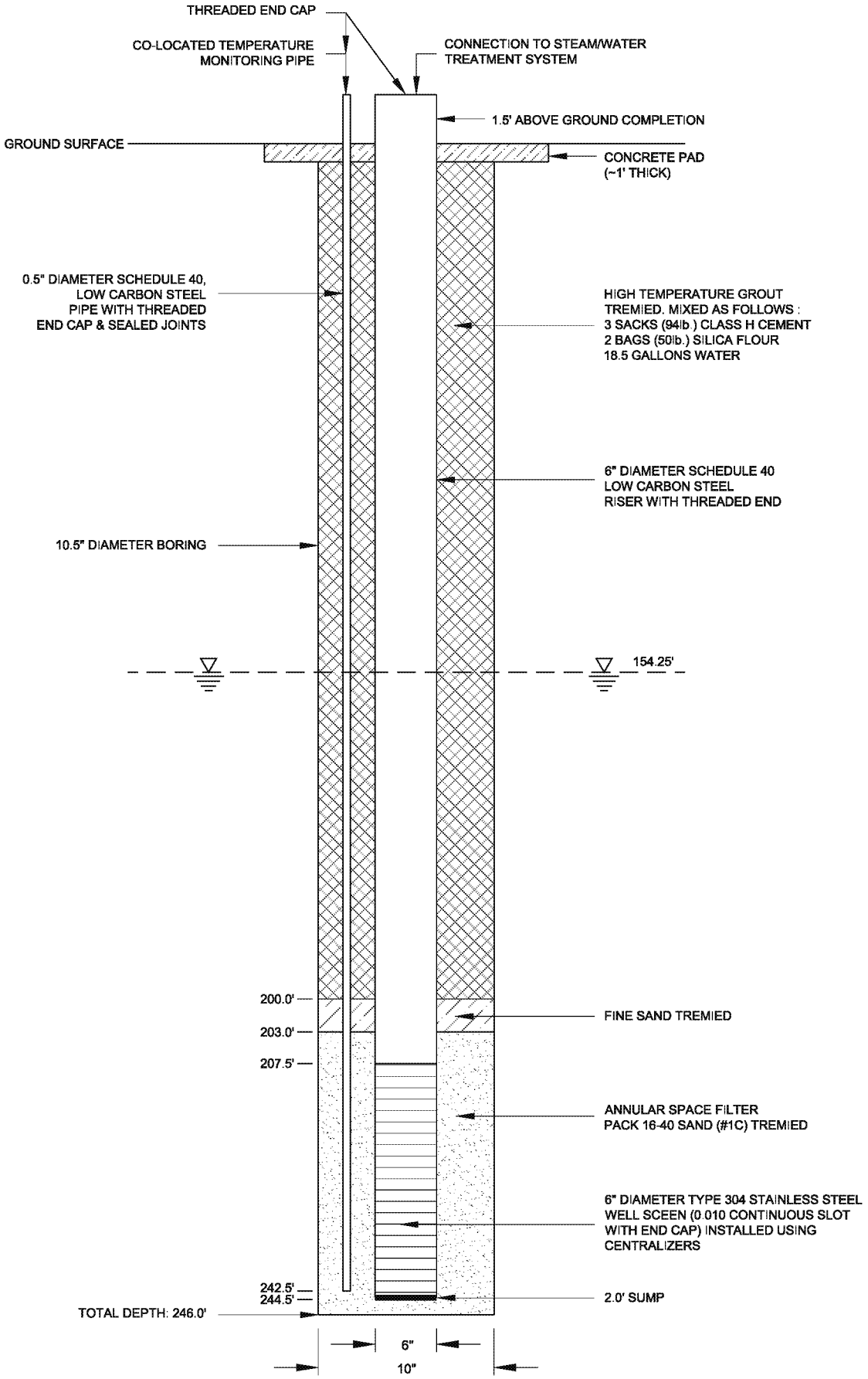

JOB NO.	9101110001
DESIGN:	SW
DRAWN:	GWH
DATE:	5/2013
SCALE:	NOT TO SCALE

FIGURE A.1-6
MONITOR WELL CONSTRUCTION ST012 - LSZ13

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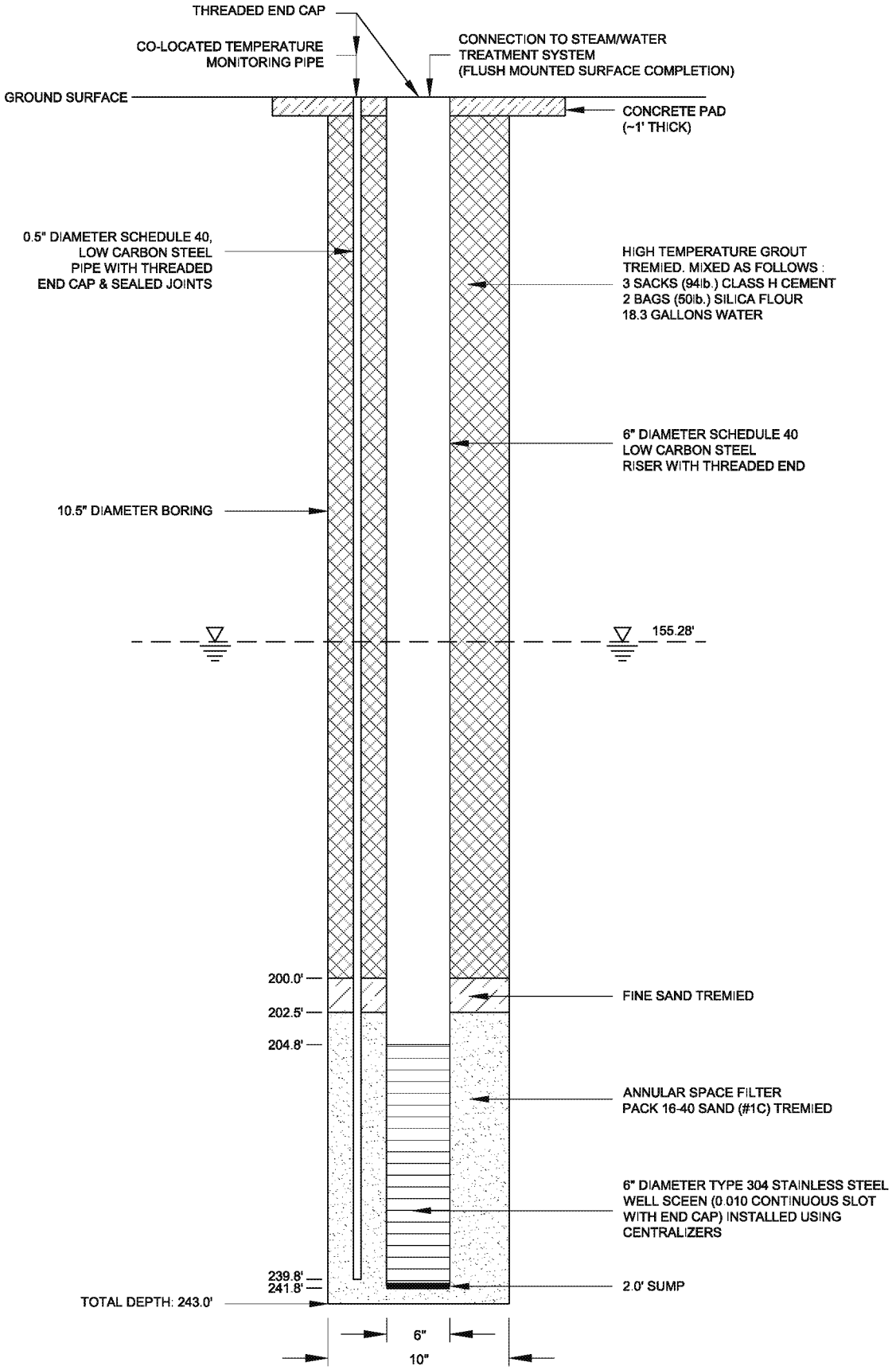

JOB NO.	9101110001
DESIGN:	SW
DRAWN:	GWH
DATE:	5/2013
SCALE:	NOT TO SCALE

FIGURE A.1-7
MONITOR WELL CONSTRUCTION ST012 - LSZ14

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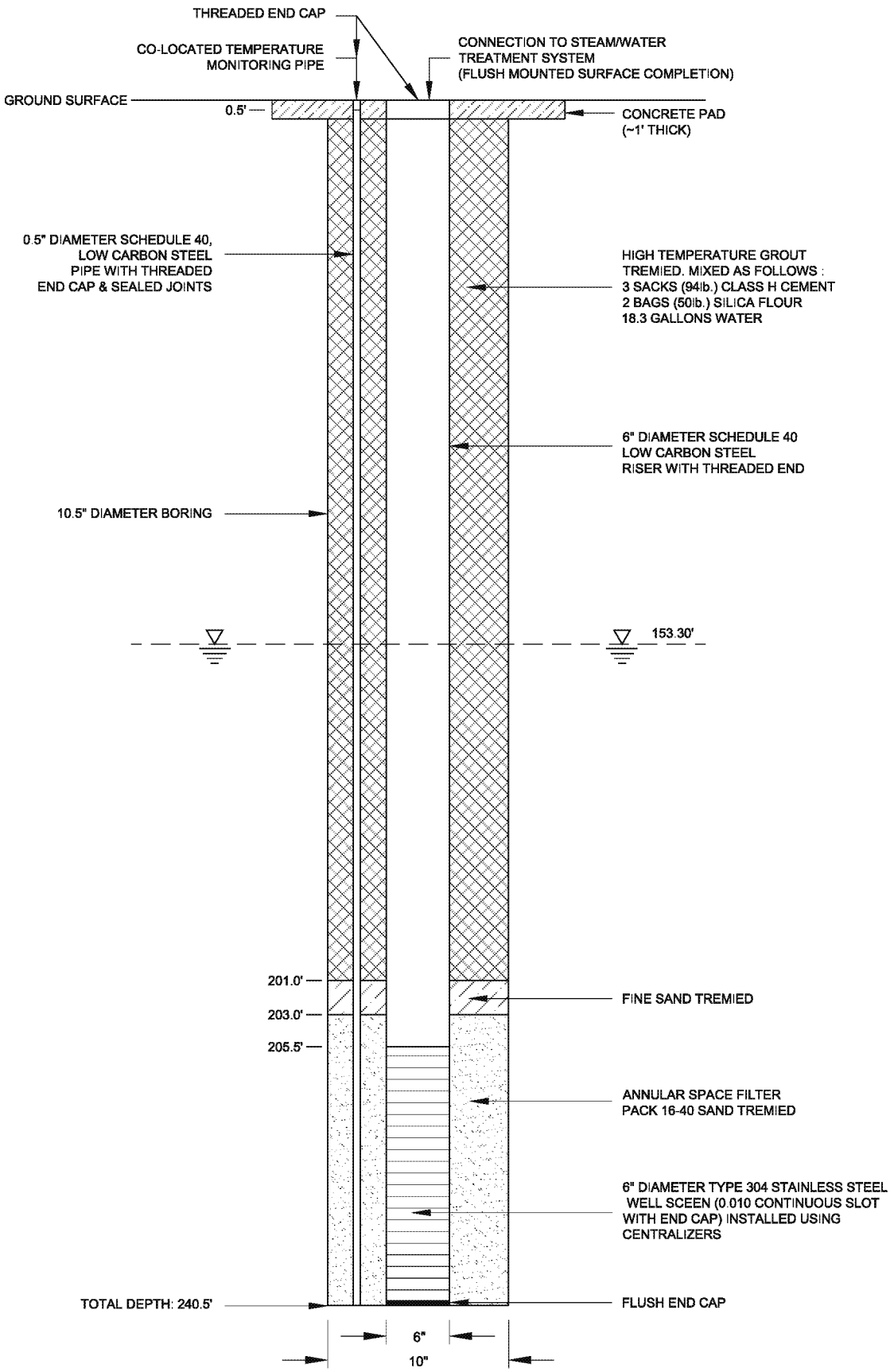
Phoenix, Arizona

P:\Phoenix\2012\9101110001-Williams Gateway\05-CADD\Well Diagram Figure.dwg



JOB NO.	9101110001
DESIGN:	SW
DRAWN:	GWH
DATE:	5/2013
SCALE:	NOT TO SCALE

FIGURE A.1-8
MONITOR WELL CONSTRUCTION ST012 - LSZ15

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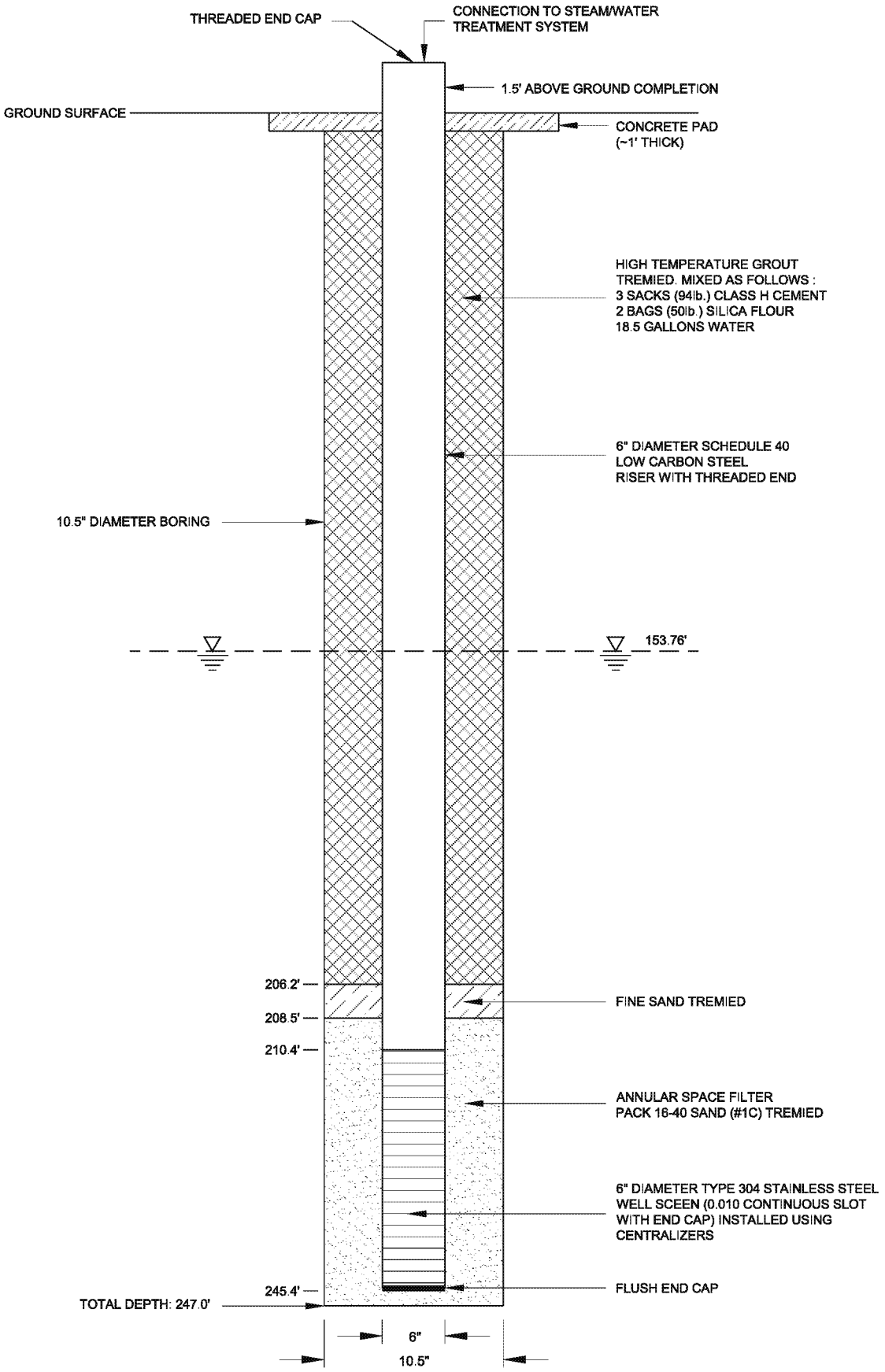

JOB NO.	9101110001
DESIGN:	SW
DRAWN:	GWH
DATE:	5/2013
SCALE:	NOT TO SCALE

FIGURE A.1-9
MONITOR WELL CONSTRUCTION ST012 - LSZ16

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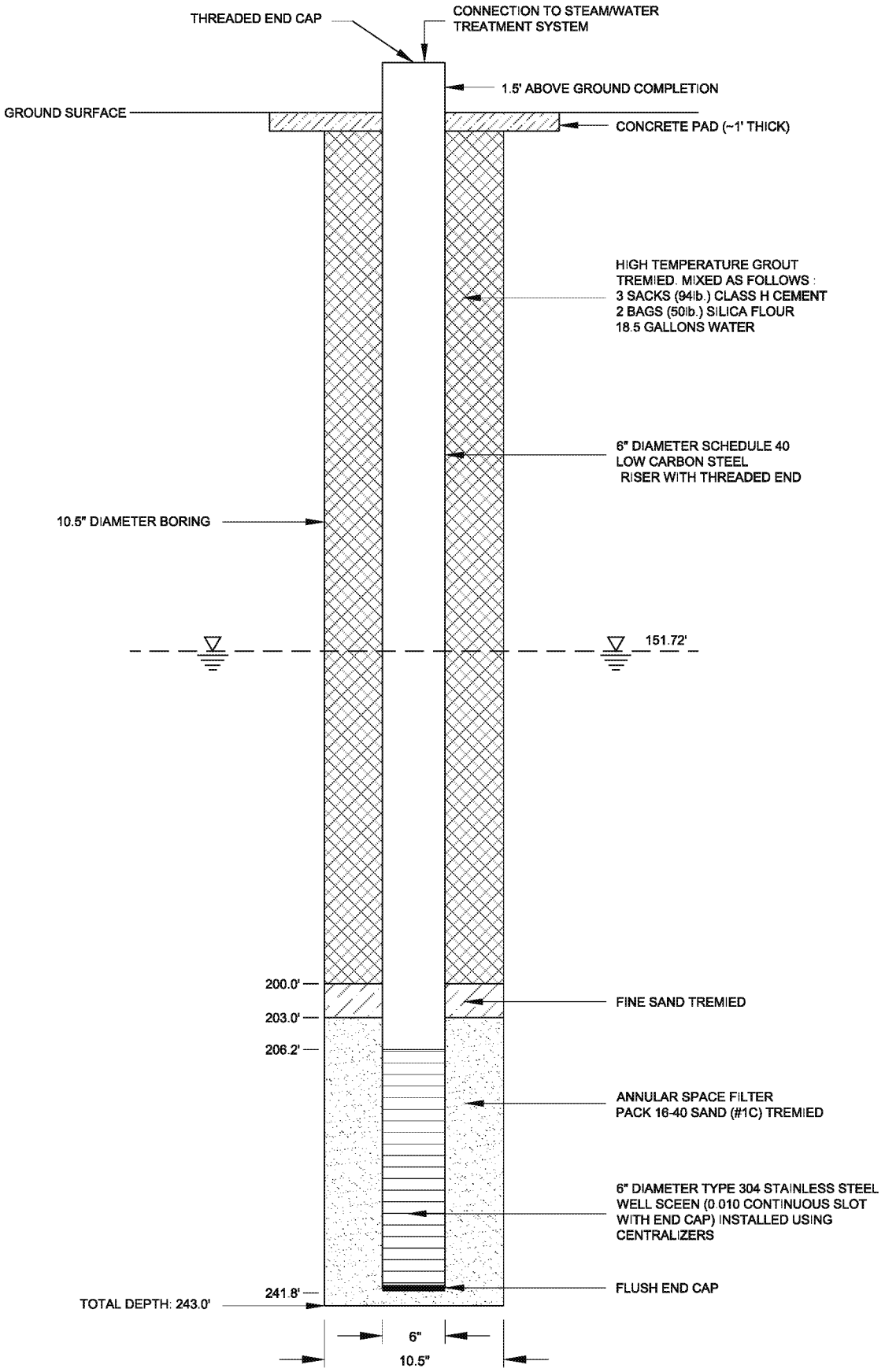
P:\Phoenix\2012\9101110001-Williams Gateway\05-CADD\Well Diagram Figure.dwg



JOB NO.	9101110001
DESIGN:	SW
DRAWN:	GWH
DATE:	5/2013
SCALE:	NOT TO SCALE

FIGURE A.1-10
MONITOR WELL CONSTRUCTION ST012 - LSZ17

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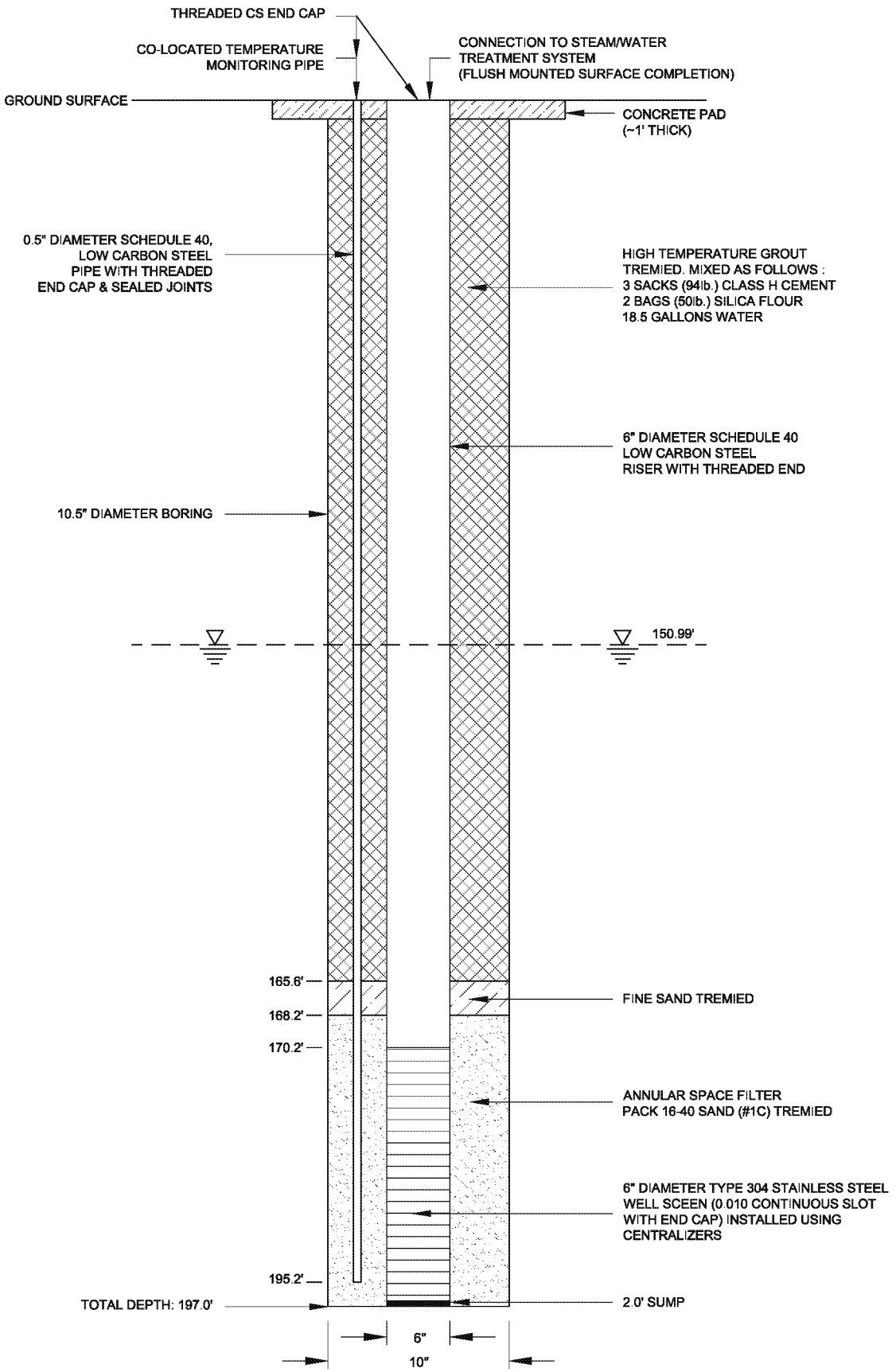

JOB NO.	9101110001
DESIGN:	SW
DRAWN:	GWH
DATE:	5/2013
SCALE:	NOT TO SCALE

FIGURE A.1-11
MONITOR WELL CONSTRUCTION UWBZ09

FORMER WILLIAMS AFB SITE ST012

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4600 East Washington Street, Suite 600
Phoenix, Arizona

P:\Phoenix\2012\9101110001-Williams Gateway\05-CADD\Well Diagram Figure.dwg

ATTACHMENT A.2

WELL REGISTRATION AND PERMIT DOCUMENTS

ARIZONA DEPARTMENT OF WATER RESOURCES
3550 N. Central Avenue Suite 200
Phoenix, Arizona 85012

DRILLING CARD
SPECIAL REQUIRMENTS APPLY (WQARF/SUPERFUND)

THIS AUTHORIZATION SHALL BE IN POSSESSION OF THE DRILLER DURING ALL DRILLING OPERATIONS

WELL REGISTRATION NO: **55-915199**

AUTHORIZED DRILLER: **BOART LONGYEAR COMPANY** LICENSE NO: **83**

NOTICE OF INTENT TO **DRILL A MONITOR WELL** HAS BEEN FILED WITH THE DEPARTMENT BY:

WELL OWNER: **AFCEC/CZRB-Griffiss**

ADDRESS: **706 Brooks Road, Rome, NY, 13441**

THE WELL(S) IS/ARE TO BE LOCATED IN THE:

NW 1/4 of the **SE** 1/4 of the **NE** 1/4 Section **31** Township **01 S** Range **07 E**

NO. OF WELLS IN THIS PROJECT: **1**

THIS AUTHORIZATION EXPIRES AT MIDNIGHT ON THE DAY OF **2/5/2014**

THE DRILLER MUST FILE A WELL DRILLER REPORT AND WELL LOG WITHIN 30 DAYS OF COMPLETION OF DRILLING

This drilling or abandonment authority was granted based upon the certifications made by the above-named Driller in the notice of intent to drill or abandon. Those certifications, along with any variances granted, are listed below. By drilling or abandoning the well pursuant to this authorization, the above-named driller acknowledges the accuracy of the driller certifications. If the certifications are in error, this authorization is invalid and driller must contact the Department of Water Resource's NOI Section in writing at the address above to correct.

Variance(s) Granted To Driller: **None**

Certification(s) Made By Driller:

- ☑ By checking this box, I certify that I have all necessary Registrar of Contractor (ROC) licenses in all necessary license categories for this drilling or abandonment project and that those licenses are current.
- ☑ If the landowner and the well owner are not the same, by checking this box, I certify that I have obtained written approval from the landowner in order to conduct this drilling or abandonment project. A copy of the written approval shall be submitted to ADWR with the Well Driller Report and Well Log or Well Abandonment Completion Report within 30 days of completion of drilling or abandonment.
- ☑ I understand that this well site is located within the boundaries of a contamination area and that special construction or abandonment requirements shall be complied with, and by checking this box, I certify that I have read the applicable special requirements, and that I shall comply with those standards.
- ☑ By checking this box, I certify that this NOI application is not an application to replace, deepen, or modify an existing well.
- ☑ By checking this box, I certify that I have been authorized by the above-named well owner to submit this Notice of Intent on the well owner's behalf.

☑ By checking this box, I certify that the information above is complete and correct, and that the well shall be drilled or abandoned in compliance with all pertinent statutes and rules, including any special standards that may be required to protect the aquifer or other water sources.

ARIZONA DEPARTMENT OF WATER RESOURCES

Electronic Filing - NOI Report

3550 N. Central Avenue Suite 200
Phoenix, Arizona 85012

NOI Type: Notice of Intent to Drill, Deepen, Modify a Monitor/Piezometer/Environmental Well
Well Type: MONITOR
Date Received at ADWR Website: 2/6/2013 4:11:59 PM

Fee Paid: $150.00 Order Number: VLFE8BB1E7AA

Well Registration Number: 55 - 915199
Number of Wells/Holes: 1 Drilling Authority Expires On: 2/5/2014

Driller's ADWR License Number: 83

Authorized Driller: BOART LONGYEAR COMPANY
ROC License Number Entered By Driller: 73446
Qualifying Party License Categories: A-4

Well Owner Name: AFCEC/CZRB-Griffiss
Well Owner Address: 706 Brooks Road
Well Owner City, State - Zip: Rome, NY - 13441
Well Owner Phone: 315 356-0810 204

Book: Map: Parcel:

Is the Land Owner the same as the Well Owner?: No

Land Owner Name: Phoenix-Mesa Gateway Airport Authority
Land Owner Address: 5835 South Sossaman Road
Land Owner City, State - Zip: Mesa, AZ - 85212
Land Owner Phone: 480 988-7600

Well Location: **NW** 1/4 of the **SE** 1/4 of the **NE** 1/4 Section **31** Township **1 S** Range **7 E**

AMA: PHOENIX AMA
County: MARICOPA
Contamination Site: WAFB WITH LUST

Primary Water Use: MONITORING
Secondary Water Use(s): N/A

Is any portion of the land, on which the well is to be located, within 100 feet of a designated municipal provider's operating water distribution system as shown on the municipal provider's most recent digitized service area map filed by the municipal provider with the director of ADWR. N/A

Proximity to a designated municipal provider's operating water distribution system exemption type:
N/A

Will you be installing a dedicated pump ?: No

Will the installed pump have a pumping capacity of greater than 35 GPM, or will the well will be used to withdraw greater than 10 Acre Feet per year?: N/A

Is this NOI an application to replace, deepen, or modify an existing well? No

Variance(s) Granted To Driller: **None**

Certification(s) Made By Driller:

- ☑ By checking this box, I certify that I have all necessary Registrar of Contractor (ROC) licenses in all necessary license categories for this drilling or abandonment project and that those licenses are current.
- ☑ If the landowner and the well owner are not the same, by checking this box, I certify that I have obtained written approval from the landowner in order to conduct this drilling or abandonment project. A copy of the written approval shall be submitted to ADWR with the Well Driller Report and Well Log or Well Abandonment Completion Report within 30 days of completion of drilling or abandonment.
- ☑ I understand that this well site is located within the boundaries of a contamination area and that special construction or abandonment requirements shall be complied with, and by checking this box, I certify that I have read the applicable special requirements, and that I shall comply with those standards.
- ☑ By checking this box, I certify that this NOI application is not an application to replace, deepen, or modify an existing well.
- ☑ By checking this box, I certify that I have been authorized by the above-named well owner to submit this Notice of Intent on the well owner's behalf.
- ☑ By checking this box, I certify that the information above is complete and correct, and that the well shall be drilled or abandoned in compliance with all pertinent statutes and rules, including any special standards that may be required to protect the aquifer or other water sources.

ARIZONA DEPARTMENT OF WATER RESOURCES
3550 N. Central Avenue Suite 200, Phoenix, Arizona 85012
Telephone (602) 771-8500
Fax (602) 771-8691

Wednesday, February 06, 2013

Janice K. Brewer
Governor

Sandra A. Fabritz-Whitney
Director

AFCEC/CZRB-Griffiss
706 Brooks Road
Rome, NY 13441

Registration No. 55- 915199
File No. D(1-7)31 ADB

Dear Applicant:

Enclosed is a copy of the Notice of Intent to Drill a Monitor/Piezometer/Environmental Well ("NOI") which you recently filed with this Department pursuant to A.R.S. § 45-596. This is to inform you that the Department has approved the NOI and has mailed (or otherwise provided) a drilling card authorizing the drilling of the well to the well driller identified in the NOI. The driller may not begin drilling until he has received the drilling card which he must keep in his posssession at the well site during drilling. Well drilling activities must be completed within one year after the date the NOI was filed with the Department. If drilling is not completed within one year, you must file a new NOI before proceeding with further drilling.

If it is necessary to change the location of the proposed well, you may not proceed with drilling until you file a new NOI with the Department and the Department issues an amended drilling card to the driller. If you change drillers, you must notify the Department of the new driller's identity. A new driller may not begin drilling until he receives a new drilling card from the Department. If in the course of drilling the well, it is determined that the well cannot be successfully completed as initially intended (dry hole, cave in, lost tools, etc.), the well must be properly abandoned and a Well Abandonment Completion Report filed as required by A.A.C. R12-15-816(F).

A.R.S. § 45-600 requires the driller to file a complete and accurate Well Drillers Report and Well Log (DWR Form 55-55) with the Department within 30 days after completion of drilling. That form was mailed to your driller with the drilling card.

Please be advised that A.R.S. § 45-593(C) requires the person to whom a well is registered to notify the Department of a change in ownership of the well and/or information pertaining to the physical characteristics of the well in order to keep this well registration file current and accurate. Any change in well information or a request to change well driller must be filed on a Request to Change Well Information form (DWR form 55-71A) that may be downloaded from the ADWR Internet website at
http://www.azwater.gov/dwr/Content/Find_by_Category/Permits_Forms_Applications/default.htm.

Susan Y. Montoya

From: ADWR <wrnoi@azwater.gov>
Sent: Wednesday, February 06, 2013 4:14 PM
To: shawn.cain@boartlongyear.com
Subject: ADWR Well NOI Confirmation re: Well Registration Number 915199

****
* Confirmation for Order: VLFE8BB1E7AA
****

Thank you for your order, Shawn Cain.

Should you have any questions concerning your order, please contact us by email at wrnoi@azwater.gov or by phone at (602) 771-8500 and be sure to mention your order number:
VLFE8BB1E7AA.

Thanks again for shopping with Arizona Department of Water Resources!

Best regards,
Arizona Department of Water Resources Management.
Phone: (602) 771-8500
Email: wrnoi@azwater.gov

Order ID: VLFE8BB1E7AA
Date: 2/6/2013
Status: Approved

Arizona Department of Water Resources
3550 N. Central Avenue Suite 200
Phoenix, AZ 85012 United States
Phone: (602) 771-8500 Fax: (602) 771-8691

Bill To: BOART LONGYEAR COMPANY-Shawn Cain
7103 W. AUGUSTA AVE
GLENDALE, AZ. 85303
Email: shawn.cain@boartlongyear.com

000600 - All Except Domestic Outside AMA/INA qty 1 - price ea. - amount $150.00

Subtotal:	$150.00
Tax Total	$0.00
Shipping	$0.00
Handling	$0.00
Total:	$150.00

Transaction Details

Help

View Transaction Status

Information for Transaction ID: VLFE8BB1E7AA

Information for Paypal Transaction ID:

Transaction Result Details

Transaction ID:	VLFE8BB1E7AA	**Result Code:**	0
PayPal Transaction ID:			
Timestamp:	Feb 06, 2013 15:16:06 PM	**Response Message:**	Approved
Transaction Type:	Sale	**Authorization Code:**	082559
Tender Type:	Visa	**AVS Street Match:**	Y
Credit Card Number:	0439	**AVS Zip Match :**	Y
Credit Card Expiration:	03 / 2013	**International AVS Indicator:**	N
Amount:	150.00 USD	**Card Security Code Match:**	Y
Tax Amount:	0.00 USD	**ABA #:**	
Shipping/Freight Amount:	0.00 USD	**Cust Ref #:**	
Duty Amount:	0.00 USD	**Recurring:**	No
Original Amount:	0.00 USD	**Payment Advice Code:**	What's this ?
Original Transaction ID:	N/A		
Batch ID:	867		
Purchase Order Number:	VLFE8BB1E7AA		
Supplier Reference #:			
Comment 1:	915199		

Billing Information

Billing Address: Shawn Cain
7103 W. AUGUSTA AVE
GLENDALE, AZ 85303
US

Email: shawn.cain@boartlongyear.com

Shipping Information

Shipping Address:

Additional Information

Client IP Address:	173.0.81.65	**Merchant:**	adwr02
Client Type:	J	**User:**	adwr02
Client Version:	4.3.2		
Transaction State:	8		
Duration:	0.00		

Transaction History

Transaction ID	Timestamp	Transaction Type	Amount	Result	Details
VLFE8BB1E7AA	Feb 06, 2013 15:16:06 PM	Sale	150.00 USD	0	--

ARIZONA DEPARTMENT OF WATER RESOURCES
3550 N. Central Avenue Suite 200
Phoenix, Arizona 85012

DRILLING CARD
SPECIAL REQUIRMENTS APPLY (WQARF/SUPERFUND)

THIS AUTHORIZATION SHALL BE IN POSSESSION OF THE DRILLER DURING ALL DRILLING OPERATIONS

WELL REGISTRATION NO: **55-915200**

AUTHORIZED DRILLER: **BOART LONGYEAR COMPANY** LICENSE NO: **83**

NOTICE OF INTENT TO **DRILL A MONITOR WELL** HAS BEEN FILED WITH THE DEPARTMENT BY:

WELL OWNER: **AFCEC/CZRB-Griffiss**

ADDRESS: **706 Brooks Road, Rome, NY, 13441**

THE WELL(S) IS/ARE TO BE LOCATED IN THE:

NW 1/4 of the **SE** 1/4 of the **NE** 1/4 Section **31** Township **01 S** Range **07 E**

NO. OF WELLS IN THIS PROJECT: **1**

THIS AUTHORIZATION EXPIRES AT MIDNIGHT ON THE DAY OF **2/5/2014**

THE DRILLER MUST FILE A WELL DRILLER REPORT AND WELL LOG WITHIN 30 DAYS OF COMPLETION OF DRILLING

This drilling or abandonment authority was granted based upon the certifications made by the above-named Driller in the notice of intent to drill or abandon. Those certifications, along with any variances granted, are listed below. By drilling or abandoning the well pursuant to this authorization, the above-named driller acknowledges the accuracy of the driller certifications. If the certifications are in error, this authorization is invalid and driller must contact the Department of Water Resource's NOI Section in writing at the address above to correct.

Variance(s) Granted To Driller: **None**

Certification(s) Made By Driller:

- ☑ By checking this box, I certify that I have all necessary Registrar of Contractor (ROC) licenses in all necessary license categories for this drilling or abandonment project and that those licenses are current.
- ☑ If the landowner and the well owner are not the same, by checking this box, I certify that I have obtained written approval from the landowner in order to conduct this drilling or abandonment project. A copy of the written approval shall be submitted to ADWR with the Well Driller Report and Well Log or Well Abandonment Completion Report within 30 days of completion of drilling or abandonment.
- ☑ I understand that this well site is located within the boundaries of a contamination area and that special construction or abandonment requirements shall be complied with, and by checking this box, I certify that I have read the applicable special requirements, and that I shall comply with those standards.
- ☑ By checking this box, I certify that this NOI application is not an application to replace, deepen, or modify an existing well.
- ☑ By checking this box, I certify that I have been authorized by the above-named well owner to submit this Notice of Intent on the well owner's behalf.

☑ By checking this box, I certify that the information above is complete and correct, and that the well shall be drilled or abandoned in compliance with all pertinent statutes and rules, including any special standards that may be required to protect the aquifer or other water sources.

ARIZONA DEPARTMENT OF WATER RESOURCES

Electronic Filing - NOI Report
3550 N. Central Avenue Suite 200
Phoenix, Arizona 85012

NOI Type: Notice of Intent to Drill, Deepen, Modify a Monitor/Piezometer/Environmental Well
Well Type: MONITOR
Date Received at ADWR Website: 2/6/2013 4:18:37 PM

Fee Paid: $150.00 Order Number: VXHEA5BC9871

Well Registration Number: 55 - 915200
Number of Wells/Holes: 1 Drilling Authority Expires On: 2/5/2014

Driller's ADWR License Number: 83

Authorized Driller: BOART LONGYEAR COMPANY
ROC License Number Entered By Driller: 73446
Qualifying Party License Categories: A-4

Well Owner Name: AFCEC/CZRB-Griffiss
Well Owner Address: 706 Brooks Road
Well Owner City, State - Zip: Rome, NY - 13441
Well Owner Phone: 315 356-0810 204

Book: Map: Parcel:

Is the Land Owner the same as the Well Owner?: No

Land Owner Name: Phoenix-Mesa Gateway Airport Authority
Land Owner Address: 5835 South Sossaman Road
Land Owner City, State - Zip: Mesa, AZ - 85212
Land Owner Phone: 480 988-7600

Well Location: **NW** 1/4 of the **SE** 1/4 of the **NE** 1/4 Section **31** Township **1 S** Range **7 E**

AMA: PHOENIX AMA
County: MARICOPA
Contamination Site: WAFB WITH LUST

Primary Water Use: MONITORING
Secondary Water Use(s): N/A

Is any portion of the land, on which the well is to be located, within 100 feet of a designated municipal provider's operating water distribution system as shown on the municipal provider's most recent digitized service area map filed by the municipal provider with the director of ADWR. N/A

Proximity to a designated municipal provider's operating water distribution system exemption type:
N/A

Will you be installing a dedicated pump ?: No

Will the installed pump have a pumping capacity of greater than 35 GPM, or will the well will be used to withdraw greater than 10 Acre Feet per year?: N/A

Is this NOI an application to replace, deepen, or modify an existing well? No

Variance(s) Granted To Driller: **None**

Certification(s) Made By Driller:

- ☑ By checking this box, I certify that I have all necessary Registrar of Contractor (ROC) licenses in all necessary license categories for this drilling or abandonment project and that those licenses are current.
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ARIZONA DEPARTMENT OF WATER RESOURCES
3550 N. Central Avenue Suite 200, Phoenix, Arizona 85012
Telephone (602) 771-8500
Fax (602) 771-8691

Wednesday, February 06, 2013

Janice K. Brewer
Governor

Sandra A. Fabritz-Whitney
Director

AFCEC/CZRB-Griffiss
706 Brooks Road
Rome, NY 13441

Registration No. 55- 915200
File No. D(1-7)31 ADB

Dear Applicant:

Enclosed is a copy of the Notice of Intent to Drill a Monitor/Piezometer/Environmental Well ("NOI") which you recently filed with this Department pursuant to A.R.S. § 45-596. This is to inform you that the Department has approved the NOI and has mailed (or otherwise provided) a drilling card authorizing the drilling of the well to the well driller identified in the NOI. The driller may not begin drilling until he has received the drilling card which he must keep in his posssession at the well site during drilling. Well drilling activities must be completed within one year after the date the NOI was filed with the Department. If drilling is not completed within one year, you must file a new NOI before proceeding with further drilling.

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A.R.S. § 45-600 requires the driller to file a complete and accurate Well Drillers Report and Well Log (DWR Form 55-55) with the Department within 30 days after completion of drilling. That form was mailed to your driller with the drilling card.

Please be advised that A.R.S. § 45-593(C) requires the person to whom a well is registered to notify the Department of a change in ownership of the well and/or information pertaining to the physical characteristics of the well in order to keep this well registration file current and accurate. Any change in well information or a request to change well driller must be filed on a Request to Change Well Information form (DWR form 55-71A) that may be downloaded from the ADWR Internet website at
http://www.azwater.gov/dwr/Content/Find_by_Category/Permits_Forms_Applications/default.htm.

Susan Y. Montoya

From: ADWR <wrnoi@azwater.gov>
Sent: Wednesday, February 06, 2013 4:20 PM
To: shawn.cain@boartlongyear.com
Subject: ADWR Well NOI Confirmation re: Well Registration Number 915200

****
* Confirmation for Order: VXHEA5BC9871
****

Thank you for your order, Shawn Cain.

Should you have any questions concerning your order, please contact us by email at wrnoi@azwater.gov or by phone at (602) 771-8500 and be sure to mention your order number:
VXHEA5BC9871.

Thanks again for shopping with Arizona Department of Water Resources!

Best regards,
Arizona Department of Water Resources Management.
Phone: (602) 771-8500
Email: wrnoi@azwater.gov

Order ID: VXHEA5BC9871
Date: 2/6/2013
Status: Approved

Arizona Department of Water Resources
3550 N. Central Avenue Suite 200
Phoenix, AZ 85012 United States
Phone: (602) 771-8500 Fax: (602) 771-8691

Bill To: BOART LONGYEAR COMPANY-Shawn Cain
7103 W. AUGUSTA AVE
GLENDALE, AZ. 85303
Email: shawn.cain@boartlongyear.com

000600 - All Except Domestic Outside AMA/INA qty 1 - price ea. - amount $150.00

Subtotal:	$150.00
Tax Total	$0.00
Shipping	$0.00
Handling	$0.00

Total:	$150.00

Transaction Details

Help

View Transaction Status

Information for Transaction ID: VXHEA5BC9871

Information for Paypal Transaction ID:

Transaction Result Details

Transaction ID:	VXHEA5BC9871	**Result Code:**	0
PayPal Transaction ID:			
Timestamp:	Feb 06, 2013 15:22:27 PM	**Response Message:**	Approved
Transaction Type:	Sale	**Authorization Code:**	069090
Tender Type:	Visa	**AVS Street Match:**	Y
Credit Card Number:	0439	**AVS Zip Match :**	Y
Credit Card Expiration:	03 / 2013	**International AVS Indicator:**	N
Amount:	150.00 USD	**Card Security Code Match:**	Y
Tax Amount:	0.00 USD	**ABA #:**	
Shipping/Freight Amount:	0.00 USD	**Cust Ref #:**	
Duty Amount:	0.00 USD	**Recurring:**	No
Original Amount:	0.00 USD	**Payment Advice Code:**	What's this ?
Original Transaction ID:	N/A		
Batch ID:	867		
Purchase Order Number:	VXHEA5BC9871		
Supplier Reference #:			
Comment 1:	915200		

Billing Information

Billing Address: Shawn Cain
7103 W. AUGUSTA AVE
GLENDALE, AZ 85303
US

Email: shawn.cain@boartlongyear.com

Shipping Information

Shipping Address:

Additional Information

Client IP Address:	173.0.81.65	**Merchant:**	adwr02
Client Type:	J	**User:**	adwr02
Client Version:	4.3.2		
Transaction State:	8		
Duration:	0.00		

Transaction History

Transaction ID	Timestamp	Transaction Type	Amount	Result	Details
VXHEA5BC9871	Feb 06, 2013 15:22:27 PM	Sale	150.00 USD	0	--

ARIZONA DEPARTMENT OF WATER RESOURCES
3550 N. Central Avenue Suite 200
Phoenix, Arizona 85012

DRILLING CARD
SPECIAL REQUIRMENTS APPLY (WQARF/SUPERFUND)

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WELL REGISTRATION NO: **55-915201**

AUTHORIZED DRILLER: **BOART LONGYEAR COMPANY** LICENSE NO: **83**

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ADDRESS: **706 Brooks Road, Rome, NY, 13441**

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NW 1/4 of the **SE** 1/4 of the **NE** 1/4 Section **31** Township **01 S** Range **07 E**

NO. OF WELLS IN THIS PROJECT: **1**

THIS AUTHORIZATION EXPIRES AT MIDNIGHT ON THE DAY OF **2/5/2014**

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Variance(s) Granted To Driller: **None**

Certification(s) Made By Driller:

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ARIZONA DEPARTMENT OF WATER RESOURCES

Electronic Filing - NOI Report

3550 N. Central Avenue Suite 200
Phoenix, Arizona 85012

NOI Type: Notice of Intent to Drill, Deepen, Modify a Monitor/Piezometer/Environmental Well
Well Type: MONITOR
Date Received at ADWR Website: 2/6/2013 4:23:35 PM

Fee Paid: $150.00 Order Number: VQFE8A2B324B

Well Registration Number: 55 - 915201
Number of Wells/Holes: 1 Drilling Authority Expires On: 2/5/2014

Driller's ADWR License Number: 83

Authorized Driller: BOART LONGYEAR COMPANY
ROC License Number Entered By Driller: 73446
Qualifying Party License Categories: A-4

Well Owner Name: AFCEC/CZRB-Griffiss
Well Owner Address: 706 Brooks Road
Well Owner City, State - Zip: Rome, NY - 13441
Well Owner Phone: 315 356-0810 204

Book: Map: Parcel:

Is the Land Owner the same as the Well Owner?: No

Land Owner Name: Phoenix-Mesa Gateway Airport Authority
Land Owner Address: 5835 South Sossaman Road
Land Owner City, State - Zip: Mesa, AZ - 85212
Land Owner Phone: 480 988-7600

Well Location: **NW** 1/4 of the **SE** 1/4 of the **NE** 1/4 Section **31** Township **1 S** Range **7 E**

AMA: PHOENIX AMA
County: MARICOPA
Contamination Site: WAFB WITH LUST

Primary Water Use: MONITORING
Secondary Water Use(s): N/A

Is any portion of the land, on which the well is to be located, within 100 feet of a designated municipal provider's operating water distribution system as shown on the municipal provider's most recent digitized service area map filed by the municipal provider with the director of ADWR. N/A

Proximity to a designated municipal provider's operating water distribution system exemption type:
N/A

Will you be installing a dedicated pump ?: No

Will the installed pump have a pumping capacity of greater than 35 GPM, or will the well will be used to withdraw greater than 10 Acre Feet per year?: N/A

Is this NOI an application to replace, deepen, or modify an existing well? No

Variance(s) Granted To Driller: **None**

Certification(s) Made By Driller:

- ☑ By checking this box, I certify that I have all necessary Registrar of Contractor (ROC) licenses in all necessary license categories for this drilling or abandonment project and that those licenses are current.
- ☑ If the landowner and the well owner are not the same, by checking this box, I certify that I have obtained written approval from the landowner in order to conduct this drilling or abandonment project. A copy of the written approval shall be submitted to ADWR with the Well Driller Report and Well Log or Well Abandonment Completion Report within 30 days of completion of drilling or abandonment.
- ☑ I understand that this well site is located within the boundaries of a contamination area and that special construction or abandonment requirements shall be complied with, and by checking this box, I certify that I have read the applicable special requirements, and that I shall comply with those standards.
- ☑ By checking this box, I certify that this NOI application is not an application to replace, deepen, or modify an existing well.
- ☑ By checking this box, I certify that I have been authorized by the above-named well owner to submit this Notice of Intent on the well owner's behalf.
- ☑ By checking this box, I certify that the information above is complete and correct, and that the well shall be drilled or abandoned in compliance with all pertinent statutes and rules, including any special standards that may be required to protect the aquifer or other water sources.

ARIZONA DEPARTMENT OF WATER RESOURCES
3550 N. Central Avenue Suite 200, Phoenix, Arizona 85012
Telephone (602) 771-8500
Fax (602) 771-8691

Wednesday, February 06, 2013

Janice K. Brewer
Governor

Sandra A. Fabritz-Whitney
Director

AFCEC/CZRB-Griffiss
706 Brooks Road
Rome, NY 13441

Registration No. 55- 915201
File No. D(1-7)31 ADB

Dear Applicant:

Enclosed is a copy of the Notice of Intent to Drill a Monitor/Piezometer/Environmental Well ("NOI") which you recently filed with this Department pursuant to A.R.S. § 45-596. This is to inform you that the Department has approved the NOI and has mailed (or otherwise provided) a drilling card authorizing the drilling of the well to the well driller identified in the NOI. The driller may not begin drilling until he has received the drilling card which he must keep in his posssession at the well site during drilling. Well drilling activities must be completed within one year after the date the NOI was filed with the Department. If drilling is not completed within one year, you must file a new NOI before proceeding with further drilling.

If it is necessary to change the location of the proposed well, you may not proceed with drilling until you file a new NOI with the Department and the Department issues an amended drilling card to the driller. If you change drillers, you must notify the Department of the new driller's identity. A new driller may not begin drilling until he receives a new drilling card from the Department. If in the course of drilling the well, it is determined that the well cannot be successfully completed as initially intended (dry hole, cave in, lost tools, etc.), the well must be properly abandoned and a Well Abandonment Completion Report filed as required by A.A.C. R12-15-816(F).

A.R.S. § 45-600 requires the driller to file a complete and accurate Well Drillers Report and Well Log (DWR Form 55-55) with the Department within 30 days after completion of drilling. That form was mailed to your driller with the drilling card.

Please be advised that A.R.S. § 45-593(C) requires the person to whom a well is registered to notify the Department of a change in ownership of the well and/or information pertaining to the physical characteristics of the well in order to keep this well registration file current and accurate. Any change in well information or a request to change well driller must be filed on a Request to Change Well Information form (DWR form 55-71A) that may be downloaded from the ADWR Internet website at
http://www.azwater.gov/dwr/Content/Find_by_Category/Permits_Forms_Applications/default.htm.

Susan Y. Montoya

From: ADWR <wrnoi@azwater.gov>
Sent: Wednesday, February 06, 2013 4:25 PM
To: shawn.cain@boartlongyear.com
Subject: ADWR Well NOI Confirmation re: Well Registration Number 915201

****
* Confirmation for Order: VQFE8A2B324B
****

Thank you for your order, Shawn Cain.

Should you have any questions concerning your order, please contact us by email at wrnoi@azwater.gov or by phone at (602) 771-8500 and be sure to mention your order number:
VQFE8A2B324B.

Thanks again for shopping with Arizona Department of Water Resources!

Best regards,
Arizona Department of Water Resources Management.
Phone: (602) 771-8500
Email: wrnoi@azwater.gov

Order ID: VQFE8A2B324B
Date: 2/6/2013
Status: Approved

Arizona Department of Water Resources
3550 N. Central Avenue Suite 200
Phoenix, AZ 85012 United States
Phone: (602) 771-8500 Fax: (602) 771-8691

Bill To: BOART LONGYEAR COMPANY-Shawn Cain
7103 W. AUGUSTA AVE
GLENDALE, AZ. 85303
Email: shawn.cain@boartlongyear.com

000600 - All Except Domestic Outside AMA/INA qty 1 - price ea. - amount $150.00

Subtotal:	$150.00
Tax Total	$0.00
Shipping	$0.00
Handling	$0.00

Total:	$150.00

Transaction Details

Help

View Transaction Status

Information for Transaction ID: VQFE8A2B324B

Information for Paypal Transaction ID:

Transaction Result Details

Transaction ID:	VQFE8A2B324B	**Result Code:**	0
PayPal Transaction ID:			
Timestamp:	Feb 06, 2013 15:27:15 PM	**Response Message:**	Approved
Transaction Type:	Sale	**Authorization Code:**	015352
Tender Type:	Visa	**AVS Street Match:**	Y
Credit Card Number:	0439	**AVS Zip Match :**	Y
Credit Card Expiration:	03 / 2013	**International AVS Indicator:**	N
Amount:	150.00 USD	**Card Security Code Match:**	Y
Tax Amount:	0.00 USD	**ABA #:**	
Shipping/Freight Amount:	0.00 USD	**Cust Ref #:**	
Duty Amount:	0.00 USD	**Recurring:**	No
Original Amount:	0.00 USD	**Payment Advice Code:**	What's this ?
Original Transaction ID:	N/A		
Batch ID:	867		
Purchase Order Number:	VQFE8A2B324B		
Supplier Reference #:			
Comment 1:	915201		

Billing Information

Billing Address: Shawn Cain
7103 W. AUGUSTA AVE
GLENDALE, AZ 85303
US

Email: shawn.cain@boartlongyear.com

Shipping Information

Shipping Address:

Additional Information

Client IP Address:	173.0.81.65	**Merchant:**	adwr02
Client Type:	J	**User:**	adwr02
Client Version:	4.3.2		
Transaction State:	8		
Duration:	0.00		

Transaction History

Transaction ID	Timestamp	Transaction Type	Amount	Result	Details
VQFE8A2B324B	Feb 06, 2013 15:27:15 PM	Sale	150.00 USD	0	--

ARIZONA DEPARTMENT OF WATER RESOURCES
3550 N. Central Avenue Suite 200
Phoenix, Arizona 85012

DRILLING CARD
SPECIAL REQUIRMENTS APPLY (WQARF/SUPERFUND)

THIS AUTHORIZATION SHALL BE IN POSSESSION OF THE DRILLER DURING ALL DRILLING OPERATIONS

WELL REGISTRATION NO: **55-915202**

AUTHORIZED DRILLER: **BOART LONGYEAR COMPANY** LICENSE NO: **83**

NOTICE OF INTENT TO **DRILL A MONITOR WELL** HAS BEEN FILED WITH THE DEPARTMENT BY:

WELL OWNER: **AFCEC/CZRB-Griffiss**

ADDRESS: **706 Brooks Road, Rome, NY, 13441**

THE WELL(S) IS/ARE TO BE LOCATED IN THE:

NW 1/4 of the **SE** 1/4 of the **NE** 1/4 Section **31** Township **01 S** Range **07 E**

NO. OF WELLS IN THIS PROJECT: 1

THIS AUTHORIZATION EXPIRES AT MIDNIGHT ON THE DAY OF **2/5/2014**

THE DRILLER MUST FILE A WELL DRILLER REPORT AND WELL LOG WITHIN 30 DAYS OF COMPLETION OF DRILLING

This drilling or abandonment authority was granted based upon the certifications made by the above-named Driller in the notice of intent to drill or abandon. Those certifications, along with any variances granted, are listed below. By drilling or abandoning the well pursuant to this authorization, the above-named driller acknowledges the accuracy of the driller certifications. If the certifications are in error, this authorization is invalid and driller must contact the Department of Water Resource's NOI Section in writing at the address above to correct.

Variance(s) Granted To Driller: **None**

Certification(s) Made By Driller:

- ☑ By checking this box, I certify that I have all necessary Registrar of Contractor (ROC) licenses in all necessary license categories for this drilling or abandonment project and that those licenses are current.
- ☑ If the landowner and the well owner are not the same, by checking this box, I certify that I have obtained written approval from the landowner in order to conduct this drilling or abandonment project. A copy of the written approval shall be submitted to ADWR with the Well Driller Report and Well Log or Well Abandonment Completion Report within 30 days of completion of drilling or abandonment.
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- ☑ By checking this box, I certify that this NOI application is not an application to replace, deepen, or modify an existing well.
- ☑ By checking this box, I certify that I have been authorized by the above-named well owner to submit this Notice of Intent on the well owner's behalf.

☑ By checking this box, I certify that the information above is complete and correct, and that the well shall be drilled or abandoned in compliance with all pertinent statutes and rules, including any special standards that may be required to protect the aquifer or other water sources.

ARIZONA DEPARTMENT OF WATER RESOURCES

Electronic Filing - NOI Report

3550 N. Central Avenue Suite 200
Phoenix, Arizona 85012

NOI Type: Notice of Intent to Drill, Deepen, Modify a Monitor/Piezometer/Environmental Well
Well Type: MONITOR
Date Received at ADWR Website: 2/6/2013 4:28:39 PM

Fee Paid: $150.00 Order Number: VXJEA5BCACD8

Well Registration Number: 55 - 915202
Number of Wells/Holes: 1 Drilling Authority Expires On: 2/5/2014

Driller's ADWR License Number: 83

Authorized Driller: BOART LONGYEAR COMPANY
ROC License Number Entered By Driller: 73446
Qualifying Party License Categories: A-4

Well Owner Name: AFCEC/CZRB-Griffiss
Well Owner Address: 706 Brooks Road
Well Owner City, State - Zip: Rome, NY - 13441
Well Owner Phone: 315 356-0810 204

Book: Map: Parcel:

Is the Land Owner the same as the Well Owner?: No

Land Owner Name: Phoenix-Mesa Gateway Airport Authority
Land Owner Address: 5835 South Sossman Road
Land Owner City, State - Zip: Mesa, AZ - 85212
Land Owner Phone: 480 988-7600

Well Location: **NW** 1/4 of the **SE** 1/4 of the **NE** 1/4 Section **31** Township **1 S** Range **7 E**

AMA: PHOENIX AMA
County: MARICOPA
Contamination Site: WAFB WITH LUST

Primary Water Use: MONITORING
Secondary Water Use(s): N/A

Is any portion of the land, on which the well is to be located, within 100 feet of a designated municipal provider's operating water distribution system as shown on the municipal provider's most recent digitized service area map filed by the municipal provider with the director of ADWR. N/A

Proximity to a designated municipal provider's operating water distribution system exemption type:
N/A

Will you be installing a dedicated pump ?: No

Will the installed pump have a pumping capacity of greater than 35 GPM, or will the well will be used to withdraw greater than 10 Acre Feet per year?: N/A

Is this NOI an application to replace, deepen, or modify an existing well? No

Variance(s) Granted To Driller: **None**

Certification(s) Made By Driller:

- ☑ By checking this box, I certify that I have all necessary Registrar of Contractor (ROC) licenses in all necessary license categories for this drilling or abandonment project and that those licenses are current.
- ☑ If the landowner and the well owner are not the same, by checking this box, I certify that I have obtained written approval from the landowner in order to conduct this drilling or abandonment project. A copy of the written approval shall be submitted to ADWR with the Well Driller Report and Well Log or Well Abandonment Completion Report within 30 days of completion of drilling or abandonment.
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ARIZONA DEPARTMENT OF WATER RESOURCES
3550 N. Central Avenue Suite 200, Phoenix, Arizona 85012
Telephone (602) 771-8500
Fax (602) 771-8691

Wednesday, February 06, 2013

Janice K. Brewer
Governor

Sandra A. Fabritz-Whitney
Director

AFCEC/CZRB-Griffiss
706 Brooks Road
Rome, NY 13441

Registration No. 55- 915202
File No. D(1-7)31 ADB

Dear Applicant:

Enclosed is a copy of the Notice of Intent to Drill a Monitor/Piezometer/Environmental Well ("NOI") which you recently filed with this Department pursuant to A.R.S. § 45-596. This is to inform you that the Department has approved the NOI and has mailed (or otherwise provided) a drilling card authorizing the drilling of the well to the well driller identified in the NOI. The driller may not begin drilling until he has received the drilling card which he must keep in his posssession at the well site during drilling. Well drilling activities must be completed within one year after the date the NOI was filed with the Department. If drilling is not completed within one year, you must file a new NOI before proceeding with further drilling.

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A.R.S. § 45-600 requires the driller to file a complete and accurate Well Drillers Report and Well Log (DWR Form 55-55) with the Department within 30 days after completion of drilling. That form was mailed to your driller with the drilling card.

Please be advised that A.R.S. § 45-593(C) requires the person to whom a well is registered to notify the Department of a change in ownership of the well and/or information pertaining to the physical characteristics of the well in order to keep this well registration file current and accurate. Any change in well information or a request to change well driller must be filed on a Request to Change Well Information form (DWR form 55-71A) that may be downloaded from the ADWR Internet website at
http://www.azwater.gov/dwr/Content/Find_by_Category/Permits_Forms_Applications/default.htm.

Susan Y. Montoya

From: ADWR <wrnoi@azwater.gov>
Sent: Wednesday, February 06, 2013 4:29 PM
To: shawn.cain@boartlongyear.com
Subject: ADWR Well NOI Confirmation re: Well Registration Number 915202

****
* Confirmation for Order: VXJEA5BCACD8
****

Thank you for your order, Shawn Cain.

Should you have any questions concerning your order, please contact us by email at wrnoi@azwater.gov or by phone at (602) 771-8500 and be sure to mention your order number:
VXJEA5BCACD8.

Thanks again for shopping with Arizona Department of Water Resources!

Best regards,
Arizona Department of Water Resources Management.
Phone: (602) 771-8500
Email: wrnoi@azwater.gov

Order ID: VXJEA5BCACD8
Date: 2/6/2013
Status: Approved

Arizona Department of Water Resources
3550 N. Central Avenue Suite 200
Phoenix, AZ 85012 United States
Phone: (602) 771-8500 Fax: (602) 771-8691

Bill To: BOART LONGYEAR COMPANY-Shawn Cain
7103 W. AUGUSTA AVE
GLENDALE, AZ. 85303
Email: shawn.cain@boartlongyear.com

000600 - All Except Domestic Outside AMA/INA qty 1 - price ea. - amount $150.00

Subtotal:	$150.00
Tax Total	$0.00
Shipping	$0.00
Handling	$0.00

Total:	$150.00

Transaction Details

Help

View Transaction Status

Information for Transaction ID: VXJEA5BCACD8

Information for Paypal Transaction ID:

Transaction Result Details

Transaction ID:	VXJEA5BCACD8	**Result Code:**	0
PayPal Transaction ID:			
Timestamp:	Feb 06, 2013 15:32:09 PM	**Response Message:**	Approved
Transaction Type:	Sale	**Authorization Code:**	063720
Tender Type:	Visa	**AVS Street Match:**	Y
Credit Card Number:	0439	**AVS Zip Match :**	Y
Credit Card Expiration:	03 / 2013	**International AVS Indicator:**	N
Amount:	150.00 USD	**Card Security Code Match:**	Y
Tax Amount:	0.00 USD	**ABA #:**	
Shipping/Freight Amount:	0.00 USD	**Cust Ref #:**	
Duty Amount:	0.00 USD	**Recurring:**	No
Original Amount:	0.00 USD	**Payment Advice Code:**	What's this ?
Original Transaction ID:	N/A		
Batch ID:	867		
Purchase Order Number:	VXJEA5BCACD8		
Supplier Reference #:			
Comment 1:	915202		

Billing Information

Billing Address: Shawn Cain
7103 W. AUGUSTA AVE
GLENDALE, AZ 85303
US

Email: shawn.cain@boartlongyear.com

Shipping Information

Shipping Address:

Additional Information

Client IP Address:	173.0.81.65	**Merchant:**	adwr02
Client Type:	J	**User:**	adwr02
Client Version:	4.3.2		
Transaction State:	8		
Duration:	0.00		

Transaction History

Transaction ID	Timestamp	Transaction Type	Amount	Result	Details
VXJEA5BCACD8	Feb 06, 2013 15:32:09 PM	Sale	150.00 USD	0	--

ARIZONA DEPARTMENT OF WATER RESOURCES
3550 N. Central Avenue Suite 200
Phoenix, Arizona 85012

DRILLING CARD
SPECIAL REQUIRMENTS APPLY (WQARF/SUPERFUND)

THIS AUTHORIZATION SHALL BE IN POSSESSION OF THE DRILLER DURING ALL DRILLING OPERATIONS

WELL REGISTRATION NO: **55-915203**

AUTHORIZED DRILLER: **BOART LONGYEAR COMPANY** LICENSE NO: **83**

NOTICE OF INTENT TO **DRILL A MONITOR WELL** HAS BEEN FILED WITH THE DEPARTMENT BY:

WELL OWNER: **AFCEC/CZRB-Griffiss**

ADDRESS: **706 Brooks Road, Rome, NY, 13441**

THE WELL(S) IS/ARE TO BE LOCATED IN THE:

NW 1/4 of the **SE** 1/4 of the **NE** 1/4 Section **31** Township **01 S** Range **07 E**

NO. OF WELLS IN THIS PROJECT: **1**

THIS AUTHORIZATION EXPIRES AT MIDNIGHT ON THE DAY OF **2/5/2014**

THE DRILLER MUST FILE A WELL DRILLER REPORT AND WELL LOG WITHIN 30 DAYS OF COMPLETION OF DRILLING

This drilling or abandonment authority was granted based upon the certifications made by the above-named Driller in the notice of intent to drill or abandon. Those certifications, along with any variances granted, are listed below. By drilling or abandoning the well pursuant to this authorization, the above-named driller acknowledges the accuracy of the driller certifications. If the certifications are in error, this authorization is invalid and driller must contact the Department of Water Resource's NOI Section in writing at the address above to correct.

Variance(s) Granted To Driller: **None**

Certification(s) Made By Driller:

- ☑ By checking this box, I certify that I have all necessary Registrar of Contractor (ROC) licenses in all necessary license categories for this drilling or abandonment project and that those licenses are current.
- ☑ If the landowner and the well owner are not the same, by checking this box, I certify that I have obtained written approval from the landowner in order to conduct this drilling or abandonment project. A copy of the written approval shall be submitted to ADWR with the Well Driller Report and Well Log or Well Abandonment Completion Report within 30 days of completion of drilling or abandonment.
- ☑ I understand that this well site is located within the boundaries of a contamination area and that special construction or abandonment requirements shall be complied with, and by checking this box, I certify that I have read the applicable special requirements, and that I shall comply with those standards.
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- ☑ By checking this box, I certify that I have been authorized by the above-named well owner to submit this Notice of Intent on the well owner's behalf.

☑ By checking this box, I certify that the information above is complete and correct, and that the well shall be drilled or abandoned in compliance with all pertinent statutes and rules, including any special standards that may be required to protect the aquifer or other water sources.

ARIZONA DEPARTMENT OF WATER RESOURCES

Electronic Filing - NOI Report

3550 N. Central Avenue Suite 200
Phoenix, Arizona 85012

NOI Type: Notice of Intent to Drill, Deepen, Modify a Monitor/Piezometer/Environmental Well
Well Type: MONITOR
Date Received at ADWR Website: 2/6/2013 4:32:26 PM

Fee Paid: $150.00 Order Number: VSYEA3C1EE50

Well Registration Number: 55 - 915203
Number of Wells/Holes: 1 Drilling Authority Expires On: 2/5/2014

Driller's ADWR License Number: 83

Authorized Driller: BOART LONGYEAR COMPANY
ROC License Number Entered By Driller: 73446
Qualifying Party License Categories: A-4

Well Owner Name: AFCEC/CZRB-Griffiss
Well Owner Address: 706 Brooks Road
Well Owner City, State - Zip: Rome, NY - 13441
Well Owner Phone: 315 356-0810

Book: Map: Parcel:

Is the Land Owner the same as the Well Owner?: No

Land Owner Name: Phoenix-Mesa Gateway Airport Authority
Land Owner Address: 5835 South Sossaman Road
Land Owner City, State - Zip: Mesa, AZ - 85212
Land Owner Phone: 480 988-7600

Well Location: **NW** 1/4 of the **SE** 1/4 of the **NE** 1/4 Section **31** Township **1 S** Range **7 E**

AMA: PHOENIX AMA
County: MARICOPA
Contamination Site: WAFB WITH LUST

Primary Water Use: MONITORING
Secondary Water Use(s): N/A

Is any portion of the land, on which the well is to be located, within 100 feet of a designated municipal provider's operating water distribution system as shown on the municipal provider's most recent digitized service area map filed by the municipal provider with the director of ADWR. N/A

Proximity to a designated municipal provider's operating water distribution system exemption type:
N/A

Will you be installing a dedicated pump ?: No

Will the installed pump have a pumping capacity of greater than 35 GPM, or will the well will be used to withdraw greater than 10 Acre Feet per year?: N/A

Is this NOI an application to replace, deepen, or modify an existing well? No

Variance(s) Granted To Driller: **None**

Certification(s) Made By Driller:

- ☑ By checking this box, I certify that I have all necessary Registrar of Contractor (ROC) licenses in all necessary license categories for this drilling or abandonment project and that those licenses are current.
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ARIZONA DEPARTMENT OF WATER RESOURCES
3550 N. Central Avenue Suite 200, Phoenix, Arizona 85012
Telephone (602) 771-8500
Fax (602) 771-8691

Wednesday, February 06, 2013

Janice K. Brewer
Governor

Sandra A. Fabritz-Whitney
Director

AFCEC/CZRB-Griffiss
706 Brooks Road
Rome, NY 13441

Registration No. 55- 915203
File No. D(1-7)31 ADB

Dear Applicant:

Enclosed is a copy of the Notice of Intent to Drill a Monitor/Piezometer/Environmental Well ("NOI") which you recently filed with this Department pursuant to A.R.S. § 45-596. This is to inform you that the Department has approved the NOI and has mailed (or otherwise provided) a drilling card authorizing the drilling of the well to the well driller identified in the NOI. The driller may not begin drilling until he has received the drilling card which he must keep in his posssession at the well site during drilling. Well drilling activities must be completed within one year after the date the NOI was filed with the Department. If drilling is not completed within one year, you must file a new NOI before proceeding with further drilling.

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Please be advised that A.R.S. § 45-593(C) requires the person to whom a well is registered to notify the Department of a change in ownership of the well and/or information pertaining to the physical characteristics of the well in order to keep this well registration file current and accurate. Any change in well information or a request to change well driller must be filed on a Request to Change Well Information form (DWR form 55-71A) that may be downloaded from the ADWR Internet website at
http://www.azwater.gov/dwr/Content/Find_by_Category/Permits_Forms_Applications/default.htm.

Susan Y. Montoya

From: ADWR <wrnoi@azwater.gov>
Sent: Wednesday, February 06, 2013 4:33 PM
To: shawn.cain@boartlongyear.com
Subject: ADWR Well NOI Confirmation re: Well Registration Number 915203

****
* Confirmation for Order: VSYEA3C1EE50
****

Thank you for your order, shawn cain.

Should you have any questions concerning your order, please contact us by email at wrnoi@azwater.gov or by phone at (602) 771-8500 and be sure to mention your order number:
VSYEA3C1EE50.

Thanks again for shopping with Arizona Department of Water Resources!

Best regards,
Arizona Department of Water Resources Management.
Phone: (602) 771-8500
Email: wrnoi@azwater.gov

Order ID: VSYEA3C1EE50
Date: 2/6/2013
Status: Approved

Arizona Department of Water Resources
3550 N. Central Avenue Suite 200
Phoenix, AZ 85012 United States
Phone: (602) 771-8500 Fax: (602) 771-8691

Bill To: BOART LONGYEAR COMPANY-shawn cain
7103 W. AUGUSTA AVE
GLENDALE, AZ. 85303
Email: shawn.cain@boartlongyear.com

000600 - All Except Domestic Outside AMA/INA qty 1 - price ea. - amount $150.00

Subtotal:	$150.00
Tax Total	$0.00
Shipping	$0.00
Handling	$0.00
Total:	$150.00

Transaction Details

Help

View Transaction Status

Information for Transaction ID: VSYEA3C1EE50

Information for Paypal Transaction ID:

Transaction Result Details

Transaction ID:	VSYEA3C1EE50	**Result Code:**	0
PayPal Transaction ID:			
Timestamp:	Feb 06, 2013 15:35:54 PM	**Response Message:**	Approved
Transaction Type:	Sale	**Authorization Code:**	066995
Tender Type:	Visa	**AVS Street Match:**	Y
Credit Card Number:	0439	**AVS Zip Match :**	Y
Credit Card Expiration:	03 / 2013	**International AVS Indicator:**	N
Amount:	150.00 USD	**Card Security Code Match:**	Y
Tax Amount:	0.00 USD	**ABA #:**	
Shipping/Freight Amount:	0.00 USD	**Cust Ref #:**	
Duty Amount:	0.00 USD	**Recurring:**	No
Original Amount:	0.00 USD	**Payment Advice Code:**	What's this ?
Original Transaction ID:	N/A		
Batch ID:	867		
Purchase Order Number:	VSYEA3C1EE50		
Supplier Reference #:			
Comment 1:	915203		

Billing Information

Billing Address: shawn cain
7103 W. AUGUSTA AVE
GLENDALE, AZ 85303
US

Email: shawn.cain@boartlongyear.com

Shipping Information

Shipping Address:

Additional Information

Client IP Address:	173.0.81.65	**Merchant:**	adwr02
Client Type:	J	**User:**	adwr02
Client Version:	4.3.2		
Transaction State:	8		
Duration:	0.00		

Transaction History

Transaction ID	Timestamp	Transaction Type	Amount	Result	Details
VSYEA3C1EE50	Feb 06, 2013 15:35:54 PM	Sale	150.00 USD	0	--

ARIZONA DEPARTMENT OF WATER RESOURCES
3550 N. Central Avenue Suite 200
Phoenix, Arizona 85012

DRILLING CARD
SPECIAL REQUIRMENTS APPLY (WQARF/SUPERFUND)

THIS AUTHORIZATION SHALL BE IN POSSESSION OF THE DRILLER DURING ALL DRILLING OPERATIONS

WELL REGISTRATION NO: **55-915204**

AUTHORIZED DRILLER: **BOART LONGYEAR COMPANY** LICENSE NO: **83**

NOTICE OF INTENT TO **DRILL A MONITOR WELL** HAS BEEN FILED WITH THE DEPARTMENT BY:

WELL OWNER: **AFCEC?CZRB-Griffiss**

ADDRESS: **706 Brooks Road, Rome, NY, 13441**

THE WELL(S) IS/ARE TO BE LOCATED IN THE:

NW 1/4 of the **SE** 1/4 of the **NE** 1/4 Section **31** Township **01 S** Range **07 E**

NO. OF WELLS IN THIS PROJECT: **1**

THIS AUTHORIZATION EXPIRES AT MIDNIGHT ON THE DAY OF **2/5/2014**

THE DRILLER MUST FILE A WELL DRILLER REPORT AND WELL LOG WITHIN 30 DAYS OF COMPLETION OF DRILLING

This drilling or abandonment authority was granted based upon the certifications made by the above-named Driller in the notice of intent to drill or abandon. Those certifications, along with any variances granted, are listed below. By drilling or abandoning the well pursuant to this authorization, the above-named driller acknowledges the accuracy of the driller certifications. If the certifications are in error, this authorization is invalid and driller must contact the Department of Water Resource's NOI Section in writing at the address above to correct.

Variance(s) Granted To Driller: **None**

Certification(s) Made By Driller:

- ☑ By checking this box, I certify that I have all necessary Registrar of Contractor (ROC) licenses in all necessary license categories for this drilling or abandonment project and that those licenses are current.
- ☑ If the landowner and the well owner are not the same, by checking this box, I certify that I have obtained written approval from the landowner in order to conduct this drilling or abandonment project. A copy of the written approval shall be submitted to ADWR with the Well Driller Report and Well Log or Well Abandonment Completion Report within 30 days of completion of drilling or abandonment.
- ☑ I understand that this well site is located within the boundaries of a contamination area and that special construction or abandonment requirements shall be complied with, and by checking this box, I certify that I have read the applicable special requirements, and that I shall comply with those standards.
- ☑ By checking this box, I certify that this NOI application is not an application to replace, deepen, or modify an existing well.
- ☑ By checking this box, I certify that I have been authorized by the above-named well owner to submit this Notice of Intent on the well owner's behalf.

☑ By checking this box, I certify that the information above is complete and correct, and that the well shall be drilled or abandoned in compliance with all pertinent statutes and rules, including any special standards that may be required to protect the aquifer or other water sources.

ARIZONA DEPARTMENT OF WATER RESOURCES

Electronic Filing - NOI Report

3550 N. Central Avenue Suite 200
Phoenix, Arizona 85012

NOI Type: Notice of Intent to Drill, Deepen, Modify a Monitor/Piezometer/Environmental Well
Well Type: MONITOR
Date Received at ADWR Website: 2/6/2013 4:36:04 PM

Fee Paid: $150.00 Order Number: VPCE7FCBBDC8

Well Registration Number: 55 - 915204
Number of Wells/Holes: 1 Drilling Authority Expires On: 2/5/2014

Driller's ADWR License Number: 83

Authorized Driller: BOART LONGYEAR COMPANY
ROC License Number Entered By Driller: 73446
Qualifying Party License Categories: A-4

Well Owner Name: AFCEC?CZRB-Griffiss
Well Owner Address: 706 Brooks Road
Well Owner City, State - Zip: Rome, NY - 13441
Well Owner Phone: 315 356-0816 204

Book: Map: Parcel:

Is the Land Owner the same as the Well Owner?: No

Land Owner Name: Phoenix-Mesa Gateway Airport Authority
Land Owner Address: 5835 South Sossaman Road
Land Owner City, State - Zip: Mesa, AZ - 85212
Land Owner Phone: 480 988-7600

Well Location: **NW** 1/4 of the **SE** 1/4 of the **NE** 1/4 Section **31** Township **1 S** Range **7 E**

AMA: PHOENIX AMA
County: MARICOPA
Contamination Site: WAFB WITH LUST

Primary Water Use: MONITORING
Secondary Water Use(s): N/A

Is any portion of the land, on which the well is to be located, within 100 feet of a designated municipal provider's operating water distribution system as shown on the municipal provider's most recent digitized service area map filed by the municipal provider with the director of ADWR. N/A

Proximity to a designated municipal provider's operating water distribution system exemption type:
N/A

Will you be installing a dedicated pump ?: No

Will the installed pump have a pumping capacity of greater than 35 GPM, or will the well will be used to withdraw greater than 10 Acre Feet per year?: N/A

Is this NOI an application to replace, deepen, or modify an existing well? No

Variance(s) Granted To Driller: **None**

Certification(s) Made By Driller:

- ☑ By checking this box, I certify that I have all necessary Registrar of Contractor (ROC) licenses in all necessary license categories for this drilling or abandonment project and that those licenses are current.
- ☑ If the landowner and the well owner are not the same, by checking this box, I certify that I have obtained written approval from the landowner in order to conduct this drilling or abandonment project. A copy of the written approval shall be submitted to ADWR with the Well Driller Report and Well Log or Well Abandonment Completion Report within 30 days of completion of drilling or abandonment.
- ☑ I understand that this well site is located within the boundaries of a contamination area and that special construction or abandonment requirements shall be complied with, and by checking this box, I certify that I have read the applicable special requirements, and that I shall comply with those standards.
- ☑ By checking this box, I certify that this NOI application is not an application to replace, deepen, or modify an existing well.
- ☑ By checking this box, I certify that I have been authorized by the above-named well owner to submit this Notice of Intent on the well owner's behalf.
- ☑ By checking this box, I certify that the information above is complete and correct, and that the well shall be drilled or abandoned in compliance with all pertinent statutes and rules, including any special standards that may be required to protect the aquifer or other water sources.

ARIZONA DEPARTMENT OF WATER RESOURCES
3550 N. Central Avenue Suite 200, Phoenix, Arizona 85012
Telephone (602) 771-8500
Fax (602) 771-8691

Wednesday, February 06, 2013

Janice K. Brewer
Governor

Sandra A. Fabritz-Whitney
Director

AFCEC?CZRB-Griffiss
706 Brooks Road
Rome, NY 13441

Registration No. 55- 915204
File No. D(1-7)31 ADB

Dear Applicant:

Enclosed is a copy of the Notice of Intent to Drill a Monitor/Piezometer/Environmental Well ("NOI") which you recently filed with this Department pursuant to A.R.S. § 45-596. This is to inform you that the Department has approved the NOI and has mailed (or otherwise provided) a drilling card authorizing the drilling of the well to the well driller identified in the NOI. The driller may not begin drilling until he has received the drilling card which he must keep in his posssession at the well site during drilling. Well drilling activities must be completed within one year after the date the NOI was filed with the Department. If drilling is not completed within one year, you must file a new NOI before proceeding with further drilling.

If it is necessary to change the location of the proposed well, you may not proceed with drilling until you file a new NOI with the Department and the Department issues an amended drilling card to the driller. If you change drillers, you must notify the Department of the new driller's identity. A new driller may not begin drilling until he receives a new drilling card from the Department. If in the course of drilling the well, it is determined that the well cannot be successfully completed as initially intended (dry hole, cave in, lost tools, etc.), the well must be properly abandoned and a Well Abandonment Completion Report filed as required by A.A.C. R12-15-816(F).

A.R.S. § 45-600 requires the driller to file a complete and accurate Well Drillers Report and Well Log (DWR Form 55-55) with the Department within 30 days after completion of drilling. That form was mailed to your driller with the drilling card.

Please be advised that A.R.S. § 45-593(C) requires the person to whom a well is registered to notify the Department of a change in ownership of the well and/or information pertaining to the physical characteristics of the well in order to keep this well registration file current and accurate. Any change in well information or a request to change well driller must be filed on a Request to Change Well Information form (DWR form 55-71A) that may be downloaded from the ADWR Internet website at
http://www.azwater.gov/dwr/Content/Find_by_Category/Permits_Forms_Applications/default.htm.

Susan Y. Montoya

From: ADWR <wrnoi@azwater.gov>
Sent: Wednesday, February 06, 2013 4:38 PM
To: shawn.cain@boartlongyear.com
Subject: ADWR Well NOI Confirmation re: Well Registration Number 915204

****
* Confirmation for Order: VPCE7FCBBDC8
****

Thank you for your order, shawn cain.

Should you have any questions concerning your order, please contact us by email at wrnoi@azwater.gov or by phone at (602) 771-8500 and be sure to mention your order number:
VPCE7FCBBDC8.

Thanks again for shopping with Arizona Department of Water Resources!

Best regards,
Arizona Department of Water Resources Management.
Phone: (602) 771-8500
Email: wrnoi@azwater.gov

Order ID: VPCE7FCBBDC8
Date: 2/6/2013
Status: Approved

Arizona Department of Water Resources
3550 N. Central Avenue Suite 200
Phoenix, AZ 85012 United States
Phone: (602) 771-8500 Fax: (602) 771-8691

Bill To: BOART LONGYEAR COMPANY-shawn cain
7103 W. AUGUSTA AVE
GLENDALE, AZ. 85303
Email: shawn.cain@boartlongyear.com

000600 - All Except Domestic Outside AMA/INA qty 1 - price ea. - amount $150.00

Subtotal:	$150.00
Tax Total	$0.00
Shipping	$0.00
Handling	$0.00
Total:	$150.00

Transaction Details

Help

View Transaction Status

Information for Transaction ID: VPCE7FCBBDC8

Information for Paypal Transaction ID:

Transaction Result Details

Transaction ID:	VPCE7FCBBDC8	**Result Code:**	0
PayPal Transaction ID:			
Timestamp:	Feb 06, 2013 15:40:23 PM	**Response Message:**	Approved
Transaction Type:	Sale	**Authorization Code:**	007698
Tender Type:	Visa	**AVS Street Match:**	Y
Credit Card Number:	0439	**AVS Zip Match :**	Y
Credit Card Expiration:	03 / 2013	**International AVS Indicator:**	N
Amount:	150.00 USD	**Card Security Code Match:**	Y
Tax Amount:	0.00 USD	**ABA #:**	
Shipping/Freight Amount:	0.00 USD	**Cust Ref #:**	
Duty Amount:	0.00 USD	**Recurring:**	No
Original Amount:	0.00 USD	**Payment Advice Code:**	What's this ?
Original Transaction ID:	N/A		
Batch ID:	867		
Purchase Order Number:	VPCE7FCBBDC8		
Supplier Reference #:			
Comment 1:	915204		

Billing Information

Billing Address: shawn cain
7103 W. AUGUSTA AVE
GLENDALE, AZ 85303
US

Email: shawn.cain@boartlongyear.com

Shipping Information

Shipping Address:

Additional Information

Client IP Address:	173.0.81.65	**Merchant:**	adwr02
Client Type:	J	**User:**	adwr02
Client Version:	4.3.2		
Transaction State:	8		
Duration:	0.00		

Transaction History

Transaction ID	Timestamp	Transaction Type	Amount	Result	Details
VPCE7FCBBDC8	Feb 06, 2013 15:40:23 PM	Sale	150.00 USD	0	--

ARIZONA DEPARTMENT OF WATER RESOURCES
3550 N. Central Avenue Suite 200
Phoenix, Arizona 85012

DRILLING CARD
SPECIAL REQUIRMENTS APPLY (WQARF/SUPERFUND)

THIS AUTHORIZATION SHALL BE IN POSSESSION OF THE DRILLER DURING ALL DRILLING OPERATIONS

WELL REGISTRATION NO: **55-915205**

AUTHORIZED DRILLER: **BOART LONGYEAR COMPANY** LICENSE NO: **83**

NOTICE OF INTENT TO **DRILL A MONITOR WELL** HAS BEEN FILED WITH THE DEPARTMENT BY:

WELL OWNER: **AFCECCZRB-Griffiss**

ADDRESS: **706 Brooks Road, Rome, NY, 13441**

THE WELL(S) IS/ARE TO BE LOCATED IN THE:

NW 1/4 of the **SE** 1/4 of the **NE** 1/4 Section **31** Township **01 S** Range **07 E**

NO. OF WELLS IN THIS PROJECT: **1**

THIS AUTHORIZATION EXPIRES AT MIDNIGHT ON THE DAY OF **2/5/2014**

THE DRILLER MUST FILE A WELL DRILLER REPORT AND WELL LOG WITHIN 30 DAYS OF COMPLETION OF DRILLING

This drilling or abandonment authority was granted based upon the certifications made by the above-named Driller in the notice of intent to drill or abandon. Those certifications, along with any variances granted, are listed below. By drilling or abandoning the well pursuant to this authorization, the above-named driller acknowledges the accuracy of the driller certifications. If the certifications are in error, this authorization is invalid and driller must contact the Department of Water Resource's NOI Section in writing at the address above to correct.

Variance(s) Granted To Driller: **None**

Certification(s) Made By Driller:

- ☑ By checking this box, I certify that I have all necessary Registrar of Contractor (ROC) licenses in all necessary license categories for this drilling or abandonment project and that those licenses are current.
- ☑ If the landowner and the well owner are not the same, by checking this box, I certify that I have obtained written approval from the landowner in order to conduct this drilling or abandonment project. A copy of the written approval shall be submitted to ADWR with the Well Driller Report and Well Log or Well Abandonment Completion Report within 30 days of completion of drilling or abandonment.
- ☑ I understand that this well site is located within the boundaries of a contamination area and that special construction or abandonment requirements shall be complied with, and by checking this box, I certify that I have read the applicable special requirements, and that I shall comply with those standards.
- ☑ By checking this box, I certify that this NOI application is not an application to replace, deepen, or modify an existing well.
- ☑ By checking this box, I certify that I have been authorized by the above-named well owner to submit this Notice of Intent on the well owner's behalf.

☑ By checking this box, I certify that the information above is complete and correct, and that the well shall be drilled or abandoned in compliance with all pertinent statutes and rules, including any special standards that may be required to protect the aquifer or other water sources.

ARIZONA DEPARTMENT OF WATER RESOURCES

Electronic Filing - NOI Report

3550 N. Central Avenue Suite 200
Phoenix, Arizona 85012

NOI Type: Notice of Intent to Drill, Deepen, Modify a Monitor/Piezometer/Environmental Well
Well Type: MONITOR
Date Received at ADWR Website: 2/6/2013 4:43:35 PM

Fee Paid: $150.00 Order Number: VTYEA59350BF

Well Registration Number: 55 - 915205
Number of Wells/Holes: 1 Drilling Authority Expires On: 2/5/2014

Driller's ADWR License Number: 83

Authorized Driller: BOART LONGYEAR COMPANY
ROC License Number Entered By Driller: 73446
Qualifying Party License Categories: A-4

Well Owner Name: AFCECCZRB-Griffiss
Well Owner Address: 706 Brooks Road
Well Owner City, State - Zip: Rome, NY - 13441
Well Owner Phone: 315 356-0816 204

Book: Map: Parcel:

Is the Land Owner the same as the Well Owner?: No

Land Owner Name: Phoenix-Mesa Gateway Airport Authority
Land Owner Address: 5835 South Sossaman Road
Land Owner City, State - Zip: Mesa, AZ - 85212
Land Owner Phone: 480 988-7600

Well Location: **NW** 1/4 of the **SE** 1/4 of the **NE** 1/4 Section **31** Township **1 S** Range **7 E**

AMA: PHOENIX AMA
County: MARICOPA
Contamination Site: WAFB WITH LUST

Primary Water Use: MONITORING
Secondary Water Use(s): N/A

Is any portion of the land, on which the well is to be located, within 100 feet of a designated municipal provider's operating water distribution system as shown on the municipal provider's most recent digitized service area map filed by the municipal provider with the director of ADWR. N/A

Proximity to a designated municipal provider's operating water distribution system exemption type:
N/A

Will you be installing a dedicated pump ?: No

Will the installed pump have a pumping capacity of greater than 35 GPM, or will the well will be used to withdraw greater than 10 Acre Feet per year?: N/A

Is this NOI an application to replace, deepen, or modify an existing well? No

Variance(s) Granted To Driller: **None**

Certification(s) Made By Driller:

- ☑ By checking this box, I certify that I have all necessary Registrar of Contractor (ROC) licenses in all necessary license categories for this drilling or abandonment project and that those licenses are current.
- ☑ If the landowner and the well owner are not the same, by checking this box, I certify that I have obtained written approval from the landowner in order to conduct this drilling or abandonment project. A copy of the written approval shall be submitted to ADWR with the Well Driller Report and Well Log or Well Abandonment Completion Report within 30 days of completion of drilling or abandonment.
- ☑ I understand that this well site is located within the boundaries of a contamination area and that special construction or abandonment requirements shall be complied with, and by checking this box, I certify that I have read the applicable special requirements, and that I shall comply with those standards.
- ☑ By checking this box, I certify that this NOI application is not an application to replace, deepen, or modify an existing well.
- ☑ By checking this box, I certify that I have been authorized by the above-named well owner to submit this Notice of Intent on the well owner's behalf.
- ☑ By checking this box, I certify that the information above is complete and correct, and that the well shall be drilled or abandoned in compliance with all pertinent statutes and rules, including any special standards that may be required to protect the aquifer or other water sources.

ARIZONA DEPARTMENT OF WATER RESOURCES
3550 N. Central Avenue Suite 200, Phoenix, Arizona 85012
Telephone (602) 771-8500
Fax (602) 771-8691

Wednesday, February 06, 2013

Janice K. Brewer
Governor

Sandra A. Fabritz-Whitney
Director

AFCECCZRB-Griffiss
706 Brooks Road
Rome, NY 13441

Registration No. 55- 915205
File No. D(1-7)31 ADB

Dear Applicant:

Enclosed is a copy of the Notice of Intent to Drill a Monitor/Piezometer/Environmental Well ("NOI") which you recently filed with this Department pursuant to A.R.S. § 45-596. This is to inform you that the Department has approved the NOI and has mailed (or otherwise provided) a drilling card authorizing the drilling of the well to the well driller identified in the NOI. The driller may not begin drilling until he has received the drilling card which he must keep in his posssession at the well site during drilling. Well drilling activities must be completed within one year after the date the NOI was filed with the Department. If drilling is not completed within one year, you must file a new NOI before proceeding with further drilling.

If it is necessary to change the location of the proposed well, you may not proceed with drilling until you file a new NOI with the Department and the Department issues an amended drilling card to the driller. If you change drillers, you must notify the Department of the new driller's identity. A new driller may not begin drilling until he receives a new drilling card from the Department. If in the course of drilling the well, it is determined that the well cannot be successfully completed as initially intended (dry hole, cave in, lost tools, etc.), the well must be properly abandoned and a Well Abandonment Completion Report filed as required by A.A.C. R12-15-816(F).

A.R.S. § 45-600 requires the driller to file a complete and accurate Well Drillers Report and Well Log (DWR Form 55-55) with the Department within 30 days after completion of drilling. That form was mailed to your driller with the drilling card.

Please be advised that A.R.S. § 45-593(C) requires the person to whom a well is registered to notify the Department of a change in ownership of the well and/or information pertaining to the physical characteristics of the well in order to keep this well registration file current and accurate. Any change in well information or a request to change well driller must be filed on a Request to Change Well Information form (DWR form 55-71A) that may be downloaded from the ADWR Internet website at
http://www.azwater.gov/dwr/Content/Find_by_Category/Permits_Forms_Applications/default.htm.

Susan Y. Montoya

From: ADWR <wrnoi@azwater.gov>
Sent: Wednesday, February 06, 2013 4:44 PM
To: shawn.cain@boartlongyear.com
Subject: ADWR Well NOI Confirmation re: Well Registration Number 915205

****
* Confirmation for Order: VTYEA59350BF
****

Thank you for your order, shawn cain.

Should you have any questions concerning your order, please contact us by email at wrnoi@azwater.gov or by phone at (602) 771-8500 and be sure to mention your order number:
VTYEA593508F.

Thanks again for shopping with Arizona Department of Water Resources!

Best regards,
Arizona Department of Water Resources Management.
Phone: (602) 771-8500
Email: wrnoi@azwater.gov

Order ID: VTYEA59350BF
Date: 2/6/2013
Status: Approved

Arizona Department of Water Resources
3550 N. Central Avenue Suite 200
Phoenix, AZ 85012 United States
Phone: (602) 771-8500 Fax: (602) 771-8691

Bill To: BOART LONGYEAR COMPANY-shawn cain
7103 W. AUGUSTA AVE
GLENDALE, AZ. 85303
Email: shawn.cain@boartlongyear.com

000600 - All Except Domestic Outside AMA/INA qty 1 - price ea. - amount $150.00

Subtotal:	$150.00
Tax Total	$0.00
Shipping	$0.00
Handling	$0.00

Total:	$150.00

Transaction Details

Help

View Transaction Status

Information for Transaction ID: VTYEA59350BF

Information for Paypal Transaction ID:

Transaction Result Details

Transaction ID:	VTYEA59350BF	**Result Code:**	0
PayPal Transaction ID:			
Timestamp:	Feb 06, 2013 15:47:11 PM	**Response Message:**	Approved
Transaction Type:	Sale	**Authorization Code:**	013984
Tender Type:	Visa	**AVS Street Match:**	Y
Credit Card Number:	0439	**AVS Zip Match :**	Y
Credit Card Expiration:	03 / 2013	**International AVS Indicator:**	N
Amount:	150.00 USD	**Card Security Code Match:**	Y
Tax Amount:	0.00 USD	**ABA #:**	
Shipping/Freight Amount:	0.00 USD	**Cust Ref #:**	
Duty Amount:	0.00 USD	**Recurring:**	No
Original Amount:	0.00 USD	**Payment Advice Code:**	What's this ?
Original Transaction ID:	N/A		
Batch ID:	867		
Purchase Order Number:	VTYEA59350BF		
Supplier Reference #:			
Comment 1:	915205		

Billing Information

Billing Address: shawn cain
7103 W. AUGUSTA AVE
GLENDALE, AZ 85303
US

Email: shawn.cain@boartlongyear.com

Shipping Information

Shipping Address:

Additional Information

Client IP Address:	173.0.81.65	**Merchant:**	adwr02
Client Type:	J	**User:**	adwr02
Client Version:	4.3.2		
Transaction State:	8		
Duration:	0.00		

Transaction History

Transaction ID	Timestamp	Transaction Type	Amount	Result	Details
VTYEA59350BF	Feb 06, 2013 15:47:11 PM	Sale	150.00 USD	0	--

ARIZONA DEPARTMENT OF WATER RESOURCES
3550 N. Central Avenue Suite 200
Phoenix, Arizona 85012

DRILLING CARD
SPECIAL REQUIRMENTS APPLY (WQARF/SUPERFUND)

THIS AUTHORIZATION SHALL BE IN POSSESSION OF THE DRILLER DURING ALL DRILLING OPERATIONS

WELL REGISTRATION NO: **55-915223**

AUTHORIZED DRILLER: **BOART LONGYEAR COMPANY** LICENSE NO: **83**

NOTICE OF INTENT TO **DRILL A MONITOR WELL** HAS BEEN FILED WITH THE DEPARTMENT BY:

WELL OWNER: **AFCEC/CZRB-Griffiss**

ADDRESS: **706 Brooks Road, Rome, NY, 13441**

THE WELL(S) IS/ARE TO BE LOCATED IN THE:

NW 1/4 of the **SE** 1/4 of the **NE** 1/4 Section **31** Township **01 S** Range **07 E**

NO. OF WELLS IN THIS PROJECT: **1**

THIS AUTHORIZATION EXPIRES AT MIDNIGHT ON THE DAY OF **2/7/2014**

THE DRILLER MUST FILE A WELL DRILLER REPORT AND WELL LOG WITHIN 30 DAYS OF COMPLETION OF DRILLING

This drilling or abandonment authority was granted based upon the certifications made by the above-named Driller in the notice of intent to drill or abandon. Those certifications, along with any variances granted, are listed below. By drilling or abandoning the well pursuant to this authorization, the above-named driller acknowledges the accuracy of the driller certifications. If the certifications are in error, this authorization is invalid and driller must contact the Department of Water Resource's NOI Section in writing at the address above to correct.

Variance(s) Granted To Driller: **None**

Certification(s) Made By Driller:

- ☑ By checking this box, I certify that I have all necessary Registrar of Contractor (ROC) licenses in all necessary license categories for this drilling or abandonment project and that those licenses are current.
- ☑ If the landowner and the well owner are not the same, by checking this box, I certify that I have obtained written approval from the landowner in order to conduct this drilling or abandonment project. A copy of the written approval shall be submitted to ADWR with the Well Driller Report and Well Log or Well Abandonment Completion Report within 30 days of completion of drilling or abandonment.
- ☑ I understand that this well site is located within the boundaries of a contamination area and that special construction or abandonment requirements shall be complied with, and by checking this box, I certify that I have read the applicable special requirements, and that I shall comply with those standards.
- ☑ By checking this box, I certify that this NOI application is not an application to replace, deepen, or modify an existing well.
- ☑ By checking this box, I certify that I have been authorized by the above-named well owner to submit this Notice of Intent on the well owner's behalf.

☑ By checking this box, I certify that the information above is complete and correct, and that the well shall be drilled or abandoned in compliance with all pertinent statutes and rules, including any special standards that may be required to protect the aquifer or other water sources.

ARIZONA DEPARTMENT OF WATER RESOURCES

Electronic Filing - NOI Report

3550 N. Central Avenue Suite 200
Phoenix, Arizona 85012

NOI Type: Notice of Intent to Drill, Deepen, Modify a Monitor/Piezometer/Environmental Well
Well Type: MONITOR
Date Received at ADWR Website: 2/8/2013 8:08:30 AM

Fee Paid: $150.00 Order Number: VRCE8A574CF1

Well Registration Number: 55 - 915223
Number of Wells/Holes: 1 Drilling Authority Expires On: 2/7/2014

Driller's ADWR License Number: 83

Authorized Driller: BOART LONGYEAR COMPANY
ROC License Number Entered By Driller: 73446
Qualifying Party License Categories: A-4

Well Owner Name: AFCEC/CZRB-Griffiss
Well Owner Address: 706 Brooks Road
Well Owner City, State - Zip: Rome, NY - 13441
Well Owner Phone: 315 356-0810 204

Book: Map: Parcel:

Is the Land Owner the same as the Well Owner?: No

Land Owner Name: Phoenix-Mesa Gateway Airport Authority
Land Owner Address: 5835 South Sossaman Road
Land Owner City, State - Zip: Mesa, AZ - 85212
Land Owner Phone: 480 988-7600

Well Location: **NW** 1/4 of the **SE** 1/4 of the **NE** 1/4 Section **31** Township **1 S** Range **7 E**

AMA: PHOENIX AMA
County: MARICOPA
Contamination Site: WAFB WITH LUST

Primary Water Use: MONITORING
Secondary Water Use(s): N/A

Is any portion of the land, on which the well is to be located, within 100 feet of a designated municipal provider's operating water distribution system as shown on the municipal provider's most recent digitized service area map filed by the municipal provider with the director of ADWR. N/A

Proximity to a designated municipal provider's operating water distribution system exemption type:
N/A

Will you be installing a dedicated pump ?: No

Will the installed pump have a pumping capacity of greater than 35 GPM, or will the well will be used to withdraw greater than 10 Acre Feet per year?: N/A

Is this NOI an application to replace, deepen, or modify an existing well? No

Variance(s) Granted To Driller: **None**

Certification(s) Made By Driller:

- ☑ By checking this box, I certify that I have all necessary Registrar of Contractor (ROC) licenses in all necessary license categories for this drilling or abandonment project and that those licenses are current.
- ☑ If the landowner and the well owner are not the same, by checking this box, I certify that I have obtained written approval from the landowner in order to conduct this drilling or abandonment project. A copy of the written approval shall be submitted to ADWR with the Well Driller Report and Well Log or Well Abandonment Completion Report within 30 days of completion of drilling or abandonment.
- ☑ I understand that this well site is located within the boundaries of a contamination area and that special construction or abandonment requirements shall be complied with, and by checking this box, I certify that I have read the applicable special requirements, and that I shall comply with those standards.
- ☑ By checking this box, I certify that this NOI application is not an application to replace, deepen, or modify an existing well.
- ☑ By checking this box, I certify that I have been authorized by the above-named well owner to submit this Notice of Intent on the well owner's behalf.
- ☑ By checking this box, I certify that the information above is complete and correct, and that the well shall be drilled or abandoned in compliance with all pertinent statutes and rules, including any special standards that may be required to protect the aquifer or other water sources.

ARIZONA DEPARTMENT OF WATER RESOURCES
3550 N. Central Avenue Suite 200, Phoenix, Arizona 85012
Telephone (602) 771-8500
Fax (602) 771-8691

Friday, February 08, 2013

Janice K. Brewer
Governor

Sandra A. Fabritz-Whitney
Director

AFCEC/CZRB-Griffiss
706 Brooks Road
Rome, NY 13441

Registration No. 55- 915223
File No. D(1-7)31 ADB

Dear Applicant:

Enclosed is a copy of the Notice of Intent to Drill a Monitor/Piezometer/Environmental Well ("NOI") which you recently filed with this Department pursuant to A.R.S. § 45-596. This is to inform you that the Department has approved the NOI and has mailed (or otherwise provided) a drilling card authorizing the drilling of the well to the well driller identified in the NOI. The driller may not begin drilling until he has received the drilling card which he must keep in his posssession at the well site during drilling. Well drilling activities must be completed within one year after the date the NOI was filed with the Department. If drilling is not completed within one year, you must file a new NOI before proceeding with further drilling.

If it is necessary to change the location of the proposed well, you may not proceed with drilling until you file a new NOI with the Department and the Department issues an amended drilling card to the driller. If you change drillers, you must notify the Department of the new driller's identity. A new driller may not begin drilling until he receives a new drilling card from the Department. If in the course of drilling the well, it is determined that the well cannot be successfully completed as initially intended (dry hole, cave in, lost tools, etc.), the well must be properly abandoned and a Well Abandonment Completion Report filed as required by A.A.C. R12-15-816(F).

A.R.S. § 45-600 requires the driller to file a complete and accurate Well Drillers Report and Well Log (DWR Form 55-55) with the Department within 30 days after completion of drilling. That form was mailed to your driller with the drilling card.

Please be advised that A.R.S. § 45-593(C) requires the person to whom a well is registered to notify the Department of a change in ownership of the well and/or information pertaining to the physical characteristics of the well in order to keep this well registration file current and accurate. Any change in well information or a request to change well driller must be filed on a Request to Change Well Information form (DWR form 55-71A) that may be downloaded from the ADWR Internet website at
http://www.azwater.gov/dwr/Content/Find_by_Category/Permits_Forms_Applications/default.htm.

ARIZONA DEPARTMENT OF WATER RESOURCES
3550 N. Central Avenue Suite 200
Phoenix, Arizona 85012

DRILLING CARD
SPECIAL REQUIRMENTS APPLY (WQARF/SUPERFUND)

THIS AUTHORIZATION SHALL BE IN POSSESSION OF THE DRILLER DURING ALL DRILLING OPERATIONS

WELL REGISTRATION NO: **55-915224**

AUTHORIZED DRILLER: **BOART LONGYEAR COMPANY** LICENSE NO: **83**

NOTICE OF INTENT TO **DRILL A MONITOR WELL** HAS BEEN FILED WITH THE DEPARTMENT BY:

WELL OWNER: **AFCEC/CZRB-Griffiss**

ADDRESS: **706 Brooks Road, Rome, NY, 13441**

THE WELL(S) IS/ARE TO BE LOCATED IN THE:

NW 1/4 of the **SE** 1/4 of the **NE** 1/4 Section **31** Township **01 S** Range **07 E**

NO. OF WELLS IN THIS PROJECT: **1**

THIS AUTHORIZATION EXPIRES AT MIDNIGHT ON THE DAY OF **2/7/2014**

THE DRILLER MUST FILE A WELL DRILLER REPORT AND WELL LOG WITHIN 30 DAYS OF COMPLETION OF DRILLING

This drilling or abandonment authority was granted based upon the certifications made by the above-named Driller in the notice of intent to drill or abandon. Those certifications, along with any variances granted, are listed below. By drilling or abandoning the well pursuant to this authorization, the above-named driller acknowledges the accuracy of the driller certifications. If the certifications are in error, this authorization is invalid and driller must contact the Department of Water Resource's NOI Section in writing at the address above to correct.

Variance(s) Granted To Driller: **None**

Certification(s) Made By Driller:

- ☑ By checking this box, I certify that I have all necessary Registrar of Contractor (ROC) licenses in all necessary license categories for this drilling or abandonment project and that those licenses are current.
- ☑ If the landowner and the well owner are not the same, by checking this box, I certify that I have obtained written approval from the landowner in order to conduct this drilling or abandonment project. A copy of the written approval shall be submitted to ADWR with the Well Driller Report and Well Log or Well Abandonment Completion Report within 30 days of completion of drilling or abandonment.
- ☑ I understand that this well site is located within the boundaries of a contamination area and that special construction or abandonment requirements shall be complied with, and by checking this box, I certify that I have read the applicable special requirements, and that I shall comply with those standards.
- ☑ By checking this box, I certify that this NOI application is not an application to replace, deepen, or modify an existing well.
- ☑ By checking this box, I certify that I have been authorized by the above-named well owner to submit this Notice of Intent on the well owner's behalf.

☑ By checking this box, I certify that the information above is complete and correct, and that the well shall be drilled or abandoned in compliance with all pertinent statutes and rules, including any special standards that may be required to protect the aquifer or other water sources.

ARIZONA DEPARTMENT OF WATER RESOURCES

Electronic Filing - NOI Report

3550 N. Central Avenue Suite 200
Phoenix, Arizona 85012

NOI Type: Notice of Intent to Drill, Deepen, Modify a Monitor/Piezometer/Environmental Well
Well Type: MONITOR
Date Received at ADWR Website: 2/8/2013 8:13:58 AM

Fee Paid: $150.00 Order Number: VSHEA3D3052D

Well Registration Number: 55 - 915224
Number of Wells/Holes: 1 Drilling Authority Expires On: 2/7/2014

Driller's ADWR License Number: 83

Authorized Driller: BOART LONGYEAR COMPANY
ROC License Number Entered By Driller: 73446
Qualifying Party License Categories: A-4

Well Owner Name: AFCEC/CZRB-Griffiss
Well Owner Address: 706 Brooks Road
Well Owner City, State - Zip: Rome, NY - 13441
Well Owner Phone: 315 356-0810 204

Book: Map: Parcel:

Is the Land Owner the same as the Well Owner?: No

Land Owner Name: Phoenix-Mesa Gateway Airport Authority
Land Owner Address: 5835 South Sossaman Road
Land Owner City, State - Zip: Mesa, AZ - 85212
Land Owner Phone: 480 988-7600

Well Location: **NW** 1/4 of the **SE** 1/4 of the **NE** 1/4 Section **31** Township **1 S** Range **7 E**

AMA: PHOENIX AMA
County: MARICOPA
Contamination Site: WAFB WITH LUST

Primary Water Use: MONITORING
Secondary Water Use(s): N/A

Is any portion of the land, on which the well is to be located, within 100 feet of a designated municipal provider's operating water distribution system as shown on the municipal provider's most recent digitized service area map filed by the municipal provider with the director of ADWR. N/A

Proximity to a designated municipal provider's operating water distribution system exemption type:
N/A

Will you be installing a dedicated pump ?: No

Will the installed pump have a pumping capacity of greater than 35 GPM, or will the well will be used to withdraw greater than 10 Acre Feet per year?: N/A

Is this NOI an application to replace, deepen, or modify an existing well? No

Variance(s) Granted To Driller: **None**

Certification(s) Made By Driller:

- ☑ By checking this box, I certify that I have all necessary Registrar of Contractor (ROC) licenses in all necessary license categories for this drilling or abandonment project and that those licenses are current.
- ☑ If the landowner and the well owner are not the same, by checking this box, I certify that I have obtained written approval from the landowner in order to conduct this drilling or abandonment project. A copy of the written approval shall be submitted to ADWR with the Well Driller Report and Well Log or Well Abandonment Completion Report within 30 days of completion of drilling or abandonment.
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- ☑ By checking this box, I certify that I have been authorized by the above-named well owner to submit this Notice of Intent on the well owner's behalf.
- ☑ By checking this box, I certify that the information above is complete and correct, and that the well shall be drilled or abandoned in compliance with all pertinent statutes and rules, including any special standards that may be required to protect the aquifer or other water sources.

ARIZONA DEPARTMENT OF WATER RESOURCES
3550 N. Central Avenue Suite 200, Phoenix, Arizona 85012
Telephone (602) 771-8500
Fax (602) 771-8691

Friday, February 08, 2013

Janice K. Brewer
Governor

Sandra A. Fabritz-Whitney
Director

AFCEC/CZRB-Griffiss
706 Brooks Road
Rome, NY 13441

Registration No. 55- 915224
File No. D(1-7)31 ADB

Dear Applicant:

Enclosed is a copy of the Notice of Intent to Drill a Monitor/Piezometer/Environmental Well ("NOI") which you recently filed with this Department pursuant to A.R.S. § 45-596. This is to inform you that the Department has approved the NOI and has mailed (or otherwise provided) a drilling card authorizing the drilling of the well to the well driller identified in the NOI. The driller may not begin drilling until he has received the drilling card which he must keep in his posssession at the well site during drilling. Well drilling activities must be completed within one year after the date the NOI was filed with the Department. If drilling is not completed within one year, you must file a new NOI before proceeding with further drilling.

If it is necessary to change the location of the proposed well, you may not proceed with drilling until you file a new NOI with the Department and the Department issues an amended drilling card to the driller. If you change drillers, you must notify the Department of the new driller's identity. A new driller may not begin drilling until he receives a new drilling card from the Department. If in the course of drilling the well, it is determined that the well cannot be successfully completed as initially intended (dry hole, cave in, lost tools, etc.), the well must be properly abandoned and a Well Abandonment Completion Report filed as required by A.A.C. R12-15-816(F).

A.R.S. § 45-600 requires the driller to file a complete and accurate Well Drillers Report and Well Log (DWR Form 55-55) with the Department within 30 days after completion of drilling. That form was mailed to your driller with the drilling card.

Please be advised that A.R.S. § 45-593(C) requires the person to whom a well is registered to notify the Department of a change in ownership of the well and/or information pertaining to the physical characteristics of the well in order to keep this well registration file current and accurate. Any change in well information or a request to change well driller must be filed on a Request to Change Well Information form (DWR form 55-71A) that may be downloaded from the ADWR Internet website at
http://www.azwater.gov/dwr/Content/Find_by_Category/Permits_Forms_Applications/default.htm.

ARIZONA DEPARTMENT OF WATER RESOURCES
3550 N. Central Avenue Suite 200
Phoenix, Arizona 85012

DRILLING CARD
SPECIAL REQUIRMENTS APPLY (WQARF/SUPERFUND)

THIS AUTHORIZATION SHALL BE IN POSSESSION OF THE DRILLER DURING ALL DRILLING OPERATIONS

WELL REGISTRATION NO: **55-915225**

AUTHORIZED DRILLER: **BOART LONGYEAR COMPANY** LICENSE NO: **83**

NOTICE OF INTENT TO **DRILL A MONITOR WELL** HAS BEEN FILED WITH THE DEPARTMENT BY:

WELL OWNER: **AFCEC-CZRB-Griffiss**

ADDRESS: **706 Brooks Road, Rome, NY, 13441**

THE WELL(S) IS/ARE TO BE LOCATED IN THE:

NE 1/4 of the **SE** 1/4 of the **NE** 1/4 Section **31** Township **01 S** Range **07 E**

NO. OF WELLS IN THIS PROJECT: **1**

THIS AUTHORIZATION EXPIRES AT MIDNIGHT ON THE DAY OF **2/7/2014**

THE DRILLER MUST FILE A WELL DRILLER REPORT AND WELL LOG WITHIN 30 DAYS OF COMPLETION OF DRILLING

This drilling or abandonment authority was granted based upon the certifications made by the above-named Driller in the notice of intent to drill or abandon. Those certifications, along with any variances granted, are listed below. By drilling or abandoning the well pursuant to this authorization, the above-named driller acknowledges the accuracy of the driller certifications. If the certifications are in error, this authorization is invalid and driller must contact the Department of Water Resource's NOI Section in writing at the address above to correct.

Variance(s) Granted To Driller: **None**

Certification(s) Made By Driller:

- ☑ By checking this box, I certify that I have all necessary Registrar of Contractor (ROC) licenses in all necessary license categories for this drilling or abandonment project and that those licenses are current.
- ☑ If the landowner and the well owner are not the same, by checking this box, I certify that I have obtained written approval from the landowner in order to conduct this drilling or abandonment project. A copy of the written approval shall be submitted to ADWR with the Well Driller Report and Well Log or Well Abandonment Completion Report within 30 days of completion of drilling or abandonment.
- ☑ I understand that this well site is located within the boundaries of a contamination area and that special construction or abandonment requirements shall be complied with, and by checking this box, I certify that I have read the applicable special requirements, and that I shall comply with those standards.
- ☑ By checking this box, I certify that this NOI application is not an application to replace, deepen, or modify an existing well.
- ☑ By checking this box, I certify that I have been authorized by the above-named well owner to submit this Notice of Intent on the well owner's behalf.

☑ By checking this box, I certify that the information above is complete and correct, and that the well shall be drilled or abandoned in compliance with all pertinent statutes and rules, including any special standards that may be required to protect the aquifer or other water sources.

ARIZONA DEPARTMENT OF WATER RESOURCES

Electronic Filing - NOI Report
3550 N. Central Avenue Suite 200
Phoenix, Arizona 85012

NOI Type: Notice of Intent to Drill, Deepen, Modify a Monitor/Piezometer/Environmental Well
Well Type: MONITOR
Date Received at ADWR Website: 2/8/2013 8:28:42 AM

Fee Paid: $150.00 Order Number: VRFE8A57835E

Well Registration Number: 55 - 915225
Number of Wells/Holes: 1 Drilling Authority Expires On: 2/7/2014

Driller's ADWR License Number: 83

Authorized Driller: BOART LONGYEAR COMPANY
ROC License Number Entered By Driller: 73446
Qualifying Party License Categories: A-4

Well Owner Name: AFCEC-CZRB-Griffiss
Well Owner Address: 706 Brooks Road
Well Owner City, State - Zip: Rome, NY - 13441
Well Owner Phone: 315 356-0810 204

Book: Map: Parcel:

Is the Land Owner the same as the Well Owner?: No

Land Owner Name: Phoenix-Mesa Gateway Airport Authority
Land Owner Address: 5835 South Sossaman
Land Owner City, State - Zip: Mesa, AZ - 85212
Land Owner Phone: 480 988-7600

Well Location: **NE** 1/4 of the **SE** 1/4 of the **NE** 1/4 Section **31** Township **1 S** Range **7 E**

AMA: PHOENIX AMA
County: MARICOPA
Contamination Site: WAFB WITH LUST

Primary Water Use: MONITORING
Secondary Water Use(s): N/A

Is any portion of the land, on which the well is to be located, within 100 feet of a designated municipal provider's operating water distribution system as shown on the municipal provider's most recent digitized service area map filed by the municipal provider with the director of ADWR. N/A

Proximity to a designated municipal provider's operating water distribution system exemption type:
N/A

Will you be installing a dedicated pump ?: No

Will the installed pump have a pumping capacity of greater than 35 GPM, or will the well will be used to withdraw greater than 10 Acre Feet per year?: N/A

Is this NOI an application to replace, deepen, or modify an existing well? No

Variance(s) Granted To Driller: **None**

Certification(s) Made By Driller:

- ☑ By checking this box, I certify that I have all necessary Registrar of Contractor (ROC) licenses in all necessary license categories for this drilling or abandonment project and that those licenses are current.
- ☑ If the landowner and the well owner are not the same, by checking this box, I certify that I have obtained written approval from the landowner in order to conduct this drilling or abandonment project. A copy of the written approval shall be submitted to ADWR with the Well Driller Report and Well Log or Well Abandonment Completion Report within 30 days of completion of drilling or abandonment.
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- ☑ By checking this box, I certify that this NOI application is not an application to replace, deepen, or modify an existing well.
- ☑ By checking this box, I certify that I have been authorized by the above-named well owner to submit this Notice of Intent on the well owner's behalf.
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ARIZONA DEPARTMENT OF WATER RESOURCES
3550 N. Central Avenue Suite 200, Phoenix, Arizona 85012
Telephone (602) 771-8500
Fax (602) 771-8691

Friday, February 08, 2013

Janice K. Brewer
Governor

Sandra A. Fabritz-Whitney
Director

AFCEC-CZRB-Griffiss
706 Brooks Road
Rome, NY 13441

Registration No. 55- 915225
File No. D(1-7)31 ADA

Dear Applicant:

Enclosed is a copy of the Notice of Intent to Drill a Monitor/Piezometer/Environmental Well ("NOI") which you recently filed with this Department pursuant to A.R.S. § 45-596. This is to inform you that the Department has approved the NOI and has mailed (or otherwise provided) a drilling card authorizing the drilling of the well to the well driller identified in the NOI. The driller may not begin drilling until he has received the drilling card which he must keep in his posssession at the well site during drilling. Well drilling activities must be completed within one year after the date the NOI was filed with the Department. If drilling is not completed within one year, you must file a new NOI before proceeding with further drilling.

If it is necessary to change the location of the proposed well, you may not proceed with drilling until you file a new NOI with the Department and the Department issues an amended drilling card to the driller. If you change drillers, you must notify the Department of the new driller's identity. A new driller may not begin drilling until he receives a new drilling card from the Department. If in the course of drilling the well, it is determined that the well cannot be successfully completed as initially intended (dry hole, cave in, lost tools, etc.), the well must be properly abandoned and a Well Abandonment Completion Report filed as required by A.A.C. R12-15-816(F).

A.R.S. § 45-600 requires the driller to file a complete and accurate Well Drillers Report and Well Log (DWR Form 55-55) with the Department within 30 days after completion of drilling. That form was mailed to your driller with the drilling card.

Please be advised that A.R.S. § 45-593(C) requires the person to whom a well is registered to notify the Department of a change in ownership of the well and/or information pertaining to the physical characteristics of the well in order to keep this well registration file current and accurate. Any change in well information or a request to change well driller must be filed on a Request to Change Well Information form (DWR form 55-71A) that may be downloaded from the ADWR Internet website at
http://www.azwater.gov/dwr/Content/Find_by_Category/Permits_Forms_Applications/default.htm.

ARIZONA DEPARTMENT OF WATER RESOURCES
3550 N. Central Avenue Suite 200
Phoenix, Arizona 85012

DRILLING CARD
SPECIAL REQUIRMENTS APPLY (WQARF/SUPERFUND)

THIS AUTHORIZATION SHALL BE IN POSSESSION OF THE DRILLER DURING ALL DRILLING OPERATIONS

WELL REGISTRATION NO: **55-915330**

AUTHORIZED DRILLER: **BOART LONGYEAR COMPANY** LICENSE NO: **83**

NOTICE OF INTENT TO **DRILL A MONITOR WELL** HAS BEEN FILED WITH THE DEPARTMENT BY:

WELL OWNER: **AFCEC/CZRB-Griffiss**

ADDRESS: **706 Brooks Rd, Rome, NY, 13441**

THE WELL(S) IS/ARE TO BE LOCATED IN THE:

SE 1/4 of the **NE** 1/4 of the **NE** 1/4 Section **31** Township **01 S** Range **07 E**

NO. OF WELLS IN THIS PROJECT: **1**

THIS AUTHORIZATION EXPIRES AT MIDNIGHT ON THE DAY OF **3/10/2014**

THE DRILLER MUST FILE A WELL DRILLER REPORT AND WELL LOG WITHIN 30 DAYS OF COMPLETION OF DRILLING

This drilling or abandonment authority was granted based upon the certifications made by the above-named Driller in the notice of intent to drill or abandon. Those certifications, along with any variances granted, are listed below. By drilling or abandoning the well pursuant to this authorization, the above-named driller acknowledges the accuracy of the driller certifications. If the certifications are in error, this authorization is invalid and driller must contact the Department of Water Resource's NOI Section in writing at the address above to correct.

Variance(s) Granted To Driller: **None**

Certification(s) Made By Driller:

- ☑ By checking this box, I certify that I have all necessary Registrar of Contractor (ROC) licenses in all necessary license categories for this drilling or abandonment project and that those licenses are current.
- ☑ If the landowner and the well owner are not the same, by checking this box, I certify that I have obtained written approval from the landowner in order to conduct this drilling or abandonment project. A copy of the written approval shall be submitted to ADWR with the Well Driller Report and Well Log or Well Abandonment Completion Report within 30 days of completion of drilling or abandonment.
- ☑ I understand that this well site is located within the boundaries of a contamination area and that special construction or abandonment requirements shall be complied with, and by checking this box, I certify that I have read the applicable special requirements, and that I shall comply with those standards.
- ☑ By checking this box, I certify that this NOI application is not an application to replace, deepen, or modify an existing well.
- ☑ By checking this box, I certify that I have been authorized by the above-named well owner to submit this Notice of Intent on the well owner's behalf.

☑ By checking this box, I certify that the information above is complete and correct, and that the well shall be drilled or abandoned in compliance with all pertinent statutes and rules, including any special standards that may be required to protect the aquifer or other water sources.

ARIZONA DEPARTMENT OF WATER RESOURCES

Electronic Filing - NOI Report
3550 N. Central Avenue Suite 200
Phoenix, Arizona 85012

NOI Type: Notice of Intent to Drill, Deepen, Modify a Monitor/Piezometer/Environmental Well
Well Type: MONITOR
Date Received at ADWR Website: 3/11/2013 4:43:37 PM

Fee Paid: $150.00 Order Number: VTHEA701A334

Well Registration Number: 55 - 915330
Number of Wells/Holes: 1 Drilling Authority Expires On: 3/10/2014

Driller's ADWR License Number: 83

Authorized Driller: BOART LONGYEAR COMPANY
ROC License Number Entered By Driller: 73446
Qualifying Party License Categories: A-04

Well Owner Name: AFCEC/CZRB-Griffiss
Well Owner Address: 706 Brooks Rd
Well Owner City, State - Zip: Rome, NY - 13441
Well Owner Phone: 315 356-0810

Book: Map: Parcel:

Is the Land Owner the same as the Well Owner?: No

Land Owner Name: Phoenix-Mesa Gateway Airport Authority
Land Owner Address: 5835 South Sossaman Road
Land Owner City, State - Zip: Mesa, AZ - 85212
Land Owner Phone: 480 988-7600

Well Location: **SE** 1/4 of the **NE** 1/4 of the **NE** 1/4 Section **31** Township **1 S** Range **7 E**

AMA: PHOENIX AMA
County: MARICOPA
Contamination Site: WILLIAMS AIR FORCE BASE

Primary Water Use: MONITORING
Secondary Water Use(s): N/A

Is any portion of the land, on which the well is to be located, within 100 feet of a designated municipal provider's operating water distribution system as shown on the municipal provider's most recent digitized service area map filed by the municipal provider with the director of ADWR. N/A

Proximity to a designated municipal provider's operating water distribution system exemption type:
N/A

Will you be installing a dedicated pump ?: No

Will the installed pump have a pumping capacity of greater than 35 GPM, or will the well will be used to withdraw greater than 10 Acre Feet per year?: N/A

Is this NOI an application to replace, deepen, or modify an existing well? No

Variance(s) Granted To Driller: **None**

Certification(s) Made By Driller:

- ☑ By checking this box, I certify that I have all necessary Registrar of Contractor (ROC) licenses in all necessary license categories for this drilling or abandonment project and that those licenses are current.
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ARIZONA DEPARTMENT OF WATER RESOURCES
3550 N. Central Avenue Suite 200, Phoenix, Arizona 85012
Telephone (602) 771-8500
Fax (602) 771-8691

Monday, March 11, 2013

Janice K. Brewer
Governor

Sandra A. Fabritz-Whitney
Director

AFCEC/CZRB-Griffiss
706 Brooks Rd
Rome, NY 13441

Registration No. 55- 915330
File No. D(1-7)31 AAD

Dear Applicant:

Enclosed is a copy of the Notice of Intent to Drill a Monitor/Piezometer/Environmental Well ("NOI") which you recently filed with this Department pursuant to A.R.S. § 45-596. This is to inform you that the Department has approved the NOI and has mailed (or otherwise provided) a drilling card authorizing the drilling of the well to the well driller identified in the NOI. The driller may not begin drilling until he has received the drilling card which he must keep in his posssession at the well site during drilling. Well drilling activities must be completed within one year after the date the NOI was filed with the Department. If drilling is not completed within one year, you must file a new NOI before proceeding with further drilling.

If it is necessary to change the location of the proposed well, you may not proceed with drilling until you file a new NOI with the Department and the Department issues an amended drilling card to the driller. If you change drillers, you must notify the Department of the new driller's identity. A new driller may not begin drilling until he receives a new drilling card from the Department. If in the course of drilling the well, it is determined that the well cannot be successfully completed as initially intended (dry hole, cave in, lost tools, etc.), the well must be properly abandoned and a Well Abandonment Completion Report filed as required by A.A.C. R12-15-816(F).

A.R.S. § 45-600 requires the driller to file a complete and accurate Well Drillers Report and Well Log (DWR Form 55-55) with the Department within 30 days after completion of drilling. That form was mailed to your driller with the drilling card.

Please be advised that A.R.S. § 45-593(C) requires the person to whom a well is registered to notify the Department of a change in ownership of the well and/or information pertaining to the physical characteristics of the well in order to keep this well registration file current and accurate. Any change in well information or a request to change well driller must be filed on a Request to Change Well Information form (DWR form 55-71A) that may be downloaded from the ADWR Internet website at
http://www.azwater.gov/dwr/Content/Find_by_Category/Permits_Forms_Applications/default.htm.

ATTACHMENT A.3

BORING LOGS

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-10-13 thru 2-13-13

LOCATION N838050.5, E774317.1
WELL REG. # ADWR Reg.# 55-915199
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1339.6'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
0				*				ML	moist	**CLAYEY SILT TO SANDY CLAYEY SILT WITH CALICHE STRINGERS,** dark brown to white brown, slight plastic, firm to loose, no stains
5								SP/SM	dry to slightly moist	**SILTY SAND TO FINE SAND,** 10% gravel, 60% sand, 30% fines, poorly graded sand, very fine to fine grained sand, nonplastic, light brown, loose, no odor note: caliche stringers in parts
10						0.3				
15										note: caliche/silt cemented/firm zone from 17' to 17'6" note: mix of gravel, well rounded to subangular up to 3" in diameter & sand with silt, caliche in parts from 19' to 20'
20						1.0		SM/SP		**SANDY SILT TO SILTY SAND,** with cemented caliche stringers, light brown, slight plastic in parts, firm in parts, no odor
25										

GROUNDWATER

	DEPTH (ft)	HOUR	DATE
▽		none	
▼			
▼			
▼			

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ08

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-10-13 thru 2-13-13

LOCATION N838050.5, E774317.1
WELL REG. # ADWR Reg.# 55-915199
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1339.6'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
25								SM/SP		**SANDY SILT TO SILTY SAND,** continued
										note: silty clay (more clay) from 26' to 26'6"
						1.7				
30										note: silty clay to silt with clay from 30' to 32'
				L		1.9	N			
								SW		**WELL GRADED SAND TO GRAVELLY SAND,** well graded (fine to coarse gravel), gray, loose, no odor
35										
										note: sandy gravel, gravel is subrounded up to 3" in diameter from 39' to 41'6"
40										
45										note: cobble/gravel zone or broken up caliche layer, caliche nodules/chunks up to 4" in diameter from 45' to 47'
				L		1.9	N	SW		**SILTY SAND TO VERY FINE SAND,** 5% gravel, 65% sand, 30% fines, light brown, loose
50										

GROUNDWATER

	DEPTH (ft)	HOUR	DATE
▽		none	
▼			
▼			
▼			

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ08

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-10-13 thru 2-13-13

LOCATION N838050.5, E774317.1
WELL REG. # ADWR Reg.# 55-915199
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1339.6'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
50								SW		**SILTY SAND TO VERY FINE SAND,** continued
								ML		**SANDY SILT,** 5% gravel, 30% sand, 65% fines, with caliche stringers, medium brown, firm slight plastic, sand fraction is very fine, clayey in parts, no odors, no stains
55				L		5.3	N			
								ML/SM		**SANDY SILT TO SILTY SAND** note: caliche strings at 60', 63', 66' & 68'
60										
65										
				L		1.7	N			
70										
						1.8				
										GRAVELLY WELL GRADED SAND, 25% gravel, 70% sand, 5% fines, gray, loose note: gravelly up to 1 1/2" in diameter
75										

GROUNDWATER

	DEPTH (ft)	HOUR	DATE
▽		none	
▼			
▼			
▼			

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ08

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-10-13 thru 2-13-13

LOCATION N838050.5, E774317.1
WELL REG. # ADWR Reg.# 55-915199
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1339.6'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
75										**GRAVELLY WELL GRADED SAND,** continued
								ML/SM		**SANDY SILT,** with clay in parts, brown, slightly firm, slight plastic in parts, slight odor
				L		3.5	N			
80										
85										note: caliche at 84'
				L		9.0	N	SP	slightly moist	**SILTY SAND,** 65% sand, 35% fines, sand is very fine to fine grained, poorly graded, slightly firm to loose, negligable odor
90										
								SW		**GRAVELLY SAND,** well graded, white to light brown, gravel is well rounded, 1 1/2" in diameter
95										
								SM/ML	moist	**SANDY SILT TO SILTY SAND,** firm in parts, nonplastic to slight plastis, brown
				L		3.5	N			note: cemented caliche layers/nodules at 96', 98', from 100' to 101' & 102'
100										

GROUNDWATER

	DEPTH (ft)	HOUR	DATE
▽		none	
▼			
▼			
▼			

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
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L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ08

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-10-13 thru 2-13-13

LOCATION N838050.5, E774317.1
WELL REG. # ADWR Reg.# 55-915199
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1339.6'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
100								SM/ML		**SANDY SILT TO SILTY SAND,** continued
105									moist	**CLAYEY SILT TO SILT WITH CLAY,** dark brown, stiff, competent, minor odor
				L		40	N			
								SW/GW		**GRAVELLY SAND TO SANDY GRAVEL,** well graded, subrounded, white to gray cobbles up to 4" in diameter, loose
110										
										note: thick gravel/cobble layer at 114'
115								ML	moist	**SANDY SILT WITH CLAY,** abundant caliche cemented zones, firm
				L		4	N			
120								SM/GM		**GRAVELLY SANDY SILT,** fine grained sand, well rounded gravel up to 1" in diameter, slightly firm to loose
								SW/SP	slightly moist	**GRAVELLY SAND,** moderately graded, predominantly fine to medium grained, loose
125										

GROUNDWATER

DEPTH (ft)	HOUR	DATE
	none	

SAMPLE TYPE
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S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ08

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-10-13 thru 2-13-13

LOCATION N838050.5, E774317.1
WELL REG. # ADWR Reg.# 55-915199
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1339.6'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
125										
								ML	moist	**CLAYEY SILT TO SANDY SILT,** with abundant caliche cement layers, slightly plastic in parts
				L		3.5	N			
130										
135										
				L		4.8	N			
140								SP		**POORLY SORTED SAND WITH GRAVEL,** fine to medium grained, loose
								GW/SW	slightly moist to moist	**GRAVELLY SAND TO SANDY GRAVEL,** 40% gravel, 60% sand to 70% gravel, 30% sand, well graded, gray to brown, loose note: subrounded gravel up to 3" in diameter
145										
				L		4.8	N	SW	wet to slightly moist	**STIFF SILTY CLAY,** dark brown, moderate plastic (thin layer between gravelly sand), compacted, stiff, no odors, no stains
								GW	wet	**GRAVELLY SAND TO SANDY GRAVEL,** with minor silt in parts, light brown to gray, wet, loose, gravel is well rounded to subrounded up to 2" in diameter
150										

GROUNDWATER

DEPTH (ft)	HOUR	DATE
	none	

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ08

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-10-13 thru 2-13-13

LOCATION N838050.5, E774317.1
WELL REG. # ADWR Reg.# 55-915199
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1339.6'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
150						4.0		GW		**GRAVELLY SAND TO SANDY GRAVEL,** continued, no odor
						4.9				
155								CL	wet	**SILTY CLAY,** trace gravel, reddish-brown, caliche in parts, less stiff (firm) in parts, stiff, compacted, no odor
				L		2.3	N			note: moist inside center of core bit, wet outside
160										
165										
								ML	wet	**As above except more sandy, SANDY SILT,** 25% sand, 75% fines, slightly firm, thin layer of silty sand, slight odor, possibly streak/stain
				L		57	N			
170								SW/GM	wet	**SANDY GRAVEL TO GRAVELLY SAND,** well graded, subrounded, fine to coarse sand, gravel up to 3" in diameter, loose (flowing)
175										

GROUNDWATER

	DEPTH (ft)	HOUR	DATE
▽		none	
▼			
▼			
▼			

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ08

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-10-13 thru 2-13-13

LOCATION N838050.5, E774317.1
WELL REG. # ADWR Reg.# 55-915199
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1339.6'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
175						3.2		SW/GM		**SANDY GRAVEL TO GRAVELLY SAND,** continued
									very moist to wet	**SILTY CLAY TO CLAYEY SILT,** moderately plastic, stiff to firm, no odor
				L		7.9	N			
180										
									wet	**SAND WITH SILT & GRAVEL,** coarse sand & gravel zones in part, loose to slightly firm, no odor
185										
				L		6.0	N			
190								CL		**CLAYEY SILT,** with trace sand & gravel, slight plastic, caliche in parts, compacted, stiff, no odors, no stains
195						4.0				
				L		4.3	N			note: more clay, stiff soil is not wet inside core, mottled, caliche stringers at 199'
200										

GROUNDWATER

DEPTH (ft)	HOUR	DATE
	none	

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ08

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-10-13 thru 2-13-13

LOCATION N838050.5, E774317.1
WELL REG. # ADWR Reg.# 55-915199
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1339.6'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
200									very moist	**CLAYEY SILT,** continued note: silty clay is white gray marl or caliche, moderate plastic from 200' to 202'
								CL	wet	**STIFF CLAY,** dark brown, moderately to very plastic, compacted, stiff, no odors, no stains
205				L		2.3	N			note: clay with sand & gravel in parts, tight stiff at 207'
210									wet	note: more sand from 210' to 212'
								SW	wet	**SAND WITH GRAVEL,** medium to coarse grained, well graded, dark gray with zone of black staining, loose
215						80	N	SW		**SILTY CLAY TO CLAYEY SILT,** as above, stiff, caliche in parts, mild hydrocarbon odor, black stains
220				L		1130	Y		slight to moderate NAPL indication	note: moderate odor
								GW	wet	**GRAVELLY SAND,** 30% gravel, 70% sand, well graded, gravel/cobbles up to 4", subrounded to rounded, dark gray, loose, stained, strong odor
225										

GROUNDWATER

DEPTH (ft)	HOUR	DATE
	none	

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ08

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-10-13 thru 2-13-13

LOCATION N838050.5, E774317.1
WELL REG. # ADWR Reg.# 55-915199
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1339.6'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
225				L		930	Y	GW	strong NAPL indication	**GRAVELLY SAND,** continued note: strong odor, staining sheen
						32				
230								ML/GM		**SILTY/CLAYEY GRAVEL,** gravel with sand to gravelly silt, slight plastic, gravel up to 3", subrounded, minor odor
									wet	**SILTY SAND TO SANDY SILT,** 30% silt, 70% sand, fine to medium grained sand, nonplastic, dark brown, loose to slightly firm, no odor
235				L		3.5	N			**SAND WITH SILT & GRAVEL,** 15% gravel, 70% sand, 15% fines, well graded, light brown, loose
240									very moist to wet	**STIFF SILTY CLAY WITH GRAVEL,** 10% gravel, 5% sand, 85% fines, moderate plastic, brown, stiff, compacted, no odor
245										Stopped Drilling at 242'6" Clean out hole & prepare for LS2 well installation
250										

GROUNDWATER

DEPTH (ft)	HOUR	DATE
	none	

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ08

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-11-13 thru 2-13-13

LOCATION N837959.2, E774263.6
WELL REG. # ADWR Reg.# 55-915200
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1339.8'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
0				*						Surface volcanic landscape cobbles
								SM	dry to slightly moist	**FILL Material** **Aggregate Base Course** **SILTY SAND WITH GRAVEL,** fine grained sand, 20% to 30% gravel, fine to coarse grained, ~30% silt, uncemented, nonplastic, brown
5						0.0				
								SM	dry to slightly moist	**SILTY SAND,** predominantly very fine grained sand, ~40% silt, weak calcium carbonate content with filaments, nonplastic, light brown, no odors, no stains note: trace clay content <5% starting at 11', increase calcium carbonate content at 11' to 12'6", whitish-brown to white filaments
10						0.8				
15						1.9				
								SM	dry to slightly moist	**SILTY SAND WITH GRAVEL,** fine to coarse grained sand, subangular to subrounded, ~30% silt, ~5% clay ~20% fine to coarse grained gravel, subangular to subrounded, uncemented, nonplastic, brown
20						1.9				
								SM	dry to slightly moist	**SILTY SAND,** predominantly very fine to fine grained sand, ~20% to 30% silt, weak calcium carbonate content, nonplastic, brown to light brown note: at 21' increase in sand content
25						2.3				

GROUNDWATER

DEPTH (ft)	HOUR	DATE
146.0	12:00	2-12-13

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ09

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-11-13 thru 2-13-13

LOCATION N837959.2, E774263.6
WELL REG. # ADWR Reg.# 55-915200
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1339.8'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
25								SM	dry to slightly moist	**SILTY SAND,** continued
										note: at 29', black colored striations in soil, possibly organic, iron-oxide type stain 'root-like"
30						1.7				
								SW-SM	dry to slightly moist	**WELL GRADED SAND WITH SILT & GRAVEL,** predominantly fine to coarse grained sand, subangular to subrounded, ~10% silt, ~20% fine to coarse grained gravel, subangular to subrounded, uncemented, nonplastic, brown, no odors, no stains
						1.9				
								SP-SM	dry to slightly moist	**POORLY GRADED SAND WITH SILT,** predominantly fine grained sand, subangular to subrounded, ~10% silt, uncemented, nonplastic, brown, no odors, no stains note: fine to coarse grained gravel at 37', ~5% to 10%
						1.6				
35										
						1.5				
				L		2.0		SM	dry to slightly moist	**SILTY SAND,** predominantly very fine grained sand, ~20% silt, uncemented, nonplastic, brown, no odors, no stains
								SW	dry to slightly moist	**WELL GRADED SAND,** predominantly fine to coarse gained sand, subangular to subrounded, <10% silt, <10% gravel, uncemented, nonplastic, light brown, no odors, no stains
						2.2				
40										
								SP-SM	dry to slightly moist	**POORLY GRADED SAND WITH SILT,** predominantly very fine to fine grained sand, ~10% silt, <5% gravel, uncemented to strongly cemented nodules, nonplastic, light brown, no odors, no stains
						3.3				
						3.9				
								SM	dry to slightly moist	**SILTY SAND,** predominantly very fine grained sand, ~30% silt, moderately cemented with strongly cemented nodules, nonplatic, light brown to whitish-brown to white, no odors, no stains
45										
						10.2				
				L		10.5				
						5.7				
50										

GROUNDWATER

DEPTH (ft)	HOUR	DATE
146.0	12:00	2-12-13

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ09

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-11-13 thru 2-13-13

LOCATION N837959.2, E774263.6
WELL REG. # ADWR Reg.# 55-915200
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1339.8'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
50								SM	dry to slightly moist	**SILTY SAND,** continued
						1.9				
						1.9				
								SM-SC	dry to slightly moist	**SILTY SAND WITH CLAY,** predominantly very fine grained sand, ~30% silt, 10% clay, moderately calcium carbonate content, moderately cemented nodules, nonplastic, light brown to brown, no odors, no stains
55						2.3				
				L		2.6				
						2.5				
60										
						2.5				
						2.8		SC	dry to moist	**CLAYEY SAND,** predominantly very fine grained sand, ~20% clay, ~5% silt, weak calcium carbonate content, low plasticity, brown with orange tint
65						3.3				
				L		4.2				
						1.8				
70										
								SM	dry to slightly moist	**SILTY SAND,** predominantly very fine grained sand, ~20% silt, <5% clay, uncemented, nonplastic, brown, no odors, no stains
						3.7				
								SP-SM	dry to slightly moist	**POORLY GRADED SAND WITH SILT,** predominantly very fine to fine grained sand, ~10% silt, <5% gravel, uncemented, nonplastic, brown, no odors, no stains
						3.0				
75										

GROUNDWATER

DEPTH (ft)	HOUR	DATE
146.0	12:00	2-12-13

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ09

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-11-13 thru 2-13-13

LOCATION N837959.2, E774263.6
WELL REG. # ADWR Reg.# 55-915200
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1339.8'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
75								SP-SM		**POORLY GRAVEL SAND WITH SILT,** continued
						5.0				note: below 74' trace coarse grained sand to fine grained gravel, subangular to subrounded ~5%
								SW-SM		**WELL GRADED SAND WITH SILT & GRAVEL,** very fine to coarse grained sand, subangular to subrounded, ~10% silt, ~10% to 20% fine to coarse grained gravel, subangular to subrounded, weak calcium carbonate cementation with moderately cemented nodules, nonplastic, light brown, no odors, no stains
				L		5.5			slightly moist to dry	
						3.0				
80								SC		**CLAYEY SAND,** predominantly very fine gained sand, ~20% clay, ~5% silt, uncemented, low plasticity, reddish-brown with orange tint, no odors, small specks of charcoal-like fragments
						2.4			dry to slightly moist	
								SM		**SILTY SAND,** predominantly very fine grained sand, ~20% to 30% silt, weak to moderate calcium carbonate content with moderately to strongly cemented nodules, nonplastic, light brown, no odors, no stains
						2.6			dry to slightly moist	
85						3.0				
								SC		**CLAYEY SAND,** predominantly very fine grained sand, ~30% to 40% clay, weak calcium carbonate content, low to medium plasticity, brown to reddish-brown, no odors, no stains
						3.9			dry to slightly moist	
								SP-SM		**POORLY GRADED SAND WITH SILT,** predominantly very fine grained sand, <5% clay, ~10% silt, uncemented, nonplastic, brown, no odors, no stains
				L		4.8				
90						3.8			dry to slightly moist	
						3.7				
95						3.2				note: between 96' to 96'6" well graded sand lense
						2.5				note: calcium carbonate filaments, white color at 99'
100				L		5.0				

GROUNDWATER

DEPTH (ft)	HOUR	DATE
146.0	12:00	2-12-13

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ09

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-11-13 thru 2-13-13

LOCATION N837959.2, E774263.6
WELL REG. # ADWR Reg.# 55-915200
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1339.8'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
100								SP-SM		**POORLY GRADED SAND WITH SILT,** continued note: below 100' trace clay ~5% note: faint odors below 100'
						2.8				
						2.3				
105						4.0				
								SP	slightly moist	**POORLY GRADED SAND,** predominantly very fine to fine grained sand, ~5% silt, <5% clay, uncemented with weak cemented nodules, nonplastic, brown, faint odor, no stains
				L		4.5				
						3.4				
110								SW	slightly moist	**WELL GRADED SAND WITH GRAVEL,** fine to coarse grained sand, subangular to subrounded, fine to coarse grained gravel, subangular to subrounded ~20%, uncemented, nonplastic, brown, no odors, no stains note: silty sand lense between 112' to 112'6" note: cobbles between 112'6" to 114'
						1.4				
						2.7				
								SP	slightly moist	**POORLY GRADED SAND,** predominantly fine grained sand, uncemented, nonplastic, brown, no odors, no stains note: at 115'6" to 116', calcium carbonate content with strongly cemented nodules, white color note: below 116', trace clay
115				L		4.0				
								SM		
						4.1				
									slightly moist	**SILTY SAND,** predominanly very fine to fine grained sand, ~20% to 30% silt, ~5% clay, calcium carbonate content, weak nodules, nonplastic, light brown to brown, faint odor, no stains note: moderately cemented nodules between 120' to 121'6", whitish-brown note: clayey sand lense between 122' to 122'6"
120						4.4				
						3.2				
								SP-SM		**POORLY GRADED SAND WITH SILT,** predominantly very fine to fine grained sand, ~10% silt, <5% clay, uncemented, nonplastic, brown, faint odors no stains
						2.1				
125										

GROUNDWATER

DEPTH (ft)	HOUR	DATE
146.0	12:00	2-12-13

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ09

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-11-13 thru 2-13-13

LOCATION N837959.2, E774263.6
WELL REG. # ADWR Reg.# 55-915200
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1339.8'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
125								SP-SM	slightly moist	**POORLY GRADED SAND WITH SILT,** continued
						3.5				
								SC	slightly moist	**CLAYEY SAND,** predominantly very fine to fine grained sand, ~20% clay, calcium carbonate filaments, low plasticity, brown, faint odors, no stains
				L		5.2				
						4.0				
130										
								SP-SC	slightly moist	**POORLY GRADED SAND WITH CLAY,** predominantly very fine to fine grained sand, ~10% clay, calcium carbonate content with filaments, nonplastic, brown, moderate odors, no stains
				L		4.9				
								SP	slightly moist	**POORLY GRADED SAND,** predominantly very fine to fine grained sand, <5% to 5% fines (silt/clay), nonplastic, faint to moderate odors, no stains, charcoal-like flakes at 136' (small, infrequent) note: predominantly fine grained sand below 137'6", subangular to subrounded & <5% gravels, fine grained, subangular to subrounded
						4.6				
135						4.5				
						4.2				
140						4.0				
						4.5		SW-GW	slightly moist to moist	**WELL GRADED SAND & GRAVEL,** ~70% fine to coarse grained sand, subangular to subrounded, ~30% fine to coarse grained gravel, subangular to subrounded, <5% to 5% fines, uncemented, nonplastic, grayish-brown, faint odors, no stains
						3.2				
145								SP	moist to wet	**POORLY GRADED SAND WITH GRAVEL,** predominantly fine grained sand, ~5% coarse grained sand, subangular to subrounded, 5% fines (silt/clay), ~20% fine grained gravel, subangular to subrounded, uncemented, nonplastic, brown, no odors, no stains
▽						4.4				
				L		8.7				
150						6.5				

GROUNDWATER

DEPTH (ft)	HOUR	DATE
146.0	12:00	2-12-13

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ09

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-11-13 thru 2-13-13

LOCATION N837959.2, E774263.6
WELL REG. # ADWR Reg.# 55-915200
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1339.8'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
150								CL	slightly moist	**CLAY,** predominantly clay, ~5% sand, very fine grained, ~5% silt, weak calcium carbonate content, high plasticity, brown to reddish-brown, no odors, no stains
						6.6				
								GW/SW	wet	**WELL GRADED GRAVEL & SAND WITH COBBLES,** predominantly fine to coarse grained gravel, subangular to subrounded, ~40% fine to coarse grained sand, subangular to subrounded, ~5% fines (silt/clay), ~5% to 10% cobbles, subangular to subrounded, uncemented, nonplastic, brown to grayish-brown, no odors, no stains
						4.6				
155										
						5.7				
								CL	slightly moist to moist	**CLAY,** predominantly clay, ~5% very fine grained sand, <5% silt, uncemented, medium to high plasticity, brown with orange tint, no odors, no stains
						4.5				
								SC	slightly moist to moist	**CLAYEY SAND,** ~60% very fine grained sand, ~40% clay, <5% silt, uncemented, low plasticity, brown to orange tint, no odors, no stains
								CL		
				L		7.8			slightly moist	**CLAY,** ~90% clay, <10% silt, calcium carbonate content with strongly cemented nodules, medium to high plasticity, light brown, no odors, no stains
160										
						13.5		SP-SC	slightly moist	**POORLY GRADED SAND WITH CLAY,** predominantly very fine to fine grained sand, ~10% clay, 5% silt, weak calcium carbonate content specks of charcoal-like filaments, possibly organic, nonplastic to very low plasticity, moderate odors
						27.4				
165										
						91.3				
								CL	slightly moist	**CLAY WITH SAND,** predominantly clay, ~20% very fine grained sand, calcium carbonate, medium plasticity, brown, strong odors, no stains
						259.9				
				L		542.0	Y (mod)			
170										
								SP-SC		**POORLY GRADED SAND WITH CLAY,** predominantly very fine grained sand, ~10% clay, nonplastic, brown, moderate odors, no stains
				L		133.7	N			
								SP		**POORLY GRADED SAND,** predominantly very fine to fine grained sand, ~5% fines (silt/clay), uncemented, nonplastic, dark brown, moderate odors, no stains note: ~10% gravels, fine to coarse grained between 176' to 177'
						27.8				
175										

GROUNDWATER

DEPTH (ft)	HOUR	DATE
146.0	12:00	2-12-13

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ09

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-11-13 thru 2-13-13

LOCATION N837959.2, E774263.6
WELL REG. # ADWR Reg.# 55-915200
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1339.8'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
175								SP	moist to wet	**POORLY GRADED SAND,** continued
						14.1				
								SM	moist to wet	**SILTY SAND WITH GRAVEL,** predominantly well graded sand, fine to coarse grained, subangular to subrounded, ~20% silt, ~20% fine to coarse grained gravel, subangular to subrounded, uncemented, nonplastic, dark brown, moderate odors, no stains
						5.8				
180						4.7				
						1.7				
						2.7				
185								SC		**CLAYEY SAND,** predominantly very fine grained sand, ~40% clay, weak calcium carbonate content, medium plasticity, brown, low odors, no stains
						5.9				
						7.4				
190				L		7.6	N			
								SW/GW	wet to moist	**WELL GRADED SAND & GRAVEL,** predomimnantly fine to coarse grained sand, subangular to subrounded, ~20% to 30% fine to coarse grained gravel, subangular to subrounded, 5% cobbles, subangular to subrounded, ~<10% fines (silt/clay), cemented, nonplastic, brown
						14.4				
						4.0				
195							N			
								CL	slightly moist to moist	**SILTY CLAY,** ~60% clay, ~40% silt, ~5% very fine grained sand, weak calcium carbonate content, low to medium plasticity, brown, black specks/streaks, moderate to strong odors
						444.0				
				L		1146.0	Y (low to mod)			
200						628.8				note: increase sand content at 199'

GROUNDWATER

DEPTH (ft)	HOUR	DATE
146.0	12:00	2-12-13

SAMPLE TYPE
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S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ09

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-11-13 thru 2-13-13

LOCATION N837959.2, E774263.6
WELL REG. # ADWR Reg.# 55-915200
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1339.8'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
200								CL	slightly moist to moist	**SILTY CLAY,** continued
						1272.0				
						1406.0				
205										note: from 204' to 208' increase calcium carbonate content, moderate to weak cemented nodules
						1155.0				
						1727.0				
								SC	wet to moist	**CLAYEY SAND,** predominantly poorly graded sand, fine grained, subangular to subrounded, ~5% gravel, subangular to subrounded, ~30% clay, pockets of clay, uncemented, low plasticity to nonplastic, dark brown to reddish-brown clay pockets, moderate odors, black stain streaks, infrequent
210				L		1789.0	Y (mod)			
						101.5				
						541.8				
215								SW-SM	wet to moist	**WELL GRADED SAND WITH SILT,** predominantly fine to coarse grained sand, subangular to subrounded, ~10% fines (silt), <5% clay, ~10% fine to coarse grained gravel, subangular to subrounded, calcium carbonate content, nonplastic, light brown, strong odors, black streaks
						314.7				
								CL-ML	slightly moist to dry	**CLAYEY SILT,** ~60% silt, ~40% clay, calcium carbonate content, low plasticity, brown to light brown, moderate odors, no stains
						992.9				
220				L		1150.0	Y (low to mod)			
						582.9				
								SW/GW	wet	**WELL GRADED SAND & GRAVEL,** 70% fine to coarse grained sand, subangular to subrounded, ~30% fine to coarse grained gravel, subangular to subrounded, ~5% to <10% fines (silt/clay), uncemented, nonplastic, grayish-brown
				L		1391.0	Y			
225										

GROUNDWATER

DEPTH (ft)	HOUR	DATE
146.0	12:00	2-12-13

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ09

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-11-13 thru 2-13-13

LOCATION N837959.2, E774263.6
WELL REG. # ADWR Reg.# 55-915200
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1339.8'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
225								SW/GW	wet	**WELL GRADED SAND & GRAVEL,** continued
						963.4				
						330.0		SP	wet to moist	**POORLY GRADED SAND,** predominantly very fine to fine grained sand, subangular to subrounded, <5% gravel, subangular to subrounded, uncemented, nonplastic, grayish color, moderate odors, staining
								CL		
						1096.0	Y (low)		slightly moist to moist	**CLAY WITH SAND,** predominantly clay, ~10% fine grained sand, rare coarse grained sand, subangular to subrounded, <5% fine grained gravel, subangular to subrounded, weak calcium carbonate content, medium plasticity, brown with orange tint, moderate odors, black streaks, infrequent
230								SP		
						14.5				
								SM	moist	**POORLY GRADED SAND,** predominantly very fine to fine grained sand, subangular to subrounded, <10% fines, uncemented, nonplastic, dark brown, no odors, no stains
						10.6	N			
235								SW/GW	slightly moist	**SILTY SAND,** predominantly very fine to fine grained sand, ~30% silt, ~5% clay, weak calcium carbonate content, nonplastic, brown, no odors, no stains
						6.2			moist	**WELL GRADED SAND WITH GRAVEL,** predominantly fine to coarse grained sand, subangular to subrounded, ~20% fine to coarse grained gravel, subangular to subrounded, fines (5%), uncemented, nonplastic, dark brown, no odors, no stains, moderately cemented nodules
240				L		68.0	N			note: trace clay at 240'
								CL-ML	dry to slightly moist	**SILTY CLAY,** ~60% clay, ~40% silt, calcium carbonate content, medium plasticity, light brown, no odors, no stains
						20.5				
245										Stopped Drilling at 242'6" Well Installed
250										

GROUNDWATER

DEPTH (ft)	HOUR	DATE
146.0	12:00	2-12-13

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ09

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-18-13 thru 2-20-13

LOCATION N837802.3, E774340.6
WELL REG. # ADWR Reg.# 55-915201
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1339.7'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
0				*				SC	dry	**CLAYEY SAND,** ~70% very fine to medium grained, subrounded to subangular sand, ~30% clay, uncemented, reacts to HCL, medium plasticity, brown, no odor
5						0.6				note: decrease in clay to 20% below 6' note: weakly cemented from 6' to 10'
10						0.9		SP	dry	**SAND,** ~95% very fine to medium grained, subrounded to subangular sand, ~5% clay, uncemented, low plasticity to nonplastic, brown, no odor
15						1.8		SC	dry	**CLAYEY SAND,** ~70% very fine to fine grained sand, ~30% clay, uncemented, medium plasticity, brown, no odor
20						1.4		SP-SC	dry	**SAND WITH CLAY,** ~80% very fine to medium grained, subrounded to subangular sand, ~10% clay, uncemented, low plasticity, brown, no odor
25						0.9				

GROUNDWATER

DEPTH (ft)	HOUR	DATE

SAMPLE TYPE
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S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ10

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-18-13 thru 2-20-13

LOCATION N837802.3, E774340.6
WELL REG. # ADWR Reg.# 55-915201
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1339.7'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
25								SC	dry	**CLAYEY SAND,** ~80% very fine to fine grained sand, ~20% clay, uncemented, medium plasticity, brown, no odor
						0.9				
30						4.5				
						10.4				note: strongly cemented sand layer with rare coarse grained gravel from 31'10" to 32'6"
				L		22.8				
						4.9		CL-ML	dry	**SILTY SANDY CLAY,** ~50% clay, 30% silt, ~20% very fine grained sand, uncemented, low plasticity, dark brown, no odor
						20.5				
						1.7				
35						7.6				note: decrease in sand below 35'
						3.2				
						3.1				
						3.3				
						2.3				
40								SP-SM	dry	**SAND WITH SILT,** ~90% very fine to fine grained sand, ~10% silt, uncemented, nonplastic, brown, no odor
								SP	dry	**SAND,** fine to medium grained, subrounded to subangular sand, uncemented, nonplastic, light brown, no odor
						4.1				
										note: ~10% fine grained, subrounded to subangular gravel below 43'
45										
				L		2.4		SP-SC	dry	**SAND WITH CLAY,** ~85% very fine to fine grained sand, ~15% clay, moderately to strongly cemented nodules, low plasticity, brown, no odor
						2.2				
50										

GROUNDWATER

DEPTH (ft)	HOUR	DATE

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
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U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ10

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-18-13 thru 2-20-13

LOCATION N837802.3, E774340.6
WELL REG. # ADWR Reg.# 55-915201
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1339.7'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
50								SP-SC	dry	**SAND WITH CLAY,** continued
								SP	dry	**SAND,** ~90% fine to medium grained, subrounded to subangular sand, ~10% fine grained, subrounded to subangular gravel, uncemented, nonplastic, light brown, no odor
						3.1				
								CL	slightly moist	**SANDY CLAY,** ~60% clay, ~40% very fine to fine grained sand, weakly cemented with strongly cemented nodules, medium plasticity, brown, no odor
55				L						
						2.3				
60										note: decrease to ~25% sand from 58' to 65'
						1.5				
65				L						
						1.8				
70										
						3.1		SC	slightly moist to dry	**CLAYEY SAND,** ~70% very fine grained sand, ~30% clay, weakly cemented with strongly cemented nodules, low plasticity, brown, no odor
75										

GROUNDWATER

DEPTH (ft)	HOUR	DATE

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ10

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-18-13 thru 2-20-13

LOCATION N837802.3, E774340.6
WELL REG. # ADWR Reg.# 55-915201
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1339.7'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
75								SC		**CLAYEY SAND,** continued
				L		2.1				
								SP	dry	**SAND WITH GRAVEL,** ~85% fine to medium grained, subrounded to subangular sand, ~15% fine grained, subrounded to subangular gravel, uncemented, nonplastic, light brown, no odor
						2.4				note: increased to ~25% fine to coarse grained, subrounded to angular gravel below 78'
80								SC	slightly moist to moist	**CLAYEY SAND,** ~70% fine to medium grained, subrounded to subangular sand, ~30% clay, weakly to moderately cemented with strongly cemented nodules, medium to high plasticity, brown, no odor
85				L		3.1				note: strongly cemented layer from 85'6" to 86'6" & 87'6" to 88'6"
						2.9				
90								SC	dry	**CLAYEY SAND,** ~80% very fine to fine grained sand, ~20% clay, uncemented, medium plasticity, brown
								SP	dry	**SAND,** very fine to fine grained sand, uncemented, nonplastic, brown, no odor
				L		1.2				note: slight menthol odor from 92' to 95'
95								SP	dry	**SAND WITH GRAVEL,** ~75% fine to medium grained, subrounded to subangular sand, ~25% fine to coarse grained, subrounded to subangular gravel, uncemented, nonplastic, brown & gray, no odor
100								SC		**CLAYEY SAND**

GROUNDWATER

DEPTH (ft)	HOUR	DATE

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ10

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-18-13 thru 2-20-13

LOCATION N837802.3, E774340.6
WELL REG. # ADWR Reg.# 55-915201
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1339.7'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
100								SC	slightly moist to moist	**CLAYEY SAND,** ~60% very fine to fine grained sand, ~40% clay, moderately to strongly cemented, medium plasticity, light brown to white, no odor
						2.9				
										note: decreased cementation below 102'6"
105										note: slight odor below 105'
				L		2.8				
						3.5				
110										
				L		2.7	N			
								SP	dry	**SAND WITH GRAVEL,** ~70% well graded, subrounded to angular sand, ~30% predominantly fine grained, subrounded to subangular gravel, <5% cobbles up to 4 1/2" in diameter, uncemented, nonplastic, brown & gray
						4.6				
115										note: has an odor like chemicals, but I'm not sure exactly what & the PID & NAPL don't show anything
								SC	slightly moist to dry	**CLAYEY SAND,** ~60% very fine to fine grained sand, ~40% clay, weakly cemented, medium plasticity, brown, no odor
						2.8				
120										note: increase sand to ~80% from 120'6" to 122'
						3.8				
125										

GROUNDWATER

DEPTH (ft)	HOUR	DATE

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ10

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-18-13 thru 2-20-13

LOCATION N837802.3, E774340.6
WELL REG. # ADWR Reg.# 55-915201
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1339.7'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
125								SC	dry to moist	**CLAYEY SAND,** continued
				L						
						3.6	N			note: ~10% silt from 124'6" to 127'
130						1.5				
135				L		2.0				
						3.1				
								SP	dry to moist	**SAND WITH GRAVEL,** ~70% predominantly fine to medium grained, subrounded to subangular sand, ~30% predominantly coarse grained, subrounded gravel, uncemented, nonplastic, brown & gray, chemical odor
140										
								GW	wet but not saturated at 145'	**GRAVEL WITH SAND,** ~60% well graded, subrounded to angular gravel, ~40% well graded, subrounded to subangular sand, uncemented, nonplastic, brown & gray, chemical odor
				L		1.2	N			
145										note: ~5% clay from 145' to 147'
								SC	moist to wet	**CLAYEY SAND,** ~70% fine to medium grained, subrounded to subangular sand, ~25% clay, ~5% fine grained, subrounded to subangular gravel, moderately to strongly cemented, low plasticity, brown, no odor
						1.7				note: decrease cementation below 148'
150										

GROUNDWATER

DEPTH (ft)	HOUR	DATE

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U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ10

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-18-13 thru 2-20-13

LOCATION N837802.3, E774340.6
WELL REG. # ADWR Reg.# 55-915201
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1339.7'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
150								SC		**CLAYEY SAND,** continued
								GW		note: decrease clay to ~15% below 149'
						2.1			wet	**GRAVEL WITH SAND,** ~70% well graded, subrounded to subangular gravel, ~30% well graded, subrounded to subangular sand, uncemented, nonplastic, brown & gray, no odor
								SC		
155				L		0.3			moist to wet	**CLAYEY SAND,** ~70% fine to medium grained, subrounded to angular sand, ~30% clay, uncemented to strongly cemented (soft material interbedded with considerable coarse grained gravel-sized strongly cemented nodules), medium plasticity, brown
										note: slight menthol odor from 153' to 157'
										note: increase to ~40% clay below 157'
						1.3				note: decrease in cementation below 160' & fuel odor below 160'
160						6.3				
						202				note: strong fuel odor below 163', some orange & dark brown staining from 163' to 164'6"
				L		1286	Y			
165								CL	moist	**SILTY SANDY CLAY,** ~40% clay, ~30% silt, ~30% very fine grained sand, uncemented with occasional strongly cemented nodules, low plasticity, brown, strong fuel odor
						985				
170										note: decrease to ~20% sand below 171'
				L						
						801	Y			
175										

GROUNDWATER

DEPTH (ft)	HOUR	DATE

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U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ10

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-18-13 thru 2-20-13

LOCATION N837802.3, E774340.6
WELL REG. # ADWR Reg.# 55-915201
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1339.7'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
175								SP-GP	wet	**SAND & GRAVEL,** ~50% predominantly medium to coarse grained, subrounded to subangular sand, ~50% predominantly coarse grained, subrounded gravel, uncemented, nonplastic, dark gray, strong fuel odor
						180	N			
								SP	wet	**SAND,** ~85% fine to medium grained, subrounded to subangular sand, ~15% predominantly fine grained, subrounded to subangular gravel, <5% clay, uncemented, nonplastic, brown, strong fuel odor
						240				
180								CL		note: clayey layer from 178' to 178'6"
						358			moist	**SANDY CLAY,** ~70% clay, ~30% very fine to fine grained sand, weakly cemented with considerable fine grained gravel-sized strongly cemented nodules, medium to high plasticity, brown, strong fuel odor
				L						
						1211	Y			note: layer of increased sand & lower plasticity from 183' to 185'
185										note: decreased cementation below 183'
						1189				
								SP	wet	**SAND,** ~95% predominantly fine to medium grained, subrounded to subangular sand, ~5% fine grained, subrounded gravel, uncemented, nonplastic, brown, strong fuel odor
190										
								SC	moist	**CLAYEY SAND,** ~60% very fine to fine grained sand, ~40% clay, moderately cemented, medium plasticity, light brown, strong fuel odor
				L		1424				
195										note: sand layer from 195' to 195'6"
						1175				
						1002				
200										

GROUNDWATER

DEPTH (ft)	HOUR	DATE

SAMPLE TYPE
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T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ10

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-18-13 thru 2-20-13

LOCATION N837802.3, E774340.6
WELL REG. # ADWR Reg.# 55-915201
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1339.7'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
200								SC	moist	**CLAYEY SAND,** continued
						73				note: decrease in cementation from 197' to 199'
205						1385				
								SP	wet	**SAND,** ~85% predominantly fine to medium grained, subrounded to subangular sand, ~10% fine grained, subrounded to subangular gravel, ~5% clay, uncemented, low plasticity to nonplastic, brown, strong fuel odor
				L						
						1450	Y			
210										
								SW	wet	**SAND WITH GRAVEL,** ~70% well graded, subrounded to subangular sand, ~30% predominantly fine grained, subrounded sand, uncemented, nonplastic, dark brown, strong fuel odor
						1345				
										note: increase in coarse grained gravel below 213'
215										
				L		1426	Y	SC	moist	**CLAYEY SAND,** ~70% very fine to fine grained sand, ~25% clay, ~5% silt, uncemented, medium plasticity, brown, strong fuel odor
						1152				
220								SP-SC	wet	**SAND WITH CLAY,** ~85% predominantly fine to medium grained sand, ~15% clay, uncemented, low plasticity, brown, strong fuel odor
				L		2060	Y			
						1909				
225										

GROUNDWATER

DEPTH (ft)	HOUR	DATE

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ10

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-18-13 thru 2-20-13

LOCATION N837802.3, E774340.6
WELL REG. # ADWR Reg.# 55-915201
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1339.7'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
225								SW	wet	**SAND WITH GRAVEL,** ~70% well graded, subrounded to subangular sand, ~25% predominantly fine grained, subrounded to subangular sand, ~5% clay, uncemented, nonplastic to low plasticity, brown & gray, strong fuel odor
						1770				
230								SP	wet	**SAND,** predominantly fine to medium grained, subrounded to subangular sand, uncemented, nonplastic, brown, little to no odor note: ~10% fine grained gravel below 236'6"
				L		2.3	N			
235						0.9				
								SW	wet	**SAND WITH GRAVEL,** ~60% well graded, subrounded to angular sand, ~40% predominantly fine grained, subrounded to subangular gravel, uncemented, nonplastic, brown & gray, no odor
						0.1				
240								CL	slightly moist	**SANDY CLAY,** ~60% clay, ~40% very fine to fine grained sand, weakly to moderately cemented, medium to high plasticity, light brown, no odor
245										Stopped Drilling at 242'6" Well Installed
250										

GROUNDWATER

DEPTH (ft)	HOUR	DATE

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ10

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-25-13 thru 2-28-13

LOCATION N837765.1, E774512.0
WELL REG. # ADWR Reg.# 55-915202
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1341.0'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
0				*				CL	moist	**CLAY,** ~90% clay, ~10% very fine to fine grained sand, uncemented, medium to high plasticity, dark brown, no odor
						0.8				
5								SP	dry	**SAND,** very fine grained sand, <5% silt, uncemented with few weakly cemented nodules, nonplastic, brown, no odor
						0.8				
								SP-SC	dry	**SAND WITH CLAY,** ~90% very fine to fine grained sand, ~10% clay, uncemented, low plasticity, brown, no odor
10										note: clayey layer from 12' to 13'6"
						1.2				
						1.1				
15										
						1.5				
20										
						1.3				
25										

GROUNDWATER

	DEPTH (ft)	HOUR	DATE
▽			
▼			
▼			
▼			

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ11

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-25-13 thru 2-28-13

LOCATION N837765.1, E774512.0
WELL REG. # ADWR Reg.# 55-915202
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1341.0'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
25								SP-SC		**SAND WITH CLAY,** continued
						1.5		SC	slightly moist	**CLAYEY SAND,** ~80% very fine to medium grained, subrounded to subangular sand, ~20% clay, uncemented, low plasticity, brown, no odor
30										
						1.7		SP	dry	**SAND,** ~90% predominantly fine to medium grained, subrounded to subangular sand, 10% fine grained, subrounded to subangular gravel, uncemented, nonplastic, brown, no odor
35								SC	slightly moist	**CLAYEY SAND,** ~75% very fine to fine grained sand, ~25% clay, uncemented, low to medium plasticity, brown, no odor note: moderately cemented nodules below 36'
						1.3				
								SP	dry	**SAND,** very fine to fine grained sand, uncemented, nonplastic, brown, no odor
40						0.9				
								SC	dry	**CLAYEY SAND,** ~70% very fine to medium grained, subrounded to subangular sand, ~30% clay, weakly cemented with strongly lime cemented nodules, medium plasticity, brown, no odor note: increase in cementation below 44'
45						0.9		CL	slightly moist	**SANDY CLAY,** ~60% clay, ~40% very fine to medium grained sand, weakly lime cemetned with strongly cemented nodules, medium plasticity, brown, no odor
								SP-SM-SC		**SAND WITH SILT & CLAY,** ~90% very fine to fine grained sand, ~5% clay, ~5% silt, uncemented, nonplastic to low plasticity, brown, no odor, note: clayey lense from 48'2" to 48'6"
50										

GROUNDWATER

DEPTH (ft)	HOUR	DATE

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ11

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-25-13 thru 2-28-13

LOCATION N837765.1, E774512.0
WELL REG. # ADWR Reg.# 55-915202
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1341.0'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
50								SP-SM-SC		**SAND WITH SILT & CLAY,** continued
						1.5		SP	dry	**SAND,** predominantly fine to medium grained sand, uncemented, nonplastic, gray, no odor
55						2.5		CL	slightly moist	**SANDY CLAY,** ~60% clay, ~40% very fine grained sand, uncemented with few moderately cemented nodules, medium plasticity, brown, no odor note: sand layer from 58' to 58'4"
60						1.8		SC	slightly moist	**CLAYEY SAND,** ~70% very fine to fine grained sand, ~30% clay, moderately to strongly cemented, medium plasticity, light brown to white, no odor note: decrease in cementation below 60'6"
65						2.6				note: increase to 40% clay below 65'
70						0.5				
75						1.6		SP-SM		**SAND WITH SILT**

GROUNDWATER

DEPTH (ft)	HOUR	DATE

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ11

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-25-13 thru 2-28-13

LOCATION N837765.1, E774512.0
WELL REG. # ADWR Reg.# 55-915202
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1341.0'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
75								SP-SM	dry	**SAND WITH SILT,** ~90% very fine to fine grained sand, ~10% silt, uncemented, nonplastic, brown, no odor
								SP	dry	**SAND WITH GRAVEL,** ~80% predominantly fine to medium grained sand, ~20% fine grained, subrounded gravel, uncemented, nonplastic, brown, no odor
								SM-SC	moist	**SILTY CLAYEY SAND,** ~60% very fine to medium grained, subrounded to subangular sand, ~20% clay, ~20% silt, uncemented, low plasticity, dark brown, no odor
						1.6				
80										
						5.7				note: weakly cemented below 84'
85								CL	moist	**SANDY CLAY,** ~60% clay, ~40% very fine to fine grained sand, weakly to moderately cemented, medium plasticity, brown & light gray, no odor
						1.4				
90								SM	slightly moist	**SILTY SAND,** ~60% very fine to fine grained sand, ~40% silt, uncemented, nonplastic, brown, no odor
						0.6				note: decrease to ~20% silt below 93'
95										
						0.5		SP	slightly moist	**SAND,** very fine to fine grained sand, uncemened, nonplastic, brown, no odor
100										

GROUNDWATER

DEPTH (ft)	HOUR	DATE

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ11

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-25-13 thru 2-28-13

LOCATION N837765.1, E774512.0
WELL REG. # ADWR Reg.# 55-915202
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1341.0'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
100								SP		**SAND,** continued
								SC		note: ~10% fine grained, subrounded gravel below 100'6"
						0.9			slightly moist	**CLAYEY SAND,** ~80% very fine to medium grained sand, ~20% clay, strongly cemented, medium plasticity, light gray, no odor note: decrease to weakly cemented below 102', uncemented below 103'
105								SC-SM	slightly moist	**SILTY CLAYEY SAND,** ~60% very fine to fine grained sand, ~25% clay, ~15% silt, uncemented, low plasticity, dark brown, no odor
						0.3		SP	dry	**SAND,** very fine to fine grained sand, uncemented, nonplastic, brown, no odor
110										
						0.2				
115										note: gravelly layer from 114'6" to 115' note: clayey layer from 116'10" to 117'2"
						0.5		SC	slightly moist	**CLAYEY SAND,** ~85% very fine to fine grained sand, ~15% clay, uncemented with strongly cemented, coarse grained gravel-sized nodules, low plasticity, brown, no odor
120										
								SP	dry	**SAND,** fine to medium grained, subrounded to subangular sand, uncemented, nonplastic, brown
						0.7		CL	moist	**SANDY CLAY,** ~60% clay, ~40% very fine to medium grained, subrounded to subangular sand, uncemented, medium to high plasticity, dark brown, no odor
125										

GROUNDWATER

DEPTH (ft)	HOUR	DATE

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ11

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-25-13 thru 2-28-13

LOCATION N837765.1, E774512.0
WELL REG. # ADWR Reg.# 55-915202
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1341.0'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
125								CL-ML	slightly moist	**SILTY CLAY,** ~50% clay, ~30% silt, ~20% very fine grained sand, uncemented, low plasticity, brown, no odor
						2.6				
						2.0				
130										note: strongly cemented layer from 134' to 134'6"
						3.2				
135								SC-SM	slightly moist	**SILTY CLAYEY SAND,** ~60% very fine to fine grained sand, ~25% clay, ~15% silt, uncemented, low plasticity, brown, no odor
140						0.9		SP	dry	**SAND WITH GRAVEL,** ~80% predominantly fine to medium grained, subrounded to subangular sand, ~20% predominantly fine grained, subrounded gravel, uncemented, nonplastic, brown & gray, no odor note: coarse grained gravel layer from 141' to 141'6"
						0.6				
145								GW	wet	**GRAVEL WITH SAND,** ~70% well graded, subrounded to subangular gravel, ~30% well graded, subrounded to subangular sand, uncemented, nonplastic, brown & gray, no odor note: clayey from 148'6" to 149'6"
						0.9				
150										

GROUNDWATER

DEPTH (ft)	HOUR	DATE

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ11

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-25-13 thru 2-28-13

LOCATION N837765.1, E774512.0
WELL REG. # ADWR Reg.# 55-915202
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1341.0'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
150								GW		**GRAVEL WITH SAND,** continued
						0.2				
						0.4				
				L			N			
155								SC		**CLAYEY SAND,** ~70% very fine to medium grained, subrounded to subangular sand, ~30% clay, weakly cemented with some strongly cemented nodules, medium plasticity, dark brown, no odor
						0.5			moist to wet	
						2.1				
160										
						3.3				
						5.0				
165										note: fuel odor starts at about 166'; sample from 165' to 166'6" fell out of the core barrel upon retreival so the sample is wet & not representative of the lithology
						59.3				
						184.9				
				L			Y (low)			
170										
				L		17.7	N			
						8.8				
175								SP		**SAND WITH GRAVEL**

GROUNDWATER

DEPTH (ft)	HOUR	DATE

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ11

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-25-13 thru 2-28-13

LOCATION N837765.1, E774512.0
WELL REG. # ADWR Reg.# 55-915202
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1341.0'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
175								SP	wet	**SAND WITH GRAVEL,** ~80% predominantly fine to medium grained, subrounded to subangular sand, ~20% predominantly fine grained, subrounded to subangular gravel, <5% clay (pockets of clayey material), uncemented, low plasticity to nonplastic, dark gray, fuel odor
						3.3				
						2.0				
								SC	moist to wet	**CLAYEY SAND,** ~70% very fine to fine grained sand, ~30% clay, uncemented to weakly lime cemented with some fine grained gravel-sized strongly lime cemented nodules, medium plasticity, dark brown, fuel odor
180										
						4.2				
						4.4				
185										
				L			Y			
						1312	(low)			note: moderately to strongly cemented from 185'6" to 186'6", decrease in sand to ~60% below 186'6"
						236				
190										
				L		1353	Y			
						1222				
195										
						226				note: moderately cemented from 194' to 195' & from 198' to 199' & from 208' to 209'
						218				
200										

GROUNDWATER

DEPTH (ft)	HOUR	DATE

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ11

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-25-13 thru 2-28-13

LOCATION N837765.1, E774512.0
WELL REG. # ADWR Reg.# 55-915202
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1341.0'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
200								SC		**CLAYEY SAND,** continued
						1736				
						1640				
205										
						1423				
				L		3558	Y			
210								SW	wet	**SAND WITH GRAVEL,** ~60% well graded, subrounded to subangular sand, ~40% predominantly fine grained, subrounded to subangular gravel, uncemented, nonplastic, brown & gray, strong fuel odor
				L		1328	Y			
								SC	moist	**CLAYEY SAND,** ~70% very fine to fine grained sand, ~20% clay, uncemented, medium plasticity, brown, strong fuel odor
						1337				
215						787				
						842				
220						60.1				note: few strongly cemented nodules from 221' to 221'6"
						75.2				
225										

GROUNDWATER

DEPTH (ft)	HOUR	DATE

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ11

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-25-13 thru 2-28-13

LOCATION N837765.1, E774512.0
WELL REG. # ADWR Reg.# 55-915202
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1341.0'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
225								SC	moist	**CLAYEY SAND,** continued
						1275		SW	wet	**SAND WITH GRAVEL,** ~60% well graded, subrounded to subangular sand, ~40% predominantly fine grained, subrounded to subangular gravel, uncemented, nonplastic, dark gray, fuel odor
				L		1291	Y			
230						41.2				
				L		65.2	N			
235						13.7				
						30.5				
240								CL	wet	**SANDY CLAY,** ~50% clay, ~35% well graded, subrounded to subangular sand, ~15% well graded, subrounded gravel, uncemented, medium plasticity, brown, slight fuel odor
						6.8				
						3.7		CL	moist	**SANDY CLAY,** ~70% clay, ~30% very fine to fine grained sand, uncemented, medium plasticity, brown, slight fuel odor
245										Stopped Drilling at 243'6" Well installed
250										

GROUNDWATER

DEPTH (ft)	HOUR	DATE

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ11

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-25-13 thru 2-28-13

LOCATION N837774.9, E774660.2
WELL REG. # ADWR Reg.# 55-915203
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1341.6'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
0				*						Asphalt at surface
								ML	dry to slightly moist	**SANDY SILT,** ~70% silt, ~30% very fine grained sand, calcium carbonate content, nonplastic, light brown, no odors, no stains
						1.8				
5										note: increase calcium carbonate content below 5', very light brown to whitish brown
										note: between 8' to 10' weakly to moderately cemented nodules
						1.3				
10										
								SM	dry to slightly moist	**SILTY SAND,** predominantly very fine to fine grained sand, ~20% silt, weak calcium carbonate content, nonplastic, light brown, no odors, no stains
						2.3				
15										note: below 15' weakly to moderately cemented nodules
						2.9				
20										note: at 20' strongly cemented nodules, whitish-brown
										note: at 21' color change back to light brown
								ML	dry to slightly moist	**SANDY SILT,** predominant silt, ~20% very fine grained sand, weak calcium carbonate content, nonplastic, light brown, no odors, no stains
						4.6				
25										

GROUNDWATER

DEPTH (ft)	HOUR	DATE

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ12

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-25-13 thru 2-28-13

LOCATION N837774.9, E774660.2
WELL REG. # ADWR Reg.# 55-915203
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1341.6'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
25								ML		**SANDY SILT,** continued
								SM	dry to slightly moist	**SILTY SAND,** predominantly very fine grained sand, ~20% to 30% silt, weak to moderate calcium carbonate content, nonplastic, light brown to brown, no odors, no stains note: at 29' to 30' calcium carbonate cemented zone, moderately cemented nodules, whitish-brown
						4.4		ML		
30								SP-SM	dry to slightly moist	**SILT WITH SAND,** predominant silt, ~10% very fine grained sand, moderately cemented, calcium carbonate content, nonplastic, whitish-brown, no odors, no stains
									dry to slightly moist	**POORLY GRADED SAND WITH SILT,** predominantly fine to very fine grained sand, subangular to subrounded, ~10% silt, weak calcium carbonate content, nonplastic, light brown, no odors, no stains note: at 31' strongly cemented nodules
								SW-SM		
35						3.7			dry to slightly moist	**WELL GRADED SAND WITH GRAVEL & SILT,** predominantly fine to coarse grained sand, subangular to subrounded, ~10% silt, ~20% coarse to fine grained gravel, subangular to subrounded, uncemented, weak calcium carbonate, nonplastic, light brown, no stains, no odors
								SM		
								SP-SM	dry to slightly moist	**SILTY SAND,** predominantly very fine grained sand, ~10% silt, uncemented, weak calcium carbonate content, nonplastic, light brown, no odors, no stains
40						5.7				
									dry to slightly moist	**POORLY GRADED SAND WITH SILT,** predominantly very fine grained sand, ~10% silt, uncemented with weak calcium carbonate content, nonplastic, light brown, no odors, no stains note: well graded sand lense between 42'6" to 43
								ML		
45						6.3			dry to slightly moist	**SANDY SILT,** predominant silt, ~30% very fine grained sand, calcium carbonate content, nonplastic, light brown, no odors, no stains
								SM		**SILTY SAND**
50						4.2				

GROUNDWATER

DEPTH (ft)	HOUR	DATE

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ12

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-25-13 thru 2-28-13

LOCATION N837774.9, E774660.2
WELL REG. # ADWR Reg.# 55-915203
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1341.6'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
50								SM	dry to slightly moist	**SILTY SAND,** predominantly very fine to fine grained sand, ~20% silt, uncemented, weak calcium carbonate content, nonplastic, brown to light brown, no odors, no stains
								SP-SM	dry to slightly moist	**POORLY GRADED SAND WITH SILT,** predominantly fine grained sand, subangular to subrounded, ~10% silt, uncemented, nonplastic, brown, no odors, no stains
55						4.1		SM	dry to slightly moist	**SILTY SAND,** predominantly very fine grained sand, ~30% silt, uncemented, weak calcium carbonate content, nonplastic, brown, no odors, no stains note: moderately to strongly cemented nodules at 58' note: at 59' clay content
60						3.3		ML SM	dry to slightly moist	**SILT WITH CLAY,** predomiant silt, ~10% clay, calcium carbonate content, nonplastic to very low plasticity, white filaments/reddish-brown color, no odors, no stains
65						5.0			dry to slightly moist	**SILTY SAND,** predominantly very fine grained sand, ~30% silt, ~5% clay content, calcium carbonate content, weak to moderate cemented nodules, nonplastic, brown to whitish-brown, no odors, no stains note: moderately cemented nodules below 62', whitish-brown to white note: at 69' strongly calcium carbonate cemented zone
70						3.5		SM	dry to slightly moist	**SILTY SAND WITH CLAY,** predominantly very fine grained sand, ~30% silt, 10% clay, calcium carbonate content, nonplastic to very low plasticity, brown to reddish-brown to whitish-brown, no odors, no stains
								SM	dry to slightly moist	**SILTY SAND,** predominantly very fine grained sand, ~10% silt, uncemented, nonplastic, brown, no odors, no stains
75						6.3		SW-SM		**WELL GRADED SAND WITH SILT & GRAVEL**

GROUNDWATER

DEPTH (ft)	HOUR	DATE

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ12

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-25-13 thru 2-28-13

LOCATION N837774.9, E774660.2
WELL REG. # ADWR Reg.# 55-915203
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1341.6'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
75								SW-SM	dry to slightly moist	**WELL GRADED SAND WITH SILT & GRAVEL,** fine to coarse grained sand, subangular to subrounded, ~10% silt, ~10% fine grained gravel, subangular to subrounded, weak calcium carbonate content, nonplastic, light brown to brown, no odors, no stains
						12.4				
80								SC	dry to slightly moist	**CLAYEY SAND,** predominantly very fine to fine grained sand, ~20% clay, ~5% silt, calcium carbonate filaments, nonplastic to low plasticity, reddish-brown with orange tint, no odors, no stains note: decrease clay & increase silt below 84'
								SM	dry to slightly moist	**SILTY SAND,** predominantly very fine grained sand, ~20% to 30% silt, 5% clay, calcium carbonate content with moderately cemented nodules, nonplastic, light brown to whitish-brown, no odors, no stains
85						4.7				
								SC	dry to slightly moist	**CLAYEY SAND,** predominantly very fine grained sand, ~20% clay, 5% silt, calcium carbonate content, moderately cemented nodules, low plasticity, brown to whitish-brown, no odors, no stains
90						4.9				
								SP-SM	slightly moist	**POORLY GRADED SAND WITH SILT,** predominantly very fine to fine grained sand, subangular to subrounded, 10% silt, <5% clay, uncemented, nonplastic, brown, no odors, black colored streaks at 91' infreqent
95						3.6				note: at 96'6" strongly cemented zone, cobble-size nodules, white color
								SM	slightly moist	**SILTY SAND,** predominantly very fine to fine grained sand, ~20% silt, <5% clay, weak calcium carbonet content, nonplastic, brown
100						1.3				

GROUNDWATER

DEPTH (ft)	HOUR	DATE

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ12

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-25-13 thru 2-28-13

LOCATION N837774.9, E774660.2
WELL REG. # ADWR Reg.# 55-915203
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1341.6'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
100								SM		**SILTY SAND,** continued
								ML		**SANDY SILT,** ~70% silt, ~30% very fine grained sand, <5% clay, calcium carbonate content, weak to strongly cemented nodules, nonplastic, light brown, no odors, no stains
								SM	slightly moist	
105						9.4			slightly moist	**SILTY SAND,** predominantly very fine grained sand, ~15% to 20% silt, uncemented, nonplastic, light brown to brown, no odors, no stains note: moderately cemented cobble-size nodules at 96'6"
								SP-SM	slightly moist	**POORLY GRADED SAND WITH SILT,** predominantly very fine to fine grained sand, subangular to subrounded, ~10% silt, uncemented, nonplastic, brown, no odors, no stains
110						2.1				note: between 110' to 114' clay content to ~5%
115						2.8				note: color change to light grayish-brown at 114'
								SW-SM	slightly moist	**WELL GRADED SAND WITH SILT & GRAVEL,** fine to coarse grained sand, subangular to subrounded, ~10% silt, <5% clay, ~15% fine grained gravel, subangular to subrounded, uncemented, nonplastic, brown, no odors, no stains
								SP-SM		
120						3.2			slightly moist	**POORLY GRADED SAND WITH SILT,** predominantly very fine to fine grained sand, ~10% silt, ~5% clay, uncemented, nonplastic, weak calcium carbonate content, brown, no odors, no stains
								ML		**SANDY SILT,** predominant silt, ~30% very fine grained sand, calcium carbonate content with weak to moderate nodules, nonplastic, light brown, no odors, no stains note: at 124' clay content ~5%
125						2.2				

GROUNDWATER

DEPTH (ft)	HOUR	DATE

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ12

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-25-13 thru 2-28-13

LOCATION N837774.9, E774660.2
WELL REG. # ADWR Reg.# 55-915203
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1341.6'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
125								SC	slightly moist	**CLAYEY SAND,** predominantly very fine to fine grained sand, ~20% clay, ~5% silt, calcium carbonate content, nonplastic to very low plasticity, brown, no stains, no odors
								SM	slightly moist	**SILTY SAND,** predominantly very fine grained sand, ~40% silt, <5% clay, calcium carbonate content, nonplastic, brown to light brown, no odors, no stains note: moderately cemented nodules at 127'6", color change to reddish-brown
130						2.3				
135						51.4				
								SP	slightly moist	**SAND,** predominantly fine grained sand, uncemented, nonplastic, brown, no odor
140						1.8				
								GW	slightly moist	**GRAVEL WITH SAND,** ~60% well graded, subrounded to subangular gravel, ~40% well graded, subrounded to subangular sand, uncemented, nonplastic, gray, no odors
145						2.1				
								SP-SC	moist	**SAND WITH CLAY,** ~80% predominantly fine to medium grained, subrounded to angular sand, ~10% fine grained, subrounded to subangular gravel, ~10% clay, uncemented with occasional moderately cemented nodules, low plasticity, brown, no odor
150						2.1				

GROUNDWATER

DEPTH (ft)	HOUR	DATE

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ12

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-25-13 thru 2-28-13

LOCATION N837774.9, E774660.2
WELL REG. # ADWR Reg.# 55-915203
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1341.6'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
150								SW	moist	**SAND WITH GRAVEL,** 70% sand, well graded, 30% gravel, well graded, subrounded to subangular, uncemented, nonplastic, no odors
						1.5				
						1.5				
155								SC	moist	**CLAYEY SAND,** 80% fine to medium grained, subrounded to subangular sand, 10% fine grained gravel, 30% clay, low plasticity, brown
						1.4				
								GW	moist	**WELL GRADED GRAVEL,** 90% subrounded, well graded gravel, 10% fines
				L			N	SC	moist	**CLAYEY SAND,** 80% fine to medium grained, subrounded to subangular sand, 10% fine grained gravel, 30% clay, low plasticity, brown
						1.7				
160								CL-ML	moist	**SILTY CLAY,** 80% clay, 20% silt, high plasticity, brown
				L		6.8	N			
								SC-SM	moist	**CLAYEY SILTY SAND,** 60% fine grained sand, 40% silt & clay, low plasticity, brown
						5.2				
165								CL	moist	**SANDY CLAY,** ~80% clay, ~20% very fine to fine grained sand, moderately cemented, high plasticity, brown, no odor note: decrease in cementation below 166'
						3.8				
								SP-SM	moist	**SAND WITH CLAY,** ~90% very fine to fine grained sand, ~10% clay, uncemented, low plasticity, brown, no odor note: clayey zones from 167'6" to 168' & 170' to 171'
						3.6				
170						2.1				
								SP	wet	**SAND WITH GRAVEL,** ~80% predominantly fine to medium grained, subrounded to subangular sand, ~20% predominantly fine grained, subrounded to subangular gravel, uncemented, nonplastic, brown, no odor
						2.7				
175										

GROUNDWATER

DEPTH (ft)	HOUR	DATE

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

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DATUM NAD 83, US Survey Feet

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175								SC	moist	**CLAYEY SAND,** ~70% very fine to fine grained sand, ~30% clay, uncemented, low plasticity, brown, slight odor
				L		81.2	N			
								SP	wet	**SAND,** ~90% fine grained sand, ~10% predominantly fine grained gravel, uncemented, nonplastic, brown & gray, slight odor
						7.9				note: increase in sand grain size to fine to medium grained below 176'6"
180										
						4.5				note: cemented clay layer from 181'6" to 182'
						2.7				
								CL	moist	**SANDY CLAY,** ~60% clay, ~40% very fine to fine grained sand, moderately to strongly cemented, medium plasticity, light brown to white, fuel odor
185						37.8				note: uncemented below 185'
								SP	wet	**SAND,** ~90% fine to medium grained sand, ~10% fine grained, subrounded gravel, uncemented, nonplastic, dark grayish-brown, slight fuel odor
				L						
						62.9	N			note: coarse grained sand layer from 190' to 190'10"
190						24.7				
						352		CL	moist	**SANDY CLAY,** ~60% clay, ~40% very fine grained sand, moderately cemented, medium plasticity, light brown, slight fuel odor
195										note: uncemented from 195' to 198'
				L		995	N			
						34.7				
200										

GROUNDWATER

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SURFACE ELEV. 1341.6'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
200								SC	slightly moist	**CLAYEY SAND,** ~70% very fine to medium grained, subrounded to subangular sand, ~30% clay, weakly cemented with strongly cemented nodules, medium plasticity, light brown, slight fuel odor
						34.2				
								CL	moist	**CLAY,** ~80% clay, ~20% very fine grained sand, uncemented, medium plasticity, brown, slight fuel odor
						53.2				
205										
								SP	wet	**SAND,** predominantly fine to medium grained, subrounded to subangular sand, <5% clay, uncemented, nonplastic, brown, slight fuel odor
						84.2				
								SC	moist	**CLAYEY SAND,** ~70% very fine to fine grained sand, ~30% clay, uncemented, low to medium grained, reddish-brown, fuel odor
				L		96.6	Y			
							(Low)			
210						289.3	N			
				L						
								SP-SC	moist	**SAND WITH CLAY,** ~90% very fine to medium grained, subrounded to subangular sand, ~10% clay, uncemented, low plasticity, brown, fuel odor
								SP	wet	**SAND WITH GRAVEL,** ~60% predominantly medium to coarse grained, subrounded to subangular sand, ~40% predominantly fine grained, subrounded to subangular gravel, uncemented, nonplastic, dark grayish-brown, slight fuel odor
						86.2				
215								SC		
						60.1		SP-SC	moist	**CLAYEY SAND,** ~70% very fine to medium grained, subrounded to subangular sand, ~20% clay, ~10% fine grained, subrounded to subangular gravel, uncemented with few strongly lime cemented nodules, low to medium grained, light brown, slight fuel odor
								SC-SM		
						78.2				
220									moist	**SAND WITH CLAY,** ~92% very fine to fine grained sand, ~8% clay, uncemented, low plasticity, brown, slight fuel odor
						122.6				
									moist	**SILTY CLAYEY SAND,** ~70% very fine to fine grained sand, ~20% clay, ~10% silt, uncemented, low plasticity, brown, slight fuel odor note: decrease in silt below 221'
						33.5				
225										

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WELL REG. # ADWR Reg.# 55-915203
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SURFACE ELEV. 1341.6'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
225				L		1152	Y	SP	wet	**SAND,** predominantly fine to medium grained, subrounded to subangular sand, <5% fine grained gravel, uncemented, nonplastic, dark gray, no odor
						35.2				
230										
						5.1		SP	wet	**SAND WITH GRAVEL,** ~75% predominantly fine to medium grained, subrounded to subangular sand, ~25% predominantly fine grained, subrounded gravel, uncemented, nonplastic, dark gray, no odor
				L		19.8	N			note: increase in coarse grained sand below 235'
235										
						11.0				
								SP	wet	**SAND WITH GRAVERL,** ~60% predominantly medium to coarse grained, subrounded to subangular sand, ~40% well graded, subrounded to subangular gravel, uncemented, nonplastic, dark gray, no odor
						5.6				
240										
								CL	slightly moist	**CLAY,** predominantly clay, ~20% silt, calcium carbonate content, medium plasticity, light brown, no odors, no stains
245										Stopped Drilling at 245' Well Installed
250										

GROUNDWATER

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Mesa, Arizona

JOB NO. 9101110001 **DATE** 3-4-13 thru 3-7-13

LOCATION N837875.7, E774746.0
WELL REG. # ADWR Reg.# 55-915204
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1341.5'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
0				*				CL	dry	**SANDY CLAY,** ~70% clay, ~30% very fine to fine grained sand, uncemented, medium to high plasticity, light brown, no odors, no stains
5						0.9				
								SP-SM	dry	**SAND,** ~90% very fine to medium grained sand, ~10% silt, uncemented, nonplastic, light brown, no odors, no stains
10						1.5				
								CL	dry	**SANDY CLAY,** ~70% clay, ~30% very fine to medium grained sand, little to no cementation, medium to high plasticity, brown, no odors, no stains
15						2.0				
								CL	dry	**SANDY CLAY,** ~85% clay, ~15% very fine to fine grained sand, uncemented, medium to high plasticity, yellowish-brown, no odors, no stains
								SW-SM	dry	**SAND WITH SILT,** ~90% fine to coarse grained sand, ~10% silt, trace gravel, subangular to subrounded, nonplastic, light yellowish-brown, no odors, no stains
20						1.1				
								SC	dry	**CLAYEY SAND,** ~40% clay, ~60% fine to medium grained sand, some weak cementation, low to medium plasticity, dark yellowish-brown, no odors, no stains
25						1.1				

GROUNDWATER

	DEPTH (ft)	HOUR	DATE
▽		none	
▼			
▼			
▼			

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WELL REG. # ADWR Reg.# 55-915204
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1341.5'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
25								SC		**CLAYEY SAND,** continued
								CL	dry	**SANDY CLAY,** ~80% clay, ~20% very fine to fine grained sand, weakly cemented (nodules that can be crushed), medium to high plasticity, dark yellowish-brown, no odors, no stains
						2.8				
30								CL	dry	**SANDY CLAY,** ~80% clay, 20% very fine to fine grained sand, strongly cemented nodules, medium to high plasticity, grayish-brown, no odors, no stains
								SP-SM	dry	**SAND,** ~90% fine to medium grained sand, ~10% silt, uncemented, nonplastic, brown, no odors, no stains
						2.3				
35								CL	dry	**SANDY CLAY,** ~90% clay, ~10% very fine to fine grained sand, weakly to moderately cemented (nodules), medium to high plasticity, light brown, no odors, no stains
						3.7				
40										
						2.0				
45										note: increasing sand content to 45'
								SP-SM	dry	**SAND,** ~90% very fine to fine grained sand, ~10% silt, trace gravel, uncemented, nonplastic, light brown, no odors, no stains
								CL	dry	**SANDY CLAY**
						1.0				
50										

GROUNDWATER

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▽		none	
▼			
▼			
▼			

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DATUM NAD 83, US Survey Feet

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50								CL		**SANDY CLAY,** ~90% clay, ~10% very fine grained sand, moderately to strongly cemented, medium to high plasticity, yellowish-brown, no odors, no stains
55						0.6				
								CL	dry	**SANDY CLAY,** ~80% clay, ~20% very fine to fine grained sand, weakly to moderately cemented (increasing size of nodules to 63', visible streaking in nodules from 61' to 63'), medium to high plasticity, grayish-brown, no odors, no stains
60						4.4				
								CL	dry	**SANDY CLAY,** ~70% clay, ~30% very fine to medium grained sand, moderately to strongly cemented, medium plasticity, light gray, no odors, no stains
								SC		
65						2.0				
									dry	**CLAYEY SAND,** ~60% very fine to medium grained sand, ~40% clay, moderately cemented, low to medium plasticity, dark yellowish-brown, no odors
								CL	dry	**SANDY CLAY,** ~70% clay, ~30% fine to medium grained sand, moderately to strongly cemented, medium plasticity, grayish-brown, no odors, no stains
70						2.3				
								CL	dry	**SANDY CLAY,** ~90% clay, ~10% very fine to fine grained sand, weakly to moderately cemented, medium to high plasticity, yellowish-brown
75						2.0				

GROUNDWATER

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	none	

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75								SP	dry	**SAND,** ~95% very fine to medium grained sand, ~5% small subangular to subrounded gravel, uncemented, nonplastic, light grayish-brown, no odors, no stains
						2.1				
80								SC	dry	**CLAYEY SAND,** ~60% fine to medium grained sand, ~40% clay, weakly cemented, low plasticity, reddish-brown, no odor, no stains
								CL	dry	**SANDY CLAY,** ~80% clay, ~20% very fine to fine grained sand, moderately to strongly cemented, high plasticity, light brown to grayish-brown, grayer interval from 87' to 88', no odors, no stains
85						1.8				
						1.2				
90								ML	dry	**SILT WITH SAND,** ~80% silt, ~20% very fine to fine grained sand, uncemented, nonplastic, dark brown, no odors, no stains
						0.5				note: increasing sand content to 95'
95								SP	dry	**SAND,** ~100% medium to coarse grained sand, trace small gravel, uncemented, nonplastic, grayish-brown, no odors, no stains
								CL	dry	**SANDY CLAY,** ~70% clay, ~30% fine grained sand, weakly to moderately cemented, medium to high plasticity, grayish-brown, increasing gray color to 100', no odors, no stains
						1.5				
100										

GROUNDWATER

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	none	

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100								CL	dry	**SANDY CLAY,** ~80% clay, ~20% very fine to fine grained sand, weakly cemented, medium to high plasticity, brown, no odors, no stains note: white streaking & moderate to strong cementation noted at 102'6", large cobbles/nodules with strong cementation noted at 106'6" & 111'6"
105						2.8				
110						2.9				
								SM	dry	**SAND,** ~80% very fine to fine grained sand, ~20% silt & clay, uncemented to weakly cemented, nonplastic, brown, no odor, no stains
115						3.1		SC	dry to slightly moist	**CLAYEY SAND,** ~60% very fine to fine grained sand, ~40% clay & silt, weakly to moderately cemented, low to medium plasticity, yellowish-brown, no odors, no stains note: increased clay content at 120', increase clay & significant color change to gray from 121'6" to 123'
120						5.1				
125						2.5				

GROUNDWATER

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▽		none	
▼			
▼			
▼			

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125								CL	dry to moist	**SANDY CLAY,** ~90% clay, ~10% very fine to fine grained sand, moderately to strongly cemented, medium to high plasticity, dark brown, no odors, no stains note: ~6" to 8" layer of gray caliche-like soil at 127'6", strong cementation
130						1.9				
135						1.8				note: increased clay content at 6" interval at 134' & 136' note: increasing sand from 134'
140						2.1		SM	dry	**SILTY SAND,** ~80% very fine & fine grained sand, ~20% silt, uncemented to weakly cemented, nonplastic, no odors, no stains note: 3" to 4" layer containing smal to medium grained at 138'6"
145						3.2		SP	dry	**SAND,** 95% very fine to medium grained sand, 5% fine to medium grained, subangular to subrounded gravel, uncemented, nonplastic, grayish-brown, no odors, no stains note: caliche-looking layer at 146'
150						2.4		CL	dry to slightly moist	**SANDY CLAY,** 60% clay, 40% fine to medium grained sand, weakly cemented, low to medium plasticity, dark brown, no odors, no stains

GROUNDWATER

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	none	

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Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
150								CL		**SANDY CLAY,** continued
				L		1.7	N	SP	dry	**SAND,** 90% medium to coarse grained sand, 10% fine to medium gravel, subangular to subrounded, uncemented, nonplastic, grayish-brown, no odors, no stains
						1.3				
155								SC	dry to moist	**CLAYEY SAND,** 75% fine to medium grained sand, 25% clay, uncemented to weakly cemented, nonplastic to low plasticity, tan, noticeable odor, no stains
						0.6				
								CL	dry to moist	**SANDY CLAY,** 80% clay, 20% very fine to fine grained sand, moderately cemented, medium to high plasticity, dark brown, noticeable odor, no stains
						1.3				
160										
						4.3				
						2.8				
165										note: very strong odor from 165' to 167'6"
				L		1126	Y			
						538				
170								CL	slightly moist	**CLAY,** 100% clay (fines), strongly cemented, medium to high plasticity, brown to yellowish-brown, very noticeable odor, no stains
						127.6				
						373.3		SP	moist	**SAND,** 100% fine to medium grained sand, uncemented, NP, grayish-brown, very noticeable odor, greenish-black staining throughout
175										

GROUNDWATER

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▽		none	
▼			
▼			
▼			

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DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
175								SC	moist	**CLAYEY SAND,** ~65% medium to coarse grained sand, ~35% clay, trace gravel, medium grained, subrounded, moderately cemented, low to medium plasticity, grayish-brown, very noticeable odor note: greenish-black staining from 176' to 177' & 179' to 181'
						171.2				
				L		385.2	Y			
180										
				L		2810	Y	CL	moist	**SANDY CLAY,** ~75% clay, ~25% very fine to medium grained sand, weakly to moderately cemented, medium plasticity, light brown, very strong odor, no stains
						2797				
								CL	moist	**SANDY CLAY,** ~95% clay, ~5% very fine to fine grained sand, sand content varies slightly throughout, strongly cemented, very high plasticity, yellowish-brown, very noticeable odor, no stains
185						806.3				
						1457				
								CL	moist	**SANDY CLAY,** ~60% clay, ~40% fine to medium grained sand, weakly cemented, low to medium plasticity, dark yellowish-brown, noticeable odor, no stains
190						991.6				
								CL	moist	**SANDY CLAY,** 90% clay, 10% very fine to fine grained sand, strongly cemented, medium to high plasticity, yellowish-brown, very strong odor, no stains note: odor dissipates below 200'
				L		1167	Y			
195						570.4				
						50.2				
200										

GROUNDWATER

DEPTH (ft)	HOUR	DATE
	none	

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ13

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 3-4-13 thru 3-7-13

LOCATION N837875.7, E774746.0
WELL REG. # ADWR Reg.# 55-915204
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1341.5'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
200								SC	dry	**CLAYEY SAND,** ~60% clay, ~40% fine to coarse grained sand, weakly to moderately cemented, low plasticity, light brown to tan, mild odor, no stains
						56.9				
						25.0				
								CL	dry to moist	**SANDY CLAY,** 90% clay, 10% very fine to fine grained sand, strongly cemented, medium to high plasticity, tan with white streaking, noticeable odor, no stains
205								CL		
						390.4			moist	**SANDY CLAY,** 70% clay, 30% fine to medium grained sand, moderately to strongly cemented, medium to high plasticity, dark reddish-brown, very strong odor from 205' to 212'
				L		1010	N			note: clay increases to 80% to 85%, 20% to 15% sand, color ranges from brown to dark yellowish-brown, odor decreases
210										
				L		122.4	N			note: minor staining at 212' (greenish-gray)
						98.2				
215										
						112.3				
						58.8				
220								CL	moist to wet	**SANDY CLAY,** 80% clay, 20% very fine to fine grained sand, moderately to strongly cemented, medium to high plasticity, dark brown, mild to no odor
						43.6				
						16.5				
225										

GROUNDWATER

DEPTH (ft)	HOUR	DATE
	none	

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ13

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 3-4-13 thru 3-7-13

LOCATION N837875.7, E774746.0
WELL REG. # ADWR Reg.# 55-915204
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1341.5'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
225								CL		**SANDY CLAY,** continued
				L		228.7	Y			note: interbedded sandy clay & poorly graded sand from 226' to 227'6", SP layers orangish-brown, strong odor
						58.3				
230								SP	moist	**SAND,** 100% very fine to medium grained sand, uncemented, nonplastic, grayish-brown, no odors, no stains
				L		5.7	N			
								SP		**SAND WITH GRAVEL,** 80% fine to coarse grained sand, 20% fine to medium gravel, subrounded, gray to brown, no odors, no stains
						1.2				note: interbbed layers of more coarsely graded sand with gravel, with layers of finer grained sand with less gravel
235						1.1				
						0.7				
								CL	moist	**SANDY CLAY,** 70% clay, 30% very fine to fine grained sand, moderately cemented, medium to high plasticity, yellowish-brown, no odors, no stains
240								SP		
								CL	moist to wet	**SAND WITH GRAVEL,** 60% coarse grained sand, 40% small subrounded gravel, uncemented, nonplastic, grayish-brown, no odors, no stains
						0.2				
									moist	**SANDY CLAY,** 90% clay, 10% very fine to fine grained sand, strongly cemented, medium to high plasticity, no odors, no stains
245										Stopped Drilling at 243'6" Well Installed
250										

GROUNDWATER

DEPTH (ft)	HOUR	DATE
	none	

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ13

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 3-4-13 thru 3-6-13

LOCATION N837992.3, E774916.9
WELL REG. # ADWR Reg.# 55-915225
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1342.3'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
0				*				CL	dry	**SANDY CLAY,** ~70% clay, ~30% very fine to fine grained sand, uncemented, medium to high plasticity, brown, no odors, no stains
						1.6				
5								CL	dry	**SANDY CLAY,** ~60% clay, ~40% very fine to medium grained, subrounded to subangular sand, weakly cemented with strongly cemented nodules, low plasticity, light brown, no odors, no stains note: increased cementation from 7' to 7'4"
								SP-SC	dry	**SAND WITH CLAY,** 85% fine to medium grained, subrounded to angular sand, ~10% clay, ~5% fine grained, subrounded to subangular gravel, uncemented with some coarse grained gravel-size cemented nodules, brown, no odors, no stains
10						2.6				
								SC	dry	**CLAYEY SAND,** ~70% very fine to medium grained, subrounded to subangular sand, ~30% clay, weakly cemented with strongly cemented nodules, low plasticity, light brown to white, no odors, no stains
								SP-SC		note: uncemented silty clay layer from 12' to 12'6"
15						1.8			dry	**SAND WITH CLAY,** ~85% well graded, subrounded to angular sand, ~10% clay, ~5% fine grained, subrounded to subangular gravel, uncemented with some moderately cemented nodules, nonplastic to low plasticity, brown, no odors, no stains
								SC	dry	**CLAYEY SAND,** ~60% very fine to fine grained sand, ~40% clay, weakly cemented, medium plasticity, brown, no odors, no stains
20						0.9				note: uncemented & reddish-brown from 20' to 23' note: moderately to strongly cemented nodules below 23'
25						1.8				

GROUNDWATER

DEPTH (ft)	HOUR	DATE
	none	

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ14

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 3-4-13 thru 3-6-13

LOCATION N837992.3, E774916.9
WELL REG. # ADWR Reg.# 55-915225
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1342.3'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
25								SC	dry	**CLAYEY SAND,** continued
30						2.6				
								SP	dry	**SAND,** ~80% predominantly fine to medium grained, subrounded to subangular sand, ~20% predominantly fine grained, subrounded gravel, uncemented, nonplastic, light grayish-brown, no odors, no stains
35						1.3		GW	dry	**SANDY GRAVEL,** ~70% well graded, subrounded gravel, ~30% predominantly medium to coarse grained, subrounded to subangular sand, uncemented, nonplastic, brown & gray, no odors, no stains note: decrease in coarse grained gravel below 38' note: decrease in gravel to ~30% from 39' to 40'
40						2.9				
								SC	dry	**CLAYEY SAND,** ~60% very fine to fine grained sand, ~40% clay, weakly cemented, medium plasticity, brown, no odors, no stains note: moderately to strongly cemented layer from 42'4" to 43' & 45' to 47'
45						1.7				
								CL	dry	**SANDY CLAY,** ~75% clay, ~25% very fine grained sand, uncemented, medium plasticity, brown, no odors, no stains note: moderately to strongly cemented from 49'6" to 51'
50						2.3				

GROUNDWATER

DEPTH (ft)	HOUR	DATE
	none	

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ14

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 3-4-13 thru 3-6-13

LOCATION N837992.3, E774916.9
WELL REG. # ADWR Reg.# 55-915225
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1342.3'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
50								CL	dry	**SANDY CLAY,** continued note: some strongly cemented nodules below 51'
						1.7				note: strongly cemented layer from 54'10" to 55'
55								SP	dry	**SAND,** ~95% predominantly fine to medium grained sand, <5% silt, uncemented with occasional moderately cemented nodules, nonplastic, brown, no odors, no stains
						0.8				note: moderately cemented clay layer from 59'6" to 60' & clayey sand layer from 60' to 61' note: moderately to strongly cemented from 62' to 63'
60										
								SC	slightly moist	**CLAYEY SAND,** ~60% very fine to fine grained sand, ~40% clay, moderately cemented, medium to high plasticity, dark brown, no odors, no stains
						0.7				
65								CL	slightly moist	**SANDY CLAY,** ~70% clay, ~30% very fine grained sand, moderately cemented, medium to high plasticity, dark brown, no odors, no stains
						0.9				
70								CL-ML	slightly moist	**CLAYEY SILT,** ~60% silt, ~30% clay, ~10% very fine grained sand, uncemented, low plasticity, brown, no odors, no stains note: increase in sand to ~25% below 74' note: changed PID meter below 70'; the other one was giving strange readings; the new one is reading much higher
						161				
75										

GROUNDWATER

DEPTH (ft)	HOUR	DATE
	none	

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ14

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 3-4-13 thru 3-6-13

LOCATION N837992.3, E774916.9
WELL REG. # ADWR Reg.# 55-915225
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1342.3'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
75								SW	dry	**SAND WITH GRAVEL,** ~70% well graded, subrounded to subangular sand, ~30% predominantly fine grained, subrounded to subangular gravel, uncemented, nonplastic, light gray, no odors, no stains
								SC	slightly moist	**CLAYEY SAND,** ~60% very fine to fine grained sand, ~40% clay, uncemented, medium plasticity, brown, no odors, no stains note: moderately to strongly cemented layer from 80'2" to 80'6" & below 83'
80						51				
85						26		CL	moist	**CLAY WITH SAND,** ~80% clay, ~20% very fine to fine grained sand, weakly cemented with strongly cemented nodules, medium to high plastcity, dark brown, no odors, no stains
90						121		SP	dry	**SAND,** predominantly fine grained sand, uncemented, nonplastic, brown, no odors, no stains
95						61.8				
								CL	dry	**SANDY CLAY,** ~80% clay, ~20% very fine grained sand, moderately to strongly cemented, medium plasticity, light brown to white, no odors, no stains
								SC	dry	**CLAYEY SAND**
100						28.4				

GROUNDWATER

DEPTH (ft)	HOUR	DATE
	none	

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ14

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 3-4-13 thru 3-6-13

LOCATION N837992.3, E774916.9
WELL REG. # ADWR Reg.# 55-915225
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1342.3'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
100								SC		**CLAYEY SAND,** ~80% very fine to fine grained sand, ~20% clay, uncemented, low plasticity, brown, no odors, no stains note: increased to ~30% clay below 100'
								CL	slightly moist	**CLAY WITH SAND,** ~80% clay, ~20% very fine grained sand, weakly cemented, medium plasticity, brown, no odors, no stains
						14.1				
105								SP		note: moderately cemented from 103'6" to 104'
									dry to slightly moist	**SAND,** predominantly very fine to fine grained sand, <5% silt, uncemented, nonplastic, brown, no odors, no stains note: weakly to moderately cemented from 108' to 108'4"
						31.5				
110										note: clayey layer with ~15% clay from 111' to 113'
						12.2				
115								CL	moist	**CLAY WITH SAND,** ~80% clay, ~20% very fine to fine grained sand, moderately to strongly cemented, medium to high plasticity, brown, no odors, no stains
								SP		**SAND,** predominantly very fine to fine grained sand, <5% silt, uncemented, nonplastic, brown, no odors, no stains note: some coarse grained gravel-size strongly cemented nodules
						2.9				
120										
						5.2				
125										

GROUNDWATER

DEPTH (ft)	HOUR	DATE
	none	

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ14

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 3-4-13 thru 3-6-13

LOCATION N837992.3, E774916.9
WELL REG. # ADWR Reg.# 55-915225
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1342.3'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
125								CL	moist	**CLAY,** ~90% clay, ~10% very fine grained sand, moderately to strongly cemented, medium to high plasticity, light brown to brown, no odors, no stains note: decrease in cementation from 127'6" to 129'6"
130						7.4				
								SP-SC	moist	**SAND WITH CLAY,** ~90% very fine to fine grained sand, ~10% clay, uncemented, low plasticity, brown, no odors, no stains
135						6.5				
								SP	dry	**SAND,** ~90% predominantly fine to medium grained sand, ~10% predominantly fine grained, subrounded gravel, uncemented, nonplastic, light brown to gray, no odors, no stains
140						8.1				
								GW	dry to slightly moist	**GRAVEL WITH SAND,** ~60% well graded, subrounded to angular gravel, ~40% well graded, subrounded to angular sand, weakly cemented with strongly cemented nodules up to 4" in diameter, nonplastic, gray, no odors, no stains
145						6.3				
								SP-SC	moist	**SAND WITH CLAY,** ~75% predominantly fine to medium grained, subrounded to subangular sand,~15% clay, ~10% predominantly fine grained, subrounded gravel, uncemented, low plasticity, brown, no odors, no stains
								SW	moist to wet	**SAND WITH GRAVEL,** ~60% well graded, subrounded to angular sand, ~40% well graded, subrounded to angular gravel, uncemented, nonplastic, brown & gray, fuel odor, no stains
150						29.8				

GROUNDWATER

DEPTH (ft)	HOUR	DATE
	none	

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ14

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 3-4-13 thru 3-6-13

LOCATION N837992.3, E774916.9
WELL REG. # ADWR Reg.# 55-915225
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1342.3'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
150								SW	wet	**SAND WITH GRAVEL,** continued, fuel odor note: decrease in gravel to 20% from 150'6" to 151'6" & 154' to 155', increase in gravel to 70% from 151'6' to 154'
						2.2				
						5.1				
155								CL	moist to wet	**SANDY CLAY,** ~60% clay, ~40% very fine grained sand, weakly cemented with strongly cemented nodules, high to medium plasticity, dark brown, fuel odor varies from slight to strong, no stains note: modeately to strongly cemented throughout from 155'6" to 156' & 159' to 159'6"
				L		8.5	N			
						7.7				
160										
						1.7				
										note: increased sand to ~60% from 163' to 164'
				L		7.1	N			
165										
						3.7				note: decrease in sand to ~25% from 165'6" to 168', decrease in cementation below 165'
						5.9				
170										
						4.2		SW	wet	**SAND WITH GRAVEL,** ~70% well graded, subrounded to subangular sand, ~30% predominantly fine grained, subrounded to subangular gravel, uncemented, nonplastic, brown, fuel odor, no stains
				L		10.5	N			
175										

GROUNDWATER

DEPTH (ft)	HOUR	DATE
	none	

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ14

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 3-4-13 thru 3-6-13

LOCATION N837992.3, E774916.9
WELL REG. # ADWR Reg.# 55-915225
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1342.3'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
175								CL	moist to wet	**CLAY WITH SAND,** ~85% clay, ~15% very fine grained sand, uncemented, medium to high plasticity, dark brown, slight odor, no stains
						9.3				
						10.2				
180										
						10.9				
						10.6				note: moderately cemented from 183' to 184' note: increase to ~25% sand from 184' to 185'
185										
						19.5				
								SC	moist	**CLAYEY SAND,** ~70% fine to medium grained, subrounded to subangular sand, ~30% clay, uncemented, medium plasticity, brown, fuel odor, no stains
				L		10.8	N			
190										
						6.7		SP-SC	wet	**SAND WITH GRAVEL & CLAY,** ~60% well graded, subrounded to subangular sand, ~30% predominantly fine grained, subrounded to angular gravel, ~10% clay, uncemented, medium plasticity, brown, strong fuel odor, no stains
				L		12.1	N	CL	moist	**SANDY CLAY,** ~60% clay, ~40% very fine grained sand, weakly cemented with strongly cemented nodules, medium to high plasticity, brown, fuel odor, no stains
195										
						8.8				
										note: moderately to strongly cemented from 198' to 200'
						9.2				
200										

GROUNDWATER

	DEPTH (ft)	HOUR	DATE
▽		none	
▼			
▼			
▼			

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ14

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 3-4-13 thru 3-6-13

LOCATION N837992.3, E774916.9
WELL REG. # ADWR Reg.# 55-915225
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1342.3'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
200								CL	moist	**SANDY CLAY,** continued, fuel odor
						8.1				note: clayey sand layer from 200' to 201'
						11.1				
205										
						2307				
										note: moderately to strongly cemented from 208' to 210'
				L		3160	Y			
210								SP	wet	**SAND WITH GRAVEL,** ~85% fine to medium grained, subrounded to subangular sand, ~15% predominantly fine grained, subrounded to subangular gravel, <5% clay, uncemented, low plasticity to nonplastic, brown, strong fuel odor, no stains
				L		3268	Y			
						2326				note: increased gravel to 30% below 213'
215								CL	moist	**SANDY CLAY,** ~60% clay, ~40% very fine to fine grained sand, uncemented to weakly cemented with strongly cemented nodules, medium plasticity, brown, odor, no stains
						37.8				
						48.3				
										note: moderately to strongly cemented from 219' to 220'
220										
				L		548	N			
								SP	moist to wet	**SAND,** ~90% very fine to medium grained sand, ~10% fine grained, subrounded to subangular gravel, uncemented, nonplastic, brown, odor, no stains
						101				
225										

GROUNDWATER

DEPTH (ft)	HOUR	DATE
	none	

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ14

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 3-4-13 thru 3-6-13

LOCATION N837992.3, E774916.9
WELL REG. # ADWR Reg.# 55-915225
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1342.3'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
225								SP	wet	**SAND,** continued
						28.1				note: slight odor below 225'
										note: increased gravel to ~30% from 226'6" to 228', 5" in diameter cobbles at 227'
						63.5				
230										note: no odor below 230'
						3.0				
						2.8				
235				L		3.4	N			
										note: increased gravel to ~30% from 237' to 240'6"
						1.9				
240								CL-ML	slightly moist	**SILTY CLAY WITH SAND,** ~50% clay, ~30% silt, ~20% very fine grained sand, weakly cemented with strongly cemented nodules, low plasticity, brown, no odor, no stains
										Stopped Drilling at 242'6" Well Installed
245										
250										

GROUNDWATER

	DEPTH (ft)	HOUR	DATE
▽		none	
▼			
▼			
▼			

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ14

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-18-13 thru 2-20-13

LOCATION N837879.7, E774352.8
WELL REG. # ADWR Reg.# 55-915205
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1339.8'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
0				*				SM	dry to slightly moist	**SILTY SAND,** ~60% very fine grained sand, ~40% silt, gravel cover at surface, weak calcium carbonate content, nonplastic, brown to light brown
5						1.3				note: increase calcium carbonate content, color change to very light brown, also moderately to strongly cemented nodules, no odor below 4'
10						5.7				note: decrease silt, increase sand content ~20% silt, 80% sand at 9'6"
								SP-SM	dry to slightly moist	**POORLY GRADED SAND WITH SILT,** predominantly very fine to fine grained sand, ~10% silt, <5% gravel, uncemented with calcium carbonate filaments, weakly cemented nodules, nonplastic, brown, no odor
15						4				note: trace clay content below 15'
								SP-SC	dry to slightly moist	**POORLY GRADED SAND WITH CLAY,** predominantly very fine grained sand, ~10% clay, <5% gravel, weak calcium carbonate content, nonplastic, brown, no odor
20						3.9		SM	dry to slightly moist	**SILTY SAND,** predominantly very fine to fine grained sand, ~20% silt, uncemented with weak calcium carbonate content filaments, nonplastic, light brown to brown, no odor
25						3.9				

GROUNDWATER

DEPTH (ft)	HOUR	DATE
144.0		2-19-13

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ15

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-18-13 thru 2-20-13

LOCATION N837879.7, E774352.8
WELL REG. # ADWR Reg.# 55-915205
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1339.8'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
25								SM		**SILTY SAND,** continued note: decreasing sand below 25', ~30% silt, 70% sand note: organic-like odor at 25'
						4.8				
30								SP-SM	dry to slightly moist	**POORLY GRADED SAND WITH SILT,** predominantly very fine to fine grained sand, subangular to subrounded, ~10% silt, uncemented, nonplastic, brown to light brown to grayish-brown, moderate odors, light stains note: coarse sand to fine gravel below 32', ~5%
						13.5				
						45.5				
35								SM	dry to slightly moist	**SILTY SAND,** predominantly very fine to fine grained sand, ~40% silt (~5% clay), weak calcium carbonate content, nonplastic, brown to light brown, moderate odors, no stains
						644.4				
				L		747		SP-SM	dry to slightly moist	**POORLY GRADED SAND WITH SILT,** predominantly very fine to fine grained sand, ~10% silt, calcium carbonate filaments, light brown, moderate odors, no stains
40						282.2				
						49.1			dry to slightly moist	**WELL GRADED SAND WITH GRAVEL,** fine to coarse grained sand, subangular to subrounded, ~5% fines (silt), ~20% fine grained gravel, subangular to subrounded, uncemented, nonplastic, brown, faint odors, no stains
								SM	dry to slightly moist	**SILTY SAND,** predominantly very fine grained sand, ~40% silt, calcium carbonate content, nonplastic, weak calcium carbonate cemented nodules, light brown to whitish-brown, odors, no stains note: poorly graded sand lense 6" thick at 45'
						1119				
45						1402				
				L		1743				
50						1703				

GROUNDWATER

DEPTH (ft)	HOUR	DATE
144.0		2-19-13

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ15

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-18-13 thru 2-20-13

LOCATION N837879.7, E774352.8
WELL REG. # ADWR Reg.# 55-915205
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1339.8'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
50								SM		**SILTY SAND,** continued
								SC	dry to slightly moist	**CLAYEY SAND,** predominantly very fine grained sand, ~20% clay (~5% silt), calcium carbonate content, moderately cemented nodules, nonplastic, light brown to whitish-brown, odors, no stains
						1491				
								SM		
						1489			dry to slightly moist	**SILTY SAND,** predominantly very fine grained sand, ~40% silt, calcium carbonate content, nonplastic, light brown, moderate odors, no stains
55				L		1734				
						1566				note: trace gravel, subangular to subrounded, ~5% to 10% at 58'
								SC	dry to slightly moist	**CLAYEY SAND WITH SILT,** predominantly very fine grained sand, ~20% clay, ~10% silt, calcium carbonate content, nonplastic to low plasticity, moderately cemented nodules, reddish-brown to whitish-brown, moderate odors, no stains
60						1548				
						1289				
						1394				
65								SM	dry to slightly moist	**SILTY SAND,** predominantly very fine grained sand, ~40% to 30% silt (<5% clay), calcium carbonate content, nonplastic, brown to whitish-brown, moderate odors, no stains
						1457				
				L		1663				note: moderately to strongly cemented nodules at 67'
						1311				note: decreasing silt below 70'
70								SP-SM		**POORLY GRADED SAND WITH SILT,** predominantly very fine to fine grained sand, ~10% silt, weak calcium carbonate content, nonplastic, light brown, moderate odors, no stains
						1354				
						1020				note: increase sand grain-size medium to coarse grained below 73'
75								SW-SM		

GROUNDWATER

DEPTH (ft)	HOUR	DATE
144.0		2-19-13

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ15

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-18-13 thru 2-20-13

LOCATION N837879.7, E774352.8
WELL REG. # ADWR Reg.# 55-915205
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1339.8'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
75								SW-SM	dry to slightly moist	**WELL GRADED SAND WITH SILT & GRAVEL,** predominantly very fine to coarse grained sand, subangular to subrounded, ~10% silt, ~15% to 20% fine gravel, subangular to subrounded, ~5% cobbles, subangular, weak calcium carbonate content, nonplastic, light brown, moderate odors, no stains
						1353				
						911.7				
								SM	dry to slightly moist	**SILTY SAND,** predominantly very fine grained sand, ~40% silt (<5% clay), calcium carbonate filaments, nonplastic, light brown, moderate to strong odors, no stains
80				L		1562				
						1522				
										note: increase clay content to ~5% below 83'
				L		1647				note: strongly cemented nodules ~3" diameter increase calcium carbonate content, color is whitish-brown below 84'
85										
						1350				
						1443				
						1612				
90										note: color change back to brown, decrease calcium carbonate content, decrease silt & no clay below 90'
						1213				
				L		1431				
95										
						1408		SP-SM	dry to slightly moist	**POORLY GRADED SAND WITH SILT,** predominantly very fine grained sand, ~10% silt, <5% coarse grained sand, subangular to subrounded, uncemented, nonplastic, brown to light brown, moderate odors, no stains, note: moderately cemented nodules from 97'6" to 98'
						1332		SM	dry to slightly moist	**SILTY SAND,** predominantly very fine grained sand, ~40% silt, calcium carbonate content, filaments, nonplastic, light brown with whitish-brown, moderate odors, no stains
100						1387				

GROUNDWATER

DEPTH (ft)	HOUR	DATE
144.0		2-19-13

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ15

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-18-13 thru 2-20-13

LOCATION N837879.7, E774352.8
WELL REG. # ADWR Reg.# 55-915205
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1339.8'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
100								SM		**SILTY SAND,** continued
						1341				
								ML	dry to slightly moist	**SANDY SILT,** predominantly silt, ~30% very fine grained sand, weak to moderate calcium carbonate content, weak nodules, nonplastic, light brown, moderate odors, no stains
						1376				
105										
				L		1383				
						1347				
								SP-SM	dry to slightly moist	**POORLY GRADED SAND WITH SILT,** predominantly very fine grained sand, ~10% silt, weak calcium carbonate content, nonplastic, brown to light brown, moderate odors, no stains note: at 111', ~5% fine to coarse grained gravel, subangular, increase in sand grain-size
110						1186				
						646.6				
						197.4		SW-SM	slightly moist	**WELL GRADED SAND WITH SILT & GRAVEL,** fine to coarse grained sand, subangular to subrounded, ~15% fine to coarse grained gravel, subangular, ~10% silt, uncemented, nonplastic, brown, faint to moderate odors, no stains
115						300.7		SM	slightly moist	**SILTY SAND,** predominantly very fine grained sand, ~30% to 40% sand, weak calcium carbonate, nonplastic, brown, moderate odors, no stains
								ML	slightly moist	**SANDY SILT,** predominantly silt, ~40% very fine grained sand (<5% clay), weak calcium carbonate content, nonplastic, light brown to brown, moderate odors, no stains
						591.4				
				L		714.2				
120										
						619.2		SM	slightly moist	**SILTY SAND,** predominantly very fine to fine grained sand, ~30% to 40% silt, weak calcium carbonate content, nonplastic, light brown, moderate odors, no stains note: increase sand at 123'
						103.5				
125										

GROUNDWATER

DEPTH (ft)	HOUR	DATE
144.0		2-19-13

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ15

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-18-13 thru 2-20-13

LOCATION N837879.7, E774352.8
WELL REG. # ADWR Reg.# 55-915205
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1339.8'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
125								SM		**SILTY SAND,** continued
						951				note: 5% clay content below 125'
						1307				
				L		1431				
130										note: moderately to strongly cemented nodules from 130' to 131'
						1344				
						1586				
135								SP-SM	slightly moist	**POORLY GRADED SAND WITH SILT,** predominantly very fine to fine grained sand, subangular to subrounded, ~10% silt, <5% gravel, uncemented, nonplastic, brown, moderate odors, no stains
				L		1592				
						1395				note: increasing sand content at 137', decrease silt
				L		1914				
140										note: at 142', trace cobbles, subangular to subrounded at 143'
						508.2		SW-SM	slightly moist to moist	**WELL GRADED SAND WITH SILT & GRAVEL,** fine to coarse grained sand, subangular to subrounded, ~10% silt, ~20% fine to coarse grained gravel, subangular to subrounded, weak calcium carbonate content, nonplastic, brown to light brown, moderate odors, no stains
▽						320.2		SP	moist to wet	**POORLY GRADED SAND,** predominantly fine to medium grained sand, subangular to subrounded, ~5% to <10% silt, ~5% fine grained gravel, uncemented, nonplastic, brown, moderate odors, no stains
145						785.6		ML	dry to slightly moist	**SANDY SILT,** ~80% silt, ~20% very fine grained sand, moderately cemented, nonplastic, whitish-brown, moderate odors, no stains
						231.6				
								SP	wet	**POORLY GRADED SAND,** predominantly fine grained sand, subangular to subrounded, ~10% coarse grained sand, uncemented, nonplastic, dark brown, moderate odors, faint stains
								SW-SM		
150										

GROUNDWATER

	DEPTH (ft)	HOUR	DATE
▽	144.0		2-19-13
▼			
▼			
▼			

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ15

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-18-13 thru 2-20-13

LOCATION N837879.7, E774352.8
WELL REG. # ADWR Reg.# 55-915205
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1339.8'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
150						343.9		SW-SM	wet to moist	**WELL GRADED SAND WITH SILT & GRAVEL,** fine to coarse grained sand, subangular to subrounded, ~10% silt, ~20% fine to coarse grained gravel, subangular to subrounded, uncemented, nonplastic, brown to grayish-brown, moderate to strong odors, faint to moderate stains
						245.6				
						173.3				note: strong stains at 155' to 156', dark gray color, cobbles from 155' to 156', subangular
155						162.5				
								CL	dry to slightly moist to moist	**CLAY WITH SILT,** ~90% clay, ~10% silt, calcium carbonate content, medium plasticity, light brown to brown, faint odors, staining at top of clay layer ~3"
						643.9				note: increase odors below 158'
160				L		1474				note: faint stains observed below 158', grayish color streaks, infrequent, color change to reddish-brown below 158'
						1402				
				L		1590		SP-SC	slightly moist	**POORLY GRADED SAND WITH CLAY,** predominantly very fine to fine grained sand, ~10% clay, <5% silt, uncemented, nonplastic, brown to reddish-brown, moderate odors, faint stains
165								SC		
						1217			slightly moist	**CLAYEY SAND,** ~60% very fine grained sand, ~5% silt, ~30% to 35% clay, calcium carbonate content, low plasticity, light brown to brown, moderate to strong odors, infrequent streaks of dark gray stains
						1221				
170						1234				
								SP-SM	moist to wet	**POORLY GRADED SAND WITH SILT,** predominantly very fine to fine grained sand, ~10% silt, uncemented, nonplastic, brown to dark brown, moderate to strong odors, dark gray stains
						1769				
				L		3446				
175										

GROUNDWATER

DEPTH (ft)	HOUR	DATE
144.0		2-19-13

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ15

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-18-13 thru 2-20-13

LOCATION N837879.7, E774352.8
WELL REG. # ADWR Reg.# 55-915205
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1339.8'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
175								SP-SM	moist to wet	**POORLY GRADED SAND WITH SILT,** continued
						2609		SW	wet	**WELL GRADED SAND WITH GRAVEL,** fine to coarse grained sand, subangular to subrounded, <5% fines, ~20% fine to coarse grained gravel, subangular to subrounded, uncemented, nonplastic, dark gray stained, oily sheen, strong odors
						2461				
180						2611				
								SM	slightly moist	**SILTY SAND,** ~60% very fine grained sand, ~40% silt, <5% clay, moderately cemented calcium carbonate nodules, nonplastic, light brown to brown, strong odors, faint stains
						1528				
				L		1705				note: increase clays at 185'
185								CL	slightly moist	**SANDY CLAY,** ~70% clay, ~30% very fine grained sand, calcium carbonate content, low to medium plasticity, whitish-brown to light brown, moderate odors, infrequent stains, streaks of dark gray color
						1452				
						1231		CL	slightly moist	**CLAY,** predominantly clay, ~5% silt, weak to moderate calcium carbonate content, high plasticity, reddish-brown to grayish colors, at 190', moderate odors, faint staining at 190'
190						1134				
						1405				note: increase sand content below 192'
								ML	slightly moist to moist	**SANDY SILT,** ~70% silt, ~30% very fine grained sand, ~5% clay, calcium carbonate content, nonplastic, brown, moderate odors, faint staining
						1884				
195						1160				note: poorly graded sand (fine grained) lense between 196'6" to 197'
								SC	slightly moist	**CLAYEY SAND,** predominantly very fine grained sand, ~5% silt, ~30% clay, weak to moderate calcium carbonate, low plasticity, brown to reddish-brown, moderate odors, no stains
				L		2194				
200										

GROUNDWATER

DEPTH (ft)	HOUR	DATE
144.0		2-19-13

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ15

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-18-13 thru 2-20-13

LOCATION N837879.7, E774352.8
WELL REG. # ADWR Reg.# 55-915205
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1339.8'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
200						1848		CL	slightly moist	**CLAY,** predominantly clay, ~5% very fine grained sand & silt, calcium carbonate content, medium to high plasticity, reddish-brown, strong odors, no stains note: increase sand content below 202'
						322.6				
								CL		
						360			slightly moist to moist	**CLAY WITH SAND,** ~90% clay, ~10% very fine grained sand, calcium carbonate content, medium to low plasticity, reddish-brown, strong odors, oily sheen at 202'6", no stains note: clay lense between 203' to 204' note: increase silt content below 204' (~10%)
205						310				
						921.5				
				L		1369				
210								SW	moist to wet	**WELL GRADED SAND WITH GRAVEL,** fine to coarse grained sand, subangular to subrounded, ~20% fine to coarse grained gravel, subangular to subrounded, ~5% fines (silt/clay), uncemented, nonplastic, dark brown to grayish-brown, moderate odors, staining (gray color), oily sheen note: cobbles between 212' to 212'6", subrounded
						1228				
						212.7				
215								SM	moist to slightly moist	**SILTY SAND & GRAVEL,** fine to coarse grained sand, subangular to subrounded, ~30% silt, ~5% clay, ~20% fine to coarse grained gravel, subangular to subrounded, calcium carbonate content, nonplastic, light brown, faint to moderate odors, faint grayish color stain
						983.2				
								CL		
						920.5				
				L		1001			slightly moist to dry	**SILTY CLAY,** ~70% clay, ~30% silt, <5% fine to coarse grained sand, subangular to subrounded, calcium carbonate content, moderately cemented nodules, low to medium plasticity, faint to moderate odors, no stains
220						914.1				
						98.4				
225										

GROUNDWATER

DEPTH (ft)	HOUR	DATE
144.0		2-19-13

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ15

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-18-13 thru 2-20-13

LOCATION N837879.7, E774352.8
WELL REG. # ADWR Reg.# 55-915205
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1339.8'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
225								GW/SW	wet	**WELL GRADED GRAVEL & SAND WITH COBBLES,** ~50% fine to coarse grained gravel, subangular to subrounded, ~40% fine to coarse grained sand, subangular to subrounded, ~10% cobbles, subrounded 3" to 6" in diameter, ~5% fines (silts/clays), uncemented, nonplastic, grayish-brown to brown, faint to no odors, faint dark gray stain, infrequent
						62.9				
				L		228				
230								CL	slightly moist	**CLAY WITH SILT,** predominantly clay, ~80% to 90%, ~10% to 20% silt, <5% fine grained sand, calcium carbonate content, medium to high plasticity, light brown to brown/reddish-brown, faint odors, infrequent specks of dark gray stains
						23				
						4.1				
235								SC	slightly moist	**CLAYEY SAND,** ~70% fine grained, subangular to subrounded, ~30% clay, <5% silt, calcium carbonate content, low plasticity, reddish-brown with orange tint, no to faint odors, specks of dark gray stain
						2.7				
240				L		5.5		SW-SC	moist to wet	**WELL GRADED SAND WITH CLAY & GRAVEL,** fine to coarse grained sand, subangular to subrounded, ~10% clay, ~20% fine to coarse grained gravel, subangular to subrounded, uncemented, nonplastic, light brown, no odors, no stains
						5.5				
						5.2				note: becoming gravelly sand from 240' to 240'6"
										note: clay content at 241'
										SANDY CLAY, ~60% clay, ~40% very fine to fine grained sand, moderately cemented, medium plasticity, light brown
245										Stopped Drilling at 244' Well Installed
250										

GROUNDWATER

DEPTH (ft)	HOUR	DATE
144.0		2-19-13

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ15

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-4-13 thru 2-7-13

LOCATION N838021.0, E774632.4
WELL REG. # ADWR Reg.# 55-915223
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1340.6'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
0				*				ML	slightly moist	**SANDY SILT,** 60% silt, 40% sand, trace clay & caliche, very fine grained sand, nonplastic, brown, loose, no odors, no stains
5										
								SM		**SILTY SAND/CALICHE,** 60% fine grained sand, 40% silt (calcihe cemented), light brown to white
10						3.5				
								SM/SW		**SAND & GRAVEL,** 70% sand, 30% silt, (caliche nodules), fine to coarse gained gravel, loose
15								ML	slightly moist	**SANDY SILT WITH CLAY,** 30% sand, 45% silt, 25% clay, low to medium plasticity
20						1.5		ML	slightly moist	**SANDY SILT,** very fine grained sand, nonplastic to low plasticity, loose
25										

GROUNDWATER

DEPTH (ft)	HOUR	DATE
149.0	15:15	2-5-13

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ16

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-4-13 thru 2-7-13

LOCATION N838021.0, E774632.4
WELL REG. # ADWR Reg.# 55-915223
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1340.6'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
25								ML		**SANDY SILT,** continued
								ML	strong petroleum odor & PID hit	**SANDY SILT,** very fine grained sand, nonplastic to low plasticity, stringers of caliche
						49				
						440				
30										
								SW	sheen present in NAPL sample,	**GRAVELLY SILTY SAND,** 30% gravel, 55% sand, 5% silt, well graded sand, gravel up to 2", subrounded, grades to fine to medium grained sand in parts, strong odor
35				L		350	Y			
40								GW		**SANDY GRAVEL,** 50% gravel, 40% sand, 10% silt, more gravel GW/SW than above, subrounded up to 1 3/4" in diameter, well graded
								CL/GW	moderate indication of NAPL	**CALICHE,** cobble size pieces of caliche, matrix is a sandy clay, medium plasticity, stiff to firm, matrix is sandy clay, moderate odor
						158	Y/N			
45				L				ML/SM	moist to slightly moist	**SILTY SAND TO SANDY SILT WITH GRAVEL,** 10% gravel, 40% sand, 50% fines, predominantly fine to very fine grained sand, loose, strong lacquer small
						1380				
50										

GROUNDWATER

DEPTH (ft)	HOUR	DATE
149.0	15:15	2-5-13

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ16

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-4-13 thru 2-7-13

LOCATION N838021.0, E774632.4
WELL REG. # ADWR Reg.# 55-915223
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1340.6'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
50								ML/SM		**SILTY SAND TO SANDY SILT WITH GRAVEL,** contined
								ML/SM		**SANDY SILT,** 5% gravel, 30% sand, 65% fines, more silt & clay, cemented layers in part, low plasticity
55										
								ML/SM	moist	**Interbedded CALICHE & SANDY SILT WITH CLAY,**, portions are cemented, low plasticity, sand is very fine grained, caliche comes up as gravel-size pieces/broken up, firm, strong odor
				L		1750	Y			
60										
				L		1770	Y		higher moisture moderate to strong indication of NAPL	More plastic, strong lacquer odor
65								SM		**SILTY SAND,** 20% gravel, 45% sand, 35% fines, portions are cemented, low plasticity, sand is very fine grained, caliche comes up as gravel-size pieces/broken up
								SM	moist	**SILT,** nonplastic to low to slight plasticity, strong odor
70						1780				
								SW	moist to slightly moist	**GRAVELLY SAND WITH SILT,** 30% gravel, 60% silt, 10% fines, gravel up to 3" diameter, rounded to subrounded, well graded sand,
75										

GROUNDWATER

DEPTH (ft)	HOUR	DATE
149.0	15:15	2-5-13

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ16

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-4-13 thru 2-7-13

LOCATION N838021.0, E774632.4
WELL REG. # ADWR Reg.# 55-915223
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1340.6'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
75								SW		**GRAVELLY SAND WITH SILT,** continued note: caliche layer layer from 77'6" to 78'
								ML/SM	strong indication of NAPL	**SANDY SILT WITH CLAY,** 10% gravel, 30% sand, 60% fines, brown with varting amounts of caliche stringers & clay zones, fine to very fine grained sand, low plasticity, stiff, strong odor
				L		1480	Y			
80										note: caliche from 82' to 83'
85				L		1380	Y			
90									strong indication of NAPL, combined sample from 91' & 95'	note: increase in fine grained sand from 90' to 93', strong odor
						1710	Y			
				L						
								SM/SW		**SILTY SAND WITH GRAVEL,** 15% gravel, 65% sand, 20% fines, well graded, light brown, loose
						1200	Y			
95										note: caliche, white firm to stiff, clayey silt with chuncks of cemented caliche from 96' to 99'
								ML		**SANDY SILT**
100										

GROUNDWATER

	DEPTH (ft)	HOUR	DATE
▽	149.0	15:15	2-5-13
▼			
▼			
▼			

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ16

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-4-13 thru 2-7-13

LOCATION N838021.0, E774632.4
WELL REG. # ADWR Reg.# 55-915223
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1340.6'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
100								ML		**SANDY SILT,** with caliche stringers, very fine grained sand, low plasticity, brown to light brown, strong reaction to HCL, firm, strong odor
105				L		1570	Y		slight to moderate NAPL indication	
								SP	moist	**POORLY GRADED SAND WITH SILT & GRAVEL,** 10% gravel, 75% sand, 15% fines, predominantly fine grained sand, grayish-brown, slight reaction to HCL, loose, strong odor
110				L		864	Y		slight NAPL indication	
115										
								ML	moist	**SANDY SILT,** trace gravel, 35% sand, 65% fines with caliche stringers, very fine grained sand, brown, loose
120				L		1550	Y		moderate indication of NAPL	
								SM	moist	**SILTY SAND,** minor caliche stringers, very fine grained sand, nonplastic, light brown
125										

GROUNDWATER

DEPTH (ft)	HOUR	DATE
149.0	15:15	2-5-13

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ16

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-4-13 thru 2-7-13

LOCATION N838021.0, E774632.4
WELL REG. # ADWR Reg.# 55-915223
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1340.6'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
125								SM		**SILTY SAND,** continued
								ML	moist	**SILT WITH CLAY & SAND TO CLAYEY SILT,** caliche stringers, low to medium plasticity, dark brown, firm to stiff, strong odor
130										
								ML	moist to very moist	**CLAYEY SILT,** fine grained sand, as above execpt more clay, low to medium plasticity, caliche stringers in parts, dark brown, slightly firm, strong odor
135				L		1210	Y		strong indication of NAPL	
								SW	moist	**GRAVELLY SAND,** well graded, gravel up to 3" in diameter, subangular to subrounded, loose
140										
								ML	very moist	**CLAYEY SANDY SILT,** medium plasticity, firm
145										
								SM/SW	wet to saturated slight NAPL indication, first H2O detected around 147'	**SILTY, GRAVELLY SAND,** well graded, loose, strong odor
				L		440	Y			
150										

GROUNDWATER

DEPTH (ft)	HOUR	DATE
149.0	15:15	2-5-13

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ16

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-4-13 thru 2-7-13

LOCATION N838021.0, E774632.4
WELL REG. # ADWR Reg.# 55-915223
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1340.6'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
150								SW/GM	wet	**SANDY GRAVEL TO GRAVELLY SAND,** subrounded, up to 5" in diameter, sandy gravel, less odor & PID than upper zone (152'), collect sample above, distinct lanced odor & at stained interval, gravel up to 5" in diameter, loose, strong odor
				L		640				note: black stained from 154' to 154'10", minor odor
155				L		230	Y/N	CL		**FAT CLAY WITH SILT,** reddish-brown (gray to grayish-brown in parts), compacted, medium to high plasticity, firm, strong petroleum odor
160						1340				note: more silt & caliche stringers, still low to medium plasticity, white in parts from 161'6" to 165'
165				L		990	Y		strong indication of NAPL saturated	note: very stiff compacted clay saturated from 167' to 169', very firm, strong odor note: clayey silt, 20% sand, 80% fines, firm, from 169' to 170'6"
170								SM		**SILTY SAND,** 70% sand, 30% silt, fine grained sand, poorly graded, loose
								SW/GW	wet	**GRAVELLY SAND,** well graded, fine to coarse grained gravel up to 3" in diameter, rounded to subangular, gray to dark gray
175										

GROUNDWATER

DEPTH (ft)	HOUR	DATE
149.0	15:15	2-5-13

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ16

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-4-13 thru 2-7-13

LOCATION N838021.0, E774632.4
WELL REG. # ADWR Reg.# 55-915223
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1340.6'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
175						1150	Y		moderate indication of NAPL	
								ML		**CLAYEY SANDY SILT,** 35% sand, 65% fines, fine grained sand, low plasticity, grayish-brown, moderately firm to loose, strong odor
				L		1900			strong odor	
								CL		**STIFF CLAY,** with caliche stringers & silty clay in parts, low to medium plasticity, reddish-brown to white, stiff to firm
180										
185				L		>2300	Y	ML	strong indication of NAPL	
						1100		SP	wet	**POORLY GRADED SAND OR SAND,** fine to medium grained sand with trace silt, poorly graded with trace gravel, dark gray, loose
190										
								CL		Very stiff clay with stringers of caliche & clayey silt
195										
				L		1400	Y		strong to moderate indication of NAPL	note: minor amounts of gravel & silt from 198' to 202'
200										

GROUNDWATER

DEPTH (ft)	HOUR	DATE
149.0	15:15	2-5-13

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ16

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-4-13 thru 2-7-13

LOCATION N838021.0, E774632.4
WELL REG. # ADWR Reg.# 55-915223
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1340.6'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
200										
205				L		1390	Y		moderate indication of NAPL	note: minor amount of gravel & silt in clay from 208' to 209'
210								SP/GM	wet; less moist; moderate indication of NAPL	**POORLY GRADED GRAVELLY SAND TO SANDY GRAVEL,** trace silt in parts, 40% gravel, 55% sand, 5% fines, poorly graded sand with abundant medium to coarse grained sand, gravel up to 2" in diameter, well rounded to subrounded, dark gray, strong odor
215				L		850	Y	ML		**SILT,** with caliche stringers, whitish light brown
								CL	less wet inside core; wet	**STIFF SILTY CLAY TO CLAY,** stiff to very stiff, medium plasticity, dark brown, wet, firm, less odor; Stiff
220				L		50		CL		Stiff clay to 222'6"
225								SW/GW		**GRAVELLY SAND,** well graded sand are fine to coarse grained with gravel/cobbles up to 3" in diameter, well rounded, dark gray, loose

GROUNDWATER

DEPTH (ft)	HOUR	DATE
149.0	15:15	2-5-13

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ16

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-4-13 thru 2-7-13

LOCATION N838021.0, E774632.4
WELL REG. # ADWR Reg.# 55-915223
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1340.6'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
225						140	N	SW/GW		**GRAVELLY SAND,** continued, no odors
230								CL	wet	**SILTY CLAY TO STIFF CLAY WITH SAND,** medium plasticity, firm to stiff, moderately plastic
235								SW		**GRAVELLY SAND,** with minor amounts of clay, well graded, fine to coarse grained sand with gravel up to 1" in diameter, grayish-brown, loose
				L		9	N			
240						14				
								CL	partially wet (drier inside core)	**STIFF CLAY,** medium plasticity, silty in parts, very stiff, no odor
245						22				
										Stopped Drilling at 246'
250										

GROUNDWATER

DEPTH (ft)	HOUR	DATE
149.0	15:15	2-5-13

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ16

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-4-13 thru 2-6-13

LOCATION N838051.3, E774491.4
WELL REG. # ADWR Reg.# 55-915224
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1340.3'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
0				*				CL	moist (driller added water to upper 2') (hand augered to 5')	Asphalt at surface to 6" bgs **CLAY WITH SAND,** ~70% clay, ~30% very fine grained sand, uncemented, medium to high plasticity, brown, no odor
						1.1				
5								SM	dry to moist	**SILTY SAND,** ~60% sand, very fine to fine grained, ~40% silt, uncemented, nonplastic, brown, no odor note: ~5% gravel, fine grained, subangular to subrounded gravel & moderately to weakly cemented nodules at 7' (caliche)
10						191.9**				
								SW-SM	dry to moist ** note: possible moisture, false high readings	**WELL GRADED SAND WITH SILT,** ~90% sand, very fine to coarse grained, subangular to subrounded, ~10% silt, <5% fine grained gravel, subangular to subrounded, uncemented, weakly cemented nodules, nonplatic, brown, no odor
15						195.2**				
20						13.3				
								SM	dry to moist	**SILTY SAND,** ~60% very fine to fine grained sand, ~40% silt, <5% gravel, weak calcium carbonate content, weak cemented nodules, nonplastic, brown to light brown
25						1.8				

GROUNDWATER

DEPTH (ft)	HOUR	DATE
149.0	15:15	2-5-13

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ17

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-4-13 thru 2-6-13

LOCATION N838051.3, E774491.4
WELL REG. # ADWR Reg.# 55-915224
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1340.3'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
25								SM		**SILTY SAND,** continued
30				L		3.8	N	SC	dry to slightly moist	**CLAYEY SAND,** ~60% to 70% very fine grained sand, ~40% to 30% clay, uncemented, low plasticity, brown, slight to faint odor
								SW	dry to slightly moist	**WELL GRADED SAND,** fine to coarse grained, subangular to subrounded sand, 5% to 10% fine to coarse grained gravel, <5% fines, uncemented, nonplastic, brown, very faint odor
35						5.6		SC	dry to slightly moist	**CLAYEY SAND,** ~80% very fine grained sand, ~20% clay, uncemented, low plasticity, brown, no odor
								SW	dry to slightly moist	**WELL GRADED SAND,** very fine to coarse grained, subangular to subrounded sand, fine to coarse grained, subangular to subrounded gravel, <5% fines, uncemented, nonplastic, brown, no odor
40						2.4				
								SC	dry to slightly moist	**CLAYEY SAND,** ~70% very fine grained sand, ~30% clay, uncemented to strongly cemented nodules, low to medium plasticity, brown, no odor
45				L		4.5	N			
								SP	slightly moist	**SAND WITH GRAVEL,** ~85% predominantly fine to medium grained, subrounded to subangular sand, ~15% fine to coarse grained, subrounded to angular gravel, uncemented, nonplastic, brown
50						2.5				

GROUNDWATER

DEPTH (ft)	HOUR	DATE
149.0	15:15	2-5-13

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ17

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-4-13 thru 2-6-13

LOCATION N838051.3, E774491.4
WELL REG. # ADWR Reg.# 55-915224
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1340.3'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
50								SP		**SAND WITH GRAVEL,** continued
								SC	slightly moist to moist	**CLAYEY SAND,** ~80% very fine to fine grained sand, ~20% clay, uncemented to moderately lime cemented with strongly cemented nodules, low plasticity, brown, no odor
						2.3				
								SC	slightly moist to moist	**CLAYEY SAND,** ~70% very fine to fine grained sand, ~30% clay, weakly to moderately cemented, medium to high plasticity, light brown, no odor
55				L		2.8	N			
60						1.3				note: hard drilling & increased cementation from 61' to 63'
								SP	slightly moist	**SAND,** ~80% fine to medium grained sand, ~15% predominantly fine grained, subrounded to angular gravel, ~5% clay, uncemented, low plasticity to nonplastic, brown, no odor
65				L		1.4	N			
								SC	slightly moist to moist	**CLAYEY SAND,** ~80% very fine to fine grained sand, ~15% clay, uncemented, medium plasticity, dark brown, no odor
										note: increased to 20% clay below 68'
										note: increased to 30% clay below 69'
70										note: strange odor not fuel, & minty/menthol from 70' to 72'6", no PID detection or free product detection so no sample was taken, possible lacquer parafin smell
						0.5	N			
				L		1.5	N			
								SP		**SAND WITH GRAVEL,** ~70% predominantly fine to medium grained sand, ~30% predominantly fine grained, subrounded to subangular gravel, uncemented, nonplastic, brown
75										

GROUNDWATER

DEPTH (ft)	HOUR	DATE
149.0	15:15	2-5-13

SAMPLE TYPE
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LOG OF TEST BORING NO. ST012-LSZ17

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-4-13 thru 2-6-13

LOCATION N838051.3, E774491.4
WELL REG. # ADWR Reg.# 55-915224
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1340.3'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
75						0.3		SP	slightly moist to moist	**SAND WITH GRAVEL,** continued note: decreased to ~20% below 74'
								SP	slightly moist to moist	**SAND,** ~95% very fine to fine grained sand, <5% silt, uncemented, nonplastic, dark brown, no odor
								SW/GW		
						0.8				**SAND & GRAVEL,** ~50% well graded, subrounded to subangular gravel, ~50% well graded, subrounded to angular sand, uncemented, nonplastic, brown & gray, no odor
80										
								SP-SM	slightly moist to moist	**POORLY GRADED SAND WITH SILT,** ~90% very fine to fine grained sand, 10% silt, uncemented, nonplastic, brown, very faint odors, no stains
								SP-SC	slightly moist to moist	**POORLY GRADED SAND WITH CLAY,** ~90% very fine grained sand, ~10% clays, weak calcium carbonate cementation, low plasticity, brown, faint odors, no stains note: increase cementation, color change to whitish-brown from 86' to 89' (caliche)
85						8.2				
				L		15.9	N			
								SC	slightly moist to moist	**CLAYEY SAND,** ~70% very fine grained sand, ~30% clays, weak calcium carbonate content, brown, strong odors
90										
								SP-SC	slightly moist to moist	**POORLY GRADED SAND WITH CLAY,** ~90% very fine to fine grained, subangular to subrounded sand, ~10% clay, uncemented, nonplastic, brown, hydrocarbon odors note: calcium carbonate content, whitish-brown in color below 95'
95						15.1				
						28.8				
				L		38	N			
100						2.5				

GROUNDWATER

DEPTH (ft)	HOUR	DATE
149.0	15:15	2-5-13

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
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LOG OF TEST BORING NO. ST012-LSZ17

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-4-13 thru 2-6-13

LOCATION N838051.3, E774491.4
WELL REG. # ADWR Reg.# 55-915224
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1340.3'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
100								SW	moist	**WELL GRADED SAND WITH GRAVEL,** ~90% very fine to coarse grained, subangular to subrounded sand, <5% fines, silt/clay, 10% gravel, fine grained, subangular to subrounded, calcium carbonate content with moderately cemented nodules, nonplastic, light brown, odors, no stains
						3.4		SP-SM		
								SP-SC		
						3.2			slightly moist	**POORLY GRADED SAND WITH SILT,** ~90% very fine to fine grained sand, ~10% silt, <5% clay, uncemented to weak calcium carbonate content, nonplastic, brown to light brown, odors, no stains note: increase clays below 103'
105										
						4.1			slightly moist	**POORLY GRADED SAND WITH CLAY,** ~90% very fine to fine grained sand, ~10% clay, uncemetned with weak calcium carbonate content, nonplastic to low plasticity, brown, odors, no stains note: increasing sands, decreasing fines at 109'
				L		13.5	N			
								SP	slightly moist to moist	**POORLY GRADED SAND,** predominantly very fine to fine grained sand, <5% to 5% fines, uncemented, nonplastic, brown, odors, no stains
110										
								SW	slightly moist	**WELL GRADED SAND WITH GRAVEL,** fine to coarse grained, subangular to subrounded sand, ~15% to 20% fine grained, subangular to subrounded gravel, uncemented, nonplastic, grayish-brown, odors, no stains
						2.7				
								SP-SC		
				L		3.2	N			
						5.1		SP	slightly moist to moist	**POORLY GRADED SAND WITH CLAY,** predominantly fine grained, subangular to subrounded sand, ~15% to 20% fine grained, subangular to subrounded gravel, uncemented, nonplastic, brown, odors, faint grayish staining at 113'
115										
								SP-SC	slightly moist	**POORLY GRADED SAND,** fine grained sand, <5% fine
						5.3			slightly moist to moist	**POORLY GRADED SAND WITH CLAY,** predominantly fine grained, subangular to subrounded sand, ~15% to 20% fine grained, subangular to subrounded gravel, uncemented, nonplastic, brown, odors, no stains
120								SP-SM		
						2.3			slightly moist to moist	**POORLY GRADED SAND WITH SILT,** ~90% very fine grained sand, ~10% silt, uncemented to weak cemented nodules, nonplastic, light brown, odors, no stains
						4.4				
125										

GROUNDWATER

DEPTH (ft)	HOUR	DATE
149.0	15:15	2-5-13

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ17

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-4-13 thru 2-6-13

LOCATION N838051.3, E774491.4
WELL REG. # ADWR Reg.# 55-915224
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1340.3'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
125								SP-SM	slightly moist to moist	**POORLY GRADED SAND WITH SILT,** continued
						2.8				
								SP-SC	slightly moist to moist	**POORLY GRADED SAND WITH CLAY,** ~90% sand, very fine to fine grained, ~10% clay, weak calcium carbonate content, nonplastic to low plasticity, brown, odors, no stains
								SC		
								SP		
				L		4.4	N			
									slightly moist to moist	**CLAYEY SAND,** ~60% very fine grained sand, ~40% clay, weak calcium carbonate content, medium plasticity, reddish-brown, odors, no stains
								SC		
130						2.1				
									moist	**POORLY GRADED SAND,** predominantly fine grained, subangular to subrounded sand, <5% fines, uncemented, nonplastic, grayish-brown, odors, no stains
						2.7				
									moist	**CLAYEY SAND,** ~70% very fine grained sand, ~30% clays, weak calcium carbonate content, cemented nodules, low to medium plasticity, brown, odors, no stains
				L		4.1				
								SP-SC	moist	**POORLY GRADED SAND WITH CLAY,** ~90% very fine to fine grained sand, ~10% clay, weak calcium carbonate content with moderately cemented nodules, nonplastic to low plasticity, brown to light brown, odors, no stains
135										
						3.5				
						1.8				
						3		SP	moist	**POORLY GRADED SAND,** predominantly very fine to fine grained, subangular to subrounded sand, 5% fines, uncemented, nonplastic, brown, odors, no stains
140										
						1.5				
								SW	moist to wet	**WELL GRADED SAND WITH GRAVEL,** ~80% fine to coarse grained, subangular to subrounded sand, ~20% fine to coarse grained, subangular to subrounded gravel, uncemented, nonplastic, brown to grayish-brown, faint to no odors, no stains
						2.3				
145										
						2.1				
				L		2.7				
▽									wet/saturated conditions at 149'	
						1.7				
150										

GROUNDWATER

	DEPTH (ft)	HOUR	DATE
▽	149.0	15:15	2-5-13
▼			
▼			
▼			

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ17

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-4-13 thru 2-6-13

LOCATION N838051.3, E774491.4
WELL REG. # ADWR Reg.# 55-915224
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1340.3'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
150								SW	wet	**WELL GRADED SAND WITH GRAVEL,** continued
						2.9				
						2.5				note: subrounded cobbles up to 4" in diameter at 154'
155								CL	moist	**CLAY,** ~80% to 90% clay, ~20% to 10% very fine grained sand, uncemented, weak calcium carbonate content, high plasticity, brown, firm to stiff, odors, no stains
						4				
				L		5.7	N			
160						4.6				
						5.4				
						2.7				
165						66.2				
				L		677.2	N			
								SP-SC	moist to wet	**POORLY GRADED SAND WITH CLAY,** predominantly very fine to fine grained sand, ~10% clay, uncemented, nonplastic to very low plasticity, brown, odors, no stains
170						204.3				
						311.8				
								SP	wet	**POORLY GRADED SAND,** predominantly fine grained, subangular to subrounded sand, 5% fines, <5% gravels, uncemented, nonplastic, grayish-brown, odors, no stains
				L		522.8	N			
175								SW		

GROUNDWATER

	DEPTH (ft)	HOUR	DATE
▽	149.0	15:15	2-5-13
▼			
▼			
▼			

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ17

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-4-13 thru 2-6-13

LOCATION N838051.3, E774491.4
WELL REG. # ADWR Reg.# 55-915224
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1340.3'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
175								SW	wet	**WELL GRADED SAND WITH GRAVEL,** fine to coarse grained, subangular to subrounded sand, ~20% fine to coarse grained, subangular to subrounded gravel, ~5% fines, uncemented, nonplastic, grayish-brown, odors, no stains note: cobbles below 177'
						11.3				
								SW-SC		
						378.2				
									wet	**WELL GRADED SAND WITH CLAY & GRAVEL,** ~70% fine to coarse grained, subangular to subrounded sand, ~20% fine to coarse grained, subangular to subrounded gravel, ~10% clays, subrounded cobbles up to 4' to 6" in diameter, uncemented, low plasticity, brown, odors, no stains
						20.2				
180								SP-SC		
						1606				
								SP-SM	moist slight indication of NAPL	**POORLY GRADED SAND WITH CLAY,** ~90% very fine to fine grained sand, ~10% clay, <5% gravel, uncemented, weak calcium carbonate content, low plasticity, light brown, odors, no stains note: silt content at 182'
				L		1646	Y (low)			
185								SC	moist	**POORLY GRADED SAND WITH SILT,** predominantly very fine to fine grained sand, ~10% silt, <5% clay, ~5% subrounded to subangular gravel, weak calcium carbonate content, nonplastic, light brown to brown, odors, no stains note: clay increase at 185'
						1557				
						464.9		CL		
						1014			moist	**CLAYEY SAND,** ~60% very fine grained sand, ~40% clay, weak calcium carbonate content, medium plasticity, brown, odors, no stains
190								SW-SC	moist	**CLAY,** ~70% clays, 30% very fine grained sand, trace silt, calcium carbonate content, high plasticity, brown to orangish, odors, no stains
						1395				
								SC	slightly moist	**WELL GRADED SAND WITH CLAY & GRAVEL,** fine to coarse grained sand, ~10% clay, 20% subangular to subrounded gravel, nonplastic, brown, odors, no stains
						1239				
195				L		1547	N		slightly moist to moist	**CLAYEY SAND,** predominantly very fine to fine grained sand, ~30% clays, trace silt, uncemented with calcium carbonate content, low plasticity, brown, odors, no stains
						724.2				
200						1025				

GROUNDWATER

DEPTH (ft)	HOUR	DATE
149.0	15:15	2-5-13

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ17

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-4-13 thru 2-6-13

LOCATION N838051.3, E774491.4
WELL REG. # ADWR Reg.# 55-915224
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1340.3'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
200								SC	slightly moist to moist	**CLAYEY SAND,** continued note: increase in calcium carbonate content, moderately cemented nodules below 200'
						1085				
				L		1267	Y (mod)		slight indication of NAPL	note: increase in sand content & becoming medium grained from 202' to 204' note: clay lense from 204' to 205'
205						1187				
								SW-SC	moist to wet	**WELL GRADED SAND WITH CLAY & GRAVEL,** fine to coarse grained, subangular to subrounded sand, ~20% fine to coarse grained, subangular to subrounded gravel, ~10% clays, <5% silt, uncemented, nonplastic, brown to dark brown, odors, no stains
						185.2				
210						237.8				
				L		1426	Y (low)			
						800				
								SW	moist	**WELL GRADED SAND WITH GRAVEL,** fine to coarse grained, subangular to subrounded sand, ~20% fine to coarse grained, subangular to subrounded gravel, uncemented, nonplastic, grayish-brown, odors, no stains note: ~5% clays below 216'
215						714.2				
						924		SP	moist	**POORLY GRADED SAND,** predominantly very fine to fine grained, subangular to subrounded sand, 5% fines, <5% gravels, uncemented, nonplastic, brown, odors, no stains
220						1082				
				L		1110	Y			
								SP-SC		**POORLY GRADED SAND WITH CLAY,** predominantly very fine to fine grained sand, ~10% clay, uncemented, nonplastic, brown with orangish tint, odors, no stains
						369.3	(mod-str)			
225										

GROUNDWATER

DEPTH (ft)	HOUR	DATE
149.0	15:15	2-5-13

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ17

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 2-4-13 thru 2-6-13

LOCATION N838051.3, E774491.4
WELL REG. # ADWR Reg.# 55-915224
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1340.3'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
225								SP	moist	**POORLY GRADED SAND,** very fine grained, subangular to subrounded sand, 5% fines, <5% gravels, uncemented, nonplastic, grayish-brown, odors, no stains
						399				
								SW	moist to wet	**WELL GRADED SAND WITH GRAVEL,** fine to coarse grained, subangular to subrounded sand, <5% fines, 20% fine to coarse grained, subangular to subrounded gravel, uncemented, nonplastic, grayish-brown, odors note: staining from 227' to 228'
						953.3				
								SC		
230						290				
									moist	**CLAYEY SAND,** ~70% very fine grained sand, ~30% clay, <5% silt, uncemented, nonplastic to very low plasticity, reddish/orangish-brown, odors, no stains note: no odors below 230'
						3.6				
								SW-SC	moist to wet	**WELL GRADED SAND WITH CLAY,** predominantly fine to coarse grained, subangular to subrounded sand, ~10% clay, <5% silt, ~5% fine grained, subangular to subrounded gravel, uncemented, nonplastic, brown, no odor, no stains
						5.6				
235								SW		
						16.9			moist	**WELL GRADED SAND WITH GRAVEL,** predominantly fine to coarse grained, subangular to subrounded sand, ~20% to 30% fine to coarse grained, subangular to subrounded gravel, uncemented, nonplastic, brown to grayish-brown, no odors, no stains
240						110.9	N	SC	moist to slightly moist	**CLAYEY SAND,** predominanrtly very fine grained sand, ~30% clay, uncemented, weak calcium carbonate content, low plasticity, light brown, no odors, no stains
						6				
								CL-ML	slightly moist	**SILTY CLAY TO CLAY WITH SILT,** ~90% clay, ~10% silt, weak calcium carbonate content, medium to high plasticity, light brown to brown, stiff to firm, no odors, no stains
						6.5				
245										
						9.8				
										Stopped Drilling to 246' Well Installed
250										

GROUNDWATER

DEPTH (ft)	HOUR	DATE
149.0	15:15	2-5-13

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-LSZ17

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 3-12-13 to 3-13-13

LOCATION N838128.8, E774748.2
WELL REG. # TBD
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1341.0'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
0				*						Disturbed by hand augering
5						1.0		CL	dry	**SANDY CLAY,** ~65% clay, ~35% fine to meduim grained sand, moderately cementation, medium to high plasticity, brown, no odors, no stains
								SC	dry	**CLAYEY SAND,** ~65% fine to medium grained sand, ~35% clay, uncemented to weak cementation, low plasticity, light brown, no odors, no stains
10						0.9		SW-SC	dry	**SAND,** ~85% fine to coarse grained sand, ~5% fine grained, subrounded gravel, ~10% fines (clay & silt), uncemented, nonplastic, grayish-brown, no odors, no stains
15						0.8		SC	dry	**SAND,** 60% fine to medium grained sand, 40% fines (mostly clay, some silt), uncemented to weak cementation, low plasticity, yellowish-brown, no odors, no stains
20						3.1		SW	dry	**SAND,** 95% fine to coarse grained sand, 5% fine grained, subangular to subrounded gravel, uncemented, nonplastic, grayish-brown, no odors, no stains
25						2.1		CL	dry	**SANDY CLAY,** 70% clay, 30% very fine to fine grained sand, moderately cemented, medium to high plasticity, yellowish-brown, no odors, no stains

GROUNDWATER

	DEPTH (ft)	HOUR	DATE
▽		none	
▼			
▼			
▼			

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-UWBZ09

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 3-12-13 to 3-13-13

LOCATION N838128.8, E774748.2
WELL REG. # TBD
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1341.0'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
25								CL		**SANDY CLAY,** continued
						2.6				
30										
								SW		**SAND,** 95% very fine to coarse grained sand, 5% fine grained, subrounded gravel, grain-size varies slightly within interval, uncemented, nonplastic, light brown to grayish-brown, no odors, no stains
						3.1			dry	
						4.6				
35										
						5.3				
				L		5.7				
40										
								CL	dry	**SANDY CLAY,** 80% clay, 20% very fine to fine grained sand, moderately cemented, high plasticity, yellowish-brown, no odors, no stains
				L		5.2				
						3.1				
						1.9				note: increase slightly toward 45', grain-size increases also, increased sand & sand grain-size around 45'
45										
								SW	dry	**SAND,** 95% fine to coarse grained sand, 5% fine grained, subrounded gravel, uncemented, nonplastic, gray to brown, no odors, no stains
						2.0				
								SC		**CLAYEY SAND**
50										

GROUNDWATER

	DEPTH (ft)	HOUR	DATE
▽		none	
▼			
▼			
▼			

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-UWBZ09

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 3-12-13 to 3-13-13

LOCATION N838128.8, E774748.2
WELL REG. # TBD
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1341.0'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
50								SC	dry	**CLAYEY SAND,** 70% fine grained sand, 40% clay fines, trace fine grained gravel, subrounded, weakly cemented, low plasticity, yellowish-brown, no odors, no stains note: medium to coarse grained sand & gravel layer from 53' to 53'6", gray to brown, uncemented, nonplastic
						1.9				
				L		3.8				
55										
						2.0				
						3.7				
								CL	dry	**CLAY,** 90% clay, 10% very fine to fine grained sand, strongly cemented, high plasticity, brown, no odors, no stains note: medium to coarse grained sand with fine grained, subrounded gravel & possibly caliche from 65' to 65'6", grayish-brown, moderately cemented, nonplastic
60										
						2.9				
				L		3.5				
65										
						1.9				
						2.9				
70										
						3.2				
								SW	dry	**SAND,** 90% fine to coarse grained sand, 10% fine grained gravel, subangular to subrounded, grain-size varies somewhat throughout interval from fine to medium to coarse grained, uncemented, nonplastic, light tan to grayish-tan, no odors, no stains
75						2.1				

GROUNDWATER

DEPTH (ft)	HOUR	DATE
	none	

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T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-UWBZ09

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 3-12-13 to 3-13-13

LOCATION N838128.8, E774748.2
WELL REG. # TBD
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1341.0'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
75								SW		**SAND,** continued
				L		3.3				
						3.0				
80								SC	dry	**CLAYEY SAND,** 80% very fine to fine grained sand, 20% clay & fines, weakly cemented, low plasticity, dark brown, no odors, no stains
						2.9				
						3.4				
85								CL	dry	**SANDY CLAY,** 70% clay, 30% very fine to fine grained sand, moderately cemented, medium to high plasticity, brown to dark brown, no odors, no stains
						3.0				
				L		4.1				
90								SP-SM	dry	**POORLY GRADED SAND WITH CLAY,** 90% very fine to fine grained sand, 10% clay, uncemented to moderately cemented, nonplastic to low plasticity, brown to grayish-brown, no odors, no stains
						3.3				
				L		2.9				
95										note: increasing sand content at 96'
								CL	dry	**CLAY,** 95% clay to silt, 5% sand, strongly cemented (clay to silt nodules), high plasticity, very light tan, no odors, no stains
						3.4				
100						3.3				

GROUNDWATER

DEPTH (ft)	HOUR	DATE
	none	

SAMPLE TYPE
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U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-UWBZ09

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 3-12-13 to 3-13-13

LOCATION N838128.8, E774748.2
WELL REG. # TBD
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1341.0'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
100								SC	dry	**SANDY CLAY,** ~70% clay, ~30% very fine to fine grained sand, weakly to moderately cemented, medium plasticity, yellowish-brown, no odors, no stains
						2.5				
										note: light colored layer (light gray) from 103'6" to 104'
				L		3.7				
105										
						3.2				
								SP	dry	**SAND,** fine to medium grained sand, uncemented, nonplastic, gray to brown, no odors, no stains
110						2.9				
						1.3				
										note: gravel appears at ~113'6", fine grained, subrounded
						0.6				
115										note: ~10% increasing from 113'6" to 116'
								CL	dry	**SANDY CLAY,** 60% clay, 40% very fine to fine grained sand, moderately cemented, low to medium plasticity, tannish-brown, no odors, no stains
						0.5				
				L		2.7				
120										
										note: some cemented clay/silt nodules from 121' to 122', strongly cemented
						1.9		SM	dry	**SILTY SAND,** 80% very fine to fine grained sand, 20% silt, uncemented to weakly cemented, nonplastic, brown, no odors, no stains
				L		2.0				
125										

GROUNDWATER

DEPTH (ft)	HOUR	DATE
	none	

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T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
L - Laboratory sample

LOG OF TEST BORING NO. ST012-UWBZ09

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 3-12-13 to 3-13-13

LOCATION N838128.8, E774748.2
WELL REG. # TBD
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1341.0'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
125								SM		**SILTY SAND,** continued
								SC	dry	**SANDY CLAY,** 65% clay, 35% fine to medium grained sand, moderately to strongly cemented, medium plasticity, dark yellowish-brown, no odors, no stains
						1.5				
						1.6				
130										
						0.2				
										note: cemented clay nodules, sand content varies slightly within interval, increased sand from 133' to 134'
				L		2.1				
135										
								SP	dry	**SAND,** 90% very fine to medium grained sand, 10% medium to large gravel, subrounded, few cobbles >3" in diameter, uncemented, nonplastic, grayish-brown to brown, no odors, no stains
						2.1				
						1.2				
140										
								CL	dry	**SANDY CLAY,** 60% clay, 40% fine grained sand, weakly to moderately cemented, low to medium plasticity, brown, no odors, no stains
						0.4		SW	dry	**SAND,** 85% fine to coarse grained sand, 15% small subrounded gravel, uncemented, nonplastic, light gray to gray to brown, no odors, no stains
						1.4				
145										note: thin layer (<6"), stained red (possibly iron-oxide) at 145'6"
								SC	dry to moist	**CLAYEY SAND,** 85% fine to medium grained sand, 15% clay found in blobs randomly distributed within interval, uncemented to weakly cemented, nonplastic to very low plasticity, dark yellowish-brown, no odors, no stains
						0.1				
				L		1.4	N			
150										

GROUNDWATER

DEPTH (ft)	HOUR	DATE
	none	

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L - Laboratory sample

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ST012 Pre-Design Investigation
Mesa, Arizona

JOB NO. 9101110001 **DATE** 3-12-13 to 3-13-13

LOCATION N838128.8, E774748.2
WELL REG. # TBD
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1341.0'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
150								SC		**CLAYEY SAND,** continued
						2.0				
						1.5				
155										
								CL		**CLAY TO SANDY CLAY,** 90% clay, 10% very fine to fine grained sand, strongly cemented, occasional clay nodule (cemented), very high plasticity, dark yellowish-brown
						1.5			dry to moist	
				L		2.1	N			
160										
						2.1				
										note: white streaking & color change to grayish-tan from 163' to 163'6"
						1.3				
165										
						2.8				note: odor becomes noticable at 166'6" & increases toward 170' then begins to dissipate, strong again near 182' then tapers to very mild odor
				L		15.8	N			
170										note: interval from 170' to 172' is 90% coarse grained sand & 10% fine grained, subrounded gravel, greenish-gray color, almost like concrete, nonplastic, uncemented, noticeable odor
				L		2.2	N			
						1.5				
175										

GROUNDWATER

DEPTH (ft)	HOUR	DATE
	none	

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U - 3" O.D. 2.42" I.D. tube sample
T - 1" O.D. thin-walled tube sample
D - 2.5" O.D. 1.9" I.D. tube sample
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LOG OF TEST BORING NO. ST012-UWBZ09

PROJECT Former Williams Air Force Base
ST012 Pre-Design Investigation
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JOB NO. 9101110001 **DATE** 3-12-13 to 3-13-13

LOCATION N838128.8, E774748.2
WELL REG. # TBD
RIG TYPE Rotosonic
SAMPLE TYPE 10 1/2" O.D. Casing
SURFACE ELEV. 1341.0'
DATUM NAD 83, US Survey Feet

Depth in Feet	Drill Rate Min./Ft.	Graphical Log	Sample	Sample Type	Blow Counts	PID Meter Reading (ppm)	LNAPL Dye Test Result	Unified Soil Classification	Remarks	VISUAL CLASSIFICATION
175								CL		**CLAY TO SANDY CLAY,** continued
						1.0				
180						1.9				
				L		5.8	N			
185						4.7				
						2.7				note: another sand/gravel area gray in color from 186' to 186'6", this one has more clay than the interval from 170' to 172', 70% medium to coarse grained sand, 10% gravel, small to medium, 20% clay, low plasticity, uncemented to weakly cemented
								SP/SC	moist	**SAND WITH CLAY,** 85% medium grained sand, 5% fine grained, subrounded gravel, 10% clay, uncemented to very weak cementation, very low plasticity, dark grayish-brown, moderate odor, no stains
190						3.1				
								CL	dry to moist	**CLAY,** 95% clay, 5% very fine to fine grained sand, very strong cementation, very high plasticity, dark yellowish-brown, noticable odor throughout, no stains
				L		3.9	N			note: orange stripping at 191'
195						2.3				note: color change at 196'6" to lighter brown/grayish-brown, but content remains consistent
						2.3				
										Stopped Drilling at 197' Well Installed
200										

GROUNDWATER

	DEPTH (ft)	HOUR	DATE
▽		none	
▼			
▼			
▼			

SAMPLE TYPE
A - Auger cuttings; NR - No Recovery
S - 2" O.D. 1.38" I.D. tube sample
U - 3" O.D. 2.42" I.D. tube sample
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LOG OF TEST BORING NO. ST012-UWBZ09

ATTACHMENT A.4

WELL DEVELOPMENT LOGS

ATTACHMENT A.5

SOIL AND GROUNDWATER TEST RESULTS

ST012 Pre-Design Investigation
Summary of Soil Sample Analytical Results - Compounds of Interest

Location ID	Sample ID	Sample Type	Sample Date	Sample Depth (ft.)	Lithology	PID (ppmv)	Percent Moisture (%)	TPH (GRO) (C6-C10) Conc. (mg/kg)	TPH (DRO) (C10-C28) Conc. (mg/kg)	1,2,4-TMBZ Conc. (µg/kg)	1,3,5-TMBZ Conc. (µg/kg)	Benzene Conc. (µg/kg)	Cyclohexane Conc. (µg/kg)	Ethylbenzene Conc. (µg/kg)	Methylcyclohexane Conc. (µg/kg)	Naphthalene Conc. (µg/kg)	n-Hexane Conc. (µg/kg)	Toluene Conc. (µg/kg)	Xylenes, Total Conc. (µg/kg)
ST012-LSZ08	ST012-LSZ08-33-213-SO-N		2/11/2013	33	SW	1.9	9.5	1.2 F	1.5 F	< 5.0 U	< 5.0 U	< 5.0 U	< 5.0 U	< 5.0 U	< 5.0 U	< 5.0 U	0.89 F	< 5.0 U	< 5.0 U
	ST012-LSZ08-47-213-SO-N		2/11/2013	47	SW	1.9	12	4.0	6.2	< 4.9 U	< 4.9 U	< 4.9 U	< 4.9 U	< 4.9 U	< 4.9 U	< 4.9 U	< 4.9 U	< 4.9 U	< 4.9 U
	ST012-LSZ08-55-213-SO-N		2/11/2013	55	ML	5.3	15	6.7	1.4 F	< 5.9 U	< 5.9 U	< 5.9 U	< 5.9 U	< 5.9 U	< 5.9 U	< 5.9 U	< 5.9 U	< 5.9 U	< 5.9 U
	ST012-LSZ08-67-213-SO-N		2/11/2013	67	ML/SM	1.4	14	1.8	1.9 F	< 5.6 U	< 5.6 U	< 5.6 U	< 5.6 U	< 5.6 U	0.5 F	< 5.6 U	< 5.6 U	< 5.6 U	< 5.6 U
	ST012-LSZ08-79-213-SO-N		2/11/2013	79	ML/SM	35	19	< 1.4 U	5.7	< 5.2 U	< 5.2 U	< 5.2 U	< 5.2 U	< 5.2 U	< 5.2 U	< 5.2 U	< 5.2 U	< 5.2 U	< 5.2 U
	ST012-LSZ08-87-213-SO-N		2/12/2013	87	SP	90	20	0.65 F	5.2	< 5.3 U	< 5.3 U	1.0 F	< 5.3 U	< 5.3 U	< 5.3 U	< 5.3 U	< 5.3 U	< 5.3 U	< 5.3 U
	ST012-LSZ08-97-213-SO-N		2/12/2013	97	SM/ML	3.3	17	1.9	5.4	< 4.8 U	< 4.8 U	1.3 F	< 4.8 U	< 4.8 U	< 4.8 U	< 4.8 U	< 4.8 U	< 4.8 U	< 4.8 U
	ST012-LSZ08-107-213-SO-N		2/12/2013	107	SM/ML	40	22	2.3	3.3 F	< 6.2 U	< 6.2 U	2.7 F	< 6.2 U	< 6.2 U	< 6.2 U	< 6.2 U	< 6.2 U	< 6.2 U	< 6.2 U
	ST012-LSZ08-117-213-SO-N		2/12/2013	117	ML	4	17	3.1	5.1	< 5.1 U	< 5.1 U	2.1 F	< 5.1 U	< 5.1 U	< 5.1 U	< 5.1 U	< 5.1 U	1.2 F	< 5.1 U
	ST012-LSZ08-127-213-SO-N		2/12/2013	127	ML	3.5	18	0.46 F	1.1 F	< 5.2 U	< 5.2 U	1.3 F	< 5.2 U	< 5.2 U	< 5.2 U	< 5.2 U	< 5.2 U	< 5.2 U	< 5.2 U
	ST012-LSZ08-137-213-SO-N		2/12/2013	137	ML	4.8	16	0.68 F	1.8 F	< 4.7 U	< 4.7 U	2.2 F	< 4.7 U	< 4.7 U	< 4.7 U	< 4.7 U	< 4.7 U	0.88 F	< 4.7 U
	ST012-LSZ08-146-213-SO-N		2/12/2013	146	CL	4.8	18	0.96 F	1.7 F	< 4.3 U	< 4.3 U	1.7 F	< 4.3 U	< 4.3 U	< 4.3 U	< 4.3 U	< 4.3 U	< 4.3 U	< 4.3 U
	ST012-LSZ08-156-213-SO-N		2/12/2013	156	CL	2.3	21	< 1.2 U	1.6 F	< 4.9 U	< 4.9 U	2.2 F	< 4.9 U	< 4.9 U	< 4.9 U	< 4.9 U	< 4.9 U	< 4.9 U	< 4.9 U
	ST012-LSZ08-169-SO-N		2/12/2013	169	ML	57	19	< 1.3 U	0.96 F	< 4.7 U	< 4.7 U	1.5 F	< 4.7 U	< 4.7 U	< 4.7 U	< 4.7 U	< 4.7 U	< 4.7 U	< 4.7 U
	ST012-LSZ08-179-SO-N		2/12/2013	179	SW/GW	7.9	13	< 1.1 U	1.6 F	< 4.5 U	< 4.5 U	1.2 F	< 4.5 U	< 4.5 U	< 4.5 U	< 4.5 U	< 4.5 U	< 4.5 U	< 4.5 U
	ST012-LSZ08-187-SO-N		2/13/2013	187	SW/GW	6	14	0.75 F	2.1 F	< 4.1 U	< 4.1 U	0.94 F	< 4.1 U	< 4.1 U	< 4.1 U	< 4.1 U	0.7 F	< 4.1 U	< 4.1 U
	DUP-07-0213-SO-FR	Duplicate	2/13/2013	187			15	2.4 J	1.4 F	< 4.6 U	< 4.6 U	0.9 F	< 4.6 U	< 4.6 U	< 4.6 U	< 4.6 U	< 4.6 U	< 4.6 U	< 4.6 U
	ST012-LSZ08-198-SO-N		2/13/2013	198	SW/GW	4.3	22	2.5	1.7 F	< 5.2 U	< 5.2 U	1.8 F	1.2 F	< 5.2 U	0.88 F	< 5.2 U	0.88 F	1.1 F	< 5.2 U
	ST012-LSZ08-207-SO-N		2/13/2013	207	CL	2.3	19	< 1.1 U	1.3 F	< 5.0 U	< 5.0 U	< 5.0 U	< 5.0 U	< 5.0 U	4.6 F	< 5.0 U	< 5.0 U	< 5.0 U	< 5.0 U
	ST012-LSZ08-219-213-SO-N		2/13/2013	219	SW	1130	21	1000 J	5.7 J	24000 J	7700 J	11000 J	56000 J	23000 J	97000 J	4400 F	34000 J	33000 J	60000 J
	DUP-08-0213-SO-FR	Duplicate	2/13/2013	219			21	5700 J	650 J	5700 J	1900 F	4200 J	14000 J	5200 J	27000 J	1200 F	10000 J	8600 J	14000 J
	ST012-LSZ08-225-213-SO-N		2/13/2013	225	SW/GW	930	11	1900	88	5100	1800	800 F	14000	4600	25000	950 F	12000	720 F	8500
	ST012-LSZ08-235-213-SO-N		2/13/2013	235	ML/GM		13	0.49 F	1.7 F	< 4.6 U	< 4.6 U	1.5 F	1.7 F	< 4.6 U	2.1 F	< 4.6 U	1.1 F	< 4.6 U	< 4.6 U
ST012-LSZ09	ST012-LSZ09-38FT-0213-SO-N		2/11/2013	38	SP-SM	2	6.4	3.3	0.8 F	< 4.6 U	< 4.6 U	< 4.6 U	0.69 F	< 4.6 U	1.3 F	< 4.6 U	0.73 F	0.64 F	< 4.6 U
	ST012-LSZ09-48FT-0213-SO-N		2/11/2013	48	SM	10.5	15	0.48 F	1.0 F	< 4.8 U	< 4.8 U	< 4.8 U	< 4.8 U	< 4.8 U	< 4.8 U	< 4.8 U	< 4.8 U	< 4.8 U	< 4.8 U
	ST012-LSZ09-58FT-0213-SO-N		2/11/2013	58	SM/SC	2.6	14	0.34 F	1.1 F	< 4.5 U	< 4.5 U	< 4.5 U	< 4.5 U	< 4.5 U	< 4.5 U	< 4.5 U	< 4.5 U	< 4.5 U	< 4.5 U
	ST012-LSZ09-68FT-0213-SO-N		2/11/2013	68	SC	4.2	17	0.35 F	1.4 F	< 4.4 U	< 4.4 U	0.53 F	0.45 F	< 4.4 U	0.62 F	< 4.4 U	0.77 F	< 4.4 U	< 4.4 U
	ST012-LSZ09-78FT-0213-SO-N		2/11/2013	78	SW/SM	5.5	5.2	< 1.1 U	< 3.9 U	< 4.5 U	< 4.5 U	< 4.5 U	< 4.5 U	< 4.5 U	< 4.5 U	< 4.5 U	< 4.5 U	< 4.5 U	< 4.5 U
	ST012-LSZ09-90FT-0213-SO-N		2/11/2013	90	SP/SM	4.8	14	< 1.1 U	1.4 F	< 4.8 U	< 4.8 U	0.75 F	< 4.8 U	< 4.8 U	< 4.8 U	< 4.8 U	< 4.8 U	< 4.8 U	< 4.8 U
	ST012-LSZ09-100FT-0213-SO-N		2/11/2013	100	SP/SM	5	11	0.74 F	< 4.4 U	< 4.8 U	< 4.8 U	0.51 F	< 4.8 U	< 4.8 U	< 4.8 U	< 4.8 U	< 4.8 U	< 4.8 U	< 4.8 U
	ST012-LSZ09-108FT-0213-SO-N		2/11/2013	108	SP	4.5	20	0.36 F	1.0 F	< 4.6 UM	< 4.6 UM	1.1 M	< 4.6 U	< 4.6 UM	< 4.6 U	< 4.6 UM	< 4.6 U	< 4.6 UM	< 4.6 UM
	ST012-LSZ09-116FT-0213-SO-N		2/11/2013	116	SP	4	5.2	0.53 F	< 4.0 U	< 5.1 U	< 5.1 U	< 5.1 U	< 5.1 U	< 5.1 U	< 5.1 U	< 5.1 U	< 5.1 U	< 5.1 U	< 5.1 U
	ST012-LSZ09-128FT-0213-SO-N		2/12/2013	128	SC	5.2	15	0.83 F	1.1 F	< 4.0 U	< 4.0 U	0.72 F	< 4.0 U	< 4.0 U	< 4.0 U	< 4.0 U	< 4.0 U	< 4.0 U	< 4.0 U
	ST012-LSZ09-132FT-0213-SO-N		2/12/2013	132	SP/SC	4.9	15	0.35 F	0.86 F	< 4.3 U	< 4.3 U	0.47 F	< 4.3 U	< 4.3 U	< 4.3 U	< 4.3 U	< 4.3 U	< 4.3 U	< 4.3 U
	ST012-LSZ09-148FT-0213-SO-N		2/12/2013	148	SP	8.7	12	0.33 F	< 4.2 U	< 4.7 U	< 4.7 U	2.0 F	< 4.7 U	< 4.7 U	< 4.7 U	< 4.7 U	< 4.7 U	< 4.7 U	< 4.7 U
	ST012-LSZ09-160FT-0213-SO-N		2/12/2013	160	CL	7.8	26	1.6	< 5.4 U	3.0 F	0.57 F	6.5	7.7	< 5.0 U	4.2 F	3.2 F	1.5 F	< 5.0 U	9.6
	ST012-LSZ09-170FT-0213-SO-N		2/12/2013	170	CL	542	20	100 J	2800	45000	17000	3400 F	70000	10000 F	130000	8700 F	48000	9000 F	88000
	DUP-05-0213-SO-FR	Duplicate	2/12/2013	170			20	5700 J	3000	50000	18000 F	4400 F	81000	11000 F	140000	8700 F	58000	9100 F	110000
	ST012-LSZ09-172FT-0213-SO-N		2/12/2013	172	SP-SC	133.7	16	21	14	160	45	520	270	69 J	420	49	130 F	29	260 J
	ST012-LSZ09-190FT-0213-SO-N		2/12/2013	190	SM	7.6	16	< 1.1 U	1.4 F	< 4.5 U	< 4.5 U	1.6 F	< 4.5 U	< 4.5 U	< 4.5 U	< 4.5 U	< 4.5 U	< 4.5 U	< 4.5 U
	ST012-LSZ09-198FT-0213-SO-N		2/13/2013	198	CL	1146	21	880	600	5500	2500	< 2300 U	17000	370 F	41000	< 4500 U	13000	< 2300 U	1200
	ST012-LSZ09-210FT-0213-SO-N		2/13/2013	210	SC	1789	15	3300	510	13000	5100	3800	17000	8400	38000	2200 F	11000	14000	32000
	ST012-LSZ09-220FT-0213-SO-N		2/13/2013	220	SW/SM	1150	19	2000	530	15000 J	5400 J	13000 J	45000 J	13000 J	75000 J	2000 F	34000 J	28000 J	45000 J
	DUP-06-0213-SO-FR	Duplicate	2/13/2013	220			19	2700	600	40000 J	15000 J	23000 J	82000 J	36000 J	140000 J	6500 J	58000 J	63000 J	130000 J
	ST012-LSZ09-224FT-0213-SO-N		2/13/2013	224	SW/GW	1391	12	7500	2600	54000	23000	18000 F	63000	42000	150000	6600 F	34000	26000	140000
	ST012-LSZ09-240FT-0213-SO-N		2/13/2013	240	SW/GW	68	12	4.0	11	2.8 F	1.2 F	1.1 F	5.6	1.3 F	8.9	1.6 F	4.3	1.8 F	4.6 J
ST012-LSZ10	ST012-LSZ10-32'-0213-SO-N		2/18/2013	32	SC	22.8	12	0.49 F	1.3 F	< 5.9 U	< 5.9 U	0.94 F	3.9 F	< 5.9 U	4.6 F	< 5.9 U	2.8 F	3.0 F	2.5 F
	ST012-LSZ10-46'-0213-SO-N		2/18/2013	46	SP-SC	2.4	22	< 1.3 U	2.0 F	< 6.1 U	< 6.1 U	0.59 F	1.2 F	< 6.1 U	1.4 F	< 6.1 U	1.0 F	1.3 F	0.84 F
	ST012-LSZ10-56'-0213-SO-N		2/18/2013	56	SC	2.3	17	6.1	1.7 F	< 6.6 U	< 6.6 U	< 6.6 U	1.7 F	< 6.6 U	2.5 F	< 6.6 U	1.3 F	1.4 F	0.95 F
	ST012-LSZ10-66'-0213-SO-N		2/18/2013	66	SC	1.8	23	0.44 F	1.5 F	< 6.8 U	< 6.8 U	< 6.8 U	1.2 F	< 6.8 U	2.0 F	< 6.8 U	< 6.8 U	< 6.8 U	< 6.8 U
	ST012-LSZ10-76'-0213-SO-N		2/18/2013	76	SC	2.1	18	< 1.4 U	1.1 F	< 5.7 U	< 5.7 U	0.87 F	2.3 F	< 5.7 U	3.4 F	< 5.7 U	1.5 F	1.9 F	1.2 F
	ST012-LSZ10-86'-0213-SO-N		2/18/2013	86	SC	3.1	20	2.2	2.2 F	< 5.7 U	< 5.7 U	0.84 F	1.9 F	< 5.7 U	2.5 F	< 5.7 U	1.7 F	1.7 F	1.2 F
	ST012-LSZ10-93'-0213-SO-N		2/18/2013	93	SP	1.2	13	< 1.3 U	5.0	< 5.3 U	< 5.3 U	2.2 F	1.6 F	< 5.3 U	2.0 F	< 5.3 U	1.1 F	1.2 F	0.83 F
	ST012-LSZ10-106'-0213-SO-N		2/18/2013	106	SC	2.8	19	< 1.3 U	7.4	< 5.4 U	< 5.4 U	1.9 F	1.2 F	< 5.4 U	1.5 F	< 5.4 U	1.2 F	1.0 F	< 5.4 U
	ST012-LSZ10-111'-0213-SO-N		2/18/2013	111	SC	2.7	15	< 1.2 U	26	< 4.8 U	< 4.8 U	3.7 F	1.8 F	< 4.8 U	2.5 F	< 4.8 U	0.88 F	1.5 F	1.2 F
	DUP-09-0213-SO-FR	Duplicate	2/18/2013	111			17	< 1.3 U	21	< 5.2 U	< 5.2 U	3.4 F	2.4 F	< 5.2 U	2.5 F	< 5.2 U	1.4 F	1.6 F	1.1 F
	ST012-LSZ10-126'-0213-SO-N		2/18/2013	126	SC	3.6	19	< 1.4 U	12	< 5.1 U	< 5.1 U	2.4 F	1.4 F	< 5.1 U	1.8 F	< 5.1 U	0.8 F	1.2 F	0.84 F
	ST012-LSZ10-136'-0213-SO-N		2/18/2013	136	SC	2	18	0.47 F	1.9 F	< 6.0 U	< 6.0 U	1.6 F	1.5 F	1.1 F	2.1 F	< 6.0 U	1.3 F	1.8 F	2.6 F
	ST012-LSZ10-144'-0213-SO-N		2/19/2013	144	GW	1.2	14	4.4	4.6	< 5.6 U	< 5.6 U	5.4 F	1.7 F	< 5.6 U	2.2 F	< 5.6 U	1.1 F	1.4 F	0.97 F
	ST012-LSZ10-156'-0213-SO-N		2/19/2013	156	SC	0.3	21	< 1.3 U	2.3 F	< 5.6 U	< 5.6 U	1.4 F	1.7 F	< 5.6 U	2.0 F	< 5.6 U	1.2 F	1.5 F	0.8 F
	ST012-LSZ10-164'-0213-SO-N		2/19/2013	164	SC	1288	25	3400	1900	52000	18000	< 15000 U	54000	15000	110000	9700 F	39000	4200 F	91000
	ST012-LSZ10-174'-0213-SO-N		2/19/2013	174	SC	801	21	1900	330	16000	6900 F	5400 F	15000	2900 F	36000	< 25000 U	8100 F	< 12000 U	37000
	ST012-LSZ10-184'-0213-SO-N		2/19/2013	184	SC	1211	22	8400	3500	82000	31000	42000	190000	74000	340000	< 51000 U	150000	200000	260000
	ST012-LSZ10-194'-0213-SO-N		2/19/2013	194	SC	1424	21	5900	1400	62000	25000 F	20000 F	110000	46000	220000	< 56000 U	80000	100000	170000
	ST012-LSZ10-208'-0213-SO-N		2/19/2013	208	SP	1450	15	6800	1300	51000	20000 F	26000	150000	54000	280000	< 44000 U	110000	130000	150000
	ST012-LSZ10-216'-0213-SO-N		2/19/2013	216	SC	1428	19	4400	560	39000	14000	14000	80000	35000	160000	< 24000 U	61000	63000	110000
	ST012-LSZ10-222'-0213-SO-N		2/19/2013	222	SP-SC	2060	21	5400	840	42000	17000	25000	120000	42000	210000	< 25000 U	87000	100000	140000
	ST012-LSZ10-234'-0213-SO-N		2/20/2013	234	SP	2.3	17	0.4 F	< 4.6 U	< 5.5 U	< 5.5 U	3.5 F	9.8	0.78 F	7.7 J	< 5.5 U	17 J	2.4 F	1.8 F
	DUP-10-0213-SO-FR	Duplicate	2/20/2013	234			17	< 1.2 U	1.0 F	0.89 F	< 4.8 U	1.3 F	8.4	1.7 F	15 J	< 4.8 U	7.6 J	2.2 F	4.3 F
ST012-LSZ11	ST012-LSZ11-155'-0213-SO-N		2/26/2013	155	SC	0.5	19	< 1.3 U	1.1 F	< 5.2 U	< 5.2 U	0.86 F	1.3 F	< 5.2 U	1.9 F	< 5.2 U	1.1 F	1.0 F	0.78 F
	ST012-LSZ11-169'-0213-SO-N		2/26/2013	169	SC	184	21	8.8	150	140	66	560	160 F	270	160 F	56	31 F	870	630 J
	ST012-LSZ11-172'-0213-SO-N		2/26/2013	172	SC	17.7	19	4.0	19	30	10	140	79	41	71	23	60	130	190
	ST012-LSZ11-186'-0213-SO-N		2/26/2013	186	SC	1312	23	1300	440	5500	2200	5800	16000	9300	28000	890 F	11000	21000	19000
	ST012-LSZ11-191'-0213-SO-N		2/27/2013	191	SC	1353	19	3500	2700	72000	26000	71000	280000	120000	440000	8700 F	190000	270000	250000
	ST012-LSZ11-208.5'-0213-SO-N		2/27/2013	208.5	SC	3558	24	3000	1500	43000	16000	20000	110000	49000	210000	< 31000 U	71000	110000	120000
	ST012-LSZ11-212'-0213-SO-N		2/27/2013	212	SW	1328	10	2100	640	22000	8100 F	5100 F	29000	19000	62000	< 25000 U	18000	27000	56000
	ST012-LSZ11-229'-0213-SO-N		2/27/2013	229	SW	1291	11	2000	1300	42000	16000	2800 F	68000	24000	150000	5100 F	46000	< 12000 U	54000
	ST012-LSZ11-234'-0213-SO-N		2/27/2013	234	SW	65.2	11	1.7	0.91 F	1.5 F	0.79 F	0.56 F	12	0.92 F	23	< 4.9 U	14	1.9 F	2.5 F

ST012 Pre-Design Investigation
Summary of Soil Sample Analytical Results - Compounds of Interest

Location ID	Sample ID	Sample Type	Sample Date	Sample Depth (ft.)	Lithology	PID (ppmv)	Percent Moisture (%)	TPH (GRO) (C6-C10) Conc. (mg/kg)	TPH (DRO) (C10-C28) Conc. (mg/kg)	1,2,4-TMBZ Conc. (µg/kg)	1,3,5-TMBZ Conc. (µg/kg)	Benzene Conc. (µg/kg)	Cyclohexane Conc. (µg/kg)	Ethylbenzene Conc. (µg/kg)	Methylcyclohexane Conc. (µg/kg)	Naphthalene Conc. (µg/kg)	n-Hexane Conc. (µg/kg)	Toluene Conc. (µg/kg)	Xylenes, Total Conc. (µg/kg)
ST012-LSZ12	ST012-LSZ12-159'-0213-SO-N		2/26/2013	159	SC	1.7	22	< 1.5 U	2.6 F	< 5.0 U	< 5.0 U	0.75 F	0.45 F	< 5.0 U	0.74 F	< 5.0 U	< 5.0 U	0.7 F	< 5.0 U
	ST012-LSZ12-162'-0213-SO-N		2/26/2013	162	CL-ML	6.8	21	< 1.4 U	2.2 F	< 5.6 U	< 5.6 U	< 5.6 U	0.57 F	< 5.6 U	0.82 F	< 5.6 U	< 5.6 U	< 5.6 U	< 5.6 U
	ST012-LSZ12-176'-0213-SO-N		2/27/2013	176	SC	81.2	17	< 1.1 U	2.2 F	< 5.1 U	< 5.1 U	2.9 F	1.1 F	< 5.1 U	1.4 F	< 5.1 U	0.83 F	1.1 F	0.65 F
	ST012-LSZ12-188'-0213-SO-N		2/28/2013	188	SP	62.9	16	34	3.3 F	350 J	< 4.8 U	40	570	420 J	1500	1.2 F	94	1.7 F	240 J
	ST012-LSZ12-196'-0213-SO-N		2/28/2013	196	SC	995	19	37	16 M	2400 J	790 J	3000	7300	2600 J	13000	110 J	4300	420	6300 J
	ST012-LSZ12-209.5'-0213-SO-N		2/28/2013	209.65	SC	96.8	22	270	210	4300	1700	460	7000	2800	13000	660	4600	58 F	2100
	ST012-LSZ12-211'-0213-SO-N		2/28/2013	211	SC	289.3	23	10	36	110 F	< 270 U	2600	260 F	420	170 F	< 540 U	59 F	150 F	210
	ST012-LSZ12-225.5'-0213-SO-N		2/28/2013	225.5	SP	1152	11	130	150	15000	5900	3100	26000	11000	48000	2200 F	15000	12000	38000
	ST012-LSZ12-234'-0213-SO-N		2/28/2013	234	SP	19.8	8.9	2.6	1.9 F	3.0 F	1.5 F	5.5	16	5.3	23	1.6 F	15	4.4 F	8.4
ST012-LSZ13	ST012-LSZ13-152-0313-SO-N		3/6/2013	152	SP	1.7	13	1.1 F	2.4 F	< 4.9 U	< 4.9 U	4.0 F	0.43 F	< 4.9 U	0.56 F	< 4.9 U	< 4.9 U	< 4.9 U	< 4.9 U
	ST012-LSZ13-167-0313-SO-N		3/6/2013	167	SC	1128	19	7600	2000	< 230 U	< 230 U	350	100 F	< 230 U	82 F	< 450 U	49 F	< 230 U	49 F
	ST012-LSZ13-179-0313-SO-N		3/6/2013	179	SC	385.2	12	200	500	5700 F	1600 F	< 5900 U	< 5900 U	< 5900 U	1000 F	< 12000 U	< 5900 U	< 5900 U	< 3000 U
	ST012-LSZ13-181.5-0313-SO-N		3/7/2013	181.5	CL	2810	23	6500	1800	66000	22000	22000	130000	39000	270000	7900 F	69000	98000	180000
	ST012-LSZ13-194-0313-SO-N		3/7/2013	194	CL	1167	18	400	390	3600 F	1300 F	3900 F	15000	5000	26000	< 9500 U	10000	9700	12000
	ST012-LSZ13-209-0313-SO-N		3/7/2013	209	SC	1010	23	7600	190	3000	1100 F	1400 F	8200	3900	13000	< 3600 U	5900	7400	8600
	ST012-LSZ13-211.5-0313-SO-N		3/7/2013	211.5	SC	122.4	19	12	3.4 F	41	9.8	4600	280	84	140	19	86	7.3	22
	ST012-LSZ13-226-0313-SO-N		3/7/2013	226	CL	228.7	19	640	62	7400	2700	7500	27000	11000	44000	< 5200 U	16000	23000	24000
	ST012-LSZ13-231-0313-SO-N		3/7/2013	231	SP	5.7	13	0.58 F	2.5 F	0.68 F	< 5.4 U	5.1 F	5.8	1.5 F	4.9 F	< 5.4 U	2.4 F	4.2 F	3.2 F
ST012-LSZ14	ST012-LSZ14-157-0313-SO-N		3/5/2013	157	CL	8.5	24	0.42 F	7.4	< 5.4 U	< 5.4 U	1.8 F	7.2	< 5.4 U	1.5 F	< 5.4 U	< 5.4 U	< 5.4 U	0.66 F
	ST012-LSZ14-164-0313-SO-N		3/5/2013	164	CL	7.1	17	1.3	2.5 F	< 5.5 U	< 5.5 U	1.2 F	0.81 F	< 5.5 U	1.0 F	< 5.5 U	1.3 F	0.86 F	< 5.5 U
	ST012-LSZ14-174.5-0313-SO-N		3/5/2013	174.5	SW	10.5	11	< 1.1 U	3.2 F	< 4.5 U	< 4.5 U	0.73 F	2.3 F	< 4.5 U	< 4.5 U	< 4.5 U	< 4.5 U	< 4.5 U	< 4.5 U
	ST012-LSZ14-188-0313-SO-N		3/5/2013	188	SC	10.8	19	1.5	2.4 F	< 230 U	< 230 U	180 F	55 F	< 230 U	50 F	< 450 U	33 F	< 230 U	< 110 U
	ST012-LSZ14-193.5-0313-SO-N		3/5/2013	193.5	CL	12.1	18	0.59 F	4.3 F	5.7 F	1.9 F	< 6.2 U	6.6	< 6.2 U	5.0 F	< 6.2 U	< 6.2 U	< 6.2 U	< 6.2 U
	ST012-LSZ14-209.5-0313-SO-N		3/6/2013	209.5	CL	3160	15	340	260	7300	2700 F	2000 F	13000	7500	25000	1600 F	9400	12000	17000
	ST012-LSZ14-212-0313-SO-N		3/6/2013	212	SP	3268	13	420	410	7900	3000 F	2700 F	15000	7700	25000	< 10000 U	11000	13000	18000
	ST012-LSZ14-221.5-0313-SO-N		3/6/2013	221.5	SC	548	23	3.3	20	< 270 U	< 270 U	940	< 270 U	< 270 U	< 270 U	< 530 U	< 270 U	< 270 U	47 F
	ST012-LSZ14-236.5-0313-SO-N		3/6/2013	236.5	SP	3.4	12	4.2	2.8 F	1.6 F	0.62 F	1.5 F	8.6	2.4 F	13	< 4.4 U	12	5.4	5.1
ST012-LSZ15	ST012-LSZ15-38FT-0213-SO-N		2/18/2013	38	SM	747	9.4	220	290	60 F	130 F	< 240 U	< 240 U	< 240 U	< 240 U	< 470 U	< 240 U	< 240 U	< 120 U
	ST012-LSZ15-48FT-0213-SO-N		2/18/2013	48	SM	1743	12	1600	2400	30000	19000	< 4700 U	< 4700 U	< 4700 U	< 4700 U	< 9400 U	< 4700 U	< 4700 U	4600
	ST012-LSZ15-56FT-0213-SO-N		2/18/2013	56	SM	1734	15	3400	3800	38000	24000	< 5000 U	< 5000 U	< 5000 U	< 5000 U	< 9900 U	< 5000 U	< 5000 U	33000
	ST012-LSZ15-68FT-0213-SO-N		2/18/2013	68	SM	1663	13	4000	4200	25000	20000	< 5400 U	< 5400 U	2900 F	< 5400 U	5500 F	< 5400 U	< 5400 U	98000
	ST012-LSZ15-80FT-0213-SO-N		2/18/2013	80	SM	1562	18	6400	4800	81000	44000	< 15000 U	< 15000 U	3100 F	< 15000 U	11000 F	< 15000 U	< 15000 U	63000
	ST012-LSZ15-84FT-0213-SO-N		2/18/2013	84	SM	1647	20	6200	7100	37000	30000	< 14000 U	< 14000 U	5300 F	< 14000 U	13000 F	< 14000 U	< 14000 U	150000
	ST012-LSZ15-94FT-0213-SO-N		2/18/2013	94	SM	1431	17	2700	3000	9700	8000	< 4900 U	< 4900 U	4300 F	< 4900 U	2600 F	< 4900 U	< 4900 U	45000
	ST012-LSZ15-106FT-0213-SO-N		2/18/2013	106	ML	1383	20	1600	1600	26000	13000	< 5500 U	< 5500 U	4800 F	8200	4500 F	< 5500 U	2100 F	85000
	ST012-LSZ15-120FT-0213-SO-N		2/18/2013	120	ML	714.2	17	380	22 J	7100	2500 F	< 4700 U	< 4700 U	< 4700 U	< 4700 U	11000	< 4700 U	< 4700 U	1300 F
	ST012-LSZ15-130FT-0213-SO-N		2/18/2013	130	SM	1431	18	5700	3200	76000	33000	< 13000 U	< 13000 U	51000	6900 F	11000 F	< 13000 U	11000 F	250000
	ST012-LSZ15-136FT-0213-SO-N		2/18/2013	136	SP-SM	1592	15	2300	1300	31000	13000	< 4900 U	< 4900 U	2300 F	17000	4600 F	< 4900 U	5600	97000
	ST012-LSZ15-140FT-0213-SO-N		2/19/2013	140	SP-SM	1914	11	2200	910	20000	8500	< 230 U	1900	590	21000	3200	67 F	680	43000
	ST012-LSZ15-160FT-0213-SO-N		2/19/2013	160	CL	1474	24	2800	930	22000	14000	< 5000 U	7600 J	< 5000 U	29000	3900 F	2000 F	< 5000 U	14000
	DUP-11-0213-SO-FR	Duplicate	2/19/2013	160			23	2800	1100	21000	12000	< 2600 U	5400 J	< 2600 U	22000	3700 F	1200 F	< 2600 U	11000
	ST012-LSZ15-164FT-0213-SO-N		2/19/2013	164	SP-SC	1590	18	8000	2800	79000	32000	33000	130000	60000	270000	11000 F	110000	140000	250000
	ST012-LSZ15-174FT-0213-SO-N		2/19/2013	174	SP-SM	3446	20	4500	2600	32000	12000	15000	64000	22000	130000	4500	47000	51000	98000
	ST012-LSZ15-184FT-0213-SO-N		2/19/2013	184	SM	1705	16	4000	720	26000	10000	4000	40000	16000	85000	4900	25000	19000	65000
	ST012-LSZ15-198FT-0213-SO-N		2/19/2013	198	ML	2194	18	2700	1200	20000	8300	4900 F	29000	14000	59000	3600 F	24000	29000	53000
	ST012-LSZ15-210FT-0213-SO-N		2/19/2013	210	CL	1369	21	3200	1200	15000	5100	5900	29000	11000	57000	2400	22000	27000	42000
	ST012-LSZ15-220FT-0213-SO-N		2/20/2013	220	CL	1001	17	11000	3100	190000	75000	81000	350000	160000	680000	23000 F	290000	380000	650000
	ST012-LSZ15-228FT-0213-SO-N		2/20/2013	228	GW/SW	228	12	47	10	50	28	59	350	120 J	840	24	190 F	14	42 J
	ST012-LSZ15-236FT-0213-SO-N		2/20/2013	236	SC	5.5	15	< 1.2 U	< 4.4 U	< 2.4 U	< 2.4 U	0.78 F	0.76 F	0.32 F	1.1 F	< 2.4 U	2.4	0.78 F	1.4 F
	DUP-12-0213-SO-FR	Duplicate	2/20/2013	236			14	1.5	1.1 F	< 4.9 U	< 4.9 U	1.1 F	1.6 F	< 4.9 U	2.7 F	< 4.9 U	1.6 F	0.95 F	0.88 F
ST012-LSZ16	ST012-LSZ16-35-0213-SO-N		2/4/2013	35	SW	350	6.8	0.38 F	390	< 1300 U	< 1300 U	< 1300 U	< 1300 U	< 1300 U	< 1300 U	< 2600 U	< 1300 U	< 1300 U	< 650 U
	ST012-LSZ16-45-0213-SO-N		2/4/2013	45	CL/GW	158/1380	16	2600	4500	67000	25000	< 2400 U	< 2400 U	< 2400 U	< 2400 U	12000	< 2400 U	< 2400 U	1700
	ST012-LSZ16-57-0213-SO-N		2/4/2013	57	ML/SM	1750	16	7800	3800	100000	38000	< 5500 U	< 5500 U	9100	< 5500 U	13000	< 5500 U	< 5500 U	170000
	ST012-LSZ16-64-0213-SO-N		2/4/2013	64	ML/SM	1770	18	4600	3600	100000	40000	< 14000 U	< 14000 U	5000 F	< 14000 U	13000 F	< 14000 U	< 14000 U	110000
	ST012-LSZ16-79-0213-SO-N		2/5/2013	79	ML/SM	1480	17	2600	5000	27000	13000 F	< 18000 U	< 18000 U	7100 F	< 18000 U	17000 F	< 18000 U	< 18000 U	54000
	ST012-LSZ16-84.5-0213-SO-N		2/5/2013	84.5	ML/SM	1380	21	1500	2500	20000	8400 F	< 15000 U	< 15000 U	2100 F	< 15000 U	9500 F	< 15000 U	< 15000 U	17000
	ST012-LSZ16-93-0213-SO-N		2/5/2013	93	SM	1280-1710	13	1800	5300	35000	14000 F	< 15000 U	< 15000 U	5000 F	< 15000 U	6800 F	< 15000 U	< 15000 U	62000
	ST012-LSZ16-105-0213-SO-N		2/5/2013	105	ML	1570	13	2300	2100	31000	13000	< 5100 U	< 5100 U	1700 F	< 5100 U	5300 F	< 5100 U	< 5100 U	17000
	ST012-LSZ16-112-0213-SO-N		2/5/2013	112	SP	864	6.7	220	2000	2000	960 F	< 1300 U	< 1300 U	850 F	< 1300 U	3200	< 1300 U	200 F	6000
	ST012-LSZ16-122-0213-SO-N		2/5/2013	122	ML-SM	1550	11	3900	3400	42000	19000	< 9400 U	< 9400 U	35000	15000	11000 F	< 9400 U	30000	180000
	ST012-LSZ16-135-0213-SO-N		2/5/2013	135	ML	1210	19	15000	3100	150000	57000	16000	450000	35000	630000	21000 F	240000	150000	520000
	ST012-LSZ16-147-0213-SO-N		2/5/2013	147	SM/SW	440	14	72	2000	1000 F	< 4400 U	< 4400 U	< 4400 U	< 4400 U	< 4400 U	8500 F	< 4400 U	< 4400 U	< 2200 U
	ST012-LSZ16-153-0213-SO-N		2/5/2013	153	SW/GW	640	10	7.1	290	34 F	< 230 U	< 230 U	130 F	< 230 U	< 230 U	< 450 U	< 230 U	< 230 U	< 110 U
	ST012-LSZ16-155-0213-SO-N		2/5/2013	155	GW/SW	230	10	270	490	< 4600 U	< 4600 U	< 4600 U	< 4600 U	< 4600 U	< 4600 U	< 9300 U	< 4600 U	< 4600 U	< 2300 U
	ST012-LSZ16-166.5-0213-SO-N		2/6/2013	166.5	CL	990	21	11000	3600	62000	22000	72000	180000 J	87000	290000 J	10000 F	110000 J	230000	220000
	DUP-03-0213-SO-FR	Duplicate	2/6/2013	166.5			22	9300	3400	76000	24000	81000	260000 J	100000	400000 J	< 46000 U	210000 J	260000	250000
	ST012-LSZ16-177-0213-SO-N		2/6/2013	177	ML	1900	19	5800	1300	80000	30000	4200 F	26000	69000	110000	9700 F	9800 F	16000	280000
	ST012-LSZ16-185-0213-SO-N		2/6/2013	185	ML	4000	24	9200	1600	55000	20000	38000	150000	68000	250000	9600 F	110000	160000	170000
	ST012-LSZ16-198-0213-SO-N		2/6/2013	198	CL	1400	19	6000	380	43000	13000	25000	120000	51000	250000	5600	78000	110000	130000
	ST012-LSZ16-206-0213-SO-N		2/6/2013	206	CL	1390	23	2300	800	17000	5500 F	13000	56000	21000	110000	2500 F	36000	51000	56000
	ST012-LSZ16-215-0213-SO-N		2/6/2013	215	SP/GP	850	11	5200	1900	41000	15000	11000	68000	47000	150000	6600 F	42000	70000	95000
	ST012-LSZ16-222-0213-SO-N		2/6/2013	222	SP/GP	50	18	16 J	2.9 F	570 J	200 F	2700	2400 J	1200 J	3900	82 F	1600	1800 J	2100 J
	DUP-04-0213-SO-FR	Duplicate	2/6/2013	222			17	32 J	2.1 F	42 J	11 J	2300	230 J	260 J	150 F	5.0 J	52 F	460 J	370 J
	ST012-LSZ16-237-0213-SO-N		2/7/2013	237			11	0.63 F	3.6 F	< 5.0 U	< 5.0 U	16	2.2 F	3.5 F	1.4 F	7.7	< 5.0 U	< 5.0 U	< 5.0 U

ST012 Pre-Design Investigation
Summary of Soil Sample Analytical Results - Compounds of Interest

Location ID	Sample ID	Sample Type	Sample Date	Sample Depth (ft.)	Lithology	PID (ppmv)	Percent Moisture (%)	TPH (GRO) (C6-C10) Conc. (mg/kg)	TPH (DRO) (C10-C28) Conc. (mg/kg)	1,2,4-TMBZ Conc. (µg/kg)	1,3,5-TMBZ Conc. (µg/kg)	Benzene Conc. (µg/kg)	Cyclohexane Conc. (µg/kg)	Ethylbenzene Conc. (µg/kg)	Methylcyclohexane Conc. (µg/kg)	Naphthalene Conc. (µg/kg)	n-Hexane Conc. (µg/kg)	Toluene Conc. (µg/kg)	Xylenes, Total Conc. (µg/kg)
ST012-LSZ17	ST012-LSZ17-31FT-0213-SO-N		2/4/2013	31	SM	3.8	20	< 1.2 U	1.4 F	< 5.5 U	< 5.5 U	< 5.5 U	< 5.5 U	< 5.5 U	< 5.5 U	< 5.5 U	< 5.5 U	< 5.5 U	< 5.5 U
	ST012-LSZ17-45FT-0213-SO-N		2/4/2013	45	SC	1.9	19	< 1.3 U	1.9 F	< 4.8 U	< 4.8 U	< 4.8 U	< 4.8 U	< 4.8 U	0.42 F	< 4.8 U	< 4.8 U	< 4.8 U	< 4.8 U
	ST012-LSZ17-55FT-0213-SO-N		2/4/2013	55	SC	2.8	13	0.41 F	1.1 F	< 5.5 U	< 5.5 U	< 5.5 U	< 5.5 U	< 5.5 U	0.56 F	< 5.5 U	< 5.5 U	< 5.5 U	< 5.5 U
	ST012-LSZ17-65FT-0213-SO-N		2/4/2013	65	SP	1.4	17	< 1.4 U	2.5 F	< 6.7 U	< 6.7 U	< 6.7 U	0.71 F	< 6.7 U	0.76 F	< 6.7 U	< 6.7 U	< 6.7 U	< 6.7 U
	ST012-LSZ17-72FT-0213-SO-N		2/4/2013	72	SP	1.5	9.7	< 1.1 U	8.6	< 4.9 U	< 4.9 U	0.84 F	0.5 F	< 4.9 U	0.73 F	< 4.9 U	< 4.9 U	< 4.9 U	< 4.9 U
	ST012-LSZ17-89FT-0213-SO-N		2/5/2013	89	SP-SC	15.9	17	< 1.2 U	8.3 J	< 5.5 U	< 5.5 U	< 5.5 U	< 5.5 U	< 5.5 U	0.58 F	< 5.5 U	< 5.5 U	< 5.5 U	< 5.5 U
	ST012-LSZ17-98FT-0213-SO-N		2/5/2013	98	SP-SC	38	15	< 1.2 U	2.9 F	< 5.8 U	< 5.8 U	0.83 F	< 5.8 U	< 5.8 U	< 5.8 U	< 5.8 U	< 5.8 U	< 5.8 U	< 5.8 U
	ST012-LSZ17-109FT-0213-SO-N		2/5/2013	109	SP-SC	13.5	15	< 1.2 U	7.6	< 4.9 U	< 4.9 U	3.2 F	0.58 F	< 4.9 U	0.69 F	< 4.9 U	< 4.9 U	< 4.9 U	< 4.9 U
	ST012-LSZ17-114FT-0213-SO-N		2/5/2013	114	SP-SC	3.2	17	< 1.3 U	4.6 J	< 4.6 U	< 4.6 U	2.7 F	0.57 F	< 4.6 U	0.98 F	< 4.6 U	0.79 F	0.68 B	< 4.6 U
	DUP-01-0213-SO-FR	Duplicate	2/5/2013	114		3.2	18	< 1.2 U	3.3 B	< 4.9 U	< 4.9 U	3.6 B	11 B	< 4.9 U	15 B	< 4.9 U	7.4 B	1.8 B	< 4.9 U
	ST012-LSZ17-128FT-0213-SO-N		2/5/2013	128	SP	4.4	5.0	< 1.2 U	5.7	< 4.8 U	< 4.8 U	9.0	0.66 F	< 4.8 U	0.91 F	< 4.8 U	< 4.8 U	1.3 B	< 4.8 U
	ST012-LSZ17-134FT-0213-SO-N		2/5/2013	134	SC	4.1	12	< 1.2 U	1.9 F	< 4.0 U	< 4.0 U	1.3 F	0.88 F	< 4.0 U	1.1 F	< 4.0 U	1.3 F	0.63 B	< 4.0 U
	ST012-LSZ17-148FT-0213-SO-N		2/5/2013	148	SW	2.7	11	< 1.2 U	1.0 F	< 3.6 U	< 3.6 U	6.3	0.51 F	< 3.6 U	0.75 F	< 3.6 U	< 3.6 U	0.84 B	< 3.6 U
	ST012-LSZ17-158FT-0213-SO-N		2/5/2013	158	CL	5.7	21	1.5	6.6	1.4 F	< 4.0 U	2.7 F	1.5 F	< 4.0 U	1.3 F	< 4.0 U	< 4.0 U	0.78 B	2.3 F
	ST012-LSZ17-168FT-0213-SO-N		2/5/2013	168	CL	677.2	18	11000	1100	27000	12000	50000	290000	45000	640000	< 21000 U	190000	280000	160000
	ST012-LSZ17-174FT-0213-SO-N		2/6/2013	174	SP	522.8	17	5.5	16	< 230 UJ	< 230 UJ	510	36 F	< 230 UJ	< 230 U	< 470 UJ	< 230 U	210 F	61 F
	ST012-LSZ17-184FT-0213-SO-N		2/6/2013	184	SP-SM	1646	18	4000 J	780	18000	7100	4200	29000 J	16000 J	91000	2700 F	14000	29000 J	54000
	DUP-02-0213-SO-FR	Duplicate	2/6/2013	184			19	2700 J	930	24000	9500 F	5300 F	40000 J	23000 J	120000	< 22000 U	19000	41000 J	72000
	ST012-LSZ17-196FT-0213-SO-N		2/6/2013	196	SC	1547	31	530 J	190	2000	770 F	5100	7900	1800	16000	< 3100 U	5100	9900	7300
	ST012-LSZ17-204FT-0213-SO-N		2/6/2013	204	SC	1267	17	4000	1000	27000	8900 F	8300 F	61000	21000	130000	3800 F	39000	50000	70000
	ST012-LSZ17-212FT-0213-SO-N		2/6/2013	212	SW-SC	1426	10	210	200	1700	560 F	< 980 U	3500	730 F	7600	< 2000 U	3100	510 F	2000
	ST012-LSZ17-222FT-0213-SO-N		2/6/2013	222	SP	1110	18	4500	1500	47000	18000	18000	110000	51000	240000	6200 F	68000	120000	140000
	ST012-LSZ17-240FT-0213-SO-N		2/7/2013	240			15	0.28 F	0.91 B	< 4.3 UM	< 4.3 UM	< 4.3 UM	1.7 F	< 4.3 UJ	2.5 F	< 4.3 U	1.7 F	0.65 B	< 4.3 F
ST012-UWBZ09	ST012-UWBZ09-39'-0313-SO-N		3/12/2013	39	SW	5.7	3.0	14 M	< 3.8 U	< 5.3 U	< 5.3 U	0.85 F	< 5.3 U	< 5.3 U	< 5.3 U	< 5.3 U	< 5.3 U	< 5.3 U	< 5.3 U
	ST012-UWBZ09-42'-0313-SO-N		3/12/2013	42	CL	5.2	25	< 2.0 U	2.6 F	< 7.9 U	< 7.9 U	< 7.9 U	< 7.9 U	< 7.9 U	< 7.9 U	< 7.9 U	< 7.9 U	< 7.9 U	< 7.9 U
	ST012-UWBZ09-54'-0313-SO-N		3/12/2013	54	SC	3.8	25	0.58 F	1.8 F	< 6.7 U	< 6.7 U	< 6.7 U	< 6.7 U	< 6.7 U	0.81 F	< 6.7 U	< 6.7 U	1.0 F	< 6.7 U
	DUP-13-0313-SO-FR	Duplicate	3/12/2013	54			16	0.6 F	1.8 F	< 9.9 U	< 9.9 U	< 9.9 U	< 9.9 U	< 9.9 U	0.94 F	< 9.9 U	< 9.9 U	< 9.9 U	< 9.9 U
	ST012-UWBZ09-65'-0313-SO-N		3/12/2013	65	CL	3.5	19	< 1.4 U	< 4.9 U	< 7.3 U	< 7.3 U	< 7.3 U	< 7.3 U	< 7.3 U	0.72 F	< 7.3 U	< 7.3 U	< 7.3 U	< 7.3 U
	ST012-UWBZ09-77'-0313-SO-N		3/12/2013	77	SW	3.3	5.3	< 1.3 U	1.4 F	< 5.0 U	< 5.0 U	0.51 F	< 5.0 U	< 5.0 U	< 5.0 U	< 5.0 U	< 5.0 U	< 5.0 U	< 5.0 U
	DUP-14-0313-SO-FR	Duplicate	3/12/2013	77			5.4	< 1.1 U	0.76 F	< 5.3 U	< 5.3 U	< 5.3 U	< 5.3 U	< 5.3 U	< 5.3 U	< 5.3 U	< 5.3 U	< 5.3 U	< 5.3 U
	ST012-UWBZ09-90'-0313-SO-N		3/12/2013	90	CL	4.1	16	0.77 F	0.84 F	< 5.3 U	< 5.3 U	< 5.3 U	< 5.3 U	< 5.3 U	< 5.3 U	< 5.3 U	0.83 F	< 5.3 U	< 5.3 U
	ST012-UWBZ09-95'-0313-SO-N		3/12/2013	95	SP-SM	2.9	14	< 1.4 U	0.95 F	< 6.4 U	< 6.4 U	< 6.4 U	< 6.4 U	< 6.4 U	< 6.4 U	< 6.4 U	< 6.4 U	< 6.4 U	< 6.4 U
	DUP-15-0313-SO-FR	Duplicate	3/12/2013	95			13	0.54 F	0.75 F	< 6.1 U	< 6.1 U	< 6.1 U	< 6.1 U	< 6.1 U	< 6.1 U	< 6.1 U	< 6.1 U	< 6.1 U	< 6.1 U
	ST012-UWBZ09-105'-0313-SO-N		3/12/2013	105	CL	3.7	16	< 1.2 U	1.0 F	< 5.4 U	< 5.4 U	< 5.4 U	< 5.4 U	< 5.4 U	< 5.4 U	< 5.4 U	< 5.4 U	< 5.4 U	< 5.4 U
	ST012-UWBZ09-120'-0313-SO-N		3/12/2013	120	CL	2.7	13	< 1.3 U	1.0 F	< 5.7 U	< 5.7 U	4.6 F	< 5.7 U	< 5.7 U	< 5.7 U	< 5.7 U	< 5.7 U	0.79 F	< 5.7 U
	ST012-UWBZ09-125'-0313-SO-N		3/12/2013	125	SM	2	6.4	< 1.3 U	0.85 F	< 5.4 U	< 5.4 U	5.1 F	< 5.4 U	< 5.4 U	< 5.4 U	< 5.4 U	< 5.4 U	< 5.4 U	< 5.4 U
	DUP-16-0313-SO-FR	Duplicate	3/12/2013	125			6.5	< 1.3 U	< 4.1 U	< 5.4 U	< 5.4 U	4.0 F	< 5.4 U	< 5.4 U	< 5.4 U	< 5.4 U	< 5.4 U	< 5.4 U	< 5.4 U
	ST012-UWBZ09-135'-0313-SO-N		3/13/2013	135	CL	2.1	17	< 1.3 U	0.85 F	< 7.9 U	< 7.9 U	1.5 F	< 7.9 U	< 7.9 U	< 7.9 U	< 7.9 U	< 7.9 U	1.2 F	< 7.9 U
	ST012-UWBZ09-150'-0313-SO-N		3/13/2013	150	SC	1.4	19	< 1.3 U	0.85 F	< 5.0 U	< 5.0 U	3.0 F	< 5.0 U	< 5.0 U	< 5.0 U	< 5.0 U	< 5.0 U	< 5.0 U	< 5.0 U
	DUP-17-0313-SO-FR	Duplicate	3/13/2013	150			21	< 1.4 U	< 5.0 U	< 5.5 U	< 5.5 U	2.9 F	< 5.5 U	< 5.5 U	0.51 F	< 5.5 U	< 5.5 U	< 5.5 U	< 5.5 U
	ST012-UWBZ09-160'-SO-N		3/13/2013	160	CL	2.1	14	0.91 F	1.8 B	< 5.7 U	< 5.7 U	< 5.7 U	< 5.7 U	< 5.7 UM	< 5.7 U	< 5.7 U	< 5.7 U	< 5.7 U	< 5.7 UM
	ST012-UWBZ09-170'-0313-SO-N		3/13/2013	170	CL	15.8	21	3.9	0.98 F	7.6	1.8 F	100	120	3.6 F	69	< 6.5 U	27 J	1.5 F	24
	DUP-18-0313-SO-N	Duplicate	3/13/2013	170			19	2.1	0.85 F	4.4 F	1.1 F	130	130	5.1	81	< 5.1 U	41 J	1.0 F	24
	ST012-UWBZ09-172.5-0313-SO-N		3/13/2013	172.5	CL	2.2	19	2.2	3.1 F	< 6.7 U	< 6.7 U	1.6 F	2.2 F	1.6 F	0.78 F	< 6.7 U	< 6.7 U	< 6.7 U	< 6.7 U
	DUP-19-0313-SO-N	Duplicate	3/13/2013	172.5			21	0.97 F	3.3 B	< 5.1 U	2.1 F	1.8 F	4.3 F	4.0 F	1.1 F	< 5.1 U	< 5.1 U	0.71 F	< 5.1 U
	ST012-UWBZ09-182.5-0313-SO-N		3/13/2013	182.5	CL	5.8	21	1.0 F	10	39	7.1	27	49	19	21	18	1.3 F	2.5 F	3.4 F
	ST012-UWBZ09-192.5-0313-SO-N		3/13/2013	192.5	CL	3.9	25	0.74 F	4.3 B	< 6.0 U	< 6.0 U	2.9 F	4.0 F	78	0.66 F	1.8 F	0.84 F	< 6.0 U	< 6.0 U

Notes:
% - percent
Conc. - Concentration
ft. - feet
ID - Identification
Lithology: SC - Clayey Sand, SM - Silty Sand, SP - Poorly Graded Sand, SW - Well Graded Sand
MDL - Method Detection Limit
mg/kg - milligrams per kilogram
µg/kg - micrograms per kilogram
PID - photoionization detector
ppmv - parts per million by volume
RL - Reporting Limit
TMBZ - trimethylbenzene
TPH (DRO) - total petroleum hydrocarbons as diesel range organics
TPH (GRO) - total petroleum hydrocarbons as gasoline range organics

Data Qualifier Definitions:
B - Sample concentration is similar to that found in an associated blank.
F - The analyte was detected, estimated above the MDL and below the RL.
J - The result is estimated due to Quality Control criteria.
M - The result is estimated due to a matrix effect.
U - The analyte was not detected above the RL shown.
< - Not detected at or above the RL.

ST012 Pre-Design Investigation
Summary of Soil Sample Analytical Results - Other Detected VOCs

								1,1-DCA	1,2-DBA	1,2-DCA	MEK	2-CT	2-Hexanone	4-IPT	Acetone	Bromoform	BME	CD	CDBME
Location ID	Sample ID	Sample Type	Sample Date	Sample Depth (ft.)	Lithology	PID (ppmv)	Percent Moisture (%)	Conc. (µg/kg)	Conc. (µg/kg)	Conc. (µg/kg)	Conc. (µg/kg)	Conc. (µg/kg)	Conc. (µg/kg)	Conc. (µg/kg)	Conc. (µg/kg)	Conc. (µg/kg)	Conc. (µg/kg)	Conc. (µg/kg)	Conc. (µg/kg)
ST012-LSZ08	ST012-LSZ08-33-213-SO-N		2/11/2013	33	SW	1.9	9.5	< 5.0 U	< 5.0 U	< 5.0 U	3.2 B	< 5.0 U	< 20 U	< 5.0 U	14 B	< 5.0 U	< 10 U	< 5.0 U	< 5.0 U
	ST012-LSZ08-47-213-SO-N		2/11/2013	47	SW	1.9	12	< 4.9 U	< 4.9 U	< 4.9 U	2.0 B	< 4.9 U	< 20 U	< 4.9 U	11 B	< 4.9 U	< 9.8 U	< 4.9 U	< 4.9 U
	ST012-LSZ08-55-213-SO-N		2/11/2013	55	ML	5.3	15	< 5.9 U	< 5.9 U	< 5.9 U	4.0 B	< 5.9 U	< 24 U	< 5.9 U	25 B	< 5.9 U	< 12 U	< 5.9 U	< 5.9 U
	ST012-LSZ08-67-213-SO-N		2/11/2013	67	ML/SM	1.4	14	< 5.6 U	< 5.6 U	< 5.6 U	4.1 B	< 5.6 U	< 23 U	< 5.6 U	21 B	0.83 B	< 11 U	< 5.6 U	< 5.6 U
	ST012-LSZ08-79-213-SO-N		2/11/2013	79	ML/SM	35	19	< 5.2 U	< 5.2 U	< 5.2 U	6.4 B	< 5.2 U	< 21 U	< 5.2 U	32 B	18	0.65 F	< 5.2 U	0.82 F
	ST012-LSZ08-87-213-SO-N		2/12/2013	87	SP	90	20	< 5.3 U	< 5.3 U	< 5.3 U	13 B	< 5.3 U	< 21 U	< 5.3 U	33 B	22	< 11 U	< 5.3 U	0.9 F
	ST012-LSZ08-97-213-SO-N		2/12/2013	97	SM/ML	3.3	17	< 4.8 U	< 4.8 U	< 4.8 U	13 B	< 4.8 U	4.7 F	< 4.8 U	53 B	5.5	0.76 F	< 4.8 U	< 4.8 U
	ST012-LSZ08-107-213-SO-N		2/12/2013	107	SM/ML	40	22	< 6.2 U	< 6.2 U	< 6.2 U	4.4 B	< 6.2 U	< 25 U	< 6.2 U	24 B	2.8 F	< 12 U	< 6.2 U	< 6.2 U
	ST012-LSZ08-117-213-SO-N		2/12/2013	117	ML	4	17	< 5.1 U	< 5.1 U	< 5.1 U	16 B	< 5.1 U	< 20 U	< 5.1 U	< 20 U	< 5.1 U	< 10 U	< 5.1 U	< 5.1 U
	ST012-LSZ08-127-213-SO-N		2/12/2013	127	ML	3.5	18	< 5.2 U	< 5.2 U	< 5.2 U	6.5 B	< 5.2 U	< 21 U	< 5.2 U	< 21 U	< 5.2 U	< 10 U	< 5.2 U	< 5.2 U
	ST012-LSZ08-137-213-SO-N		2/12/2013	137	ML	4.8	16	< 4.7 U	< 4.7 U	< 4.7 U	8.7 B	< 4.7 U	< 19 U	< 4.7 U	28 B	< 4.7 U	< 9.4 U	< 4.7 U	< 4.7 U
	ST012-LSZ08-146-213-SO-N		2/12/2013	146	CL	4.8	18	< 4.3 U	< 4.3 U	< 4.3 U	3.8 B	< 4.3 U	< 17 U	< 4.3 U	17 B	< 4.3 U	< 8.6 U	< 4.3 U	< 4.3 U
	ST012-LSZ08-156-213-SO-N		2/12/2013	156	CL	2.3	21	< 4.9 U	< 4.9 U	< 4.9 U	3.3 B	< 4.9 U	< 20 U	< 4.9 U	< 20 U	< 4.9 U	< 9.9 U	< 4.9 U	< 4.9 U
	ST012-LSZ08-169-SO-N		2/12/2013	169	ML	57	19	< 4.7 U	< 4.7 U	< 4.7 U	4.4 B	< 4.7 U	< 19 U	< 4.7 U	22 B	< 4.7 U	< 9.4 U	< 4.7 U	< 4.7 U
	ST012-LSZ08-179-SO-N		2/12/2013	179	SW/GW	7.9	13	< 4.5 U	< 4.5 U	< 4.5 U	2.4 B	< 4.5 U	< 18 U	< 4.5 U	11 B	< 4.5 U	< 9.1 U	< 4.5 U	< 4.5 U
	ST012-LSZ08-187-SO-N		2/13/2013	187	SW/GW	6	14	< 4.1 U	< 4.1 U	< 4.1 U	6.9 B	< 4.1 U	< 16 U	< 4.1 U	12 B	0.47 F	< 8.2 U	< 4.1 U	< 4.1 U
	DUP-07-0213-SO-FR	Duplicate	2/13/2013	187			15	< 4.6 U	< 4.6 U	< 4.6 U	6.0 B	< 4.6 U	< 18 U	< 4.6 U	< 18 U	0.38 F	< 9.2 U	< 4.6 U	< 4.6 U
	ST012-LSZ08-198-SO-N		2/13/2013	198	SW/GW	4.3	22	< 5.2 U	< 5.2 U	< 5.2 U	3.7 B	< 5.2 U	< 21 U	< 5.2 U	< 21 U	< 5.2 U	< 10 U	< 5.2 U	< 5.2 U
	ST012-LSZ08-207-SO-N		2/13/2013	207	CL	2.3	19	< 5.0 U	< 5.0 U	< 5.0 U	4.7 B	< 5.0 U	< 20 U	< 5.0 U	< 20 U	< 5.0 U	< 10 U	< 5.0 U	< 5.0 U
	ST012-LSZ08-219-213-SO-N		2/13/2013	219	SW	1130	21	< 2800 U	< 2800 U	< 2800 U	< 11000 U	< 2800 U	< 11000 U	2300 F	13000 B	< 2800 U	< 5600 U	< 2800 U	< 2800 U
	DUP-08-0213-SO-FR	Duplicate	2/13/2013	219			21	< 2500 U	< 2500 U	< 2500 U	< 9900 U	< 2500 U	< 9900 U	550 F	< 15000 U	< 2500 U	< 5000 U	< 2500 U	< 2500 U
	ST012-LSZ08-225-213-SO-N		2/13/2013	225	SW/GW	930	11	< 1200 U	< 1200 U	< 1200 U	< 4700 U	< 1200 U	< 4700 U	460 F	< 7100 U	< 1200 U	< 2400 U	< 1200 U	< 1200 U
	ST012-LSZ08-235-213-SO-N		2/13/2013	235	ML/GM		13	< 4.6 U	< 4.6 U	< 4.6 U	3.9 B	< 4.6 U	< 18 U	< 4.6 U	< 18 U	< 4.6 U	< 9.2 U	< 4.6 U	< 4.6 U
ST012-LSZ09	ST012-LSZ09-38FT-0213-SO-N		2/11/2013	38	SP-SM	2	6.4	< 4.6 U	< 4.6 U	< 4.6 U	2.6 B	< 4.6 U	< 18 U	< 4.6 U	< 18 U	2.3 F	< 9.1 U	< 4.6 U	< 4.6 U
	ST012-LSZ09-48FT-0213-SO-N		2/11/2013	48	SM	10.5	15	< 4.8 U	< 4.8 U	< 4.8 U	6.5 B	< 4.8 U	< 19 U	< 4.8 U	< 19 U	0.87 F	< 9.6 U	< 4.8 U	< 4.8 U
	ST012-LSZ09-58FT-0213-SO-N		2/11/2013	58	SM/SC	2.6	14	< 4.5 U	< 4.5 U	< 4.5 U	3.3 B	< 4.5 U	< 18 U	< 4.5 U	< 18 U	< 4.5 U	< 9.1 U	< 4.5 U	< 4.5 U
	ST012-LSZ09-68FT-0213-SO-N		2/11/2013	68	SC	4.2	17	< 4.4 U	< 4.4 U	< 4.4 U	10 B	< 4.4 U	< 18 U	< 4.4 U	40 B	8.8	< 8.8 U	< 4.4 U	< 4.4 U
	ST012-LSZ09-78FT-0213-SO-N		2/11/2013	78	SW/SM	5.5	5.2	< 4.5 U	< 4.5 U	< 4.5 U	2.2 B	< 4.5 U	< 18 U	< 4.5 U	< 18 U	< 4.5 U	< 9.1 U	< 4.5 U	< 4.5 U
	ST012-LSZ09-90FT-0213-SO-N		2/11/2013	90	SP/SM	4.8	14	< 4.8 U	< 4.8 U	< 4.8 U	3.0 B	< 4.8 U	< 19 U	< 4.8 U	< 19 U	6.6	< 9.6 U	< 4.8 U	< 4.8 U
	ST012-LSZ09-100FT-0213-SO-N		2/11/2013	100	SP/SM	5	11	< 4.8 U	< 4.8 U	< 4.8 U	3.0 B	< 4.8 U	< 19 U	< 4.8 U	< 19 U	< 4.8 U	< 9.5 U	< 4.8 U	< 4.8 U
	ST012-LSZ09-108FT-0213-SO-N		2/11/2013	108	SP	4.5	20	< 4.6 UM	< 4.6 UM	< 4.6 UM	3.3 B	< 4.6 UM	< 19 UM	< 4.6 UM	< 19 UM	< 4.6 UM	< 9.3 U	< 4.6 U	< 4.6 UM
	ST012-LSZ09-116FT-0213-SO-N		2/11/2013	116	SP	4	5.2	< 5.1 U	< 5.1 U	< 5.1 U	2.3 B	< 5.1 U	< 20 U	< 5.1 U	< 20 U	< 5.1 U	< 10 U	< 5.1 U	< 5.1 U
	ST012-LSZ09-128FT-0213-SO-N		2/12/2013	128	SC	5.2	15	< 4.0 U	< 4.0 U	< 4.0 U	17 B	< 4.0 U	< 16 U	< 4.0 U	46 B	< 4.0 U	< 7.9 U	< 4.0 U	< 4.0 U
	ST012-LSZ09-132FT-0213-SO-N		2/12/2013	132	SP/SC	4.9	15	< 4.3 U	< 4.3 U	< 4.3 U	4.2 B	< 4.3 U	< 17 U	< 4.3 U	< 17 U	< 4.3 U	< 8.7 U	< 4.3 U	< 4.3 U
	ST012-LSZ09-148FT-0213-SO-N		2/12/2013	148	SP	8.7	12	< 4.7 U	< 4.7 U	< 4.7 U	5.7 B	< 4.7 U	< 19 U	< 4.7 U	< 19 U	0.3 F	< 9.4 U	< 4.7 U	< 4.7 U
	ST012-LSZ09-160FT-0213-SO-N		2/12/2013	160	CL	7.8	26	< 5.0 U	< 5.0 U	< 5.0 U	< 20 U	< 5.0 U	< 20 U	< 5.0 U	< 20 U	< 5.0 U	< 9.9 U	< 5.0 U	< 5.0 U
	ST012-LSZ09-170FT-0213-SO-N		2/12/2013	170	CL	542	20	< 11000 U	< 11000 U	< 11000 U	< 46000 U	< 11000 U	< 46000 U	4000 F	< 69000 U	< 11000 U	< 23000 U	< 11000 U	< 11000 U
	DUP-05-0213-SO-FR	Duplicate	2/12/2013	170			20	< 24000 U	< 24000 U	< 24000 U	< 95000 U	< 24000 U	< 95000 U	4400 F	68000 B	< 24000 U	< 47000 U	< 24000 U	< 24000 U
	ST012-LSZ09-172FT-0213-SO-N		2/12/2013	172	SP-SC	133.7	16	< 4.0 U	< 4.0 U	< 4.0 U	170 B	< 4.0 U	280	15	33 B	< 4.0 U	< 8.0 U	< 4.0 U	< 4.0 U
	ST012-LSZ09-190FT-0213-SO-N		2/12/2013	190	SM	7.6	16	< 4.5 U	< 4.5 U	< 4.5 U	< 18 U	< 4.5 U	< 18 U	< 4.5 U	< 18 U	0.28 F	< 9.0 U	< 4.5 U	< 4.5 U
	ST012-LSZ09-198FT-0213-SO-N		2/13/2013	198	CL	1146	21	< 2300 U	< 2300 U	< 2300 U	< 9000 U	< 2300 U	< 9000 U	650 F	10000 B	< 2300 U	< 4500 U	< 2300 U	< 2300 U
	ST012-LSZ09-210FT-0213-SO-N		2/13/2013	210	SC	1789	15	< 2100 U	< 2100 U	< 2100 U	< 8500 U	< 2100 U	< 8500 U	1100 F	< 13000 U	< 2100 U	< 4300 U	< 2100 U	< 2100 U
	ST012-LSZ09-220FT-0213-SO-N		2/13/2013	220	SW/SM	1150	19	< 2200 U	< 2200 U	< 2200 U	< 8900 U	< 2200 U	< 8900 U	1200 F	< 13000 U	< 2200 U	< 4500 U	< 2200 U	< 2200 U
	DUP-06-0213-SO-FR	Duplicate	2/13/2013	220			19	< 2200 U	< 2200 U	< 2200 U	< 8800 U	< 2200 U	< 8800 U	3100 J	16000 B	< 2200 U	< 4400 U	< 2200 U	< 2200 U
	ST012-LSZ09-224FT-0213-SO-N		2/13/2013	224	SW/GW	1391	12	< 21000 U	< 21000 U	< 21000 U	< 82000 U	< 21000 U	< 82000 U	4600 F	56000 B	< 21000 U	< 41000 U	< 21000 U	< 21000 U
	ST012-LSZ09-240FT-0213-SO-N		2/13/2013	240	SW/GW	68	12	< 3.9 U	< 3.9 U	< 3.9 U	9.0 B	< 3.9 U	< 16 U	< 3.9 U	< 16 U	< 3.9 U	< 7.9 U	< 3.9 U	< 3.9 U
ST012-LSZ10	ST012-LSZ10-32'-0213-SO-N		2/18/2013	32	SC	22.8	12	< 5.9 U	< 5.9 U	< 5.9 U	4.9 B	< 5.9 U	< 24 U	< 5.9 U	20 B	0.86 B	< 12 U	< 5.9 U	< 5.9 U
	ST012-LSZ10-46'-0213-SO-N		2/18/2013	46	SP-SC	2.4	22	< 6.1 U	< 6.1 U	< 6.1 U	4.4 B	< 6.1 U	< 25 U	< 6.1 U	16 B	0.46 B	< 12 U	< 6.1 U	< 6.1 U
	ST012-LSZ10-56'-0213-SO-N		2/18/2013	56	SC	2.3	17	< 6.6 U	< 6.6 U	< 6.6 U	7.6 B	< 6.6 U	< 26 U	< 6.6 U	35 B	0.48 B	< 13 U	< 6.6 U	< 6.6 U
	ST012-LSZ10-66'-0213-SO-N		2/18/2013	66	SC	1.8	23	< 6.8 U	< 6.8 U	< 6.8 U	6.0 B	< 6.8 U	< 27 U	< 6.8 U	26 B	0.62 B	< 14 U	< 6.8 U	< 6.8 U
	ST012-LSZ10-76'-0213-SO-N		2/18/2013	76	SC	2.1	18	< 5.7 U	< 5.7 U	< 5.7 U	6.5 B	< 5.7 U	< 23 U	< 5.7 U	27 B	0.69 B	< 11 U	< 5.7 U	< 5.7 U
	ST012-LSZ10-86'-0213-SO-N		2/18/2013	86	SC	3.1	20	< 5.7 U	< 5.7 U	< 5.7 U	4.6 B	< 5.7 U	< 23 U	< 5.7 U	17 B	0.45 B	< 11 U	< 5.7 U	< 5.7 U
	ST012-LSZ10-93'-0213-SO-N		2/18/2013	93	SP	1.2	13	< 5.3 U	< 5.3 U	< 5.3 U	17 B	< 5.3 U	< 21 U	< 5.3 U	67 B	1.2 B	< 11 U	< 5.3 U	< 5.3 U
	ST012-LSZ10-106'-0213-SO-N		2/18/2013	106	SC	2.8	19	< 5.4 U	< 5.4 U	< 5.4 U	21 B	< 5.4 U	< 21 U	< 5.4 U	< 21 U	1.9 B	< 11 U	< 5.4 U	< 5.4 U
	ST012-LSZ10-111'-0213-SO-N		2/18/2013	111	SC	2.7	15	< 4.8 U	< 4.8 U	< 4.8 U	62 B	< 4.8 U	16 F	< 4.8 U	160 B	0.53 B	< 9.7 U	< 4.8 U	< 4.8 U
	DUP-09-0213-SO-FR	Duplicate	2/18/2013	111			17	< 5.2 U	< 5.2 U	< 5.2 U	45 B	< 5.2 U	12 F	< 5.2 U	120 B	0.6 B	< 10 U	< 5.2 U	< 5.2 U
	ST012-LSZ10-126'-0213-SO-N		2/18/2013	126	SC	3.6	19	< 5.1 U	< 5.1 U	< 5.1 U	36 B	< 5.1 U	6.4 F	< 5.1 U	120 B	0.55 B	< 10 U	< 5.1 U	< 5.1 U
	ST012-LSZ10-136'-0213-SO-N		2/18/2013	136	SC	2	18	< 6.0 U	< 6.0 U	< 6.0 U	8.0 B	< 6.0 U	< 24 U	< 6.0 U	23 B	0.5 B	< 12 U	< 6.0 U	< 6.0 U
	ST012-LSZ10-144'-0213-SO-N		2/19/2013	144	GW	1.2	14	< 5.6 U	< 5.6 U	< 5.6 U	20 B	< 5.6 U	< 22 U	< 5.6 U	56 B	0.41 B	< 11 U	< 5.6 U	< 5.6 U
	ST012-LSZ10-156'-0213-SO-N		2/19/2013	156	SC	0.3	21	< 5.6 U	< 5.6 U	< 5.6 U	6.5 B	< 5.6 U	< 23 U	< 5.6 U	25 B	1.9 B	< 11 U	< 5.6 U	< 5.6 U
	ST012-LSZ10-164'-0213-SO-N		2/19/2013	164	SC	1288	25	< 15000 U	< 15000 U	< 15000 U	< 62000 U	< 15000 U	< 62000 U	5000 F	< 93000 U	< 15000 U	< 31000 U	< 15000 U	< 15000 U
	ST012-LSZ10-174'-0213-SO-N		2/19/2013	174	SC	801	21	< 12000 U	< 12000 U	< 12000 U	< 49000 U	< 12000 U	< 49000 U	< 12000 U	< 74000 U	< 12000 U	< 25000 U	< 12000 U	< 12000 U
	ST012-LSZ10-184'-0213-SO-N		2/19/2013	184	SC	1211	22	< 26000 U	< 26000 U	< 26000 U	< 100000 U	< 26000 U	< 100000 U	6600 F	< 150000 U	< 26000 U	< 51000 U	< 26000 U	< 26000 U
	ST012-LSZ10-194'-0213-SO-N		2/19/2013	194	SC	1424	21	< 28000 U	< 28000 U	< 28000 U	< 110000 U	< 28000 U	< 110000 U	5400 F	< 170000 U	< 28000 U	< 56000 U	< 28000 U	< 28000 U
	ST012-LSZ10-208'-0213-SO-N		2/19/2013	208	SP	1450	15	< 22000 U	< 22000 U	< 22000 U	< 87000 U	< 22000 U	< 87000 U	4300 F	< 130000 U	< 22000 U	< 44000 U	< 22000 U	< 22000 U
	ST012-LSZ10-216'-0213-SO-N		2/19/2013	216	SC	1428	19	< 12000 U	< 12000 U	< 12000 U	< 48000 U	< 12000 U	< 48000 U	3300 F	< 72000 U	< 12000 U	< 24000 U	< 12000 U	< 12000 U
	ST012-LSZ10-222'-0213-SO-N		2/19/2013	222	SP-SC	2060	21	< 13000 U	< 13000 U	< 13000 U	< 51000 U	< 13000 U	< 51000 U	3300 F	< 76000 U	< 13000 U	< 25000 U	< 13000 U	< 13000 U
	ST012-LSZ10-234'-0213-SO-N		2/20/2013	234	SP	2.3	17	< 5.5 U	< 5.5 U	< 5.5 U	7.1 B	< 5.5 U	< 22 U	< 5.5 U	17 B	0.47 B	< 11 U	< 5.5 U	< 5.5 U
	DUP-10-0213-SO-FR	Duplicate	2/20/2013	234			17	< 4.8 U	< 4.8 U	< 4.8 U	5.3 B	< 4.8 U	< 19 U	< 4.8 U	13 B	0.31 B	< 9.7 U	< 4.8 U	< 4.8 U

ST012 Pre-Design Investigation
Summary of Soil Sample Analytical Results - Other Detected VOCs

Location ID	Sample ID	Sample Type	Sample Date	Sample Depth (ft.)	Lithology	PID (ppmv)	Percent Moisture (%)	1,1-DCA Conc. (µg/kg)	1,2-DBA Conc. (µg/kg)	1,2-DCA Conc. (µg/kg)	MEK Conc. (µg/kg)	2-CT Conc. (µg/kg)	2-Hexanone Conc. (µg/kg)	4-IPT Conc. (µg/kg)	Acetone Conc. (µg/kg)	Bromoform Conc. (µg/kg)	BME Conc. (µg/kg)	CD Conc. (µg/kg)	CDBME Conc. (µg/kg)
ST012-LSZ11	ST012-LSZ11-155'-0213-SO-N		2/26/2013	155	SC	0.5	19	< 5.2 U	< 5.2 U	< 5.2 U	7.7 B	< 5.2 U	< 21 U	< 5.2 U	21 B	0.38 B	< 10 U	< 5.2 U	< 5.2 U
	ST012-LSZ11-169'-0213-SO-N		2/26/2013	169	SC	184	21	< 4.8 U	< 4.8 U	< 4.8 U	280 B	< 4.8 U	< 19 U	13	450 B	0.33 B	< 9.5 U	< 4.8 U	< 4.8 U
	ST012-LSZ11-172'-0213-SO-N		2/26/2013	172	SC	17.7	19	< 5.5 U	< 5.5 U	< 5.5 U	130 B	< 5.5 U	< 22 U	1.5 F	250 B	0.36 B	< 11 U	< 5.5 U	< 5.5 U
	ST012-LSZ11-186'-0213-SO-N		2/26/2013	186	SC	1312	23	< 1300 U	< 1300 U	< 1300 U	< 5200 U	< 1300 U	< 5200 U	530 F	< 7900 U	< 1300 U	< 2600 U	< 1300 U	< 1300 U
	ST012-LSZ11-191'-0213-SO-N		2/27/2013	191	SC	1353	19	< 12000 U	< 12000 U	< 12000 U	< 50000 U	< 12000 U	< 50000 U	6500 F	< 74000 U	< 12000 U	< 25000 U	< 12000 U	< 12000 U
	ST012-LSZ11-208.5'-0213-SO-N		2/27/2013	208.5	SC	3558	24	< 15000 U	< 15000 U	< 15000 U	< 61000 U	< 15000 U	< 61000 U	3900 F	< 92000 U	< 15000 U	< 31000 U	< 15000 U	< 15000 U
	ST012-LSZ11-212'-0213-SO-N		2/27/2013	212	SW	1328	10	< 12000 U	< 12000 U	< 12000 U	< 49000 U	< 12000 U	< 49000 U	2000 F	< 74000 U	< 12000 U	< 25000 U	< 12000 U	< 12000 U
	ST012-LSZ11-229'-0213-SO-N		2/27/2013	229	SW	1291	11	< 12000 U	< 12000 U	< 12000 U	< 47000 U	< 12000 U	< 47000 U	3700 F	< 71000 U	< 12000 U	< 24000 U	< 12000 U	< 12000 U
	ST012-LSZ11-234'-0213-SO-N		2/27/2013	234	SW	65.2	11	< 4.9 U	< 4.9 U	< 4.9 U	3.8 B	< 4.9 U	< 20 U	< 4.9 U	11 B	0.39 B	< 9.8 U	< 4.9 U	< 4.9 U
ST012-LSZ12	ST012-LSZ12-159'-0213-SO-N		2/26/2013	159	SC	1.7	22	< 5.0 U	< 5.0 U	< 5.0 U	5.2 B	< 5.0 U	< 20 U	< 5.0 U	14 B	0.35 B	< 10 U	< 5.0 U	< 5.0 U
	ST012-LSZ12-162'-0213-SO-N		2/26/2013	162	CL-ML	6.8	21	< 5.6 U	< 5.6 U	< 5.6 U	3.2 B	< 5.6 U	< 23 U	< 5.6 U	9.5 B	0.43 B	< 11 U	< 5.6 U	< 5.6 U
	ST012-LSZ12-176'-0213-SO-N		2/27/2013	176	SC	81.2	17	< 5.1 U	< 5.1 U	< 5.1 U	4.6 B	< 5.1 U	< 20 U	< 5.1 U	17 B	0.38 B	< 10 U	< 5.1 U	< 5.1 U
	ST012-LSZ12-188'-0213-SO-N		2/28/2013	188	SP	62.9	16	< 4.8 U	< 4.8 U	< 4.8 U	< 19 U	< 4.8 U	< 19 U	22	< 19 U	< 4.8 U	< 9.6 U	< 4.8 U	< 4.8 U
	ST012-LSZ12-196'-0213-SO-N		2/28/2013	196	SC	995	19	< 4.9 U	< 4.9 U	< 4.9 U	< 20 U	< 4.9 U	< 20 U	110 J	< 20 U	0.35 B	< 9.8 U	< 4.9 U	< 4.9 U
	ST012-LSZ12-209.5'-0213-SO-N		2/28/2013	209.65	SC	96.8	22	< 300 U	< 300 U	< 300 U	< 1200 U	< 300 U	< 1200 U	460	< 1800 U	< 300 U	< 590 U	< 300 U	< 300 U
	ST012-LSZ12-211'-0213-SO-N		2/28/2013	211	SC	289.3	23	< 270 U	< 270 U	< 270 U	< 1100 U	< 270 U	< 1100 U	< 270 U	< 1600 U	< 270 U	< 540 U	< 270 U	< 270 U
	ST012-LSZ12-225.5'-0213-SO-N		2/28/2013	225.5	SP	1152	11	< 1100 U	< 1100 U	< 1100 U	< 4600 U	< 1100 U	< 4600 U	1300	< 6900 U	< 1100 U	< 2300 U	< 1100 U	< 1100 U
	ST012-LSZ12-234'-0213-SO-N		2/28/2013	234	SP	19.8	8.9	< 5.2 U	< 5.2 U	< 5.2 U	5.8 B	< 5.2 U	< 21 U	< 5.2 U	13 B	< 5.2 U	< 10 U	0.48 F	< 5.2 U
ST012-LSZ13	ST012-LSZ13-152-0313-SO-N		3/6/2013	152	SP	1.7	13	< 4.9 U	< 4.9 U	< 4.9 U	< 20 U	< 4.9 U	< 20 U	< 4.9 U	15 B	< 4.9 U	< 9.8 U	< 4.9 U	< 4.9 U
	ST012-LSZ13-167-0313-SO-N		3/6/2013	167	SC	1128	19	< 230 U	< 230 U	< 230 U	< 910 U	< 230 U	< 910 U	< 230 U	< 1400 U	< 230 U	< 450 U	< 230 U	< 230 U
	ST012-LSZ13-179-0313-SO-N		3/6/2013	179	SC	385.2	12	< 5900 U	< 5900 U	< 5900 U	< 24000 U	< 5900 U	< 24000 U	770 F	15000 B	< 5900 U	< 12000 U	< 5900 U	< 5900 U
	ST012-LSZ13-181.5-0313-SO-N		3/7/2013	181.5	CL	2810	23	< 16000 U	< 16000 U	< 16000 U	< 62000 U	< 16000 U	< 62000 U	5600 F	54000 B	< 16000 U	< 31000 U	< 16000 U	< 16000 U
	ST012-LSZ13-194-0313-SO-N		3/7/2013	194	CL	1167	18	< 4700 U	< 4700 U	< 4700 U	< 19000 U	< 4700 U	< 19000 U	< 4700 U	16000 B	< 4700 U	< 9500 U	< 4700 U	< 4700 U
	ST012-LSZ13-209-0313-SO-N		3/7/2013	209	SC	1010	23	< 1800 U	< 1800 U	< 1800 U	< 7200 U	< 1800 U	< 7200 U	270 F	6100 B	< 1800 U	< 3600 U	< 1800 U	< 1800 U
	ST012-LSZ13-211.5-0313-SO-N		3/7/2013	211.5	SC	122.4	19	0.79 F	< 5.0 U	< 5.0 U	87 B	< 5.0 U	< 20 U	1.3 F	33 B	< 5.0 U	< 10 U	< 5.0 U	< 5.0 U
	ST012-LSZ13-226-0313-SO-N		3/7/2013	226	CL	228.7	19	< 2600 U	< 2600 U	< 2600 U	< 10000 U	< 2600 U	< 10000 U	650 F	10000 B	< 2600 U	< 5200 U	< 2600 U	< 2600 U
	ST012-LSZ13-231-0313-SO-N		3/7/2013	231	SP	5.7	13	< 5.4 U	< 5.4 U	< 5.4 U	< 21 U	< 5.4 U	< 21 U	< 5.4 U	13 B	< 5.4 U	< 11 U	0.56 F	< 5.4 U
ST012-LSZ14	ST012-LSZ14-157-0313-SO-N		3/5/2013	157	CL	8.5	24	< 5.4 U	< 5.4 U	< 5.4 U	19 B	< 5.4 U	< 21 U	< 5.4 U	60 B	< 5.4 U	< 11 U	< 5.4 U	< 5.4 U
	ST012-LSZ14-164-0313-SO-N		3/5/2013	164	CL	7.1	17	< 5.5 U	< 5.5 U	< 5.5 U	< 22 U	< 5.5 U	< 22 U	< 5.5 U	23 B	< 5.5 U	< 11 U	< 5.5 U	< 5.5 U
	ST012-LSZ14-174.5-0313-SO-N		3/5/2013	174.5	SW	10.5	11	< 4.5 U	< 4.5 U	< 4.5 U	3.6 B	< 4.5 U	< 18 U	< 4.5 U	23 B	< 4.5 U	< 9.0 U	< 4.5 U	< 4.5 U
	ST012-LSZ14-188-0313-SO-N		3/5/2013	188	SC	10.8	19	< 230 U	< 230 U	< 230 U	< 910 U	< 230 U	< 910 U	< 230 U	700 B	< 230 U	< 450 U	< 230 U	< 230 U
	ST012-LSZ14-193.5-0313-SO-N		3/5/2013	193.5	CL	12.1	18	< 6.2 U	< 6.2 U	< 6.2 U	4.0 B	< 6.2 U	< 25 U	< 6.2 U	19 B	< 6.2 U	< 12 U	< 6.2 U	< 6.2 U
	ST012-LSZ14-209.5-0313-SO-N		3/6/2013	209.5	CL	3160	15	< 2800 U	< 2800 U	< 2800 U	< 11000 U	< 2800 U	< 11000 U	770 F	11000 B	< 2800 U	< 5500 U	< 2800 U	< 2800 U
	ST012-LSZ14-212-0313-SO-N		3/6/2013	212	SP	3268	13	< 5100 U	< 5100 U	< 5100 U	< 21000 U	< 5100 U	< 21000 U	800 F	19000 B	< 5100 U	< 10000 U	< 5100 U	< 5100 U
	ST012-LSZ14-221.5-0313-SO-N		3/6/2013	221.5	SC	548	23	< 270 U	< 270 U	< 270 U	< 1100 U	< 270 U	< 1100 U	< 270 U	< 1600 U	< 270 U	< 530 U	< 270 U	< 270 U
	ST012-LSZ14-236.5-0313-SO-N		3/6/2013	236.5	SP	3.4	12	< 4.4 U	< 4.4 U	< 4.4 U	< 18 U	< 4.4 U	< 18 U	< 4.4 U	8.5 B	< 4.4 U	< 8.8 U	< 4.4 U	< 4.4 U
ST012-LSZ15	ST012-LSZ15-38FT-0213-SO-N		2/18/2013	38	SM	747	9.4	< 240 U	< 240 U	< 240 U	< 950 U	< 240 U	< 950 U	< 240 U	< 1400 U	< 240 U	< 470 U	< 240 U	< 240 U
	ST012-LSZ15-48FT-0213-SO-N		2/18/2013	48	SM	1743	12	< 4700 U	< 4700 U	< 4700 U	< 19000 U	< 4700 U	< 19000 U	4400 F	< 28000 U	< 4700 U	< 9400 U	< 4700 U	< 4700 U
	ST012-LSZ15-56FT-0213-SO-N		2/18/2013	56	SM	1734	15	< 5000 U	< 5000 U	< 5000 U	< 20000 U	< 5000 U	< 20000 U	3800 F	< 30000 U	< 5000 U	< 9900 U	< 5000 U	< 5000 U
	ST012-LSZ15-68FT-0213-SO-N		2/18/2013	68	SM	1663	13	< 5400 U	< 5400 U	< 5400 U	< 22000 U	< 5400 U	< 22000 U	1300 F	18000 B	< 5400 U	< 11000 U	< 5400 U	< 5400 U
	ST012-LSZ15-80FT-0213-SO-N		2/18/2013	80	SM	1562	18	< 15000 U	< 15000 U	< 15000 U	< 58000 U	< 15000 U	< 58000 U	6000 F	< 88000 U	< 15000 U	< 29000 U	< 15000 U	< 15000 U
	ST012-LSZ15-84FT-0213-SO-N		2/18/2013	84	SM	1647	20	< 14000 U	< 14000 U	< 14000 U	< 55000 U	< 14000 U	< 55000 U	< 14000 U	< 82000 U	< 14000 U	< 27000 U	< 14000 U	< 14000 U
	ST012-LSZ15-94FT-0213-SO-N		2/18/2013	94	SM	1431	17	< 4900 U	< 4900 U	< 4900 U	< 20000 U	< 4900 U	< 20000 U	< 4900 U	< 29000 U	< 4900 U	< 9800 U	< 4900 U	< 4900 U
	ST012-LSZ15-106FT-0213-SO-N		2/18/2013	106	ML	1383	20	< 5500 U	< 5500 U	< 5500 U	< 22000 U	< 5500 U	< 22000 U	1800 F	< 33000 U	< 5500 U	< 11000 U	< 5500 U	< 5500 U
	ST012-LSZ15-120FT-0213-SO-N		2/18/2013	120	ML	714.2	17	< 4700 U	< 4700 U	< 4700 U	< 19000 U	< 4700 U	< 19000 U	1200 F	< 28000 U	< 4700 U	< 9500 U	< 4700 U	< 4700 U
	ST012-LSZ15-130FT-0213-SO-N		2/18/2013	130	SM	1431	18	< 13000 U	< 13000 U	< 13000 U	< 52000 U	< 13000 U	< 52000 U	5900 F	< 78000 U	< 13000 U	< 26000 U	< 13000 U	< 13000 U
	ST012-LSZ15-136FT-0213-SO-N		2/18/2013	136	SP-SM	1592	15	< 4900 U	< 4900 U	< 4900 U	< 19000 U	< 4900 U	< 19000 U	2400 F	< 29000 U	< 4900 U	< 9700 U	< 4900 U	< 4900 U
	ST012-LSZ15-140FT-0213-SO-N		2/19/2013	140	SP-SM	1914	11	< 230 U	< 230 U	< 230 U	< 920 U	< 230 U	< 920 U	1400	< 1400 U	< 230 U	< 460 U	< 230 U	< 230 U
	ST012-LSZ15-160FT-0213-SO-N		2/19/2013	160	CL	1474	24	< 5000 U	< 5000 U	< 5000 U	< 20000 U	< 5000 U	< 20000 U	2800 F	< 30000 U	< 5000 U	< 10000 U	< 5000 U	< 5000 U
	DUP-11-0213-SO-FR	Duplicate	2/19/2013	160			23	< 2600 U	< 2600 U	< 2600 U	< 10000 U	< 2600 U	< 10000 U	2800	< 16000 U	< 2600 U	< 5200 U	< 2600 U	< 2600 U
	ST012-LSZ15-164FT-0213-SO-N		2/19/2013	164	SP-SC	1590	18	< 12000 U	< 12000 U	< 12000 U	< 48000 U	< 12000 U	< 48000 U	5900 F	< 73000 U	< 12000 U	< 24000 U	< 12000 U	< 12000 U
	ST012-LSZ15-174FT-0213-SO-N		2/19/2013	174	SP-SM	3446	20	< 250 U	< 250 U	< 250 U	< 1000 U	< 250 U	< 1000 U	2500	10000 B	< 250 U	< 500 U	< 250 U	< 250 U
	ST012-LSZ15-184FT-0213-SO-N		2/19/2013	184	SM	1705	16	< 1300 U	< 1300 U	< 1300 U	< 5000 U	< 1300 U	< 5000 U	2200	< 7500 U	< 1300 U	< 2500 U	< 1300 U	< 1300 U
	ST012-LSZ15-198FT-0213-SO-N		2/19/2013	198	ML	2194	18	< 5000 U	< 5000 U	< 5000 U	< 20000 U	< 5000 U	< 20000 U	1700 F	< 30000 U	< 5000 U	< 9900 U	< 5000 U	< 5000 U
	ST012-LSZ15-210FT-0213-SO-N		2/19/2013	210	CL	1369	21	< 260 U	< 260 U	< 260 U	< 1100 U	< 260 U	< 1100 U	1200	< 1600 U	< 260 U	< 530 U	< 260 U	< 260 U
	ST012-LSZ15-220FT-0213-SO-N		2/20/2013	220	CL	1001	17	< 24000 U	< 24000 U	< 24000 U	< 97000 U	< 24000 U	< 97000 U	13000 F	< 150000 U	< 24000 U	< 48000 U	< 24000 U	< 24000 U
	ST012-LSZ15-228FT-0213-SO-N		2/20/2013	228	GW/SW	228	12	< 4.8 U	< 4.8 U	< 4.8 U	< 19 U	< 4.8 U	< 19 U	26	< 19 U	0.36 B	< 9.6 U	0.5 F	< 4.8 U
	ST012-LSZ15-236FT-0213-SO-N		2/20/2013	236	SC	5.5	15	< 2.4 U	< 2.4 U	< 2.4 U	< 9.5 U	0.36 F	< 9.5 U	< 2.4 U	6.9 B	< 2.4 U	< 4.7 U	< 2.4 U	< 2.4 U
	DUP-12-0213-SO-FR	Duplicate	2/20/2013	236			14	< 4.9 U	< 4.9 U	< 4.9 U	< 20 U	< 4.9 U	< 20 U	< 4.9 U	14 B	0.46 B	< 9.8 U	< 4.9 U	< 4.9 U

ST012 Pre-Design Investigation
Summary of Soil Sample Analytical Results - Other Detected VOCs

Location ID	Sample ID	Sample Type	Sample Date	Sample Depth (ft.)	Lithology	PID (ppmv)	Percent Moisture (%)	1,1-DCA Conc. (µg/kg)	1,2-DBA Conc. (µg/kg)	1,2-DCA Conc. (µg/kg)	MEK Conc. (µg/kg)	2-CT Conc. (µg/kg)	2-Hexanone Conc. (µg/kg)	4-IPT Conc. (µg/kg)	Acetone Conc. (µg/kg)	Bromoform Conc. (µg/kg)	BME Conc. (µg/kg)	CD Conc. (µg/kg)	CDBME Conc. (µg/kg)
ST012-LSZ16	ST012-LSZ16-35-0213-SO-N		2/4/2013	35	SW	350	6.8	< 1300 U	< 1300 U	< 1300 U	< 5200 U	< 1300 U	< 5200 U	< 1300 U	< 7800 U	< 1300 U	< 2600 U	< 1300 U	< 1300 U
	ST012-LSZ16-45-0213-SO-N		2/4/2013	45	CL/GW	158/1380	16	< 2400 U	< 2400 U	< 2400 U	< 9800 U	< 2400 U	< 9800 U	4700	6700 B	< 2400 U	< 4900 U	< 2400 U	< 2400 U
	ST012-LSZ16-57-0213-SO-N		2/4/2013	57	ML/SM	1750	16	< 5500 U	< 5500 U	< 5500 U	< 22000 U	< 5500 U	< 22000 U	8100	16000 B	< 5500 U	< 11000 U	< 5500 U	< 5500 U
	ST012-LSZ16-64-0213-SO-N		2/4/2013	64	ML/SM	1770	18	< 14000 U	< 14000 U	< 14000 U	< 56000 U	< 14000 U	< 56000 U	7600 F	36000 B	< 14000 U	< 28000 U	< 14000 U	< 14000 U
	ST012-LSZ16-79-0213-SO-N		2/5/2013	79	ML/SM	1480	17	< 18000 U	< 18000 U	< 18000 U	< 71000 U	< 18000 U	< 71000 U	< 18000 U	39000 B	< 18000 U	< 36000 U	< 18000 U	< 18000 U
	ST012-LSZ16-84.5-0213-SO-N		2/5/2013	84.5	ML/SM	1380	21	< 15000 U	< 15000 U	< 15000 U	< 61000 U	< 15000 U	< 61000 U	2000 F	< 91000 U	< 15000 U	< 30000 U	< 15000 U	< 15000 U
	ST012-LSZ16-93-0213-SO-N		2/5/2013	93	SM	1280-	13	< 15000 U	< 15000 U	< 15000 U	< 60000 U	< 15000 U	< 60000 U	2600 F	< 90000 U	< 15000 U	< 30000 U	< 15000 U	< 15000 U
	ST012-LSZ16-105-0213-SO-N		2/5/2013	105	ML	1570	13	< 5100 U	< 5100 U	< 5100 U	< 21000 U	< 5100 U	< 21000 U	2400 F	14000 B	< 5100 U	< 10000 U	< 5100 U	< 5100 U
	ST012-LSZ16-112-0213-SO-N		2/5/2013	112	SP	864	6.7	< 1300 U	< 1300 U	< 1300 U	< 5000 U	< 1300 U	< 5000 U	< 1300 U	< 7500 U	< 1300 U	< 2500 U	< 1300 U	< 1300 U
	ST012-LSZ16-122-0213-SO-N		2/5/2013	122	ML-SM	1550	11	< 9400 U	< 9400 U	< 9400 U	< 37000 U	< 9400 U	< 37000 U	2500 F	35000 B	< 9400 U	< 19000 U	< 9400 U	< 9400 U
	ST012-LSZ16-135-0213-SO-N		2/5/2013	135	ML	1210	19	< 14000 U	< 14000 U	< 14000 U	< 54000 U	< 14000 U	< 54000 U	14000	< 81000 U	< 14000 U	< 27000 U	< 14000 U	< 14000 U
	ST012-LSZ16-147-0213-SO-N		2/5/2013	147	SM/SW	440	14	< 4400 U	< 4400 U	< 4400 U	< 18000 U	< 4400 U	< 18000 U	< 4400 U	< 26000 U	< 4400 U	< 8800 U	< 4400 U	< 4400 U
	ST012-LSZ16-153-0213-SO-N		2/5/2013	153	SW/GW	640	10	< 230 U	< 230 U	< 230 U	< 910 U	< 230 U	< 910 U	< 230 U	< 1400 U	< 230 U	< 450 U	< 230 U	< 230 U
	ST012-LSZ16-155-0213-SO-N		2/5/2013	155	GW/SW	230	10	< 4600 U	< 4600 U	< 4600 U	< 19000 U	< 4600 U	< 19000 U	< 4600 U	< 28000 U	< 4600 U	< 9300 U	< 4600 U	< 4600 U
	ST012-LSZ16-166.5-0213-SO-N		2/6/2013	166.5	CL	990	21	< 12000 U	< 12000 U	< 12000 U	< 49000 U	< 12000 U	< 49000 U	5300 F	< 73000 U	< 12000 U	< 24000 U	< 12000 U	< 12000 U
	DUP-03-0213-SO-FR	Duplicate	2/6/2013	166.5			22	< 23000 U	< 23000 U	< 23000 U	< 92000 U	< 23000 U	< 92000 U	6700 F	< 140000 U	< 23000 U	< 46000 U	< 23000 U	< 23000 U
	ST012-LSZ16-177-0213-SO-N		2/6/2013	177	ML	1900	19	< 13000 U	< 13000 U	< 13000 U	< 54000 U	< 13000 U	< 54000 U	6700 F	< 81000 U	< 13000 U	< 27000 U	< 13000 U	< 13000 U
	ST012-LSZ16-185-0213-SO-N		2/6/2013	185	ML	4000	24	< 14000 U	< 14000 U	< 14000 U	< 54000 U	< 14000 U	< 54000 U	4800 F	41000 B	< 14000 U	< 27000 U	< 14000 U	< 14000 U
	ST012-LSZ16-198-0213-SO-N		2/6/2013	198	CL	1400	19	< 2600 U	< 2600 U	< 2600 U	< 10000 U	< 2600 U	< 10000 U	3700	< 16000 U	< 2600 U	< 5200 U	< 2600 U	< 2600 U
	ST012-LSZ16-206-0213-SO-N		2/6/2013	206	CL	1390	23	< 6100 U	< 6100 U	< 6100 U	< 24000 U	< 6100 U	< 24000 U	1500 F	< 37000 U	< 6100 U	< 12000 U	< 6100 U	< 6100 U
	ST012-LSZ16-215-0213-SO-N		2/6/2013	215	SP/GP	850	11	< 11000 U	< 11000 U	< 11000 U	< 46000 U	< 11000 U	< 46000 U	3700 F	< 69000 U	< 11000 U	< 23000 U	< 11000 U	< 11000 U
	ST012-LSZ16-222-0213-SO-N		2/6/2013	222	SP/GP	50	18	< 220 U	< 220 U	< 220 U	< 890 U	< 220 U	< 890 U	48 F	< 1300 U	< 220 U	< 440 U	< 220 U	< 220 U
	DUP-04-0213-SO-FR	Duplicate	2/6/2013	222			17	0.27 F	2.2 F	< 4.3 U	< 17 U	< 4.3 U	< 17 U	6.0 J	9.7 B	< 4.3 U	< 8.5 U	< 4.3 U	< 4.3 U
	ST012-LSZ16-237-0213-SO-N		2/7/2013	237			11	< 5.0 U	< 5.0 U	< 5.0 U	4.3 B	< 5.0 U	< 20 U	< 5.0 U	18 B	< 5.0 U	< 10 U	< 5.0 U	< 5.0 U
ST012-LSZ17	ST012-LSZ17-31FT-0213-SO-N		2/4/2013	31	SM	3.8	20	< 5.5 U	< 5.5 U	< 5.5 U	10 B	< 5.5 U	< 22 U	< 5.5 U	48 B	0.32 F	< 11 U	< 5.5 U	< 5.5 U
	ST012-LSZ17-45FT-0213-SO-N		2/4/2013	45	SC	1.9	19	< 4.8 U	< 4.8 U	< 4.8 U	2.7 B	< 4.8 U	< 19 U	< 4.8 U	15 B	0.32 F	< 9.7 U	< 4.8 U	< 4.8 U
	ST012-LSZ17-55FT-0213-SO-N		2/4/2013	55	SC	2.8	13	< 5.5 U	< 5.5 U	< 5.5 U	3.2 B	< 5.5 U	< 22 U	< 5.5 U	22 B	< 5.5 U	< 11 U	< 5.5 U	< 5.5 U
	ST012-LSZ17-65FT-0213-SO-N		2/4/2013	65	SP	1.4	17	< 6.7 U	< 6.7 U	< 6.7 U	4.2 B	< 6.7 U	< 27 U	< 6.7 U	27 B	0.39 F	< 13 U	< 6.7 U	< 6.7 U
	ST012-LSZ17-72FT-0213-SO-N		2/4/2013	72	SP	1.5	9.7	< 4.9 U	< 4.9 U	< 4.9 U	16 B	< 4.9 U	< 19 U	< 4.9 U	66 B	0.42 F	< 9.7 U	< 4.9 U	< 4.9 U
	ST012-LSZ17-89FT-0213-SO-N		2/5/2013	89	SP-SC	15.9	17	< 5.5 U	< 5.5 U	< 5.5 U	4.2 B	< 5.5 U	< 22 U	< 5.5 U	22 B	0.28 F	< 11 U	< 5.5 U	< 5.5 U
	ST012-LSZ17-98FT-0213-SO-N		2/5/2013	98	SP-SC	38	15	< 5.8 U	1.2 F	< 5.8 U	4.4 B	< 5.8 U	< 23 U	< 5.8 U	19 B	0.28 F	< 12 U	< 5.8 U	< 5.8 U
	ST012-LSZ17-109FT-0213-SO-N		2/5/2013	109	SP-SC	13.5	15	< 4.9 U	2.6 F	0.99 F	12 B	< 4.9 U	< 20 U	< 4.9 U	36 B	0.38 F	< 9.9 U	< 4.9 U	< 4.9 U
	ST012-LSZ17-114FT-0213-SO-N		2/5/2013	114	SP-SC	3.2	17	< 4.6 U	2.4 F	0.78 F	9.2 B	< 4.6 U	< 18 U	< 4.6 U	31 B	0.46 F	< 9.2 U	< 4.6 U	< 4.6 U
	DUP-01-0213-SO-FR	Duplicate	2/5/2013	114		3.2	18	< 4.9 U	2.4 F	< 4.9 U	13 B	< 4.9 U	< 20 U	< 4.9 U	33 B	0.76 F	< 9.8 U	< 4.9 U	< 4.9 U
	ST012-LSZ17-128FT-0213-SO-N		2/5/2013	128	SP	4.4	5.0	< 4.8 U	5.3	2.4 F	29 B	< 4.8 U	5.7 F	< 4.8 U	86 B	< 4.8 U	< 9.6 U	< 4.8 U	< 4.8 U
	ST012-LSZ17-134FT-0213-SO-N		2/5/2013	134	SC	4.1	12	< 4.0 U	0.63 F	0.96 F	18 B	< 4.0 U	5.4 F	< 4.0 U	65 B	< 4.0 U	< 7.9 U	< 4.0 U	< 4.0 U
	ST012-LSZ17-148FT-0213-SO-N		2/5/2013	148	SW	2.7	11	< 3.6 U	1.4 F	< 3.6 U	3.2 B	< 3.6 U	< 14 U	< 3.6 U	14 B	< 3.6 U	< 7.1 U	< 3.6 U	< 3.6 U
	ST012-LSZ17-158FT-0213-SO-N		2/5/2013	158	CL	5.7	21	< 4.0 U	1.0 F	< 4.0 U	20 B	< 4.0 U	< 16 U	< 4.0 U	62 B	< 4.0 U	< 8.0 U	< 4.0 U	< 4.0 U
	ST012-LSZ17-168FT-0213-SO-N		2/5/2013	168	CL	677.2	18	< 11000 U	< 11000 U	< 11000 U	< 43000 U	< 11000 U	< 43000 U	1900 F	< 64000 U	< 11000 U	< 21000 U	< 11000 U	< 11000 U
	ST012-LSZ17-174FT-0213-SO-N		2/6/2013	174	SP	522.8	17	< 230 U	< 230 UJ	< 230 U	< 930 U	< 230 UJ	< 930 U	< 230 UJ	< 1400 U	< 230 UJ	< 470 U	< 230 U	< 230 UJ
	ST012-LSZ17-184FT-0213-SO-N		2/6/2013	184	SP-SM	1646	18	< 4200 U	< 4200 U	< 4200 U	< 17000 U	< 4200 U	< 17000 U	1500 F	< 25000 U	< 4200 U	< 8500 U	< 4200 U	< 4200 U
	DUP-02-0213-SO-FR	Duplicate	2/6/2013	184			19	< 11000 U	< 11000 U	< 11000 U	< 44000 U	< 11000 U	< 44000 U	2000 F	29000 B	< 11000 U	< 22000 U	< 11000 U	< 11000 U
	ST012-LSZ17-196FT-0213-SO-N		2/6/2013	196	SC	1547	31	< 1600 U	< 1600 U	< 1600 U	< 6300 U	< 1600 U	< 6300 U	< 1600 U	< 9400 U	< 1600 U	< 3100 U	< 1600 U	< 1600 U
	ST012-LSZ17-204FT-0213-SO-N		2/6/2013	204	SC	1267	17	< 11000 U	< 11000 U	< 11000 U	< 43000 U	< 11000 U	< 43000 U	2400 F	< 65000 U	< 11000 U	< 22000 U	< 11000 U	< 11000 U
	ST012-LSZ17-212FT-0213-SO-N		2/6/2013	212	SW-SC	1426	10	< 980 U	< 980 U	< 980 U	< 3900 U	< 980 U	< 3900 U	160 F	< 5900 U	< 980 U	< 2000 U	< 980 U	< 980 U
	ST012-LSZ17-222FT-0213-SO-N		2/6/2013	222	SP	1110	18	< 12000 U	< 12000 U	< 12000 U	< 47000 U	< 12000 U	< 47000 U	3800 F	< 70000 U	< 12000 U	< 23000 U	< 12000 U	< 12000 U
	ST012-LSZ17-240FT-0213-SO-N		2/7/2013	240			15	< 4.3 UM	< 4.3 U	< 4.3 U	4.1 B	< 4.3 UM	< 17 U	< 4.3 UM	< 17 U	< 4.3 U	< 8.6 UM	< 4.3 UM	< 4.3 U

ST012 Pre-Design Investigation
Summary of Soil Sample Analytical Results - Other Detected VOCs

Location ID	Sample ID	Sample Type	Sample Date	Sample Depth (ft.)	Lithology	PID (ppmv)	Percent Moisture (%)	1,1-DCA Conc. (µg/kg)	1,2-DBA Conc. (µg/kg)	1,2-DCA Conc. (µg/kg)	MEK Conc. (µg/kg)	2-CT Conc. (µg/kg)	2-Hexanone Conc. (µg/kg)	4-IPT Conc. (µg/kg)	Acetone Conc. (µg/kg)	Bromoform Conc. (µg/kg)	BME Conc. (µg/kg)	CD Conc. (µg/kg)	CDBME Conc. (µg/kg)
ST012-UWBZ09	ST012-UWBZ09-39'-0313-SO-N		3/12/2013	39	SW	5.7	3.0	< 5.3 U	< 5.3 U	< 5.3 U	< 21 U	< 5.3 U	< 21 U	< 5.3 U	13 B	< 5.3 U	< 11 U	< 5.3 U	< 5.3 U
	ST012-UWBZ09-42'-0313-SO-N		3/12/2013	42	CL	5.2	25	< 7.9 U	< 7.9 U	< 7.9 U	3.3 B	< 7.9 U	< 32 U	< 7.9 U	33 B	< 7.9 U	< 16 U	< 7.9 U	< 7.9 U
	ST012-UWBZ09-54'-0313-SO-N		3/12/2013	54	SC	3.8	25	< 6.7 U	< 6.7 U	< 6.7 U	3.9 B	< 6.7 U	< 27 U	< 6.7 U	32 B	< 6.7 U	< 13 U	< 6.7 U	< 6.7 U
	DUP-13-0313-SO-FR	Duplicate	3/12/2013	54			16	< 9.9 U	< 9.9 U	< 9.9 U	5.0 B	< 9.9 U	< 40 U	< 9.9 U	61 B	< 9.9 U	< 20 U	< 9.9 U	< 9.9 U
	ST012-UWBZ09-65'-0313-SO-N		3/12/2013	65	CL	3.5	19	< 7.3 U	< 7.3 U	< 7.3 U	< 29 U	< 7.3 U	< 29 U	< 7.3 U	21 B	< 7.3 U	< 15 U	< 7.3 U	< 7.3 U
	ST012-UWBZ09-77'-0313-SO-N		3/12/2013	77	SW	3.3	5.3	< 5.0 U	< 5.0 U	< 5.0 U	< 20 U	< 5.0 U	< 20 U	< 5.0 U	18 B	< 5.0 U	< 10 U	< 5.0 U	< 5.0 U
	DUP-14-0313-SO-FR	Duplicate	3/12/2013	77			5.4	< 5.3 U	< 5.3 U	< 5.3 U	< 21 U	< 5.3 U	< 21 U	< 5.3 U	12 B	< 5.3 U	< 11 U	< 5.3 U	< 5.3 U
	ST012-UWBZ09-90'-0313-SO-N		3/12/2013	90	CL	4.1	16	< 5.3 U	< 5.3 U	< 5.3 U	< 21 U	< 5.3 U	< 21 U	< 5.3 U	17 B	< 5.3 U	< 11 U	< 5.3 U	< 5.3 U
	ST012-UWBZ09-95'-0313-SO-N		3/12/2013	95	SP-SM	2.9	14	< 6.4 U	< 6.4 U	< 6.4 U	< 26 U	< 6.4 U	< 26 U	< 6.4 U	19 B	< 6.4 U	< 13 U	< 6.4 U	< 6.4 U
	DUP-15-0313-SO-FR	Duplicate	3/12/2013	95			13	< 6.1 U	< 6.1 U	< 6.1 U	< 24 U	< 6.1 U	< 24 U	< 6.1 U	15 B	< 6.1 U	< 12 U	< 6.1 U	< 6.1 U
	ST012-UWBZ09-105'-0313-SO-N		3/12/2013	105	CL	3.7	16	< 5.4 U	< 5.4 U	< 5.4 U	< 22 U	< 5.4 U	< 22 U	< 5.4 U	16 B	< 5.4 U	< 11 U	< 5.4 U	< 5.4 U
	ST012-UWBZ09-120'-0313-SO-N		3/12/2013	120	CL	2.7	13	< 5.7 U	< 5.7 U	< 5.7 U	3.3 B	< 5.7 U	< 23 U	< 5.7 U	34 B	< 5.7 U	< 11 U	< 5.7 U	< 5.7 U
	ST012-UWBZ09-125'-0313-SO-N		3/12/2013	125	SM	2	6.4	< 5.4 U	< 5.4 U	< 5.4 U	< 22 U	< 5.4 U	< 22 U	< 5.4 U	19 B	< 5.4 U	< 11 U	< 5.4 U	< 5.4 U
	DUP-16-0313-SO-FR	Duplicate	3/12/2013	125			6.5	< 5.4 U	< 5.4 U	< 5.4 U	< 22 U	< 5.4 U	< 22 U	< 5.4 U	17 B	< 5.4 U	< 11 U	< 5.4 U	< 5.4 U
	ST012-UWBZ09-135'-0313-SO-N		3/13/2013	135	CL	2.1	17	< 7.9 U	< 7.9 U	< 7.9 U	4.9 B	< 7.9 U	< 31 U	< 7.9 U	33 B	< 7.9 U	< 16 U	< 7.9 U	< 7.9 U
	ST012-UWBZ09-150'-0313-SO-N		3/13/2013	150	SC	1.4	19	< 5.0 U	< 5.0 U	< 5.0 U	2.8 B	< 5.0 U	< 20 U	< 5.0 U	25 B	< 5.0 U	< 10 U	< 5.0 U	< 5.0 U
	DUP-17-0313-SO-FR	Duplicate	3/13/2013	150			21	< 5.5 U	< 5.5 U	< 5.5 U	< 22 U	< 5.5 U	< 22 U	< 5.5 U	20 B	< 5.5 U	< 11 U	< 5.5 U	< 5.5 U
	ST012-UWBZ09-160'-SO-N		3/13/2013	160	CL	2.1	14	< 5.7 U	< 5.7 U	< 5.7 U	< 23 U	< 5.7 U	< 23 U	< 5.7 UM	14 B	< 5.7 U	< 11 U	< 5.7 U	< 5.7 U
	ST012-UWBZ09-170'-0313-SO-N		3/13/2013	170	CL	15.8	21	< 6.5 U	< 6.5 U	< 6.5 U	< 26 U	< 6.5 U	< 26 U	0.63 F	29 B	< 6.5 U	< 13 U	0.68 F	< 6.5 U
	DUP-18-0313-SO-N	Duplicate	3/13/2013	170			19	< 5.1 U	< 5.1 U	< 5.1 U	< 20 U	< 5.1 U	< 20 U	0.58 F	31 B	< 5.1 U	< 10 U	< 5.1 U	< 5.1 U
	ST012-UWBZ09-172.5-0313-SO-N		3/13/2013	172.5	CL	2.2	19	< 6.7 U	< 6.7 U	< 6.7 U	3.0 B	< 6.7 U	< 27 U	< 6.7 U	22 B	< 6.7 U	< 13 U	< 6.7 U	< 6.7 U
	DUP-19-0313-SO-N	Duplicate	3/13/2013	172.5			21	< 5.1 U	< 5.1 U	< 5.1 U	< 20 U	< 5.1 U	< 20 U	0.52 F	19 B	< 5.1 U	< 10 U	< 5.1 U	< 5.1 U
	ST012-UWBZ09-182.5-0313-SO-N		3/13/2013	182.5	CL	5.8	21	< 5.4 U	< 5.4 U	< 5.4 U	130 B	< 5.4 U	9.3 F	1.1 F	310 B	< 5.4 U	< 11 U	< 5.4 U	< 5.4 U
	ST012-UWBZ09-192.5-0313-SO-N		3/13/2013	192.5	CL	3.9	25	< 6.0 U	< 6.0 U	< 6.0 U	9.4 B	< 6.0 U	< 24 U	1.2 F	44 B	< 6.0 U	< 12 U	< 6.0 U	< 6.0 U

Notes:
µg/kg - micrograms per kilogram
DCA - dichloromethane, DBA - dibromoethane, MEK - methyl-ethyl-ketone or 2-butanone, CT - chlorotoluene, BME - bromomethane, IPT - isopropyltoluene, CDBME - chlorodibromomethane, CE - chloroethene, CME - chloromethane, MIBK - methyl-isobutyl-ketone, MTBE - methyl-t-butyl-ether, MCH - methyl cyclohexane, MC - methylene
ft. - feet.
ID - Identification.
Lithology: SC - Clayey Sand, SM - Silty Sand, SP - Poorly Graded Sand, SW - Well Graded Sand
MDL - Method Detection Limit.
NL - No Limit established or not available for this constituent.
PID - photoionization detector
ppmv - parts per million by volume.
RL - Reporting Limit.

Data Qualifier Definitions:
B - Sample concentration is similar to that found in an associated blank.
F - The analyte was detected, estimated above the MDL and below the RL.
J - The result is estimated due to QC criteria.
M - The result is estimated due to a matrix effect.
U - The analyte was not detected above the RL shown.
< - Not detected at or above the RL.

ST012 Pre-Design Investigation
Summary of Soil Sample Analytical Results - Other Detected VOCs

								CE	Chloroform	CME	i-PBZ	MIBK	MTBE	MC	n-BBZ	n-PBZ	sec-BBZ	t-1,3-DCP	TCE
Location ID	Sample ID	Sample Type	Sample Date	Sample Depth (ft.)	Lithology	PID (ppmv)	Percent Moisture (%)	Conc. (µg/kg)	Conc. (µg/kg)	Conc. (µg/kg)	Conc. (µg/kg)	Conc. (µg/kg)	Conc. (µg/kg)	Conc. (µg/kg)	Conc. (µg/kg)	Conc. (µg/kg)	Conc. (µg/kg)	Conc. (µg/kg)	Conc. (µg/kg)
ST012-LSZ08	ST012-LSZ08-33-213-SO-N		2/11/2013	33	SW	1.9	9.5	< 10 U	< 10 U	< 10 U	< 5.0 U	< 20 U	< 20 U	< 5.0 U	< 5.0 U	< 5.0 U	< 5.0 U	< 5.0 U	< 5.0 U
	ST012-LSZ08-47-213-SO-N		2/11/2013	47	SW	1.9	12	< 9.8 U	< 9.8 U	< 9.8 U	< 4.9 U	< 20 U	< 20 U	< 4.9 U	< 4.9 U	< 4.9 U	< 4.9 U	< 4.9 U	< 4.9 U
	ST012-LSZ08-55-213-SO-N		2/11/2013	55	ML	5.3	15	< 12 U	< 12 U	< 12 U	< 5.9 U	< 24 U	< 24 U	< 5.9 U	< 5.9 U	< 5.9 U	< 5.9 U	< 5.9 U	< 5.9 U
	ST012-LSZ08-67-213-SO-N		2/11/2013	67	ML/SM	1.4	14	< 11 U	< 11 U	< 11 U	< 5.6 U	< 23 U	< 23 U	< 5.6 U	< 5.6 U	< 5.6 U	< 5.6 U	< 5.6 U	< 5.6 U
	ST012-LSZ08-79-213-SO-N		2/11/2013	79	ML/SM	35	19	< 10 U	< 10 U	< 10 U	< 5.2 U	< 21 U	< 21 U	< 5.2 U	< 5.2 U	< 5.2 U	< 5.2 U	< 5.2 U	< 5.2 U
	ST012-LSZ08-87-213-SO-N		2/12/2013	87	SP	90	20	1.2 F	< 11 U	< 11 U	< 5.3 U	< 21 U	< 21 U	< 5.3 U	< 5.3 U	< 5.3 U	< 5.3 U	< 5.3 U	< 5.3 U
	ST012-LSZ08-97-213-SO-N		2/12/2013	97	SM/ML	3.3	17	< 9.6 U	< 9.6 U	0.78 F	< 4.8 U	< 19 U	< 19 U	< 4.8 U	< 4.8 U	< 4.8 U	< 4.8 U	< 4.8 U	< 4.8 U
	ST012-LSZ08-107-213-SO-N		2/12/2013	107	SM/ML	40	22	< 12 U	< 12 U	< 12 U	< 6.2 U	< 25 U	< 25 U	< 6.2 U	< 6.2 U	< 6.2 U	< 6.2 U	< 6.2 U	< 6.2 U
	ST012-LSZ08-117-213-SO-N		2/12/2013	117	ML	4	17	< 10 U	< 10 U	< 10 U	< 5.1 U	< 20 U	< 20 U	< 5.1 U	< 5.1 U	< 5.1 U	< 5.1 U	< 5.1 U	< 5.1 U
	ST012-LSZ08-127-213-SO-N		2/12/2013	127	ML	3.5	18	< 10 U	< 10 U	< 10 U	< 5.2 U	< 21 U	< 21 U	< 5.2 U	< 5.2 U	< 5.2 U	< 5.2 U	< 5.2 U	< 5.2 U
	ST012-LSZ08-137-213-SO-N		2/12/2013	137	ML	4.8	16	< 9.4 U	< 9.4 U	< 9.4 U	< 4.7 U	< 19 U	< 19 U	< 4.7 U	< 4.7 U	< 4.7 U	< 4.7 U	< 4.7 U	< 4.7 U
	ST012-LSZ08-146-213-SO-N		2/12/2013	146	CL	4.8	18	< 8.6 U	< 8.6 U	< 8.6 U	< 4.3 U	< 17 U	< 17 U	< 4.3 U	< 4.3 U	< 4.3 U	< 4.3 U	< 4.3 U	< 4.3 U
	ST012-LSZ08-156-213-SO-N		2/12/2013	156	CL	2.3	21	< 9.9 U	< 9.9 U	< 9.9 U	< 4.9 U	< 20 U	< 20 U	< 4.9 U	< 4.9 U	< 4.9 U	< 4.9 U	< 4.9 U	< 4.9 U
	ST012-LSZ08-169-SO-N		2/12/2013	169	ML	57	19	< 9.4 U	< 9.4 U	< 9.4 U	< 4.7 U	< 19 U	< 19 U	< 4.7 U	< 4.7 U	< 4.7 U	< 4.7 U	< 4.7 U	< 4.7 U
	ST012-LSZ08-179-SO-N		2/12/2013	179	SW/GW	7.9	13	< 9.1 U	< 9.1 U	< 9.1 U	< 4.5 U	< 18 U	< 18 U	< 4.5 U	< 4.5 U	< 4.5 U	< 4.5 U	< 4.5 U	< 4.5 U
	ST012-LSZ08-187-SO-N		2/13/2013	187	SW/GW	6	14	< 8.2 U	< 8.2 U	< 8.2 U	< 4.1 U	< 16 U	< 16 U	< 4.1 U	< 4.1 U	< 4.1 U	< 4.1 U	< 4.1 U	< 4.1 U
	DUP-07-0213-SO-FR	Duplicate	2/13/2013	187			15	< 9.2 U	< 9.2 U	< 9.2 U	< 4.6 U	< 18 U	< 18 U	< 4.6 U	< 4.6 U	< 4.6 U	< 4.6 U	< 4.6 U	< 4.6 U
	ST012-LSZ08-198-SO-N		2/13/2013	198	SW/GW	4.3	22	< 10 U	< 10 U	< 10 U	< 5.2 U	< 21 U	< 21 U	< 5.2 U	< 5.2 U	< 5.2 U	< 5.2 U	< 5.2 U	< 5.2 U
	ST012-LSZ08-207-SO-N		2/13/2013	207	CL	2.3	19	< 10 U	< 10 U	< 10 U	< 5.0 U	< 20 U	< 20 U	< 5.0 U	< 5.0 U	< 5.0 U	< 5.0 U	< 5.0 U	< 5.0 U
	ST012-LSZ08-219-213-SO-N		2/13/2013	219	SW	1130	21	< 5600 U	< 2800 U	< 5600 U	4500 J	< 11000 U	< 2800 U	2400 B	2800 J	7000 J	< 2800 U	< 2800 U	< 2800 U
	DUP-08-0213-SO-FR	Duplicate	2/13/2013	219			21	< 5000 U	< 2500 U	< 5000 U	1100 F	< 9900 U	< 2500 U	2000 B	< 2500 U	1600 F	< 2500 U	< 2500 U	< 2500 U
	ST012-LSZ08-225-213-SO-N		2/13/2013	225	SW/GW	930	11	< 2400 U	< 1200 U	< 2400 U	980 F	< 4700 U	< 1200 U	490 B	580 F	1400	< 1200 U	< 1200 U	< 1200 U
	ST012-LSZ08-235-213-SO-N		2/13/2013	235	ML/GM		13	< 9.2 U	< 9.2 U	< 9.2 U	< 4.6 U	< 18 U	< 18 U	< 4.6 U	< 4.6 U	< 4.6 U	< 4.6 U	< 4.6 U	< 4.6 U
ST012-LSZ09	ST012-LSZ09-38FT-0213-SO-N		2/11/2013	38	SP-SM	2	6.4	< 9.1 U	< 9.1 U	< 9.1 U	< 4.6 U	< 18 U	< 18 U	< 4.6 U	< 4.6 U	< 4.6 U	< 4.6 U	< 4.6 U	< 4.6 U
	ST012-LSZ09-48FT-0213-SO-N		2/11/2013	48	SM	10.5	15	< 9.6 U	< 9.6 U	< 9.6 U	< 4.8 U	< 19 U	< 19 U	< 4.8 U	< 4.8 U	< 4.8 U	< 4.8 U	< 4.8 U	< 4.8 U
	ST012-LSZ09-58FT-0213-SO-N		2/11/2013	58	SM/SC	2.6	14	< 9.1 U	< 9.1 U	< 9.1 U	< 4.5 U	< 18 U	< 18 U	< 4.5 U	< 4.5 U	< 4.5 U	< 4.5 U	< 4.5 U	< 4.5 U
	ST012-LSZ09-68FT-0213-SO-N		2/11/2013	68	SC	4.2	17	< 8.8 U	< 8.8 U	1.5 F	< 4.4 U	< 18 U	< 18 U	< 4.4 U	< 4.4 U	< 4.4 U	< 4.4 U	< 4.4 U	< 4.4 U
	ST012-LSZ09-78FT-0213-SO-N		2/11/2013	78	SW/SM	5.5	5.2	< 9.1 U	< 9.1 U	< 9.1 U	< 4.5 U	< 18 U	< 18 U	< 4.5 U	< 4.5 U	< 4.5 U	< 4.5 U	< 4.5 U	< 4.5 U
	ST012-LSZ09-90FT-0213-SO-N		2/11/2013	90	SP/SM	4.8	14	< 9.6 U	< 9.6 U	< 9.6 U	< 4.8 U	< 19 U	< 19 U	< 4.8 U	< 4.8 U	< 4.8 U	< 4.8 U	< 4.8 U	< 4.8 U
	ST012-LSZ09-100FT-0213-SO-N		2/11/2013	100	SP/SM	5	11	< 9.5 U	< 9.5 U	< 9.5 U	< 4.8 U	< 19 U	< 19 U	< 4.8 U	< 4.8 U	< 4.8 U	< 4.8 U	< 4.8 U	< 4.8 U
	ST012-LSZ09-108FT-0213-SO-N		2/11/2013	108	SP	4.5	20	< 9.3 U	< 9.3 U	< 9.3 U	< 4.6 UM	< 19 UM	< 19 UM	< 4.6 UM	< 4.6 UM	< 4.6 UM	< 4.6 UM	< 4.6 UM	< 4.6 UM
	ST012-LSZ09-116FT-0213-SO-N		2/11/2013	116	SP	4	5.2	< 10 U	< 10 U	< 10 U	< 5.1 U	< 20 U	< 20 U	< 5.1 U	< 5.1 U	< 5.1 U	< 5.1 U	< 5.1 U	< 5.1 U
	ST012-LSZ09-128FT-0213-SO-N		2/12/2013	128	SC	5.2	15	< 7.9 U	< 7.9 U	< 7.9 U	< 4.0 U	< 16 U	< 16 U	< 4.0 U	< 4.0 U	< 4.0 U	< 4.0 U	< 4.0 U	< 4.0 U
	ST012-LSZ09-132FT-0213-SO-N		2/12/2013	132	SP/SC	4.9	15	< 8.7 U	< 8.7 U	< 8.7 U	< 4.3 U	< 17 U	< 17 U	< 4.3 U	< 4.3 U	< 4.3 U	< 4.3 U	< 4.3 U	< 4.3 U
	ST012-LSZ09-148FT-0213-SO-N		2/12/2013	148	SP	8.7	12	< 9.4 U	< 9.4 U	< 9.4 U	< 4.7 U	< 19 U	< 19 U	< 4.7 U	< 4.7 U	< 4.7 U	< 4.7 U	< 4.7 U	< 4.7 U
	ST012-LSZ09-160FT-0213-SO-N		2/12/2013	160	CL	7.8	26	< 9.9 U	< 9.9 U	< 9.9 U	< 5.0 U	< 20 U	< 20 U	< 5.0 U	< 5.0 U	< 5.0 U	< 5.0 U	< 5.0 U	< 5.0 U
	ST012-LSZ09-170FT-0213-SO-N		2/12/2013	170	CL	542	20	< 23000 U	< 11000 U	< 23000 U	3400 F	< 46000 U	< 11000 U	9300 B	3500 F	4800 F	< 11000 U	< 11000 U	< 11000 U
	DUP-05-0213-SO-FR	Duplicate	2/12/2013	170			20	< 47000 U	< 24000 U	< 47000 U	3700 F	< 95000 U	< 24000 U	19000 B	3400 F	4600 F	< 24000 U	< 24000 U	< 24000 U
	ST012-LSZ09-172FT-0213-SO-N		2/12/2013	172	SP-SC	133.7	16	< 8.0 U	< 8.0 U	< 8.0 U	11	19	< 16 U	< 4.0 U	5.9	12	< 4.0 U	< 4.0 U	< 4.0 U
	ST012-LSZ09-190FT-0213-SO-N		2/12/2013	190	SM	7.6	16	< 9.0 U	< 9.0 U	< 9.0 U	< 4.5 U	< 18 U	< 18 U	< 4.5 U	< 4.5 U	< 4.5 U	< 4.5 U	< 4.5 U	< 4.5 U
	ST012-LSZ09-198FT-0213-SO-N		2/13/2013	198	CL	1146	21	< 4500 U	< 2300 U	< 4500 U	990 F	< 9000 U	< 2300 U	1800 B	880 F	1800 F	< 2300 U	< 2300 U	< 2300 U
	ST012-LSZ09-210FT-0213-SO-N		2/13/2013	210	SC	1789	15	< 4300 U	< 2100 U	< 4300 U	1900 F	< 8500 U	< 2100 U	1500 B	1400 F	3000	< 2100 U	< 2100 U	< 2100 U
	ST012-LSZ09-220FT-0213-SO-N		2/13/2013	220	SW/SM	1150	19	< 4500 U	< 2200 U	< 4500 U	2900 J	< 8900 U	< 2200 U	< 2200 U	1500 F	4100 J	< 2200 U	< 2200 U	< 2200 U
	DUP-06-0213-SO-FR	Duplicate	2/13/2013	220			19	< 4400 U	< 2200 U	< 4400 U	7000 J	< 8800 U	< 2200 U	1800 B	4200 J	10000 J	< 2200 U	< 2200 U	< 2200 U
	ST012-LSZ09-224FT-0213-SO-N		2/13/2013	224	SW/GW	1391	12	< 41000 U	< 21000 U	< 41000 U	9500 F	< 82000 U	< 21000 U	15000 B	6000 F	13000 F	< 21000 U	< 21000 U	< 21000 U
	ST012-LSZ09-240FT-0213-SO-N		2/13/2013	240	SW/GW	68	12	< 7.9 U	< 7.9 U	< 7.9 U	< 3.9 U	< 16 U	< 16 U	< 3.9 U	0.57 F	< 3.9 U	< 3.9 U	< 3.9 U	< 3.9 U
ST012-LSZ10	ST012-LSZ10-32'-0213-SO-N		2/18/2013	32	SC	22.8	12	< 12 U	< 12 U	< 12 U	< 5.9 U	< 24 U	< 24 U	< 5.9 U	< 5.9 U	< 5.9 U	< 5.9 U	< 5.9 U	< 5.9 U
	ST012-LSZ10-46'-0213-SO-N		2/18/2013	46	SP-SC	2.4	22	< 12 U	< 12 U	< 12 U	< 6.1 U	< 25 U	< 25 U	< 6.1 U	< 6.1 U	< 6.1 U	< 6.1 U	< 6.1 U	< 6.1 U
	ST012-LSZ10-56'-0213-SO-N		2/18/2013	56	SC	2.3	17	< 13 U	< 13 U	< 13 U	< 6.6 U	< 26 U	< 26 U	< 6.6 U	< 6.6 U	< 6.6 U	< 6.6 U	< 6.6 U	< 6.6 U
	ST012-LSZ10-66'-0213-SO-N		2/18/2013	66	SC	1.8	23	< 14 U	< 14 U	< 14 U	< 6.8 U	< 27 U	< 27 U	< 6.8 U	< 6.8 U	< 6.8 U	< 6.8 U	< 6.8 U	< 6.8 U
	ST012-LSZ10-76'-0213-SO-N		2/18/2013	76	SC	2.1	18	< 11 U	< 11 U	< 11 U	< 5.7 U	< 23 U	< 23 U	< 5.7 U	< 5.7 U	< 5.7 U	< 5.7 U	< 5.7 U	< 5.7 U
	ST012-LSZ10-86'-0213-SO-N		2/18/2013	86	SC	3.1	20	< 11 U	< 11 U	< 11 U	< 5.7 U	< 23 U	< 23 U	< 5.7 U	< 5.7 U	< 5.7 U	< 5.7 U	< 5.7 U	< 5.7 U
	ST012-LSZ10-93'-0213-SO-N		2/18/2013	93	SP	1.2	13	< 11 U	< 11 U	< 11 U	< 5.3 U	< 21 U	< 21 U	< 5.3 U	< 5.3 U	< 5.3 U	< 5.3 U	< 5.3 U	< 5.3 U
	ST012-LSZ10-106'-0213-SO-N		2/18/2013	106	SC	2.8	19	< 11 U	< 11 U	< 11 U	< 5.4 U	< 21 U	< 21 U	< 5.4 U	< 5.4 U	< 5.4 U	< 5.4 U	< 5.4 U	< 5.4 U
	ST012-LSZ10-111'-0213-SO-N		2/18/2013	111	SC	2.7	15	< 9.7 U	< 9.7 U	< 9.7 U	< 4.8 U	5.1 B	< 19 U	< 4.8 U	< 4.8 U	< 4.8 U	< 4.8 U	< 4.8 U	< 4.8 U
	DUP-09-0213-SO-FR	Duplicate	2/18/2013	111			17	< 10 U	< 10 U	< 10 U	< 5.2 U	4.5 B	< 21 U	< 5.2 U	< 5.2 U	< 5.2 U	< 5.2 U	< 5.2 U	< 5.2 U
	ST012-LSZ10-126'-0213-SO-N		2/18/2013	126	SC	3.6	19	< 10 U	< 10 U	< 10 U	< 5.1 U	< 21 U	< 21 U	< 5.1 U	< 5.1 U	< 5.1 U	< 5.1 U	< 5.1 U	< 5.1 U
	ST012-LSZ10-136'-0213-SO-N		2/18/2013	136	SC	2	18	< 12 U	< 12 U	< 12 U	< 6.0 U	< 24 U	< 24 U	< 6.0 U	< 6.0 U	< 6.0 U	< 6.0 U	< 6.0 U	< 6.0 U
	ST012-LSZ10-144'-0213-SO-N		2/19/2013	144	GW	1.2	14	< 11 U	< 11 U	< 11 U	< 5.6 U	< 22 U	< 22 U	< 5.6 U	< 5.6 U	< 5.6 U	< 5.6 U	< 5.6 U	< 5.6 U
	ST012-LSZ10-156'-0213-SO-N		2/19/2013	156	SC	0.3	21	< 11 U	< 11 U	< 11 U	< 5.6 U	< 23 U	< 23 U	< 5.6 U	< 5.6 U	< 5.6 U	< 5.6 U	< 5.6 U	< 5.6 U
	ST012-LSZ10-164'-0213-SO-N		2/19/2013	164	SC	1288	25	< 31000 U	< 15000 U	< 31000 U	6700 F	< 62000 U	< 15000 U	6400 B	5800 F	10000 F	< 15000 U	< 15000 U	< 15000 U
	ST012-LSZ10-174'-0213-SO-N		2/19/2013	174	SC	801	21	< 25000 U	< 12000 U	< 25000 U	< 12000 U	< 49000 U	< 12000 U	5100 B	< 12000 U	< 12000 U	< 12000 U	< 12000 U	< 12000 U
	ST012-LSZ10-184'-0213-SO-N		2/19/2013	184	SC	1211	22	< 51000 U	< 26000 U	< 51000 U	15000 F	< 100000 U	< 26000 U	12000 B	8200 F	22000 F	< 26000 U	< 26000 U	< 26000 U
	ST012-LSZ10-194'-0213-SO-N		2/19/2013	194	SC	1424	21	< 56000 U	< 28000 U	< 56000 U	10000 F	< 110000 U	< 28000 U	12000 B	< 28000 U	15000 F	< 28000 U	< 28000 U	< 28000 U
	ST012-LSZ10-208'-0213-SO-N		2/19/2013	208	SP	1450	15	< 44000 U	< 22000 U	< 44000 U	10000 F	< 87000 U	< 22000 U	9300 B	6100 F	15000 F	< 22000 U	< 22000 U	< 22000 U
	ST012-LSZ10-216'-0213-SO-N		2/19/2013	216	SC	1428	19	< 24000 U	< 12000 U	< 24000 U	7300 F	< 48000 U	< 12000 U	5400 B	< 12000 U	11000 F	< 12000 U	< 12000 U	< 12000 U
	ST012-LSZ10-222'-0213-SO-N		2/19/2013	222	SP-SC	2060	21	< 25000 U	< 13000 U	< 25000 U	8300 F	< 51000 U	< 13000 U	6100 B	4900 F	12000 F	< 13000 U	< 13000 U	< 13000 U
	ST012-LSZ10-234'-0213-SO-N		2/20/2013	234	SP	2.3	17	< 11 U	< 11 U	< 11 U	< 5.5 U	< 22 U	< 22 U	29 B	< 5.5 U	< 5.5 U	< 5.5 U	< 5.5 U	< 5.5 U
	DUP-10-0213-SO-FR	Duplicate	2/20/2013	234			17	< 9.7 U	< 9.7 U	< 9.7 U	< 4.8 U	< 19 U	< 19 U	6.3 B	< 4.8 U	0.76 F	< 4.8 U	< 4.8 U	< 4.8 U

ST012 Pre-Design Investigation
Summary of Soil Sample Analytical Results - Other Detected VOCs

								CE	Chloroform	CME	i-PBZ	MIBK	MTBE	MC	n-BBZ	n-PBZ	sec-BBZ	t-1,3-DCP	TCE
Location ID	Sample ID	Sample Type	Sample Date	Sample Depth (ft.)	Lithology	PID (ppmv)	Percent Moisture (%)	Conc. (µg/kg)	Conc. (µg/kg)	Conc. (µg/kg)	Conc. (µg/kg)	Conc. (µg/kg)	Conc. (µg/kg)	Conc. (µg/kg)	Conc. (µg/kg)	Conc. (µg/kg)	Conc. (µg/kg)	Conc. (µg/kg)	Conc. (µg/kg)
ST012-LSZ11	ST012-LSZ11-155'-0213-SO-N		2/26/2013	155	SC	0.5	19	< 10 U	1.4 F	< 10 U	< 5.2 U	< 21 U	< 21 U	< 5.2 U	< 5.2 U	< 5.2 U	< 5.2 U	< 5.2 U	0.87 F
	ST012-LSZ11-169'-0213-SO-N		2/26/2013	169	SC	184	21	< 9.5 U	< 9.5 U	< 9.5 U	34	< 19 U	< 19 U	< 4.8 U	15	45	< 4.8 U	< 4.8 U	0.46 F
	ST012-LSZ11-172'-0213-SO-N		2/26/2013	172	SC	17.7	19	< 11 U	< 11 U	< 11 U	4.1 F	17 F	< 22 U	< 5.5 U	< 5.5 U	4.5 F	1.3 F	< 5.5 U	< 5.5 U
	ST012-LSZ11-186'-0213-SO-N		2/26/2013	186	SC	1312	23	< 2600 U	< 1300 U	< 2600 U	1500	< 5200 U	< 1300 U	570 B	970 F	2400	< 1300 U	< 1300 U	< 1300 U
	ST012-LSZ11-191'-0213-SO-N		2/27/2013	191	SC	1353	19	< 25000 U	< 12000 U	< 25000 U	20000	< 50000 U	< 12000 U	5300 B	12000	31000	< 12000 U	< 12000 U	< 12000 U
	ST012-LSZ11-208.5'-0213-SO-N		2/27/2013	208.5	SC	3558	24	< 31000 U	< 15000 U	< 31000 U	9600 F	< 61000 U	< 15000 U	5800 B	5900 F	16000	< 15000 U	< 15000 U	< 15000 U
	ST012-LSZ11-212'-0213-SO-N		2/27/2013	212	SW	1328	10	< 25000 U	< 12000 U	< 25000 U	4200 F	< 49000 U	< 12000 U	3900 B	< 12000 U	6700 F	< 12000 U	< 12000 U	< 12000 U
	ST012-LSZ11-229'-0213-SO-N		2/27/2013	229	SW	1291	11	< 24000 U	< 12000 U	< 24000 U	7300 F	< 47000 U	< 12000 U	4000 B	4900 F	12000	< 12000 U	< 12000 U	< 12000 U
	ST012-LSZ11-234'-0213-SO-N		2/27/2013	234	SW	65.2	11	< 9.8 U	< 9.8 U	< 9.8 U	< 4.9 U	< 20 U	< 20 U	< 4.9 U	< 4.9 U	0.7 F	< 4.9 U	< 4.9 U	< 4.9 U
ST012-LSZ12	ST012-LSZ12-159'-0213-SO-N		2/26/2013	159	SC	1.7	22	< 10 U	< 10 U	< 10 U	< 5.0 U	< 20 U	< 20 U	< 5.0 U	< 5.0 U	< 5.0 U	< 5.0 U	< 5.0 U	< 5.0 U
	ST012-LSZ12-162'-0213-SO-N		2/26/2013	162	CL-ML	6.8	21	< 11 U	0.34 F	< 11 U	< 5.6 U	< 23 U	< 23 U	< 5.6 U	< 5.6 U	< 5.6 U	< 5.6 U	< 5.6 U	< 5.6 U
	ST012-LSZ12-176'-0213-SO-N		2/27/2013	176	SC	81.2	17	< 10 U	< 10 U	< 10 U	< 5.1 U	< 20 U	< 20 U	< 5.1 U	< 5.1 U	< 5.1 U	< 5.1 U	< 5.1 U	< 5.1 U
	ST012-LSZ12-188'-0213-SO-N		2/28/2013	188	SP	62.9	16	< 9.6 U	< 9.6 U	< 9.6 U	34	< 19 U	< 19 U	< 4.8 U	17	53	< 4.8 U	< 4.8 U	< 4.8 U
	ST012-LSZ12-196'-0213-SO-N		2/28/2013	196	SC	995	19	< 9.8 U	< 9.8 U	< 9.8 U	520 J	< 20 U	< 20 U	2.8 B	110 J	800 J	120 J	1.2 F	< 4.9 U
	ST012-LSZ12-209.5'-0213-SO-N		2/28/2013	209.65	SC	96.8	22	< 590 U	< 300 U	< 590 U	810	< 1200 U	< 300 U	120 B	730	1400	< 300 U	< 300 U	< 300 U
	ST012-LSZ12-211'-0213-SO-N		2/28/2013	211	SC	289.3	23	< 540 U	< 270 U	< 540 U	34 F	< 1100 U	< 270 U	80 B	< 270 U	< 270 U	< 270 U	< 270 U	< 270 U
	ST012-LSZ12-225.5'-0213-SO-N		2/28/2013	225.5	SP	1152	11	< 2300 U	< 1100 U	< 2300 U	2800	< 4600 U	< 1100 U	440 B	1700	4300	< 1100 U	< 1100 U	< 1100 U
	ST012-LSZ12-234'-0213-SO-N		2/28/2013	234	SP	19.8	8.9	< 10 U	< 10 U	< 10 U	1.1 F	< 21 U	< 21 U	< 5.2 U	< 5.2 U	1.1 F	< 5.2 U	< 5.2 U	< 5.2 U
ST012-LSZ13	ST012-LSZ13-152-0313-SO-N		3/6/2013	152	SP	1.7	13	< 9.8 U	< 9.8 U	< 9.8 U	< 4.9 U	< 20 U	< 20 U	< 4.9 U	< 4.9 U	< 4.9 U	< 4.9 U	< 4.9 U	< 4.9 U
	ST012-LSZ13-167-0313-SO-N		3/6/2013	167	SC	1128	19	< 450 U	< 230 U	< 450 U	< 230 U	< 910 U	< 230 U	< 230 U	< 230 U	< 230 U	< 230 U	< 230 U	< 230 U
	ST012-LSZ13-179-0313-SO-N		3/6/2013	179	SC	385.2	12	< 12000 U	< 5900 U	< 12000 U	< 5900 U	< 24000 U	< 5900 U	2400 B	1300 F	< 5900 U	< 5900 U	< 5900 U	< 5900 U
	ST012-LSZ13-181.5-0313-SO-N		3/7/2013	181.5	CL	2810	23	< 31000 U	< 16000 U	< 31000 U	8900 F	< 62000 U	< 16000 U	6800 B	8000 F	12000 F	< 16000 U	< 16000 U	< 16000 U
	ST012-LSZ13-194-0313-SO-N		3/7/2013	194	CL	1167	18	< 9500 U	< 4700 U	< 9500 U	920 F	< 19000 U	< 4700 U	1900 B	< 4700 U	1400 F	< 4700 U	< 4700 U	< 4700 U
	ST012-LSZ13-209-0313-SO-N		3/7/2013	209	SC	1010	23	< 3600 U	< 1800 U	< 3600 U	740 F	< 7200 U	< 1800 U	500 B	460 F	1100 F	< 1800 U	< 1800 U	< 1800 U
	ST012-LSZ13-211.5-0313-SO-N		3/7/2013	211.5	SC	122.4	19	< 10 U	< 10 U	< 10 U	17	7.9 B	1.2 F	< 5.0 U	1.7 F	13	2.5 F	< 5.0 U	< 5.0 U
	ST012-LSZ13-226-0313-SO-N		3/7/2013	226	CL	228.7	19	< 5200 U	< 2600 U	< 5200 U	2000 F	< 10000 U	< 2600 U	890 B	1100 F	3000	< 2600 U	< 2600 U	< 2600 U
	ST012-LSZ13-231-0313-SO-N		3/7/2013	231	SP	5.7	13	< 11 U	< 11 U	< 11 U	< 5.4 U	< 21 U	< 21 U	< 5.4 U	< 5.4 U	< 5.4 U	< 5.4 U	< 5.4 U	< 5.4 U
ST012-LSZ14	ST012-LSZ14-157-0313-SO-N		3/5/2013	157	CL	8.5	24	< 11 U	< 11 U	< 11 U	2.2 F	< 21 U	< 21 U	< 5.4 U	< 5.4 U	0.84 F	< 5.4 U	< 5.4 U	< 5.4 U
	ST012-LSZ14-164-0313-SO-N		3/5/2013	164	CL	7.1	17	< 11 U	< 11 U	< 11 U	< 5.5 U	< 22 U	< 22 U	< 5.5 U	< 5.5 U	< 5.5 U	< 5.5 U	< 5.5 U	< 5.5 U
	ST012-LSZ14-174.5-0313-SO-N		3/5/2013	174.5	SW	10.5	11	< 9.0 U	< 9.0 U	< 9.0 U	0.58 F	< 18 U	< 18 U	< 4.5 U	< 4.5 U	< 4.5 U	< 4.5 U	< 4.5 U	< 4.5 U
	ST012-LSZ14-188-0313-SO-N		3/5/2013	188	SC	10.8	19	< 450 U	< 230 U	< 450 U	< 230 U	< 910 U	< 230 U	93 B	< 230 U	< 230 U	< 230 U	< 230 U	< 230 U
	ST012-LSZ14-193.5-0313-SO-N		3/5/2013	193.5	CL	12.1	18	< 12 U	< 12 U	< 12 U	1.1 F	< 25 U	< 25 U	< 6.2 U	< 6.2 U	< 6.2 U	< 6.2 U	< 6.2 U	< 6.2 U
	ST012-LSZ14-209.5-0313-SO-N		3/6/2013	209.5	CL	3160	15	< 5500 U	< 2800 U	< 5500 U	1700 F	< 11000 U	< 2800 U	950 B	1300 F	2700 F	< 2800 U	< 2800 U	< 2800 U
	ST012-LSZ14-212-0313-SO-N		3/6/2013	212	SP	3268	13	< 10000 U	< 5100 U	< 10000 U	1800 F	< 21000 U	< 5100 U	2400 B	1400 F	2900 F	< 5100 U	< 5100 U	< 5100 U
	ST012-LSZ14-221.5-0313-SO-N		3/6/2013	221.5	SC	548	23	< 530 U	< 270 U	< 530 U	< 270 U	< 1100 U	< 270 U	< 270 U	< 270 U	< 270 U	< 270 U	< 270 U	< 270 U
	ST012-LSZ14-236.5-0313-SO-N		3/6/2013	236.5	SP	3.4	12	< 8.8 U	< 8.8 U	< 8.8 U	< 4.4 U	< 18 U	< 18 U	< 4.4 U	< 4.4 U	0.6 F	< 4.4 U	< 4.4 U	< 4.4 U
ST012-LSZ15	ST012-LSZ15-38FT-0213-SO-N		2/18/2013	38	SM	747	9.4	< 470 U	< 240 U	< 470 U	< 240 U	< 950 U	< 240 U	110 B	< 240 U	< 240 U	< 240 U	< 240 U	< 240 U
	ST012-LSZ15-48FT-0213-SO-N		2/18/2013	48	SM	1743	12	< 9400 U	< 4700 U	< 9400 U	1400 F	< 19000 U	< 4700 U	1500 B	< 4700 U	< 4700 U	< 4700 U	< 4700 U	< 4700 U
	ST012-LSZ15-56FT-0213-SO-N		2/18/2013	56	SM	1734	15	< 9900 U	< 5000 U	< 9900 U	770 F	< 20000 U	< 5000 U	1500 B	< 5000 U	< 5000 U	< 5000 U	< 5000 U	< 5000 U
	ST012-LSZ15-68FT-0213-SO-N		2/18/2013	68	SM	1663	13	< 11000 U	< 5400 U	< 11000 U	5200 F	< 22000 U	< 5400 U	1900 B	3900 F	9500	6200	< 5400 U	< 5400 U
	ST012-LSZ15-80FT-0213-SO-N		2/18/2013	80	SM	1562	18	< 29000 U	< 15000 U	< 29000 U	8100 F	< 58000 U	< 15000 U	4500 B	8000 F	12000 F	< 15000 U	< 15000 U	< 15000 U
	ST012-LSZ15-84FT-0213-SO-N		2/18/2013	84	SM	1647	20	< 27000 U	< 14000 U	< 27000 U	5600 F	< 55000 U	< 14000 U	4200 B	< 14000 U	9200 F	< 14000 U	< 14000 U	< 14000 U
	ST012-LSZ15-94FT-0213-SO-N		2/18/2013	94	SM	1431	17	< 9800 U	< 4900 U	< 9800 U	2100 F	< 20000 U	< 4900 U	1700 B	< 4900 U	4700 F	< 4900 U	< 4900 U	< 4900 U
	ST012-LSZ15-106FT-0213-SO-N		2/18/2013	106	ML	1383	20	< 11000 U	< 5500 U	< 11000 U	2500 F	< 22000 U	< 5500 U	1900 B	1300 F	< 5500 U	< 5500 U	< 5500 U	< 5500 U
	ST012-LSZ15-120FT-0213-SO-N		2/18/2013	120	ML	714.2	17	< 9500 U	< 4700 U	< 9500 U	< 4700 U	< 19000 U	< 4700 U	2100 B	4800	< 4700 U	< 4700 U	< 4700 U	< 4700 U
	ST012-LSZ15-130FT-0213-SO-N		2/18/2013	130	SM	1431	18	< 26000 U	< 13000 U	< 26000 U	12000 F	< 52000 U	< 13000 U	5600 B	7600 F	19000	< 13000 U	< 13000 U	< 13000 U
	ST012-LSZ15-136FT-0213-SO-N		2/18/2013	136	SP-SM	1592	15	< 9700 U	< 4900 U	< 9700 U	1700 F	< 19000 U	< 4900 U	2000 B	< 4900 U	< 4900 U	< 4900 U	< 4900 U	< 4900 U
	ST012-LSZ15-140FT-0213-SO-N		2/19/2013	140	SP-SM	1914	11	< 460 U	< 230 U	< 460 U	1200	< 920 U	< 230 U	96 B	1600	1100	< 230 U	< 230 U	< 230 U
	ST012-LSZ15-160FT-0213-SO-N		2/19/2013	160	CL	1474	24	< 10000 U	< 5000 U	< 10000 U	< 5000 U	< 20000 U	< 5000 U	2000 B	< 5000 U	< 5000 U	< 5000 U	< 5000 U	< 5000 U
	DUP-11-0213-SO-FR	Duplicate	2/19/2013	160			23	< 5200 U	< 2600 U	< 5200 U	< 2600 U	< 10000 U	< 2600 U	1100 B	< 2600 U	< 2600 U	< 2600 U	< 2600 U	< 2600 U
	ST012-LSZ15-164FT-0213-SO-N		2/19/2013	164	SP-SC	1590	18	< 24000 U	< 12000 U	< 24000 U	13000	< 48000 U	< 12000 U	5700 B	7500 F	19000	< 12000 U	< 12000 U	< 12000 U
	ST012-LSZ15-174FT-0213-SO-N		2/19/2013	174	SP-SM	3446	20	< 500 U	< 250 U	< 500 U	4900	< 1000 U	< 250 U	190 B	3300	7400	< 250 U	< 250 U	< 250 U
	ST012-LSZ15-184FT-0213-SO-N		2/19/2013	184	SM	1705	16	< 2500 U	< 1300 U	< 2500 U	3800	< 5000 U	< 1300 U	620 B	2900	5800	< 1300 U	< 1300 U	< 1300 U
	ST012-LSZ15-198FT-0213-SO-N		2/19/2013	198	ML	2194	18	< 9900 U	< 5000 U	< 9900 U	3300 F	< 20000 U	< 5000 U	2100 B	2100 F	4900 F	< 5000 U	< 5000 U	< 5000 U
	ST012-LSZ15-210FT-0213-SO-N		2/19/2013	210	CL	1369	21	< 530 U	< 260 U	< 530 U	2300	< 1100 U	< 260 U	170 B	1700	3700	< 260 U	< 260 U	< 260 U
	ST012-LSZ15-220FT-0213-SO-N		2/20/2013	220	CL	1001	17	< 48000 U	< 24000 U	< 48000 U	33000	< 97000 U	< 24000 U	17000 B	17000 F	50000	< 24000 U	< 24000 U	< 24000 U
	ST012-LSZ15-228FT-0213-SO-N		2/20/2013	228	GW/SW	228	12	< 9.6 U	< 9.6 U	< 9.6 U	52	< 19 U	< 19 U	< 4.8 U	43	74	52	< 4.8 U	< 4.8 U
	ST012-LSZ15-236FT-0213-SO-N		2/20/2013	236	SC	5.5	15	< 4.7 U	< 4.7 U	< 4.7 U	< 2.4 U	< 9.5 U	< 9.5 U	< 2.4 U	< 2.4 U	< 2.4 U	< 2.4 U	< 2.4 U	< 2.4 U
	DUP-12-0213-SO-FR	Duplicate	2/20/2013	236			14	< 9.8 U	< 9.8 U	< 9.8 U	< 4.9 U	< 20 U	< 20 U	< 4.9 U	< 4.9 U	< 4.9 U	< 4.9 U	< 4.9 U	< 4.9 U

ST012 Pre-Design Investigation
Summary of Soil Sample Analytical Results - Other Detected VOCs

								CE	Chloroform	CME	i-PBZ	MIBK	MTBE	MC	n-BBZ	n-PBZ	sec-BBZ	t-1,3-DCP	TCE
Location ID	Sample ID	Sample Type	Sample Date	Sample Depth (ft.)	Lithology	PID (ppmv)	Percent Moisture (%)	Conc. (µg/kg)	Conc. (µg/kg)	Conc. (µg/kg)	Conc. (µg/kg)	Conc. (µg/kg)	Conc. (µg/kg)	Conc. (µg/kg)	Conc. (µg/kg)	Conc. (µg/kg)	Conc. (µg/kg)	Conc. (µg/kg)	Conc. (µg/kg)
ST012-LSZ16	ST012-LSZ16-35-0213-SO-N		2/4/2013	35	SW	350	6.8	< 2600 U	< 1300 U	< 2600 U	< 1300 U	< 5200 U	< 1300 U	1300 B	< 1300 U	< 1300 U	< 1300 U	< 1300 U	< 1300 U
	ST012-LSZ16-45-0213-SO-N		2/4/2013	45	CL/GW	158/1380	16	< 4900 U	< 2400 U	< 4900 U	1400 F	< 9800 U	< 2400 U	2400 B	9800	8800	11000	< 2400 U	< 2400 U
	ST012-LSZ16-57-0213-SO-N		2/4/2013	57	ML/SM	1750	16	< 11000 U	< 5500 U	< 11000 U	26000	< 22000 U	< 5500 U	5600 B	14000	40000	13000	< 5500 U	< 5500 U
	ST012-LSZ16-64-0213-SO-N		2/4/2013	64	ML/SM	1770	18	< 28000 U	< 14000 U	< 28000 U	23000	< 56000 U	< 14000 U	16000 B	13000 F	41000	14000	< 14000 U	< 14000 U
	ST012-LSZ16-79-0213-SO-N		2/5/2013	79	ML/SM	1480	17	< 36000 U	< 18000 U	< 36000 U	5900 F	< 71000 U	< 18000 U	17000 B	5600 F	13000 F	< 18000 U	< 18000 U	< 18000 U
	ST012-LSZ16-84.5-0213-SO-N		2/5/2013	84.5	ML/SM	1380	21	< 30000 U	< 15000 U	< 30000 U	< 15000 U	< 61000 U	< 15000 U	15000 B	6400 F	5100 F	< 15000 U	< 15000 U	< 15000 U
	ST012-LSZ16-93-0213-SO-N		2/5/2013	93	SM	1280-	13	< 30000 U	< 15000 U	< 30000 U	5900 F	< 60000 U	< 15000 U	16000 B	3400 F	7500 F	< 15000 U	< 15000 U	< 15000 U
	ST012-LSZ16-105-0213-SO-N		2/5/2013	105	ML	1570	13	< 10000 U	< 5100 U	< 10000 U	3300 F	< 21000 U	< 5100 U	5300 B	4200 F	11000	< 5100 U	< 5100 U	< 5100 U
	ST012-LSZ16-112-0213-SO-N		2/5/2013	112	SP	864	6.7	< 2500 U	< 1300 U	< 2500 U	320 F	< 5000 U	< 1300 U	840 B	490 F	730 F	< 1300 U	< 1300 U	< 1300 U
	ST012-LSZ16-122-0213-SO-N		2/5/2013	122	ML-SM	1550	11	< 19000 U	< 9400 U	< 19000 U	9300 F	< 37000 U	< 9400 U	9300 B	6800 F	21000	< 9400 U	< 9400 U	< 9400 U
	ST012-LSZ16-135-0213-SO-N		2/5/2013	135	ML	1210	19	< 27000 U	< 14000 U	< 27000 U	27000	< 54000 U	< 14000 U	15000 B	20000	21000	21000	< 14000 U	< 14000 U
	ST012-LSZ16-147-0213-SO-N		2/5/2013	147	SM/SW	440	14	< 8800 U	< 4400 U	< 8800 U	< 4400 U	< 18000 U	< 4400 U	4400 B	590 F	< 4400 U	< 4400 U	< 4400 U	< 4400 U
	ST012-LSZ16-153-0213-SO-N		2/5/2013	153	SW/GW	640	10	< 450 U	< 230 U	< 450 U	< 230 U	< 910 U	< 230 U	160 B	< 230 U	< 230 U	< 230 U	< 230 U	< 230 U
	ST012-LSZ16-155-0213-SO-N		2/5/2013	155	GW/SW	230	10	< 9300 U	< 4600 U	< 9300 U	< 4600 U	< 19000 U	< 4600 U	4900 B	< 4600 U	< 4600 U	< 4600 U	< 4600 U	< 4600 U
	ST012-LSZ16-166.5-0213-SO-N		2/6/2013	166.5	CL	990	21	< 24000 U	< 12000 U	< 24000 U	14000	< 49000 U	< 12000 U	13000 B	7400 F	21000	< 12000 U	< 12000 U	< 12000 U
	DUP-03-0213-SO-FR	Duplicate	2/6/2013	166.5			22	< 46000 U	< 23000 U	< 46000 U	18000 F	< 92000 U	< 23000 U	17000 B	10000 F	27000	< 23000 U	< 23000 U	< 23000 U
	ST012-LSZ16-177-0213-SO-N		2/6/2013	177	ML	1900	19	< 27000 U	< 13000 U	< 27000 U	17000	< 54000 U	< 13000 U	8700 B	10000 F	25000	9400 F	< 13000 U	< 13000 U
	ST012-LSZ16-185-0213-SO-N		2/6/2013	185	ML	4000	24	< 27000 U	< 14000 U	< 27000 U	12000 F	< 54000 U	< 14000 U	14000 B	7100 F	18000	< 14000 U	< 14000 U	< 14000 U
	ST012-LSZ16-198-0213-SO-N		2/6/2013	198	CL	1400	19	< 5200 U	< 2600 U	< 5200 U	9200	< 10000 U	< 2600 U	1900 B	5700	14000	< 2600 U	< 2600 U	< 2600 U
	ST012-LSZ16-206-0213-SO-N		2/6/2013	206	CL	1390	23	< 12000 U	< 6100 U	< 12000 U	3700 F	< 24000 U	< 6100 U	6400 B	2000 F	5600 F	< 6100 U	< 6100 U	< 6100 U
	ST012-LSZ16-215-0213-SO-N		2/6/2013	215	SP/GP	850	11	< 23000 U	< 11000 U	< 23000 U	10000 F	< 46000 U	< 11000 U	7600 B	6100 F	13000	4900 F	< 11000 U	< 11000 U
	ST012-LSZ16-222-0213-SO-N		2/6/2013	222	SP/GP	50	18	< 440 U	< 220 U	< 440 U	160 F	< 890 U	< 220 U	250 B	91 F	240 J	< 220 U	< 220 U	< 220 U
	DUP-04-0213-SO-FR	Duplicate	2/6/2013	222			17	< 8.5 U	< 8.5 U	< 8.5 U	26 J	< 17 U	< 17 U	< 4.3 U	13 J	37 J	< 4.3 U	< 4.3 U	< 4.3 U
	ST012-LSZ16-237-0213-SO-N		2/7/2013	237			11	< 10 U	< 10 U	< 10 U	1.1 F	< 20 U	< 20 U	< 5.0 U	< 5.0 U	< 5.0 U	< 5.0 U	< 5.0 U	< 5.0 U
ST012-LSZ17	ST012-LSZ17-31FT-0213-SO-N		2/4/2013	31	SM	3.8	20	< 11 U	< 11 U	< 11 U	< 5.5 U	< 22 U	< 22 U	< 5.5 U	< 5.5 U	< 5.5 U	< 5.5 U	< 5.5 U	< 5.5 U
	ST012-LSZ17-45FT-0213-SO-N		2/4/2013	45	SC	1.9	19	< 9.7 U	< 9.7 U	< 9.7 U	< 4.8 U	< 19 U	< 19 U	< 4.8 U	< 4.8 U	< 4.8 U	< 4.8 U	< 4.8 U	< 4.8 U
	ST012-LSZ17-55FT-0213-SO-N		2/4/2013	55	SC	2.8	13	< 11 U	< 11 U	< 11 U	< 5.5 U	< 22 U	< 22 U	< 5.5 U	< 5.5 U	< 5.5 U	< 5.5 U	< 5.5 U	< 5.5 U
	ST012-LSZ17-65FT-0213-SO-N		2/4/2013	65	SP	1.4	17	< 13 U	< 13 U	< 13 U	< 6.7 U	< 27 U	< 27 U	< 6.7 U	< 6.7 U	< 6.7 U	< 6.7 U	< 6.7 U	< 6.7 U
	ST012-LSZ17-72FT-0213-SO-N		2/4/2013	72	SP	1.5	9.7	< 9.7 U	< 9.7 U	< 9.7 U	< 4.9 U	< 19 U	< 19 U	< 4.9 U	< 4.9 U	< 4.9 U	< 4.9 U	< 4.9 U	< 4.9 U
	ST012-LSZ17-89FT-0213-SO-N		2/5/2013	89	SP-SC	15.9	17	< 11 U	< 11 U	< 11 U	< 5.5 U	< 22 U	< 22 U	< 5.5 U	< 5.5 U	< 5.5 U	< 5.5 U	< 5.5 U	< 5.5 U
	ST012-LSZ17-98FT-0213-SO-N		2/5/2013	98	SP-SC	38	15	< 12 U	< 12 U	< 12 U	< 5.8 U	< 23 U	< 23 U	< 5.8 U	< 5.8 U	< 5.8 U	< 5.8 U	< 5.8 U	< 5.8 U
	ST012-LSZ17-109FT-0213-SO-N		2/5/2013	109	SP-SC	13.5	15	< 9.9 U	< 9.9 U	< 9.9 U	< 4.9 U	< 20 U	< 20 U	< 4.9 U	< 4.9 U	< 4.9 U	< 4.9 U	< 4.9 U	< 4.9 U
	ST012-LSZ17-114FT-0213-SO-N		2/5/2013	114	SP-SC	3.2	17	< 9.2 U	< 9.2 U	< 9.2 U	< 4.6 U	< 18 U	< 18 U	< 4.6 U	< 4.6 U	< 4.6 U	< 4.6 U	< 4.6 U	< 4.6 U
	DUP-01-0213-SO-FR	Duplicate	2/5/2013	114		3.2	18	< 9.8 U	< 9.8 U	< 9.8 U	< 4.9 U	< 20 U	< 20 U	< 4.9 U	< 4.9 U	< 4.9 U	< 4.9 U	< 4.9 U	< 4.9 U
	ST012-LSZ17-128FT-0213-SO-N		2/5/2013	128	SP	4.4	5.0	2.0 F	< 9.6 U	< 9.6 U	< 4.8 U	< 19 U	< 19 U	< 4.8 U	< 4.8 U	< 4.8 U	< 4.8 U	< 4.8 U	< 4.8 U
	ST012-LSZ17-134FT-0213-SO-N		2/5/2013	134	SC	4.1	12	< 7.9 U	< 7.9 U	< 7.9 U	< 4.0 U	< 16 U	< 16 U	< 4.0 U	< 4.0 U	< 4.0 U	< 4.0 U	< 4.0 U	< 4.0 U
	ST012-LSZ17-148FT-0213-SO-N		2/5/2013	148	SW	2.7	11	< 7.1 U	< 7.1 U	< 7.1 U	< 3.6 U	< 14 U	< 14 U	< 3.6 U	< 3.6 U	< 3.6 U	< 3.6 U	< 3.6 U	< 3.6 U
	ST012-LSZ17-158FT-0213-SO-N		2/5/2013	158	CL	5.7	21	< 8.0 U	< 8.0 U	< 8.0 U	< 4.0 U	< 16 U	< 16 U	< 4.0 U	< 4.0 U	< 4.0 U	< 4.0 U	< 4.0 U	< 4.0 U
	ST012-LSZ17-168FT-0213-SO-N		2/5/2013	168	CL	677.2	18	< 21000 U	< 11000 U	< 21000 U	9300 F	< 43000 U	< 11000 U	15000	2900 F	9000 F	< 11000 U	< 11000 U	< 11000 U
	ST012-LSZ17-174FT-0213-SO-N		2/6/2013	174	SP	522.8	17	< 470 U	< 230 U	< 470 U	< 230 UJ	< 930 U	< 230 U	260 B	< 230 UJ	< 230 UJ	< 230 UJ	< 230 U	< 230 U
	ST012-LSZ17-184FT-0213-SO-N		2/6/2013	184	SP-SM	1646	18	< 8500 U	< 4200 U	< 8500 U	3800 F	< 17000 U	< 4200 U	5100 B	< 4200 U	5600	< 4200 U	< 4200 U	< 4200 U
	DUP-02-0213-SO-FR	Duplicate	2/6/2013	184			19	< 22000 U	< 11000 U	< 22000 U	5200 F	< 44000 U	< 11000 U	13000 B	2900 F	7400 F	< 11000 U	< 11000 U	< 11000 U
	ST012-LSZ17-196FT-0213-SO-N		2/6/2013	196	SC	1547	31	< 3100 U	< 1600 U	< 3100 U	460 F	< 6300 U	< 1600 U	1900 B	< 1600 U	580 F	< 1600 U	< 1600 U	< 1600 U
	ST012-LSZ17-204FT-0213-SO-N		2/6/2013	204	SC	1267	17	< 22000 U	< 11000 U	< 22000 U	5500 F	< 43000 U	< 11000 U	12000 B	3300 F	7800 F	< 11000 U	< 11000 U	< 11000 U
	ST012-LSZ17-212FT-0213-SO-N		2/6/2013	212	SW-SC	1426	10	< 2000 U	< 980 U	< 2000 U	280 F	< 3900 U	< 980 U	1200 B	< 980 U	430 F	< 980 U	< 980 U	< 980 U
	ST012-LSZ17-222FT-0213-SO-N		2/6/2013	222	SP	1110	18	< 23000 U	< 12000 U	< 23000 U	10000 F	< 47000 U	< 12000 U	15000 B	5500 F	14000	< 12000 U	< 12000 U	< 12000 U
	ST012-LSZ17-240FT-0213-SO-N		2/7/2013	240			15	< 8.6 UM	< 8.6 UM	< 8.6 UM	< 4.3 UM	< 17 U	< 17 U	< 4.3 U	< 4.3 UM	< 4.3 UM	< 4.3 UM	< 4.3 U	< 4.3 UM

ST012 Pre-Design Investigation
Summary of Soil Sample Analytical Results - Other Detected VOCs

								CE	Chloroform	CME	i-PBZ	MIBK	MTBE	MC	n-BBZ	n-PBZ	sec-BBZ	t-1,3-DCP	TCE
Location ID	Sample ID	Sample Type	Sample Date	Sample Depth (ft.)	Lithology	PID (ppmv)	Percent Moisture (%)	Conc. (µg/kg)	Conc. (µg/kg)	Conc. (µg/kg)	Conc. (µg/kg)	Conc. (µg/kg)	Conc. (µg/kg)	Conc. (µg/kg)	Conc. (µg/kg)	Conc. (µg/kg)	Conc. (µg/kg)	Conc. (µg/kg)	Conc. (µg/kg)
ST012-UWBZ09	ST012-UWBZ09-39'-0313-SO-N		3/12/2013	39	SW	5.7	3.0	< 11 U	< 11 U	< 11 U	< 5.3 U	< 21 U	< 21 U	< 5.3 U	< 5.3 U	< 5.3 U	< 5.3 U	< 5.3 U	< 5.3 U
	ST012-UWBZ09-42'-0313-SO-N		3/12/2013	42	CL	5.2	25	< 16 U	< 16 U	< 16 U	< 7.9 U	< 32 U	< 32 U	< 7.9 U	< 7.9 U	< 7.9 U	< 7.9 U	< 7.9 U	< 7.9 U
	ST012-UWBZ09-54'-0313-SO-N		3/12/2013	54	SC	3.8	25	< 13 U	< 13 U	< 13 U	< 6.7 U	< 27 U	< 27 U	< 6.7 U	< 6.7 U	< 6.7 U	< 6.7 U	< 6.7 U	< 6.7 U
	DUP-13-0313-SO-FR	Duplicate	3/12/2013	54			16	< 20 U	< 20 U	< 20 U	< 9.9 U	< 40 U	< 40 U	< 9.9 U	< 9.9 U	< 9.9 U	< 9.9 U	< 9.9 U	< 9.9 U
	ST012-UWBZ09-65'-0313-SO-N		3/12/2013	65	CL	3.5	19	< 15 U	< 15 U	< 15 U	< 7.3 U	< 29 U	< 29 U	< 7.3 U	< 7.3 U	< 7.3 U	< 7.3 U	< 7.3 U	< 7.3 U
	ST012-UWBZ09-77'-0313-SO-N		3/12/2013	77	SW	3.3	5.3	< 10 U	< 10 U	< 10 U	< 5.0 U	< 20 U	< 20 U	< 5.0 U	< 5.0 U	< 5.0 U	< 5.0 U	< 5.0 U	< 5.0 U
	DUP-14-0313-SO-FR	Duplicate	3/12/2013	77			5.4	< 11 U	< 11 U	< 11 U	< 5.3 U	< 21 U	< 21 U	< 5.3 U	< 5.3 U	< 5.3 U	< 5.3 U	< 5.3 U	< 5.3 U
	ST012-UWBZ09-90'-0313-SO-N		3/12/2013	90	CL	4.1	16	< 11 U	< 11 U	< 11 U	< 5.3 U	< 21 U	< 21 U	< 5.3 U	< 5.3 U	< 5.3 U	< 5.3 U	< 5.3 U	< 5.3 U
	ST012-UWBZ09-95'-0313-SO-N		3/12/2013	95	SP-SM	2.9	14	< 13 U	< 13 U	< 13 U	< 6.4 U	< 26 U	< 26 U	< 6.4 U	< 6.4 U	< 6.4 U	< 6.4 U	< 6.4 U	< 6.4 U
	DUP-15-0313-SO-FR	Duplicate	3/12/2013	95			13	< 12 U	< 12 U	< 12 U	< 6.1 U	< 24 U	< 24 U	< 6.1 U	< 6.1 U	< 6.1 U	< 6.1 U	< 6.1 U	< 6.1 U
	ST012-UWBZ09-105'-0313-SO-N		3/12/2013	105	CL	3.7	16	< 11 U	< 11 U	< 11 U	< 5.4 U	< 22 U	< 22 U	< 5.4 U	< 5.4 U	< 5.4 U	< 5.4 U	< 5.4 U	< 5.4 U
	ST012-UWBZ09-120'-0313-SO-N		3/12/2013	120	CL	2.7	13	< 11 U	< 11 U	< 11 U	< 5.7 U	< 23 U	< 23 U	< 5.7 U	< 5.7 U	< 5.7 U	< 5.7 U	< 5.7 U	< 5.7 U
	ST012-UWBZ09-125'-0313-SO-N		3/12/2013	125	SM	2	6.4	< 11 U	< 11 U	< 11 U	< 5.4 U	< 22 U	< 22 U	< 5.4 U	< 5.4 U	< 5.4 U	< 5.4 U	< 5.4 U	< 5.4 U
	DUP-16-0313-SO-FR	Duplicate	3/12/2013	125			6.5	< 11 U	< 11 U	< 11 U	< 5.4 U	< 22 U	< 22 U	< 5.4 U	< 5.4 U	< 5.4 U	< 5.4 U	< 5.4 U	< 5.4 U
	ST012-UWBZ09-135'-0313-SO-N		3/13/2013	135	CL	2.1	17	< 16 U	< 16 U	< 16 U	< 7.9 U	< 31 U	< 31 U	< 7.9 U	< 7.9 U	< 7.9 U	< 7.9 U	< 7.9 U	< 7.9 U
	ST012-UWBZ09-150'-0313-SO-N		3/13/2013	150	SC	1.4	19	< 10 U	< 10 U	< 10 U	< 5.0 U	< 20 U	< 20 U	< 5.0 U	< 5.0 U	< 5.0 U	< 5.0 U	< 5.0 U	2.4 F
	DUP-17-0313-SO-FR	Duplicate	3/13/2013	150			21	< 11 U	< 11 U	< 11 U	< 5.5 U	< 22 U	< 22 U	< 5.5 U	< 5.5 U	< 5.5 U	< 5.5 U	< 5.5 U	4.1 F
	ST012-UWBZ09-160'-SO-N		3/13/2013	160	CL	2.1	14	< 11 U	< 11 U	< 11 U	< 5.7 U	< 23 U	< 23 U	< 5.7 U	< 5.7 U	< 5.7 U	< 5.7 U	< 5.7 U	0.94 F
	ST012-UWBZ09-170'-0313-SO-N		3/13/2013	170	CL	15.8	21	< 13 U	< 13 U	< 13 U	1.1	< 26 U	< 26 U	< 6.5 U	< 6.5 U	0.75 F	< 6.5 U	< 6.5 U	0.39 F
	DUP-18-0313-SO-N	Duplicate	3/13/2013	170			19	< 10 U	< 10 U	< 10 U	1.3 F	< 20 U	< 20 U	< 5.1 U	< 5.1 U	0.91 F	< 5.1 U	< 5.1 U	0.4 F
	ST012-UWBZ09-172.5-0313-SO-N		3/13/2013	172.5	CL	2.2	19	< 13 U	< 13 U	< 13 U	1.1 F	< 27 U	< 27 U	< 6.7 U	< 6.7 U	< 6.7 U	< 6.7 U	< 6.7 U	< 6.7 U
	DUP-19-0313-SO-N	Duplicate	3/13/2013	172.5			21	< 10 U	< 10 U	< 10 U	2.6 F	< 20 U	< 20 U	< 5.1 U	< 5.1 U	1.1 F	0.85 F	< 5.1 U	0.43 F
	ST012-UWBZ09-182.5-0313-SO-N		3/13/2013	182.5	CL	5.8	21	< 11 U	< 11 U	< 11 U	3.2 F	5.5 B	< 22 U	< 5.4 U	< 5.4 U	2.1 F	< 5.4 U	< 5.4 U	< 5.4 U
	ST012-UWBZ09-192.5-0313-SO-N		3/13/2013	192.5	CL	3.9	25	< 12 U	< 12 U	< 12 U	15	< 24 U	< 24 U	< 6.0 U	1.4 F	8.7	3.2 F	< 6.0 U	< 6.0 U

Notes:
µg/kg - micrograms per kilogram
DCA - dichloromethane, DBA - dibromoethane, MEK - methyl-ethyl-ketone or 2-butanone, CT - chlorotoluene, BME - bromo› chloride, BBZ - butylbenzene, PBZ - propylbenzene, t-1,3-DCP - trans-1,3-dichloropropene, TCE -trichloroethene
ft. - feet.
ID - Identification.
Lithology: SC - Clayey Sand, SM - Silty Sand, SP - Poorly Graded Sand, SW - Well Graded Sand
MDL - Method Detection Limit.
NL - No Limit established or not available for this constituent.
PID - photoionization detector
ppmv - parts per million by volume.
RL - Reporting Limit.

Data Qualifier Definitions:
B - Sample concentration is similar to that found in an associated blank.
F - The analyte was detected, estimated above the MDL and below the RL.
J - The result is estimated due to QC criteria.
M - The result is estimated due to a matrix effect.
U - The analyte was not detected above the RL shown.
< - Not detected at or above the RL.

ST012 Pre-Design Investigation
Summary of Groundwater Anlytical Results

Location ID	Sample ID	Sample Type	Sample Date	Sample Depth (ft.)	TPH (GRO) (C6-C10) Conc. (mg/L)	TPH (DRO) (C10-C28) Conc. (mg/L)	TPH (MO) (C20-C38) Conc. (mg/L)	1,1,1,2-Tetrachloroethane Conc. (µg/L)	1,1,1-Trichloroethane Conc. (µg/L)	1,1,2,2-Tetrachloroethane Conc. (µg/L)	1,1,2-Trichloroethane Conc. (µg/L)	1,1-Dichloroethane Conc. (µg/L)	1,1-Dichloroethene Conc. (µg/L)	1,1-Dichloropropene Conc. (µg/L)	1,2,3-Trichlorobenzene Conc. (µg/L)
ST012-DPE01	ST012-DPE01-WG-165-0413		4/18/2013	165	8.7	NA	NA	< 5.0 U	< 5.0 U	< 5.0 U	< 5.0 U	< 5.0 U	< 5.0 U	< 5.0 U	< 5.0 U
	ST012-DUP01-WG-0413	Duplicate	4/18/2013	165	9.7	NA	NA	< 2.5 U	< 2.5 UJ	< 2.5 U	< 2.5 U	< 2.5 U	< 2.5 UJ	< 2.5 U	< 2.5 U
	ST012-DPE01-WG-185-0413		4/18/2013	185	6	NA	NA	< 5.0 U	< 5.0 U	< 5.0 U	< 5.0 U	< 5.0 U	< 5.0 U	< 5.0 U	< 5.0 U
	ST012-DPE01-WG-205-0413		4/18/2013	205	6.3	NA	NA	< 5.0 U	< 5.0 U	< 5.0 U	< 5.0 U	< 5.0 U	< 5.0 U	< 5.0 U	< 5.0 U
	ST012-DPE01-WG-230-0413		4/18/2013	230	7.2	NA	NA	< 5.0 U	< 5.0 U	< 5.0 U	< 5.0 U	< 5.0 U	< 5.0 U	< 5.0 U	< 5.0 U
ST012-DPE02	ST012-DPE02-WG-165-0413		4/18/2013	165	0.27 J	NA	NA	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
	ST012-DPE02-WG-195-0413		4/18/2013	195	0.24 J	NA	NA	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
	ST012-DPE02-WG-215-0413		4/18/2013	215	0.23 J	NA	NA	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
ST012-LSZ08	ST012-LSZ08-WG-0313		3/27/2013	211	20	1.1	0.073 F	< 10 U	< 10 U	< 10 U	< 10 U	< 10 U	< 10 U	< 10 U	< 10 U
	ST012-DUP04-WG-0313	Duplicate	3/27/2013	211	20	1.0	0.072 F	< 10 U	< 10 U	< 10 U	< 10 U	< 10 U	< 10 U	< 10 U	< 10 U
ST012-LSZ09	ST012-LSZ09-WG-0313		3/29/2013	211	31	2.5	0.19 B	< 50 UJ	< 50 U	< 50 U	< 50 U	< 50 U	< 50 U	< 50 U	< 50 U
ST012-LSZ10	ST012-LSZ10-WG-0313		3/27/2013	211	49	2.7	0.19 F	< 50 UJ	< 50 U	< 50 U	< 50 U	< 50 U	< 50 U	< 50 U	< 50 U
ST012-LSZ11	ST012-LSZ11-WG-0313		3/27/2013		63	2.1	0.28 F	< 50 UJ	< 50 U	< 50 U	< 50 U	< 50 U	< 50 U	< 50 U	< 50 U
ST012-LSZ12	ST012-LSZ12-WG-0313		4/1/2013		37	2.0	0.24 B	< 20 UJ	< 20 U	< 20 U	< 20 U	< 20 U	< 20 U	< 20 U	< 20 U
ST012-LSZ13	ST012-LSZ13-WG-0313		3/27/2013		16	0.76	0.1 F	< 10 U	< 10 U	< 10 U	< 10 U	< 10 U	< 10 U	< 10 U	< 10 U
ST012-LSZ14	ST012-LSZ14-WG-0313		3/28/2013		25	2.5	0.36 F	< 10 UJ	< 10 U	< 10 U	< 10 U	< 10 U	< 10 U	< 10 U	< 10 U
ST012-LSZ15	ST012-LSZ15-WG-0313		3/29/2013		65	4.5	0.23 F	< 50 UJ	< 50 U	< 50 U	< 50 U	< 50 U	< 50 U	< 50 U	< 50 U
ST012-LSZ16	ST012-LSZ16-WG-0313		3/26/2013	211	2.2	3.9 J	0.36 F	< 2.0 U	< 2.0 U	< 2.0 U	< 2.0 U	< 2.0 U	< 2.0 U	< 2.0 U	< 2.0 U
	ST012-DUP02-WG-0313	Duplicate	3/26/2013	211	2.5	4.1 J	0.39 F	< 2.0 U	< 2.0 U	< 2.0 U	< 2.0 U	< 2.0 U	< 2.0 U	< 2.0 U	< 2.0 U
ST012-LSZ17	ST012-LSZ17-WG-0313		3/26/2013	211	25	0.99	0.18 F	< 20 U	< 20 U	< 20 U	< 20 U	< 20 U	< 20 U	< 20 U	< 20 U
	ST012-DUP03-WG-0313	Duplicate	3/26/2013	211	26	1.0 J	0.15 F	< 20 U	< 20 U	< 20 U	< 20 U	< 20 U	< 20 U	< 20 U	< 20 U
ST012-MWN03A	ST012-MWN03A-WG-0313		3/25/2013	177	6.9	15 J	0.6 J	< 4.0 U	< 4.0 U	< 4.0 U	< 4.0 U	< 4.0 U	< 4.0 U	< 4.0 U	< 4.0 U
ST012-MWN03C	ST012-MWN03C-WG-0313		4/3/2013	136	3.1	0.066 F	0.85	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
ST012-MWN05A	ST012-MWN05A-WG-0313		4/3/2013	176	12	16	0.84	< 20 U	< 20 U	< 20 U	< 20 U	< 20 U	< 20 U	< 20 U	< 20 U
ST012-MWN05C	ST012-MWN05C-WG-0313		3/26/2013	235	2.1	0.64 J	0.071 F	< 4.0 U	< 4.0 U	< 4.0 U	< 4.0 U	< 4.0 U	< 4.0 U	< 4.0 U	< 4.0 U
	ST012-DUP01-WG-0313	Duplicate	3/26/2013	235	2.2	0.63 J	0.059 F	< 4.0 U	< 4.0 U	< 4.0 U	< 4.0 U	< 4.0 U	< 4.0 U	< 4.0 U	< 4.0 U
ST012-N06	ST012-N06-WG-175-0413		4/18/2013	175	3.7	NA	NA	< 4.0 U	< 4.0 U	< 4.0 U	< 4.0 U	< 4.0 U	< 4.0 U	< 4.0 U	< 4.0 U
	ST012-DUP02-WG-0413	Duplicate	4/18/2013	175	3.6	NA	NA	< 10 U	< 10 U	< 10 U	< 10 U	< 10 U	< 10 U	< 10 U	< 10 U
	ST012-N06-WG-190-0413		4/18/2013	190	4.3	NA	NA	< 4.0 U	< 4.0 U	< 4.0 U	< 4.0 U	< 4.0 U	< 4.0 U	< 4.0 U	< 4.0 U
	ST012-N06-WG-205-0413		4/18/2013	205	4.4	NA	NA	< 4.0 U	< 4.0 U	< 4.0 U	< 4.0 U	< 4.0 U	< 4.0 U	< 4.0 U	< 4.0 U
	ST012-N06-WG-220-0413		4/18/2013	220	3.1	NA	NA	< 2.0 U	< 2.0 U	< 2.0 U	< 2.0 U	< 2.0 U	< 2.0 U	< 2.0 U	< 2.0 U
	ST012-N06-WG-230-0413		4/18/2013	230	3.2	NA	NA	< 2.0 U	< 2.0 U	< 2.0 U	< 2.0 U	< 2.0 U	< 2.0 U	< 2.0 U	< 2.0 U
ST012-N13	ST012-N13-WG-160-0413		4/18/2013	160	11	NA	NA	< 4.0 U	< 4.0 U	< 4.0 U	< 4.0 U	< 4.0 U	< 4.0 U	< 4.0 U	< 4.0 U
	ST012-N13-WG-190-0413		4/18/2013	190	7.5	NA	NA	< 2.0 U	< 2.0 UJ	< 2.0 U	< 2.0 U	< 2.0 U	< 2.0 UJ	< 2.0 U	< 2.0 U
	ST012-N13-WG-205-0413		4/18/2013	205	7.2	NA	NA	< 10 U	< 10 U	< 10 U	< 10 U	< 10 U	< 10 U	< 10 U	< 10 U
	ST012-N13-WG-230-0413		4/18/2013	230	6.7	NA	NA	< 10 U	< 10 U	< 10 U	< 10 U	< 10 U	< 10 U	< 10 U	< 10 U
ST012-UWBZ09	ST012-UWBZ09-WG-0313		3/28/2013	170	3.3	6.1	0.67	< 1.0 UJ	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
ST012-W03	ST012-W03-WG-0313		4/1/2013		38	1.3	0.057 F	< 100 UJ	< 100 U	< 100 U	< 100 U	< 100 U	< 100 U	< 100 U	< 100 U
ST012-W05	ST012-W05-WG-0313		3/25/2013	218	32	2.7 J	0.059 F	< 40 U	< 40 U	< 40 U	< 40 U	< 40 U	< 40 U	< 40 U	< 40 U
ST012-W08	ST012-W08-WG-0313		4/2/2013		18	0.61	< 0.49 U	< 50 U	< 50 U	< 50 U	< 50 U	< 50 U	< 50 U	< 50 U	< 50 U
ST012-W09	ST012-W09-WG-0313		4/2/2013		28	3.8	0.16 F	< 50 U	< 50 U	< 50 U	< 50 U	< 50 U	< 50 U	< 50 U	< 50 U
ST012-W11	ST012-W11-WG-210-0413		4/18/2013	210	8.9	NA	NA	< 2.0 U	< 2.0 U	< 2.0 U	< 2.0 U	< 2.0 U	< 2.0 U	< 2.0 U	< 2.0 U
	ST012-W11-WG-220-0413		4/18/2013	220	7.6	NA	NA	< 2.0 U	< 2.0 U	< 2.0 U	< 2.0 U	< 2.0 U	< 2.0 U	< 2.0 U	< 2.0 U
	ST012-W11-WG-230-0413		4/18/2013	230	11	NA	NA	< 2.0 U	< 2.0 U	< 2.0 U	< 2.0 U	< 2.0 U	< 2.0 U	< 2.0 U	< 2.0 U
	ST012-W11-WG-240-0413		4/18/2013	240	9.8	NA	NA	< 2.0 U	< 2.0 U	< 2.0 U	25	< 2.0 U	< 2.0 U	< 2.0 U	< 2.0 U
ST012-W13	ST012-W13-WG-210-0413		4/18/2013	210	13	NA	NA	< 10 U	< 10 U	< 10 U	< 10 U	< 10 U	< 10 U	< 10 U	< 10 U
	ST012-W13-WG-220-0413		4/18/2013	220	13	NA	NA	< 10 U	< 10 U	< 10 U	60	< 10 U	< 10 U	< 10 U	< 10 U
	ST012-W13-WG-230-0413		4/18/2013	230	14	NA	NA	< 10 U	< 10 U	< 10 U	< 10 U	< 10 U	< 10 U	< 10 U	< 10 U
	ST012-W13-WG-240-0413		4/18/2013	240	12	NA	NA	< 10 U	< 10 U	< 10 U	< 10 U	< 10 U	< 10 U	< 10 U	< 10 U
	ST012-DUP03-WG-0413	Duplicate	4/18/2013	240	12	NA	NA	< 10 U	< 10 U	< 10 U	< 10 U	< 10 U	< 10 U	< 10 U	< 10 U
ST012-W32	ST012-W32-WG-0313		4/2/2013		25	6.8	0.22 F	< 4.0 U	< 4.0 U	< 4.0 U	< 4.0 U	< 4.0 U	< 4.0 U	< 4.0 U	< 4.0 U

Notes:
µg/L - micrograms per liter
Conc. - Concentration
ft. - feet
ID - Identification
MDL - Method Detection Limit
mg/L - milligrams per liter
RL - Reporting Limit
TPH (DRO) (C10-C28) - total petroleum hydrocarbons as diesel range organics (hydrocarbons with 10 to 28 carbon atoms)
TPH (GRO) (C6 - C10) - total petroleum hydrocarbons as gasoline range organics (hydrocarbons with 6 to 10 carbon atoms)
TPH (MO) (C20 - C38) - total petroleum hydrocarbons as motor oil (hydrocargons with 20 to 38 carbon atoms)
Data Qualifier Definitions:
B - Sample concentration is similar to that found in an associated blank.
F - The analyte was detected, estimated above the MDL and below the RL.
J - The result is estimated due to QC criteria.
U - The analyte was not detected above the RL shown.
< - Not detected at or above the RL.

ST012 Pre-Design Investigation
Summary of Groundwater Anlytical Results

Location ID	Sample ID	Sample Type	Sample Date	Sample Depth (ft.)	1,2,3-Trichloropropane Conc. (µg/L)		1,2,4-Trichlorobenzene Conc. (µg/L)		1,2,4-Trimethylbenzene Conc. (µg/L)		1,2-Dibromo-3-Chloropropane Conc. (µg/L)		1,2-Dibromoethane Conc. (µg/L)		1,2-Dichlorobenzene Conc. (µg/L)		1,2-Dichloroethane Conc. (µg/L)		1,2-Dichloropropane Conc. (µg/L)		1,3,5-Trimethylbenzene Conc. (µg/L)		1,3-Dichlorobenzene Conc. (µg/L)	
ST012-DPE01	ST012-DPE01-WG-165-0413		4/18/2013	165	< 15	U	< 5.0	U	220		< 25	U	< 5.0	U	< 5.0	U	< 5.0	U	< 5.0	U	59	J	< 5.0	U
	ST012-DUP01-WG-0413	Duplicate	4/18/2013	165	< 7.5	U	< 2.5	U	280		< 13	U	< 2.5	U	< 2.5	U	< 2.5	U	< 2.5	U	81	J	< 2.5	U
	ST012-DPE01-WG-185-0413		4/18/2013	185	< 15	U	< 5.0	U	76		< 25	U	< 5.0	U	< 5.0	U	< 5.0	U	< 5.0	U	19		< 5.0	U
	ST012-DPE01-WG-205-0413		4/18/2013	205	< 15	U	< 5.0	U	140		< 25	U	< 5.0	U	< 5.0	U	< 5.0	U	< 5.0	U	36		< 5.0	U
	ST012-DPE01-WG-230-0413		4/18/2013	230	< 15	U	< 5.0	U	180		< 25	U	< 5.0	U	< 5.0	U	< 5.0	U	< 5.0	U	46		< 5.0	U
ST012-DPE02	ST012-DPE02-WG-165-0413		4/18/2013	165	< 3.0	U	< 1.0	U	0.7	F	< 5.0	U	< 1.0	U	< 1.0	U	< 1.0	U	< 1.0	U	6.4		< 1.0	U
	ST012-DPE02-WG-195-0413		4/18/2013	195	< 3.0	U	< 1.0	U	0.59	F	< 5.0	U	< 1.0	U	< 1.0	U	< 1.0	U	< 1.0	U	3.9		< 1.0	U
	ST012-DPE02-WG-215-0413		4/18/2013	215	< 3.0	U	< 1.0	U	0.56	F	< 5.0	U	< 1.0	U	< 1.0	U	< 1.0	U	< 1.0	U	3.5		< 1.0	U
ST012-LSZ08	ST012-LSZ08-WG-0313		3/27/2013	211	< 30	U	< 10	U	140		< 50	U	< 10	U	< 10	U	< 10	U	< 10	U	33		< 10	U
	ST012-DUP04-WG-0313	Duplicate	3/27/2013	211	< 30	U	< 10	U	140		< 50	U	< 10	U	< 10	U	< 10	U	< 10	U	40		< 10	U
ST012-LSZ09	ST012-LSZ09-WG-0313		3/29/2013	211	< 150	U	< 50	U	110		< 250	U	< 50	U	< 50	U	< 50	U	< 50	U	38	F	< 50	U
ST012-LSZ10	ST012-LSZ10-WG-0313		3/27/2013	211	< 150	U	< 50	U	190		< 250	U	< 50	U	< 50	U	< 50	U	< 50	U	60		< 50	U
ST012-LSZ11	ST012-LSZ11-WG-0313		3/27/2013		< 150	U	< 50	U	240		< 250	U	< 50	U	< 50	U	< 50	U	< 50	U	66		< 50	U
ST012-LSZ12	ST012-LSZ12-WG-0313		4/1/2013		< 60	U	< 20	U	210		< 100	U	< 20	U	< 20	U	< 20	U	< 20	U	60		< 20	U
ST012-LSZ13	ST012-LSZ13-WG-0313		3/27/2013		< 30	U	< 10	U	84		< 50	U	< 10	U	< 10	U	< 10	U	< 10	U	24		< 10	U
ST012-LSZ14	ST012-LSZ14-WG-0313		3/28/2013		< 30	U	< 10	U	130		< 50	U	5.3	F	< 10	U	< 10	U	< 10	U	35		< 10	U
ST012-LSZ15	ST012-LSZ15-WG-0313		3/29/2013		< 150	U	< 50	U	240		< 250	U	< 50	U	< 50	U	< 50	U	< 50	U	83		< 50	U
ST012-LSZ16	ST012-LSZ16-WG-0313		3/26/2013	211	< 6.0	U	< 2.0	U	4.0		< 10	U	< 2.0	U	< 2.0	U	< 2.0	U	< 2.0	U	1.5	F	< 2.0	U
	ST012-DUP02-WG-0313	Duplicate	3/26/2013	211	< 6.0	U	< 2.0	U	7.4		< 10	U	< 2.0	U	< 2.0	U	< 2.0	U	< 2.0	U	2.3		< 2.0	U
ST012-LSZ17	ST012-LSZ17-WG-0313		3/26/2013	211	< 60	U	< 20	U	48		< 100	U	< 20	U	< 20	U	< 20	U	< 20	U	14	F	< 20	U
	ST012-DUP03-WG-0313	Duplicate	3/26/2013	211	< 60	U	< 20	U	49		< 100	U	< 20	U	< 20	U	< 20	U	< 20	U	15	F	< 20	U
ST012-MWN03A	ST012-MWN03A-WG-0313		3/25/2013	177	< 12	U	< 4.0	U	130		< 20	U	< 4.0	U	< 4.0	U	< 4.0	U	< 4.0	U	36		< 4.0	U
ST012-MWN03C	ST012-MWN03C-WG-0313		4/3/2013	136	< 3.0	U	< 1.0	U	19		< 5.0	U	< 1.0	U	< 1.0	U	< 1.0	U	< 1.0	U	5.4		< 1.0	U
ST012-MWN05A	ST012-MWN05A-WG-0313		4/3/2013	176	< 60	U	< 20	U	100		< 100	U	< 20	U	< 20	U	< 20	U	< 20	U	13	F	< 20	U
ST012-MWN05C	ST012-MWN05C-WG-0313		3/26/2013	235	< 12	U	< 4.0	U	< 4.0	U	< 20	U	< 4.0	U	< 4.0	U	< 4.0	U	< 4.0	U	< 4.0	U	< 4.0	U
	ST012-DUP01-WG-0313	Duplicate	3/26/2013	235	< 12	U	< 4.0	U	< 4.0	U	< 20	U	< 4.0	U	< 4.0	U	< 4.0	U	< 4.0	U	< 4.0	U	< 4.0	U
ST012-N06	ST012-N06-WG-175-0413		4/18/2013	175	< 12	U	< 4.0	U	9.5	J	< 20	U	< 4.0	U	< 4.0	U	< 4.0	U	< 4.0	U	< 4.0	U	< 4.0	U
	ST012-DUP02-WG-0413	Duplicate	4/18/2013	175	< 30	U	< 10	U	58	J	< 50	U	< 10	U	< 10	U	< 10	U	< 10	U	< 10	U	< 10	U
	ST012-N06-WG-190-0413		4/18/2013	190	< 12	U	< 4.0	U	12		< 20	U	< 4.0	U	< 4.0	U	< 4.0	U	< 4.0	U	< 4.0	U	< 4.0	U
	ST012-N06-WG-205-0413		4/18/2013	205	< 12	U	< 4.0	U	9.2		< 20	U	< 4.0	U	< 4.0	U	< 4.0	U	< 4.0	U	< 4.0	U	< 4.0	U
	ST012-N06-WG-220-0413		4/18/2013	220	< 6.0	U	< 2.0	U	15		< 10	U	< 2.0	U	< 2.0	U	< 2.0	U	< 2.0	U	1.2	F	< 2.0	U
	ST012-N06-WG-230-0413		4/18/2013	230	< 6.0	U	< 2.0	U	14		< 10	U	< 2.0	U	< 2.0	U	< 2.0	U	< 2.0	U	1.2	F	< 2.0	U
ST012-N13	ST012-N13-WG-160-0413		4/18/2013	160	< 12	U	< 4.0	U	150		< 20	U	< 4.0	U	< 4.0	U	< 4.0	U	< 4.0	U	37		< 4.0	U
	ST012-N13-WG-190-0413		4/18/2013	190	< 6.0	U	< 2.0	U	63		< 10	U	< 2.0	U	< 2.0	U	< 2.0	U	< 2.0	U	13		< 2.0	U
	ST012-N13-WG-205-0413		4/18/2013	205	< 30	U	< 10	U	65		< 50	U	< 10	U	< 10	U	< 10	U	< 10	U	13		< 10	U
	ST012-N13-WG-230-0413		4/18/2013	230	< 30	U	< 10	U	52		< 50	U	< 10	U	< 10	U	< 10	U	< 10	U	10		< 10	U
ST012-UWBZ09	ST012-UWBZ09-WG-0313		3/28/2013	170	< 3.0	U	< 1.0	U	30		< 5.0	U	< 1.0	U	< 1.0	U	< 1.0	U	< 1.0	U	14		< 1.0	U
ST012-W03	ST012-W03-WG-0313		4/1/2013		< 300	U	< 100	U	28	F	< 500	U	< 100	U	< 100	U	< 100	U	< 100	U	< 100	U	< 100	U
ST012-W05	ST012-W05-WG-0313		3/25/2013	218	< 120	U	< 40	U	< 40	U	< 200	U	< 40	U	< 40	U	< 40	U	< 40	U	< 40	U	< 40	U
ST012-W08	ST012-W08-WG-0313		4/2/2013		< 150	U	< 50	U	< 50	U	< 250	U	< 50	U	< 50	U	< 50	U	< 50	U	< 50	U	< 50	U
ST012-W09	ST012-W09-WG-0313		4/2/2013		< 150	U	< 50	U	8.6	F	< 250	U	< 50	U	< 50	U	< 50	U	< 50	U	< 50	U	< 50	U
ST012-W11	ST012-W11-WG-210-0413		4/18/2013	210	< 6.0	U	< 2.0	U	310		< 10	U	< 2.0	U	< 2.0	U	< 2.0	U	< 2.0	U	83		< 2.0	U
	ST012-W11-WG-220-0413		4/18/2013	220	< 6.0	U	< 2.0	U	310		< 10	U	< 2.0	U	< 2.0	U	< 2.0	U	< 2.0	U	94		< 2.0	U
	ST012-W11-WG-230-0413		4/18/2013	230	< 6.0	U	< 2.0	U	300		< 10	U	< 2.0	U	< 2.0	U	< 2.0	U	< 2.0	U	97		< 2.0	U
	ST012-W11-WG-240-0413		4/18/2013	240	< 6.0	U	< 2.0	U	280		< 10	U	< 2.0	U	< 2.0	U	< 2.0	U	< 2.0	U	89		< 2.0	U
ST012-W13	ST012-W13-WG-210-0413		4/18/2013	210	< 30	U	< 10	U	210		< 50	U	< 10	U	< 10	U	<10	U	< 10	U	29		< 10	U
	ST012-W13-WG-220-0413		4/18/2013	220	< 30	U	< 10	U	230		< 50	U	< 10	U	< 10	U	<10	U	< 10	U	46		< 10	U
	ST012-W13-WG-230-0413		4/18/2013	230	< 30	U	< 10	U	220		< 50	U	< 10	U	< 10	U	< 10	U	< 10	U	44		< 10	U
	ST012-W13-WG-240-0413		4/18/2013	240	< 30	U	< 10	U	210		< 50	U	< 10	U	< 10	U	< 10	U	< 10	U	42		< 10	U
	ST012-DUP03-WG-0413	Duplicate	4/18/2013	240	< 30	U	< 10	U	230		< 50	U	< 10	U	< 10	U	< 10	U	< 10	U	45		< 10	U
ST012-W32	ST012-W32-WG-0313		4/2/2013		< 12	U	< 4.0	U	3.6	F	< 20	U	< 4.0	U	< 4.0	U	< 4.0	U	< 4.0	U	< 4.0	U	< 4.0	U

Notes:
µg/L - micrograms per liter
Conc. - Concentration
ft. - feet
ID - Identification
MDL - Method Detection Limit
mg/L - milligrams per liter
RL - Reporting Limit
TPH (DRO) (C10-C28) - total petroleum hydrocarbons as diesel range organics (hydrocarbons \
TPH (GRO) (C6 - C10) - total petroleum hydrocarbons as gasoline range organics (hydrocarbor
TPH (MO) (C20 - C38) - total petroleum hydrocarbons as motor oil (hydrocargons with 20 to 38
Data Qualifier Definitions:
B - Sample concentration is similar to that found in an associated blank.
F - The analyte was detected, estimated above the MDL and below the RL.
J - The result is estimated due to QC criteria.
U - The analyte was not detected above the RL shown.
< - Not detected at or above the RL.

ST012 Pre-Design Investigation
Summary of Groundwater Anlytical Results

					1,3-Dichloropropane		1,4-Dichlorobenzene		1-Chlorohexane		2,2-Dichloropropane		2-Butanone		2-Chlorotoluene		4-Chlorotoluene		4-Isopropyltoluene		Acetone		Benzene		Bromobenzene	
Location ID	Sample ID	Sample Type	Sample Date	Sample Depth (ft.)	Conc. (µg/L)		Conc. (µg/L)		Conc. (µg/L)		Conc. (µg/L)		Conc. (µg/L)		Conc. (µg/L)		Conc. (µg/L)		Conc. (µg/L)		Conc. (µg/L)		Conc. (µg/L)		Conc. (µg/L)	
ST012-DPE01	ST012-DPE01-WG-165-0413		4/18/2013	165	< 5.0	U	< 5.0	U	< 5.0	U	< 5.0	U	< 30	U	< 5.0	U	< 5.0	U	18	J	110	B	860		< 5.0	U
	ST012-DUP01-WG-0413	Duplicate	4/18/2013	165	< 2.5	U	< 2.5	U	< 2.5	U	< 2.5	UJ	< 15	U	< 2.5	U	< 2.5	U	25	J	< 25	UJ	720		< 2.5	U
	ST012-DPE01-WG-185-0413		4/18/2013	185	< 5.0	U	< 5.0	U	< 5.0	U	< 5.0	U	< 30	U	< 5.0	U	< 5.0	U	5.8		160	B	810		< 5.0	U
	ST012-DPE01-WG-205-0413		4/18/2013	205	< 5.0	U	< 5.0	U	< 5.0	U	< 5.0	U	< 30	U	< 5.0	U	< 5.0	U	9.7		83	B	880		< 5.0	U
	ST012-DPE01-WG-230-0413		4/18/2013	230	< 5.0	U	< 5.0	U	< 5.0	U	< 5.0	U	< 30	U	< 5.0	U	< 5.0	U	11		71	B	880		< 5.0	U
ST012-DPE02	ST012-DPE02-WG-165-0413		4/18/2013	165	< 1.0	U	< 1.0	U	< 1.0	U	< 1.0	U	< 6.0	U	< 1.0	U	< 1.0	U	0.75	F	15	B	1.6		< 1.0	U
	ST012-DPE02-WG-195-0413		4/18/2013	195	< 1.0	U	< 1.0	U	< 1.0	U	< 1.0	U	< 6.0	U	< 1.0	U	< 1.0	U	0.23	F	17	B	4.7		< 1.0	U
	ST012-DPE02-WG-215-0413		4/18/2013	215	< 1.0	U	< 1.0	U	< 1.0	U	< 1.0	U	< 6.0	U	< 1.0	U	< 1.0	U	< 1.0	U	12	B	4.6		< 1.0	U
ST012-LSZ08	ST012-LSZ08-WG-0313		3/27/2013	211	< 10	U	< 10	U	< 10	U	< 10	U	< 60	U	< 10	U	< 10	U	2.0	F	< 100	U	1200		< 10	U
	ST012-DUP04-WG-0313	Duplicate	3/27/2013	211	< 10	U	< 10	U	< 10	U	< 10	U	< 60	U	< 10	U	< 10	U	2.1	F	< 100	U	1200		< 10	U
ST012-LSZ09	ST012-LSZ09-WG-0313		3/29/2013	211	< 50	U	< 50	U	< 50	U	< 50	U	< 300	U	< 50	U	< 50	U	< 50	U	< 500	U	7100		< 50	U
ST012-LSZ10	ST012-LSZ10-WG-0313		3/27/2013	211	< 50	U	< 50	U	< 50	U	< 50	U	< 300	U	< 50	U	< 50	U	< 50	U	190	B	12000		< 50	U
ST012-LSZ11	ST012-LSZ11-WG-0313		3/27/2013		< 50	U	< 50	U	< 50	U	< 50	U	< 300	U	< 50	U	< 50	U	< 50	U	160	B	14000		< 50	U
ST012-LSZ12	ST012-LSZ12-WG-0313		4/1/2013		< 20	U	< 20	U	< 20	U	< 20	U	< 120	U	< 20	U	< 20	U	6.7	F	< 200	U	8100		< 20	U
ST012-LSZ13	ST012-LSZ13-WG-0313		3/27/2013		< 10	U	< 10	U	< 10	U	< 10	U	< 60	U	< 10	U	< 10	U	2.9	F	51	B	3000		< 10	U
ST012-LSZ14	ST012-LSZ14-WG-0313		3/28/2013		< 10	U	< 10	U	< 10	U	< 10	U	< 60	U	< 10	U	< 10	U	3.0	F	< 100	U	4300		< 10	U
ST012-LSZ15	ST012-LSZ15-WG-0313		3/29/2013		< 50	U	< 50	U	< 50	U	< 50	U	< 300	U	< 50	U	< 50	U	< 50	U	< 500	U	14000		< 50	U
ST012-LSZ16	ST012-LSZ16-WG-0313		3/26/2013	211	< 2.0	U	< 2.0	U	< 2.0	U	< 2.0	U	< 12	U	< 2.0	U	< 2.0	U	< 2.0	U	13	B	640		< 2.0	U
	ST012-DUP02-WG-0313	Duplicate	3/26/2013	211	< 2.0	U	< 2.0	U	< 2.0	U	< 2.0	U	< 12	U	< 2.0	U	< 2.0	U	< 2.0	U	< 20	U	660		< 2.0	U
ST012-LSZ17	ST012-LSZ17-WG-0313		3/26/2013	211	< 20	U	< 20	U	< 20	U	< 20	U	< 120	U	< 20	U	< 20	U	< 20	U	< 200	U	3600		< 20	U
	ST012-DUP03-WG-0313	Duplicate	3/26/2013	211	< 20	U	< 20	U	< 20	U	< 20	U	< 120	U	< 20	U	< 20	U	< 20	U	< 200	U	3800		< 20	U
ST012-MWN03A	ST012-MWN03A-WG-0313		3/25/2013	177	< 4.0	U	< 4.0	U	< 4.0	U	< 4.0	U	< 24	U	< 4.0	U	< 4.0	U	7.8		< 40	U	490		< 4.0	U
ST012-MWN03C	ST012-MWN03C-WG-0313		4/3/2013	136	< 1.0	U	< 1.0	U	< 1.0	U	< 1.0	U	< 6.0	U	< 1.0	U	< 1.0	U	0.49	F	< 10	U	120		< 1.0	U
ST012-MWN05A	ST012-MWN05A-WG-0313		4/3/2013	176	< 20	U	< 20	U	< 20	U	< 20	U	< 120	U	< 20	U	< 20	U	< 20	U	< 200	U	2800		< 20	U
ST012-MWN05C	ST012-MWN05C-WG-0313		3/26/2013	235	< 4.0	U	< 4.0	U	< 4.0	U	< 4.0	U	< 24	U	< 4.0	U	< 4.0	U	< 4.0	U	< 40	U	830		< 4.0	U
	ST012-DUP01-WG-0313	Duplicate	3/26/2013	235	< 4.0	U	< 4.0	U	< 4.0	U	< 4.0	U	< 24	U	< 4.0	U	< 4.0	U	< 4.0	U	< 40	U	860		< 4.0	U
ST012-N06	ST012-N06-WG-175-0413		4/18/2013	175	< 4.0	U	< 4.0	U	< 4.0	U	< 4.0	U	< 24	U	< 4.0	U	< 4.0	U	6.7	J	89	B	510	J	< 4.0	U
	ST012-DUP02-WG-0413	Duplicate	4/18/2013	175	< 10	U	< 10	U	< 10	U	< 10	U	< 60	U	< 10	U	< 10	U	46	J	110	B	2600	J	< 10	U
	ST012-N06-WG-190-0413		4/18/2013	190	< 4.0	U	< 4.0	U	< 4.0	U	< 4.0	U	< 24	U	< 4.0	U	< 4.0	U	8.8		74	B	630		< 4.0	U
	ST012-N06-WG-205-0413		4/18/2013	205	< 4.0	U	< 4.0	U	< 4.0	U	< 4.0	U	< 24	U	< 4.0	U	< 4.0	U	6.2		77	B	620		< 4.0	U
	ST012-N06-WG-220-0413		4/18/2013	220	< 2.0	U	< 2.0	U	< 2.0	U	< 2.0	U	< 12	U	< 2.0	U	< 2.0	U	7.9		43	B	600		< 2.0	U
	ST012-N06-WG-230-0413		4/18/2013	230	< 2.0	U	< 2.0	U	< 2.0	U	< 2.0	U	< 12	U	< 2.0	U	< 2.0	U	7.3		32	B	600		< 2.0	U
ST012-N13	ST012-N13-WG-160-0413		4/18/2013	160	< 4.0	U	< 4.0	U	< 4.0	U	< 4.0	U	< 24	U	< 4.0	U	< 4.0	U	14		11	B	1300		< 4.0	U
	ST012-N13-WG-190-0413		4/18/2013	190	< 2.0	U	< 2.0	U	< 2.0	U	< 2.0	UJ	< 12	U	< 2.0	U	< 2.0	U	3.7		13	B	1300		< 2.0	U
	ST012-N13-WG-205-0413		4/18/2013	205	< 10	U	< 10	U	< 10	U	< 10	U	< 60	U	< 10	U	< 10	U	3.7	F	< 100	U	1500		< 10	U
	ST012-N13-WG-230-0413		4/18/2013	230	< 10	U	< 10	U	< 10	U	< 10	U	< 60	U	< 10	U	< 10	U	2.7	F	< 100	U	1400		< 10	U
ST012-UWBZ09	ST012-UWBZ09-WG-0313		3/28/2013	170	< 1.0	U	< 1.0	U	< 1.0	U	< 1.0	U	< 6.0	U	< 1.0	U	< 1.0	U	1.6		< 10	U	200		< 1.0	U
ST012-W03	ST012-W03-WG-0313		4/1/2013		< 100	U	< 100	U	< 100	U	< 100	U	< 600	U	< 100	U	< 100	U	< 100	U	< 1000	U	16000		< 100	U
ST012-W05	ST012-W05-WG-0313		3/25/2013	218	< 40	U	< 40	U	< 40	U	< 40	U	< 240	U	< 40	U	< 40	U	< 40	U	< 400	U	12000		< 40	U
ST012-W08	ST012-W08-WG-0313		4/2/2013		< 50	U	< 50	U	< 50	U	< 50	U	< 300	U	< 50	U	< 50	U	< 50	U	< 500	U	6500		< 50	U
ST012-W09	ST012-W09-WG-0313		4/2/2013		< 50	U	< 50	U	< 50	U	< 50	U	< 300	U	< 50	U	< 50	U	< 50	U	< 500	U	11000		< 50	U
ST012-W11	ST012-W11-WG-210-0413		4/18/2013	210	< 2.0	U	< 2.0	U	< 2.0	U	< 2.0	U	< 12	U	< 2.0	U	< 2.0	U	15		< 20	U	84		< 2.0	U
	ST012-W11-WG-220-0413		4/18/2013	220	< 2.0	U	< 2.0	U	< 2.0	U	< 2.0	U	< 12	U	< 2.0	U	< 2.0	U	13		20	B	86		< 2.0	U
	ST012-W11-WG-230-0413		4/18/2013	230	< 2.0	U	< 2.0	U	< 2.0	U	< 2.0	U	< 12	U	< 2.0	U	< 2.0	U	12		13	B	82		< 2.0	U
	ST012-W11-WG-240-0413		4/18/2013	240	< 2.0	U	< 2.0	U	< 2.0	U	< 2.0	U	< 12	U	< 2.0	U	< 2.0	U	13		8.6	B	24		< 2.0	U
ST012-W13	ST012-W13-WG-210-0413		4/18/2013	210	< 10	U	< 10	U	< 10	U	< 10	U	< 60	U	< 10	U	< 10	U	11		< 100	U	2300		< 10	U
	ST012-W13-WG-220-0413		4/18/2013	220	< 10	U	< 10	U	< 10	U	< 10	U	38	B	< 10	U	< 10	U	11		< 100	U	3100		< 10	U
	ST012-W13-WG-230-0413		4/18/2013	230	< 10	U	< 10	U	< 10	U	< 10	U	< 60	U	< 10	U	< 10	U	9.6	F	< 100	U	3100		< 10	U
	ST012-W13-WG-240-0413		4/18/2013	240	< 10	U	< 10	U	< 10	U	< 10	U	< 60	U	< 10	U	< 10	U	9.3	F	20	B	2900		< 10	U
	ST012-DUP03-WG-0413	Duplicate	4/18/2013	240	< 10	U	< 10	U	< 10	U	< 10	U	< 60	U	< 10	U	< 10	U	11		< 100	U	2600		< 10	U
ST012-W32	ST012-W32-WG-0313		4/2/2013		< 4.0	U	< 4.0	U	< 4.0	U	< 4.0	U	< 24	U	< 4.0	U	< 4.0	U	< 4.0	U	< 40	U	9400		< 4.0	U

Notes:
µg/L - micrograms per liter
Conc. - Concentration
ft. - feet
ID - Identification
MDL - Method Detection Limit
mg/L - milligrams per liter
RL - Reporting Limit
TPH (DRO) (C10-C28) - total petroleum hydrocarbons as diesel range organics (hydrocarbons \
TPH (GRO) (C6 - C10) - total petroleum hydrocarbons as gasoline range organics (hydrocarbor
TPH (MO) (C20 - C38) - total petroleum hydrocarbons as motor oil (hydrocargons with 20 to 38

Data Qualifier Definitions:
B - Sample concentration is similar to that found in an associated blank.
F - The analyte was detected, estimated above the MDL and below the RL.
J - The result is estimated due to QC criteria.
U - The analyte was not detected above the RL shown.
< - Not detected at or above the RL.

ST012 Pre-Design Investigation
Summary of Groundwater Anlytical Results

Location ID	Sample ID	Sample Type	Sample Date	Sample Depth (ft.)	Bromodichloromethane Conc. (µg/L)	Bromoform Conc. (µg/L)	Bromomethane Conc. (µg/L)	Carbon tetrachloride Conc. (µg/L)	Chlorobenzene Conc. (µg/L)	Chlorobromomethane Conc. (µg/L)	Chlorodibromomethane Conc. (µg/L)	Chloroethane Conc. (µg/L)	Chloroform Conc. (µg/L)	Chloromethane Conc. (µg/L)	cis-1,2-Dichloroethene Conc. (µg/L)
ST012-DPE01	ST012-DPE01-WG-165-0413		4/18/2013	165	< 5.0 U	< 5.0 U	< 10 U	< 10 U	< 5.0 U	< 5.0 U	< 5.0 U	< 10 U	< 5.0 U	< 10 U	< 5.0 U
	ST012-DUP01-WG-0413	Duplicate	4/18/2013	165	< 2.5 U	< 2.5 U	< 5.0 U	< 5.0 U	< 2.5 U	< 2.5 UJ	< 2.5 U	< 5.0 UJ	< 2.5 UJ	< 5.0 UJ	< 2.5 UJ
	ST012-DPE01-WG-185-0413		4/18/2013	185	< 5.0 U	< 5.0 U	< 10 U	< 10 U	< 5.0 U	< 5.0 U	< 5.0 U	< 10 U	< 5.0 U	< 10 U	< 5.0 U
	ST012-DPE01-WG-205-0413		4/18/2013	205	< 5.0 U	< 5.0 U	< 10 U	< 10 U	< 5.0 U	< 5.0 U	< 5.0 U	< 10 U	< 5.0 U	< 10 U	< 5.0 U
	ST012-DPE01-WG-230-0413		4/18/2013	230	< 5.0 U	< 5.0 U	< 10 U	< 10 U	< 5.0 U	< 5.0 U	< 5.0 U	< 10 U	< 5.0 U	< 10 U	< 5.0 U
ST012-DPE02	ST012-DPE02-WG-165-0413		4/18/2013	165	< 1.0 U	< 1.0 U	< 2.0 U	< 2.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 2.0 U	< 1.0 U	< 2.0 U	< 1.0 U
	ST012-DPE02-WG-195-0413		4/18/2013	195	< 1.0 U	< 1.0 U	< 2.0 U	< 2.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 2.0 U	< 1.0 U	< 2.0 U	< 1.0 U
	ST012-DPE02-WG-215-0413		4/18/2013	215	< 1.0 U	< 1.0 U	< 2.0 U	< 2.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 2.0 U	< 1.0 U	< 2.0 U	< 1.0 U
ST012-LSZ08	ST012-LSZ08-WG-0313		3/27/2013	211	< 10 U	< 10 U	< 20 U	< 20 U	< 10 U	< 10 U	< 10 U	< 20 U	< 10 U	< 20 U	< 10 U
	ST012-DUP04-WG-0313	Duplicate	3/27/2013	211	< 10 U	< 10 U	< 20 U	< 20 U	< 10 U	< 10 U	< 10 U	< 20 U	< 10 U	< 20 U	< 10 U
ST012-LSZ09	ST012-LSZ09-WG-0313		3/29/2013	211	< 50 U	< 50 U	< 100 U	< 100 U	< 50 U	< 50 U	< 50 U	< 100 U	< 50 U	< 100 U	< 50 U
ST012-LSZ10	ST012-LSZ10-WG-0313		3/27/2013	211	< 50 U	< 50 U	< 100 U	< 100 U	< 50 U	< 50 U	< 50 U	< 100 U	< 50 U	< 100 U	< 50 U
ST012-LSZ11	ST012-LSZ11-WG-0313		3/27/2013		< 50 U	< 50 U	< 100 U	< 100 U	< 50 U	< 50 U	< 50 U	< 100 U	< 50 U	< 100 U	< 50 U
ST012-LSZ12	ST012-LSZ12-WG-0313		4/1/2013		< 20 U	< 20 U	< 40 U	< 40 U	< 20 U	< 20 U	< 20 U	< 40 U	< 20 U	< 40 U	< 20 U
ST012-LSZ13	ST012-LSZ13-WG-0313		3/27/2013		< 10 U	< 10 U	< 20 U	< 20 U	< 10 U	< 10 U	< 10 U	< 20 U	< 10 U	< 20 U	< 10 U
ST012-LSZ14	ST012-LSZ14-WG-0313		3/28/2013		< 10 U	< 10 U	< 20 U	< 20 U	< 10 U	< 10 U	< 10 U	< 20 U	< 10 U	< 20 U	< 10 U
ST012-LSZ15	ST012-LSZ15-WG-0313		3/29/2013		< 50 U	< 50 U	< 100 U	< 100 U	< 50 U	< 50 U	< 50 U	< 100 U	< 50 U	< 100 U	< 50 U
ST012-LSZ16	ST012-LSZ16-WG-0313		3/26/2013	211	< 2.0 U	< 2.0 U	< 4.0 U	< 4.0 U	< 2.0 U	< 2.0 U	< 2.0 U	< 4.0 U	< 2.0 U	< 4.0 U	< 2.0 U
	ST012-DUP02-WG-0313	Duplicate	3/26/2013	211	< 2.0 U	< 2.0 U	< 4.0 U	< 4.0 U	< 2.0 U	< 2.0 U	< 2.0 U	< 4.0 U	< 2.0 U	< 4.0 U	< 2.0 U
ST012-LSZ17	ST012-LSZ17-WG-0313		3/26/2013	211	< 20 U	< 20 U	< 40 U	< 40 U	< 20 U	< 20 U	< 20 U	< 40 U	< 20 U	< 40 U	< 20 U
	ST012-DUP03-WG-0313	Duplicate	3/26/2013	211	< 20 U	< 20 U	< 40 U	< 40 U	< 20 U	< 20 U	< 20 U	< 40 U	< 20 U	< 40 U	< 20 U
ST012-MWN03A	ST012-MWN03A-WG-0313		3/25/2013	177	< 4.0 U	< 4.0 U	< 8.0 U	< 8.0 U	< 4.0 U	< 4.0 U	< 4.0 U	< 8.0 U	< 4.0 U	< 8.0 U	< 4.0 U
ST012-MWN03C	ST012-MWN03C-WG-0313		4/3/2013	136	< 1.0 U	< 1.0 U	< 2.0 U	< 2.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 2.0 U	< 1.0 U	< 2.0 U	< 1.0 U
ST012-MWN05A	ST012-MWN05A-WG-0313		4/3/2013	176	< 20 U	< 20 U	< 40 U	< 40 U	< 20 U	< 20 U	< 20 U	< 40 U	< 20 U	< 40 U	< 20 U
ST012-MWN05C	ST012-MWN05C-WG-0313		3/26/2013	235	< 4.0 U	< 4.0 U	< 8.0 U	< 8.0 U	< 4.0 U	< 4.0 U	< 4.0 U	< 8.0 U	< 4.0 U	< 8.0 U	< 4.0 U
	ST012-DUP01-WG-0313	Duplicate	3/26/2013	235	< 4.0 U	< 4.0 U	< 8.0 U	< 8.0 U	< 4.0 U	< 4.0 U	< 4.0 U	< 8.0 U	< 4.0 U	< 8.0 U	< 4.0 U
ST012-N06	ST012-N06-WG-175-0413		4/18/2013	175	< 4.0 U	< 4.0 U	< 8.0 U	< 8.0 U	< 4.0 U	< 4.0 U	< 4.0 U	< 8.0 U	< 4.0 U	< 8.0 U	< 4.0 U
	ST012-DUP02-WG-0413	Duplicate	4/18/2013	175	< 10 U	< 10 U	< 20 U	< 20 U	< 10 U	< 10 U	< 10 U	< 20 U	< 10 U	< 20 U	< 10 U
	ST012-N06-WG-190-0413		4/18/2013	190	< 4.0 U	< 4.0 U	< 8.0 U	< 8.0 U	< 4.0 U	< 4.0 U	< 4.0 U	< 8.0 U	< 4.0 U	< 8.0 U	< 4.0 U
	ST012-N06-WG-205-0413		4/18/2013	205	< 4.0 U	< 4.0 U	< 8.0 U	< 8.0 U	< 4.0 U	< 4.0 U	< 4.0 U	< 8.0 U	< 4.0 U	< 8.0 U	< 4.0 U
	ST012-N06-WG-220-0413		4/18/2013	220	< 2.0 U	< 2.0 U	< 4.0 U	< 4.0 U	< 2.0 U	< 2.0 U	< 2.0 U	< 4.0 U	< 2.0 U	< 4.0 U	< 2.0 U
	ST012-N06-WG-230-0413		4/18/2013	230	< 2.0 U	< 2.0 U	< 4.0 U	< 4.0 U	< 2.0 U	< 2.0 U	< 2.0 U	< 4.0 U	< 2.0 U	< 4.0 U	< 2.0 U
ST012-N13	ST012-N13-WG-160-0413		4/18/2013	160	2.8 F	< 4.0 U	< 8.0 U	< 8.0 U	< 4.0 U	< 4.0 U	< 4.0 U	< 8.0 U	< 4.0 U	< 8.0 U	< 4.0 U
	ST012-N13-WG-190-0413		4/18/2013	190	< 2.0 U	< 2.0 U	< 4.0 U	< 4.0 U	< 2.0 U	< 2.0 UJ	< 2.0 U	< 4.0 UJ	< 2.0 UJ	< 4.0 UJ	< 2.0 UJ
	ST012-N13-WG-205-0413		4/18/2013	205	< 10 U	< 10 U	< 20 U	< 20 U	< 10 U	< 10 U	< 10 U	< 20 U	< 10 U	< 20 U	< 10 U
	ST012-N13-WG-230-0413		4/18/2013	230	< 10 U	< 10 U	< 20 U	< 20 U	< 10 U	< 10 U	< 10 U	< 20 U	< 10 U	< 20 U	< 10 U
ST012-UWBZ09	ST012-UWBZ09-WG-0313		3/28/2013	170	< 1.0 U	< 1.0 U	< 2.0 U	< 2.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 2.0 U	0.78 F	< 2.0 U	< 1.0 U
ST012-W03	ST012-W03-WG-0313		4/1/2013		< 100 U	< 100 U	< 200 U	< 200 U	< 100 U	< 100 U	< 100 U	< 200 U	< 100 U	< 200 U	< 100 U
ST012-W05	ST012-W05-WG-0313		3/25/2013	218	< 40 U	< 40 U	< 80 U	< 80 U	< 40 U	< 40 U	< 40 U	< 80 U	< 40 U	< 80 U	< 40 U
ST012-W08	ST012-W08-WG-0313		4/2/2013		< 50 U	< 50 U	< 100 U	< 100 U	< 50 U	< 50 U	< 50 U	< 100 U	< 50 U	< 100 U	< 50 U
ST012-W09	ST012-W09-WG-0313		4/2/2013		< 50 U	< 50 U	< 100 U	< 100 U	< 50 U	< 50 U	< 50 U	< 100 U	< 50 U	< 100 U	< 50 U
ST012-W11	ST012-W11-WG-210-0413		4/18/2013	210	< 2.0 U	< 2.0 U	< 4.0 U	< 4.0 U	< 2.0 U	< 2.0 U	< 2.0 U	< 4.0 U	< 2.0 U	0.62 F	< 2.0 U
	ST012-W11-WG-220-0413		4/18/2013	220	< 2.0 U	< 2.0 U	< 4.0 U	< 4.0 U	< 2.0 U	< 2.0 U	< 2.0 U	< 4.0 U	< 2.0 U	< 4.0 U	< 2.0 U
	ST012-W11-WG-230-0413		4/18/2013	230	< 2.0 U	< 2.0 U	< 4.0 U	< 4.0 U	< 2.0 U	< 2.0 U	< 2.0 U	< 4.0 U	< 2.0 U	< 4.0 U	< 2.0 U
	ST012-W11-WG-240-0413		4/18/2013	240	< 2.0 U	< 2.0 U	< 4.0 U	< 4.0 U	< 2.0 U	< 2.0 U	< 2.0 U	< 4.0 U	< 2.0 U	< 4.0 U	< 2.0 U
ST012-W13	ST012-W13-WG-210-0413		4/18/2013	210	< 10 U	< 10 U	< 20 U	< 20 U	< 10 U	< 10 U	< 10 U	< 20 U	< 10 U	< 20 U	< 10 U
	ST012-W13-WG-220-0413		4/18/2013	220	< 10 U	< 10 U	< 20 U	< 20 U	< 10 U	< 10 U	< 10 U	< 20 U	< 10 U	< 20 U	< 10 U
	ST012-W13-WG-230-0413		4/18/2013	230	< 10 U	< 10 U	< 20 U	< 20 U	< 10 U	< 10 U	< 10 U	< 20 U	< 10 U	< 20 U	< 10 U
	ST012-W13-WG-240-0413		4/18/2013	240	< 10 U	< 10 U	< 20 U	< 20 U	< 10 U	< 10 U	< 10 U	< 20 U	< 10 U	< 20 U	< 10 U
	ST012-DUP03-WG-0413	Duplicate	4/18/2013	240	< 10 U	< 10 U	< 20 U	< 20 U	< 10 U	< 10 U	< 10 U	< 20 U	< 10 U	< 20 U	< 10 U
ST012-W32	ST012-W32-WG-0313		4/2/2013		< 4.0 U	< 4.0 U	< 8.0 U	< 8.0 U	< 4.0 U	< 4.0 U	< 4.0 U	< 8.0 U	< 4.0 U	< 8.0 U	< 4.0 U

Notes:
µg/L - micrograms per liter
Conc. - Concentration
ft. - feet
ID - Identification
MDL - Method Detection Limit
mg/L - milligrams per liter
RL - Reporting Limit
TPH (DRO) (C10-C28) - total petroleum hydrocarbons as diesel range organics (hydrocarbons \
TPH (GRO) (C6 - C10) - total petroleum hydrocarbons as gasoline range organics (hydrocarbor
TPH (MO) (C20 - C38) - total petroleum hydrocarbons as motor oil (hydrocargons with 20 to 38

Data Qualifier Definitions:
B - Sample concentration is similar to that found in an associated blank.
F - The analyte was detected, estimated above the MDL and below the RL.
J - The result is estimated due to QC criteria.
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ST012 Pre-Design Investigation
Summary of Groundwater Anlytical Results

					cis-1,3-Dichloropropene		Dibromomethane		Dichlorodifluoromethane		Ethylbenzene	Hexachlorobutadiene		Isopropylbenzene		Methyl isobutyl ketone		MTBE		Methylene chloride		Naphthalene	
Location ID	**Sample ID**	**Sample Type**	**Sample Date**	**Sample Depth (ft.)**	**Conc. (µg/L)**		**Conc. (µg/L)**		**Conc. (µg/L)**		**Conc. (µg/L)**	**Conc. (µg/L)**		**Conc. (µg/L)**		**Conc. (µg/L)**		**Conc. (µg/L)**		**Conc. (µg/L)**		**Conc. (µg/L)**	
ST012-DPE01	ST012-DPE01-WG-165-0413		4/18/2013	165	< 5.0	U	< 5.0	U	< 10	U	480	< 5.0	U	80	J	< 25	U	< 25	U	2.4	B	160	
	ST012-DUP01-WG-0413	Duplicate	4/18/2013	165	< 2.5	U	< 2.5	U	< 5.0	UJ	520	< 2.5	U	110	J	< 13	U	< 13	U	< 13	UJ	190	
	ST012-DPE01-WG-185-0413		4/18/2013	185	< 5.0	U	< 5.0	U	< 10	U	340	< 5.0	U	50		< 25	U	< 25	U	3.4	B	160	
	ST012-DPE01-WG-205-0413		4/18/2013	205	< 5.0	U	< 5.0	U	< 10	U	420	< 5.0	U	68		< 25	U	< 25	U	3.1	B	170	
	ST012-DPE01-WG-230-0413		4/18/2013	230	< 5.0	U	< 5.0	U	< 10	U	450	< 5.0	U	74		< 25	U	< 25	U	3.0	B	150	
ST012-DPE02	ST012-DPE02-WG-165-0413		4/18/2013	165	< 1.0	U	< 1.0	U	< 2.0	U	1.8	< 1.0	U	0.68	F	< 5.0	U	< 5.0	U	< 5.0	U	6.0	
	ST012-DPE02-WG-195-0413		4/18/2013	195	< 1.0	U	< 1.0	U	< 2.0	U	3.4	< 1.0	U	0.97	F	< 5.0	U	< 5.0	U	< 5.0	U	5.5	
	ST012-DPE02-WG-215-0413		4/18/2013	215	< 1.0	U	< 1.0	U	< 2.0	U	3.0	< 1.0	U	0.89	F	< 5.0	U	< 5.0	U	< 5.0	U	5.0	
ST012-LSZ08	ST012-LSZ08-WG-0313		3/27/2013	211	< 10	U	< 10	U	< 20	U	580	< 10	U	34		< 50	U	< 50	U	< 50	U	68	
	ST012-DUP04-WG-0313	Duplicate	3/27/2013	211	< 10	U	< 10	U	< 20	U	590	< 10	U	35		< 50	U	< 50	U	< 50	U	69	
ST012-LSZ09	ST012-LSZ09-WG-0313		3/29/2013	211	< 50	U	< 50	U	< 100	U	480	< 50	U	25	F	< 250	U	< 250	U	31	B	54	
ST012-LSZ10	ST012-LSZ10-WG-0313		3/27/2013	211	< 50	U	< 50	U	< 100	U	900	< 50	U	45	F	< 250	U	< 250	U	29	B	75	
ST012-LSZ11	ST012-LSZ11-WG-0313		3/27/2013		< 50	U	< 50	U	< 100	U	1300	< 50	U	62		< 250	U	< 250	U	30	B	85	
ST012-LSZ12	ST012-LSZ12-WG-0313		4/1/2013		< 20	U	< 20	U	< 40	U	1100	< 20	U	56		36	F	< 100	U	10	B	84	
ST012-LSZ13	ST012-LSZ13-WG-0313		3/27/2013		< 10	U	< 10	U	< 20	U	390	< 10	U	22		< 50	U	< 50	U	< 50	U	30	
ST012-LSZ14	ST012-LSZ14-WG-0313		3/28/2013		< 10	U	< 10	U	< 20	U	640	< 10	U	39		< 50	U	< 50	U	6.1	B	38	
ST012-LSZ15	ST012-LSZ15-WG-0313		3/29/2013		< 50	U	< 50	U	< 100	U	1100	< 50	U	53		< 250	U	< 250	U	32	B	100	
ST012-LSZ16	ST012-LSZ16-WG-0313		3/26/2013	211	< 2.0	U	< 2.0	U	< 4.0	U	23	< 2.0	U	4.3		< 10	U	< 10	U	< 10	U	10	
	ST012-DUP02-WG-0313	Duplicate	3/26/2013	211	< 2.0	U	< 2.0	U	< 4.0	U	27	< 2.0	U	5.3		< 10	U	< 10	U	< 10	U	11	
ST012-LSZ17	ST012-LSZ17-WG-0313		3/26/2013	211	< 20	U	< 20	U	< 40	U	410	< 20	U	17	F	< 100	U	< 100	U	< 100	U	24	
	ST012-DUP03-WG-0313	Duplicate	3/26/2013	211	< 20	U	< 20	U	< 40	U	440	< 20	U	17	F	< 100	U	< 100	U	< 100	U	26	
ST012-MWN03A	ST012-MWN03A-WG-0313		3/25/2013	177	< 4.0	U	< 4.0	U	< 8.0	U	250	< 4.0	U	30		< 20	U	< 20	U	< 20	U	30	
ST012-MWN03C	ST012-MWN03C-WG-0313		4/3/2013	136	< 1.0	U	< 1.0	U	< 2.0	U	130	< 1.0	U	9.2		< 5.0	U	< 5.0	U	< 5.0	U	13	
ST012-MWN05A	ST012-MWN05A-WG-0313		4/3/2013	176	< 20	U	< 20	U	< 40	U	490	< 20	U	33		< 100	U	< 100	U	< 100	U	130	
ST012-MWN05C	ST012-MWN05C-WG-0313		3/26/2013	235	< 4.0	U	< 4.0	U	< 8.0	U	11	< 4.0	U	1.9	F	< 20	U	< 20	U	< 20	U	< 4.0	U
	ST012-DUP01-WG-0313	Duplicate	3/26/2013	235	< 4.0	U	< 4.0	U	< 8.0	U	10	< 4.0	U	1.8	F	< 20	U	< 20	U	< 20	U	< 4.0	U
ST012-N06	ST012-N06-WG-175-0413		4/18/2013	175	< 4.0	U	< 4.0	U	< 8.0	U	300	J	< 4.0	U	50	J	< 20	U	< 20	U	2.5	B	100	J
	ST012-DUP02-WG-0413	Duplicate	4/18/2013	175	< 10	U	< 10	U	< 20	U	1800	J	< 10	U	280	J	< 50	U	< 50	U	< 50	U	600	J
	ST012-N06-WG-190-0413		4/18/2013	190	< 4.0	U	< 4.0	U	< 8.0	U	360		< 4.0	U	55		< 20	U	< 20	U	2.4	B	110	
	ST012-N06-WG-205-0413		4/18/2013	205	< 4.0	U	< 4.0	U	< 8.0	U	360		< 4.0	U	54		< 20	U	< 20	U	2.5	B	110	
	ST012-N06-WG-220-0413		4/18/2013	220	< 2.0	U	< 2.0	U	< 4.0	U	330		< 2.0	U	39		< 10	U	< 10	U	0.68	B	96	
	ST012-N06-WG-230-0413		4/18/2013	230	< 2.0	U	< 2.0	U	< 4.0	U	320		< 2.0	U	34		< 10	U	< 10	U	< 10	U	91	
ST012-N13	ST012-N13-WG-160-0413		4/18/2013	160	< 4.0	U	< 4.0	U	< 8.0	U	210		< 4.0	U	34		25	B	< 20	U	< 20	U	92	
	ST012-N13-WG-190-0413		4/18/2013	190	< 2.0	U	< 2.0	U	< 4.0	UJ	230		< 2.0	U	62		17	B	< 10	U	< 10	UJ	180	
	ST012-N13-WG-205-0413		4/18/2013	205	< 10	U	< 10	U	< 20	U	320		< 10	U	67		16	B	< 50	U	< 50	U	190	
	ST012-N13-WG-230-0413		4/18/2013	230	< 10	U	< 10	U	< 20	U	290		< 10	U	53		18	B	< 50	U	< 50	U	180	
ST012-UWBZ09	ST012-UWBZ09-WG-0313		3/28/2013	170	< 1.0	U	< 1.0	U	< 2.0	U	140		< 1.0	U	14		3.7	F	< 5.0	U	< 5.0	U	13	
ST012-W03	ST012-W03-WG-0313		4/1/2013		< 100	U	< 100	U	< 200	U	380		< 100	U	< 100	U	< 500	U	< 500	U	53	B	< 100	U
ST012-W05	ST012-W05-WG-0313		3/25/2013	218	< 40	U	< 40	U	< 80	U	360		< 40	U	21	F	< 200	U	13	F	< 200	U	32	F
ST012-W08	ST012-W08-WG-0313		4/2/2013		< 50	U	< 50	U	< 100	U	320		< 50	U	< 50	U	< 250	U	< 250	U	< 250	U	< 50	U
ST012-W09	ST012-W09-WG-0313		4/2/2013		< 50	U	< 50	U	< 100	U	800		< 50	U	27	F	< 250	U	< 250	U	< 250	U	32	F
ST012-W11	ST012-W11-WG-210-0413		4/18/2013	210	< 2.0	U	< 2.0	U	< 4.0	U	530		< 2.0	U	82		< 10	U	< 10	U	< 10	U	76	
	ST012-W11-WG-220-0413		4/18/2013	220	< 2.0	U	< 2.0	U	< 4.0	U	550		< 2.0	U	82		< 10	U	< 10	U	< 10	U	70	
	ST012-W11-WG-230-0413		4/18/2013	230	< 2.0	U	< 2.0	U	< 4.0	U	540		< 2.0	U	82		< 10	U	< 10	U	< 10	U	70	
	ST012-W11-WG-240-0413		4/18/2013	240	< 2.0	U	< 2.0	U	< 4.0	U	350		< 2.0	U	59		< 10	U	< 10	U	< 10	U	56	
ST012-W13	ST012-W13-WG-210-0413		4/18/2013	210	< 10	U	< 10	U	< 20	U	990		< 10	U	90		< 50	U	< 50	U	< 50	U	120	
	ST012-W13-WG-220-0413		4/18/2013	220	< 10	U	< 10	U	< 20	U	810		< 10	U	63		< 50	U	< 50	U	< 50	U	91	
	ST012-W13-WG-230-0413		4/18/2013	230	< 10	U	< 10	U	< 20	U	810		< 10	U	64		< 50	U	< 50	U	< 50	U	90	
	ST012-W13-WG-240-0413		4/18/2013	240	< 10	U	< 10	U	< 20	U	830		< 10	U	65		< 50	U	< 50	U	< 50	U	91	
	ST012-DUP03-WG-0413	Duplicate	4/18/2013	240	< 10	U	< 10	U	< 20	U	780		< 10	U	67		< 50	U	< 50	U	< 50	U	95	
ST012-W32	ST012-W32-WG-0313		4/2/2013		< 4.0	U	< 4.0	U	< 8.0	U	530		< 4.0	U	39		< 20	U	< 20	U	< 20	U	140	

Notes:
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TPH (MO) (C20 - C38) - total petroleum hydrocarbons as motor oil (hydrocargons with 20 to 38
Data Qualifier Definitions:
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ST012 Pre-Design Investigation
Summary of Groundwater Anlytical Results

					n-Butylbenzene		n-Propylbenzene		sec-Butylbenzene		Styrene		tert-Butyl alcohol		tert-Butylbenzene		Tetrachloroethene		Toluene		trans-1,2-Dichloroethene		trans-1,3-Dichloropropene	
Location ID	Sample ID	Sample Type	Sample Date	Sample Depth (ft.)	Conc. (µg/L)		Conc. (µg/L)		Conc. (µg/L)		Conc. (µg/L)		Conc. (µg/L)		Conc. (µg/L)		Conc. (µg/L)		Conc. (µg/L)		Conc. (µg/L)		Conc. (µg/L)	
ST012-DPE01	ST012-DPE01-WG-165-0413		4/18/2013	165	32	J	91	J	37	J	< 5.0	U	< 250	U	< 5.0	U	< 5.0	U	2.8	F	< 5.0	U	< 5.0	U
	ST012-DUP01-WG-0413	Duplicate	4/18/2013	165	47	J	140	J	59	J	< 2.5	U	< 130	U	< 2.5	U	< 2.5	U	3.3		< 2.5	U	< 2.5	U
	ST012-DPE01-WG-185-0413		4/18/2013	185	14		51		21		< 5.0	U	< 250	U	1.1	F	< 5.0	U	4.4	F	< 5.0	U	< 5.0	U
	ST012-DPE01-WG-205-0413		4/18/2013	205	17		74		25		< 5.0	U	< 250	U	< 5.0	U	< 5.0	U	2.0	F	< 5.0	U	< 5.0	U
	ST012-DPE01-WG-230-0413		4/18/2013	230	17		79		24		< 5.0	U	< 250	U	< 5.0	U	< 5.0	U	2.1	F	< 5.0	U	< 5.0	U
ST012-DPE02	ST012-DPE02-WG-165-0413		4/18/2013	165	< 1.0	U	0.69	F	0.56	F	< 1.0	U	< 50	U	< 1.0	U	< 1.0	U	0.39	F	< 1.0	U	< 1.0	U
	ST012-DPE02-WG-195-0413		4/18/2013	195	< 1.0	U	0.92	F	0.6	F	< 1.0	U	< 50	U	< 1.0	U	< 1.0	U	0.44	F	< 1.0	U	< 1.0	U
	ST012-DPE02-WG-215-0413		4/18/2013	215	< 1.0	U	1.3		0.49	F	< 1.0	U	< 50	U	< 1.0	U	< 1.0	U	0.49	F	< 1.0	U	< 1.0	U
ST012-LSZ08	ST012-LSZ08-WG-0313		3/27/2013	211	< 10	U	25		2.8	F	< 10	U	< 500	U	< 10	U	< 10	U	3000		< 10	U	< 10	U
	ST012-DUP04-WG-0313	Duplicate	3/27/2013	211	< 10	U	26		2.9	F	< 10	U	< 500	U	< 10	U	< 10	U	3000		< 10	U	< 10	U
ST012-LSZ09	ST012-LSZ09-WG-0313		3/29/2013	211	< 50	U	19	F	< 50	U	< 50	U	< 2500	U	< 50	U	< 50	U	4500		< 50	U	< 50	U
ST012-LSZ10	ST012-LSZ10-WG-0313		3/27/2013	211	< 50	U	33	F	< 50	U	< 50	U	< 2500	U	< 50	U	< 50	U	6400		< 50	U	< 50	U
ST012-LSZ11	ST012-LSZ11-WG-0313		3/27/2013		< 50	U	46	F	< 50	U	< 50	U	< 2500	U	< 50	U	< 50	U	10000		< 50	U	< 50	U
ST012-LSZ12	ST012-LSZ12-WG-0313		4/1/2013		10	F	54		< 20	U	< 20	U	< 1000	U	< 20	U	< 20	U	2600		< 20	U	< 20	U
ST012-LSZ13	ST012-LSZ13-WG-0313		3/27/2013		< 10	U	20		2.5	F	< 10	U	< 500	U	< 10	U	< 10	U	2400		< 10	U	< 10	U
ST012-LSZ14	ST012-LSZ14-WG-0313		3/28/2013		3.5	F	32		4.9	F	< 10	U	< 500	U	< 10	U	< 10	U	4600		< 10	U	< 10	U
ST012-LSZ15	ST012-LSZ15-WG-0313		3/29/2013		< 50	U	40	F	< 50	U	< 50	U	< 2500	U	< 50	U	< 50	U	9800		< 50	U	< 50	U
ST012-LSZ16	ST012-LSZ16-WG-0313		3/26/2013	211	< 2.0	U	1.4	F	0.6	F	< 2.0	U	< 100	U	< 2.0	U	< 2.0	U	31		< 2.0	U	< 2.0	U
	ST012-DUP02-WG-0313	Duplicate	3/26/2013	211	< 2.0	U	1.8	F	0.75	F	< 2.0	U	< 100	U	< 2.0	U	< 2.0	U	31		< 2.0	U	< 2.0	U
ST012-LSZ17	ST012-LSZ17-WG-0313		3/26/2013	211	< 20	U	8.6	F	< 20	U	< 20	U	< 1000	U	< 20	U	< 20	U	4100		< 20	U	< 20	U
	ST012-DUP03-WG-0313	Duplicate	3/26/2013	211	< 20	U	9.0	F	< 20	U	< 20	U	< 1000	U	< 20	U	< 20	U	4700		< 20	U	< 20	U
ST012-MWN03A	ST012-MWN03A-WG-0313		3/25/2013	177	12		32		11		< 4.0	U	< 200	U	< 4.0	U	< 4.0	U	9.3		< 4.0	U	< 4.0	U
ST012-MWN03C	ST012-MWN03C-WG-0313		4/3/2013	136	0.64	F	4.1		0.9	F	< 1.0	U	< 50	U	< 1.0	U	< 1.0	U	490		< 1.0	U	< 1.0	U
ST012-MWN05A	ST012-MWN05A-WG-0313		4/3/2013	176	9.6	F	26		< 20	U	< 20	U	< 1000	U	< 20	U	< 20	U	4.2	B	< 20	U	< 20	U
ST012-MWN05C	ST012-MWN05C-WG-0313		3/26/2013	235	< 4.0	U	0.91	F	< 4.0	U	< 4.0	U	< 200	U	< 4.0	U	< 4.0	U	12		< 4.0	U	< 4.0	U
	ST012-DUP01-WG-0313	Duplicate	3/26/2013	235	< 4.0	U	0.86	F	< 4.0	U	< 4.0	U	< 200	U	< 4.0	U	< 4.0	U	14		< 4.0	U	< 4.0	U
ST012-N06	ST012-N06-WG-175-0413		4/18/2013	175	7.0	J	50	J	16	J	< 4.0	U	< 200	U	1.0	F	< 4.0	U	< 4.0	U	< 4.0	U	< 4.0	U
	ST012-DUP02-WG-0413	Duplicate	4/18/2013	175	80	J	310	J	110	J	< 10	U	< 500	U	7.2	F	< 10	U	2.8	F	< 10	U	< 10	U
	ST012-N06-WG-190-0413		4/18/2013	190	9.0		55		18		< 4.0	U	< 200	U	1.1	F	< 4.0	U	< 4.0	U	< 4.0	U	< 4.0	U
	ST012-N06-WG-205-0413		4/18/2013	205	6.3		53		14		< 4.0	U	< 200	U	0.94	F	< 4.0	U	< 4.0	U	< 4.0	U	< 4.0	U
	ST012-N06-WG-220-0413		4/18/2013	220	5.7		35		9.6		< 2.0	U	< 100	U	< 2.0	U	< 2.0	U	0.46	F	< 2.0	U	< 2.0	U
	ST012-N06-WG-230-0413		4/18/2013	230	5.3		31		8.5		< 2.0	U	< 100	U	< 2.0	U	< 2.0	U	0.46	F	< 2.0	U	< 2.0	U
ST012-N13	ST012-N13-WG-160-0413		4/18/2013	160	5.9		17		11		< 4.0	U	< 200	U	< 4.0	U	< 4.0	U	39		< 4.0	U	< 4.0	U
	ST012-N13-WG-190-0413		4/18/2013	190	7.5		28		13		< 2.0	U	< 100	U	< 2.0	U	< 2.0	U	16		< 2.0	U	< 2.0	U
	ST012-N13-WG-205-0413		4/18/2013	205	7.7	F	30		12		< 10	U	< 500	U	< 10	U	< 10	U	18		< 10	U	< 10	U
	ST012-N13-WG-230-0413		4/18/2013	230	5.6	F	22		8.4	F	< 10	U	< 500	U	< 10	U	< 10	U	17		< 10	U	< 10	U
ST012-UWBZ09	ST012-UWBZ09-WG-0313		3/28/2013	170	1.1		9.9		1.8		< 1.0	U	< 50	U	< 1.0	U	< 1.0	U	270		< 1.0	U	< 1.0	U
ST012-W03	ST012-W03-WG-0313		4/1/2013		< 100	U	< 100	U	< 100	U	< 100	U	< 5000	U	< 100	U	< 100	U	< 100	U	< 100	U	< 100	U
ST012-W05	ST012-W05-WG-0313		3/25/2013	218	< 40	U	14	F	< 40	U	< 40	U	< 2000	U	< 40	U	< 40	U	< 40	U	< 40	U	< 40	U
ST012-W08	ST012-W08-WG-0313		4/2/2013		< 50	U	< 50	U	< 50	U	< 50	U	< 2500	U	< 50	U	< 50	U	< 50	U	< 50	U	< 50	U
ST012-W09	ST012-W09-WG-0313		4/2/2013		< 50	U	14	F	< 50	U	< 50	U	< 2500	U	< 50	U	< 50	U	36	F	< 50	U	< 50	U
ST012-W11	ST012-W11-WG-210-0413		4/18/2013	210	17		90		20		< 2.0	U	< 100	U	< 2.0	U	< 2.0	U	1.9	F	< 2.0	U	< 2.0	U
	ST012-W11-WG-220-0413		4/18/2013	220	14		87		18		< 2.0	U	< 100	U	< 2.0	U	< 2.0	U	2.5		< 2.0	U	< 2.0	U
	ST012-W11-WG-230-0413		4/18/2013	230	13		87		18		< 2.0	U	< 100	U	< 2.0	U	< 2.0	U	2.7		< 2.0	U	< 2.0	U
	ST012-W11-WG-240-0413		4/18/2013	240	16		61		15		< 2.0	U	< 100	U	< 2.0	U	< 2.0	U	2.9		< 2.0	U	< 2.0	U
ST012-W13	ST012-W13-WG-210-0413		4/18/2013	210	18		84		8.8	F	< 10	U	< 500	U	< 10	U	< 10	U	1.7	F	< 10	U	< 10	U
	ST012-W13-WG-220-0413		4/18/2013	220	14		54		16		< 10	U	< 500	U	< 10	U	< 10	U	1.9	F	< 10	U	< 10	U
	ST012-W13-WG-230-0413		4/18/2013	230	12		54		6.1	F	< 10	U	< 500	U	< 10	U	< 10	U	2.3	F	< 10	U	< 10	U
	ST012-W13-WG-240-0413		4/18/2013	240	12		56		14		< 10	U	< 500	U	< 10	U	< 10	U	2.8	F	< 10	U	< 10	U
	ST012-DUP03-WG-0413	Duplicate	4/18/2013	240	14		59		15		< 10	U	< 500	U	< 10	U	< 10	U	3.1	F	< 10	U	< 10	U
ST012-W32	ST012-W32-WG-0313		4/2/2013		5.7		26		5.4		0.78	F	< 200	U	< 4.0	U	< 4.0	U	6.2		< 4.0	U	< 4.0	U

Notes:
µg/L - micrograms per liter
Conc. - Concentration
ft. - feet
ID - Identification
MDL - Method Detection Limit
mg/L - milligrams per liter
RL - Reporting Limit
TPH (DRO) (C10-C28) - total petroleum hydrocarbons as diesel range organics (hydrocarbons \
TPH (GRO) (C6 - C10) - total petroleum hydrocarbons as gasoline range organics (hydrocarbor
TPH (MO) (C20 - C38) - total petroleum hydrocarbons as motor oil (hydrocargons with 20 to 38

Data Qualifier Definitions:
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ST012 Pre-Design Investigation
Summary of Groundwater Anlytical Results

					Trichloroethene		Trichlorofluoromethane		Vinyl Chloride		Xylenes, Total	
Location ID	**Sample ID**	**Sample Type**	**Sample Date**	**Sample Depth (ft.)**	**Conc. (µg/L)**		**Conc. (µg/L)**		**Conc. (µg/L)**		**Conc. (µg/L)**	
ST012-DPE01	ST012-DPE01-WG-165-0413		4/18/2013	165	0.96	F	< 10	U	< 7.5	U	250	
	ST012-DUP01-WG-0413	Duplicate	4/18/2013	165	0.6	F	< 5.0	U	< 3.8	UJ	260	
	ST012-DPE01-WG-185-0413		4/18/2013	185	0.93	F	< 10	U	< 7.5	U	110	
	ST012-DPE01-WG-205-0413		4/18/2013	205	0.88	F	< 10	U	< 7.5	U	140	
	ST012-DPE01-WG-230-0413		4/18/2013	230	0.83	F	< 10	U	< 7.5	U	170	
ST012-DPE02	ST012-DPE02-WG-165-0413		4/18/2013	165	< 1.0	U	< 2.0	U	< 1.5	U	4.2	
	ST012-DPE02-WG-195-0413		4/18/2013	195	< 1.0	U	< 2.0	U	< 1.5	U	3.8	
	ST012-DPE02-WG-215-0413		4/18/2013	215	< 1.0	U	< 2.0	U	< 1.5	U	3.7	
ST012-LSZ08	ST012-LSZ08-WG-0313		3/27/2013	211	< 10	U	< 20	U	< 15	U	1600	
	ST012-DUP04-WG-0313	Duplicate	3/27/2013	211	< 10	U	< 20	U	< 15	U	1600	
ST012-LSZ09	ST012-LSZ09-WG-0313		3/29/2013	211	< 50	U	< 100	U	< 75	U	1600	
ST012-LSZ10	ST012-LSZ10-WG-0313		3/27/2013	211	< 50	U	< 100	U	< 75	U	2900	
ST012-LSZ11	ST012-LSZ11-WG-0313		3/27/2013		< 50	U	< 100	U	< 75	U	3500	
ST012-LSZ12	ST012-LSZ12-WG-0313		4/1/2013		< 20	U	< 40	U	< 30	U	2500	
ST012-LSZ13	ST012-LSZ13-WG-0313		3/27/2013		< 10	U	< 20	U	< 15	U	990	
ST012-LSZ14	ST012-LSZ14-WG-0313		3/28/2013		< 10	U	< 20	U	< 15	U	1500	
ST012-LSZ15	ST012-LSZ15-WG-0313		3/29/2013		< 50	U	< 100	U	< 75	U	3800	
ST012-LSZ16	ST012-LSZ16-WG-0313		3/26/2013	211	< 2.0	U	< 4.0	U	< 3.0	U	44	
	ST012-DUP02-WG-0313	Duplicate	3/26/2013	211	< 2.0	U	< 4.0	U	< 3.0	U	54	
ST012-LSZ17	ST012-LSZ17-WG-0313		3/26/2013	211	< 20	U	< 40	U	< 30	U	1100	
	ST012-DUP03-WG-0313	Duplicate	3/26/2013	211	< 20	U	< 40	U	< 30	U	1200	
ST012-MWN03A	ST012-MWN03A-WG-0313		3/25/2013	177	< 4.0	U	< 8.0	U	< 6.0	U	280	
ST012-MWN03C	ST012-MWN03C-WG-0313		4/3/2013	136	< 1.0	U	< 2.0	U	< 1.5	U	290	
ST012-MWN05A	ST012-MWN05A-WG-0313		4/3/2013	176	< 20	U	< 40	U	< 30	U	220	
ST012-MWN05C	ST012-MWN05C-WG-0313		3/26/2013	235	< 4.0	U	< 8.0	U	< 6.0	U	2.2	F
	ST012-DUP01-WG-0313	Duplicate	3/26/2013	235	< 4.0	U	< 8.0	U	< 6.0	U	2.2	F
ST012-N06	ST012-N06-WG-175-0413		4/18/2013	175	0.66	F	< 8.0	U	< 6.0	U	17	J
	ST012-DUP02-WG-0413	Duplicate	4/18/2013	175	1.7	F	< 20	U	< 15	U	58	J
	ST012-N06-WG-190-0413		4/18/2013	190	< 4.0	U	< 8.0	U	< 6.0	U	19	
	ST012-N06-WG-205-0413		4/18/2013	205	< 4.0	U	< 8.0	U	< 6.0	U	18	
	ST012-N06-WG-220-0413		4/18/2013	220	0.44	F	< 4.0	U	< 3.0	U	17	
	ST012-N06-WG-230-0413		4/18/2013	230	0.4	F	< 4.0	U	< 3.0	U	15	
ST012-N13	ST012-N13-WG-160-0413		4/18/2013	160	1.1	F	< 8.0	U	< 6.0	U	460	
	ST012-N13-WG-190-0413		4/18/2013	190	0.87	F	< 4.0	U	< 3.0	UJ	230	
	ST012-N13-WG-205-0413		4/18/2013	205	< 10	U	< 20	U	< 15	U	310	
	ST012-N13-WG-230-0413		4/18/2013	230	< 10	U	< 20	U	< 15	U	290	
ST012-UWBZ09	ST012-UWBZ09-WG-0313		3/28/2013	170	1.3		< 2.0	U	< 1.5	U	170	
ST012-W03	ST012-W03-WG-0313		4/1/2013		< 100	U	< 200	U	< 150	U	35	F
ST012-W05	ST012-W05-WG-0313		3/25/2013	218	< 40	U	< 80	U	< 60	U	< 40	U
ST012-W08	ST012-W08-WG-0313		4/2/2013		< 50	U	< 100	U	< 75	U	< 50	U
ST012-W09	ST012-W09-WG-0313		4/2/2013		< 50	U	< 100	U	< 75	U	100	
ST012-W11	ST012-W11-WG-210-0413		4/18/2013	210	< 2.0	U	< 4.0	U	< 3.0	U	340	
	ST012-W11-WG-220-0413		4/18/2013	220	< 2.0	U	< 4.0	U	< 3.0	U	500	
	ST012-W11-WG-230-0413		4/18/2013	230	< 2.0	U	< 4.0	U	< 3.0	U	560	
	ST012-W11-WG-240-0413		4/18/2013	240	< 2.0	U	< 4.0	U	< 3.0	U	640	
ST012-W13	ST012-W13-WG-210-0413		4/18/2013	210	< 10	U	< 20	U	< 15	U	76	
	ST012-W13-WG-220-0413		4/18/2013	220	< 10	U	< 20	U	< 15	U	170	
	ST012-W13-WG-230-0413		4/18/2013	230	< 10	U	< 20	U	< 15	U	170	
	ST012-W13-WG-240-0413		4/18/2013	240	< 10	U	< 20	U	< 15	U	150	
	ST012-DUP03-WG-0413	Duplicate	4/18/2013	240	< 10	U	< 20	U	< 15	U	160	
ST012-W32	ST012-W32-WG-0313		4/2/2013		0.73	F	< 8.0	U	< 6.0	U	11	

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ST012 Pre-Design Investigation
Summary of Groundwater Anlytical Results - Detected VOCs

					TPH (GRO) (C6-C10)	TPH (DRO) (C10-C28)	TPH (MO) (C20-C38)	1,1,2-Trichloroethane	1,2,4-Trimethylbenzene	1,2-Dibromoethane	1,2-Dichloroethane	1,3,5-Trimethylbenzene	2-Butanone	4-Isopropyltoluene	Acetone
Location ID	Sample ID	Sample Type	Sample Date	Sample Depth (ft.)	Conc. (mg/L)	Conc. (mg/L)	Conc. (mg/L)	Conc. (µg/L)	Conc. (µg/L)	Conc. (µg/L)	Conc. (µg/L)	Conc. (µg/L)	Conc. (µg/L)	Conc. (µg/L)	Conc. (µg/L)
ST012-DPE01	ST012-DPE01-WG-165-0413		4/18/2013	165	8.7	NA	NA	< 5.0 U	220	< 5.0 U	< 5.0 U	59 J	< 30 U	18 J	110 B
	ST012-DUP01-WG-0413	Duplicate	4/18/2013	165	9.7	NA	NA	< 2.5 U	280	< 2.5 U	< 2.5 U	81 J	< 15 U	25 J	< 25 UJ
	ST012-DPE01-WG-185-0413		4/18/2013	185	6	NA	NA	< 5.0 U	76	< 5.0 U	< 5.0 U	19	< 30 U	5.8	160 B
	ST012-DPE01-WG-205-0413		4/18/2013	205	6.3	NA	NA	< 5.0 U	140	< 5.0 U	< 5.0 U	36	< 30 U	9.7	83 B
	ST012-DPE01-WG-230-0413		4/18/2013	230	7.2	NA	NA	< 5.0 U	180	< 5.0 U	< 5.0 U	46	< 30 U	11	71 B
ST012-DPE02	ST012-DPE02-WG-165-0413		4/18/2013	165	0.27 J	NA	NA	< 1.0 U	0.7 F	< 1.0 U	< 1.0 U	6.4	< 6.0 U	0.75 F	15 B
	ST012-DPE02-WG-195-0413		4/18/2013	195	0.24 J	NA	NA	< 1.0 U	0.59 F	< 1.0 U	< 1.0 U	3.9	< 6.0 U	0.23 F	17 B
	ST012-DPE02-WG-215-0413		4/18/2013	215	0.23 J	NA	NA	< 1.0 U	0.56 F	< 1.0 U	< 1.0 U	3.5	< 6.0 U	< 1.0 U	12 B
ST012-LSZ08	ST012-LSZ08-WG-0313		3/27/2013	211	20	1.1	0.073 F	< 10 U	140	< 10 U	< 10 U	33	< 60 U	2.0 F	< 100 U
	ST012-DUP04-WG-0313	Duplicate	3/27/2013	211	20	1.0	0.072 F	< 10 U	140	< 10 U	< 10 U	40	< 60 U	2.1 F	< 100 U
ST012-LSZ09	ST012-LSZ09-WG-0313		3/29/2013	211	31	2.5	0.19 B	< 50 U	110	< 50 U	< 50 U	38 F	< 300 U	< 50 U	< 500 U
ST012-LSZ10	ST012-LSZ10-WG-0313		3/27/2013	211	49	2.7	0.19 F	< 50 U	190	< 50 U	< 50 U	60	< 300 U	< 50 U	190 B
ST012-LSZ11	ST012-LSZ11-WG-0313		3/27/2013	211	63	2.1	0.28 F	< 50 U	240	< 50 U	< 50 U	66	< 300 U	< 50 U	160 B
ST012-LSZ12	ST012-LSZ12-WG-0313		4/1/2013	211	37	2.0	0.24 B	< 20 U	210	< 20 U	< 20 U	60	< 120 U	6.7 F	< 200 U
ST012-LSZ13	ST012-LSZ13-WG-0313		3/27/2013	211	16	0.76	0.1 F	< 10 U	84	< 10 U	< 10 U	24	< 60 U	2.9 F	51 B
ST012-LSZ14	ST012-LSZ14-WG-0313		3/28/2013	211	25	2.5	0.36 F	< 10 U	130	5.3 F	< 10 U	35	< 60 U	3.0 F	< 100 U
ST012-LSZ15	ST012-LSZ15-WG-0313		3/29/2013	211	65	4.5	0.23 F	< 50 U	240	< 50 U	< 50 U	83	< 300 U	< 50 U	< 500 U
ST012-LSZ16	ST012-LSZ16-WG-0313		3/26/2013	211	2.2	3.9 J	0.36 F	< 2.0 U	4.0	< 2.0 U	< 2.0 U	1.5 F	< 12 U	< 2.0 U	13 B
	ST012-DUP02-WG-0313	Duplicate	3/26/2013	211	2.5	4.1 J	0.39 F	< 2.0 U	7.4	< 2.0 U	< 2.0 U	2.3	< 12 U	< 2.0 U	< 20 U
ST012-LSZ17	ST012-LSZ17-WG-0313		3/26/2013	211	25	0.99	0.18 F	< 20 U	48	< 20 U	< 20 U	14 F	< 120 U	< 20 U	< 200 U
	ST012-DUP03-WG-0313	Duplicate	3/26/2013	211	26	1.0 J	0.15 F	< 20 U	49	< 20 U	< 20 U	15 F	< 120 U	< 20 U	< 200 U
ST012-MWN03A	ST012-MWN03A-WG-0313		3/25/2013	177	6.9	15 J	0.6 J	< 4.0 U	130	< 4.0 U	< 4.0 U	36	< 24 U	7.8	< 40 U
ST012-MWN03C	ST012-MWN03C-WG-0313		4/3/2013	136	3.1	0.066 F	0.85	< 1.0 U	19	< 1.0 U	< 1.0 U	5.4	< 6.0 U	0.49 F	< 10 U
ST012-MWN05A	ST012-MWN05A-WG-0313		4/3/2013	176	12	16	0.84	< 20 U	100	< 20 U	< 20 U	13 F	< 120 U	< 20 U	< 200 U
ST012-MWN05C	ST012-MWN05C-WG-0313		3/26/2013	235	2.1	0.64 J	0.071 F	< 4.0 U	< 4.0 U	< 4.0 U	< 4.0 U	< 4.0 U	< 24 U	< 4.0 U	< 40 U
	ST012-DUP01-WG-0313	Duplicate	3/26/2013	235	2.2	0.63 J	0.059 F	< 4.0 U	< 4.0 U	< 4.0 U	< 4.0 U	< 4.0 U	< 24 U	< 4.0 U	< 40 U
ST012-N06	ST012-N06-WG-175-0413		4/18/2013	175	3.7	NA	NA	< 4.0 U	9.5 J	< 4.0 U	< 4.0 U	< 4.0 U	< 24 U	6.7 J	89 B
	ST012-DUP02-WG-0413	Duplicate	4/18/2013	175	3.6	NA	NA	< 10 U	58 J	< 10 U	< 10 U	< 10 U	< 60 U	46 J	110 B
	ST012-N06-WG-190-0413		4/18/2013	190	4.3	NA	NA	< 4.0 U	12	< 4.0 U	< 4.0 U	< 4.0 U	< 24 U	8.8	74 B
	ST012-N06-WG-205-0413		4/18/2013	205	4.4	NA	NA	< 4.0 U	9.2	< 4.0 U	< 4.0 U	< 4.0 U	< 24 U	6.2	77 B
	ST012-N06-WG-220-0413		4/18/2013	220	3.1	NA	NA	< 2.0 U	15	< 2.0 U	< 2.0 U	1.2 F	< 12 U	7.9	43 B
	ST012-N06-WG-230-0413		4/18/2013	230	3.2	NA	NA	< 2.0 U	14	< 2.0 U	< 2.0 U	1.2 F	< 12 U	7.3	32 B
ST012-N13	ST012-N13-WG-160-0413		4/18/2013	160	11	NA	NA	< 4.0 U	150	< 4.0 U	< 4.0 U	37	< 24 U	14	11 B
	ST012-N13-WG-190-0413		4/18/2013	190	7.5	NA	NA	< 2.0 U	63	< 2.0 U	< 2.0 U	13	< 12 U	3.7	13 B
	ST012-N13-WG-205-0413		4/18/2013	205	7.2	NA	NA	< 10 U	65	< 10 U	< 10 U	13	< 60 U	3.7 F	< 100 U
	ST012-N13-WG-230-0413		4/18/2013	230	6.7	NA	NA	< 10 U	52	< 10 U	< 10 U	10	< 60 U	2.7 F	< 100 U
ST012-UWBZ09	ST012-UWBZ09-WG-0313		3/28/2013	170	3.3	6.1	0.67	< 1.0 U	30	< 1.0 U	< 1.0 U	14	< 6.0 U	1.6	< 10 U
ST012-W03	ST012-W03-WG-0313		4/1/2013		38	1.3	0.057 F	< 100 U	28 F	< 100 U	< 100 U	< 100 U	< 600 U	< 100 U	< 1000 U
ST012-W05	ST012-W05-WG-0313		3/25/2013	218	32	2.7 J	0.059 F	< 40 U	< 40 U	< 40 U	< 40 U	< 40 U	< 240 U	< 40 U	< 400 U
ST012-W08	ST012-W08-WG-0313		4/2/2013		18	0.61	< 0.49 U	< 50 U	< 50 U	< 50 U	< 50 U	< 50 U	< 300 U	< 50 U	< 500 U
ST012-W09	ST012-W09-WG-0313		4/2/2013		28	3.8	0.16 F	< 50 U	8.6 F	< 50 U	< 50 U	< 50 U	< 300 U	< 50 U	< 500 U
ST012-W11	ST012-W11-WG-210-0413		4/18/2013	210	8.9	NA	NA	< 2.0 U	310	< 2.0 U	< 2.0 U	83	< 12 U	15	< 20 U
	ST012-W11-WG-220-0413		4/18/2013	220	7.6	NA	NA	< 2.0 U	310	< 2.0 U	< 2.0 U	94	< 12 U	13	20 B
	ST012-W11-WG-230-0413		4/18/2013	230	11	NA	NA	< 2.0 U	300	< 2.0 U	< 2.0 U	97	< 12 U	12	13 B
	ST012-W11-WG-240-0413		4/18/2013	240	9.8	NA	NA	25	280	< 2.0 U	< 2.0 U	89	< 12 U	13	8.6 B
ST012-W13	ST012-W13-WG-210-0413		4/18/2013	210	13	NA	NA	< 10 U	210	< 10 U	<10 U	29	< 60 U	11	< 100 U
	ST012-W13-WG-220-0413		4/18/2013	220	13	NA	NA	60	230	< 10 U	<10 U	46	38 B	11	< 100 U
	ST012-W13-WG-230-0413		4/18/2013	230	14	NA	NA	< 10 U	220	< 10 U	< 10 U	44	< 60 U	9.6 F	< 100 U
	ST012-W13-WG-240-0413		4/18/2013	240	12	NA	NA	< 10 U	210	< 10 U	< 10 U	42	< 60 U	9.3 F	20 B
	ST012-DUP03-WG-0413	Duplicate	4/18/2013	240	12	NA	NA	< 10 U	230	< 10 U	< 10 U	45	< 60 U	11	< 100 U
ST012-W32	ST012-W32-WG-0313		4/2/2013		25	6.8	0.22 F	< 4.0 U	3.6 F	< 4.0 U	< 4.0 U	< 4.0 U	< 24 U	< 4.0 U	< 40 U

Notes:
µg/L - micrograms per liter
Conc. - Concentration
ft. - feet
ID - Identification
MDL - Method Detection Limit
mg/L - milligrams per liter
RL - Reporting Limit
TPH (DRO) (C10-C28) - total petroleum hydrocarbons as diesel range organics (hydrocarbons with 10 to 28 carbon atoms)
TPH (GRO) (C6 - C10) - total petroleum hydrocarbons as gasoline range organics (hydrocarbons with 6 to 10 carbon atoms)
TPH (MO) (C20 - C38) - total petroleum hydrocarbons as motor oil (hydrocargons with 20 to 38 carbon atoms)
VOCs - volatile organic compounds

Data Qualifier Definitions:
B - Sample concentration is similar to that found in an associated blank.
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J - The result is estimated due to Quality Control criteria.
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ST012 Pre-Design Investigation
Summary of Groundwater Anlytical Results - Detected VOCs

					Benzene	Bromodichloromethane	Chloroform	Chloromethane	Ethylbenzene	Isopropylbenzene	Methyl isobutyl ketone	MTBE	Methylene chloride	Naphthalene
Location ID	Sample ID	Sample Type	Sample Date	Sample Depth (ft.)	Conc. (µg/L)	Conc. (µg/L)	Conc. (µg/L)	Conc. (µg/L)	Conc. (µg/L)	Conc. (µg/L)	Conc. (µg/L)	Conc. (µg/L)	Conc. (µg/L)	Conc. (µg/L)
ST012-DPE01	ST012-DPE01-WG-165-0413		4/18/2013	165	860	< 5.0 U	< 5.0 U	< 10 U	480	80 J	< 25 U	< 25 U	2.4 B	160
	ST012-DUP01-WG-0413	Duplicate	4/18/2013	165	720	< 2.5 U	< 2.5 UJ	< 5.0 UJ	520	110 J	< 13 U	< 13 U	< 13 UJ	190
	ST012-DPE01-WG-185-0413		4/18/2013	185	810	< 5.0 U	< 5.0 U	< 10 U	340	50	< 25 U	< 25 U	3.4 B	160
	ST012-DPE01-WG-205-0413		4/18/2013	205	880	< 5.0 U	< 5.0 U	< 10 U	420	68	< 25 U	< 25 U	3.1 B	170
	ST012-DPE01-WG-230-0413		4/18/2013	230	880	< 5.0 U	< 5.0 U	< 10 U	450	74	< 25 U	< 25 U	3.0 B	150
ST012-DPE02	ST012-DPE02-WG-165-0413		4/18/2013	165	1.6	< 1.0 U	< 1.0 U	< 2.0 U	1.8	0.68 F	< 5.0 U	< 5.0 U	< 5.0 U	6.0
	ST012-DPE02-WG-195-0413		4/18/2013	195	4.7	< 1.0 U	< 1.0 U	< 2.0 U	3.4	0.97 F	< 5.0 U	< 5.0 U	< 5.0 U	5.5
	ST012-DPE02-WG-215-0413		4/18/2013	215	4.6	< 1.0 U	< 1.0 U	< 2.0 U	3.0	0.89 F	< 5.0 U	< 5.0 U	< 5.0 U	5.0
ST012-LSZ08	ST012-LSZ08-WG-0313		3/27/2013	211	1200	< 10 U	< 10 U	< 20 U	580	34	< 50 U	< 50 U	< 50 U	68
	ST012-DUP04-WG-0313	Duplicate	3/27/2013	211	1200	< 10 U	< 10 U	< 20 U	590	35	< 50 U	< 50 U	< 50 U	69
ST012-LSZ09	ST012-LSZ09-WG-0313		3/29/2013	211	7100	< 50 U	< 50 U	< 100 U	480	25 F	< 250 U	< 250 U	31 B	54
ST012-LSZ10	ST012-LSZ10-WG-0313		3/27/2013	211	12000	< 50 U	< 50 U	< 100 U	900	45 F	< 250 U	< 250 U	29 B	75
ST012-LSZ11	ST012-LSZ11-WG-0313		3/27/2013	211	14000	< 50 U	< 50 U	< 100 U	1300	62	< 250 U	< 250 U	30 B	85
ST012-LSZ12	ST012-LSZ12-WG-0313		4/1/2013	211	8100	< 20 U	< 20 U	< 40 U	1100	56	36 F	< 100 U	10 B	84
ST012-LSZ13	ST012-LSZ13-WG-0313		3/27/2013	211	3000	< 10 U	< 10 U	< 20 U	390	22	< 50 U	< 50 U	< 50 U	30
ST012-LSZ14	ST012-LSZ14-WG-0313		3/28/2013	211	4300	< 10 U	< 10 U	< 20 U	640	39	< 50 U	< 50 U	6.1 B	38
ST012-LSZ15	ST012-LSZ15-WG-0313		3/29/2013	211	14000	< 50 U	< 50 U	< 100 U	1100	53	< 250 U	< 250 U	32 B	100
ST012-LSZ16	ST012-LSZ16-WG-0313		3/26/2013	211	640	< 2.0 U	< 2.0 U	< 4.0 U	23	4.3	< 10 U	< 10 U	< 10 U	10
	ST012-DUP02-WG-0313	Duplicate	3/26/2013	211	660	< 2.0 U	< 2.0 U	< 4.0 U	27	5.3	< 10 U	< 10 U	< 10 U	11
ST012-LSZ17	ST012-LSZ17-WG-0313		3/26/2013	211	3600	< 20 U	< 20 U	< 40 U	410	17 F	< 100 U	< 100 U	< 100 U	24
	ST012-DUP03-WG-0313	Duplicate	3/26/2013	211	3800	< 20 U	< 20 U	< 40 U	440	17 F	< 100 U	< 100 U	< 100 U	26
ST012-MWN03A	ST012-MWN03A-WG-0313		3/25/2013	177	490	< 4.0 U	< 4.0 U	< 8.0 U	250	30	< 20 U	< 20 U	< 20 U	30
ST012-MWN03C	ST012-MWN03C-WG-0313		4/3/2013	136	120	< 1.0 U	< 1.0 U	< 2.0 U	130	9.2	< 5.0 U	< 5.0 U	< 5.0 U	13
ST012-MWN05A	ST012-MWN05A-WG-0313		4/3/2013	176	2800	< 20 U	< 20 U	< 40 U	490	33	< 100 U	< 100 U	< 100 U	130
ST012-MWN05C	ST012-MWN05C-WG-0313		3/26/2013	235	830	< 4.0 U	< 4.0 U	< 8.0 U	11	1.9 F	< 20 U	< 20 U	< 20 U	< 4.0 U
	ST012-DUP01-WG-0313	Duplicate	3/26/2013	235	860	< 4.0 U	< 4.0 U	< 8.0 U	10	1.8 F	< 20 U	< 20 U	< 20 U	< 4.0 U
ST012-N06	ST012-N06-WG-175-0413		4/18/2013	175	510 J	< 4.0 U	< 4.0 U	< 8.0 U	300 J	50 J	< 20 U	< 20 U	2.5 B	100 J
	ST012-DUP02-WG-0413	Duplicate	4/18/2013	175	2600 J	< 10 U	< 10 U	< 20 U	1800 J	280 J	< 50 U	< 50 U	< 50 U	600 J
	ST012-N06-WG-190-0413		4/18/2013	190	630	< 4.0 U	< 4.0 U	< 8.0 U	360	55	< 20 U	< 20 U	2.4 B	110
	ST012-N06-WG-205-0413		4/18/2013	205	620	< 4.0 U	< 4.0 U	< 8.0 U	360	54	< 20 U	< 20 U	2.5 B	110
	ST012-N06-WG-220-0413		4/18/2013	220	600	< 2.0 U	< 2.0 U	< 4.0 U	330	39	< 10 U	< 10 U	0.68 B	96
	ST012-N06-WG-230-0413		4/18/2013	230	600	< 2.0 U	< 2.0 U	< 4.0 U	320	34	< 10 U	< 10 U	< 10 U	91
ST012-N13	ST012-N13-WG-160-0413		4/18/2013	160	1300	2.8 F	< 4.0 U	< 8.0 U	210	34	25 B	< 20 U	< 20 U	92
	ST012-N13-WG-190-0413		4/18/2013	190	1300	< 2.0 U	< 2.0 UJ	< 4.0 UJ	230	62	17 B	< 10 U	< 10 UJ	180
	ST012-N13-WG-205-0413		4/18/2013	205	1500	< 10 U	< 10 U	< 20 U	320	67	16 B	< 50 U	< 50 U	190
	ST012-N13-WG-230-0413		4/18/2013	230	1400	< 10 U	< 10 U	< 20 U	290	53	18 B	< 50 U	< 50 U	180
ST012-UWBZ09	ST012-UWBZ09-WG-0313		3/28/2013	170	200	< 1.0 U	0.78 F	< 2.0 U	140	14	3.7 F	< 5.0 U	< 5.0 U	13
ST012-W03	ST012-W03-WG-0313		4/1/2013		16000	< 100 U	< 100 U	< 200 U	380	< 100 U	< 500 U	< 500 U	53 B	< 100 U
ST012-W05	ST012-W05-WG-0313		3/25/2013	218	12000	< 40 U	< 40 U	< 80 U	360	21 F	< 200 U	13 F	< 200 U	32 F
ST012-W08	ST012-W08-WG-0313		4/2/2013		6500	< 50 U	< 50 U	< 100 U	320	< 50 U	< 250 U	< 250 U	< 250 U	< 50 U
ST012-W09	ST012-W09-WG-0313		4/2/2013		11000	< 50 U	< 50 U	< 100 U	800	27 F	< 250 U	< 250 U	< 250 U	32 F
ST012-W11	ST012-W11-WG-210-0413		4/18/2013	210	84	< 2.0 U	< 2.0 U	0.62 F	530	82	< 10 U	< 10 U	< 10 U	76
	ST012-W11-WG-220-0413		4/18/2013	220	86	< 2.0 U	< 2.0 U	< 4.0 U	550	82	< 10 U	< 10 U	< 10 U	70
	ST012-W11-WG-230-0413		4/18/2013	230	82	< 2.0 U	< 2.0 U	< 4.0 U	540	82	< 10 U	< 10 U	< 10 U	70
	ST012-W11-WG-240-0413		4/18/2013	240	24	< 2.0 U	< 2.0 U	< 4.0 U	350	59	< 10 U	< 10 U	< 10 U	56
ST012-W13	ST012-W13-WG-210-0413		4/18/2013	210	2300	< 10 U	< 10 U	< 20 U	990	90	< 50 U	< 50 U	< 50 U	120
	ST012-W13-WG-220-0413		4/18/2013	220	3100	< 10 U	< 10 U	< 20 U	810	63	< 50 U	< 50 U	< 50 U	91
	ST012-W13-WG-230-0413		4/18/2013	230	3100	< 10 U	< 10 U	< 20 U	810	64	< 50 U	< 50 U	< 50 U	90
	ST012-W13-WG-240-0413		4/18/2013	240	2900	< 10 U	< 10 U	< 20 U	830	65	< 50 U	< 50 U	< 50 U	91
	ST012-DUP03-WG-0413	Duplicate	4/18/2013	240	2600	< 10 U	< 10 U	< 20 U	780	67	< 50 U	< 50 U	< 50 U	95
ST012-W32	ST012-W32-WG-0313		4/2/2013		9400	< 4.0 U	< 4.0 U	< 8.0 U	530	39	< 20 U	< 20 U	< 20 U	140

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ST012 Pre-Design Investigation
Summary of Groundwater Anlytical Results - Detected VOCs

					n-Butylbenzene		n-Propylbenzene		sec-Butylbenzene		Styrene		tert-Butylbenzene		Toluene		Trichloroethene		Xylenes, Total	
Location ID	Sample ID	Sample Type	Sample Date	Sample Depth (ft.)	Conc. (µg/L)		Conc. (µg/L)		Conc. (µg/L)		Conc. (µg/L)		Conc. (µg/L)		Conc. (µg/L)		Conc. (µg/L)		Conc. (µg/L)	
ST012-DPE01	ST012-DPE01-WG-165-0413		4/18/2013	165	32	J	91	J	37	J	< 5.0	U	< 5.0	U	2.8	F	0.96	F	250	
	ST012-DUP01-WG-0413	Duplicate	4/18/2013	165	47	J	140	J	59	J	< 2.5	U	< 2.5	U	3.3		0.6	F	260	
	ST012-DPE01-WG-185-0413		4/18/2013	185	14		51		21		< 5.0	U	1.1	F	4.4	F	0.93	F	110	
	ST012-DPE01-WG-205-0413		4/18/2013	205	17		74		25		< 5.0	U	< 5.0	U	2.0	F	0.88	F	140	
	ST012-DPE01-WG-230-0413		4/18/2013	230	17		79		24		< 5.0	U	< 5.0	U	2.1	F	0.83	F	170	
ST012-DPE02	ST012-DPE02-WG-165-0413		4/18/2013	165	< 1.0	U	0.69	F	0.56	F	< 1.0	U	< 1.0	U	0.39	F	< 1.0	U	4.2	
	ST012-DPE02-WG-195-0413		4/18/2013	195	< 1.0	U	0.92	F	0.6	F	< 1.0	U	< 1.0	U	0.44	F	< 1.0	U	3.8	
	ST012-DPE02-WG-215-0413		4/18/2013	215	< 1.0	U	1.3		0.49	F	< 1.0	U	< 1.0	U	0.49	F	< 1.0	U	3.7	
ST012-LSZ08	ST012-LSZ08-WG-0313		3/27/2013	211	< 10	U	25		2.8	F	< 10	U	< 10	U	3000		< 10	U	1600	
	ST012-DUP04-WG-0313	Duplicate	3/27/2013	211	< 10	U	26		2.9	F	< 10	U	< 10	U	3000		< 10	U	1600	
ST012-LSZ09	ST012-LSZ09-WG-0313		3/29/2013	211	< 50	U	19	F	< 50	U	< 50	U	< 50	U	4500		< 50	U	1600	
ST012-LSZ10	ST012-LSZ10-WG-0313		3/27/2013	211	< 50	U	33	F	< 50	U	< 50	U	< 50	U	6400		< 50	U	2900	
ST012-LSZ11	ST012-LSZ11-WG-0313		3/27/2013	211	< 50	U	46	F	< 50	U	< 50	U	< 50	U	10000		< 50	U	3500	
ST012-LSZ12	ST012-LSZ12-WG-0313		4/1/2013	211	10	F	54		< 20	U	< 20	U	< 20	U	2600		< 20	U	2500	
ST012-LSZ13	ST012-LSZ13-WG-0313		3/27/2013	211	< 10	U	20		2.5	F	< 10	U	< 10	U	2400		< 10	U	990	
ST012-LSZ14	ST012-LSZ14-WG-0313		3/28/2013	211	3.5	F	32		4.9	F	< 10	U	< 10	U	4600		< 10	U	1500	
ST012-LSZ15	ST012-LSZ15-WG-0313		3/29/2013	211	< 50	U	40	F	< 50	U	< 50	U	< 50	U	9800		< 50	U	3800	
ST012-LSZ16	ST012-LSZ16-WG-0313		3/26/2013	211	< 2.0	U	1.4	F	0.6	F	< 2.0	U	< 2.0	U	31		< 2.0	U	44	
	ST012-DUP02-WG-0313	Duplicate	3/26/2013	211	< 2.0	U	1.8	F	0.75	F	< 2.0	U	< 2.0	U	31		< 2.0	U	54	
ST012-LSZ17	ST012-LSZ17-WG-0313		3/26/2013	211	< 20	U	8.6	F	< 20	U	< 20	U	< 20	U	4100		< 20	U	1100	
	ST012-DUP03-WG-0313	Duplicate	3/26/2013	211	< 20	U	9.0	F	< 20	U	< 20	U	< 20	U	4700		< 20	U	1200	
ST012-MWN03A	ST012-MWN03A-WG-0313		3/25/2013	177	12		32		11		< 4.0	U	< 4.0	U	9.3		< 4.0	U	280	
ST012-MWN03C	ST012-MWN03C-WG-0313		4/3/2013	136	0.64	F	4.1		0.9	F	< 1.0	U	< 1.0	U	490		< 1.0	U	290	
ST012-MWN05A	ST012-MWN05A-WG-0313		4/3/2013	176	9.6	F	26		< 20	U	< 20	U	< 20	U	4.2	B	< 20	U	220	
ST012-MWN05C	ST012-MWN05C-WG-0313		3/26/2013	235	< 4.0	U	0.91	F	< 4.0	U	< 4.0	U	< 4.0	U	12		< 4.0	U	2.2	F
	ST012-DUP01-WG-0313	Duplicate	3/26/2013	235	< 4.0	U	0.86	F	< 4.0	U	< 4.0	U	< 4.0	U	14		< 4.0	U	2.2	F
ST012-N06	ST012-N06-WG-175-0413		4/18/2013	175	7.0	J	50	J	16	J	< 4.0	U	1.0	F	< 4.0	U	0.66	F	17	J
	ST012-DUP02-WG-0413	Duplicate	4/18/2013	175	80	J	310	J	110	J	< 10	U	7.2	F	2.8	F	1.7	F	58	J
	ST012-N06-WG-190-0413		4/18/2013	190	9.0		55		18		< 4.0	U	1.1	F	< 4.0	U	< 4.0	U	19	
	ST012-N06-WG-205-0413		4/18/2013	205	6.3		53		14		< 4.0	U	0.94	F	< 4.0	U	< 4.0	U	18	
	ST012-N06-WG-220-0413		4/18/2013	220	5.7		35		9.6		< 2.0	U	< 2.0	U	0.46	F	0.44	F	17	
	ST012-N06-WG-230-0413		4/18/2013	230	5.3		31		8.5		< 2.0	U	< 2.0	U	0.46	F	0.4	F	15	
ST012-N13	ST012-N13-WG-160-0413		4/18/2013	160	5.9		17		11		< 4.0	U	< 4.0	U	39		1.1	F	460	
	ST012-N13-WG-190-0413		4/18/2013	190	7.5		28		13		< 2.0	U	< 2.0	U	16		0.87	F	230	
	ST012-N13-WG-205-0413		4/18/2013	205	7.7	F	30		12		< 10	U	< 10	U	18		< 10	U	310	
	ST012-N13-WG-230-0413		4/18/2013	230	5.6	F	22		8.4	F	< 10	U	< 10	U	17		< 10	U	290	
ST012-UWBZ09	ST012-UWBZ09-WG-0313		3/28/2013	170	1.1		9.9		1.8		< 1.0	U	< 1.0	U	270		1.3		170	
ST012-W03	ST012-W03-WG-0313		4/1/2013		< 100	U	< 100	U	< 100	U	< 100	U	< 100	U	< 100	U	< 100	U	35	F
ST012-W05	ST012-W05-WG-0313		3/25/2013	218	< 40	U	14	F	< 40	U	< 40	U	< 40	U	< 40	U	< 40	U	< 40	U
ST012-W08	ST012-W08-WG-0313		4/2/2013		< 50	U	< 50	U	< 50	U	< 50	U	< 50	U	< 50	U	< 50	U	< 50	U
ST012-W09	ST012-W09-WG-0313		4/2/2013		< 50	U	14	F	< 50	U	< 50	U	< 50	U	36	F	< 50	U	100	
ST012-W11	ST012-W11-WG-210-0413		4/18/2013	210	17		90		20		< 2.0	U	< 2.0	U	1.9	F	< 2.0	U	340	
	ST012-W11-WG-220-0413		4/18/2013	220	14		87		18		< 2.0	U	< 2.0	U	2.5		< 2.0	U	500	
	ST012-W11-WG-230-0413		4/18/2013	230	13		87		18		< 2.0	U	< 2.0	U	2.7		< 2.0	U	560	
	ST012-W11-WG-240-0413		4/18/2013	240	16		61		15		< 2.0	U	< 2.0	U	2.9		< 2.0	U	640	
ST012-W13	ST012-W13-WG-210-0413		4/18/2013	210	18		84		8.8	F	< 10	U	< 10	U	1.7	F	< 10	U	76	
	ST012-W13-WG-220-0413		4/18/2013	220	14		54		16		< 10	U	< 10	U	1.9	F	< 10	U	170	
	ST012-W13-WG-230-0413		4/18/2013	230	12		54		6.1	F	< 10	U	< 10	U	2.3	F	< 10	U	170	
	ST012-W13-WG-240-0413		4/18/2013	240	12		56		14		< 10	U	< 10	U	2.8	F	< 10	U	150	
	ST012-DUP03-WG-0413	Duplicate	4/18/2013	240	14		59		15		< 10	U	< 10	U	3.1	F	< 10	U	160	
ST012-W32	ST012-W32-WG-0313		4/2/2013		5.7		26		5.4		0.78	F	< 4.0	U	6.2		0.73	F	11	

Notes:
µg/L - micrograms per liter
Conc. - Concentration
ft. - feet
ID - Identification
MDL - Method Detection Limit
mg/L - milligrams per liter
RL - Reporting Limit
TPH (DRO) (C10-C28) - total petroleum hydrocarbons as diesel range organics (hydrocarbons
TPH (GRO) (C6 - C10) - total petroleum hydrocarbons as gasoline range organics (hydrocarbo
TPH (MO) (C20 - C38) - total petroleum hydrocarbons as motor oil (hydrocargons with 20 to 38
VOCs - volatile organic compounds

Data Qualifier Definitions:
B - Sample concentration is similar to that found in an associated blank.
F - The analyte was detected, estimated above the MDL and below the RL.
J - The result is estimated due to Quality Control criteria.
U - The analyte was not detected above the RL shown.
< - Not detected at or above the RL.

ATTACHMENT A.6

LABORATORY TEST RESULTS AND DATA VALIDATION SUMMARIES

ATTACHMENT A.7

SLUG TEST RESULTS

Water Level Measurement Form

Project	9101110001	Project Name	Williams Air Force Base - ST012
Meter Type	Solinst Model 122	Measuring Point	TOC
Field Personnel	Stephen Flora	Project Manager	Jim Clarke

Monitoring Well Number	Date	Time	Time since start of slug test (sec)	Depth to Water (ft BTOC)	H (ft)	H/Ho	Comments
LSZ07	4/9/2013	9:55		153.94			Static Water Level
		9:56					5 Gallon Slug of Water
		9:57	0				Unable to get accurate reading with WL meter

Water Level Measurement Form

Project	9101110001	Project Name	Williams Air Force Base - ST012
Meter Type	Solinst Model 122	Measuring Point	TOC
Field Personnel	Stephen Flora	Project Manager	Jim Clarke

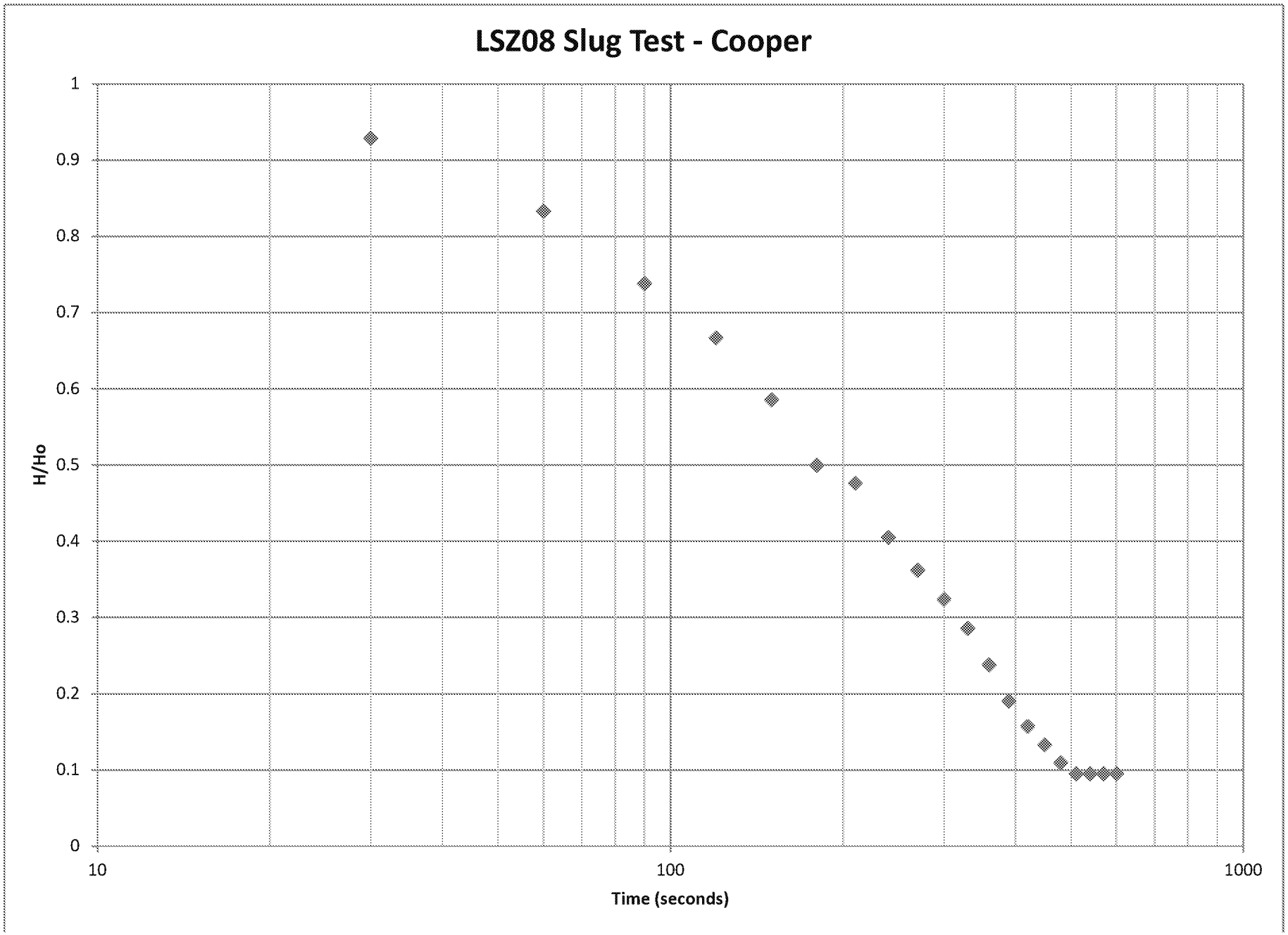
Monitoring Well Number	Date	Time	Time since start of slug test (sec)	Depth to Water (ft BTOC)	H (ft)	H/Ho	Comments
LSZ08	4/8/2013	13:52		150.9			Static Water Level
		13:53					5 Gallon Slug of Water
		13:54	0	148.8	2.1	1	
			30	148.95	1.95	0.928571429	
		13:55	60	149.15	1.75	0.833333333	
			90	149.35	1.55	0.738095238	
		13:56	120	149.5	1.4	0.666666667	
			150	149.67	1.23	0.585714286	
		13:57	180	149.85	1.05	0.5	
			210	149.9	1	0.476190476	
		13:58	240	150.05	0.85	0.404761905	
			270	150.14	0.76	0.361904762	
		13:59	300	150.22	0.68	0.323809524	
			330	150.3	0.6	0.285714286	
		14:00	360	150.4	0.5	0.238095238	
			390	150.5	0.4	0.19047619	
		14:01	420	150.57	0.33	0.157142857	
			450	150.62	0.28	0.133333333	
		14:02	480	150.67	0.23	0.10952381	
			510	150.7	0.2	0.095238095	
		14:03	540	150.7	0.2	0.095238095	
			570	150.7	0.2	0.095238095	
		14:04	600	150.7	0.2	0.095238095	End of WL readings

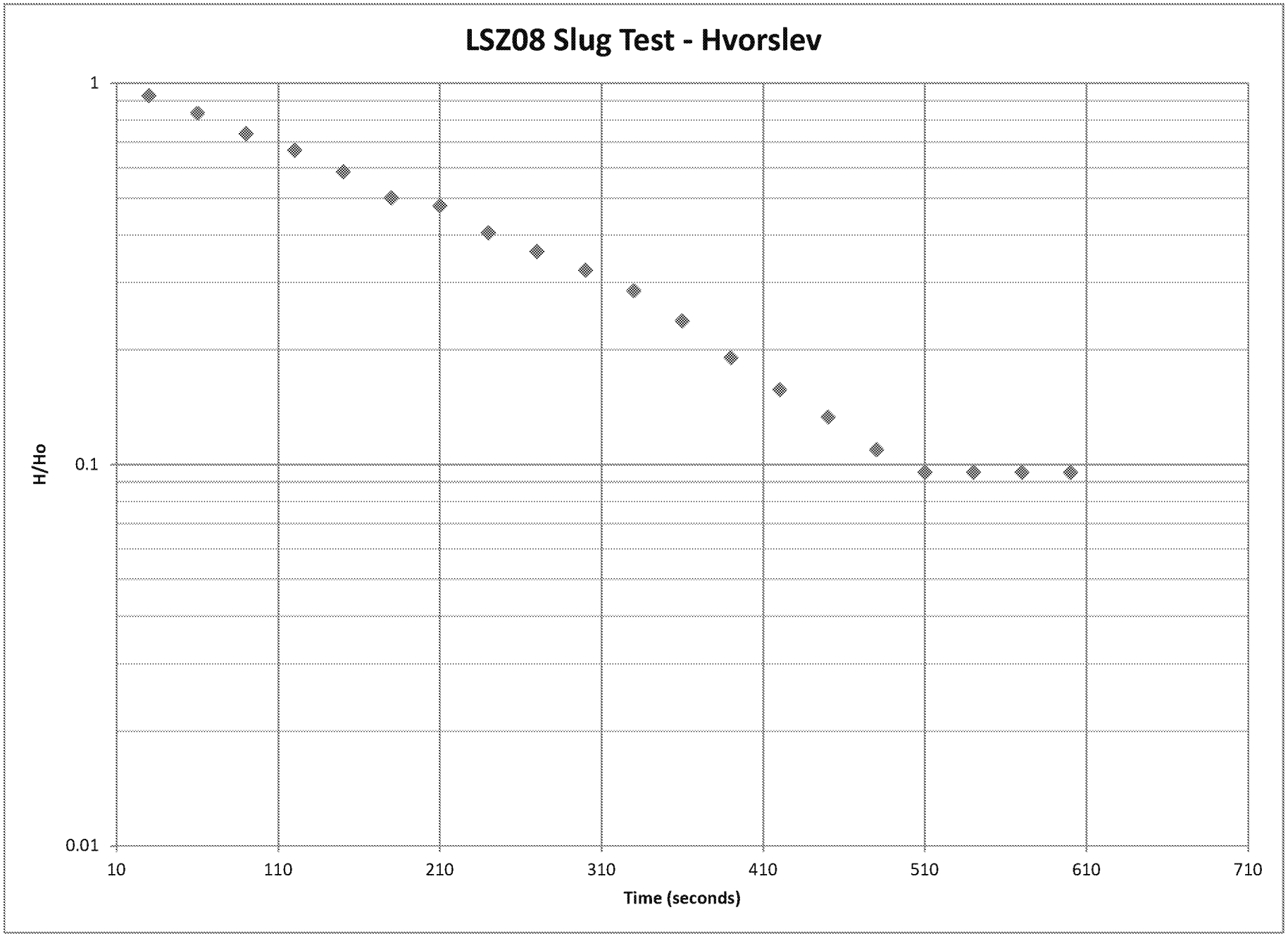
Hydraulic Conductivity (K) Calculations LSZ08

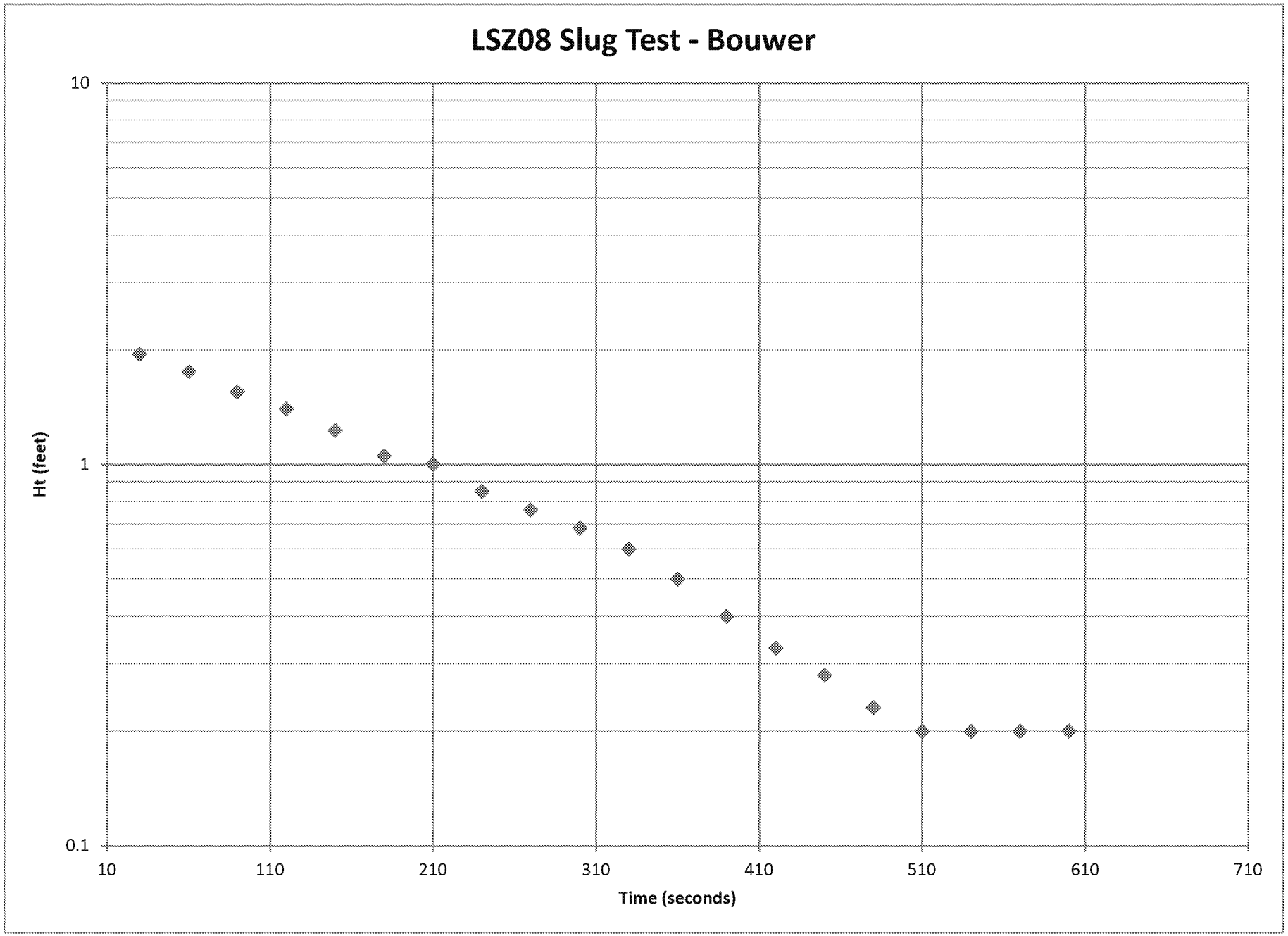
Hvorslev Slug Test Method
K = r2ln(Le/R)/2LeTo)

K = hydraulic conductivity
r = radius of the well casing 0.25 ft (3 in)
R = radius of the well screen (borehole) 0.42 ft (5 in)
Le = length of the well screen 40 ft
To = time it takes water level to rise or fall to
37% of the initial change 265

r2	0.0625	ft2
Le/R	95.23809524	ft/ft
2LeTo	21200	ft sec
ln(Le/R)	4.556380022	
K	1.34327E-05	ft/sec
K	**1.160587364**	**ft/day**


LSZ08 Slug Test - Cooper
H/Ho
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
10
100
1000
Time (seconds)


LSZ08 Slug Test - Hvorslev
1
0.1
0.01
H/Ho
10
110
210
310
410
510
610
710
Time (seconds)


LSZ08 Slug Test - Bouwer
10
1
0.1
Ht (feet)
10
110
210
310
410
510
610
710
Time (seconds)

Water Level Measurement Form

Project	9101110001	Project Name	Williams Air Force Base - ST012
Meter Type	Solinst Model 122	Measuring Point	TOC
Field Personnel	Stephen Flora	Project Manager	Jim Clarke

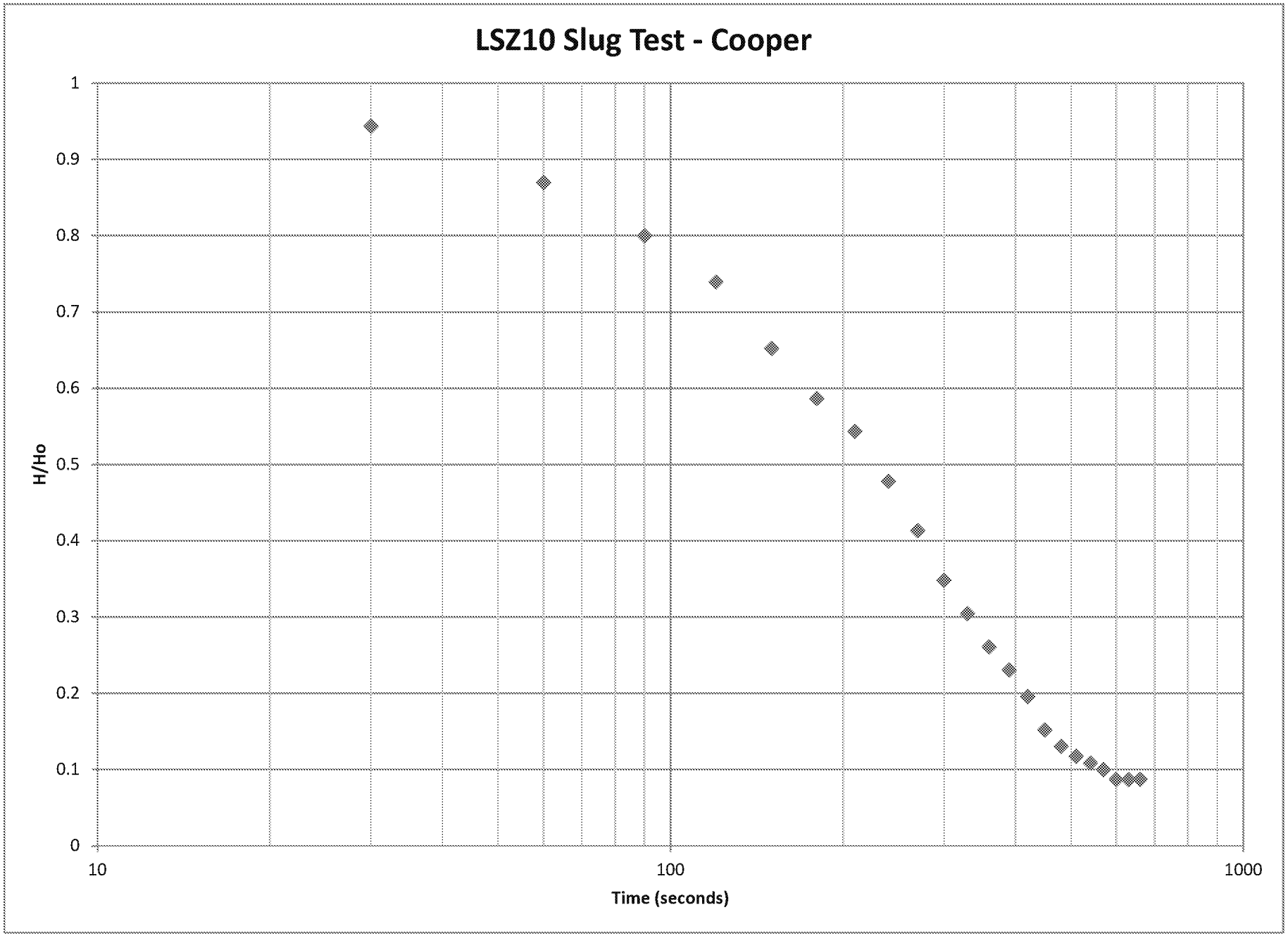
Monitoring Well Number	Date	Time	Time since start of slug test (sec)	Depth to Water (ft BTOC)	H (ft)	H/Ho	Comments
LSZ10	4/8/2013	10:35		152.2			Static Water Level
		10:36					5 Gallon Slug of Water
		10:37	0	149.9	2.3	1	
			30	150.03	2.17	0.943478261	
		10:38	60	150.2	2	0.869565217	
			90	150.36	1.84	0.8	
		10:39	120	150.5	1.7	0.739130435	
			150	150.7	1.5	0.652173913	
		10:40	180	150.85	1.35	0.586956522	
			210	150.95	1.25	0.543478261	
		10:41	240	151.1	1.1	0.47826087	
			270	151.25	0.95	0.413043478	
		10:42	300	151.4	0.8	0.347826087	
			330	151.5	0.7	0.304347826	
		10:43	360	151.6	0.6	0.260869565	
			390	151.67	0.53	0.230434783	
		10:44	420	151.75	0.45	0.195652174	
			450	151.85	0.35	0.152173913	
		10:45	480	151.9	0.3	0.130434783	
			510	151.93	0.27	0.117391304	
		10:46	540	151.95	0.25	0.108695652	
			570	151.97	0.23	0.1	
		10:47	600	152	0.2	0.086956522	
			630	152	0.2	0.086956522	
		10:48	660	152	0.2	0.086956522	End of WL readings

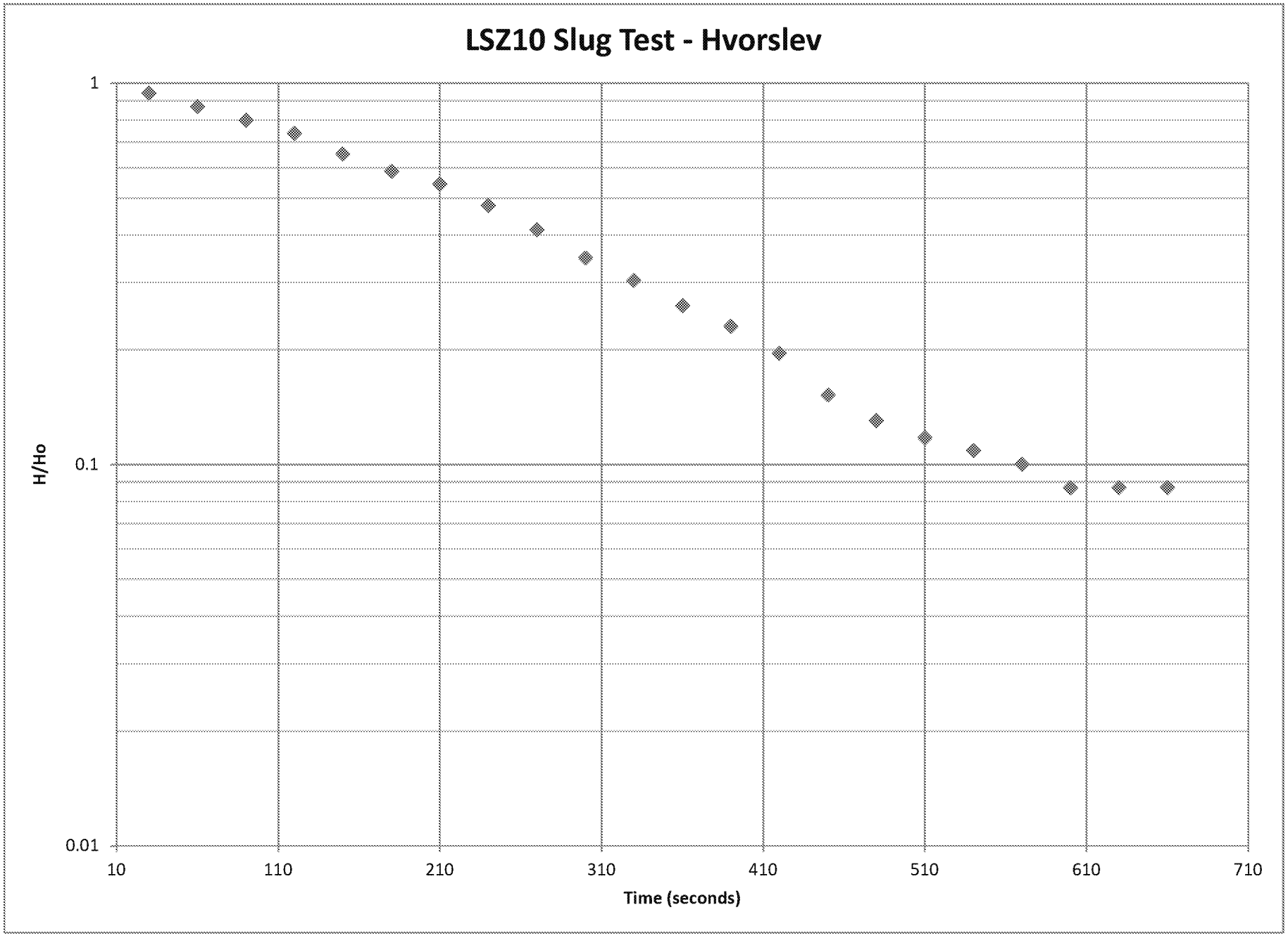
Hydraulic Conductivity (K) Calculations LSZ10

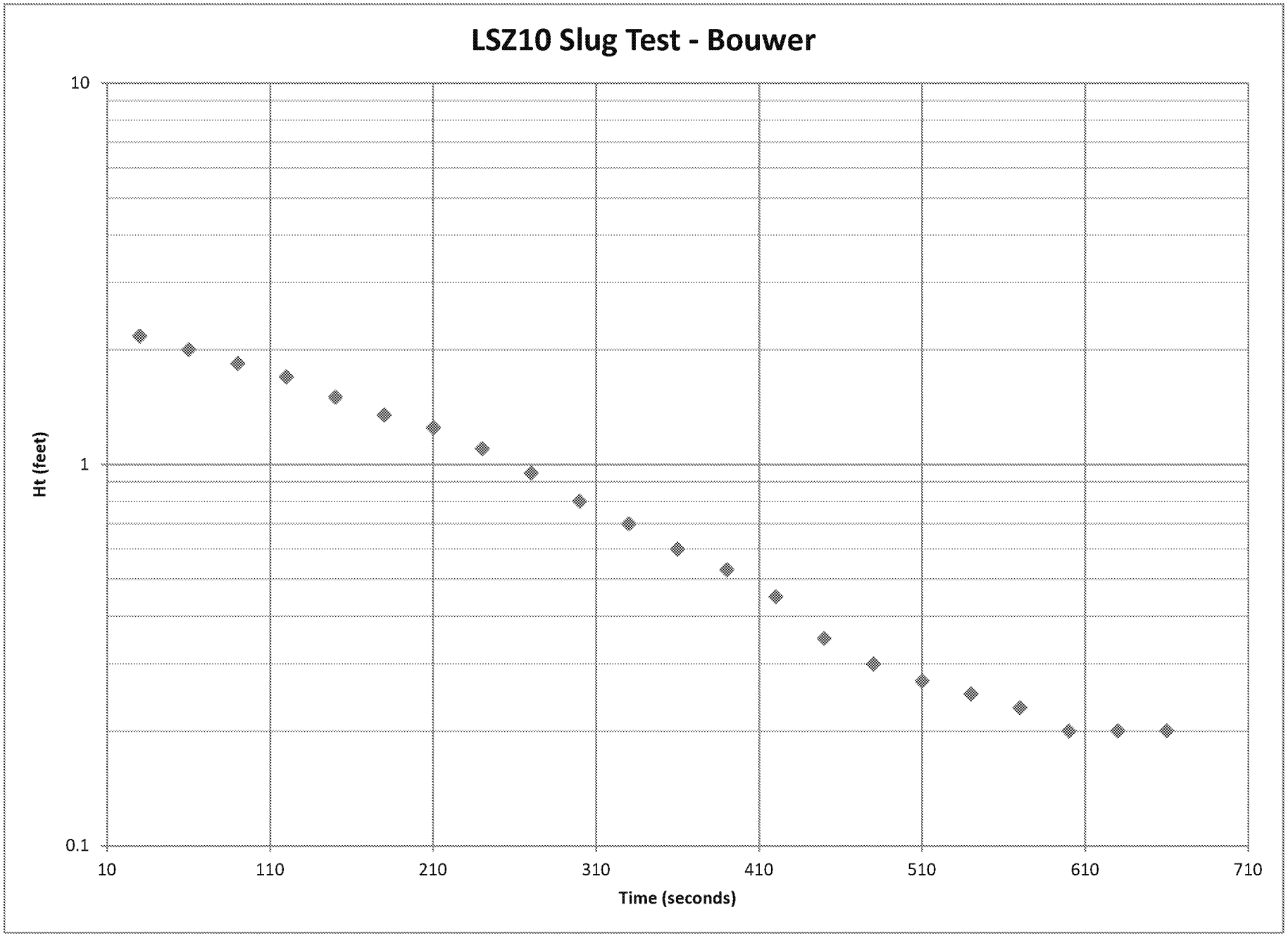
Hvorslev Slug Test Method
K = r2ln(Le/R)/2LeTo)

K = hydraulic conductivity
r = radius of the well casing 0.25 ft (3 in)
R = radius of the well screen (borehole) 0.42 ft (5 in)
Le = length of the well screen 40 ft
To = time it takes water level to rise or fall to
37% of the initial change 290 sec

r2	0.0625	ft2
Le/R	95.23809524	ft/ft
2LeTo	23200	ft sec
ln(Le/R)	4.556380022	
K	1.22747E-05	ft/sec
K	**1.060536729**	**ft/day**


LSZ10 Slug Test - Cooper
H/Ho
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
10
100
1000
Time (seconds)


LSZ10 Slug Test - Hvorslev
H/Ho
1
0.1
0.01
10
110
210
310
410
510
610
710
Time (seconds)


LSZ10 Slug Test - Bouwer
10
1
0.1
Ht (feet)
10
110
210
310
410
510
610
710
Time (seconds)

Water Level Measurement Form

Project	9101110001	Project Name	Williams Air Force Base - ST012
Meter Type	Solinst Model 122	Measuring Point	TOC
Field Personnel	Stephen Flora	Project Manager	Jim Clarke

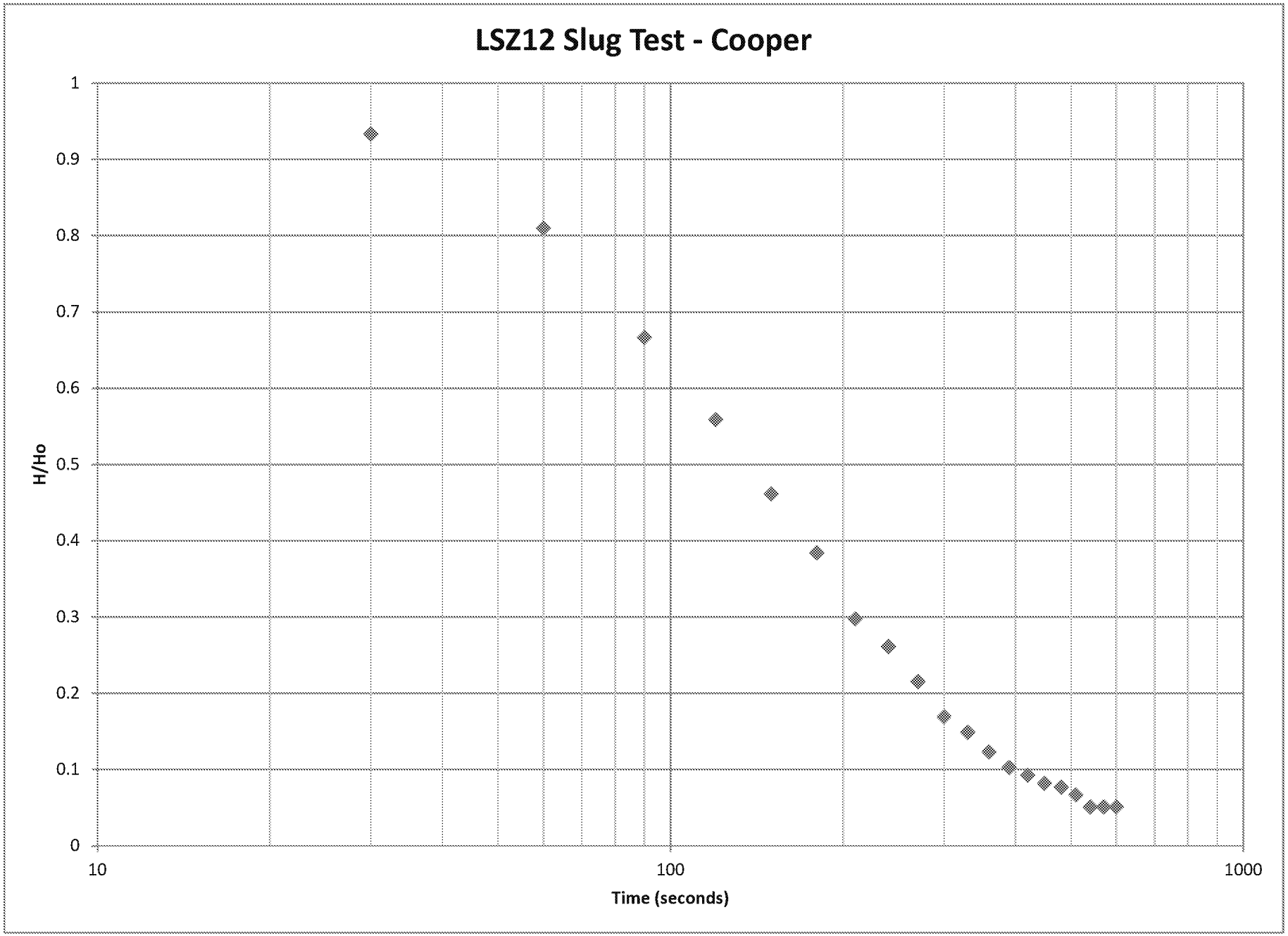
Monitoring Well Number	Date	Time	Time since start of slug test (sec)	Depth to Water (ft BTOC)	H (ft)	H/Ho	Comments
LSZ12	4/8/2013	14:25		155.15			Static Water Level
		14:26					5 Gallon Slug of Water
		14:27	0	153.2	1.95	1	
			30	153.33	1.82	0.933333333	
		14:28	60	153.57	1.58	0.81025641	
			90	153.85	1.3	0.666666667	
		14:29	120	154.06	1.09	0.558974359	
			150	154.25	0.9	0.461538462	
		14:30	180	154.4	0.75	0.384615385	
			210	154.57	0.58	0.297435897	
		14:31	240	154.64	0.51	0.261538462	
			270	154.73	0.42	0.215384615	
		14:32	300	154.82	0.33	0.169230769	
			330	154.86	0.29	0.148717949	
		14:33	360	154.91	0.24	0.123076923	
			390	154.95	0.2	0.102564103	
		14:34	420	154.97	0.18	0.092307692	
			450	154.99	0.16	0.082051282	
		14:35	480	155	0.15	0.076923077	
			510	155.02	0.13	0.066666667	
		14:36	540	155.05	0.1	0.051282051	
			570	155.05	0.1	0.051282051	
		14:37	600	155.05	0.1	0.051282051	End of WL readings

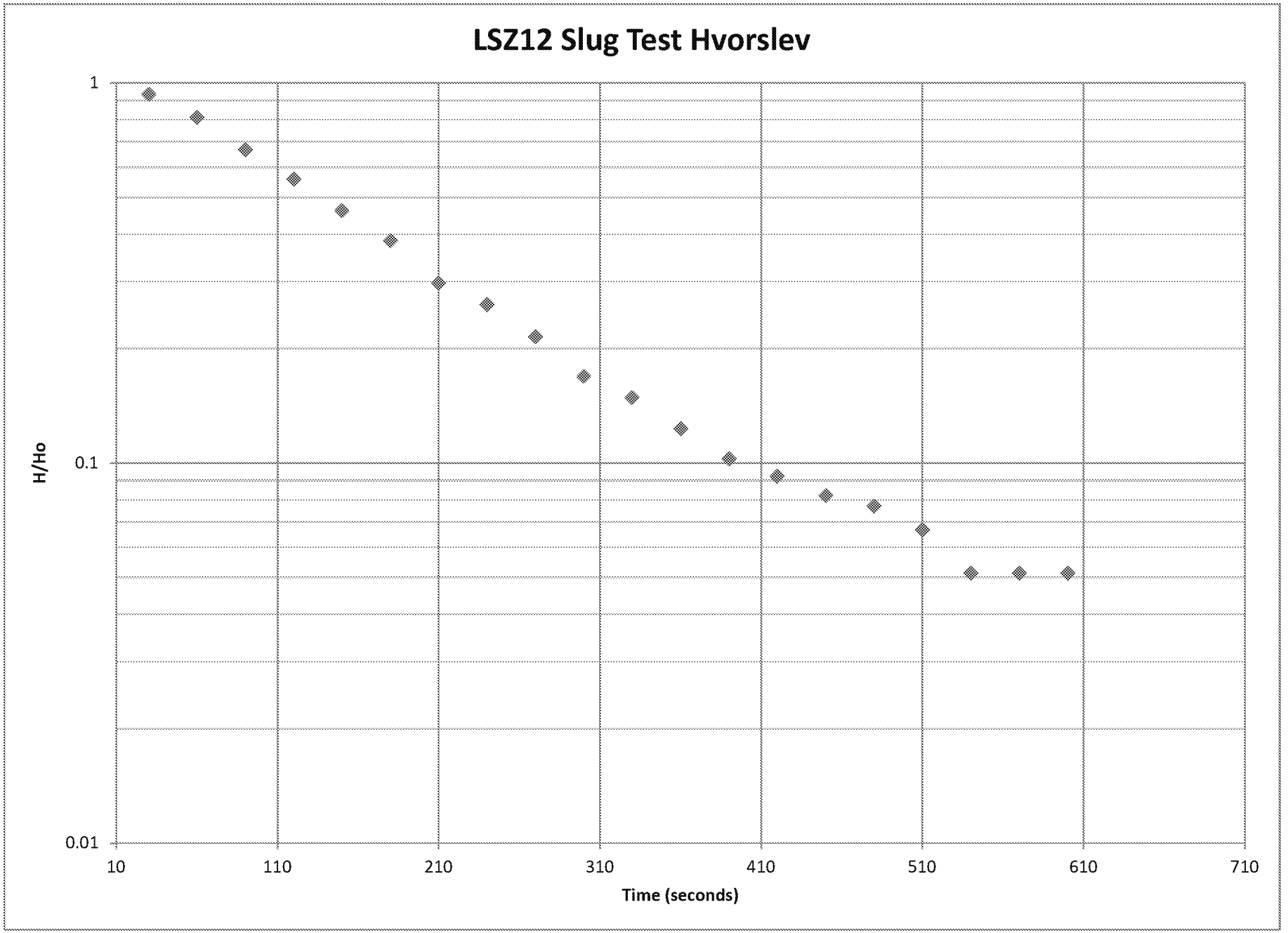
Hydraulic Conductivity (K) Calculations LSZ12

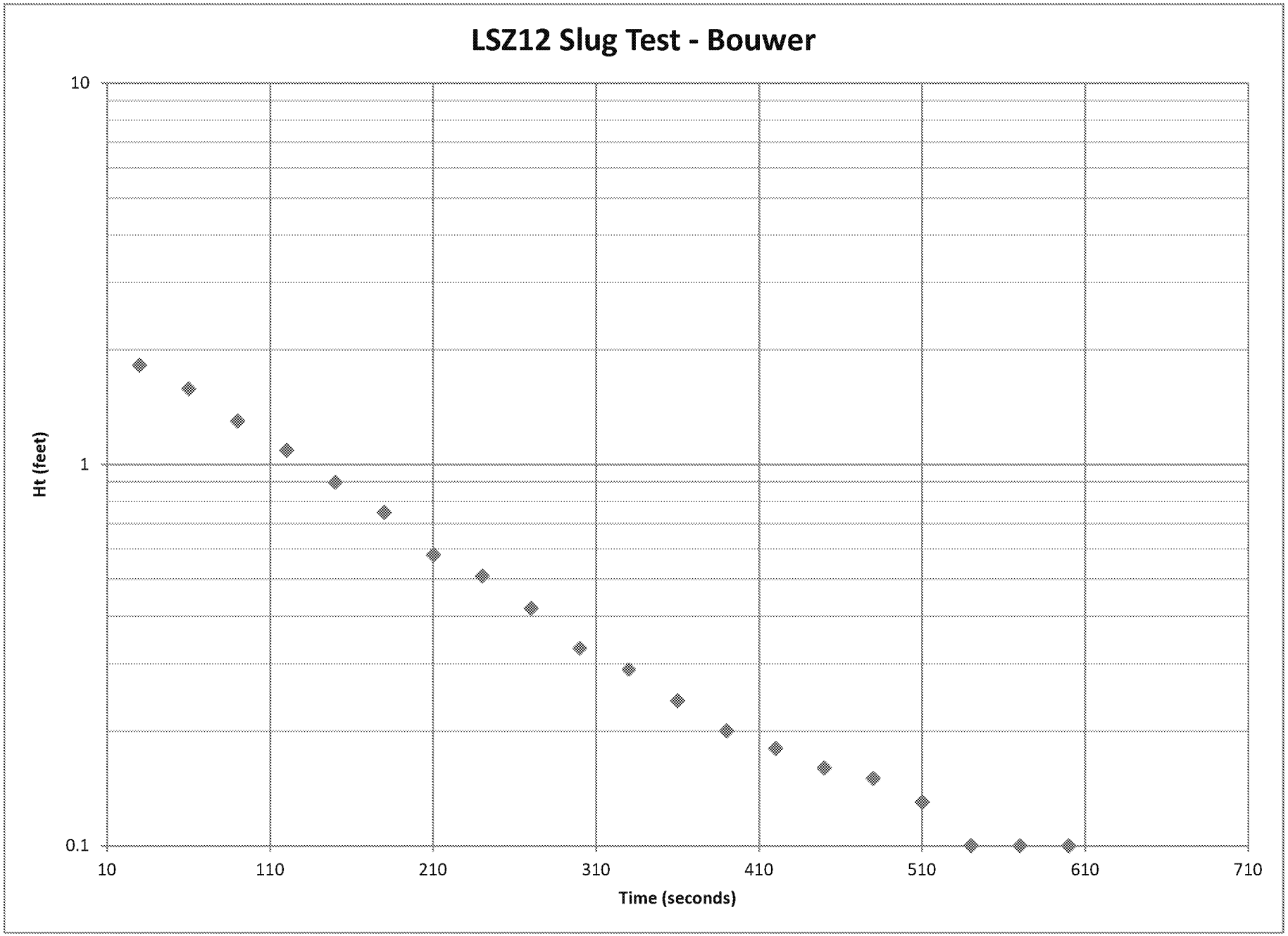
Hvorslev Slug Test Method
K = r2ln(Le/R)/2LeTo)

K = hydraulic conductivity
r = radius of the well casing 0.25 ft (3 in)
R = radius of the well screen (borehole) 0.42 ft (5 in)
Le = length of the well screen 40 ft
To = time it takes water level to rise or fall to 37% of the initial change 185

r2	0.0625	ft2
Le/R	95.23809524	ft/ft
2LeTo	14800	ft sec
ln(Le/R)	4.556380022	
K	1.92415E-05	ft/sec
K	**1.662462981**	**ft/day**


LSZ12 Slug Test - Cooper
H/Ho
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
10
100
1000
Time (seconds)


LSZ12 Slug Test Hvorslev
1
0.1
0.01
H/Ho
10
110
210
310
410
510
610
710
Time (seconds)


LSZ12 Slug Test - Bouwer
10
1
0.1
Ht (feet)
10
110
210
310
410
510
610
710
Time (seconds)

Water Level Measurement Form

Project	9101110001	Project Name	Williams Air Force Base - ST012
Meter Type	Solinst Model 122	Measuring Point	TOC
Field Personnel	Stephen Flora	Project Manager	Jim Clarke

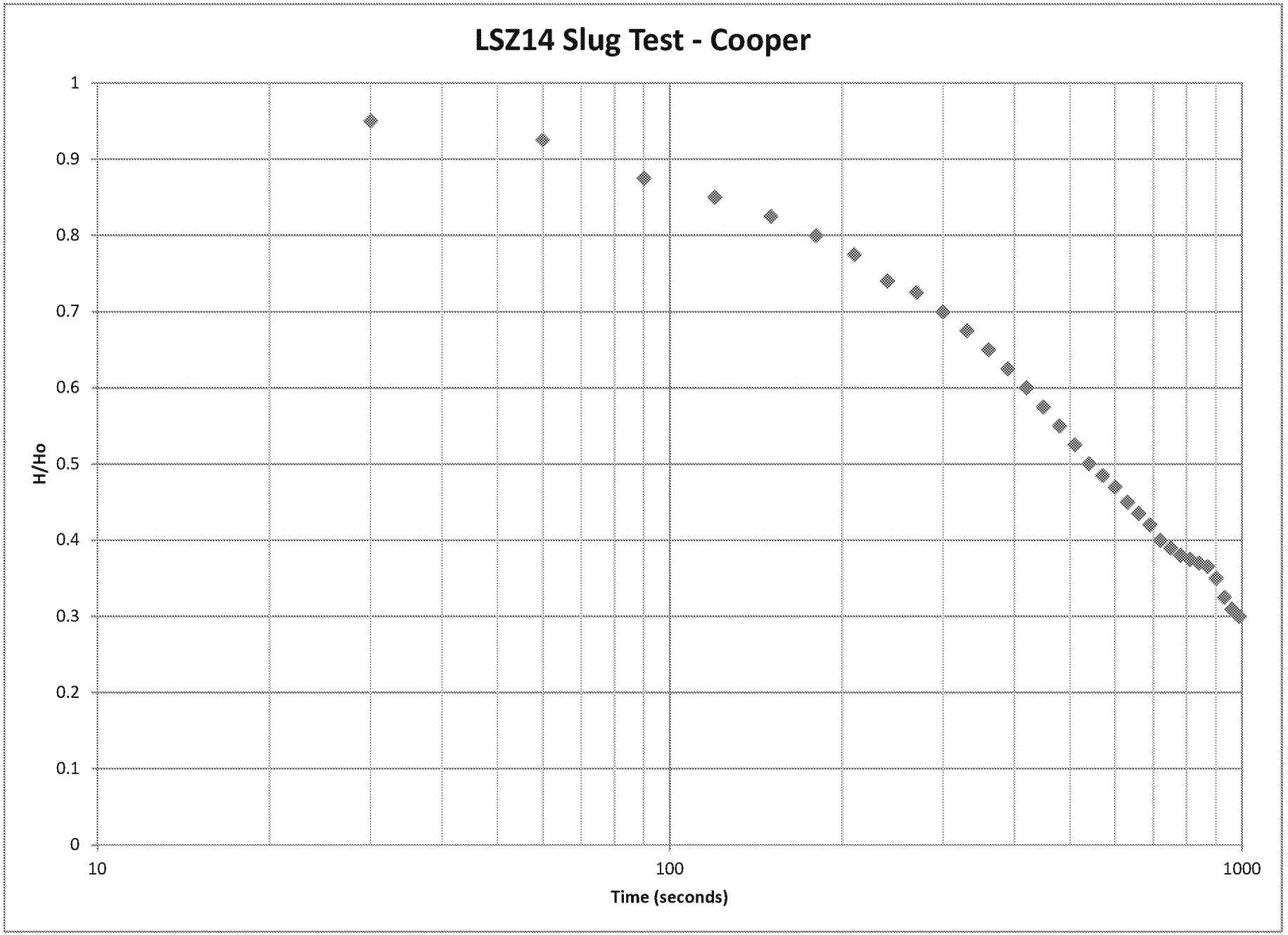
Monitoring Well Number	Date	Time	Time since start of slug test (sec)	Depth to Water (ft BTOC)	H (ft)	H/Ho	Comments
LSZ14	4/8/2013	14:53		154.8			Static Water Level
		14:54					5 Gallon Slug of Water
		14:55	0	152.8	2	1	
			30	152.9	1.9	0.95	
		14:56	60	152.95	1.85	0.925	
			90	153.05	1.75	0.875	
		14:57	120	153.1	1.7	0.85	
			150	153.15	1.65	0.825	
		14:58	180	153.2	1.6	0.8	
			210	153.25	1.55	0.775	
		14:59	240	153.32	1.48	0.74	
			270	153.35	1.45	0.725	
		15:00	300	153.4	1.4	0.7	
			330	153.45	1.35	0.675	
		15:01	360	153.5	1.3	0.65	
			390	153.55	1.25	0.625	
		15:02	420	153.6	1.2	0.6	
			450	153.65	1.15	0.575	
		15:03	480	153.7	1.1	0.55	
			510	153.75	1.05	0.525	
		15:04	540	153.8	1	0.5	
			570	153.83	0.97	0.485	
		15:05	600	153.86	0.94	0.47	
			630	153.9	0.9	0.45	
		15:06	660	153.93	0.87	0.435	
			690	153.96	0.84	0.42	
		15:07	720	154	0.8	0.4	
			750	154.02	0.78	0.39	
		15:08	780	154.04	0.76	0.38	WL Meter issues - continuous buzz
LSZ14	4/18/2013		810	154.05	0.75	0.375	WL Meter issues - continuous buzz
		15:09	840	154.06	0.74	0.37	
			870	154.07	0.73	0.365	
		15:10	900	154.1	0.7	0.35	
			930	154.15	0.65	0.325	
		15:11	960	154.18	0.62	0.31	
			990	154.2	0.6	0.3	
		15:12	1020	154.22	0.58	0.29	
			1050	154.25	0.55	0.275	
		15:13	1080	154.3	0.5	0.25	
			1110	154.35	0.45	0.225	
		15:14	1140	154.38	0.42	0.21	
			1170	154.4	0.4	0.2	
		15:15	1200	154.4	0.4	0.2	
			1230	154.4	0.4	0.2	
		15:16	1260	154.4	0.4	0.2	End of WL readings

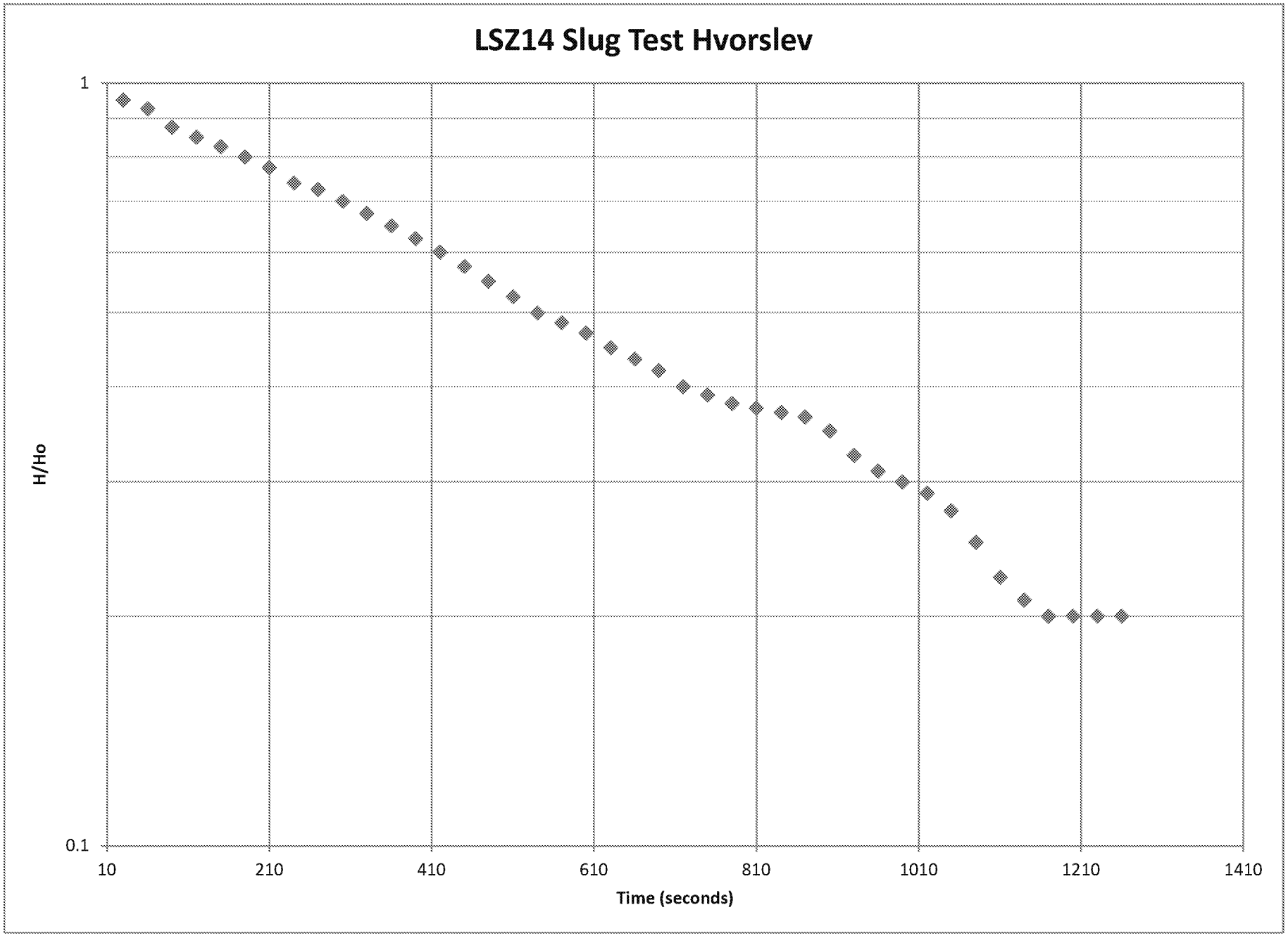
Hydraulic Conductivity (K) Calculations LSZ14

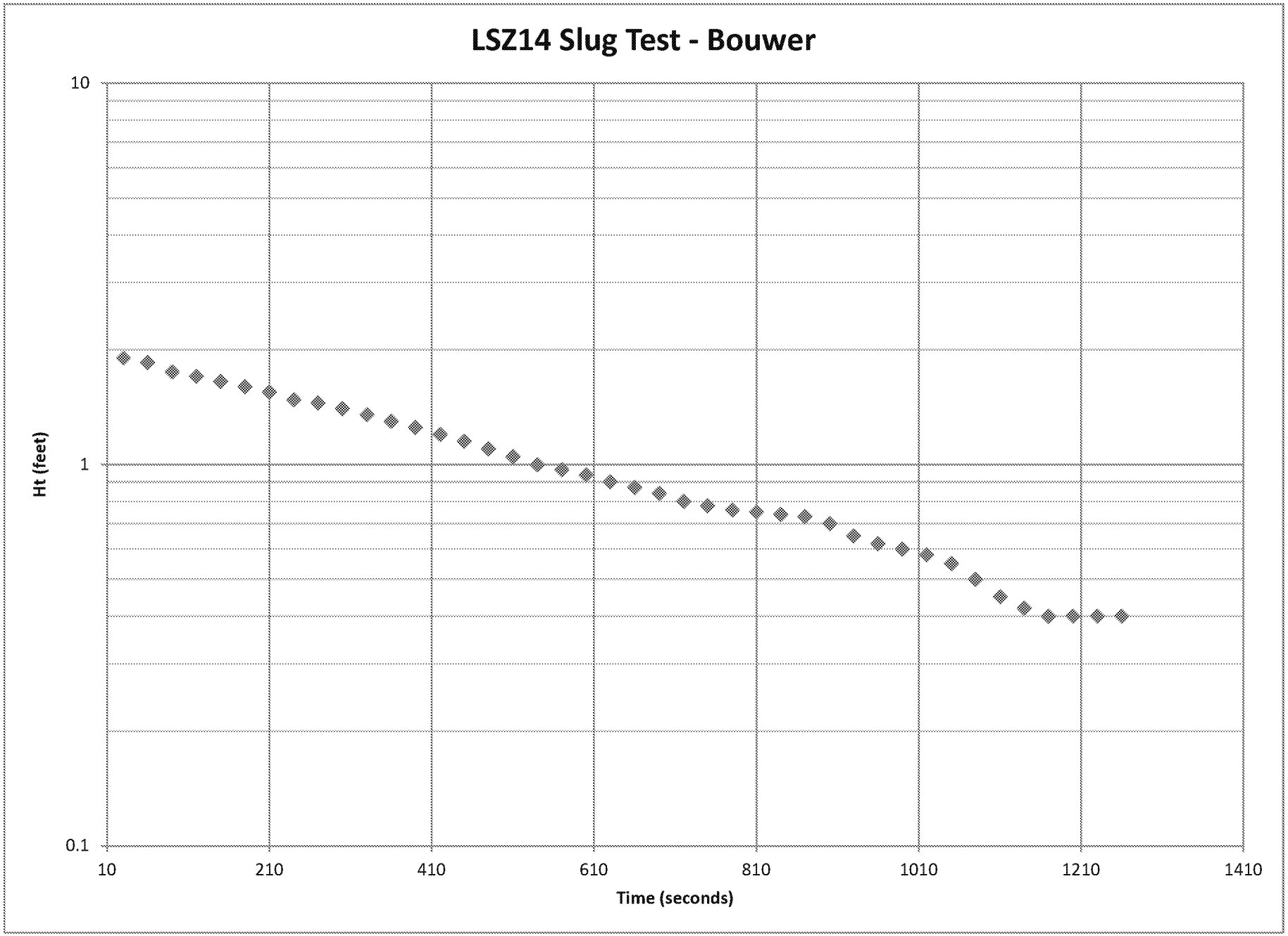
Hvorslev Slug Test Method
K = r2ln(Le/R)/2LeTo)

K = hydraulic conductivity
r = radius of the well casing 0.25 ft (3 in)
R = radius of the well screen (borehole) 0.42 ft (5 in)
Le = length of the well screen 40 ft
To = time it takes water level to rise or fall to
37% of the initial change 840

r2	0.0625	ft2
Le/R	95.23809524	ft/ft
2LeTo	67200	ft sec
ln(Le/R)	4.556380022	
K	4.2377E-06	ft/sec
K	**0.36613768**	**ft/day**


LSZ14 Slug Test - Cooper
H/Ho
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
10
100
1000
Time (seconds)


LSZ14 Slug Test Hvorslev
1
0.1
H/Ho
10
210
410
610
810
1010
1210
1410
Time (seconds)


LSZ14 Slug Test - Bouwer
10
1
0.1
Ht (feet)
10
210
410
610
810
1010
1210
1410
Time (seconds)

Water Level Measurement Form

Project	9101110001	Project Name	Williams Air Force Base - ST012
Meter Type	Solinst Model 122	Measuring Point	TOC
Field Personnel	Stephen Flora	Project Manager	Jim Clarke

Monitoring Well Number	Date	Time	Time since start of slug test (sec)	Depth to Water (ft BTOC)	H (ft)	H/Ho	Comments
UWBZ07	4/9/2013	10:38		153.97			Static Water Level
		10:39					5 Gallon Slug of Water
		10:40	0				Unable to get accurate reading with WL meter

ATTACHMENT A.8

IDW MANAGEMENT DOCUMENTS

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

4625 East Cotton Center Blvd. Ste 189, Phoenix, AZ 85040 (602) 437-3340 Fax:(602) 454-9303

LABORATORY REPORT

Prepared For: AMEC Environment & Infrastructure Inc - Phoenix
4600 E Washington Street, 6th Floor
Phoenix, AZ 85034
Attention: Jim Clarke

Project: FWAFBST012FD/RA Mesa, AZ

Sampled: 02/10/13-02/11/13
Received: 02/11/13
Issued: 02/25/13 17:11

NELAP #01109CA / AZ100001 Arizona DHS#AZ0728

The results listed within this Laboratory Report pertain only to the samples tested in the laboratory. The analyses contained in this report were performed in accordance with the applicable certifications as noted. All soil samples are reported on a wet weight basis unless otherwise noted in the report. This Laboratory Report is confidential and is intended for the sole use of TestAmerica and its client. This report shall not be reproduced, except in full, without written permission from TestAmerica. The Chain of Custody, 1 page, is included and is an integral part of this report.
This entire report was reviewed and approved for release.

CASE NARRATIVE

LABORATORY ID	CLIENT ID	MATRIX
PWB0697-01	ST012-IDW1-213-SP-N	Soil
PWB0697-02	ST012-IDW1a/1b/1c/1d-213-SP-N	Soil
PWB0697-03	EB-01-021113	Water

TestAmerica Phoenix

Kylie Emily
Project Manager

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THE LEADER IN ENVIRONMENTAL TESTING
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AMEC Environment & Infrastructure Inc - Phoenix
4600 E Washington Street, 6th Floor
Phoenix, AZ 85034
Attention: Jim Clarke

Project ID: FWAFBST012FD/RA Mesa, AZ
Report Number: PWB0697

Sampled: 02/10/13-02/11/13
Received: 02/11/13

SAMPLE RECEIPT:	Samples were received intact, at 4°C, on ice and with chain of custody documentation.
HOLDING TIMES:	All samples were analyzed within prescribed holding times and/or in accordance with the TestAmerica Sample Acceptance Policy unless otherwise noted in the report.
PRESERVATION:	Samples requiring preservation were verified prior to sample analysis.
QA/QC CRITERIA:	All analyses met method criteria, except as noted in the report with data qualifiers. L3-Laboratory Control Sample and/or Laboratory Control Sample Duplicate recovery was above the acceptance limits. Analyte not detected, data not impacted. N1-The LCS and/or LCSD as well as the MS and/or MSD recovered high and outside of acceptance limits. All associated samples are non-detect for this compound and therefore should not be impacted. N1a-There was no MS/MSD analyzed with this batch due to the nature of the source sample matrix. N1b-13B0354-MS Only-The LCS and/or LCSD as well as the MS and/or MSD recovered high and outside of acceptance limits. All associated samples are non-detect for this compound and therefore should not be impacted. N1b- The initial calibration verification analyzed immediately following the calibration recovered high and outside of acceptance limits for Vinyl Acetate. All associated samples had results less than the reporting limit for this analyte and therefore should not be impacted. N1c-Due to sample matrix effects, the surrogate recovery was outside the acceptance limits.
COMMENTS:	Results that fall between the MDL and RL are 'E4' flagged.
SUBCONTRACTED:	No analyses were subcontracted to an outside laboratory.

Reviewed By:

TestAmerica Phoenix

Kylie Emily
Project Manager

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AMEC Environment & Infrastructure Inc - Phoenix
4600 E Washington Street, 6th Floor
Phoenix, AZ 85034
Attention: Jim Clarke

Project ID: FWAFBST012FD/RA Mesa, AZ
Report Number: PWB0697

Sampled: 02/10/13-02/11/13
Received: 02/11/13

EXTRACTABLE FUEL HYDROCARBONS (ADHS 8015AZR1)

Analyte	Method	Batch	Reporting Limit	Sample Result	Dilution Factor	Date Extracted	Date Analyzed	Data Qualifiers
Sample ID: PWB0697-01 (ST012-IDW1-213-SP-N - Soil)					**Sampled: 02/10/13**			
Reporting Units: mg/kg								
DRO (C10-C22)	8015AZ R.1	13B0403	30	**210**	0.996	2/12/2013	2/13/2013	
ORO (C22-C32)	8015AZ R.1	13B0403	100	ND	0.996	2/12/2013	2/13/2013	
Total (C10-C32)	8015AZ R.1	13B0403	130	**210**	0.996	2/12/2013	2/13/2013	
Surrogate: o-terphenyl (70-130%)				*95 %*				

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Kylie Emily
Project Manager

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Phoenix, AZ 85034
Attention: Jim Clarke

Project ID: FWAFBST012FD/RA Mesa, AZ
Report Number: PWB0697

Sampled: 02/10/13-02/11/13
Received: 02/11/13

VOLATILE ORGANICS BY GC/MS (EPA 5030B/8260B)

Analyte	Method	Batch	Reporting Limit	Sample Result	Dilution Factor	Date Extracted	Date Analyzed	Data Qualifiers
Sample ID: PWB0697-03 (EB-01-021113 - Water)					**Sampled: 02/11/13**			
Reporting Units: ug/l								
1,1,1-Trichloroethane	EPA 8260B	13B0552	1.0	ND	1	2/15/2013	2/15/2013	
1,1,2,2-Tetrachloroethane	EPA 8260B	13B0552	1.0	ND	1	2/15/2013	2/15/2013	
1,1,2-Trichloroethane	EPA 8260B	13B0552	1.0	ND	1	2/15/2013	2/15/2013	
1,1-Dichloroethane	EPA 8260B	13B0552	1.0	ND	1	2/15/2013	2/15/2013	
1,1-Dichloroethene	EPA 8260B	13B0552	1.0	ND	1	2/15/2013	2/15/2013	
1,1-Dichloropropene	EPA 8260B	13B0552	1.0	ND	1	2/15/2013	2/15/2013	
1,2,3-Trichlorobenzene	EPA 8260B	13B0552	2.0	ND	1	2/15/2013	2/15/2013	
1,2,3-Trichloropropane	EPA 8260B	13B0552	2.0	ND	1	2/15/2013	2/15/2013	
1,2,4-Trichlorobenzene	EPA 8260B	13B0552	2.0	ND	1	2/15/2013	2/15/2013	
1,2,4-Trimethylbenzene	EPA 8260B	13B0552	1.0	ND	1	2/15/2013	2/15/2013	
1,2-Dibromoethane (EDB)	EPA 8260B	13B0552	1.0	ND	1	2/15/2013	2/15/2013	
1,2-Dichlorobenzene	EPA 8260B	13B0552	1.0	ND	1	2/15/2013	2/15/2013	
1,2-Dichloroethane	EPA 8260B	13B0552	1.0	ND	1	2/15/2013	2/15/2013	
1,2-Dichloropropane	EPA 8260B	13B0552	1.0	ND	1	2/15/2013	2/15/2013	
1,3,5-Trimethylbenzene	EPA 8260B	13B0552	1.0	ND	1	2/15/2013	2/15/2013	
1,3-Dichlorobenzene	EPA 8260B	13B0552	1.0	ND	1	2/15/2013	2/15/2013	
1,3-Dichloropropane	EPA 8260B	13B0552	1.0	ND	1	2/15/2013	2/15/2013	
1,4-Dichlorobenzene	EPA 8260B	13B0552	1.0	ND	1	2/15/2013	2/15/2013	
2,2-Dichloropropane	EPA 8260B	13B0552	2.0	ND	1	2/15/2013	2/15/2013	
2-Butanone (MEK)	EPA 8260B	13B0552	5.0	ND	1	2/15/2013	2/15/2013	
2-Chlorotoluene	EPA 8260B	13B0552	1.0	ND	1	2/15/2013	2/15/2013	
2-Hexanone	EPA 8260B	13B0552	5.0	ND	1	2/15/2013	2/15/2013	
4-Chlorotoluene	EPA 8260B	13B0552	1.0	ND	1	2/15/2013	2/15/2013	
4-Methyl-2-pentanone (MIBK)	EPA 8260B	13B0552	5.0	ND	1	2/15/2013	2/15/2013	
Acetone	EPA 8260B	13B0552	20	ND	1	2/15/2013	2/15/2013	
Benzene	EPA 8260B	13B0552	1.0	ND	1	2/15/2013	2/15/2013	
Bromobenzene	EPA 8260B	13B0552	1.0	ND	1	2/15/2013	2/15/2013	
Bromochloromethane	EPA 8260B	13B0552	1.0	ND	1	2/15/2013	2/15/2013	
Bromodichloromethane	EPA 8260B	13B0552	1.0	ND	1	2/15/2013	2/15/2013	
Bromoform	EPA 8260B	13B0552	1.0	ND	1	2/15/2013	2/15/2013	
Bromomethane	EPA 8260B	13B0552	2.0	ND	1	2/15/2013	2/15/2013	
Carbon tetrachloride	EPA 8260B	13B0552	1.0	ND	1	2/15/2013	2/15/2013	
Chlorobenzene	EPA 8260B	13B0552	1.0	ND	1	2/15/2013	2/15/2013	
Chloroethane	EPA 8260B	13B0552	1.0	ND	1	2/15/2013	2/15/2013	
Chloroform	EPA 8260B	13B0552	1.0	ND	1	2/15/2013	2/15/2013	
Chloromethane	EPA 8260B	13B0552	5.0	ND	1	2/15/2013	2/15/2013	
cis-1,2-Dichloroethene	EPA 8260B	13B0552	1.0	ND	1	2/15/2013	2/15/2013	
cis-1,3-Dichloropropene	EPA 8260B	13B0552	1.0	ND	1	2/15/2013	2/15/2013	
Dibromochloromethane	EPA 8260B	13B0552	1.0	ND	1	2/15/2013	2/15/2013	
Dichlorodifluoromethane	EPA 8260B	13B0552	1.0	ND	1	2/15/2013	2/15/2013	

TestAmerica Phoenix

Kylie Emily
Project Manager

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AMEC Environment & Infrastructure Inc - Phoenix
4600 E Washington Street, 6th Floor
Phoenix, AZ 85034
Attention: Jim Clarke

Project ID: FWAFBST012FD/RA Mesa, AZ
Report Number: PWB0697

Sampled: 02/10/13-02/11/13
Received: 02/11/13

VOLATILE ORGANICS BY GC/MS (EPA 5030B/8260B)

Analyte	Method	Batch	Reporting Limit	Sample Result	Dilution Factor	Date Extracted	Date Analyzed	Data Qualifiers
Sample ID: PWB0697-03 (EB-01-021113 - Water) - cont.					**Sampled: 02/11/13**			
Reporting Units: ug/l								
Ethylbenzene	EPA 8260B	13B0552	1.0	ND	1	2/15/2013	2/15/2013	
m,p-Xylenes	EPA 8260B	13B0552	2.0	ND	1	2/15/2013	2/15/2013	
Methyl-tert-butyl Ether (MTBE)	EPA 8260B	13B0552	1.0	ND	1	2/15/2013	2/15/2013	
Methylene Chloride	EPA 8260B	13B0552	2.0	ND	1	2/15/2013	2/15/2013	
n-Butylbenzene	EPA 8260B	13B0552	1.0	ND	1	2/15/2013	2/15/2013	
n-Propylbenzene	EPA 8260B	13B0552	1.0	ND	1	2/15/2013	2/15/2013	
o-Xylene	EPA 8260B	13B0552	1.0	ND	1	2/15/2013	2/15/2013	
p-Isopropyltoluene	EPA 8260B	13B0552	1.0	ND	1	2/15/2013	2/15/2013	
sec-Butylbenzene	EPA 8260B	13B0552	1.0	ND	1	2/15/2013	2/15/2013	
Styrene	EPA 8260B	13B0552	1.0	ND	1	2/15/2013	2/15/2013	
tert-Butylbenzene	EPA 8260B	13B0552	1.0	ND	1	2/15/2013	2/15/2013	
Tetrachloroethene	EPA 8260B	13B0552	1.0	ND	1	2/15/2013	2/15/2013	
Toluene	EPA 8260B	13B0552	1.0	ND	1	2/15/2013	2/15/2013	
trans-1,2-Dichloroethene	EPA 8260B	13B0552	1.0	ND	1	2/15/2013	2/15/2013	
trans-1,3-Dichloropropene	EPA 8260B	13B0552	1.0	ND	1	2/15/2013	2/15/2013	
Trichloroethene	EPA 8260B	13B0552	1.0	ND	1	2/15/2013	2/15/2013	
Trichlorofluoromethane	EPA 8260B	13B0552	1.0	ND	1	2/15/2013	2/15/2013	
Vinyl Acetate	EPA 8260B	13B0552	2.0	ND	1	2/15/2013	2/15/2013	L3, N1b
Vinyl chloride	EPA 8260B	13B0552	1.0	ND	1	2/15/2013	2/15/2013	
Surrogate: Dibromofluoromethane (70-130%)				*106 %*				
Surrogate: Toluene-d8 (70-130%)				*91 %*				
Surrogate: 4-Bromofluorobenzene (70-130%)				*93 %*				

TestAmerica Phoenix

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Report Number: PWB0697
Sampled: 02/10/13-02/11/13
Received: 02/11/13

VOLATILE ORGANICS BY GC/MS (EPA 5035/8260B)

Analyte	Method	Batch	Reporting Limit	Sample Result	Dilution Factor	Date Extracted	Date Analyzed	Data Qualifiers
Sample ID: PWB0697-02 (ST012-IDW1a/1b/1c/1d-213-SP-N - Soil)				**Sampled: 02/10/13**				
Reporting Units: ug/kg								
1,1,1-Trichloroethane	EPA 8260B	13B0354	210	ND	4.29	2/10/2013	2/15/2013	
1,1,2,2-Tetrachloroethane	EPA 8260B	13B0354	210	ND	4.29	2/10/2013	2/15/2013	
1,1,2-Trichloroethane	EPA 8260B	13B0354	210	ND	4.29	2/10/2013	2/15/2013	
1,1-Dichloroethane	EPA 8260B	13B0354	210	ND	4.29	2/10/2013	2/15/2013	
1,1-Dichloroethene	EPA 8260B	13B0354	210	ND	4.29	2/10/2013	2/15/2013	
1,1-Dichloropropene	EPA 8260B	13B0354	210	ND	4.29	2/10/2013	2/15/2013	
1,2,3-Trichlorobenzene	EPA 8260B	13B0354	430	ND	4.29	2/10/2013	2/15/2013	
1,2,3-Trichloropropane	EPA 8260B	13B0354	430	ND	4.29	2/10/2013	2/15/2013	
1,2,4-Trimethylbenzene	EPA 8260B	13B0354	2100	**57000**	42.9	2/10/2013	2/18/2013	
1,2-Dibromoethane (EDB)	EPA 8260B	13B0354	210	ND	4.29	2/10/2013	2/15/2013	
1,2-Dichlorobenzene	EPA 8260B	13B0354	210	ND	4.29	2/10/2013	2/15/2013	
1,2-Dichloroethane	EPA 8260B	13B0354	210	ND	4.29	2/10/2013	2/15/2013	
1,2-Dichloropropane	EPA 8260B	13B0354	210	ND	4.29	2/10/2013	2/15/2013	
1,3,5-Trimethylbenzene	EPA 8260B	13B0354	210	**18000**	4.29	2/10/2013	2/15/2013	
1,3-Dichlorobenzene	EPA 8260B	13B0354	210	ND	4.29	2/10/2013	2/15/2013	
1,3-Dichloropropane	EPA 8260B	13B0354	210	ND	4.29	2/10/2013	2/15/2013	
1,4-Dichlorobenzene	EPA 8260B	13B0354	210	ND	4.29	2/10/2013	2/15/2013	
2,2-Dichloropropane	EPA 8260B	13B0354	430	ND	4.29	2/10/2013	2/15/2013	
2-Butanone (MEK)	EPA 8260B	13B0354	2100	ND	4.29	2/10/2013	2/15/2013	
2-Chlorotoluene	EPA 8260B	13B0354	210	ND	4.29	2/10/2013	2/15/2013	
2-Hexanone	EPA 8260B	13B0354	1100	ND	4.29	2/10/2013	2/15/2013	
4-Chlorotoluene	EPA 8260B	13B0354	210	ND	4.29	2/10/2013	2/15/2013	
4-Methyl-2-pentanone (MIBK)	EPA 8260B	13B0354	1100	ND	4.29	2/10/2013	2/15/2013	
Acetone	EPA 8260B	13B0354	4300	ND	4.29	2/10/2013	2/15/2013	
Benzene	EPA 8260B	13B0354	210	ND	4.29	2/10/2013	2/15/2013	
Bromobenzene	EPA 8260B	13B0354	210	ND	4.29	2/10/2013	2/15/2013	
Bromochloromethane	EPA 8260B	13B0354	210	ND	4.29	2/10/2013	2/15/2013	
Bromodichloromethane	EPA 8260B	13B0354	210	ND	4.29	2/10/2013	2/15/2013	
Bromoform	EPA 8260B	13B0354	210	ND	4.29	2/10/2013	2/15/2013	
Bromomethane	EPA 8260B	13B0354	1100	ND	4.29	2/10/2013	2/15/2013	
Carbon tetrachloride	EPA 8260B	13B0354	210	ND	4.29	2/10/2013	2/15/2013	
Chlorobenzene	EPA 8260B	13B0354	210	ND	4.29	2/10/2013	2/15/2013	
Chloroethane	EPA 8260B	13B0354	210	ND	4.29	2/10/2013	2/15/2013	
Chloroform	EPA 8260B	13B0354	210	ND	4.29	2/10/2013	2/15/2013	
Chloromethane	EPA 8260B	13B0354	1100	ND	4.29	2/10/2013	2/15/2013	
cis-1,2-Dichloroethene	EPA 8260B	13B0354	210	ND	4.29	2/10/2013	2/15/2013	
cis-1,3-Dichloropropene	EPA 8260B	13B0354	210	ND	4.29	2/10/2013	2/15/2013	
Dibromochloromethane	EPA 8260B	13B0354	210	ND	4.29	2/10/2013	2/15/2013	
Dichlorodifluoromethane	EPA 8260B	13B0354	210	ND	4.29	2/10/2013	2/15/2013	
Ethylbenzene	EPA 8260B	13B0354	210	**35000**	4.29	2/10/2013	2/15/2013	

TestAmerica Phoenix

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Project Manager

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AMEC Environment & Infrastructure Inc - Phoenix
4600 E Washington Street, 6th Floor
Phoenix, AZ 85034
Attention: Jim Clarke

Project ID: FWAFBST012FD/RA Mesa, AZ
Report Number: PWB0697
Sampled: 02/10/13-02/11/13
Received: 02/11/13

VOLATILE ORGANICS BY GC/MS (EPA 5035/8260B)

Analyte	Method	Batch	Reporting Limit	Sample Result	Dilution Factor	Date Extracted	Date Analyzed	Data Qualifiers
Sample ID: PWB0697-02 (ST012-IDW1a/1b/1c/1d-213-SP-N - Soil) - cont.				**Sampled: 02/10/13**				
Reporting Units: ug/kg								
m,p-Xylenes	EPA 8260B	13B0354	4300	**120000**	42.9	2/10/2013	2/18/2013	
Methyl-tert-butyl Ether (MTBE)	EPA 8260B	13B0354	210	ND	4.29	2/10/2013	2/15/2013	
Methylene Chloride	EPA 8260B	13B0354	430	ND	4.29	2/10/2013	2/15/2013	
n-Butylbenzene	EPA 8260B	13B0354	210	**9100**	4.29	2/10/2013	2/15/2013	
n-Propylbenzene	EPA 8260B	13B0354	210	**22000**	4.29	2/10/2013	2/15/2013	
o-Xylene	EPA 8260B	13B0354	2100	**55000**	42.9	2/10/2013	2/18/2013	
p-Isopropyltoluene	EPA 8260B	13B0354	210	**3900**	4.29	2/10/2013	2/15/2013	
sec-Butylbenzene	EPA 8260B	13B0354	210	**7300**	4.29	2/10/2013	2/15/2013	
Styrene	EPA 8260B	13B0354	210	ND	4.29	2/10/2013	2/15/2013	
tert-Butylbenzene	EPA 8260B	13B0354	210	ND	4.29	2/10/2013	2/15/2013	
Tetrachloroethene	EPA 8260B	13B0354	210	ND	4.29	2/10/2013	2/15/2013	
Toluene	EPA 8260B	13B0354	210	**220**	4.29	2/10/2013	2/15/2013	
trans-1,2-Dichloroethene	EPA 8260B	13B0354	210	ND	4.29	2/10/2013	2/15/2013	
trans-1,3-Dichloropropene	EPA 8260B	13B0354	210	ND	4.29	2/10/2013	2/15/2013	
Trichloroethene	EPA 8260B	13B0354	210	ND	4.29	2/10/2013	2/15/2013	
Trichlorofluoromethane	EPA 8260B	13B0354	210	ND	4.29	2/10/2013	2/15/2013	
Vinyl Acetate	EPA 8260B	13B0354	430	ND	4.29	2/10/2013	2/15/2013	L3
Vinyl chloride	EPA 8260B	13B0354	210	ND	4.29	2/10/2013	2/15/2013	
Surrogate: Dibromofluoromethane (51-115%)				*92 %*				
Surrogate: Toluene-d8 (54-115%)				*97 %*				
Surrogate: 4-Bromofluorobenzene (51-117%)				*195 %*				*N1c*

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AMEC Environment & Infrastructure Inc - Phoenix
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Phoenix, AZ 85034
Attention: Jim Clarke

Project ID: FWAFBST012FD/RA Mesa, AZ
Report Number: PWB0697

Sampled: 02/10/13-02/11/13
Received: 02/11/13

POLYNUCLEAR AROMATIC HYDROCARBONS (EPA 3545/8310)

Analyte	Method	Batch	Reporting Limit	Sample Result	Dilution Factor	Date Extracted	Date Analyzed	Data Qualifiers
Sample ID: PWB0697-01RE1 (ST012-IDW1-213-SP-N - Soil)				**Sampled: 02/10/13**				
Reporting Units: mg/kg								
Naphthalene	EPA 8310	13B0681	0.20	**0.29**	0.997	2/19/2013	2/22/2013	
Acenaphthylene	EPA 8310	13B0681	0.30	ND	0.997	2/19/2013	2/22/2013	
Acenaphthene	EPA 8310	13B0681	0.20	ND	0.997	2/19/2013	2/22/2013	
Fluorene	EPA 8310	13B0681	0.030	ND	0.997	2/19/2013	2/22/2013	
Phenanthrene	EPA 8310	13B0681	0.030	**0.069**	0.997	2/19/2013	2/22/2013	C8
Anthracene	EPA 8310	13B0681	0.020	ND	0.997	2/19/2013	2/22/2013	
Fluoranthene	EPA 8310	13B0681	0.030	ND	0.997	2/19/2013	2/22/2013	
Pyrene	EPA 8310	13B0681	0.020	ND	0.997	2/19/2013	2/22/2013	
Benzanthracene	EPA 8310	13B0681	0.010	ND	0.997	2/19/2013	2/22/2013	
Chrysene	EPA 8310	13B0681	0.020	ND	0.997	2/19/2013	2/22/2013	
Benzo(b)fluoranthene	EPA 8310	13B0681	0.020	ND	0.997	2/19/2013	2/22/2013	
Benzo(k)fluoranthene	EPA 8310	13B0681	0.010	ND	0.997	2/19/2013	2/22/2013	
Benzo(a)pyrene	EPA 8310	13B0681	0.010	ND	0.997	2/19/2013	2/22/2013	
Dibenz(a,h)anthracene	EPA 8310	13B0681	0.010	ND	0.997	2/19/2013	2/22/2013	
Benzo(g,h,i)perylene	EPA 8310	13B0681	0.030	ND	0.997	2/19/2013	2/22/2013	
Indeno(1,2,3-cd)pyrene	EPA 8310	13B0681	0.010	ND	0.997	2/19/2013	2/22/2013	
Surrogate: 2-Chloroanthracene (18-128%)				*60 %*				

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Kylie Emily
Project Manager

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Report Number: PWB0697

Sampled: 02/10/13-02/11/13
Received: 02/11/13

TOTAL METALS

Analyte	Method	Batch	Reporting Limit	Sample Result	Dilution Factor	Date Extracted	Date Analyzed	Data Qualifiers
Sample ID: PWB0697-01 (ST012-IDW1-213-SP-N - Soil)				**Sampled: 02/10/13**				
Reporting Units: mg/kg								
Arsenic	EPA 6010B	13B0484	5.0	ND	0.997	2/13/2013	2/14/2013	
Barium	EPA 6010B	13B0484	5.0	**110**	0.997	2/13/2013	2/14/2013	
Cadmium	EPA 6010B	13B0484	0.50	ND	0.997	2/13/2013	2/14/2013	
Chromium	EPA 6010B	13B0484	2.0	**11**	0.997	2/13/2013	2/14/2013	
Lead	EPA 6010B	13B0484	5.0	**7.6**	0.997	2/13/2013	2/14/2013	
Mercury	EPA 7471A	13B0673	0.10	ND	1.03	2/19/2013	2/19/2013	
Selenium	EPA 6010B	13B0484	5.0	ND	0.997	2/13/2013	2/14/2013	
Silver	EPA 6010B	13B0484	2.5	ND	0.997	2/13/2013	2/14/2013	

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Sampled: 02/10/13-02/11/13
Received: 02/11/13

SHORT HOLD TIME DETAIL REPORT

	Hold Time (in days)	Date/Time Sampled	Date/Time Received	Date/Time Extracted	Date/Time Analyzed
Sample ID: ST012-IDW1a/1b/1c/1d-213-SP-N (PWB0697-02) - Soil					
EPA 8260B	2	02/10/2013 09:15	02/11/2013 15:00	02/10/2013 09:15	02/15/2013 15:48

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Report Number: PWB0697

Sampled: 02/10/13-02/11/13
Received: 02/11/13

METHOD BLANK/QC DATA

EXTRACTABLE FUEL HYDROCARBONS (ADHS 8015AZR1)

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Data Qualifiers
Batch: 13B0403 Extracted: 02/12/13										
Blank Analyzed: 02/13/2013 (13B0403-BLK1)										
DRO (C10-C22)	ND	30	mg/kg							
ORO (C22-C32)	ND	100	mg/kg							
Total (C10-C32)	ND	130	mg/kg							
Surrogate: o-terphenyl	*46.4*		*mg/kg*	*50.0*		*93*	*70-130*			
LCS Analyzed: 02/13/2013 (13B0403-BS1)										
DRO (C10-C22)	220	30	mg/kg	199		112	70-130			
ORO (C22-C32)	460	100	mg/kg	398		117	70-130			
Surrogate: o-terphenyl	*48.2*		*mg/kg*	*49.8*		*97*	*70-130*			
LCS Dup Analyzed: 02/13/2013 (13B0403-BSD1)										
DRO (C10-C22)	200	30	mg/kg	199		100	70-130	12	20	
ORO (C22-C32)	430	100	mg/kg	397		109	70-130	7	20	
Surrogate: o-terphenyl	*44.2*		*mg/kg*	*49.7*		*89*	*70-130*			
Matrix Spike Analyzed: 02/13/2013 (13B0403-MS1)					**Source: PWB0472-01**					
DRO (C10-C22)	270	150	mg/kg	199	ND	135	56-145			
ORO (C22-C32)	4500	500	mg/kg	398	4600	-25	77-136			*M3*
Surrogate: o-terphenyl	*46.3*		*mg/kg*	*49.7*		*93*	*70-130*			
Matrix Spike Dup Analyzed: 02/13/2013 (13B0403-MSD1)					**Source: PWB0472-01**					
DRO (C10-C22)	270	150	mg/kg	199	ND	138	56-145	2	30	
ORO (C22-C32)	4700	500	mg/kg	398	4600	30	77-136	5	20	*M3*
Surrogate: o-terphenyl	*46.1*		*mg/kg*	*49.7*		*93*	*70-130*			

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METHOD BLANK/QC DATA

VOLATILE ORGANICS BY GC/MS (EPA 5030B/8260B)

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Data Qualifiers
Batch: 13B0552 Extracted: 02/15/13										
Blank Analyzed: 02/15/2013 (13B0552-BLK1)										
1,1,1-Trichloroethane	ND	1.0	ug/l							
1,1,2,2-Tetrachloroethane	ND	1.0	ug/l							
1,1,2-Trichloroethane	ND	1.0	ug/l							
1,1-Dichloroethane	ND	1.0	ug/l							
1,1-Dichloroethene	ND	1.0	ug/l							
1,1-Dichloropropene	ND	1.0	ug/l							
1,2,3-Trichlorobenzene	ND	2.0	ug/l							
1,2,3-Trichloropropane	ND	2.0	ug/l							
1,2,4-Trichlorobenzene	ND	2.0	ug/l							
1,2,4-Trimethylbenzene	ND	1.0	ug/l							
1,2-Dibromoethane (EDB)	ND	1.0	ug/l							
1,2-Dichlorobenzene	ND	1.0	ug/l							
1,2-Dichloroethane	ND	1.0	ug/l							
1,2-Dichloropropane	ND	1.0	ug/l							
1,3,5-Trimethylbenzene	ND	1.0	ug/l							
1,3-Dichlorobenzene	ND	1.0	ug/l							
1,3-Dichloropropane	ND	1.0	ug/l							
1,4-Dichlorobenzene	ND	1.0	ug/l							
2,2-Dichloropropane	ND	2.0	ug/l							
2-Butanone (MEK)	ND	5.0	ug/l							
2-Chlorotoluene	ND	1.0	ug/l							
2-Hexanone	ND	5.0	ug/l							
4-Chlorotoluene	ND	1.0	ug/l							
4-Methyl-2-pentanone (MIBK)	ND	5.0	ug/l							
Acetone	ND	20	ug/l							
Benzene	ND	1.0	ug/l							
Bromobenzene	ND	1.0	ug/l							
Bromochloromethane	ND	1.0	ug/l							
Bromodichloromethane	ND	1.0	ug/l							
Bromoform	ND	1.0	ug/l							
Bromomethane	ND	2.0	ug/l							
Carbon tetrachloride	ND	1.0	ug/l							
Chlorobenzene	ND	1.0	ug/l							
Chloroethane	ND	1.0	ug/l							
Chloroform	ND	1.0	ug/l							

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METHOD BLANK/QC DATA

VOLATILE ORGANICS BY GC/MS (EPA 5030B/8260B)

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Data Qualifiers
Batch: 13B0552 Extracted: 02/15/13										
Blank Analyzed: 02/15/2013 (13B0552-BLK1)										
Chloromethane	ND	5.0	ug/l							
cis-1,2-Dichloroethene	ND	1.0	ug/l							
cis-1,3-Dichloropropene	ND	1.0	ug/l							
Dibromochloromethane	ND	1.0	ug/l							
Dichlorodifluoromethane	ND	1.0	ug/l							
Ethylbenzene	ND	1.0	ug/l							
m,p-Xylenes	ND	2.0	ug/l							
Methyl-tert-butyl Ether (MTBE)	ND	1.0	ug/l							
Methylene Chloride	ND	2.0	ug/l							
n-Butylbenzene	ND	1.0	ug/l							
n-Propylbenzene	ND	1.0	ug/l							
o-Xylene	ND	1.0	ug/l							
p-Isopropyltoluene	ND	1.0	ug/l							
sec-Butylbenzene	ND	1.0	ug/l							
Styrene	ND	1.0	ug/l							
tert-Butylbenzene	ND	1.0	ug/l							
Tetrachloroethene	ND	1.0	ug/l							
Toluene	ND	1.0	ug/l							
trans-1,2-Dichloroethene	ND	1.0	ug/l							
trans-1,3-Dichloropropene	ND	1.0	ug/l							
Trichloroethene	ND	1.0	ug/l							
Trichlorofluoromethane	ND	1.0	ug/l							
Vinyl Acetate	ND	2.0	ug/l							*N1b*
Vinyl chloride	ND	1.0	ug/l							
Surrogate: Dibromofluoromethane	*24.2*		*ug/l*	*25.0*		*97*	*70-130*			
Surrogate: Toluene-d8	*26.5*		*ug/l*	*25.0*		*106*	*70-130*			
Surrogate: 4-Bromofluorobenzene	*24.9*		*ug/l*	*25.0*		*100*	*70-130*			

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METHOD BLANK/QC DATA

VOLATILE ORGANICS BY GC/MS (EPA 5030B/8260B)

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Data Qualifiers
Batch: 13B0552 Extracted: 02/15/13										
LCS Analyzed: 02/15/2013 (13B0552-BS1)										
1,1,1-Trichloroethane	26.8	1.0	ug/l	25.0		107	71-131			
1,1,2,2-Tetrachloroethane	24.6	1.0	ug/l	25.0		99	70-130			
1,1,2-Trichloroethane	25.8	1.0	ug/l	25.0		103	70-130			
1,1-Dichloroethane	24.4	1.0	ug/l	25.0		97	70-130			
1,1-Dichloroethene	27.8	1.0	ug/l	25.0		111	63-131			
1,1-Dichloropropene	22.1	1.0	ug/l	25.0		88	70-130			
1,2,3-Trichlorobenzene	25.0	2.0	ug/l	25.0		100	79-139			
1,2,3-Trichloropropane	26.7	2.0	ug/l	25.0		107	70-130			
1,2,4-Trichlorobenzene	23.6	2.0	ug/l	25.0		94	80-137			
1,2,4-Trimethylbenzene	26.2	1.0	ug/l	25.0		105	70-130			
1,2-Dibromoethane (EDB)	26.9	1.0	ug/l	25.0		108	70-130			
1,2-Dichlorobenzene	24.0	1.0	ug/l	25.0		96	70-130			
1,2-Dichloroethane	27.0	1.0	ug/l	25.0		108	66-139			
1,2-Dichloropropane	23.9	1.0	ug/l	25.0		96	70-130			
1,3,5-Trimethylbenzene	26.8	1.0	ug/l	25.0		107	70-130			
1,3-Dichlorobenzene	25.7	1.0	ug/l	25.0		103	70-130			
1,3-Dichloropropane	26.4	1.0	ug/l	25.0		105	70-130			
1,4-Dichlorobenzene	24.9	1.0	ug/l	25.0		100	70-130			
2,2-Dichloropropane	27.0	2.0	ug/l	25.0		108	69-139			
2-Butanone (MEK)	27.9	5.0	ug/l	25.0		111	53-150			
2-Chlorotoluene	25.7	1.0	ug/l	25.0		103	70-130			
2-Hexanone	27.8	5.0	ug/l	25.0		111	55-150			
4-Chlorotoluene	27.2	1.0	ug/l	25.0		109	70-130			
4-Methyl-2-pentanone (MIBK)	23.5	5.0	ug/l	25.0		94	64-142			
Acetone	35.1	20	ug/l	25.0		140	38-150			
Benzene	26.2	1.0	ug/l	25.0		105	70-130			
Bromobenzene	24.7	1.0	ug/l	25.0		99	70-130			
Bromochloromethane	25.2	1.0	ug/l	25.0		101	70-130			
Bromodichloromethane	26.2	1.0	ug/l	25.0		105	70-130			
Bromoform	28.0	1.0	ug/l	25.0		112	69-129			
Bromomethane	26.7	2.0	ug/l	25.0		107	57-138			
Carbon tetrachloride	26.3	1.0	ug/l	25.0		105	70-143			
Chlorobenzene	25.7	1.0	ug/l	25.0		103	70-130			
Chloroethane	22.7	1.0	ug/l	25.0		91	66-131			
Chloroform	25.5	1.0	ug/l	25.0		102	70-130			

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Project ID: FWAFBST012FD/RA Mesa, AZ
Report Number: PWB0697

Sampled: 02/10/13-02/11/13
Received: 02/11/13

METHOD BLANK/QC DATA

VOLATILE ORGANICS BY GC/MS (EPA 5030B/8260B)

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Data Qualifiers
Batch: 13B0552 Extracted: 02/15/13										
LCS Analyzed: 02/15/2013 (13B0552-BS1)										
Chloromethane	25.4	5.0	ug/l	25.0		101	56-129			
cis-1,2-Dichloroethene	26.4	1.0	ug/l	25.0		105	70-130			
cis-1,3-Dichloropropene	24.2	1.0	ug/l	25.0		97	70-130			
Dibromochloromethane	27.6	1.0	ug/l	25.0		110	70-130			
Dichlorodifluoromethane	21.8	1.0	ug/l	25.0		87	46-144			
Ethylbenzene	27.1	1.0	ug/l	25.0		108	70-130			
m,p-Xylenes	23.2	2.0	ug/l	25.0		93	70-130			
Methyl-tert-butyl Ether (MTBE)	23.0	1.0	ug/l	25.0		92	70-130			
Methylene Chloride	23.3	2.0	ug/l	25.0		93	63-128			
n-Butylbenzene	26.1	1.0	ug/l	25.0		104	70-130			
n-Propylbenzene	27.0	1.0	ug/l	25.0		108	70-130			
o-Xylene	28.2	1.0	ug/l	25.0		113	70-130			
p-Isopropyltoluene	24.8	1.0	ug/l	25.0		99	70-130			
sec-Butylbenzene	26.5	1.0	ug/l	25.0		106	70-130			
Styrene	28.1	1.0	ug/l	25.0		112	70-130			
tert-Butylbenzene	25.1	1.0	ug/l	25.0		100	70-130			
Tetrachloroethene	28.6	1.0	ug/l	25.0		114	70-130			
Toluene	25.1	1.0	ug/l	25.0		100	70-130			
trans-1,2-Dichloroethene	25.7	1.0	ug/l	25.0		103	69-127			
trans-1,3-Dichloropropene	24.4	1.0	ug/l	25.0		98	70-130			
Trichloroethene	24.7	1.0	ug/l	25.0		99	70-130			
Trichlorofluoromethane	30.0	1.0	ug/l	25.0		120	69-150			
Vinyl Acetate	39.8	2.0	ug/l	25.0		159	67-148			*L3, N1b*
Vinyl chloride	25.9	1.0	ug/l	25.0		103	65-137			
Surrogate: Dibromofluoromethane	*25.4*		*ug/l*	*25.0*		*101*	*70-130*			
Surrogate: Toluene-d8	*22.9*		*ug/l*	*25.0*		*92*	*70-130*			
Surrogate: 4-Bromofluorobenzene	*29.1*		*ug/l*	*25.0*		*116*	*70-130*			

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Report Number: PWB0697

Sampled: 02/10/13-02/11/13
Received: 02/11/13

METHOD BLANK/QC DATA

VOLATILE ORGANICS BY GC/MS (EPA 5030B/8260B)

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Data Qualifiers
Batch: 13B0552 Extracted: 02/15/13										
LCS Dup Analyzed: 02/15/2013 (13B0552-BSD1)										
1,1,1-Trichloroethane	26.8	1.0	ug/l	25.0		107	71-131	0.1	20	
1,1,2,2-Tetrachloroethane	22.8	1.0	ug/l	25.0		91	70-130	8	20	
1,1,2-Trichloroethane	26.0	1.0	ug/l	25.0		104	70-130	0.5	20	
1,1-Dichloroethane	24.8	1.0	ug/l	25.0		99	70-130	2	20	
1,1-Dichloroethene	27.0	1.0	ug/l	25.0		108	63-131	3	22	
1,1-Dichloropropene	22.1	1.0	ug/l	25.0		89	70-130	0.2	20	
1,2,3-Trichlorobenzene	26.0	2.0	ug/l	25.0		104	79-139	4	20	
1,2,3-Trichloropropane	25.3	2.0	ug/l	25.0		101	70-130	5	20	
1,2,4-Trichlorobenzene	23.7	2.0	ug/l	25.0		95	80-137	0.5	20	
1,2,4-Trimethylbenzene	22.1	1.0	ug/l	25.0		89	70-130	17	20	
1,2-Dibromoethane (EDB)	24.4	1.0	ug/l	25.0		98	70-130	10	20	
1,2-Dichlorobenzene	24.4	1.0	ug/l	25.0		98	70-130	2	20	
1,2-Dichloroethane	26.6	1.0	ug/l	25.0		106	66-139	1	20	
1,2-Dichloropropane	24.4	1.0	ug/l	25.0		98	70-130	2	20	
1,3,5-Trimethylbenzene	26.4	1.0	ug/l	25.0		105	70-130	2	20	
1,3-Dichlorobenzene	25.1	1.0	ug/l	25.0		100	70-130	2	20	
1,3-Dichloropropane	24.9	1.0	ug/l	25.0		99	70-130	6	20	
1,4-Dichlorobenzene	25.1	1.0	ug/l	25.0		100	70-130	0.8	20	
2,2-Dichloropropane	26.0	2.0	ug/l	25.0		104	69-139	3	20	
2-Butanone (MEK)	26.4	5.0	ug/l	25.0		106	53-150	5	35	
2-Chlorotoluene	25.4	1.0	ug/l	25.0		102	70-130	1	20	
2-Hexanone	24.8	5.0	ug/l	25.0		99	55-150	11	35	
4-Chlorotoluene	26.3	1.0	ug/l	25.0		105	70-130	3	20	
4-Methyl-2-pentanone (MIBK)	22.1	5.0	ug/l	25.0		89	64-142	6	25	
Acetone	32.9	20	ug/l	25.0		132	38-150	7	35	
Benzene	26.3	1.0	ug/l	25.0		105	70-130	0.5	20	
Bromobenzene	24.5	1.0	ug/l	25.0		98	70-130	0.5	20	
Bromochloromethane	24.5	1.0	ug/l	25.0		98	70-130	3	20	
Bromodichloromethane	26.7	1.0	ug/l	25.0		107	70-130	2	20	
Bromoform	26.8	1.0	ug/l	25.0		107	69-129	4	20	
Bromomethane	26.2	2.0	ug/l	25.0		105	57-138	2	20	
Carbon tetrachloride	26.2	1.0	ug/l	25.0		105	70-143	0.3	20	
Chlorobenzene	26.1	1.0	ug/l	25.0		104	70-130	1	20	
Chloroethane	22.8	1.0	ug/l	25.0		91	66-131	0.4	20	
Chloroform	24.9	1.0	ug/l	25.0		100	70-130	3	20	

TestAmerica Phoenix

Kylie Emily
Project Manager

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THE LEADER IN ENVIRONMENTAL TESTING

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AMEC Environment & Infrastructure Inc - Phoenix
4600 E Washington Street, 6th Floor
Phoenix, AZ 85034
Attention: Jim Clarke

Project ID: FWAFBST012FD/RA Mesa, AZ
Report Number: PWB0697

Sampled: 02/10/13-02/11/13
Received: 02/11/13

METHOD BLANK/QC DATA

VOLATILE ORGANICS BY GC/MS (EPA 5030B/8260B)

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Data Qualifiers
Batch: 13B0552 Extracted: 02/15/13										
LCS Dup Analyzed: 02/15/2013 (13B0552-BSD1)										
Chloromethane	24.9	5.0	ug/l	25.0		100	56-129	2	20	
cis-1,2-Dichloroethene	25.7	1.0	ug/l	25.0		103	70-130	2	20	
cis-1,3-Dichloropropene	24.9	1.0	ug/l	25.0		100	70-130	3	20	
Dibromochloromethane	26.5	1.0	ug/l	25.0		106	70-130	4	20	
Dichlorodifluoromethane	22.0	1.0	ug/l	25.0		88	46-144	0.9	23	
Ethylbenzene	26.4	1.0	ug/l	25.0		106	70-130	3	20	
m,p-Xylenes	26.3	2.0	ug/l	25.0		105	70-130	13	20	
Methyl-tert-butyl Ether (MTBE)	22.2	1.0	ug/l	25.0		89	70-130	3	20	
Methylene Chloride	24.5	2.0	ug/l	25.0		98	63-128	5	21	
n-Butylbenzene	26.0	1.0	ug/l	25.0		104	70-130	0.5	20	
n-Propylbenzene	26.9	1.0	ug/l	25.0		108	70-130	0.5	20	
o-Xylene	27.2	1.0	ug/l	25.0		109	70-130	3	20	
p-Isopropyltoluene	23.4	1.0	ug/l	25.0		94	70-130	6	20	
sec-Butylbenzene	25.1	1.0	ug/l	25.0		100	70-130	5	20	
Styrene	27.7	1.0	ug/l	25.0		111	70-130	1	20	
tert-Butylbenzene	24.6	1.0	ug/l	25.0		98	70-130	2	20	
Tetrachloroethene	26.0	1.0	ug/l	25.0		104	70-130	9	20	
Toluene	26.8	1.0	ug/l	25.0		107	70-130	6	20	
trans-1,2-Dichloroethene	25.7	1.0	ug/l	25.0		103	69-127	0.1	20	
trans-1,3-Dichloropropene	26.3	1.0	ug/l	25.0		105	70-130	7	20	
Trichloroethene	25.7	1.0	ug/l	25.0		103	70-130	4	20	
Trichlorofluoromethane	29.4	1.0	ug/l	25.0		118	69-150	2	22	
Vinyl Acetate	36.3	2.0	ug/l	25.0		145	67-148	9	22	*N1b*
Vinyl chloride	25.0	1.0	ug/l	25.0		100	65-137	3	20	
Surrogate: Dibromofluoromethane	*25.2*		*ug/l*	*25.0*		*101*	*70-130*			
Surrogate: Toluene-d8	*24.6*		*ug/l*	*25.0*		*98*	*70-130*			
Surrogate: 4-Bromofluorobenzene	*27.6*		*ug/l*	*25.0*		*111*	*70-130*			

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Project Manager

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AMEC Environment & Infrastructure Inc - Phoenix
4600 E Washington Street, 6th Floor
Phoenix, AZ 85034
Attention: Jim Clarke

Project ID: FWAFBST012FD/RA Mesa, AZ
Report Number: PWB0697

Sampled: 02/10/13-02/11/13
Received: 02/11/13

METHOD BLANK/QC DATA

VOLATILE ORGANICS BY GC/MS (EPA 5030B/8260B)

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Data Qualifiers
Batch: 13B0552 Extracted: 02/15/13										
Matrix Spike Analyzed: 02/15/2013 (13B0552-MS1)					**Source: PWB1019-01**					
1,1,1-Trichloroethane	31.5	1.0	ug/l	25.0	ND	126	64-138			
1,1,2,2-Tetrachloroethane	30.8	1.0	ug/l	25.0	ND	123	63-137			
1,1,2-Trichloroethane	30.9	1.0	ug/l	25.0	ND	124	63-132			
1,1-Dichloroethane	28.5	1.0	ug/l	25.0	ND	114	62-130			
1,1-Dichloroethene	31.6	1.0	ug/l	25.0	ND	126	57-137			
1,1-Dichloropropene	25.1	1.0	ug/l	25.0	ND	100	64-134			
1,2,3-Trichlorobenzene	29.6	2.0	ug/l	25.0	ND	118	74-139			
1,2,3-Trichloropropane	33.0	2.0	ug/l	25.0	ND	132	68-130			*M1*
1,2,4-Trichlorobenzene	26.6	2.0	ug/l	25.0	ND	106	74-138			
1,2,4-Trimethylbenzene	29.2	1.0	ug/l	25.0	ND	117	63-135			
1,2-Dibromoethane (EDB)	32.4	1.0	ug/l	25.0	ND	129	70-130			
1,2-Dichlorobenzene	27.4	1.0	ug/l	25.0	ND	109	70-130			
1,2-Dichloroethane	31.7	1.0	ug/l	25.0	ND	127	54-147			
1,2-Dichloropropane	28.1	1.0	ug/l	25.0	ND	112	68-126			
1,3,5-Trimethylbenzene	30.2	1.0	ug/l	25.0	ND	121	66-137			
1,3-Dichlorobenzene	29.0	1.0	ug/l	25.0	ND	116	70-130			
1,3-Dichloropropane	33.5	1.0	ug/l	25.0	ND	134	68-129			*M1*
1,4-Dichlorobenzene	28.1	1.0	ug/l	25.0	ND	112	70-130			
2,2-Dichloropropane	31.1	2.0	ug/l	25.0	ND	124	60-146			
2-Butanone (MEK)	25.1	5.0	ug/l	25.0	ND	100	31-143			
2-Chlorotoluene	28.9	1.0	ug/l	25.0	ND	116	71-131			
2-Hexanone	29.0	5.0	ug/l	25.0	ND	116	40-142			
4-Chlorotoluene	30.1	1.0	ug/l	25.0	ND	120	70-130			
4-Methyl-2-pentanone (MIBK)	31.4	5.0	ug/l	25.0	ND	126	52-143			
Acetone	22.6	20	ug/l	25.0	ND	90	29-139			
Benzene	30.3	1.0	ug/l	25.0	ND	121	68-131			
Bromobenzene	29.1	1.0	ug/l	25.0	ND	116	70-130			
Bromochloromethane	28.9	1.0	ug/l	25.0	ND	116	64-132			
Bromodichloromethane	31.0	1.0	ug/l	25.0	ND	124	63-138			
Bromoform	33.0	1.0	ug/l	25.0	ND	132	60-128			*M1*
Bromomethane	31.0	2.0	ug/l	25.0	ND	124	47-144			
Carbon tetrachloride	31.2	1.0	ug/l	25.0	ND	125	65-147			
Chlorobenzene	31.8	1.0	ug/l	25.0	ND	127	70-130			
Chloroethane	28.0	1.0	ug/l	25.0	ND	112	57-139			
Chloroform	30.3	1.0	ug/l	25.0	0.880	118	63-131			

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Kylie Emily
Project Manager

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AMEC Environment & Infrastructure Inc - Phoenix
4600 E Washington Street, 6th Floor
Phoenix, AZ 85034
Attention: Jim Clarke

Project ID: FWAFBST012FD/RA Mesa, AZ
Report Number: PWB0697

Sampled: 02/10/13-02/11/13
Received: 02/11/13

METHOD BLANK/QC DATA

VOLATILE ORGANICS BY GC/MS (EPA 5030B/8260B)

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Data Qualifiers
Batch: 13B0552 Extracted: 02/15/13										
Matrix Spike Analyzed: 02/15/2013 (13B0552-MS1)					**Source: PWB1019-01**					
Chloromethane	29.6	5.0	ug/l	25.0	ND	118	47-134			
cis-1,2-Dichloroethene	30.0	1.0	ug/l	25.0	ND	120	65-127			
cis-1,3-Dichloropropene	29.9	1.0	ug/l	25.0	ND	120	63-135			
Dibromochloromethane	34.6	1.0	ug/l	25.0	ND	138	65-134			*M1*
Dichlorodifluoromethane	26.3	1.0	ug/l	25.0	ND	105	40-148			
Ethylbenzene	32.8	1.0	ug/l	25.0	ND	131	74-134			
m,p-Xylenes	31.4	2.0	ug/l	25.0	ND	125	58-138			
Methyl-tert-butyl Ether (MTBE)	25.2	1.0	ug/l	25.0	ND	101	67-138			
Methylene Chloride	28.8	2.0	ug/l	25.0	ND	115	55-133			
n-Butylbenzene	29.3	1.0	ug/l	25.0	ND	117	69-140			
n-Propylbenzene	31.7	1.0	ug/l	25.0	ND	127	74-140			
o-Xylene	34.9	1.0	ug/l	25.0	ND	139	66-137			*M1*
p-Isopropyltoluene	27.7	1.0	ug/l	25.0	ND	111	70-133			
sec-Butylbenzene	30.7	1.0	ug/l	25.0	ND	123	72-136			
Styrene	30.6	1.0	ug/l	25.0	ND	122	43-144			
tert-Butylbenzene	28.8	1.0	ug/l	25.0	ND	115	74-135			
Tetrachloroethene	33.8	1.0	ug/l	25.0	ND	135	67-131			*M1*
Toluene	29.7	1.0	ug/l	25.0	ND	119	65-138			
trans-1,2-Dichloroethene	29.2	1.0	ug/l	25.0	ND	117	62-131			
trans-1,3-Dichloropropene	30.6	1.0	ug/l	25.0	ND	123	58-136			
Trichloroethene	28.9	1.0	ug/l	25.0	ND	115	66-132			
Trichlorofluoromethane	34.1	1.0	ug/l	25.0	ND	136	62-150			
Vinyl Acetate	46.1	2.0	ug/l	25.0	ND	184	47-150			*N1, N1b*
Vinyl chloride	30.6	1.0	ug/l	25.0	ND	122	55-146			
Surrogate: Dibromofluoromethane	*26.2*		*ug/l*	*25.0*		*105*	*70-130*			
Surrogate: Toluene-d8	*23.7*		*ug/l*	*25.0*		*95*	*70-130*			
Surrogate: 4-Bromofluorobenzene	*31.4*		*ug/l*	*25.0*		*126*	*70-130*			

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Project Manager

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AMEC Environment & Infrastructure Inc - Phoenix
4600 E Washington Street, 6th Floor
Phoenix, AZ 85034
Attention: Jim Clarke

Project ID: FWAFBST012FD/RA Mesa, AZ
Report Number: PWB0697

Sampled: 02/10/13-02/11/13
Received: 02/11/13

METHOD BLANK/QC DATA

VOLATILE ORGANICS BY GC/MS (EPA 5030B/8260B)

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Data Qualifiers
Batch: 13B0552 Extracted: 02/15/13										
Matrix Spike Dup Analyzed: 02/15/2013 (13B0552-MSD1)					**Source: PWB1019-01**					
1,1,1-Trichloroethane	27.3	1.0	ug/l	25.0	ND	109	64-138	14	35	
1,1,2,2-Tetrachloroethane	25.8	1.0	ug/l	25.0	ND	103	63-137	18	32	
1,1,2-Trichloroethane	28.1	1.0	ug/l	25.0	ND	112	63-132	9	35	
1,1-Dichloroethane	25.6	1.0	ug/l	25.0	ND	102	62-130	11	34	
1,1-Dichloroethene	27.9	1.0	ug/l	25.0	ND	112	57-137	12	35	
1,1-Dichloropropene	24.1	1.0	ug/l	25.0	ND	97	64-134	4	34	
1,2,3-Trichlorobenzene	26.3	2.0	ug/l	25.0	ND	105	74-139	12	26	
1,2,3-Trichloropropane	27.8	2.0	ug/l	25.0	ND	111	68-130	17	32	
1,2,4-Trichlorobenzene	25.0	2.0	ug/l	25.0	ND	100	74-138	6	26	
1,2,4-Trimethylbenzene	27.1	1.0	ug/l	25.0	ND	108	63-135	8	31	
1,2-Dibromoethane (EDB)	27.9	1.0	ug/l	25.0	ND	111	70-130	15	33	
1,2-Dichlorobenzene	24.8	1.0	ug/l	25.0	ND	99	70-130	10	27	
1,2-Dichloroethane	27.8	1.0	ug/l	25.0	ND	111	54-147	13	35	
1,2-Dichloropropane	25.9	1.0	ug/l	25.0	ND	104	68-126	8	32	
1,3,5-Trimethylbenzene	27.5	1.0	ug/l	25.0	ND	110	66-137	9	30	
1,3-Dichlorobenzene	26.9	1.0	ug/l	25.0	ND	108	70-130	7	28	
1,3-Dichloropropane	28.7	1.0	ug/l	25.0	ND	115	68-129	16	33	
1,4-Dichlorobenzene	26.1	1.0	ug/l	25.0	ND	104	70-130	7	26	
2,2-Dichloropropane	25.8	2.0	ug/l	25.0	ND	103	60-146	18	35	
2-Butanone (MEK)	20.8	5.0	ug/l	25.0	ND	83	31-143	19	35	
2-Chlorotoluene	25.8	1.0	ug/l	25.0	ND	103	71-131	11	29	
2-Hexanone	22.7	5.0	ug/l	25.0	ND	91	40-142	24	35	
4-Chlorotoluene	27.0	1.0	ug/l	25.0	ND	108	70-130	11	28	
4-Methyl-2-pentanone (MIBK)	22.6	5.0	ug/l	25.0	ND	90	52-143	33	35	
Acetone	19.5	20	ug/l	25.0	ND	78	29-139	15	35	
Benzene	29.0	1.0	ug/l	25.0	ND	116	68-131	4	32	
Bromobenzene	25.7	1.0	ug/l	25.0	ND	103	70-130	12	28	
Bromochloromethane	25.6	1.0	ug/l	25.0	ND	102	64-132	12	35	
Bromodichloromethane	29.4	1.0	ug/l	25.0	ND	118	63-138	5	31	
Bromoform	28.6	1.0	ug/l	25.0	ND	114	60-128	14	31	
Bromomethane	27.3	2.0	ug/l	25.0	ND	109	47-144	13	35	
Carbon tetrachloride	28.8	1.0	ug/l	25.0	ND	115	65-147	8	35	
Chlorobenzene	28.4	1.0	ug/l	25.0	ND	113	70-130	11	30	
Chloroethane	24.4	1.0	ug/l	25.0	ND	97	57-139	14	35	
Chloroform	26.5	1.0	ug/l	25.0	0.880	102	63-131	13	33	

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Attention: Jim Clarke

Project ID: FWAFBST012FD/RA Mesa, AZ
Report Number: PWB0697

Sampled: 02/10/13-02/11/13
Received: 02/11/13

METHOD BLANK/QC DATA

VOLATILE ORGANICS BY GC/MS (EPA 5030B/8260B)

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Data Qualifiers
Batch: 13B0552 Extracted: 02/15/13										
Matrix Spike Dup Analyzed: 02/15/2013 (13B0552-MSD1)					**Source: PWB1019-01**					
Chloromethane	26.3	5.0	ug/l	25.0	ND	105	47-134	12	35	
cis-1,2-Dichloroethene	26.8	1.0	ug/l	25.0	ND	107	65-127	11	34	
cis-1,3-Dichloropropene	25.0	1.0	ug/l	25.0	ND	100	63-135	18	35	
Dibromochloromethane	30.5	1.0	ug/l	25.0	ND	122	65-134	13	33	
Dichlorodifluoromethane	23.3	1.0	ug/l	25.0	ND	93	40-148	12	35	
Ethylbenzene	29.7	1.0	ug/l	25.0	ND	119	74-134	10	32	
m,p-Xylenes	28.5	2.0	ug/l	25.0	ND	114	58-138	9	29	
Methyl-tert-butyl Ether (MTBE)	23.1	1.0	ug/l	25.0	ND	92	67-138	9	21	
Methylene Chloride	26.3	2.0	ug/l	25.0	ND	105	55-133	9	35	
n-Butylbenzene	27.2	1.0	ug/l	25.0	ND	109	69-140	7	32	
n-Propylbenzene	28.6	1.0	ug/l	25.0	ND	115	74-140	10	32	
o-Xylene	30.9	1.0	ug/l	25.0	ND	124	66-137	12	26	
p-Isopropyltoluene	25.3	1.0	ug/l	25.0	ND	101	70-133	9	32	
sec-Butylbenzene	27.1	1.0	ug/l	25.0	ND	109	72-136	12	33	
Styrene	27.8	1.0	ug/l	25.0	ND	111	43-144	10	35	
tert-Butylbenzene	25.6	1.0	ug/l	25.0	ND	102	74-135	12	32	
Tetrachloroethene	30.5	1.0	ug/l	25.0	ND	122	67-131	10	31	
Toluene	28.7	1.0	ug/l	25.0	ND	115	65-138	3	33	
trans-1,2-Dichloroethene	26.8	1.0	ug/l	25.0	ND	107	62-131	9	35	
trans-1,3-Dichloropropene	25.8	1.0	ug/l	25.0	ND	103	58-136	17	35	
Trichloroethene	27.0	1.0	ug/l	25.0	ND	108	66-132	7	29	
Trichlorofluoromethane	31.3	1.0	ug/l	25.0	ND	125	62-150	9	35	
Vinyl Acetate	39.6	2.0	ug/l	25.0	ND	158	47-150	15	35	*N1, N1b*
Vinyl chloride	27.0	1.0	ug/l	25.0	ND	108	55-146	13	35	
Surrogate: Dibromofluoromethane	*25.3*		*ug/l*	*25.0*		*101*	*70-130*			
Surrogate: Toluene-d8	*24.1*		*ug/l*	*25.0*		*96*	*70-130*			
Surrogate: 4-Bromofluorobenzene	*28.7*		*ug/l*	*25.0*		*115*	*70-130*			

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Project ID: FWAFBST012FD/RA Mesa, AZ
Report Number: PWB0697

Sampled: 02/10/13-02/11/13
Received: 02/11/13

METHOD BLANK/QC DATA

VOLATILE ORGANICS BY GC/MS (EPA 5035/8260B)

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Data Qualifiers
Batch: 13B0354 Extracted: 02/11/13										
Blank Analyzed: 02/12/2013 (13B0354-BLK1)										
1,1,1-Trichloroethane	ND	50	ug/kg							
1,1,2,2-Tetrachloroethane	ND	50	ug/kg							
1,1,2-Trichloroethane	ND	50	ug/kg							
1,1-Dichloroethane	ND	50	ug/kg							
1,1-Dichloroethene	ND	50	ug/kg							
1,1-Dichloropropene	ND	50	ug/kg							
1,2,3-Trichlorobenzene	ND	100	ug/kg							
1,2,3-Trichloropropane	ND	100	ug/kg							
1,2,4-Trimethylbenzene	ND	50	ug/kg							
1,2-Dibromoethane (EDB)	ND	50	ug/kg							
1,2-Dichlorobenzene	ND	50	ug/kg							
1,2-Dichloroethane	ND	50	ug/kg							
1,2-Dichloropropane	ND	50	ug/kg							
1,3,5-Trimethylbenzene	ND	50	ug/kg							
1,3-Dichlorobenzene	ND	50	ug/kg							
1,3-Dichloropropane	ND	50	ug/kg							
1,4-Dichlorobenzene	ND	50	ug/kg							
2,2-Dichloropropane	ND	100	ug/kg							
2-Butanone (MEK)	ND	500	ug/kg							
2-Chlorotoluene	ND	50	ug/kg							
2-Hexanone	ND	250	ug/kg							
4-Chlorotoluene	ND	50	ug/kg							
4-Methyl-2-pentanone (MIBK)	ND	250	ug/kg							
Acetone	ND	1000	ug/kg							
Benzene	ND	50	ug/kg							
Bromobenzene	ND	50	ug/kg							
Bromochloromethane	ND	50	ug/kg							
Bromodichloromethane	ND	50	ug/kg							
Bromoform	ND	50	ug/kg							
Bromomethane	ND	250	ug/kg							
Carbon tetrachloride	ND	50	ug/kg							
Chlorobenzene	ND	50	ug/kg							
Chloroethane	ND	50	ug/kg							
Chloroform	ND	50	ug/kg							
Chloromethane	ND	250	ug/kg							

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Report Number: PWB0697

Sampled: 02/10/13-02/11/13
Received: 02/11/13

METHOD BLANK/QC DATA

VOLATILE ORGANICS BY GC/MS (EPA 5035/8260B)

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Data Qualifiers
Batch: 13B0354 Extracted: 02/11/13										
Blank Analyzed: 02/12/2013 (13B0354-BLK1)										
cis-1,2-Dichloroethene	ND	50	ug/kg							
cis-1,3-Dichloropropene	ND	50	ug/kg							
Dibromochloromethane	ND	50	ug/kg							
Dichlorodifluoromethane	ND	50	ug/kg							
Ethylbenzene	ND	50	ug/kg							
m,p-Xylenes	ND	100	ug/kg							
Methyl-tert-butyl Ether (MTBE)	ND	50	ug/kg							
Methylene Chloride	ND	100	ug/kg							
n-Butylbenzene	ND	50	ug/kg							
n-Propylbenzene	ND	50	ug/kg							
o-Xylene	ND	50	ug/kg							
p-Isopropyltoluene	ND	50	ug/kg							
sec-Butylbenzene	ND	50	ug/kg							
Styrene	ND	50	ug/kg							
tert-Butylbenzene	ND	50	ug/kg							
Tetrachloroethene	ND	50	ug/kg							
Toluene	ND	50	ug/kg							
trans-1,2-Dichloroethene	ND	50	ug/kg							
trans-1,3-Dichloropropene	ND	50	ug/kg							
Trichloroethene	ND	50	ug/kg							
Trichlorofluoromethane	ND	50	ug/kg							
Vinyl Acetate	ND	100	ug/kg							
Vinyl chloride	ND	50	ug/kg							
Surrogate: Dibromofluoromethane	*1300*		*ug/kg*	*1250*		*105*	*51-115*			
Surrogate: Toluene-d8	*1240*		*ug/kg*	*1250*		*100*	*54-115*			
Surrogate: 4-Bromofluorobenzene	*1260*		*ug/kg*	*1250*		*101*	*51-117*			
LCS Analyzed: 02/12/2013 (13B0354-BS1)										
1,1,1-Trichloroethane	1240	50	ug/kg	1240		100	67-119			
1,1,2,2-Tetrachloroethane	1260	50	ug/kg	1240		102	62-125			
1,1,2-Trichloroethane	1320	50	ug/kg	1240		107	65-125			
1,1-Dichloroethane	1230	50	ug/kg	1240		99	60-112			
1,1-Dichloroethene	1150	50	ug/kg	1240		93	54-118			
1,1-Dichloropropene	1160	50	ug/kg	1240		94	58-120			
1,2,3-Trichlorobenzene	1410	100	ug/kg	1240		114	70-137			
1,2,3-Trichloropropane	1300	100	ug/kg	1240		105	62-129			

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METHOD BLANK/QC DATA

VOLATILE ORGANICS BY GC/MS (EPA 5035/8260B)

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Data Qualifiers
Batch: 13B0354 Extracted: 02/11/13										
LCS Analyzed: 02/12/2013 (13B0354-BS1)										
1,2,4-Trimethylbenzene	1200	50	ug/kg	1240		97	70-130			
1,2-Dibromoethane (EDB)	1370	50	ug/kg	1240		111	68-126			
1,2-Dichlorobenzene	1270	50	ug/kg	1240		103	70-130			
1,2-Dichloroethane	1370	50	ug/kg	1240		111	67-128			
1,2-Dichloropropane	1230	50	ug/kg	1240		99	64-117			
1,3,5-Trimethylbenzene	1210	50	ug/kg	1240		97	70-130			
1,3-Dichlorobenzene	1280	50	ug/kg	1240		103	70-130			
1,3-Dichloropropane	1290	50	ug/kg	1240		104	68-120			
1,4-Dichlorobenzene	1290	50	ug/kg	1240		104	70-130			
2,2-Dichloropropane	1020	100	ug/kg	1240		82	65-118			
2-Butanone (MEK)	1310	500	ug/kg	1240		106	42-132			
2-Chlorotoluene	1200	50	ug/kg	1240		97	70-130			
2-Hexanone	1330	250	ug/kg	1240		107	50-140			
4-Chlorotoluene	1220	50	ug/kg	1240		99	70-130			
4-Methyl-2-pentanone (MIBK)	1260	250	ug/kg	1240		102	52-129			
Acetone	1150	1000	ug/kg	1240		93	37-148			
Benzene	1280	50	ug/kg	1240		104	67-118			
Bromobenzene	1230	50	ug/kg	1240		100	70-130			
Bromochloromethane	1290	50	ug/kg	1240		104	66-124			
Bromodichloromethane	1300	50	ug/kg	1240		105	69-118			
Bromoform	1250	50	ug/kg	1240		101	59-115			
Bromomethane	1030	250	ug/kg	1240		84	63-111			
Carbon tetrachloride	1260	50	ug/kg	1240		102	65-130			
Chlorobenzene	1300	50	ug/kg	1240		105	70-130			
Chloroethane	1010	50	ug/kg	1240		82	51-113			
Chloroform	1210	50	ug/kg	1240		98	66-116			
Chloromethane	995	250	ug/kg	1240		80	54-101			
cis-1,2-Dichloroethene	1270	50	ug/kg	1240		103	61-115			
cis-1,3-Dichloropropene	1310	50	ug/kg	1240		106	64-124			
Dibromochloromethane	1270	50	ug/kg	1240		102	61-119			
Dichlorodifluoromethane	706	50	ug/kg	1240		57	29-90			
Ethylbenzene	1290	50	ug/kg	1240		104	68-124			
m,p-Xylenes	1270	100	ug/kg	1240		103	64-122			
Methyl-tert-butyl Ether (MTBE)	1190	50	ug/kg	1240		96	57-126			
Methylene Chloride	1020	100	ug/kg	1240		82	61-117			

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Report Number: PWB0697

Sampled: 02/10/13-02/11/13
Received: 02/11/13

METHOD BLANK/QC DATA

VOLATILE ORGANICS BY GC/MS (EPA 5035/8260B)

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Data Qualifiers
Batch: 13B0354 Extracted: 02/11/13										
LCS Analyzed: 02/12/2013 (13B0354-BS1)										
n-Butylbenzene	1280	50	ug/kg	1240		103	64-131			
n-Propylbenzene	1260	50	ug/kg	1240		102	68-132			
o-Xylene	1300	50	ug/kg	1240		105	70-130			
p-Isopropyltoluene	1200	50	ug/kg	1240		97	67-122			
sec-Butylbenzene	1200	50	ug/kg	1240		97	66-127			
Styrene	1310	50	ug/kg	1240		106	67-121			
tert-Butylbenzene	1200	50	ug/kg	1240		97	70-130			
Tetrachloroethene	1320	50	ug/kg	1240		107	65-124			
Toluene	1320	50	ug/kg	1240		106	68-122			
trans-1,2-Dichloroethene	1310	50	ug/kg	1240		106	59-115			
trans-1,3-Dichloropropene	1360	50	ug/kg	1240		110	64-123			
Trichloroethene	1300	50	ug/kg	1240		105	68-117			
Trichlorofluoromethane	1220	50	ug/kg	1240		99	63-139			
Vinyl Acetate	1790	100	ug/kg	1240		144	51-134			*L3*
Vinyl chloride	548	50	ug/kg	1240		44	10-99			
Surrogate: Dibromofluoromethane	*1210*		*ug/kg*	*1240*		*97*	*66-118*			
Surrogate: Toluene-d8	*1240*		*ug/kg*	*1240*		*100*	*68-119*			
Surrogate: 4-Bromofluorobenzene	*1200*		*ug/kg*	*1240*		*97*	*68-115*			
LCS Dup Analyzed: 02/12/2013 (13B0354-BSD1)										
1,1,1-Trichloroethane	1240	50	ug/kg	1240		100	67-119	0.3	20	
1,1,2,2-Tetrachloroethane	1250	50	ug/kg	1240		101	62-125	1	29	
1,1,2-Trichloroethane	1340	50	ug/kg	1240		108	65-125	1	26	
1,1-Dichloroethane	1210	50	ug/kg	1240		97	60-112	1	20	
1,1-Dichloroethene	1120	50	ug/kg	1240		90	54-118	2	20	
1,1-Dichloropropene	1130	50	ug/kg	1240		91	58-120	2	20	
1,2,3-Trichlorobenzene	1430	100	ug/kg	1240		115	70-137	1	24	
1,2,3-Trichloropropane	1210	100	ug/kg	1240		98	62-129	7	32	
1,2,4-Trimethylbenzene	1230	50	ug/kg	1240		99	70-130	3	20	
1,2-Dibromoethane (EDB)	1380	50	ug/kg	1240		111	68-126	0.6	26	
1,2-Dichlorobenzene	1310	50	ug/kg	1240		106	70-130	3	20	
1,2-Dichloroethane	1370	50	ug/kg	1240		110	67-128	0.03	26	
1,2-Dichloropropane	1250	50	ug/kg	1240		101	64-117	2	21	
1,3,5-Trimethylbenzene	1240	50	ug/kg	1240		100	70-130	3	20	
1,3-Dichlorobenzene	1310	50	ug/kg	1240		105	70-130	2	20	
1,3-Dichloropropane	1290	50	ug/kg	1240		104	68-120	0.3	22	

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Project ID: FWAFBST012FD/RA Mesa, AZ
Report Number: PWB0697

Sampled: 02/10/13-02/11/13
Received: 02/11/13

METHOD BLANK/QC DATA

VOLATILE ORGANICS BY GC/MS (EPA 5035/8260B)

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Data Qualifiers
Batch: 13B0354 Extracted: 02/11/13										
LCS Dup Analyzed: 02/12/2013 (13B0354-BSD1)										
1,4-Dichlorobenzene	1340	50	ug/kg	1240		108	70-130	4	20	
2,2-Dichloropropane	1000	100	ug/kg	1240		81	65-118	2	20	
2-Butanone (MEK)	1210	500	ug/kg	1240		97	42-132	8	40	
2-Chlorotoluene	1230	50	ug/kg	1240		99	70-130	3	20	
2-Hexanone	1290	250	ug/kg	1240		104	50-140	3	36	
4-Chlorotoluene	1250	50	ug/kg	1240		101	70-130	3	20	
4-Methyl-2-pentanone (MIBK)	1210	250	ug/kg	1240		97	52-129	4	36	
Acetone	1100	1000	ug/kg	1240		88	37-148	5	40	
Benzene	1280	50	ug/kg	1240		103	67-118	0.3	20	
Bromobenzene	1270	50	ug/kg	1240		103	70-130	3	20	
Bromochloromethane	1270	50	ug/kg	1240		102	66-124	2	26	
Bromodichloromethane	1320	50	ug/kg	1240		107	69-118	2	20	
Bromoform	1250	50	ug/kg	1240		100	59-115	0.001	27	
Bromomethane	1030	250	ug/kg	1240		83	63-111	0.3	21	
Carbon tetrachloride	1260	50	ug/kg	1240		101	65-130	0.04	20	
Chlorobenzene	1310	50	ug/kg	1240		105	70-130	0.9	20	
Chloroethane	996	50	ug/kg	1240		80	51-113	2	22	
Chloroform	1230	50	ug/kg	1240		99	66-116	1	21	
Chloromethane	951	250	ug/kg	1240		77	54-101	4	32	
cis-1,2-Dichloroethene	1270	50	ug/kg	1240		102	61-115	0.7	23	
cis-1,3-Dichloropropene	1330	50	ug/kg	1240		107	64-124	1	22	
Dibromochloromethane	1290	50	ug/kg	1240		104	61-119	2	24	
Dichlorodifluoromethane	647	50	ug/kg	1240		52	29-90	9	40	
Ethylbenzene	1300	50	ug/kg	1240		105	68-124	1	20	
m,p-Xylenes	1280	100	ug/kg	1240		103	64-122	0.8	20	
Methyl-tert-butyl Ether (MTBE)	1250	50	ug/kg	1240		101	57-126	5	32	
Methylene Chloride	1010	100	ug/kg	1240		81	61-117	1	23	
n-Butylbenzene	1290	50	ug/kg	1240		104	64-131	1	20	
n-Propylbenzene	1280	50	ug/kg	1240		103	68-132	2	20	
o-Xylene	1310	50	ug/kg	1240		106	70-130	1	20	
p-Isopropyltoluene	1230	50	ug/kg	1240		99	67-122	3	20	
sec-Butylbenzene	1250	50	ug/kg	1240		100	66-127	4	20	
Styrene	1350	50	ug/kg	1240		109	67-121	3	20	
tert-Butylbenzene	1250	50	ug/kg	1240		100	70-130	4	20	
Tetrachloroethene	1320	50	ug/kg	1240		106	65-124	0.6	20	

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METHOD BLANK/QC DATA

VOLATILE ORGANICS BY GC/MS (EPA 5035/8260B)

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Data Qualifiers
Batch: 13B0354 Extracted: 02/11/13										
LCS Dup Analyzed: 02/12/2013 (13B0354-BSD1)										
Toluene	1330	50	ug/kg	1240		107	68-122	1	20	
trans-1,2-Dichloroethene	1240	50	ug/kg	1240		100	59-115	6	20	
trans-1,3-Dichloropropene	1380	50	ug/kg	1240		111	64-123	1	24	
Trichloroethene	1290	50	ug/kg	1240		104	68-117	0.4	20	
Trichlorofluoromethane	1210	50	ug/kg	1240		98	63-139	0.7	21	
Vinyl Acetate	1850	100	ug/kg	1240		149	51-134	4	37	*L3*
Vinyl chloride	530	50	ug/kg	1240		43	10-99	3	30	
Surrogate: Dibromofluoromethane	*1230*		*ug/kg*	*1240*		*99*	*66-118*			
Surrogate: Toluene-d8	*1260*		*ug/kg*	*1240*		*101*	*68-119*			
Surrogate: 4-Bromofluorobenzene	*1260*		*ug/kg*	*1240*		*101*	*68-115*			
Matrix Spike Analyzed: 02/12/2013 (13B0354-MS1)					**Source: PWB0639-01**					
1,1,1-Trichloroethane	1290	50	ug/kg	1260	ND	103	50-119			
1,1,2,2-Tetrachloroethane	1350	50	ug/kg	1260	ND	108	41-132			
1,1,2-Trichloroethane	1340	50	ug/kg	1260	ND	107	47-128			
1,1-Dichloroethane	1240	50	ug/kg	1260	ND	99	46-111			
1,1-Dichloroethene	1130	50	ug/kg	1260	ND	90	36-114			
1,1-Dichloropropene	1160	50	ug/kg	1260	ND	92	45-117			
1,2,3-Trichlorobenzene	1460	100	ug/kg	1260	ND	116	41-150			
1,2,3-Trichloropropane	1330	100	ug/kg	1260	ND	106	51-129			
1,2,4-Trimethylbenzene	1310	50	ug/kg	1260	ND	104	42-137			
1,2-Dibromoethane (EDB)	1380	50	ug/kg	1260	ND	110	49-130			
1,2-Dichlorobenzene	1340	50	ug/kg	1260	ND	106	54-130			
1,2-Dichloroethane	1340	50	ug/kg	1260	ND	107	53-124			
1,2-Dichloropropane	1230	50	ug/kg	1260	ND	98	48-118			
1,3,5-Trimethylbenzene	1300	50	ug/kg	1260	ND	104	50-131			
1,3-Dichlorobenzene	1360	50	ug/kg	1260	ND	108	56-127			
1,3-Dichloropropane	1270	50	ug/kg	1260	ND	101	50-124			
1,4-Dichlorobenzene	1360	50	ug/kg	1260	ND	108	52-128			
2,2-Dichloropropane	1050	100	ug/kg	1260	ND	84	47-117			
2-Butanone (MEK)	1310	500	ug/kg	1260	ND	105	32-130			
2-Chlorotoluene	1280	50	ug/kg	1260	ND	102	54-123			
2-Hexanone	1360	250	ug/kg	1260	ND	108	32-144			
4-Chlorotoluene	1290	50	ug/kg	1260	ND	103	56-123			
4-Methyl-2-pentanone (MIBK)	1300	250	ug/kg	1260	ND	104	37-134			
Acetone	1180	1000	ug/kg	1260	ND	94	32-148			

TestAmerica Phoenix

Kylie Emily
Project Manager

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AMEC Environment & Infrastructure Inc - Phoenix
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Phoenix, AZ 85034
Attention: Jim Clarke

Project ID: FWAFBST012FD/RA Mesa, AZ
Report Number: PWB0697

Sampled: 02/10/13-02/11/13
Received: 02/11/13

METHOD BLANK/QC DATA

VOLATILE ORGANICS BY GC/MS (EPA 5035/8260B)

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Data Qualifiers
Batch: 13B0354 Extracted: 02/11/13										
Matrix Spike Analyzed: 02/12/2013 (13B0354-MS1)					**Source: PWB0639-01**					
Benzene	1280	50	ug/kg	1260	ND	102	51-118			
Bromobenzene	1310	50	ug/kg	1260	ND	104	58-127			
Bromochloromethane	1250	50	ug/kg	1260	ND	100	50-123			
Bromodichloromethane	1330	50	ug/kg	1260	ND	106	51-122			
Bromoform	1320	50	ug/kg	1260	ND	105	45-115			
Bromomethane	996	250	ug/kg	1260	ND	79	28-115			
Carbon tetrachloride	1300	50	ug/kg	1260	ND	103	48-128			
Chlorobenzene	1310	50	ug/kg	1260	ND	104	57-122			
Chloroethane	966	50	ug/kg	1260	ND	77	32-107			
Chloroform	1270	50	ug/kg	1260	ND	101	52-116			
Chloromethane	902	250	ug/kg	1260	ND	72	28-100			
cis-1,2-Dichloroethene	1280	50	ug/kg	1260	ND	102	47-113			
cis-1,3-Dichloropropene	1320	50	ug/kg	1260	ND	105	41-130			
Dibromochloromethane	1290	50	ug/kg	1260	ND	103	44-122			
Dichlorodifluoromethane	530	50	ug/kg	1260	ND	42	10-73			
Ethylbenzene	1320	50	ug/kg	1260	ND	105	50-130			
m,p-Xylenes	1290	100	ug/kg	1260	ND	103	43-128			
Methyl-tert-butyl Ether (MTBE)	1270	50	ug/kg	1260	ND	102	41-125			
Methylene Chloride	1010	100	ug/kg	1260	ND	80	45-115			
n-Butylbenzene	1370	50	ug/kg	1260	ND	109	44-140			
n-Propylbenzene	1360	50	ug/kg	1260	ND	108	52-135			
o-Xylene	1310	50	ug/kg	1260	ND	105	48-127			
p-Isopropyltoluene	1320	50	ug/kg	1260	ND	105	51-126			
sec-Butylbenzene	1330	50	ug/kg	1260	ND	106	49-131			
Styrene	1340	50	ug/kg	1260	ND	107	49-123			
tert-Butylbenzene	1340	50	ug/kg	1260	ND	106	54-130			
Tetrachloroethene	1350	50	ug/kg	1260	ND	108	49-124			
Toluene	1350	50	ug/kg	1260	ND	108	52-126			
trans-1,2-Dichloroethene	1280	50	ug/kg	1260	ND	102	44-113			
trans-1,3-Dichloropropene	1370	50	ug/kg	1260	ND	109	43-130			
Trichloroethene	1310	50	ug/kg	1260	ND	104	53-120			
Trichlorofluoromethane	1210	50	ug/kg	1260	ND	96	33-134			
Vinyl Acetate	1650	100	ug/kg	1260	ND	132	10-126			*N1b*
Vinyl chloride	499	50	ug/kg	1260	ND	40	10-82			
Surrogate: Dibromofluoromethane	*1250*		*ug/kg*	*1260*		*99*	*51-115*			

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Project ID: FWAFBST012FD/RA Mesa, AZ
Report Number: PWB0697

Sampled: 02/10/13-02/11/13
Received: 02/11/13

METHOD BLANK/QC DATA

VOLATILE ORGANICS BY GC/MS (EPA 5035/8260B)

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Data Qualifiers
Batch: 13B0354 Extracted: 02/11/13										
Matrix Spike Analyzed: 02/12/2013 (13B0354-MS1)					**Source: PWB0639-01**					
Surrogate: Toluene-d8	*1270*		*ug/kg*	*1260*		*101*	*54-115*			
Surrogate: 4-Bromofluorobenzene	*1230*		*ug/kg*	*1260*		*98*	*51-117*			
Matrix Spike Dup Analyzed: 02/12/2013 (13B0354-MSD1)					**Source: PWB0639-01**					
1,1,1-Trichloroethane	1230	50	ug/kg	1260	ND	98	50-119	4	29	
1,1,2,2-Tetrachloroethane	1340	50	ug/kg	1260	ND	106	41-132	1	37	
1,1,2-Trichloroethane	1280	50	ug/kg	1260	ND	102	47-128	4	34	
1,1-Dichloroethane	1180	50	ug/kg	1260	ND	94	46-111	5	26	
1,1-Dichloroethene	1080	50	ug/kg	1260	ND	85	36-114	5	32	
1,1-Dichloropropene	1150	50	ug/kg	1260	ND	91	45-117	1	29	
1,2,3-Trichlorobenzene	1430	100	ug/kg	1260	ND	113	41-150	2	38	
1,2,3-Trichloropropane	1250	100	ug/kg	1260	ND	99	51-129	7	40	
1,2,4-Trimethylbenzene	1300	50	ug/kg	1260	ND	103	42-137	0.5	40	
1,2-Dibromoethane (EDB)	1380	50	ug/kg	1260	ND	109	49-130	0.1	39	
1,2-Dichlorobenzene	1330	50	ug/kg	1260	ND	105	54-130	0.5	38	
1,2-Dichloroethane	1270	50	ug/kg	1260	ND	101	53-124	5	32	
1,2-Dichloropropane	1210	50	ug/kg	1260	ND	96	48-118	2	30	
1,3,5-Trimethylbenzene	1310	50	ug/kg	1260	ND	104	50-131	0.5	36	
1,3-Dichlorobenzene	1360	50	ug/kg	1260	ND	108	56-127	0.03	33	
1,3-Dichloropropane	1280	50	ug/kg	1260	ND	101	50-124	0.8	35	
1,4-Dichlorobenzene	1350	50	ug/kg	1260	ND	107	52-128	0.2	33	
2,2-Dichloropropane	973	100	ug/kg	1260	ND	77	47-117	8	27	
2-Butanone (MEK)	1200	500	ug/kg	1260	ND	95	32-130	9	40	
2-Chlorotoluene	1270	50	ug/kg	1260	ND	101	54-123	0.3	33	
2-Hexanone	1280	250	ug/kg	1260	ND	102	32-144	6	40	
4-Chlorotoluene	1290	50	ug/kg	1260	ND	102	56-123	0.01	32	
4-Methyl-2-pentanone (MIBK)	1230	250	ug/kg	1260	ND	97	37-134	6	40	
Acetone	1020	1000	ug/kg	1260	ND	81	32-148	15	40	
Benzene	1250	50	ug/kg	1260	ND	99	51-118	3	27	
Bromobenzene	1300	50	ug/kg	1260	ND	103	58-127	0.3	36	
Bromochloromethane	1200	50	ug/kg	1260	ND	95	50-123	4	32	
Bromodichloromethane	1300	50	ug/kg	1260	ND	103	51-122	2	33	
Bromoform	1320	50	ug/kg	1260	ND	105	45-115	0.2	39	
Bromomethane	929	250	ug/kg	1260	ND	74	28-115	7	40	
Carbon tetrachloride	1280	50	ug/kg	1260	ND	102	48-128	1	31	
Chlorobenzene	1310	50	ug/kg	1260	ND	104	57-122	0.5	34	

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Project ID: FWAFBST012FD/RA Mesa, AZ
Report Number: PWB0697

Sampled: 02/10/13-02/11/13
Received: 02/11/13

METHOD BLANK/QC DATA

VOLATILE ORGANICS BY GC/MS (EPA 5035/8260B)

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Data Qualifiers
Batch: 13B0354 Extracted: 02/11/13										
Matrix Spike Dup Analyzed: 02/12/2013 (13B0354-MSD1)					**Source: PWB0639-01**					
Chloroethane	919	50	ug/kg	1260	ND	73	32-107	5	40	
Chloroform	1190	50	ug/kg	1260	ND	95	52-116	6	29	
Chloromethane	825	250	ug/kg	1260	ND	65	28-100	9	40	
cis-1,2-Dichloroethene	1240	50	ug/kg	1260	ND	98	47-113	3	29	
cis-1,3-Dichloropropene	1270	50	ug/kg	1260	ND	101	41-130	3	34	
Dibromochloromethane	1290	50	ug/kg	1260	ND	103	44-122	0.2	40	
Dichlorodifluoromethane	481	50	ug/kg	1260	ND	38	10-73	10	40	
Ethylbenzene	1330	50	ug/kg	1260	ND	106	50-130	0.9	32	
m,p-Xylenes	1320	100	ug/kg	1260	ND	104	43-128	2	37	
Methyl-tert-butyl Ether (MTBE)	1180	50	ug/kg	1260	ND	94	41-125	8	35	
Methylene Chloride	959	100	ug/kg	1260	ND	76	45-115	5	26	
n-Butylbenzene	1370	50	ug/kg	1260	ND	109	44-140	0.2	34	
n-Propylbenzene	1370	50	ug/kg	1260	ND	108	52-135	0.6	33	
o-Xylene	1330	50	ug/kg	1260	ND	106	48-127	1	39	
p-Isopropyltoluene	1320	50	ug/kg	1260	ND	104	51-126	0.5	34	
sec-Butylbenzene	1350	50	ug/kg	1260	ND	107	49-131	1	34	
Styrene	1340	50	ug/kg	1260	ND	107	49-123	0.4	33	
tert-Butylbenzene	1350	50	ug/kg	1260	ND	107	54-130	0.7	35	
Tetrachloroethene	1370	50	ug/kg	1260	ND	108	49-124	1	32	
Toluene	1320	50	ug/kg	1260	ND	105	52-126	2	30	
trans-1,2-Dichloroethene	1240	50	ug/kg	1260	ND	99	44-113	3	26	
trans-1,3-Dichloropropene	1320	50	ug/kg	1260	ND	105	43-130	3	34	
Trichloroethene	1300	50	ug/kg	1260	ND	103	53-120	0.5	29	
Trichlorofluoromethane	1150	50	ug/kg	1260	ND	92	33-134	5	40	
Vinyl Acetate	1530	100	ug/kg	1260	ND	121	10-126	8	40	
Vinyl chloride	474	50	ug/kg	1260	ND	38	10-82	5	40	
Surrogate: Dibromofluoromethane	*1180*		*ug/kg*	*1260*		*94*	*51-115*			
Surrogate: Toluene-d8	*1230*		*ug/kg*	*1260*		*98*	*54-115*			
Surrogate: 4-Bromofluorobenzene	*1230*		*ug/kg*	*1260*		*97*	*51-117*			

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Project ID: FWAFBST012FD/RA Mesa, AZ
Report Number: PWB0697

Sampled: 02/10/13-02/11/13
Received: 02/11/13

METHOD BLANK/QC DATA

POLYNUCLEAR AROMATIC HYDROCARBONS (EPA 3545/8310)

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Data Qualifiers
Batch: 13B0681 Extracted: 02/19/13										
Blank Analyzed: 02/21/2013 (13B0681-BLK1)										
Naphthalene	ND	0.20	mg/kg							
Acenaphthylene	ND	0.30	mg/kg							
Acenaphthene	ND	0.20	mg/kg							
Fluorene	ND	0.030	mg/kg							
Phenanthrene	ND	0.030	mg/kg							
Anthracene	ND	0.020	mg/kg							
Fluoranthene	ND	0.030	mg/kg							
Pyrene	ND	0.020	mg/kg							*V1*
Benzanthracene	ND	0.010	mg/kg							*V1*
Chrysene	ND	0.020	mg/kg							*V1*
Benzo(b)fluoranthene	ND	0.020	mg/kg							
Benzo(k)fluoranthene	ND	0.010	mg/kg							
Benzo(a)pyrene	ND	0.010	mg/kg							*V1*
Dibenz(a,h)anthracene	ND	0.010	mg/kg							
Benzo(g,h,i)perylene	ND	0.030	mg/kg							*V1*
Indeno(1,2,3-cd)pyrene	ND	0.010	mg/kg							
Surrogate: 2-Chloroanthracene	*0.384*		*mg/kg*	*0.417*		*92*	*18-128*			
LCS Analyzed: 02/21/2013 (13B0681-BS1)										**N1a**
Naphthalene	0.130	0.20	mg/kg	0.167		78	51-126			
Acenaphthylene	0.350	0.30	mg/kg	0.333		105	51-124			
Acenaphthene	0.139	0.20	mg/kg	0.167		83	45-122			
Fluorene	0.0282	0.030	mg/kg	0.0333		85	48-123			
Phenanthrene	0.0159	0.030	mg/kg	0.0167		95	57-123			
Anthracene	0.0171	0.020	mg/kg	0.0167		102	60-138			
Fluoranthene	0.0343	0.030	mg/kg	0.0333		103	65-125			
Pyrene	0.0199	0.020	mg/kg	0.0167		120	57-132			*V1*
Benzanthracene	0.0171	0.010	mg/kg	0.0167		103	66-127			*V1*
Chrysene	0.0178	0.020	mg/kg	0.0167		107	69-128			*V1*
Benzo(b)fluoranthene	0.0326	0.020	mg/kg	0.0333		98	76-124			
Benzo(k)fluoranthene	0.0166	0.010	mg/kg	0.0167		100	75-125			
Benzo(a)pyrene	0.0145	0.010	mg/kg	0.0167		87	48-137			*V1*
Dibenz(a,h)anthracene	0.0310	0.010	mg/kg	0.0333		93	73-130			
Benzo(g,h,i)perylene	0.0349	0.030	mg/kg	0.0333		105	63-134			*V1*
Indeno(1,2,3-cd)pyrene	0.0152	0.010	mg/kg	0.0167		91	69-129			
Surrogate: 2-Chloroanthracene	*0.387*		*mg/kg*	*0.417*		*93*	*62-124*			

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Kylie Emily
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Report Number: PWB0697

Sampled: 02/10/13-02/11/13
Received: 02/11/13

METHOD BLANK/QC DATA

POLYNUCLEAR AROMATIC HYDROCARBONS (EPA 3545/8310)

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Data Qualifiers
Batch: 13B0681 Extracted: 02/19/13										
LCS Dup Analyzed: 02/22/2013 (13B0681-BSD1)										**N1a**
Naphthalene	0.125	0.20	mg/kg	0.167		75	51-126	4	20	
Acenaphthylene	0.331	0.30	mg/kg	0.333		99	51-124	6	40	
Acenaphthene	0.134	0.20	mg/kg	0.167		81	45-122	3	30	
Fluorene	0.0271	0.030	mg/kg	0.0333		81	48-123	4	30	
Phenanthrene	0.0156	0.030	mg/kg	0.0167		94	57-123	2	30	
Anthracene	0.0172	0.020	mg/kg	0.0167		103	60-138	0.5	31	
Fluoranthene	0.0330	0.030	mg/kg	0.0333		99	65-125	4	31	
Pyrene	0.0190	0.020	mg/kg	0.0167		114	57-132	5	31	
Benzanthracene	0.0164	0.010	mg/kg	0.0167		98	66-127	4	31	
Chrysene	0.0170	0.020	mg/kg	0.0167		102	69-128	5	31	
Benzo(b)fluoranthene	0.0316	0.020	mg/kg	0.0333		95	76-124	3	31	
Benzo(k)fluoranthene	0.0160	0.010	mg/kg	0.0167		96	75-125	3	31	
Benzo(a)pyrene	0.0148	0.010	mg/kg	0.0167		89	48-137	2	32	
Dibenz(a,h)anthracene	0.0300	0.010	mg/kg	0.0333		90	73-130	3	31	
Benzo(g,h,i)perylene	0.0351	0.030	mg/kg	0.0333		105	63-134	0.4	31	
Indeno(1,2,3-cd)pyrene	0.0148	0.010	mg/kg	0.0167		89	69-129	2	32	
Surrogate: 2-Chloroanthracene	*0.378*		*mg/kg*	*0.417*		*91*	*62-124*			

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Kylie Emily
Project Manager

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Project ID: FWAFBST012FD/RA Mesa, AZ
Report Number: PWB0697

Sampled: 02/10/13-02/11/13
Received: 02/11/13

METHOD BLANK/QC DATA

TOTAL METALS

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Data Qualifiers
Batch: 13B0484 Extracted: 02/13/13										
Blank Analyzed: 02/14/2013 (13B0484-BLK1)										
Arsenic	ND	5.0	mg/kg							
Barium	ND	5.0	mg/kg							
Cadmium	ND	0.50	mg/kg							
Chromium	ND	2.0	mg/kg							
Lead	ND	5.0	mg/kg							
Selenium	ND	5.0	mg/kg							
Silver	ND	2.5	mg/kg							
LCS Analyzed: 02/14/2013 (13B0484-BS1)										
Arsenic	45.6	5.0	mg/kg	49.8		92	81-109			
Barium	48.1	5.0	mg/kg	49.8		97	87-114			
Cadmium	45.6	0.50	mg/kg	49.8		91	83-110			
Chromium	49.2	2.0	mg/kg	49.8		99	86-112			
Lead	46.0	5.0	mg/kg	49.8		92	83-113			
Selenium	43.0	5.0	mg/kg	49.8		86	78-110			
Silver	3.43	2.5	mg/kg	3.74		92	72-120			
LCS Dup Analyzed: 02/14/2013 (13B0484-BSD1)										
Arsenic	44.8	5.0	mg/kg	49.4		91	81-109	2	20	
Barium	47.3	5.0	mg/kg	49.4		96	87-114	2	20	
Cadmium	45.1	0.50	mg/kg	49.4		91	83-110	1	20	
Chromium	48.2	2.0	mg/kg	49.4		98	86-112	2	20	
Lead	45.6	5.0	mg/kg	49.4		92	83-113	0.8	20	
Selenium	42.6	5.0	mg/kg	49.4		86	78-110	0.9	20	
Silver	3.43	2.5	mg/kg	3.70		92	72-120	0.06	20	
Matrix Spike Analyzed: 02/15/2013 (13B0484-MS1)					**Source: PWB0658-01**					
Arsenic	57.9	50	mg/kg	50.0	19.0	78	75-125			*M4*
Barium	216	50	mg/kg	50.0	565	-698	75-125			*M4*
Cadmium	48.3	5.0	mg/kg	50.0	1.07	94	75-125			*M4*
Chromium	109	20	mg/kg	50.0	130	-42	75-125			*M4*
Lead	111	50	mg/kg	50.0	85.6	50	75-125			*M4*
Selenium	49.9	50	mg/kg	50.0	6.28	87	75-125			*M4*
Silver	3.15	25	mg/kg	3.75	0.0449	83	75-125			*M4*

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Project ID: FWAFBST012FD/RA Mesa, AZ
Report Number: PWB0697

Sampled: 02/10/13-02/11/13
Received: 02/11/13

METHOD BLANK/QC DATA

TOTAL METALS

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Data Qualifiers
Batch: 13B0484 Extracted: 02/13/13										
Matrix Spike Dup Analyzed: 02/15/2013 (13B0484-MSD1)					**Source: PWB0658-01**					
Arsenic	70.2	50	mg/kg	49.8	19.0	103	75-125	19	20	*M4*
Barium	229	50	mg/kg	49.8	565	-675	75-125	6	20	*M4*
Cadmium	53.7	5.0	mg/kg	49.8	1.07	106	75-125	11	20	*M4*
Chromium	119	20	mg/kg	49.8	130	-21	75-125	9	20	*M4*
Lead	104	50	mg/kg	49.8	85.6	36	75-125	7	20	*M4*
Selenium	55.0	50	mg/kg	49.8	6.28	98	75-125	10	20	*M4*
Silver	3.50	25	mg/kg	3.74	0.0449	92	75-125	11	20	*M4*
Batch: 13B0673 Extracted: 02/19/13										
Blank Analyzed: 02/19/2013 (13B0673-BLK1)										
Mercury	ND	0.10	mg/kg							
LCS Analyzed: 02/19/2013 (13B0673-BS1)										
Mercury	1.64	0.10	mg/kg	1.61		101	80-120			
LCS Dup Analyzed: 02/19/2013 (13B0673-BSD1)										
Mercury	1.83	0.10	mg/kg	1.79		103	80-120	11	20	
Matrix Spike Analyzed: 02/19/2013 (13B0673-MS1)					**Source: PWB0643-05**					
Mercury	1.78	0.10	mg/kg	1.61	0.137	102	75-125			
Matrix Spike Dup Analyzed: 02/19/2013 (13B0673-MSD1)					**Source: PWB0643-05**					
Mercury	1.96	0.10	mg/kg	1.76	0.137	103	75-125	10	20	

TestAmerica Phoenix

Kylie Emily
Project Manager

The results pertain only to the samples tested in the laboratory. This report shall not be reproduced, except in full, without written permission from TestAmerica.

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING
4625 East Cotton Center Blvd. Ste 189, Phoenix, AZ 85040 (602) 437-3340 Fax:(602) 454-9303

AMEC Environment & Infrastructure Inc - Phoenix
4600 E Washington Street, 6th Floor
Phoenix, AZ 85034
Attention: Jim Clarke

Project ID: FWAFBST012FD/RA Mesa, AZ
Report Number: PWB0697

Sampled: 02/10/13-02/11/13
Received: 02/11/13

DATA QUALIFIERS AND DEFINITIONS

C8	Sample RPD between the primary and confirmatory analysis exceeded 40%. Per EPA Method 8000C, the lower value was reported as there was no evidence of chromatographic problems.
L3	The associated blank spike recovery was above method acceptance limits.
M1	Matrix spike recovery was high; the associated blank spike recovery was acceptable.
M3	The spike recovery value is unusable since the analyte concentration in the sample is disproportionate to the spike level. The associated blank spike recovery was acceptable.
M4	The analysis of the spiked sample required a dilution such that the spike recovery calculation does not provide useful information. The associated blank spike recovery was acceptable.
N1	See case narrative.
V1	CCV recovery was above method acceptance limits. This target analyte was not detected in the sample.
ND	Analyte NOT DETECTED at or above the reporting limit or MDL, if MDL is specified.
RPD	Relative Percent Difference

ADDITIONAL COMMENTS

For Extractable Fuel Hydrocarbons (EFH, DRO, ORO) by 8015b/d :

Unless otherwise noted, Extractable Fuel Hydrocarbons by method 8015b/d (EFH, DRO, ORO) are quantitated against a Diesel Fuel Standard.

TestAmerica Phoenix

Kylie Emily
Project Manager

The results pertain only to the samples tested in the laboratory. This report shall not be reproduced, except in full, without written permission from TestAmerica.

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

4625 East Cotton Center Blvd. Ste 189, Phoenix, AZ 85040 (602) 437-3340 Fax:(602) 454-9303

AMEC Environment & Infrastructure Inc - Phoenix
4600 E Washington Street, 6th Floor
Phoenix, AZ 85034
Attention: Jim Clarke

Project ID: FWAFBST012FD/RA Mesa, AZ
Report Number: PWB0697

Sampled: 02/10/13-02/11/13
Received: 02/11/13

Certification Summary

TestAmerica Phoenix

Method	Matrix	Nelac	Arizona
8015AZ R.1	Soil		X
EPA 6010B	Soil	N/A	X
EPA 7471A	Soil		X
EPA 8260B	Soil	X	X
EPA 8260B	Water	X	X
EPA 8310	Soil		X

Nevada and NELAP provide analyte specific accreditations. Analyte specific information for TestAmerica may be obtained by contacting the laboratory or visiting our website at www.testamericainc.com

TestAmerica Phoenix

Kylie Emily
Project Manager

The results pertain only to the samples tested in the laboratory. This report shall not be reproduced, except in full, without written permission from TestAmerica.

Chain of Custody Record

TAL-4124-280 (0508)

Sampler ID _____

Temperature on Receipt _____

Drinking Water? Yes ☐ No ☒

TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING

PWB0697

Client: AMEC E&I	Project Manager: James Clarke	Date:	Chain of Custody Number: 169525
Address: 4600 E. Washington St. Ste 600	Telephone Number (Area Code)/Fax Number: 602-733-6000	Lab Number:	Page ____ of ____
City: Phoenix State: AZ Zip Code: 85034	Site Contact:	Lab Contact: M	
Project Name and Location (State): FWAFB ST012 RD/RA Mesa, AZ	Carrier/Waybill Number:		
Contract/Purchase Order/Quote No.:			

Analysis (Attach list if more space is needed)

Sample I.D. No. and Description (Containers for each sample may be combined on one line)	Date	Time	Air	Aqueous	Sed.	Soil	Unpres.	H2SO4	HNO3	HCl	NaOH	ZnAc/NaOH	8310 PAH	8015 TPH	RCRA 8 metals	8260B			Special Instructions/ Conditions of Receipt
ST012-IDW1-213-SP-N	2-10-13	9:45				X	X						X	X	X			3	-01
ST012-IDW1a-213-SP-N	2-10-13	9:15				X										X	composite	3	Composite -02
ST012-IDW1b-213-SP-N	2-10-13	9:20				X										X	into one	3	Composite
ST012-IDW1c-213-SP-N	2-10-13	9:25				X										X	sample	3	Composite
ST012-IDW1d-213-SP-N	2-10-13	9:30				X										X	ST012-IDW1-213	3	Composite
EB-01-021113-	2-11-13	9:40														X		3	-03

Possible Hazard Identification: ☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

Sample Disposal: ☐ Return To Client ☐ Disposal By Lab ☐ Archive For ____ Months (A fee may be assessed if samples are retained longer than 1 month)

Turn Around Time Required: ☐ 24 Hours ☐ 48 Hours ☐ 7 Days ☐ 14 Days ☐ 21 Days ☐ Other _____

QC Requirements (Specify)

	Date	Time		Date	Time
1. Relinquished By: [signature]	2/11/13	1500	1. Received By:		
2. Relinquished By:			2. Received By:		
3. Relinquished By:			3. Received By: [signature]	2/11/13	1500

Comments

DISTRIBUTION: WHITE - Returned to Client with Report; CANARY - Stays with the Sample; PINK - Field Copy

3:8c

ED_005025_00013386-00391

SITE
A J LANDFIL
Apache Junction, AZ 85119 480-982-7003

CUSTOMER
000409
ENVIROMENTAL RESPONSE
2202 W MEDTRONICS WAY #108
TEMPE, AZ 85281
#4752134324

SITE	TICKET #	CELL
75	9(91	

WEIGHMASTER: MARY L.

DATE/TIME IN	DATE/TIME OUT
04-01-2013 8:13 am	04-1-2013 8:13 am

VEHICLE: SS3042
CONTAINER:
REFERENCE: AECEC INVOICE
BILL OF LADING: 1390281

SCALE IN	GROSS WEIGHT	51,580	NET TONS	7.71	
TARE OUT	TARE WEIGHT	36,160	NET WEIGHT	15,420	INBOUND

QTY.	UNIT	DESCRIPTION	RATE	EXTENSION	TAX	TOTAL
0.00	YD	TRACKING QTY				
7.71	TN	SW-CONT SOIL				

NET AMOUNT
TENDERED
CHANGE
CHECK#

The undersigned individual signing this document on behalf of Customer acknowledges that he or she has read and understands the terms and conditions on the reverse side and that he or she has the authority to sign this document on behalf of the customer.

RS-F012UPR (07/12)

SIGNATURE:

Please print or type
(Form designed for use on elite 12-pitch typewriter)

NON-HAZARDOUS WASTE MANIFEST	1. Generator ID Number	2. Page 1 of	3. Emergency Response Phone	4. Waste Tracking Number
	AZ7570028582	1	800-535-5053	1390281

5. Generator's Name and Mailing Address
AFCEC/CZRB-Griffiss -
706 Brooks Road
Rome, NY 13441
Generator's Phone: 315 356-0810

Generator's Site Address (if different than mailing address)
AFCEC Former Williams AFB
7411 E. Ulysses
Mesa, AZ 85212

6. Transporter 1 Company Name: Environmental Response Inc.
U.S. EPA ID Number: AZ0000303032

7. Transporter 2 Company Name:
U.S. EPA ID Number:

8. Designated Facility Name and Site Address
Apache Junction Landfill
4050 S Tomahawk Rd.
Apache Junction, AZ 85219
Facility's Phone: 480-982-7003
U.S. EPA ID Number: Not Required

9. Waste Shipping Name and Description	10. Containers No.	10. Containers Type	11. Total Quantity	12. Unit Wt./Vol.
1. Non-Regulated Material (Petroleum Contaminated Soil) (Drill Cuttings)	1	CM	~~20~~ 7	T
2.				
3.				
4.				

13. Special Handling Instructions and Additional Information
1) WP# 4752-13 4324, Bin # B97
ER Phone Chemtrec 800-535-5053, CD Required, ERI# 20-139028-4

14. GENERATOR'S CERTIFICATION: I certify the materials described above on this manifest are not subject to federal regulations for reporting proper disposal of Hazardous Waste.

Generator's/Offeror's Printed/Typed Name: Louis W Hiltonen
Signature: [signature]
Month 04 Day 01 Year 13

15. International Shipments ☐ Import to U.S. ☐ Export from U.S. Port of entry/exit:
Transporter Signature (for exports only): Date leaving U.S.:

16. Transporter Acknowledgment of Receipt of Materials
Transporter 1 Printed/Typed Name: Justin Thompson
Signature: [signature]
Month 04 Day 01 Year 13
Transporter 2 Printed/Typed Name:
Signature:
Month Day Year

17. Discrepancy
17a. Discrepancy Indication Space ☐ Quantity ☐ Type ☐ Residue ☐ Partial Rejection ☐ Full Rejection
Manifest Reference Number:

17b. Alternate Facility (or Generator)
U.S. EPA ID Number:
Facility's Phone:

17c. Signature of Alternate Facility (or Generator)
Month Day Year

18. Designated Facility Owner or Operator: Certification of receipt of materials covered by the manifest except as noted in Item 17a
Printed/Typed Name: M. Leach
Signature: M. Leach
Month 04 Day 01 Year 13

GENERATOR — INT'L — TRANSPORTER — DESIGNATED FACILITY

GC Labels • Printed in the USA
1-800-997-6966

DESIGNATED FACILITY TO GENERATOR

Reorder Part# MANIFEST-C6NHW
913-897-6966

SITE
A J LANDFILL

Apache Junction, AZ 85119 480-982-7003

CUSTOMER
000409
ENVIROMENTAL RESPONSE
2202 W MEDTRONICS WAY #108
TEMPE, AZ 85281
#4752134324

SITE	TICKET #	CELL
75	9 12	

WEIGHMASTER: MARY L.

DATE/TIME IN: 04-01-2013 9:49 am

DATE/TIME OUT: 04-1-2013 9:49 am

VEHICLE: SS3042

CONTAINER:

REFERENCE: AFCEC

INVOICE

BILL OF LADING: 1390282

SCALE IN	GROSS WEIGHT	56,220	NET TONS	10.03	
TARE OUT	TARE WEIGHT	36,160	NET WEIGHT	20,060	INBOUND

QTY.	UNIT	DESCRIPTION	RATE	EXTENSION	TAX	TOTAL
0.00	YD	TRACKING QTY				
10.03	TN	SW-CONT SOIL				

NET AMOUNT

TENDERED

CHANGE

CHECK#

The undersigned individual signing this document on behalf of Customer acknowledges that he or she has read and understands the terms and conditions on the reverse side and that he or she has the authority to sign this document on behalf of the customer.

RS-F042UPR (07/12) 9/24

SIGNATURE

Please print or type
(Form designed for use on elite (12 pitch) typewriter)

NON-HAZARDOUS WASTE MANIFEST	1. Generator ID Number	2. Page 1 of	3. Emergency Response Phone	4. Waste Tracking Number
	AZ7570028582	1	800-535-5053	1390282

5. Generator's Name and Mailing Address
AFCEC/CZRB-Griffiss -
706 Brooks Road
Rome, NY 13441
Generator's Phone: 315 356-0810

Generator's Site Address (if different than mailing address)
AFCEC Former Williams
7411 E. Ulysses
Mesa, AZ 85212

6. Transporter 1 Company Name: Environmental Response Inc — U.S. EPA ID Number: AZ0000303032

7. Transporter 2 Company Name — U.S. EPA ID Number:

8. Designated Facility Name and Site Address
Apache Junction Landfill
4050 S Tomahawk Rd.
Apache Junction, AZ 85219
Facility's Phone: 480-982-7003
U.S. EPA ID Number: Not Required

9. Waste Shipping Name and Description	10. Containers No.	10. Containers Type	11. Total Quantity	12. Unit Wt./Vol.
1. Non-Regulated Material (Petroleum Contaminated Soil) (Drill Cuttings)	1	CM	~~10~~ 11	T
2.				
3.				
4.				

13. Special Handling Instructions and Additional Information
1) WF# 4752-13-4324, Bin # 961978
ER Phone Chemtrec 800-535-5053, CD Required, ERI# 20-139028-4

14. GENERATOR'S CERTIFICATION: I certify the materials described above on this manifest are not subject to federal regulations for reporting proper disposal of Hazardous Waste.
Generator's/Offeror's Printed/Typed Name: Louis W Hiltonen — Signature: [signature] — Month 04 Day 01 Year 13

15. International Shipments ☐ Import to U.S. ☐ Export from U.S. Port of entry/exit:
Transporter Signature (for exports only): Date leaving U.S.:

16. Transporter Acknowledgment of Receipt of Materials
Transporter 1 Printed/Typed Name: Justin Thompson — Signature: [signature] — Month 04 Day 01 Year 13
Transporter 2 Printed/Typed Name — Signature — Month Day Year

17. Discrepancy
17a. Discrepancy Indication Space ☐ Quantity ☐ Type ☐ Residue ☐ Partial Rejection ☐ Full Rejection
Manifest Reference Number:
17b. Alternate Facility (or Generator) — U.S. EPA ID Number
Facility's Phone:
17c. Signature of Alternate Facility (or Generator) — Month Day Year

18. Designated Facility Owner or Operator: Certification of receipt of materials covered by the manifest except as noted in Item 17a
Printed/Typed Name: M. Leach — Signature: M. Leach — Month 09 Day 01 Year 03

GENERATOR — INT'L — TRANSPORTER — DESIGNATED FACILITY

GC Labels • Printed in the USA
1-800-997-6966

DESIGNATED FACILITY TO GENERATOR

Reorder Part# MANIFEST-C6NHW
913-897-6966

SITE

A J LANDFILL

Apache Junction, AZ 85119 480-982-7003

CUSTOMER

000409
ENVIROMENTAL RESPONSE
2202 W MEDTRONICS WAY #108
TEMPE, AZ 85281
#4752134324

SITE	TICKET #	CELL
75	904154	

WEIGHMASTER: Tiffany S.

DATE/TIME IN: 04-02-2013 3:51 pm

DATE/TIME OUT: 04-2-2013 3:51 pm

VEHICLE: GEN

CONTAINER:

REFERENCE: INVOICE

BILL OF LADING:

SCALE IN	GROSS WEIGHT	74,980	NET TONS	17.48
MANUAL OUT	TARE WEIGHT	40,020	NET WEIGHT	34,960

INBOUND

QTY.	UNIT	DESCRIPTION	RATE	EXTENSION	TAX	TOTAL
0.00	YD	TRACKING QTY				
17.48	TN	SW-CONT SOIL				

NET AMOUNT

TENDERED

CHANGE

CHECK#

The undersigned individual signing this document on behalf of Customer acknowledges that he or she has read and understands the terms and conditions on the reverse side and that he or she has the authority to sign this document on behalf of the customer.

SIGNATURE

RS-F042UPR (07/12)

ED_005025_00013386-00396

Please print or type
(Form designed to be used on elite (12-pitch) typewriter.)

NON-HAZARDOUS WASTE MANIFEST

1. Generator ID Number: AZ7570028582
2. Page 1 of: 1
3. Emergency Response Phone: 800-535-5053
4. Waste Tracking Number: 1390289

5. Generator's Name and Mailing Address
AFCEC/CZRG-Griffiss
706 Brooks Road
Rome, NY 13441
Generator's Phone: 315 356-0810

Generator's Site Address (if different than mailing address)
AFCEC Former Williams
7411 E. Ulysses
Mesa, AZ 85212

6. Transporter 1 Company Name: Environmental Response Inc.
U.S. EPA ID Number: AZ0000303032

7. Transporter 2 Company Name:
U.S. EPA ID Number:

8. Designated Facility Name and Site Address
Apache Junction Landfill
4050 S Tomahawk Rd.
Apache Junction, AZ 85219
Facility's Phone: 480-982-7003
U.S. EPA ID Number: Not Required

	9. Waste Shipping Name and Description	10. Containers No.	10. Containers Type	11. Total Quantity	12. Unit Wt./Vol.	
1.	Non-Regulated Material (Petroleum Contaminated Soil) (Drill Cuttings)	1	CM	~~20~~ 5	T	
2.						
3.						
4.						

13. Special Handling Instructions and Additional Information
1) WP# 4752-13-4324, Bin # 1482
ER Phone Chemtrec 800-535-5053, CD Required, ERI# 20-139028-4

14. GENERATOR'S CERTIFICATION: I certify the materials described above on this manifest are not subject to federal regulations for reporting proper disposal of Hazardous Waste.
Generator's/Offeror's Printed/Typed Name: Louis A Hittner
Signature:
Month 04 Day 02 Year 13

15. International Shipments ☐ Import to U.S. ☐ Export from U.S. Port of entry/exit:
Transporter Signature (for exports only): Date leaving U.S.:

16. Transporter Acknowledgment of Receipt of Materials
Transporter 1 Printed/Typed Name: Justin Thompson
Signature:
Month 04 Day 02 Year 13
Transporter 2 Printed/Typed Name:
Signature:
Month Day Year

17. Discrepancy
17a. Discrepancy Indication Space ☐ Quantity ☐ Type ☐ Residue ☐ Partial Rejection ☐ Full Rejection
Manifest Reference Number:
17b. Alternate Facility (or Generator)
U.S. EPA ID Number
Facility's Phone:
17c. Signature of Alternate Facility (or Generator)
Month Day Year

18. Designated Facility Owner or Operator: Certification of receipt of materials covered by the manifest except as noted in Item 17a
Printed/Typed Name: Tiffany Snow
Signature:
Month 4 Day 2 Year 13

GENERATOR — INTL — TRANSPORTER — DESIGNATED FACILITY

GC Labels • Printed in the USA 1-800-897-5966

DESIGNATED FACILITY TO GENERATOR

Reorder Part# MANIFEST-C6NHW 913-897-6966

SITE

A J LANDFIL

Apache Junction, AZ 85119 480-982-7003

CUSTOMER

000409
ENVIROMENTAL RESPONSE
2202 W MEDTRONICS WAY #108
TEMPE, AZ 85281
#4752134324

SITE 75 | TICKET # 6 158 | CELL

WEIGHMASTER: Deborah M.

DATE/TIME IN: 04-03-2013 6:01 am | DATE/TIME OUT: 04-3-2013 6:01 am

VEHICLE: SS3042 | CONTAINER

REFERENCE: INVOICE

BILL OF LADING

SCALE IN	GROSS WEIGHT	65,900	NET TONS	14.87	
TARE OUT	TARE WEIGHT	36,160	NET WEIGHT	29,740	INBOUND

QTY.	UNIT	DESCRIPTION	RATE	EXTENSION	TAX	TOTAL
0.00	YD	TRACKING QTY				
14.87	TN	SW-CONT SOIL				

NET AMOUNT

TENDERED

CHANGE

CHECK#

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RS-F042UPR (07/12) 2/21

SIGNATURE

Please print or type
(Form designed for use on elite (12-pitch) typewriter)

NON-HAZARDOUS WASTE MANIFEST	1. Generator ID Number	2. Page 1 of	3. Emergency Response Phone	4. Waste Tracking Number
	AZ7570028582	1	800-535-5053	13902811

5. Generator's Name and Mailing Address
AFCEC/CZRB-Griffiss -
706 Brooks Road
Rome, NY 13441
Generator's Phone: 315 356-0810

Generator's Site Address (if different than mailing address)
AFCEC Former Williams
7411 E. Olysses
Mesa, AZ 85212

6. Transporter 1 Company Name: Environmental Response Inc.
U.S. EPA ID Number: AZ0000303032

7. Transporter 2 Company Name:
U.S. EPA ID Number:

8. Designated Facility Name and Site Address
Apache Junction Landfill
4050 S Tomahawk Rd.
Apache Junction, AZ 85212
Facility's Phone: 480-982-7003
U.S. EPA ID Number: Not Required

9. Waste Shipping Name and Description	10. Containers No.	10. Containers Type	11. Total Quantity	12. Unit Wt./Vol.
1. Non-Regulated Material (Petroleum Contaminated Soil) (Drill Cuttings)	1	CM	~~20~~ 15	T
2.				
3.				
4.				

13. Special Handling Instructions and Additional Information
1) WP# 4752-13-4324, Bin # 66184
ER Phone Chemtrec 800-535-5053, CD Required, ERI# 20-139028-4

14. GENERATOR'S CERTIFICATION: I certify the materials described above on this manifest are not subject to federal regulations for reporting proper disposal of Hazardous Waste.

Generator's/Offeror's Printed/Typed Name: Louis v Hiltonen
Signature: [signature]
Month 04 Day 03 Year 12

15. International Shipments ☐ Import to U.S. ☐ Export from U.S. Port of entry/exit:
Transporter Signature (for exports only): Date leaving U.S.:

16. Transporter Acknowledgment of Receipt of Materials

Transporter 1 Printed/Typed Name: Justin Thompson
Signature:
Month 04 Day 03 Year 12

Transporter 2 Printed/Typed Name:
Signature:
Month Day Year

17. Discrepancy

17a. Discrepancy Indication Space ☐ Quantity ☐ Type ☐ Residue ☐ Partial Rejection ☐ Full Rejection

Manifest Reference Number:

17b. Alternate Facility (or Generator)
U.S. EPA ID Number
Facility's Phone:

17c. Signature of Alternate Facility (or Generator)
Month Day Year

18. Designated Facility Owner or Operator: Certification of receipt of materials covered by the manifest except as noted in Item 17a

Printed/Typed Name: Debbie Manske
Signature: [signature]
Month 4 Day 3 Year 12

GENERATOR — INT'L — TRANSPORTER — DESIGNATED FACILITY

GC Labels • Printed in the USA
1-800-997-6966

DESIGNATED FACILITY TO GENERATOR

Reorder Part# MANIFEST-C5NHW
913-897-6966

SITE
A J LANDFIL

Apache Junction, AZ 85119 480-982-7003

CUSTOMER
000409
ENVIROMENTAL RESPONSE
2202 W MEDTRONICS WAY #108
TEMPE, AZ 85281
#4752134324

SITE	TICKET #	CELL
75	9 086	

WEIGHMASTER: Tiffany S.

DATE/TIME IN: 04-02-2013 12:35 pm
DATE/TIME OUT: 04-2-2013 12:35 pm
VEHICLE: SS3042
CONTAINER:
REFERENCE: INVOICE
BILL OF LADING:

SCALE IN	GROSS WEIGHT	60,480	NET TONS	12.16	
TARE OUT	TARE WEIGHT	36,160	NET WEIGHT	24,320	INBOUND

QTY.	UNIT	DESCRIPTION	RATE	EXTENSION	TAX	TOTAL
0.00	YD	TRACKING QTY				
12.16	TN	SW-CONT SOIL				

NET AMOUNT
TENDERED
CHANGE
CHECK#

The undersigned individual signing this document on behalf of Customer acknowledges that he or she has read and understands the terms and conditions on the reverse side and that he or she has the authority to sign this document on behalf of the customer.

RS-F042UPR (07/12)

SIGNATURE

Please print or type
(Form designed for use on elite (12-pitch) typewriter)

NON-HAZARDOUS WASTE MANIFEST	1. Generator ID Number	2. Page 1 of	3. Emergency Response Phone	4. Waste Tracking Number
	AZ7570028582	1	800-535-5053	13902810

GENERATOR

5. Generator's Name and Mailing Address
AFCEC/CZRB-Griffiss -
706 Brooks Road
Rome, NY 13441
Generator's Phone: 315 356-0810

Generator's Site Address (if different than mailing address)
AFCEC Former Williams
7411 E. Ulysses
Mesa, AZ 85212

6. Transporter 1 Company Name: Environmental Response Inc.
U.S. EPA ID Number: AZ0000303032

7. Transporter 2 Company Name:
U.S. EPA ID Number:

8. Designated Facility Name and Site Address
Apache Junction Landfill
4050 S Tomahawk Rd.
Apache Junction, AZ 85219
Facility's Phone: 480-982-7003
U.S. EPA ID Number: Not Required

9. Waste Shipping Name and Description	10. Containers No.	10. Containers Type	11. Total Quantity	12. Unit Wt./Vol.
1. Non-Regulated Material (Petroleum Contaminated Soil) (Drill Cuttings)	1	CM	~~20~~ 12	T
2.				
3.				
4.				

13. Special Handling Instructions and Additional Information
1) WP# 4752-13-4324, Bin # 66188
ER Phone Chemtrec 800-535-5053, CL Required, ERI# 20-139028-4

14. GENERATOR'S CERTIFICATION: I certify the materials described above on this manifest are not subject to federal regulations for reporting proper disposal of Hazardous Waste.

Generator's/Offeror's Printed/Typed Name: Louis M Hittman
Signature: [signature]
Month Day Year

INT'L

15. International Shipments ☐ Import to U.S. ☐ Export from U.S. Port of entry/exit:
Transporter Signature (for exports only): Date leaving U.S.:

TRANSPORTER

16. Transporter Acknowledgment of Receipt of Materials

Transporter 1 Printed/Typed Name: Justin Thompson
Signature: [signature]
Month Day Year

Transporter 2 Printed/Typed Name:
Signature:
Month Day Year

DESIGNATED FACILITY

17. Discrepancy

17a. Discrepancy Indication Space ☐ Quantity ☐ Type ☐ Residue ☐ Partial Rejection ☐ Full Rejection

Manifest Reference Number:

17b. Alternate Facility (or Generator)
U.S. EPA ID Number
Facility's Phone:

17c. Signature of Alternate Facility (or Generator)
Month Day Year

18. Designated Facility Owner or Operator: Certification of receipt of materials covered by the manifest except as noted in Item 17a

Printed/Typed Name: [signature]
Signature: [signature]
Month Day Year: 4 2 13

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DESIGNATED FACILITY TO GENERATOR

Reorder Part# MANIFEST-C6NHW
913-897-6966

SITE
A J LANDFIL
Apache Junction, AZ 85119 480-982-7003

CUSTOMER
000409
ENVIROMENTAL RESPONSE
2202 W MEDTRONICS WAY #108
TEMPE, AZ 85281
#4752134324

SITE 75 | TICKET # 9 958 | CELL

WEIGHMASTER Tiffany S.

DATE/TIME IN 04-02-2013 10:54 am | DATE/TIME OUT 04-2-2013 10:54 am

VEHICLE SS3042 | CONTAINER

REFERENCE

INVOICE

BILL OF LADING

SCALE IN	GROSS WEIGHT	58,620	NET TONS	11.23
TARE OUT	TARE WEIGHT	36,160	NET WEIGHT	22,460

INBOUND

QTY.	UNIT	DESCRIPTION	RATE	EXTENSION	TAX	TOTAL
0.00	YD	TRACKING QTY				
11.23	TN	SW-CONT SOIL				

NET AMOUNT

TENDERED

CHANGE

CHECK#

The undersigned individual signing this document on behalf of Customer acknowledges that he or she has read and understands the terms and conditions on the reverse side and that he or she has the authority to sign this document on behalf of the customer.

RS-F042UPR (07/12)

SIGNATURE

Please print or type.
(Form designed for use on elite (12 pitch) typewriter.)

NON-HAZARDOUS WASTE MANIFEST	1. Generator ID Number	2. Page 1 of	3. Emergency Response Phone	4. Waste Tracking Number
	AZ7570028582	1	800-535-5053	1390287

GENERATOR

5. Generator's Name and Mailing Address
AFCEC/CZRB-Griffiss -
706 Brooks Road
Rome, NY 13441
Generator's Phone: 315 356 0810

Generator's Site Address (if different than mailing address)
AFCEC Former Williams
7411 E. Ulysses
Mesa, AZ 85212

6. Transporter 1 Company Name: Environmental Response Inc.
U.S. EPA ID Number: AZ0000303032

7. Transporter 2 Company Name:
U.S. EPA ID Number:

8. Designated Facility Name and Site Address
Apache Junction Landfill
4050 S Tomahawk Rd.
Apache Junction, AZ 85219
Facility's Phone: 480-982-7003
U.S. EPA ID Number: Not Required

	9. Waste Shipping Name and Description	10. Containers No.	10. Containers Type	11. Total Quantity	12. Unit Wt./Vol.	
1.	Non-Regulated Material (Petroleum Contaminated Soil) (Drill Cuttings)	1	CM	~~20~~ 13	T	
2.						
3.						
4.						

13. Special Handling Instructions and Additional Information
1) WP# 4752-13-4324, Bin # 63298
ER Phone Chemtrec 800-535-5053, CD Required, ER1# 20-139028-4

14. GENERATOR'S CERTIFICATION: I certify the materials described above on this manifest are not subject to federal regulations for reporting proper disposal of Hazardous Waste.

Generator's/Offeror's Printed/Typed Name: Louis - Hiltman
Signature: [signature]
Month 04 Day 02 Year 12

INT'L

15. International Shipments ☐ Import to U.S. ☐ Export from U.S. Port of entry/exit:
Transporter Signature (for exports only): Date leaving U.S.:

TRANSPORTER

16. Transporter Acknowledgment of Receipt of Materials

Transporter 1 Printed/Typed Name: Justin Thompson
Signature: [signature]
Month 04 Day 02 Year 12

Transporter 2 Printed/Typed Name:
Signature:
Month Day Year

DESIGNATED FACILITY

17. Discrepancy

17a. Discrepancy Indication Space ☐ Quantity ☐ Type ☐ Residue ☐ Partial Rejection ☐ Full Rejection

Manifest Reference Number:

17b. Alternate Facility (or Generator)
U.S. EPA ID Number
Facility's Phone:

17c. Signature of Alternate Facility (or Generator)
Month Day Year

18. Designated Facility Owner or Operator: Certification of receipt of materials covered by the manifest except as noted in Item 17a.

Printed/Typed Name: Tiffany Snow
Signature: [signature]
Month 4 Day 2 Year 13

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1-800-997-6966

DESIGNATED FACILITY TO GENERATOR

Reorder Part# MANIFEST-C6NHW
913-897-6966

SITE
A J LANDFILL
Apache Junction, AZ 85119 480-982-7003

CUSTOMER
000409
ENVIROMENTAL RESPONSE
2202 W MEDTRONICS WAY #108
TEMPE, AZ 85281
#4752134324

SITE 75 | TICKET # 9 984 | CELL
WEIGHMASTER Tiffany S.
DATE/TIME IN 04-02-2013 7:09 am | DATE/TIME OUT 04-2-2013 7:53 am
VEHICLE CEN | CONTAINER
REFERENCE SPRAY 303 INVOICE
BILL OF LADING

SCALE IN	GROSS WEIGHT	74,880	NET TONS	17.43	
SCALE OUT	TARE WEIGHT	40,020	NET WEIGHT	34,860	INBOUND

QTY.	UNIT	DESCRIPTION	RATE	EXTENSION	TAX	TOTAL
0.00	YD	TRACKING QTY				
17.43	TN	SW-CONT SOIL				

NET AMOUNT
TENDERED
CHANGE
CHECK#

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RS-F042UPR (07/12) 2/24

SIGNATURE

Please print or type
(Form designed for use on elite (12 pitch) typewriter)

NON-HAZARDOUS WASTE MANIFEST

1. Generator ID Number: AZ7570028582
2. Page 1 of: 1
3. Emergency Response Phone: 800-535-5053
4. Waste Tracking Number: 1390285

5. Generator's Name and Mailing Address
AFCEC/CZRB-Griffiss -
706 Brooks Road
Rome, NY 13441
Generator's Phone: 315 356-0310

Generator's Site Address (if different than mailing address)
AFCEC Former Williams
7411 E. Ulysses
Mesa, AZ 85212

6. Transporter 1 Company Name: Environmental Response Inc.
U.S. EPA ID Number: AZ0000303032

7. Transporter 2 Company Name:
U.S. EPA ID Number:

8. Designated Facility Name and Site Address
Apache Junction Landfill
4050 S Tomahawk Rd.
Apache Junction, AZ 85219
Facility's Phone: 480-982-7003
U.S. EPA ID Number: Not Required

	9. Waste Shipping Name and Description	10. Containers No.	10. Containers Type	11. Total Quantity	12. Unit Wt./Vol.	
1.	Non-Regulated Material (Petroleum Contaminated Soil) (Drill Cuttings)	1	CM	~~20~~ 11	T	
2.						
3.						
4.						

13. Special Handling Instructions and Additional Information
1) WP# 4752-13-4324, Bin #683041
ER Phone Chemtrec 800-535-5053, CD Required, ERI# 20-139028-4

14. GENERATOR'S CERTIFICATION: I certify the materials described above on this manifest are not subject to federal regulations for reporting proper disposal of Hazardous Waste.

Generator's/Offeror's Printed/Typed Name: Louis - Hitchen
Signature:
Month 04 Day 02 Year 13

15. International Shipments ☐ Import to U.S. ☐ Export from U.S. Port of entry/exit:
Transporter Signature (for exports only): Date leaving U.S.:

16. Transporter Acknowledgment of Receipt of Materials
Transporter 1 Printed/Typed Name: JUSTIN THOMPSON
Signature:
Month 04 Day 02 Year 13
Transporter 2 Printed/Typed Name:
Signature:
Month Day Year

17. Discrepancy
17a. Discrepancy Indication Space ☐ Quantity ☐ Type ☐ Residue ☐ Partial Rejection ☐ Full Rejection
Manifest Reference Number:

17b. Alternate Facility (or Generator)
U.S. EPA ID Number
Facility's Phone:

17c. Signature of Alternate Facility (or Generator)
Month Day Year

18. Designated Facility Owner or Operator: Certification of receipt of materials covered by the manifest except as noted in Item 17a
Printed/Typed Name:
Signature:
Month 4 Day 2 Year 13

GENERATOR — INT'L — TRANSPORTER — DESIGNATED FACILITY

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1-800-997-6966

DESIGNATED FACILITY TO GENERATOR

Reorder Part# MANIFEST-C6NHW
913-897-9966

SITE
A J LANDFIL

Apache Junction, AZ 85119 480-982-7003

CUSTOMER
000409
ENVIROMENTAL RESPONSE
2202 W MEDTRONICS WAY #108
TEMPE, AZ 85281
#4752134324

SITE	TICKET #	CELL
75	9 369	

WEIGHMASTER: Tiffany S.

DATE/TIME IN	DATE/TIME OUT
04-02-2013 7:00 am	04-2-2013 7:00 am

VEHICLE	CONTAINER
SS3042	

REFERENCE: INVOICE

BILL OF LADING

SCALE IN	GROSS WEIGHT	87,880	NET TONS	25.86	
TARE OUT	TARE WEIGHT	36,160	NET WEIGHT	51,720	INBOUND

QTY.	UNIT	DESCRIPTION	RATE	EXTENSION	TAX	TOTAL
0.00	YD	TRACKING QTY				
25.86	TN	SW-CONT SOIL				

NET AMOUNT

TENDERED

CHANGE

CHECK#

The undersigned individual signing this document on behalf of Customer acknowledges that he or she has read and understands the terms and conditions on the reverse side and that he or she has the authority to sign this document on behalf of the customer.

RS-F012UPR (07/12) 2/21

SIGNATURE

Please print or type
(Form designed for use on elite (12-pitch) typewriter)

NON-HAZARDOUS WASTE MANIFEST	1. Generator ID Number	2. Page 1 of	3. Emergency Response Phone	4. Waste Tracking Number
	AZ7570028582	1	800-535-5053	1390284

GENERATOR

5. Generator's Name and Mailing Address
AFCEC/CZRB-Griffiss -
706 Brooks Road
Rome, NY 13441
Generator's Phone: 315 356-0810

Generator's Site Address (if different than mailing address)
AFCEC Former Williams
7411 E. Ulysses
Mesa, AZ 85212

6. Transporter 1 Company Name: Environmental Response Inc.
U.S. EPA ID Number: AZ0000303032

7. Transporter 2 Company Name:
U.S. EPA ID Number:

8. Designated Facility Name and Site Address
Apache Junction Landfill
4050 S Tomahawk Rd.
Apache Junction, AZ 85219
Facility's Phone: 480-982-7003
U.S. EPA ID Number: Not Required

	9. Waste Shipping Name and Description	10. Containers No.	10. Containers Type	11. Total Quantity	12. Unit Wt./Vol.
1.	Non Regulated Material (Petroleum Contaminated Soil) (Drill Cuttings)	1	CM	~~20~~ 12	T
2.					
3.					
4.					

13. Special Handling Instructions and Additional Information
1) WP# 4752-13-4324, Bin #66189
ER Phone Chemtrec 800-535-5053, CD Required, ERI# 20-139028-4

14. GENERATOR'S CERTIFICATION: I certify the materials described above on this manifest are not subject to federal regulations for reporting proper disposal of Hazardous Waste.

Generator's/Offeror's Printed/Typed Name: Louis W Hiltunen
Signature: [signature]
Month 04 Day 02 Year 13

INT'L

15. International Shipments ☐ Import to U.S. ☐ Export from U.S. Port of entry/exit:
Transporter Signature (for exports only): Date leaving U.S.:

TRANSPORTER

16. Transporter Acknowledgment of Receipt of Materials

Transporter 1 Printed/Typed Name: Justin Thompson
Signature: [signature]
Month 04 Day 02 Year 13

Transporter 2 Printed/Typed Name:
Signature:
Month Day Year

DESIGNATED FACILITY

17. Discrepancy

17a. Discrepancy Indication Space ☐ Quantity ☐ Type ☐ Residue ☐ Partial Rejection ☐ Full Rejection

Manifest Reference Number:

17b. Alternate Facility (or Generator)
U.S. EPA ID Number:
Facility's Phone:

17c. Signature of Alternate Facility (or Generator)
Month Day Year

18. Designated Facility Owner or Operator: Certification of receipt of materials covered by the manifest except as noted in Item 17a

Printed/Typed Name: [signature]
Signature: [signature]
Month 4 Day 2 Year 13

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DESIGNATED FACILITY TO GENERATOR

Reorder Part# MANIFEST-C6NHW
913-897-6966

APPENDIX B

LNAPL VOLUME CALCULATIONS

Job No.	9101110001	Sheet 1 of 6		amec
Phase	5100	Task 02		
Job Name	Williams AFB, Site ST012			
By	NRL	Date 7/10/13		
Checked By	SCP	Date 7/20/13		511 Congress Street
Revision 1	SCP	Date 9/9/13		Portland, ME 04101
Checked By		Date		+1 (207) 775-5401 Fax +1 (207) 772-4762

Purpose: Estimate the volume of residual LNAPL remaining in the thermal treatment zone.

Method:

1 - Estimate volumes of LNAPL contaminated soil in each lithologic unit and within the thermal treatment zone of each lithologic unit .
2 - Calculate pore space volume in each lithologic unit in the thermal treatment zone.
3 - Estimate saturation percentage in each lithologic unit based on TPH analytical data and literature values.
4 - Calculate volume of residual LNAPL.
5 - Estimate the amount of LNAPL that has been removed by previous treatment and natural attenuation.
6 - Calculate the estimated range of remaining residual LNAPL.

Assumptions:

LNAPL contours derived from a review of historical data and the pre-design investigation were used to generate two three dimensional models (in TecPlot) representing a range of volume of soil on site. The smaller volume represents the areas with strong indication of LNAPL presence through recent data (PDI soil testing, recent measureable LNAPL in wells, and supported by high dissolved phase groundwater concentrations). This volume represents the volume likely to be contributing the most to dissolve phase concentrations above cleanup levels. The second, more conservative volume represents areas that may have been exposed to LNAPL at some point in the site history, but may not currently have free-phase product or high groundwater concentrations.

The same review was also used to review soil classification data and model the divisions between lithologic units. The Tecplot model was used to determine the volume of LNAPL contaminated soils within each unit and within the thermal treatment zone.

Porosity of 0.3 for all lithologic units was used to maintain consistency with the Terratherm design assumptions.

Applied NAPL Science Review, Volume 2, Issue 1, January 2012, LCCM Tools: Conversion of TPH in Soils to NAPL Saturation, gives a relationship between TPH and NAPL saturation as follows:

$$S_n = \text{TPH} \cdot \frac{(1-\phi)\cdot \text{Grain Density} \cdot 10^{-6}}{\phi\rho} \quad \text{where } \phi = \text{porosity, and } \rho = \text{LNAPL density}$$

where:

S_n = natural saturation (dimensionless)
TPH = soil total petroleum hydrocarbon contamination (mg/kg)
Φ = soil porosity
ρ = LNAPL density g/cm^3
and grain density is in g/cm^3

Literature values identified in previous BEM modeling efforts for LNAPL saturation of different soil types are also assumed to be valid.

LNAPL is assumed to be at residual saturation. Although some LNAPL accumulates in monitoring wells indicating mobile LNAPL above residual saturation, a condition of residual saturation is likely present for most of the area.

Previous contaminant removal quantities are summarized and sourced in the 2012 FFS, Section 3.4. Only methods impacting soils in the thermal treatment zones were included (the SVE systems were not screened deeply enough to impact the soils in question, and so were not included in the calculation.

In some instances, adjacent soil samples provided analytical results ranging from high concentrations to non-detect and not all borings within the interpreted distribution of LNAPL show strong indicators of LNAPL presence; this suggests that LNAPL distribution is not uniform across the estimated volume of LNAPL contaminated soils and LNAPL volumes estimated assuming uniform distribution of LNAPL within the area may over estimate actual LNAPL volume. . Assumed factors are applied to develop a range to reflect this condition although there is no reliable data to quantitatively estimate this factor.

Constants and Inputs:

2.65 g/cm^3	grain density
0.3 -	total porosity
0.7787 g/cm^3	LNAPL specific gravity (ranges from 0.75 to 0.80 for JP-4)
1% -	cobble zone LNAPL saturation (no literature value was found matching the cobble zone soil type; an engineer's estimate of 1% was used for the associated LNAPL calculations)
75% -	assumed low end factor of percent of interpreted LNAPL area actually impacted by LNAPL

References:

Hawthorne, J. M. & Kirkman, A. J. (2012). LCCM Tools: Conversion of TPH in Soils to NAPL Saturation. *Applied NAPL Science Review, 2*(1).

BEM, 2010, *Final Construction Completion/Inspection Report, Former Williams Air Force Base, Arizona*, prepared for Air Force Center for Engineering and the Environment, Lackland AFB, Texas, May 2010.

AMEC, 2012, *Final Focused Feasibility Study, Remedial Alternatives for Operable Unit 2, Site ST012, Former Williams Air Force Base, Mesa, Arizona*, prepared for the Air Force Civil Engineer Center (AFCEC), Lackland Air Force Base, Texas,

Calculations:

1 - Estimate volumes of LNAPL contaminated soil in each lithologic unit and within the thermal treatment zone of each lithologic unit .

A. Interpret vertical distribution of LNAPL in individual borings for pre-design investigation locations and historical borings (where available)

The following scoring interpretations were used based on observations/data for borings:

Staining:	0 - None, no evidence of LNAPL
	1 - Minimal staining, weak evidence of LNAPL
	2 - Staining or dark staining, strong evidence of LNAPL
Odor:	0 - None, no evidence of LNAPL
	1 - Slight/very slight odor, weak evidence of LNAPL
	2 - Odor, or strong/very strong odor, strong evidence of LNAPL
Dye Test:	0 - None
	4 - LNAPL present
PID:	0 - <45 ppmv, no evidence of LNAPL
	1 - between 45 and 450 ppmv, weak evidence of LNAPL
	2 - > 450 ppmv, strong evidence of LNAPL
Benzene:	0 - less than 20 mg/kg, no evidence of LNAPL
	1 - between 20 and 200 mg/kg, weak evidence of LNAPL
	2 - > 200 mg/kg, strong evidence of LNAPL
TPH (JP-4)	0 - less than 25 mg/kg, no evidence of LNAPL
	1 - between 25 and 250 mg/kg, weak evidence of LNAPL
	2 - > 250 mg/kg, strong evidence of LNAPL

Interpretations were made on 1-foot vertical intervals. Where data for a given parameter was available less frequently, the score from the closest location above was carried down unless there was a technical basis to do otherwise (e.g., significant change in lithologic unit, maximum depth of historical water table)

The score from all of the factors were sumed for each 1-foot interval. Sumed values of 4 and greater were considered vertical intervals where current or historical LNAPL presence was likely. The sumed scores were input into the TecPlot model and graphical presentation of the results are shown in Figures B-1a and B-1b.

B. Interpretation of LNAPL data to develop LNAPL volumes.

To interpret the extent of LNAPL, the scores for the individual 1-foot intervals were summed for 10-foot intervals (see Figures B-2a and B-2b). The extent of LNAPL was then contoured manually for each 10-foot interval. Two different interpretations of LNAPL extent were made with the manual contouring. The first interpretation focused on scores greater than 30 on recent data from the Pre-Design Investigation borings additionally informed by areas of measured LNAPL in monitoring wells and with consideration of whether LNAPL presence is supported by dissolved phase concentrations. This second, more conservative interpretation considered scores greater than 20 for a 10-foot interval representative of LNAPL presence and considered both historical and Pre-Design Investigation locations. Contours were extended to include monitoring wells known to have observed LNAPL but lack additional evidence of LNAPL (e.g. boring logs not available). The individual 10-foot contours were entered into the TecPlot model. Figures B-3 and B-4 represent the estimated extent of LNAPL under these two interpretations. Figures B-5 through B-7 show the TTZ and EBR treatment zones relative to the LNAPL interpretation footprints for the CZ, UWBZ, and LSZ respectively.

The Tecplot model was used to determine the volume of LNAPL saturated soils within the lithologic units at the site and within the thermal treatment zones (TTZs).

	LNAPL Volume Interpretation		Conservative LNAPL Volume Interpretation	
	Total Volume (cu ft)	Volume within TTZ (cu ft)	Total Volume (cu ft)	Volume within TTZ (cu ft)
CZ	329,994	256,716	763,500	579,750
UWBZ	3,112,992	1,670,490	4,321,500	1,902,750
LPZ	2,236,500	1,479,371	2,858,500	1,719,000
LSZ	6,376,000	5,550,741	7,897,000	6,118,250

Job No.	9101110001	Sheet 3 of 6		amec
Phase	5100	Task 02		
Job Name	Williams AFB, Site ST012			
By	NRL	Date 7/10/13		
Checked By	SCP	Date 7/20/13		511 Congress Street Portland, ME 04101 +1 (207) 775-5401 Fax +1 (207) 772-4762

2 - Calculate pore space volume in each lithologic unit in the thermal treatment zone.

A porosity of 0.3 was used for all lithologic units to remain consistent with the SEE design.

	LNAPL Volume Interpretation		Conservative LNAPL Volume	
	Total Pore Space (cu ft)	Pore Space within TTZ (cu	Total Pore Space (cu ft)	Pore Space within TTZ (cu ft)
CZ	98,998	77,015	229,050	173,925
UWBZ	933,898	501,147	1,296,450	570,825
LPZ	670,950	443,811	857,550	515,700
LSZ	1,912,800	1,665,222	2,369,100	1,835,475

3 - Estimate saturation percentage in each lithologic unit based on TPH analytical data and literature values.

	Grain Density (g/cc)	LNAPL Density (g/cc)	Average Observed Concentration TPH (mg/kg)	Calculated LNAPL Saturation	Literature Value LNAPL Saturation
CZ	2.65	0.7787	1,921	1.53%	1.00%
UWBZ	2.65	0.7787	7,901	6.27%	4.10%
LPZ	2.65	0.7787	1,498	1.19%	2.80%
LSZ	2.65	0.7787	3,340	2.65%	5.80%

4 - Calculate volume of residual LNAPL.

Total Residual Volume - LNAPL Volume Interpretation

	Total Pore Space (cu ft)	Calculated LNAPL Saturation	Calculated Volume of LNAPL (cu ft)	Literature Value LNAPL Saturation	Literature Volume of LNAPL (cu ft)
CZ	98,998	1.53%	1,510	1.00%	990
UWBZ	933,898	6.27%	58,591	4.10%	38,290
LPZ	670,950	1.19%	7,981	2.80%	18,787
LSZ	1,912,800	2.65%	50,730	5.80%	110,942
Total	3,616,646		118,813		169,009

Residual Volume within TTZs - LNAPL Volume Interpretation

	Treatment Area Pore Space (cu ft)	Calculated LNAPL Saturation	Calculated Volume of LNAPL (cu ft)	Literature Value LNAPL Saturation	Literature Volume of LNAPL (cu ft)
CZ	77,015	1.53%	1,175	1.00%	770
UWBZ	501,147	6.27%	31,441	4.10%	20,547
LPZ	443,811	1.19%	5,279	2.80%	12,427
LSZ	1,665,222	2.65%	44,164	5.80%	96,583
Total	2,687,195		82,059		130,327

Total Residual Volume - Conservative LNAPL Volume Interpretation

	Total Pore Space (cu ft)	Calculated LNAPL Saturation	Calculated Volume of LNAPL (cu ft)	Literature Value LNAPL Saturation	Literature Volume of LNAPL (cu ft)
CZ	229,050	1.53%	3,494	1.00%	2,291
UWBZ	1,296,450	6.27%	81,337	4.10%	53,154
LPZ	857,550	1.19%	10,201	2.80%	24,011
LSZ	2,369,100	2.65%	62,832	5.80%	137,408
Total	4,752,150		157,864		216,864

Job No.	9101110001	Sheet 4 of 6		amec
Phase	5100	Task 02		
Job Name	Williams AFB, Site ST012			
By	NRL	Date 7/10/13		
Checked By	SCP	Date 7/20/13		511 Congress Street Portland, ME 04101 +1 (207) 775-5401 Fax +1 (207) 772-4762

Residual Volume within TTZs - Conservative LNAPL Volume Interpretation

	Treatment Area Pore Space (cu ft)	Calculated LNAPL Saturation	Calculated Volume of LNAPL (cu ft)	Literature Value LNAPL Saturation	Literature Volume of LNAPL (cu ft)
CZ	173,925	1.53%	2,653	1.00%	1,739
UWBZ	570,825	6.27%	35,813	4.10%	23,404
LPZ	515,700	1.19%	6,134	2.80%	14,440
LSZ	1,835,475	2.65%	48,680	5.80%	106,458
Total	3,095,925		93,280		146,040

5 - Estimate the amount of LNAPL that has been removed by previous treatment and natural attenuation.
See FFS (AMEC, 2012) for basis/references.

	UWBZ (gallons)	LSZ (gallons)	Total (gallons)	
TEE Pilot	9,070	9,070	18,140	(assumed roughly equal in each zone)
Biodegradation	997	4,986	5,980	(100 % LSZ from 1969-1997, then 50/50)
Skimming/Bioslurping	0	10,564	10,564	(primarily removed from LSZ)
Total	10,067	24,620	34,684	

Note: Additional LNAPL mass has been removed from the CZ by the deep soil SVE system but has not been

6 - Calculate the estimated range of remaining residual LNAPL.
LNAPL Interpretation

		EBR Treatment Area Volume		Treatment Area Volume		Total Residual Volume	
	TTZ	Calculated Volume of LNAPL	Literature Volume of LNAPL	Calculated Volume of LNAPL	Literature Volume of LNAPL	Calculated Volume of LNAPL	Literature Volume of LNAPL
cu ft	CZ	335	220	1,175	770	1,510	990
gallons	CZ	2,508	1,644	8,787	5,761	11,296	7,405
NAPL Removed (gallons)	CZ	0	0	0	0	0	0
Remaining NAPL (gallons)	CZ	2,508	1,644	8,787	5,761	11,296	7,405
Uncertainty Factor	CZ	50%	50%	75%	75%	69%	69%
Lower Range (gallons)	CZ	1,254	822	6,590	4,321	7,845	5,143
cu ft	UWBZ	27,150	17,743	31,441	20,547	58,591	38,290
gallons	UWBZ	203,083	132,716	235,180	153,692	438,264	286,408
NAPL Removed (gallons)	UWBZ	0	0	10,067	10,067	10,067	10,067
Remaining NAPL (gallons)	UWBZ	203,083	132,716	225,113	143,625	428,196	276,340
Uncertainty Factor	UWBZ	50%	50%	75%	75%	63%	63%
Lower Range (gallons)	UWBZ	101,542	66,358	168,835	107,718	270,376	174,076
cu ft	LPZ	2,702	6,360	5,279	12,427	7,981	18,787
gallons	LPZ	20,210	47,572	39,488	92,952	59,697	140,524
NAPL Removed (gallons)	LPZ	0	0	0	0	0	0
Remaining NAPL (gallons)	LPZ	20,210	47,572	39,488	92,952	59,697	140,524
Uncertainty Factor	LPZ	50%	50%	75%	75%	67%	67%
Lower Range (gallons)	LPZ	10,105	23,786	29,616	69,714	39,721	93,500
cu ft	LSZ	6,566	14,360	44,164	96,583	50,730	110,942
gallons	LSZ	49,115	107,409	330,349	722,440	379,464	829,849
NAPL Removed (gallons)	LSZ	0	0	24,620	24,620	24,620	24,620
Remaining NAPL (gallons)	LSZ	49,115	107,409	305,729	697,820	354,843	805,229
Uncertainty Factor	LSZ	50%	50%	75%	75%	72%	72%
Lower Range (gallons)	LSZ	24,557	53,705	229,297	523,365	253,854	577,069
cu ft	CZ/UWBZ TTZ	28,836	21,143	35,256	27,531	64,092	48,673
gallons	CZ/UWBZ TTZ	215,696	158,146	263,712	205,928	479,408	364,075
NAPL Removed (gallons)	CZ/UWBZ TTZ	0	0	10,067	10,067	10,067	10,067
Remaining NAPL (gallons)	CZ/UWBZ TTZ	215,696	158,146	253,645	195,861	469,341	354,007
Uncertainty Factor	CZ/UWBZ TTZ	50%	50%	75%	75%	64%	64%
Lower Range (gallons)	CZ/UWBZ TTZ	107,848	79,073	190,233	146,896	298,081	225,969
cu ft	LSZ TTZ	7,917	17,539	46,804	102,796	54,721	120,336
gallons	LSZ TTZ	59,220	131,195	350,093	768,916	409,312	900,111
NAPL Removed (gallons)	LSZ TTZ	0	0	24,620	24,620	24,620	24,620
Remaining NAPL (gallons)	LSZ TTZ	59,220	131,195	325,473	744,296	384,692	875,491

Job No.	9101110001	Sheet	5 of 6	
Phase	5100	Task	02	
Job Name	Williams AFB, Site ST012			
By	NRL	Date	7/10/13	
Checked By	SCP	Date	7/20/13	

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Uncertainty Factor	LSZ TTZ	50%	50%	75%	75%	71%	71%
Lower Range (gallons)	LSZ TTZ	29,610	65,598	244,104	558,222	273,714	623,819
cu ft	CZ/UWBZ+LSZ	36,753	38,682	82,059	130,327	118,813	169,009
gallons	CZ/UWBZ+LSZ	274,916	289,341	613,805	974,844	888,720	1,264,186
NAPL Removed (gallons)	CZ/UWBZ+LSZ	0	0	34,687	34,687	34,687	34,687
Remaining NAPL (gallons)	CZ/UWBZ+LSZ	274,916	289,341	579,117	940,157	854,033	1,229,498
Uncertainty Factor	CZ/UWBZ+LSZ	50%	50%	75%	75%	67%	69%
Lower Range (gallons)	CZ/UWBZ+LSZ	137,458	144,671	434,338	705,118	571,796	849,788

Conservative LNAPL Interpretation

		EBR Treatment Area Volume		Treatment Area Volume		Total Residual Volume	
	TTZ	Calculated Volume of LNAPL	Literature Volume of LNAPL	Calculated Volume of LNAPL	Literature Volume of LNAPL	Calculated Volume of LNAPL	Literature Volume of LNAPL
cu ft	CZ	841	551	2,653	1,739	3,494	2,291
gallons	CZ	6,290	4,123	19,845	13,010	26,134	17,133
NAPL Removed (gallons)	CZ	0	0	0	0	0	0
Remaining NAPL (gallons)	CZ	6,290	4,123	19,845	13,010	26,134	17,133
Uncertainty Factor	CZ	75%	75%	75%	75%	75%	75%
Lower Range (gallons)	CZ	4,717	3,093	14,883	9,757	19,601	12,850
cu ft	UWBZ	45,525	29,751	35,813	23,404	81,337	53,154
gallons	UWBZ	340,525	222,535	267,879	175,061	608,404	397,595
NAPL Removed (gallons)	UWBZ	0	0	10,067	10,067	10,067	10,067
Remaining NAPL (gallons)	UWBZ	340,525	222,535	257,812	164,993	598,337	387,528
Uncertainty Factor	UWBZ	75%	75%	75%	75%	75%	75%
Lower Range (gallons)	UWBZ	255,393	166,901	193,359	123,745	448,752	290,646
cu ft	LPZ	4,066	9,572	6,134	14,440	10,201	24,011
gallons	LPZ	30,416	71,597	45,884	108,008	76,300	179,605
NAPL Removed (gallons)	LPZ	0	0	0	0	0	0
Remaining NAPL (gallons)	LPZ	30,416	71,597	45,884	108,008	76,300	179,605
Uncertainty Factor	LPZ	75%	75%	75%	75%	75%	75%
Lower Range (gallons)	LPZ	22,812	53,698	34,413	81,006	57,225	134,704
cu ft	LSZ	14,153	30,950	48,680	106,458	62,832	137,408
gallons	LSZ	105,861	231,508	364,124	796,302	469,985	1,027,810
NAPL Removed (gallons)	LSZ	0	0	24,620	24,620	24,620	24,620
Remaining NAPL (gallons)	LSZ	105,861	231,508	339,504	771,682	445,365	1,003,190
Uncertainty Factor	LSZ	75%	75%	75%	75%	75%	75%
Lower Range (gallons)	LSZ	79,396	173,631	254,628	578,762	334,024	752,393
cu ft	CZ/UWBZ TTZ	48,399	35,088	41,533	32,363	89,932	67,451
gallons	CZ/UWBZ TTZ	362,022	262,457	310,666	242,074	672,688	504,531
NAPL Removed (gallons)	CZ/UWBZ TTZ	0	0	10,067	10,067	10,067	10,067
Remaining NAPL (gallons)	CZ/UWBZ TTZ	362,022	262,457	300,599	232,007	662,621	494,464
Uncertainty Factor	CZ/UWBZ TTZ	75%	75%	75%	75%	75%	75%
Lower Range (gallons)	CZ/UWBZ TTZ	271,517	196,842	225,449	174,005	496,966	370,848
cu ft	LSZ TTZ	16,186	35,736	51,747	113,677	67,932	149,414
gallons	LSZ TTZ	121,069	267,306	387,066	850,307	508,135	1,117,613
NAPL Removed (gallons)	LSZ TTZ	0	0	24,620	24,620	24,620	24,620
Remaining NAPL (gallons)	LSZ TTZ	121,069	267,306	362,446	825,686	483,515	1,092,993
Uncertainty Factor	LSZ TTZ	75%	75%	75%	75%	75%	75%
Lower Range (gallons)	LSZ TTZ	90,802	200,480	271,834	619,265	362,636	819,745
cu ft	CZ/UWBZ+LSZ	64,584	70,824	93,280	146,040	157,864	216,864
gallons	CZ/UWBZ+LSZ	483,091	529,763	697,732	1,092,381	1,180,823	1,622,144
NAPL Removed (gallons)	CZ/UWBZ+LSZ	0	0	34,687	34,687	34,687	34,687
Remaining NAPL (gallons)	CZ/UWBZ+LSZ	483,091	529,763	663,044	1,057,693	1,146,136	1,587,456
Uncertainty Factor	CZ/UWBZ+LSZ	75%	75%	75%	75%	75%	75%
Lower Range (gallons)	CZ/UWBZ+LSZ	362,319	397,322	497,283	793,270	859,602	1,190,592

Job No.	9101110001	Sheet	6	of	6
Phase	5100	Task	02		
Job Name	Williams AFB, Site ST012				
By	NRL	Date	7/10/13		
Checked By	SCP	Date	7/20/13		

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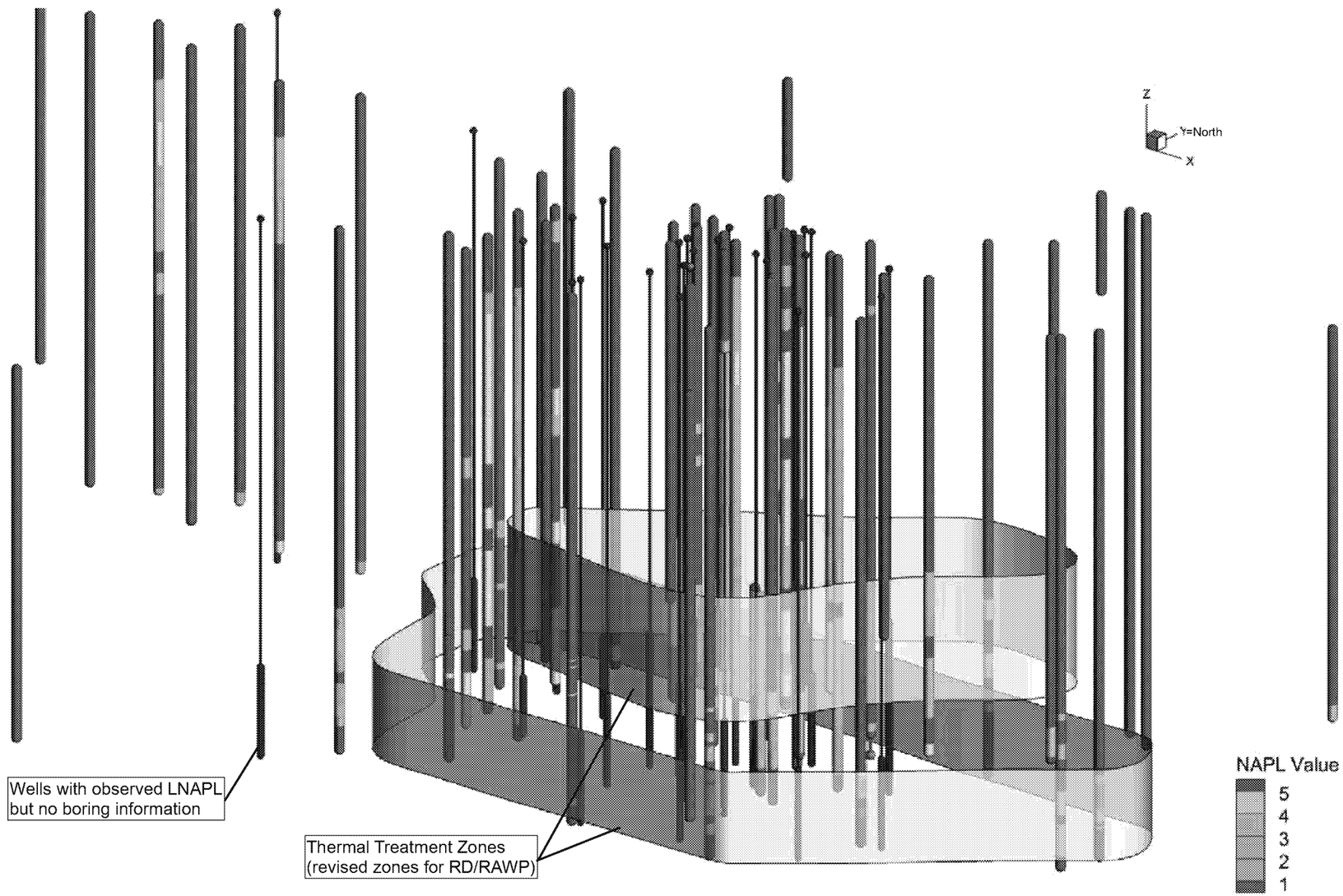
Conclusion:

Using the literature values that BEM used in previous site modeling during the TEE pilot test and the new interpretations of LNAPL extent, the amount of LNAPL in the thermal treatment zones is estimated to be between 705,000 and 940,000 (base interpretation) or 790,000 and 1,050,000 gallons (conservative LNAPL interpretation), leaving between 140,000 and 290,000 (base interpretation) or 400,000 and 530,000 gallons (conservative LNAPL interpretation) in the area outside the thermal treatment zones. Using the concentrations of TPH in the soil and the equation developed by Hawthorne and Kirkman, the amount of NAPL in the thermal treatment zone is estimated to be between 430,000 and 580,000 (base interpretation) or 500,000 and 660,000 gallons (conservative LNAPL interpretation), leaving between 140,000 and 270,000 (base interpretation) 360,000 and 480,000 gallons (conservative LNAPL interpretation) in the area outside the treatment zone.



Notes:
LNAPL = Light Non-Aqueous Phase Liquid
RD/RAWP = Remedial Design/Remedial Action Work Plan

Draft Final
LNAPL Volume Calculations
ST012 - Former Williams Air Force Base
Mesa, Arizona

NAPL Scoring Results
View from the Southeast

FIGURE
B-1a

Job No. 9101-11-0001
PM: EW
Date: 1/27/2014
Scale: Unknown

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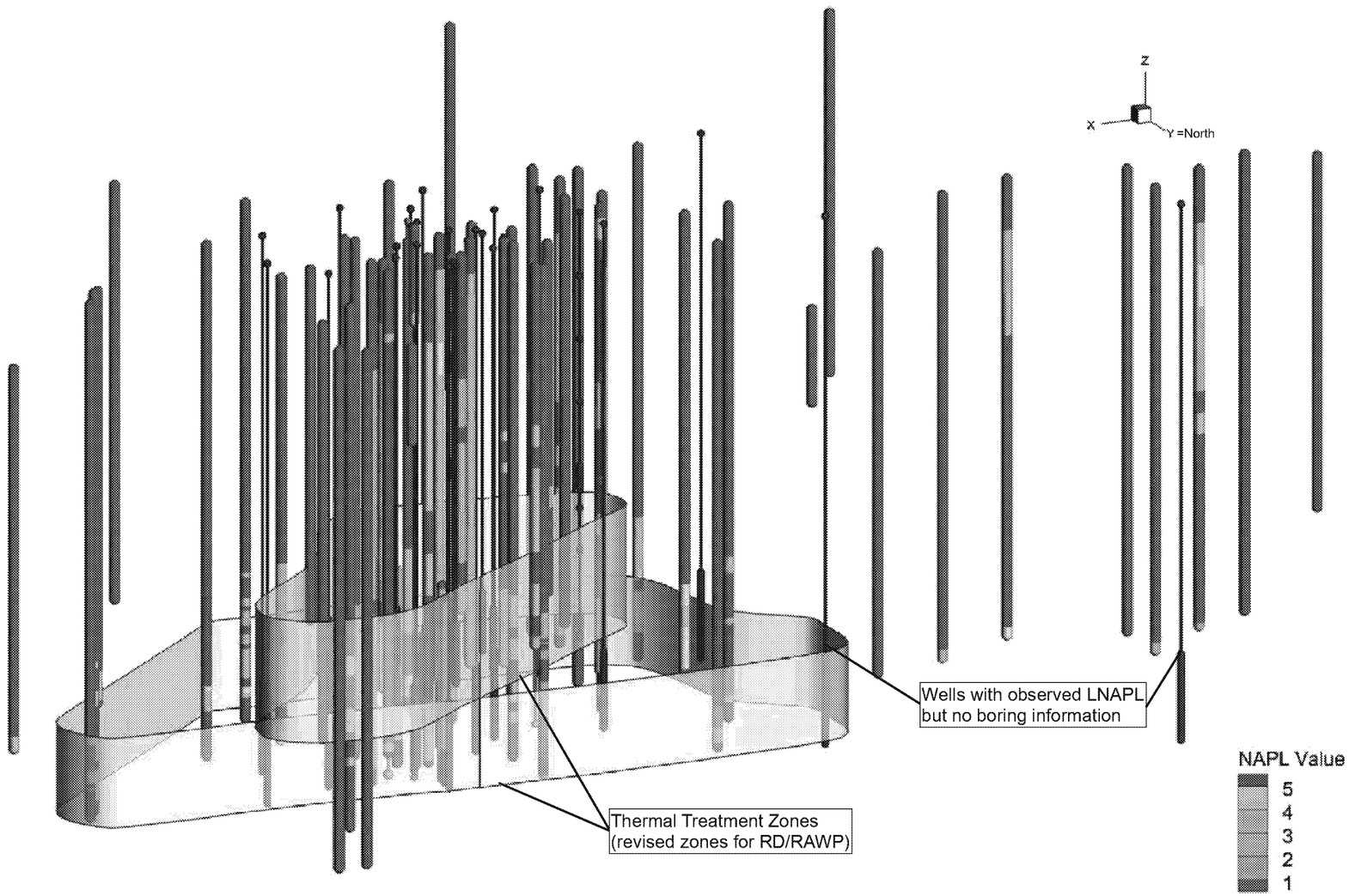

Notes:
LNAPL = Light Non-Aqueous Phase Liquid
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Mesa, Arizona

NAPL Scoring Results
View from the North

FIGURE **B-1b**

Job No.	9101-11-0001
PM:	EW
Date:	1/27/2014
Scale:	Unknown

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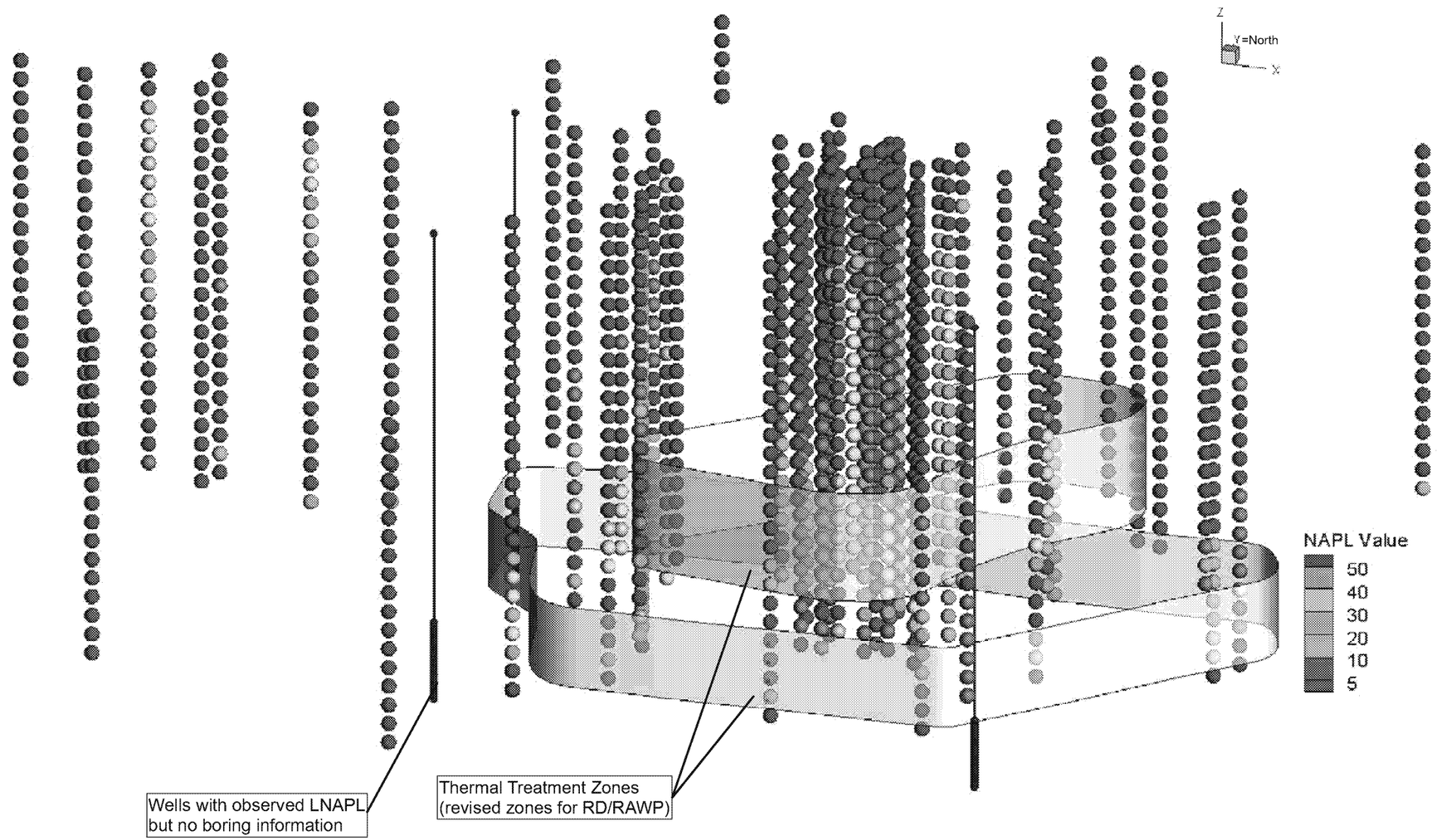

Notes:
LNAPL = Light Non-Aqueous Phase Liquid
RD/RAWP = Remedial Design/Remedial Action Work Plan

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Mesa, Arizona

Sum of NAPL Scoring Results in10-foot intervals - View from the Southeast

FIGURE **B-2a**

Job No.	9101-11-0001
PM:	EW
Date:	1/27/2014
Scale:	Unknown

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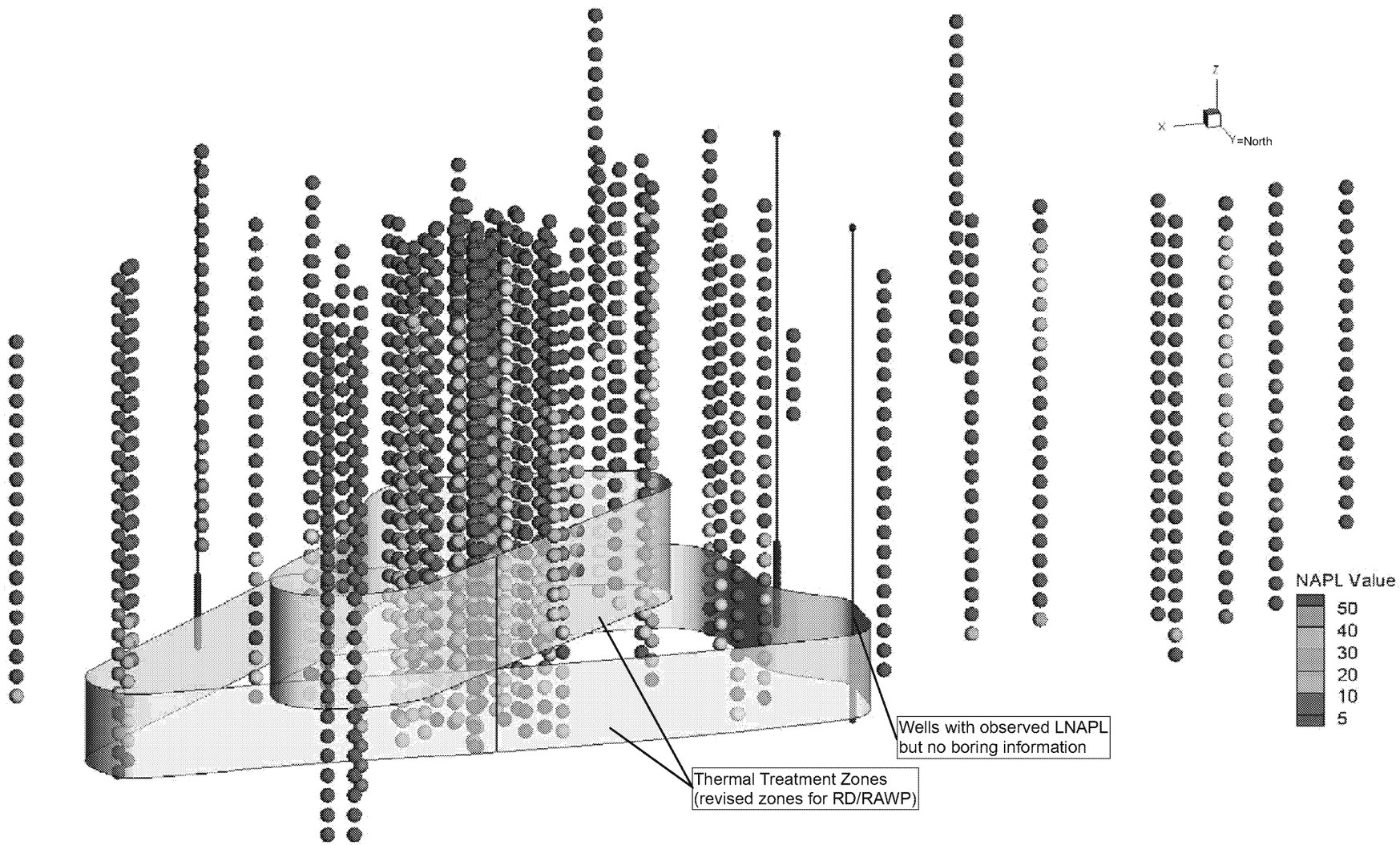

Notes:
LNAPL = Light Non-Aqueous Phase Liquid
RD/RAWP = Remedial Design/Remedial Action Work Plan

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Sum of NAPL Scoring Results in10-foot intervals - View from the North

FIGURE **B-2b**

Job No.	9101-11-0001
PM:	EW
Date:	1/27/2014
Scale:	Unknown

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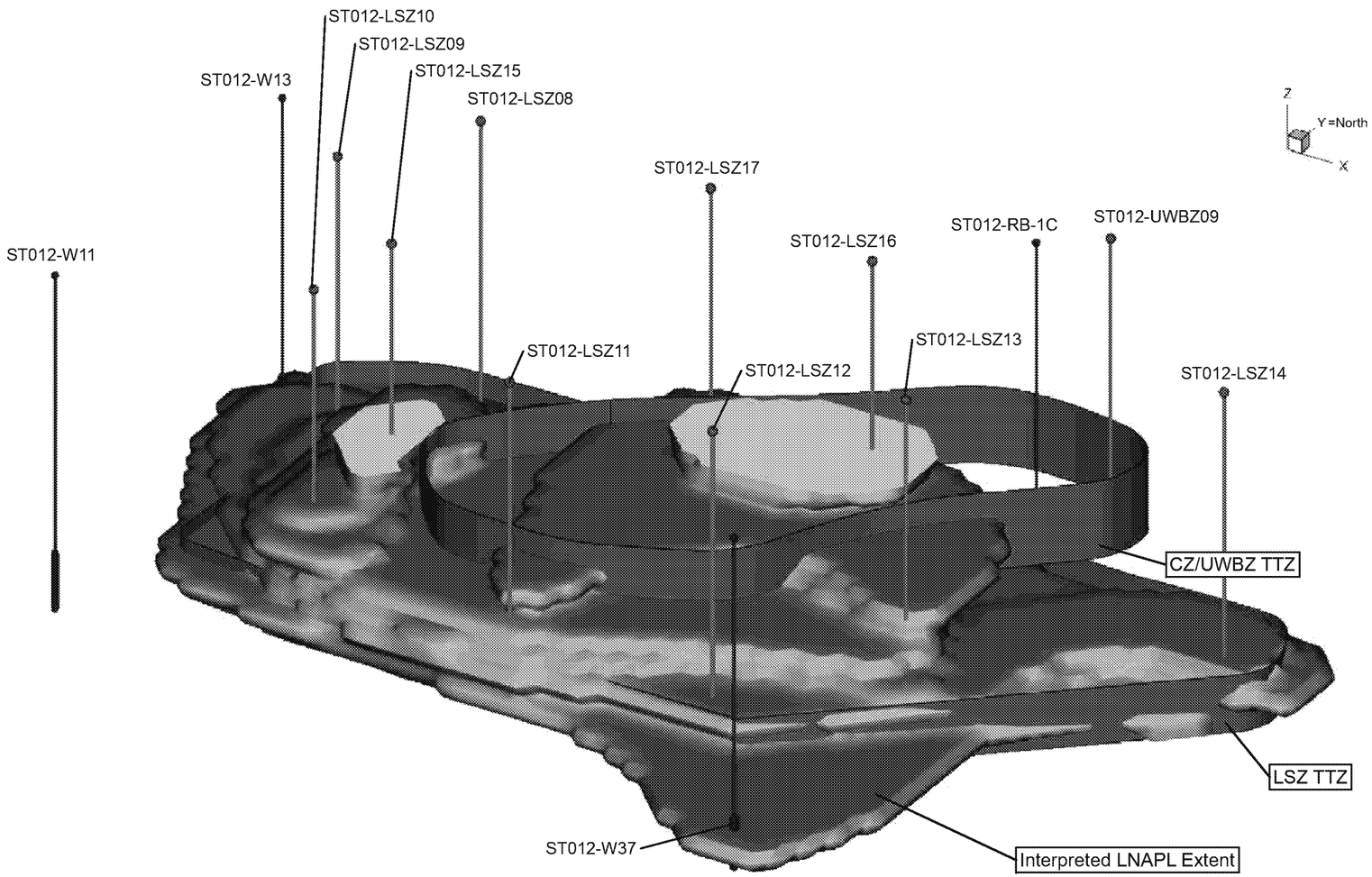

Notes:
CZ/UWBZ = Cobble Zone/Upper Water Bearing Zone
LNAPL = Light Non-Aqueous Phase Liquid
LSZ = Lower Saturated Zone
TTZ = Thermal Treatment Zone

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LNAPL Volume Calculations
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Base LNAPL Interpretation

FIGURE **B-3**

Job No.	9101-11-0001
PM:	EW
Date:	12/20/2013
Scale:	Unknown

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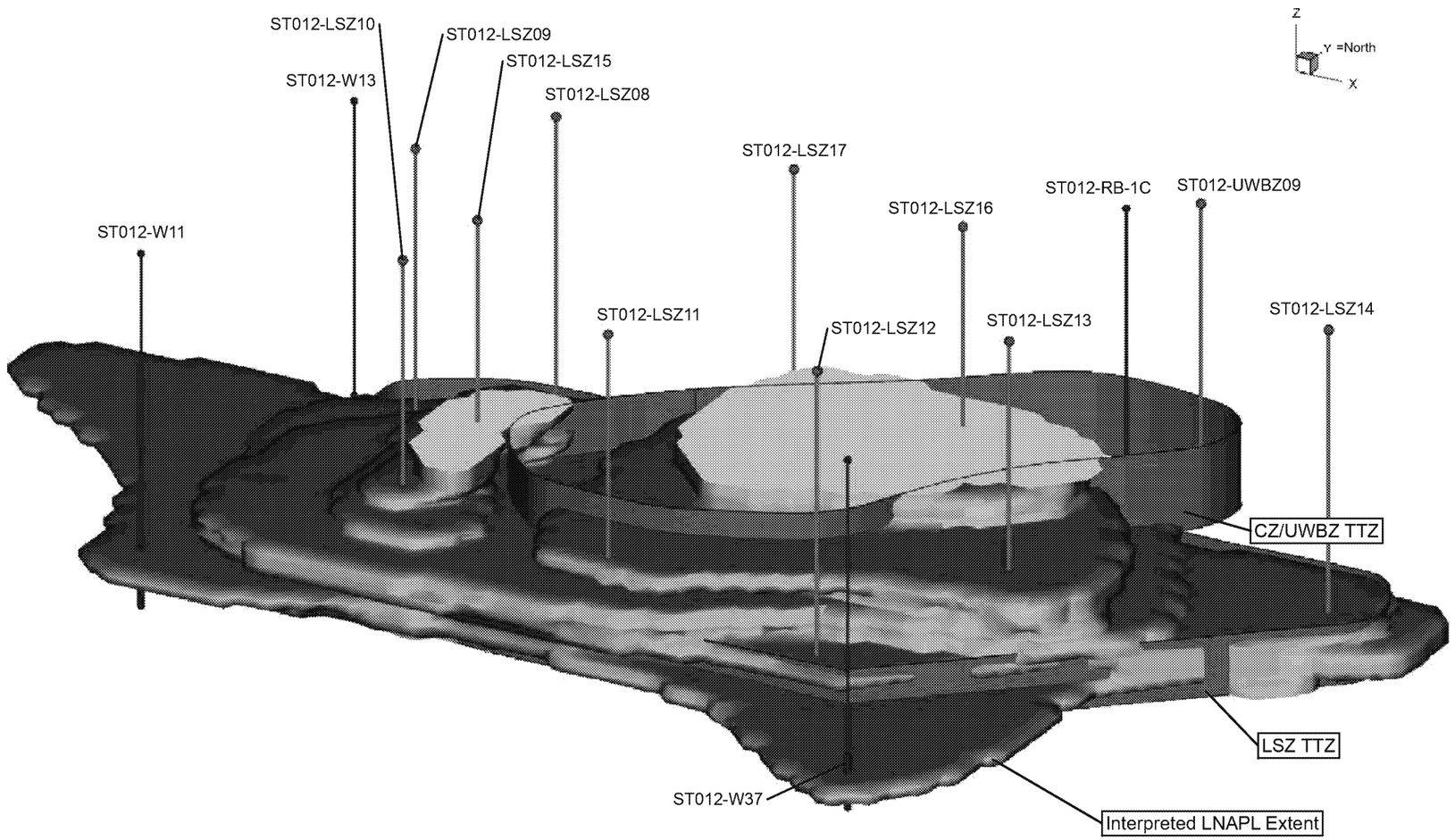

Notes:
CZ/UWBZ = Cobble Zone/Upper Water Bearing Zone
LNAPL = Light Non-Aqueous Phase Liquid
LSZ = Lower Saturated Zone
TTZ = Thermal Treatment Zone

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Conservative LNAPL Interpretation

FIGURE **B-4**

Job No. 9101-11-0001
PM: EW
Date: 12/20/2013
Scale: Unknown

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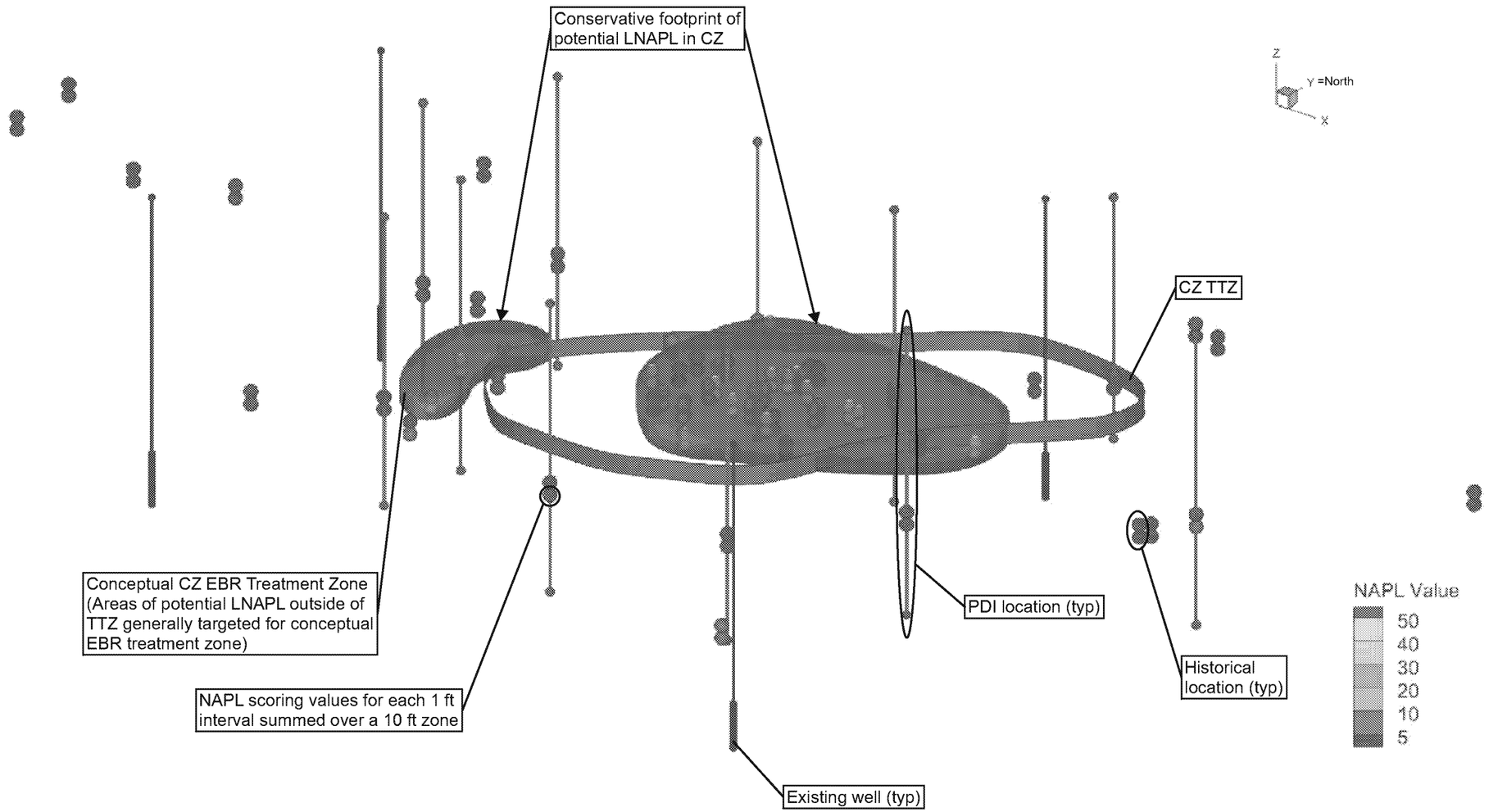

Notes:
CZ = Cobble Zone
EBR = Enhanced Bioremediation
LNAPL = Light Non-Aqueous Phase Liquid
PDI = Pre-Design Investigation
TTZ = Thermal Treatment Zone

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NAPL Scoring, TTZ and Conceptual EBR Zone in the CZ

FIGURE **B-5**

Job No. 9101-11-0001
PM: EW
Date: 12/20/2013
Scale: Unknown

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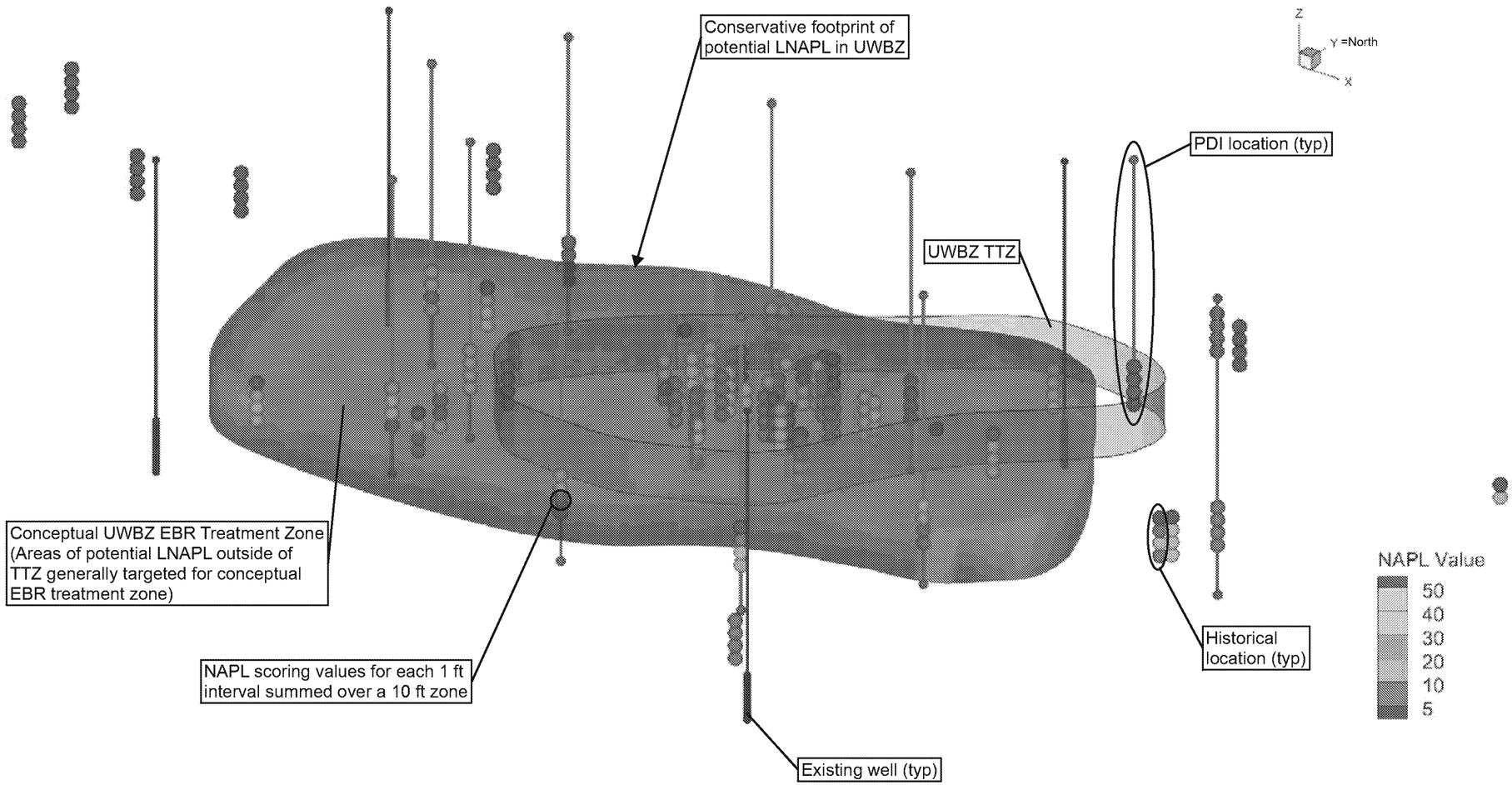

Notes:
EBR = Enhanced Bioremediation
LNAPL = Light Non-Aqueous Phase Liquid
PDI = Pre-Design Investigation
TTZ = Thermal Treatment Zone
UWBZ = Upper Water Bearing Zone

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NAPL Scoring, TTZ and Conceptual EBR Zone in the UWBZ

FIGURE **B-6**

Job No. 9101-11-0001
PM: EW
Date: 12/20/2013
Scale: Unknown

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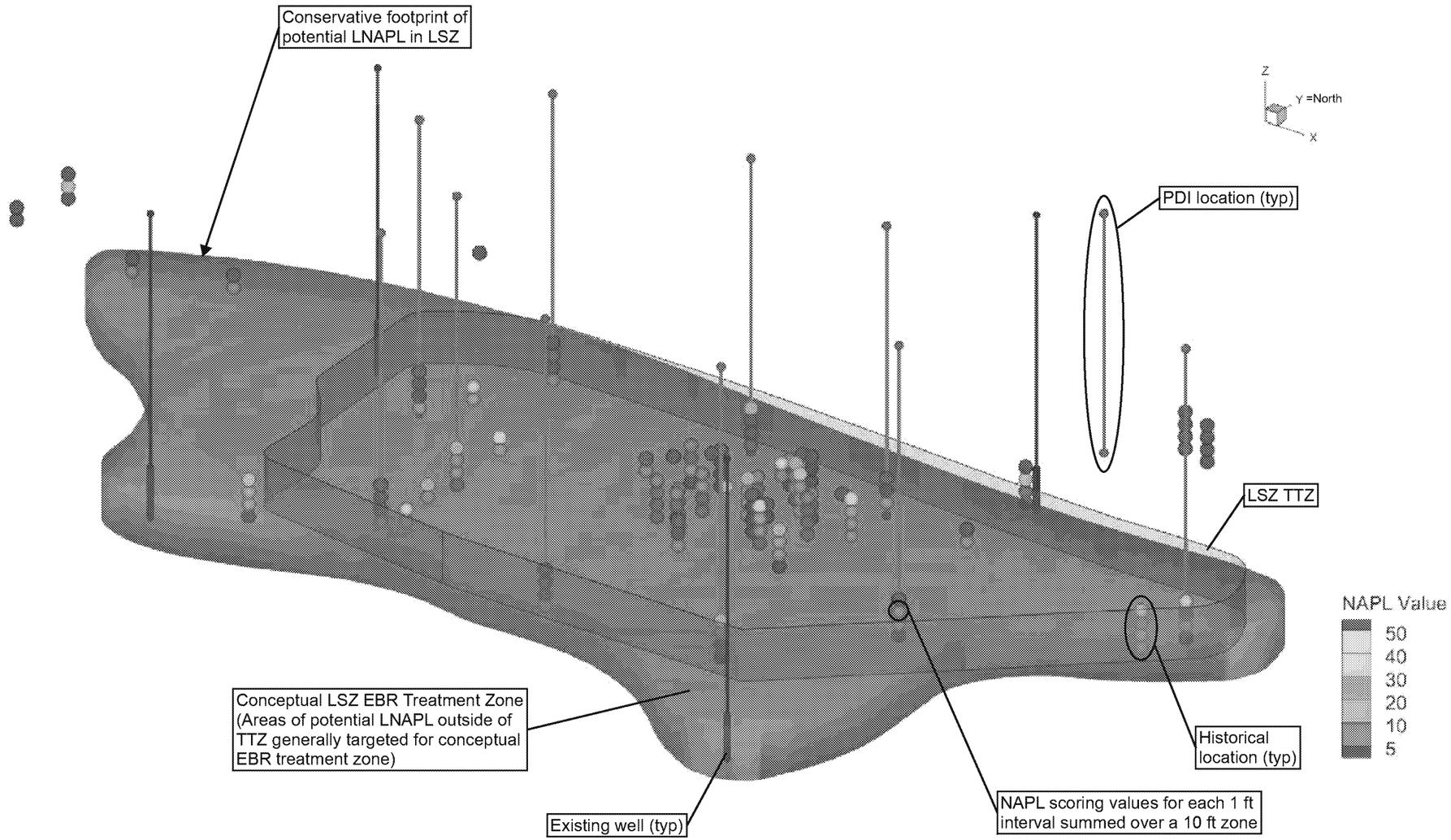

Notes:
EBR = Enhanced Bioremediation
LNAPL = Light Non-Aqueous Phase Liquid
LSZ = Lower Saturated Zone
PDI = Pre-Design Investigation
TTZ = Thermal Treatment Zone

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LNAPL Volume Calculations
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NAPL Scoring, TTZ and Conceptual EBR Zone in the LSZ

FIGURE **B-7**

Job No. 9101-11-0001
PM: EW
Date: 12/20/2013
Scale: Unknown

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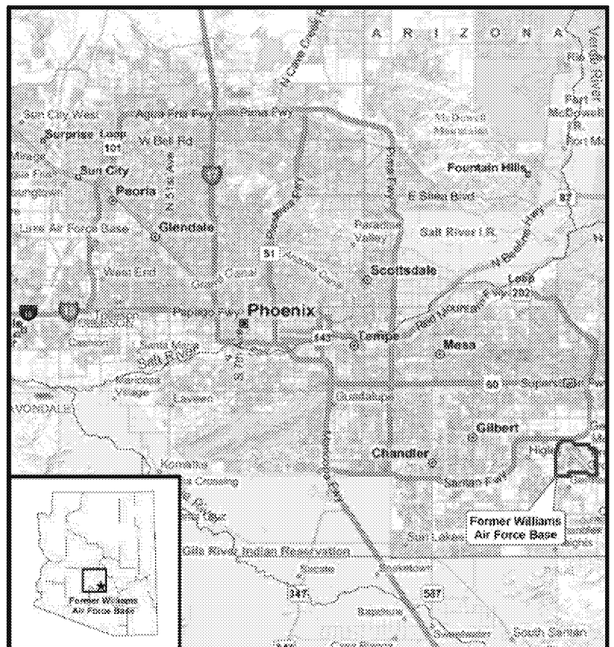
APPENDIX C

DESIGN DRAWINGS

REMEDIAL DESIGN/REMEDIAL ACTION WORK PLAN
ST012 – FORMER WILLIAMS AIR FORCE BASE
MESA, ARIZONA
SEPTEMBER 2013



LOCUS MAP

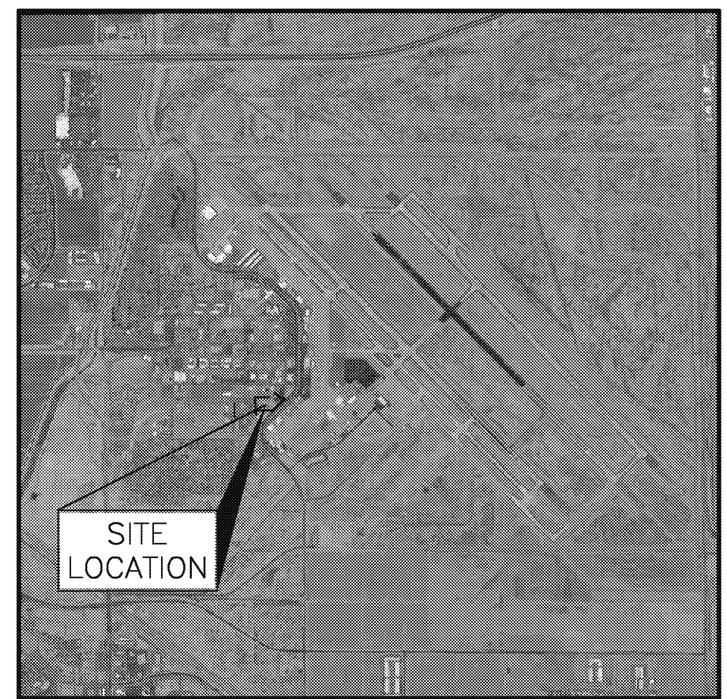
NOT TO SCALE

PROJECT SITE:
FORMER WILLIAMS AIR FORCE BASE
MESA, ARIZONA

N

DRAWING INDEX

INCLUDED THIS SUBMITTAL: AMEC DRAWING	INCLUDED THIS SUBMITTAL: TERRATHERM DRAWING	DRAWING TITLE	DRAWING NUMBER
●	○	COVER SHEET	G–001
●	○	GENERAL NOTES LEGEND AND ABBREVIATIONS	G–002
●	○	EXISTING CONDITIONS PLAN	CS–100
●	○	WELL ABANDONMENT AND MODIFICATION PLAN	CS–101
●	○	SITE ACCESS PLAN	CS–102
●	○	UTILITY SERVICE PLAN	CS–103
●	○	TRAFFIC ROUTING PLAN	CS–104
●	○	SOIL VAPOR EXTRACTION MODIFICATION PLAN	CS–105
●	○	CIVIL SITE DETAILS 1	CS–301
●	○	CIVIL SITE DETAILS 2	CS–302
○	●	WELLFIELD LAYOUT PLAN	C103
○	●	STEAM INJECTION/MULTIPHASE EXTRACTION WELL DETAILS	C104
○	●	TYPICAL WELLHEAD CONNECTION DETAIL	C105
○	●	TEMPERATURE MONITORING WELL DETAILS	C106
○	●	ELECTRICAL LEGEND	E100
○	●	ELECTRICAL ONELINE (6 SHEETS)	E101
○	●	ELECTRICAL LAYOUT	E102
○	●	MECHANICAL EQUIPMENT LAYOUT	M101
○	●	WELLFIELD PIPING LAYOUT (3 SHEETS)	M102
○	●	PROCESS FLOW DIAGRAM (3 SHEETS)	P101
○	●	AREA CLASSIFICATION (4 SHEETS)	P103



SITE MAP

0 1000 2000 4000
SCALE IN FEET

PROJECT SITE:
FORMER WILLIAMS AIR FORCE BASE
MESA, ARIZONA

N

NO.	DATE	REVISION	BY	APVD
D	12/20/13	DRAFT FINAL REMEDIAL DESIGN / REMEDIAL ACTION WP	BJB	TDD
C	11/19/13	ISSUED FOR UTILITY SERVICES AND SITE PREPARATION BIDS	BJB	TDD
B	09/23/13	DRAFT REMEDIAL DESIGN / REMEDIAL ACTION WP	BJB	TDD
A	07/23/13	WORKING COPY FOR REMEDIAL DESIGN / REMEDIAL ACTION WP	JVM	TDD

DSGN J. MCKENZIE | DR M. STACEY | CHK T. DONOVAN | APVD S. PEARSON

REMEDIAL DESIGN/REMEDIAL ACTION WORK PLAN
ST012-FORMER WILLIAMS AIR FORCE BASE
6011 SOUTH TERRIPIN MALL
MESA, ARIZONA

COVER SHEET

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VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE
9101-11-0001
DWG G-001
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GENERAL NOTES

1. PROJECT COORDINATE SYSTEM IS NAD83 ARIZONA STATE PLANE CENTRAL ZONE, US FOOT.
2. DRAWING REFERENCES: DRAWING NO. C03, UNDERGROUND PIPING PLAN AND DRAWING NO. C04, DATED: 04–01–10, PROVIDED BY: BEM SYSTEMS, INC. AND DRAWING NO. ST012 TOPO 4–1–13 SURVEY PLAN, DATED: 04–01–13, PROVIDED BY: AMEC ENVIRONMENT & INFRASTRUCTURE.
3. THE LOCATIONS OF EXISTING UTILITIES, STRUCTURES, AND OTHER FEATURES ARE APPROXIMATE. THEREFORE, CONTRACTOR SHALL CONTACT ARIZONA BLUE STATE AT 1–800–782–5348 FOR STAKING OF EXISTING UTILITIES PRIOR TO COMMENCEMENT OF ANY EARTHWORK OR SUBSURFACE ACTIVITIES.
4. CONTRACTOR SHALL VISUALLY INSPECT THE SITE TO ASCERTAIN THE CONDITION OF ALL EXISTING FEATURES AND FAMILIARIZE THEMSELVES WITH THE WORK.
5. THE CONTRACTOR SHALL BE RESPONSIBLE TO SECURE ALL NECESSARY PERMITS EXCEPT ANY SPECIFICALLY IDENTIFIED AS SECURED BY OWNER.
6. ALL WORK SHALL BE IN ACCORDANCE WITH ALL FEDERAL, STATE, AND LOCAL REGULATIONS AND ORDINANCES.
7. SEQUENCING OF SITE PREPARATION, DEMOLITION ACTIVITIES, TRAFFIC PLANNING/ROUTING, ESTABLISHMENT OF WORKER PARKING AREAS, OFFICE OR STORAGE TRAILERS, PERIMETER FENCING, AND ANY OTHER NON–GROUND INTRUSIVE ACTIVITIES SHALL BE COORDINATED WITH THE SEQUENCE OF CONSTRUCTION.
8. CONTRACTOR WILL BE REQUIRED TO MAINTAIN THE INTEGRITY OF UTILITIES AND SITE FEATURES AND REPAIR ANY DAMAGE AT NO ADDITIONAL COST TO OWNER.
9. SHOULD UNCHARTED, OR INCORRECTLY CHARTED PIPING OR OTHER UTILITIES BE ENCOUNTERED DURING PERFORMANCE OF WORK, CONSULT ENGINEER, SITE OWNER, AND UTILITY OWNER IMMEDIATELY FOR DIRECTION. COOPERATE WITH SITE OWNER AND UTILITY OWNER IN KEEPING REPECTIVE FACILITIES IN OPERATION. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE COST TO REPAIR OR REPLACEMENT OF OF ANY UTILITIES DAMAGED BY THE CONTRACTOR TO THE SATISFACTION OF THE SITE OWNER OR UTILITY OWNER.
10. THE CONTRACTOR SHALL MANAGE ALL DEMOLITION WASTES IN ACCORDANCE WITH ALL APPLICABLE REGULATIONS AND REQUIREMENTS.
11. THE EXTENT OF DEMOLITION TO BE PERFORMED BY THE CONTRACTOR MAY BE MODIFIED AS NECESSARY,
12. ROAD CLOSURES SHALL BE LIMITED TO THOSE INDICATED ON THE TRAFFIC ROUTING PLAN AND SHALL BE COORDINATED WITH THE SEQUENCE OF CONSTRUCTION.

LIST OF ACRONYMS AND ABBREVIATIONS

°F	DEGREES FAHRENHEIT
ADEQ	ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY
ADWR	ARIZONA DEPARTMENT OF WATER RESOURCES
AFB	AIR FORCE BASE
AFCEC	AIR FORCE CIVIL ENGINEER CENTER
AMSL	ABOVE MEAN SEA LEVEL
ARAR	APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENT
AV	AEROVIRONMENT, INC.
AVGAS	AVIATION GASOLINE
BEM	BALANCED ENVIRONMENTAL MANAGEMENT SYSTEMS, INC.
BGS	BELOW GROUND SURFACE
BTEX	BENZENE, TOLUENE, ETHYLBENZENE AND XYLENES
CDM	CAMP DRESSER MCKEE
CERCLA	COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION AND LIABILITY ACT
CIP	CORRUGATED IRON PIPE
CM/S	CENTIMETERS PER SECOND
COC	CONTAMINANT OF CONCERN
COPC	CHEMICAL OF POTENTIAL CONCERN
CPVC	CHLORINATED POLYVINYL CHLORIDE PIPE
CSM	CONCEPTUAL SITE MODEL
DCD	DEMONSTRATION CONCEPTUAL DESIGN
DIP	DUCTILE IRON PIPE
DO	DISSOLVED OXYGEN
DPE	DUAL–PHASE EXTRACTION
FFA	FEDERAL FACILITY AGREEMENT
FFS	FOCUSED FEASIBILITY STUDY
FS	FEASIBILITY STUDY
GAC	GRANULAR ACTIVATED CARBON
FT	FEET/FOOT
FT/YR	FEET PER YEAR
FT/DAY	FEET PER DAY
FT/FT	FEET PER FOOT
GAC	GRANULAR ACTIVATED CARBON
GPD/FT	GALLONS PER DAY PER FOOT
GPM	GALLONS PER MINUTE
GRC	GEO/RESOURCE CONSULTANTS, INC.
HGL	HYDROGEOLOGIC, INC.
ICE	INTERNAL COMBUSTION ENGINE
ID	INSIDE DIAMETER
IT	IT CORPORATION
IRP	INSTALLATION RESTORATION PROGRAM
JP–4	JET PETROLEUM GRADE 4
LBS	POUNDS
LFSA	LIQUID FUELS STORAGE AREA
LNAPL	LIGHT NON–AQUEOUS PHASE LIQUID
LPZ	LOW PERMEABILITY ZONE
LSZ	LOWER SATURATED ZONE
mg/kg	MILLIGRAMS PER KILOGRAM
mg/L	MILLIGRAMS PER LITER
MNA	MONITORED NATURAL ATTENUATION
MP	MONITORING POINT
MPE	MULTIPHASE EXTRACTION
MUTCD	MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES
NAPL	NON–AQUEOUS PHASE LIQUID
O&M	OPERATION AND MAINTENANCE
ORP	OXIDATION REDUCTION POTENTIAL
OU	OPERABLE UNIT
PARSONS	PARSONS ENGINEERING SCIENCE, INC.
PCF	POUNDS PER CUBIC FOOT
PE	POLYETHYLENE PIPE
PHC	PETROLEUM HYDROCARBON
PMGAA	PHOENIX–MESA GATEWAY AIRPORT AUTHORITY
PPMV	PARTS PER MILLION VOLUME
PS/DS	PILOT STUDY/DEMONSTRATION STUDY
PVC	POLYVINYL CHLORIDE PIPE
RAO	REMEDIAL ACTION OBJECTIVE
RI	REMEDIAL INVESTIGATION
ROD	RECORD OF DECISION
RODA	RECORD OF DECISION AMENDMENT
SCFM	STANDARD CUBIC FEET PER MINUTE
SEE	STEAM ENHANCED EXTRACTION
SVE	SOIL VAPOR EXTRACTION
TEE	THERMAL ENHANCED EXTRACTION
TOX	THERMAL OXIDATION
TPH	TOTAL PETROLEUM HYDROCARBONS
TS/RAD	TREATABILITY STUDY/REMEDIAL ACTION DECISION
TVH	TOTAL VOLATILE HYDROCARBONS
URS	URS CORPORATION
µg/L	MICROGRAMS PER LITER
USACE	UNITED STATES ARMY CORPS OF ENGINEERS
USAF	UNITED STATES AIR FORCE
USCS	UNIFIED SOIL CLASSIFICATION SYSTEM
USEPA	UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
UST	UNDERGROUND STORAGE TANK
UWBZ	UPPER WATER BEARING ZONE
VOC	VOLATILE ORGANIC COMPOUND
WGAA	WILLIAMS GATEWAY AIRPORT AUTHORITY

LEGEND

EXISTING		PROPOSED
	FENCE AND GATE	
	GAS LINE – UNDERGROUND	GAS
	ELECTRIC – OVER–HEAD	
	ELECTRIC – UNDERGROUND	
	SEWER – UNDERGROUND	SS
	SVE LINE – ABOVE GROUND	
	SVE LINE – UNDERGROUND	
	TELEPHONE – UNDERGROUND	
	WATER – UNDERGROUND	
	WATER – UNDERGROUND (PER BEM DESIGN)	
	WATER – UNDERGROUND	W
	TEE PILOT PROCESS PIPING	
	WATER VALVE	
	HYDRANT	
	POWER POLE	
	GUY WIRE	
	ELECTRIC METER	
	ELECTRIC PANEL	
	ELECTRIC CABINET	
	TELEPHONE BOX	
	ELECTRIC TRANSFORMER	T
	SANITARY SEWER MANHOLE	
	SEWER MANHOLE	SS
	SANITARY CLEANOUT	
	WATER METER	
	GAS METER	
	GAS RISER	
	PALM TREE	
	JUNCTION BOX	
	WATER VALVE	
	WATER METER	
	BACKFLOW PREVENTER / SHUT OFF	
	SEWER METER	
	BELOW GRADE VALVE BOX	
	BRASS CAP	
	WELL TO BE ABANDONED	
	ABANDONED WELL	
	BORING	
	EXTRACTION WELL	
	DUAL PHASED EXTRACTION WELL	
	MONITORING WELL	
	SOIL VAPOR EXTRACTION (SVE) WELL	
	PAVEMENT	
	CONCRETE	
	CONCRETE BARRIER WITH CHAINLINK FENCE	
	STABILIZED CONSTRUCTION ENTRANCE	
	SIW COBBLE ZONE (CZ) = 6	ST012–CZ04–SIW
	SIW UPPER WATER BEARING ZONE (UBWZ) = 10	ST012–UWBZ07–SIW
	SIW LOWER SATURATED ZONE (LSZ) = 18	ST012–LSZ07–SIW
	MPE COBBLE ZONE (CZ) = 13	ST012–CZ16–MPE
	MPE UPPER WATER BEARING ZONE (UBWZ) = 14	ST012–UWBZ01–MPE
	MPE LOWER SATURATED ZONE (LSZ) = 24	ST012–LSZ01–MPE
	TEMPERATURE MONITORING LOCATION = 17	TMP–11

NO.	DATE	REVISION	BY	APVD
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REMEDIAL DESIGN/REMEDIAL ACTION WORK PLAN
ST012-FORMER WILLIAMS AIR FORCE BASE
6011 SOUTH TERRIPIN MALL
MESA, ARIZONA

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GENERAL NOTES, LEGEND AND ABBREVIATIONS

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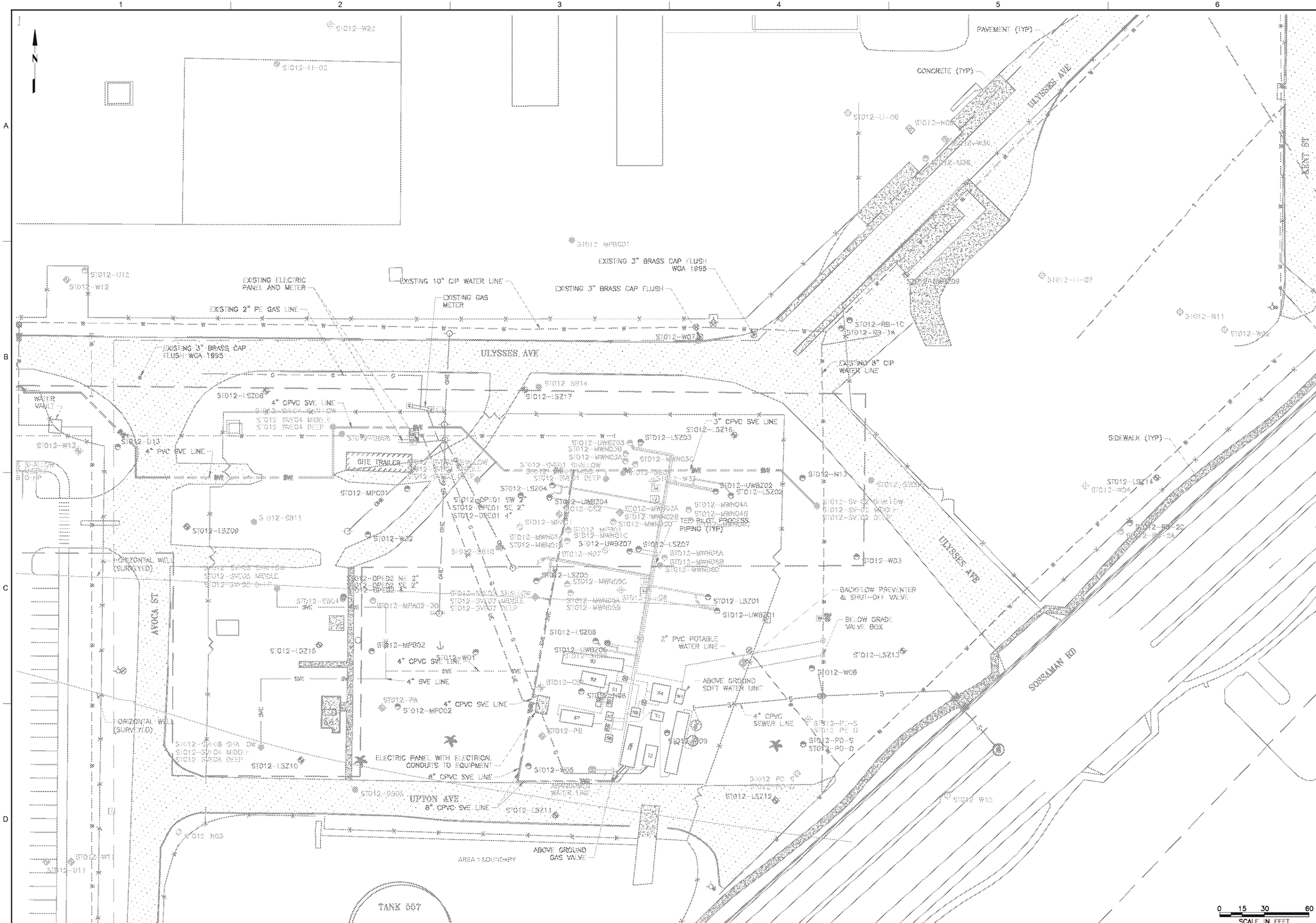

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EXISTING CONDITIONS PLAN

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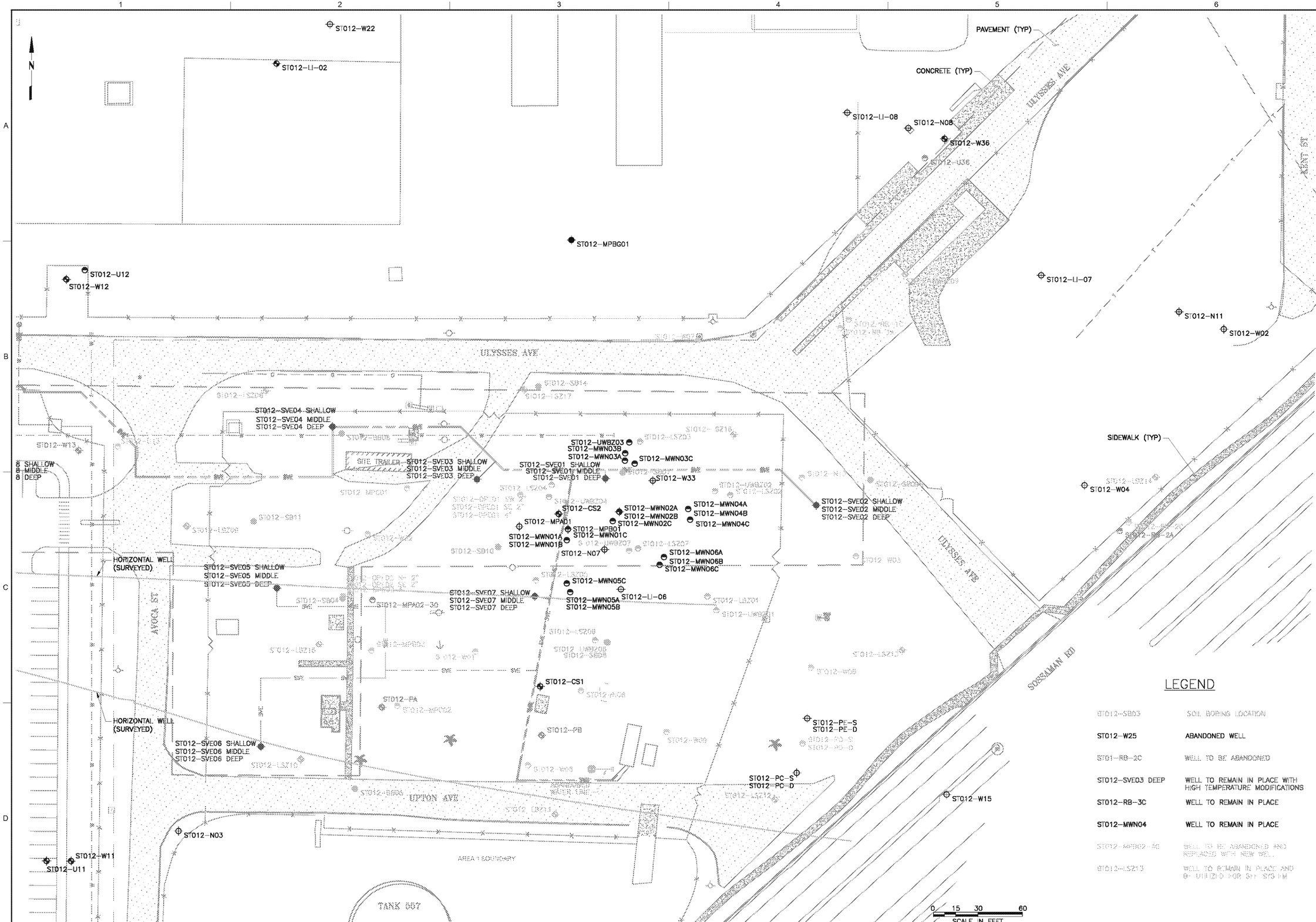

LEGEND

ST012-SB03	SOIL BORING LOCATION
ST012-W25	ABANDONED WELL
ST01-RB-2C	WELL TO BE ABANDONED
ST012-SVE03 DEEP	WELL TO REMAIN IN PLACE WITH HIGH TEMPERATURE MODIFICATIONS
ST012-RB-3C	WELL TO REMAIN IN PLACE
ST012-MWN04	WELL TO REMAIN IN PLACE
ST012-MPB02-3C	WELL TO BE ABANDONED AND REPLACED WITH NEW WELL
ST012-LS213	WELL TO REMAIN IN PLACE AND BE UTILIZED FOR SVE SYSTEM

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WELL ABANDONMENT AND AND MODIFICATION PLAN

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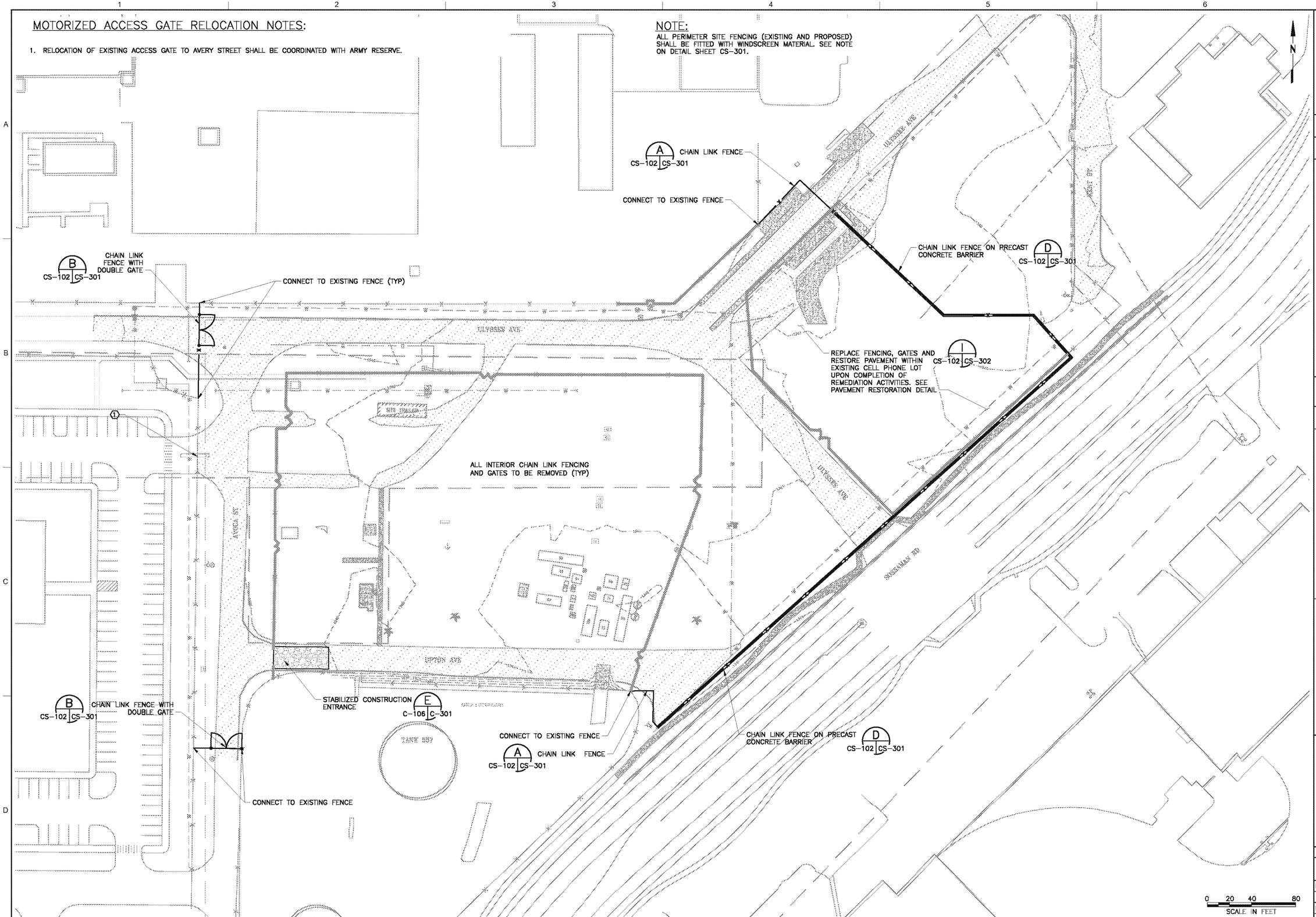
MOTORIZED ACCESS GATE RELOCATION NOTES:

1. RELOCATION OF EXISTING ACCESS GATE TO AVERY STREET SHALL BE COORDINATED WITH ARMY RESERVE.

NOTE:

ALL PERIMETER SITE FENCING (EXISTING AND PROPOSED) SHALL BE FITTED WITH WINDSCREEN MATERIAL. SEE NOTE ON DETAIL SHEET CS-301.



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SITE ACCESS PLAN

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GENERAL NOTE:

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DRAWING SOURCE:

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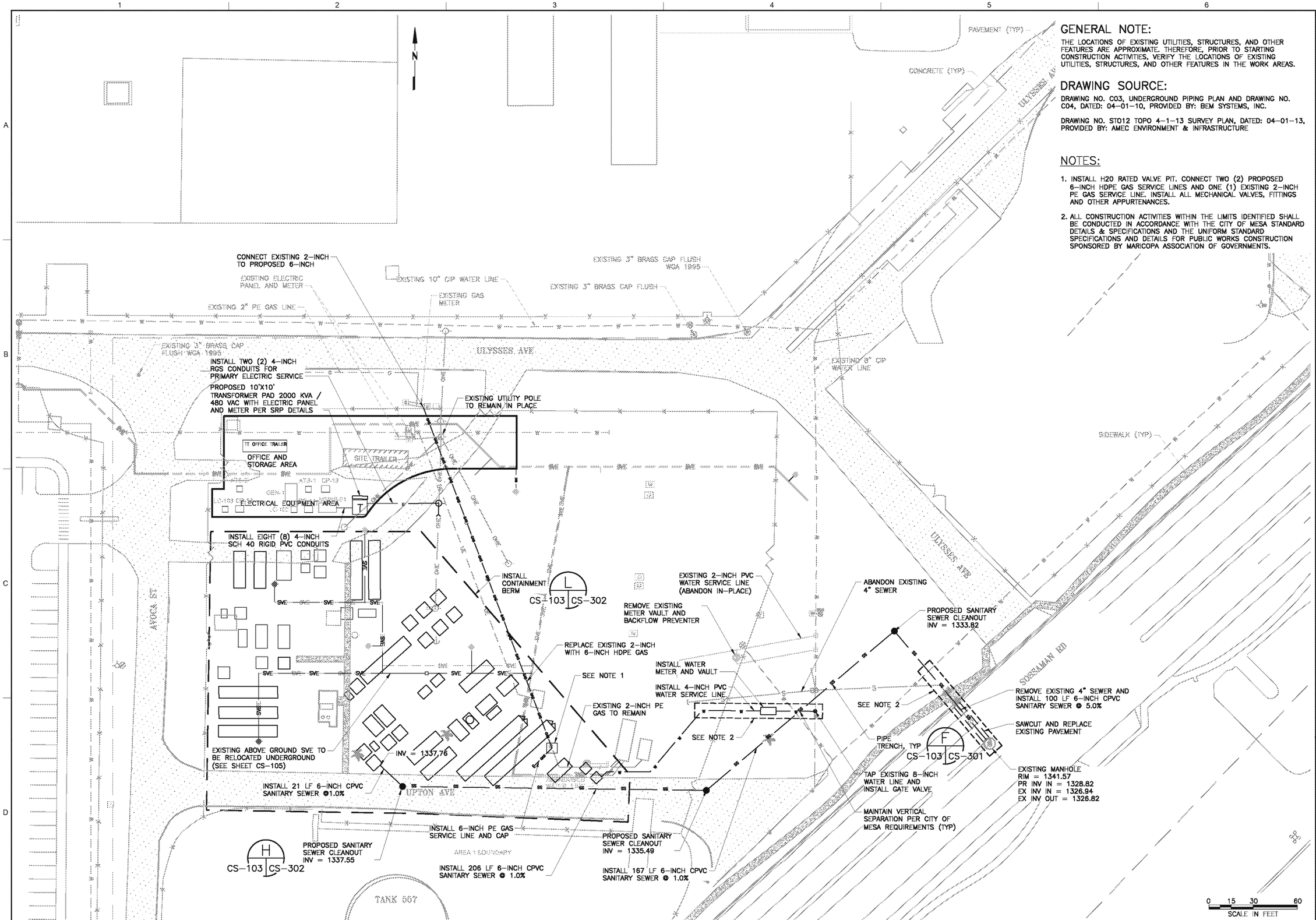
DRAWING NO. ST012 TOPO 4–1–13 SURVEY PLAN, DATED: 04–01–13, PROVIDED BY: AMEC ENVIRONMENT & INFRASTRUCTURE

NOTES:

1. INSTALL H20 RATED VALVE PIT. CONNECT TWO (2) PROPOSED 6–INCH HDPE GAS SERVICE LINES AND ONE (1) EXISTING 2–INCH PE GAS SERVICE LINE. INSTALL ALL MECHANICAL VALVES, FITTINGS AND OTHER APPURTENANCES.
2. ALL CONSTRUCTION ACTIVITIES WITHIN THE LIMITS IDENTIFIED SHALL BE CONDUCTED IN ACCORDANCE WITH THE CITY OF MESA STANDARD DETAILS & SPECIFICATIONS AND THE UNIFORM STANDARD SPECIFICATIONS AND DETAILS FOR PUBLIC WORKS CONSTRUCTION SPONSORED BY MARICOPA ASSOCIATION OF GOVERNMENTS.



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PROPOSED UTILITY SERVICE PLAN

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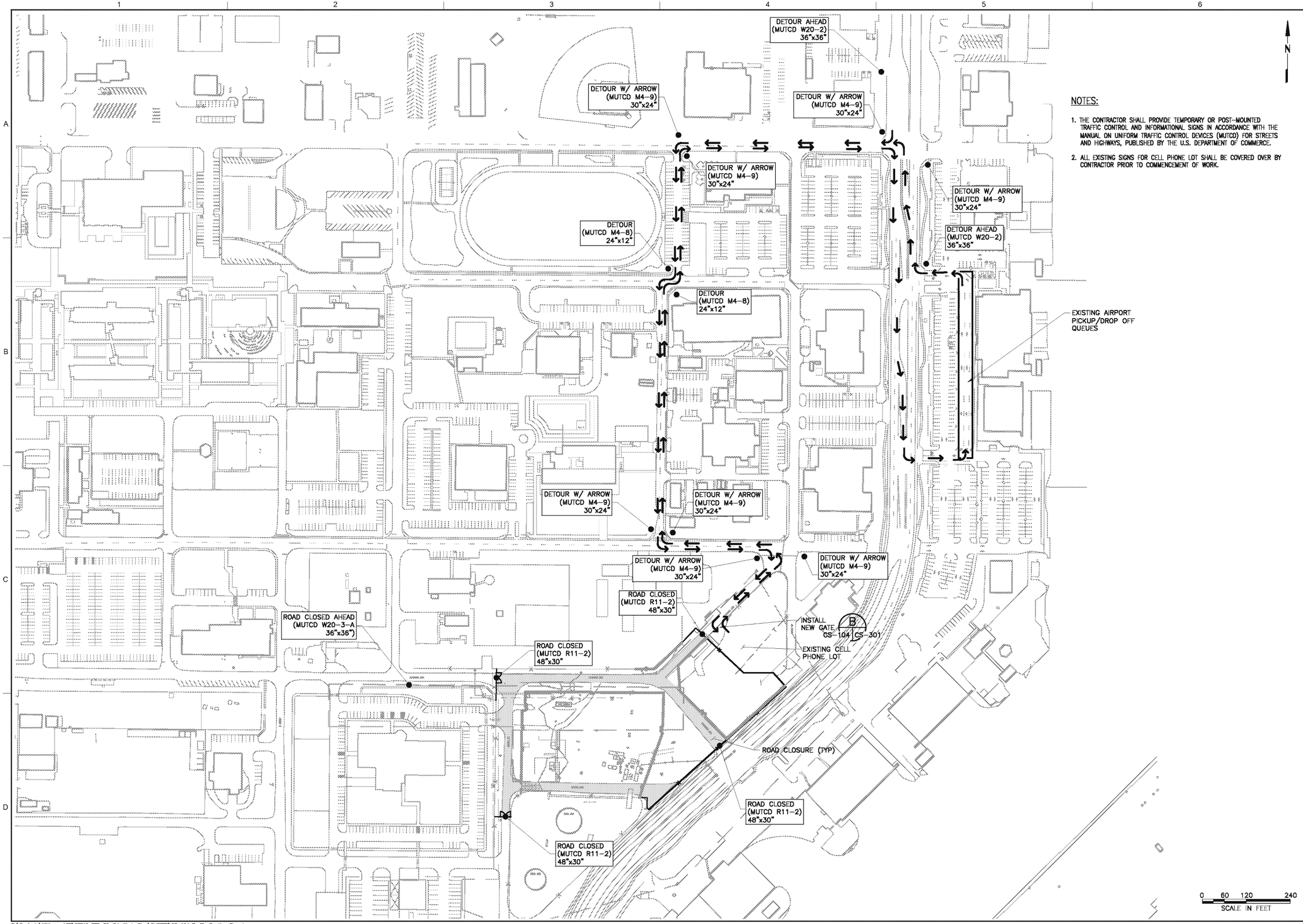

NOTES:

1. THE CONTRACTOR SHALL PROVIDE TEMPORARY OR POST-MOUNTED TRAFFIC CONTROL AND INFORMATIONAL SIGNS IN ACCORDANCE WITH THE MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES (MUTCD) FOR STREETS AND HIGHWAYS, PUBLISHED BY THE U.S. DEPARTMENT OF COMMERCE.
2. ALL EXISTING SIGNS FOR CELL PHONE LOT SHALL BE COVERED OVER BY CONTRACTOR PRIOR TO COMMENCEMENT OF WORK.

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TRAFFIC ROUTING AND SIGNAGE PLAN

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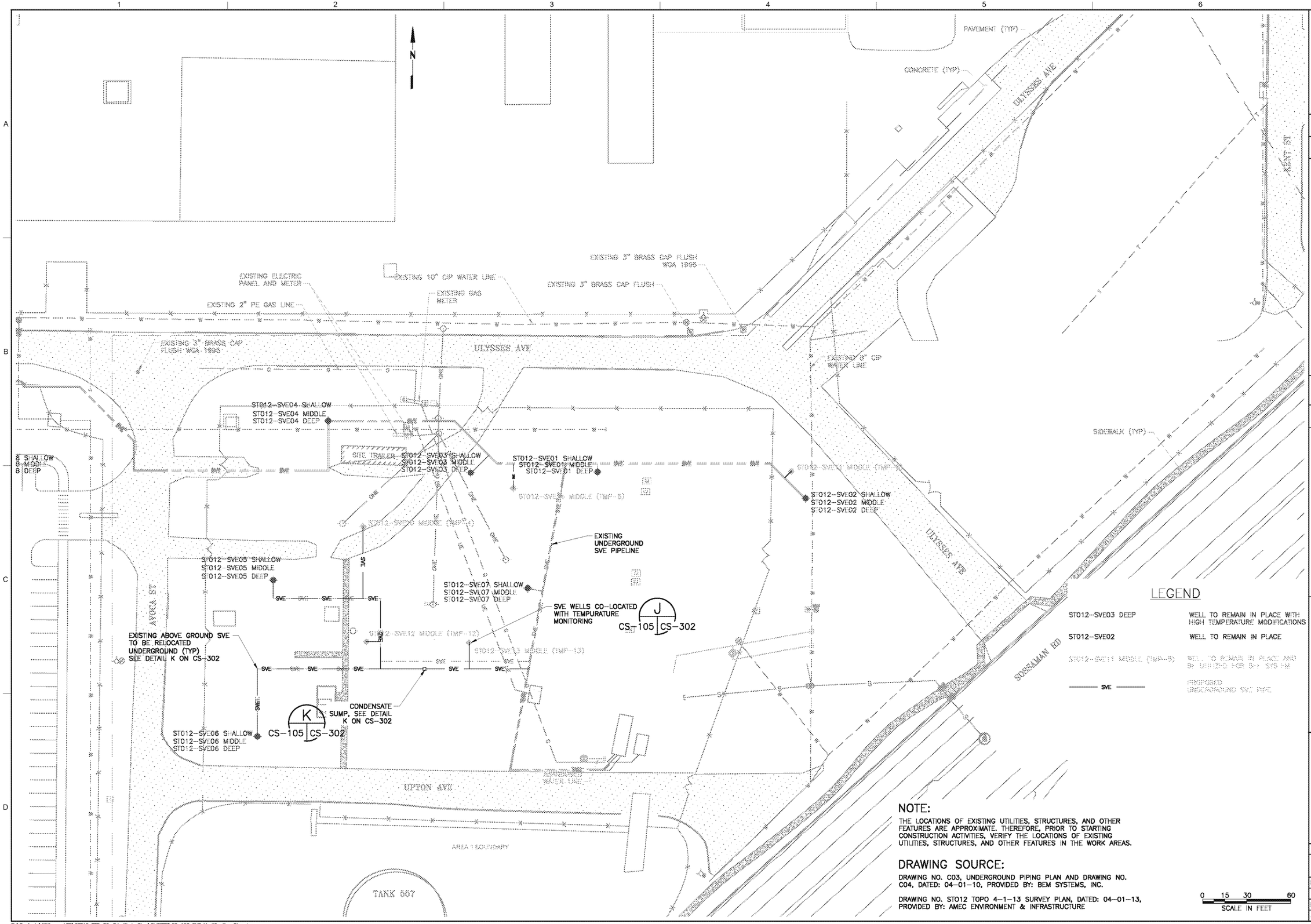

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DRAWING NO. STO12 TOPO 4–1–13 SURVEY PLAN, DATED: 04–01–13, PROVIDED BY: AMEC ENVIRONMENT & INFRASTRUCTURE

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SOIL VAPOR EXTRACTION SYSTEM MODIFICATION PLAN

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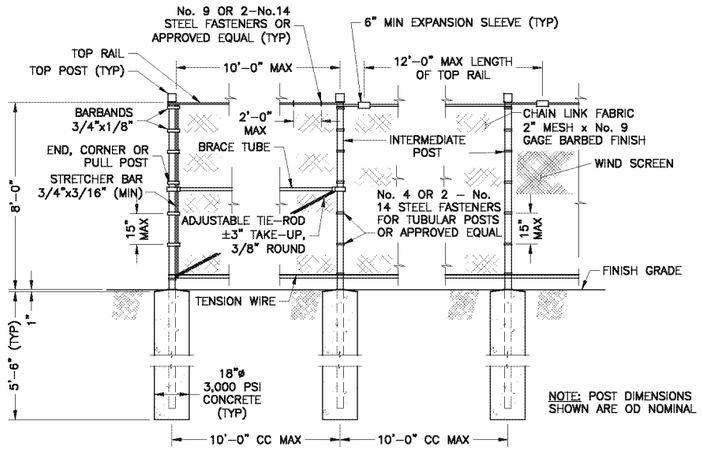


DESCRIPTION

END, CORNER AND PULL POSTS:
ROUND 2.875"ø SCHEDULE 40 STEEL PIPE

INTERMEDIATE POSTS:
ROUND 2.375"ø SCHEDULE 40 STEEL PIPE

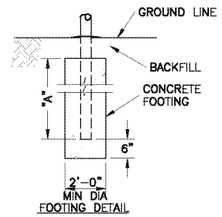
BRACE TUBES:
1.625" OD SCHEDULE 40 STEEL PIPE.

STRETCHER BARS:
LENGTH TO BE 1" LESS THAN FULL HEIGHT OF FABRIC. ONE STRETCHER BAR FOR EACH GATE AND END POST. TWO STRETCHER BARS FOR CORNERS AND BRACING.

TENSION WIRE:
7 GA GALVANIZED COIL SPRING WIRE

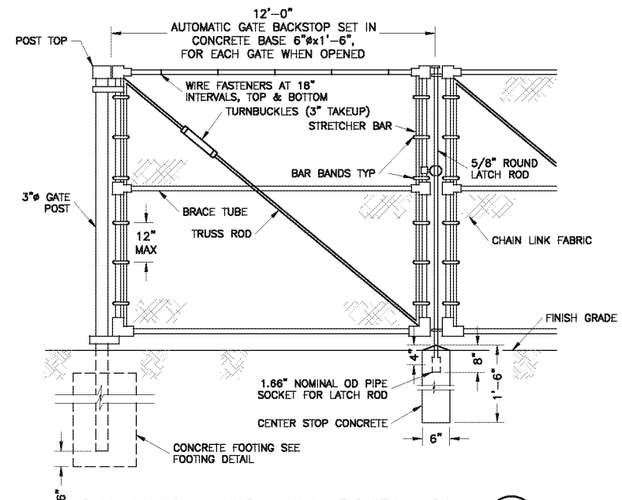
TOP RAIL:
1.66"OD SCHEDULE 40 STEEL PIPE.

CHAIN LINK FENCE (A)
NTS CS–102 | CS–301

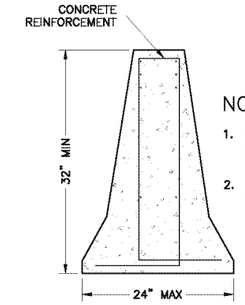


GATE POST BASE

"A" = 6'–0" FOR ALL GATE POSTS



CHAIN LINK FENCE WITH DOUBLE GATE (B)
NTS CS–102 | CS–301



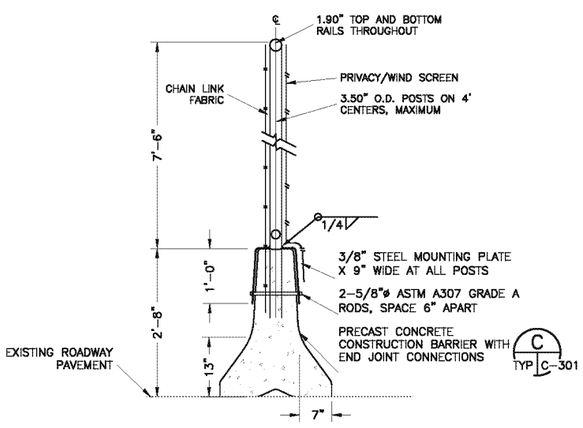
NOTE:

1. PROVIDE TYPE 4 CONCRETE BARRIER WITH DRAINAGE SLOT PER NJDOT SPECIFICATIONS.
2. PROVIDE AROUND PERIMETER OF CONSTRUCTION AREAS ADJACENT TO VEHICLE TRAFFIC AREAS.

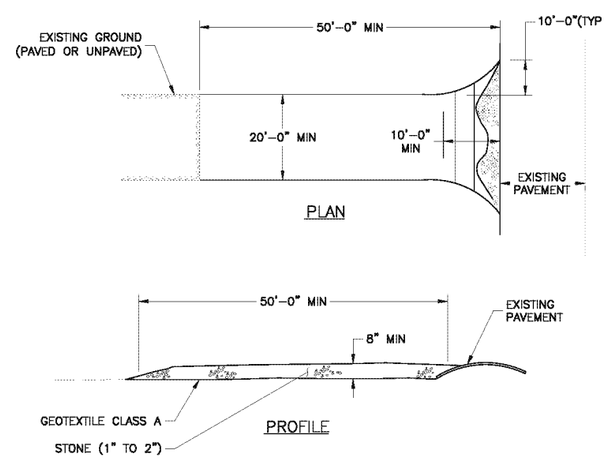
CONCRETE BARRIER (C)
NOT TO SCALE TYP | CS–301

WIND SCREENING NOTE:

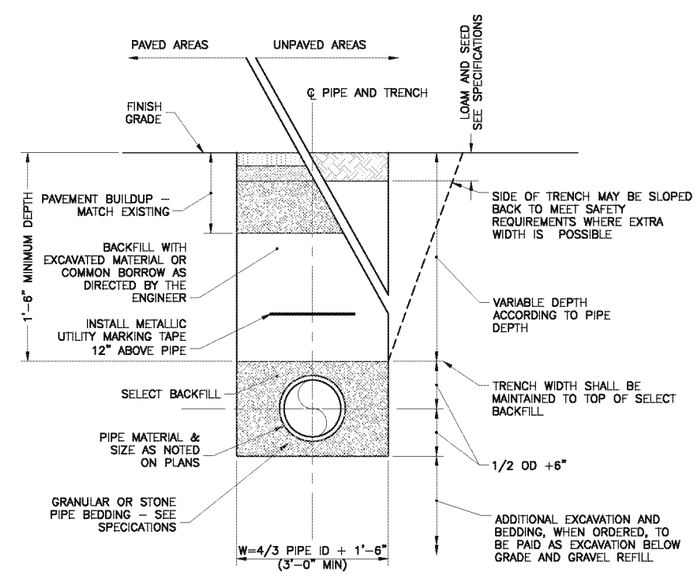
ALL FENCING SHALL HAVE WIND SCREENING. WIND SCREEN SHALL BE 92% SLIT FILM POLYETHYLENE DARK GREEN SCREEN WITH BORDERS AND FASTENING GROMMETS ON 16" CENTER ON TOP AND 12" CENTERS ON BOTTOM. SCREEN SHALL BE MANUFACTURED IN THE U.S.A. BY TEX–NET INC., FLORENCE, NJ (609–499–9111) OR AN APPROVED EQUAL. SCREEN SHALL BE INSTALLED ON ALL FENCING. MOUNT CHAIN LINK FABRIC ON FENCE EXTERIOR WITH WIND SCREEN ON INTERIOR



CHAIN LINK FENCE ON PRECAST CONCRETE BARRIER (D)
NTS CS–102 | CS–301



STABILIZED CONSTRUCTION ACCESS (E)
NTS CS–102 | CS–301



PIPE TRENCH (F)
NTS TYP | CS–301

NO.	DATE	REVISION	BY	APVD
D	12/20/13	DRAFT FINAL REMEDIAL DESIGN / REMEDIAL ACTION WP	BJB	TDD
C	11/19/13	ISSUED FOR UTILITY SERVICES AND SITE PREPARATION BIDS	BJB	TDD
B	08/23/13	DRAFT REMEDIAL DESIGN / REMEDIAL ACTION WP	BJB	TDD
A	07/23/13	WORKING COPY FOR REMEDIAL DESIGN / REMEDIAL ACTION WP	JVM	TDD

DSGN J. MCKENZIE | DR M. STACEY | CHK T. DONOVAN | APVD S. PEARSON

REMEDIAL DESIGN/REMEDIAL ACTION WORK PLAN
ST012-FORMER WILLIAMS AIR FORCE BASE
6011 SOUTH TERRIPIN MALL
MESA, ARIZONA

CIVIL
CIVIL SITE DETAILS

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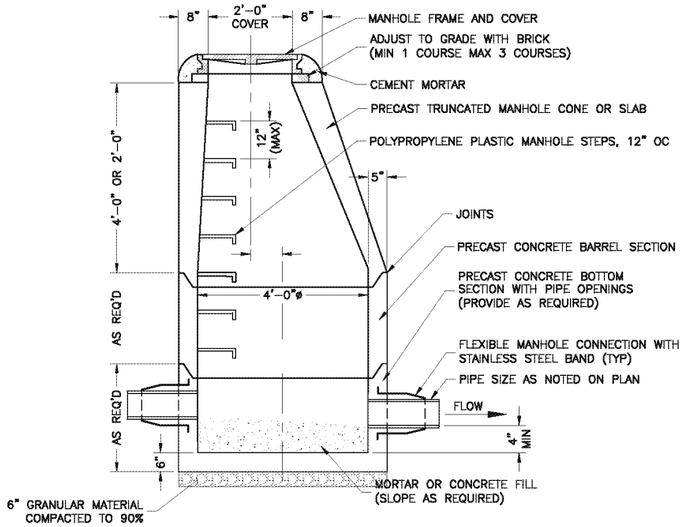
Environment & Infrastructure, Inc.
511 Congress Street
Portland, Maine 04101
(207) 775-5401

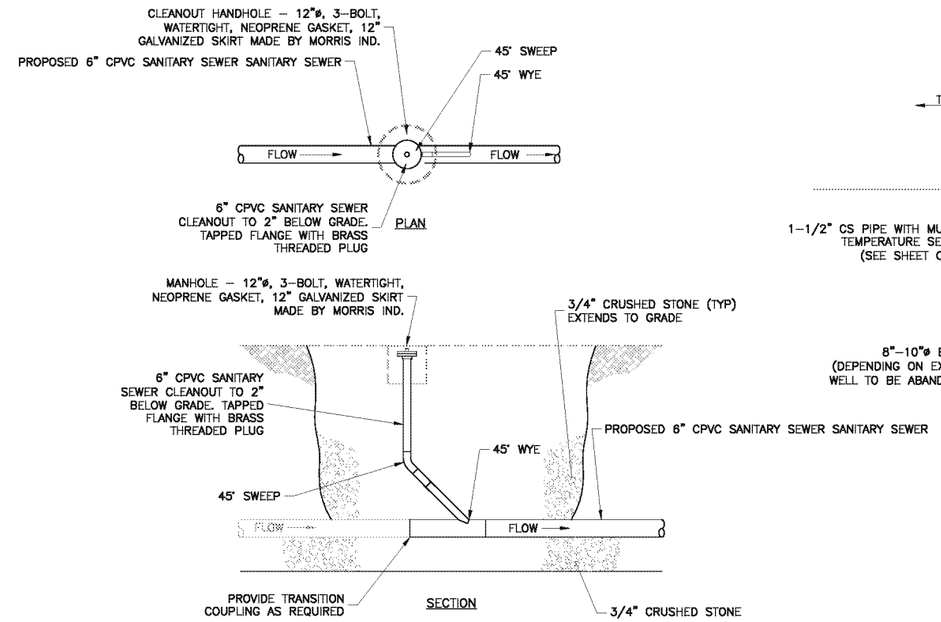
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE
9101-11-0001
DWG CS-301
SHEET OF

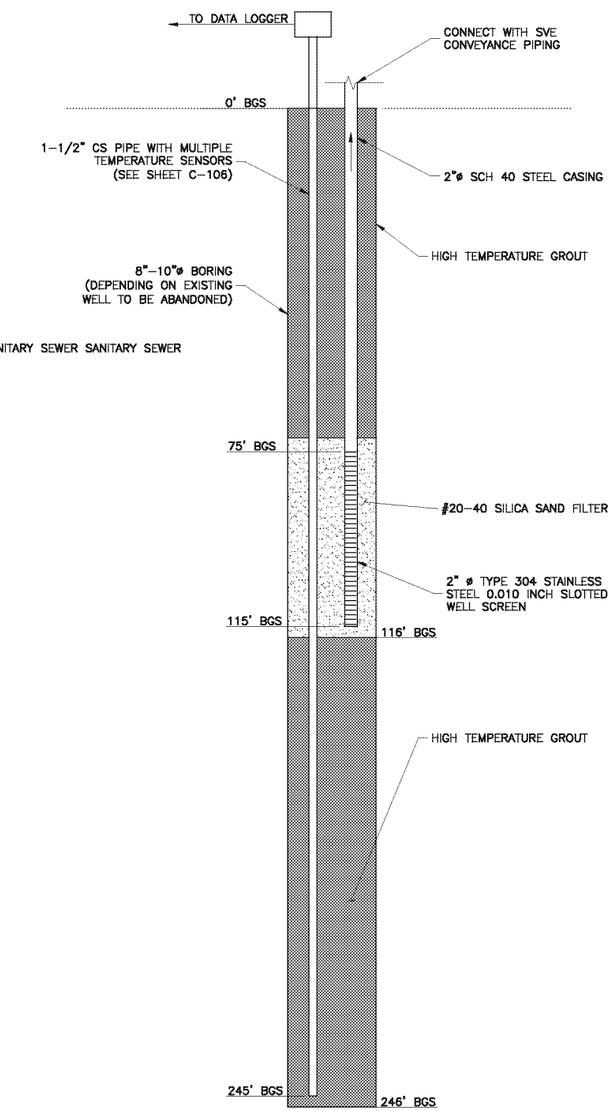
Z:\Projects\Williams AFB\ST012 FFS-RD-RA-Work-Plan\SHEETS\CS-301 CIVIL SITE DETAILS.dwg



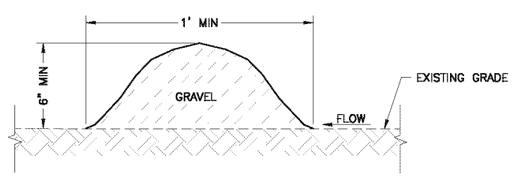
PRECAST CONCRETE MANHOLE (G)
NTS
CS-103 | CS-302



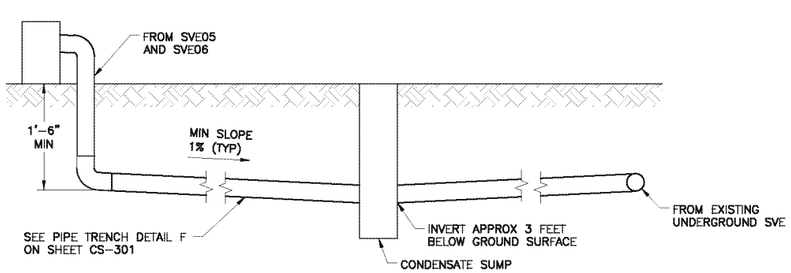
SANITARY SEWER CLEANOUT (H)
NTS
CS-103 | CS-302



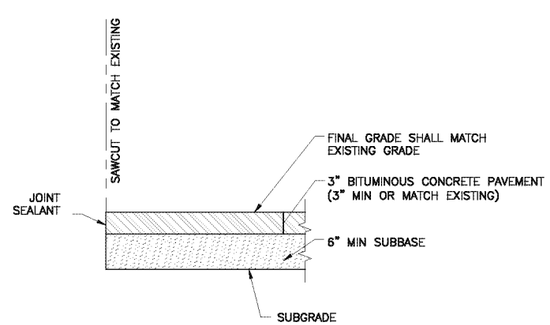
SVE WELLS CO-LOCATED WITH TEMPERATURE MONITORING DETAIL (J)
NTS
C-106 | CS-302
(THIS DETAIL APPLIEDS TO ST012-TMP 4, 5, 12, 13, 15)



CONTAINMENT BERM (L)
NTS
C-103 | C-302



CONDENSATE SUMP DETAIL (K)
NTS
CS-103 | CS-302



PAVEMENT RESTORATION DETAIL (I)
NTS
CS-102 | CS-302

NO.	DATE	REVISION	BY	APVD
D	12/20/13	DRAFT FINAL, REMEDIAL DESIGN / REMEDIAL ACTION WP	BJB	TDD
C	11/19/13	ISSUED FOR UTILITY SERVICES AND SITE PREPARATION BIDS	BJB	TDD
B	08/23/13	DRAFT REMEDIAL DESIGN / REMEDIAL ACTION WP	BJB	TDD
A	07/23/13	WORKING COPY FOR REMEDIAL DESIGN / REMEDIAL ACTION WP	JVM	TDD

DSGN J. MCKENZIE | DR M. STACEY | CHK T. DONOVAN | APVD S. PEARSON

REMEDIAL DESIGN/REMEDIAL ACTION WORK PLAN
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CIVIL SITE DETAILS 2

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Z:\Projects\Williams AFB\ST012 FFS-RD-RA-Work-Plan\SHEETS\CS-302 CIVIL SITE DETAILS.dwg

EXISTING 10" CIP WATER LINE

EXISTING GAS METER

EXISTING 2" PE GAS LINE

ULYSSES AVE

PROPOSED TRANSFORMER PAD 2000 KVA / 480 VAC

EXISTING UTILITY POLE TO REMAIN IN PLACE

EXISTING 8" CIP WATER LINE

TT OFFICE TRAILER

OFFICE AND STORAGE AREA

ELECTRICAL EQUIPMENT AREA

REMOVE EXISTING POLES AND OVERHEAD ELECTRIC LINES (TYP OF 3)

INSTALL VALVE PIT AND CONNECT PROPOSED 12-INCH PE GAS SERVICE LINE

CONNECT WITH EXISTING WATER SERVICE LINE

INSTALL 2-INCH PVC WATER SERVICE LINE

PROPOSED MH-1

TREATMENT EQUIPMENT AREA

INSTALL 27 LF 6-INCH CPVC SANITARY SEWER @2.0%

UPTON AVE

8" CPVC SVC LINE

AVOCA ST

PROPOSED SANITARY SEWER CLEANOUT

INSTALL 205 LF 6-INCH CPVC SANITARY SEWER @ 2.0%

ABOVE GROUND GAS VALVE

INSTALL 105 LF 6-INCH CPVC SANITARY SEWER @ 2.0%

PROPOSED MH-2

TANK 567

NOTES:

1. UTILITY SERVICE PLAN INFO PROVIDED BY AMEC.
2. AREAS IDENTIFIED FOR TREATMENT AND ELECTRICAL GEAR ARE REQUIRED TO BE GRADED LEVEL
3. AREAS IDENTIFIED FOR SPILL BERMS ARE REQUIRED TO BE FURTHER GRADED SMOOTH WITH 2" TO 3" PEA GRAVEL LAYER
4. ALL ABOVE GRADE CONSTRUCTION WITHIN THE TREATMENT EQUIPMENT AREA MUST BE REMOVED
5. TERRATHERM ASSUMES NO OBSTRUCTIONS WILL REMAIN FOR THE PROPOSED PIPING AND EQUIPMENT LAYOUT

THESE DRAWINGS HAVE BEEN PREPARED BASED ON PROJECT INFORMATION AVAILABLE TO DATE AND ARE SUITABLE FOR TERRATHERM'S USE DURING PROJECT IMPLEMENTATION. CHANGES TO THE DESIGN MADE BY TERRATHERM DURING IMPLEMENTATION WILL BE UPDATED AS PART OF THE AS-BUILT DRAWING PACKAGE TO BE SUBMITTED AFTER PROJECT COMPLETION.

LEGEND

- SIW COBBLE ZONE (CZ)
- SIW UPPER WATER BEARING ZONE (UWBZ)
- SIW LOWER SATURATED ZONE (LSZ)
- MPE COBBLE ZONE (CZ)
- MPE UPPER WATER BEARING ZONE (UWBZ)
- MPE LOWER SATURATED ZONE (LSZ)
- TEMPERATURE MONITORING LOCATION
- TREATMENT EQUIPMENT LOCATIONS

N

APPROX. SCALE

0 30 60 90 120 FT

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REVISIONS

REV	DATE	BY	CHK	ENG	DESCRIPTION	APPROVED
E	12/30/13	DC	DB	DM	REMOVED SECONDARY CONTAINMENT	

TERRATHERM

ST012-FORMER WILLIAMS AIR FORCE BASE
MESA, ARIZONA
SITE PREPARATION-UTILITY SERVICE PLAN

SIZE	FILE NO.	DWG NO.	REV
D	C102	C102	E

SCALE: DNS SHEET 1 OF 1

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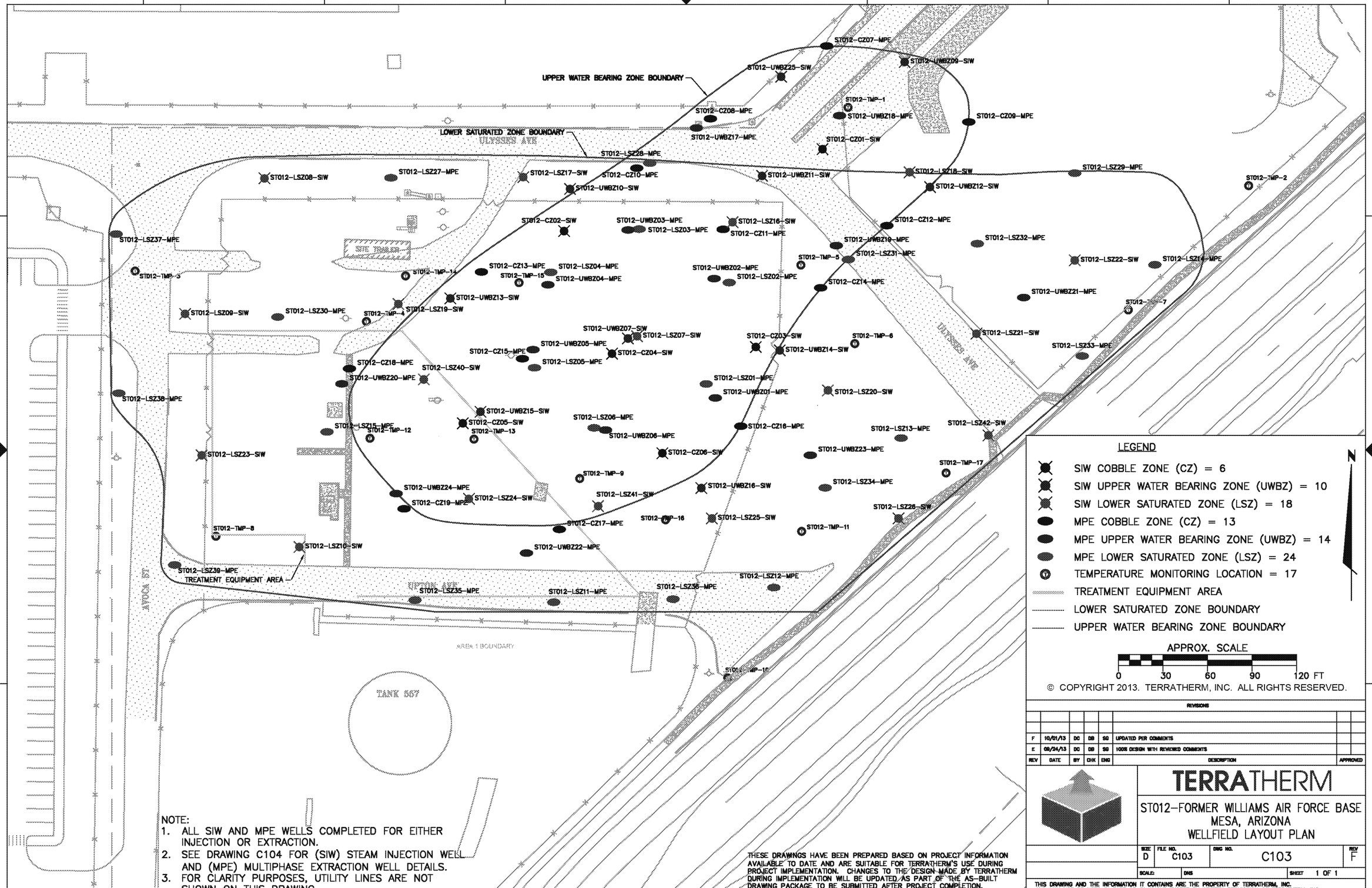

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NOTE:
1. ALL SIW AND MPE WELLS COMPLETED FOR EITHER INJECTION OR EXTRACTION.
2. SEE DRAWING C104 FOR (SIW) STEAM INJECTION WELL AND (MPE) MULTIPHASE EXTRACTION WELL DETAILS.
3. FOR CLARITY PURPOSES, UTILITY LINES ARE NOT SHOWN ON THIS DRAWING.

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REVISIONS

REV	DATE	BY	CHK	ENG	DESCRIPTION	APPROVED
F	10/01/13	DC	DB	SG	UPDATED PER COMMENTS	
E	09/24/13	DC	DB	SG	100% DESIGN WITH REVIEWED COMMENTS	

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ST012–FORMER WILLIAMS AIR FORCE BASE
MESA, ARIZONA
WELLFIELD LAYOUT PLAN

SIZE	FILE NO.	DWG NO.	REV
D	C103	C103	F

SCALE: DNS SHEET 1 OF 1

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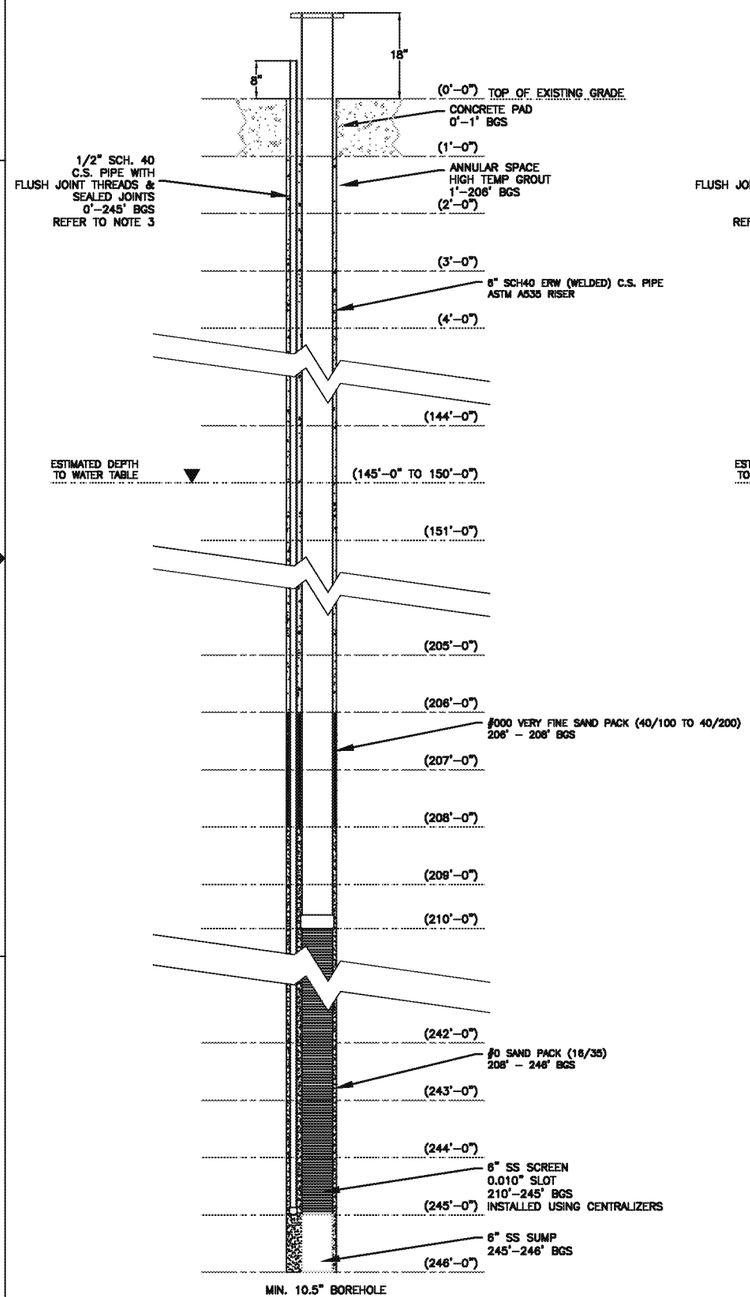
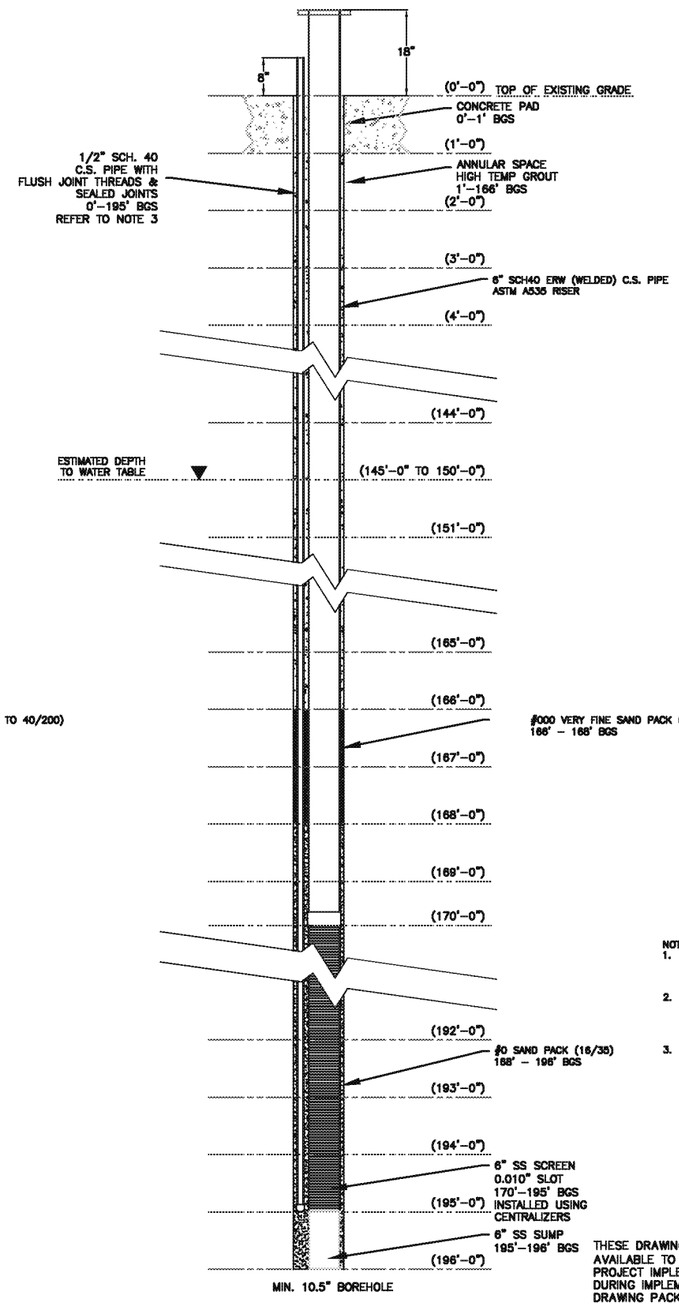
LOWER SATURATED ZONE (LSZ) TYPICAL WELL DETAIL

TOTAL QTY (42) @ 246 FEET DEEP
PROPOSED FUNCTIONALITY: QTY (18) SIW, QTY (24) MPE
35'L X 6" WELL SCREEN, 0.010 SLOT, SS W/1' SS SUMP
6" SCH 40 ERW (WELDED) C.S. PIPE ASTM A53B RISER W/ 300LB FLANGE



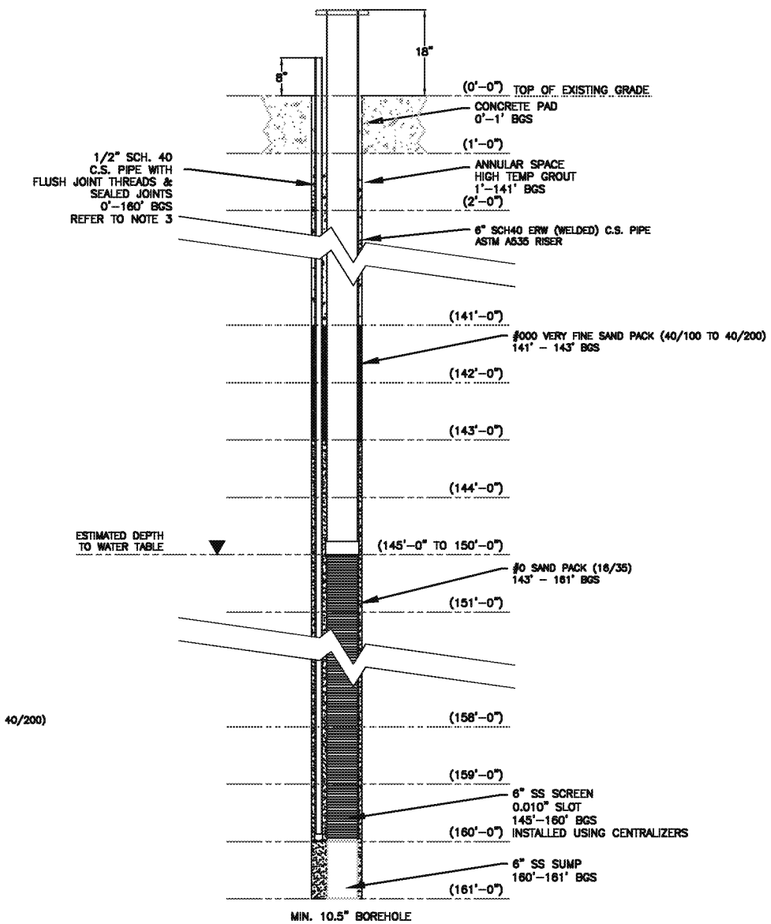
UPPER WATER BEARING ZONE (UWBZ) TYPICAL WELL DETAIL

TOTAL QTY (24) @ 196 FEET DEEP
PROPOSED FUNCTIONALITY: QTY (10) SIW, QTY (14) MPE
25'L X 6" WELL SCREEN, 0.010 SLOT, SS W/ 1' SS SUMP
6" SCH 40 ERW (WELDED) C.S. PIPE ASTM A53B RISER W/ 300 LB FLANGE



COBBLE ZONE (CZ) TYPICAL WELL DETAIL

TOTAL QTY (19) @ 161 FEET DEEP
PROPOSED FUNCTIONALITY: QTY (6) SIW, QTY (13) MPE
15'L X 6" WELL SCREEN, 0.010 SLOT, SS W/ 1' SS SUMP
6" SCH 40 ERW (WELDED) C.S. PIPE ASTM A53B RISER W/ 300 LB FLANGE



NOTE:
1. THE FINAL INSTALLATION DEPTH OF LSZ WELLS TO BE ADJUSTED TO THE TOP OF CLAY LAYER LOCATED ~245FT BGS AS PERMITTED BY FIELD CONDITIONS.
2. EACH WELL WILL BE EQUIPPED FOR EITHER STEAM INJECTION OR MULTIPHASE EXTRACTION BASED ON OBSERVATIONS DURING DRILLING. SELECTED WELLS MAY BE DUAL PURPOSE WELLS FOR ALTERNATING OPERATION. SEE DRAWING C105 FOR DETAILS.
3. EACH STEAM INJECTION AND MPE WELL WILL BE EQUIPPED WITH THREE THERMOCOUPLES TO MONITOR TEMPERATURE AT THE TOP, MIDDLE, AND BOTTOM OF THE TREATMENT ZONE.

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E	09/24/13	DC	DB	SG	100% DESIGN WITH REVIEWED COMMENTS	

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ST012-FORMER WILLIAMS AIR FORCE BASE
MESA, ARIZONA
STEAM INJECTION / MULTIPHASE EXTRACTION WELL DETAILS

SIZE	FILE NO.	DWG NO.	REV
D	C104	C104	F

SCALE: AS SHOWN | DNS | DSN | SHEET 1 OF 1

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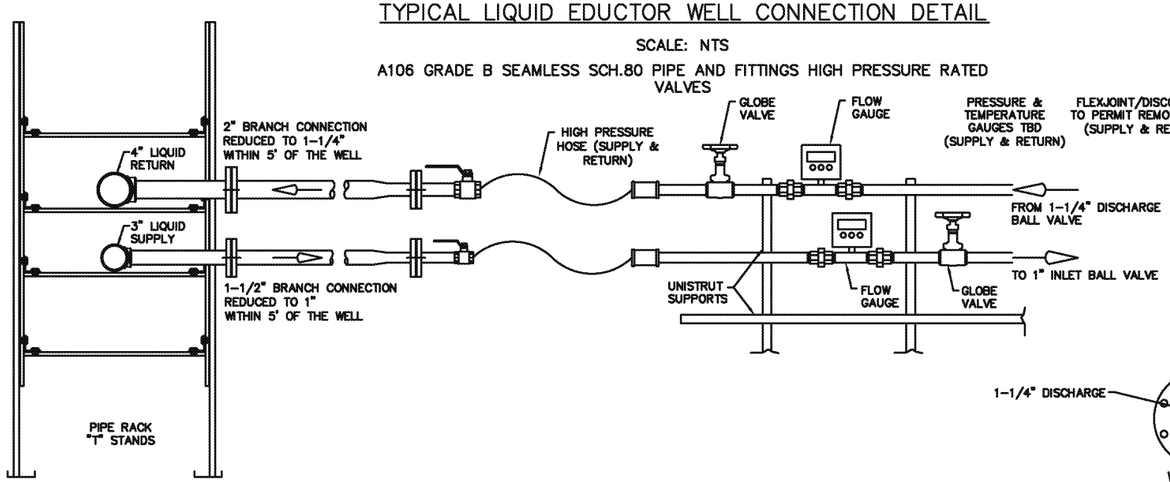
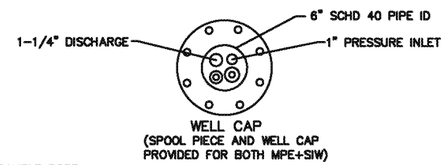
DETAIL 3

TYPICAL LIQUID EDUCTOR WELL CONNECTION DETAIL

SCALE: NTS

A106 GRADE B SEAMLESS SCH.80 PIPE AND FITTINGS HIGH PRESSURE RATED VALVES



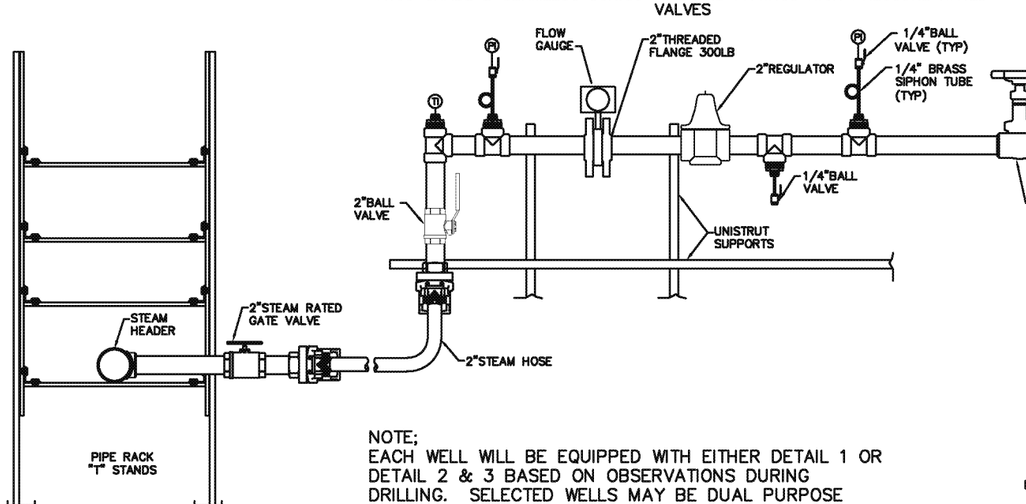


DETAIL 1

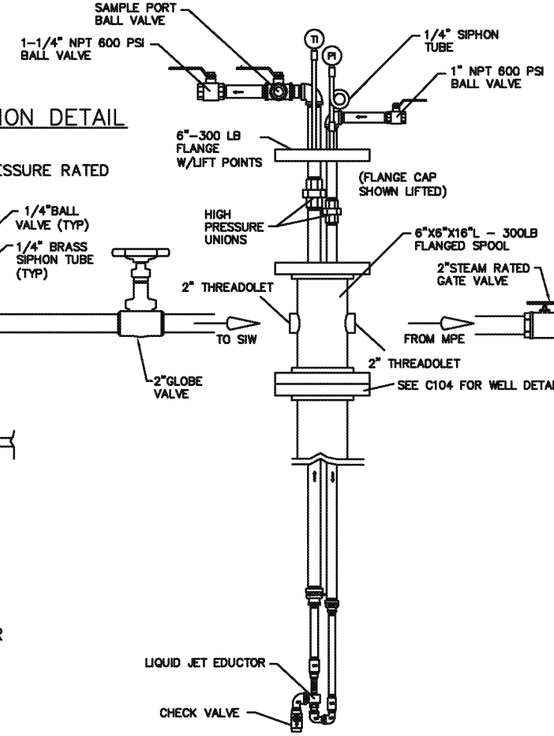
TYPICAL 2" STEAM INJECTION WELL CONNECTION DETAIL

SCALE: NTS

A106 GRADE B SEAMLESS SCH.80 PIPE AND FITTINGS HIGH PRESSURE RATED VALVES



NOTE;
EACH WELL WILL BE EQUIPPED WITH EITHER DETAIL 1 OR DETAIL 2 & 3 BASED ON OBSERVATIONS DURING DRILLING. SELECTED WELLS MAY BE DUAL PURPOSE WELLS AND EQUIPPED WITH ALL THREE CONNECTION TYPES FOR ALTERNATING OPERATION. STEAM INJECTION WELLS WILL NOT HAVE THE DOWNHOLE WELL EDUCTOR SYSTEM INSTALLED.



DETAIL 4

TYPICAL WELL EDUCTOR SYSTEM DETAIL

SCALE: NTS

NOTES:

1. THE HEIGHT OF THE TOP CROSSBAR WILL CHANGE TO ACCOMODATE THE DIFFERENCE IN ELEVATION ALONG THE MANIFOLD PIPE.

2. VAPOR PIPE IS SLOPED 1/2% TO 1% TOWARD TREATMENT EQUIPMENT. STEAM PIPE IS SLOPED TOWARD STEAM TRAP ENDS.

3. THE DETAIL IS A REPRESENTATION OF A TYPICAL CONNECTION.

4. ALL PIPING IS CONNECTED AT A SINGLE PIPE RACK. (PIPE RACKS ARE SHOWN SEPARATED ONLY FOR CLARITY).

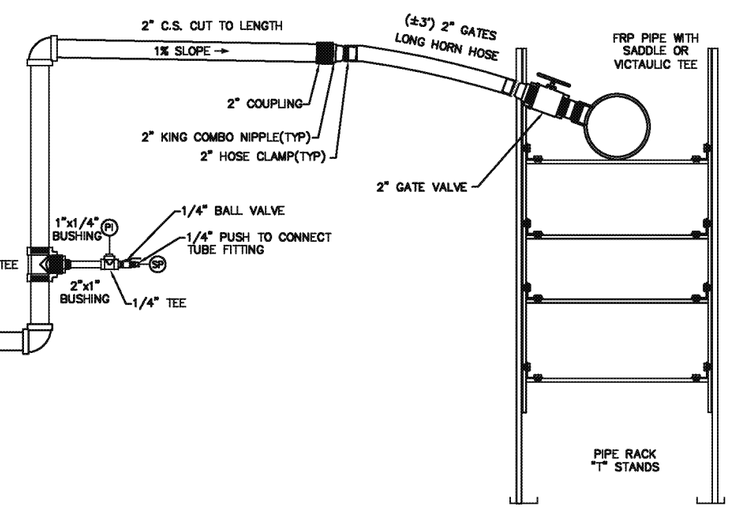
5. INSULATION NOT SHOWN FOR CLARITY

DETAIL 2

TYPICAL VAPOR EXTRACTION WELL CONNECTION DETAIL

SCALE: NTS

SCHEDULE 40 CS PIPE AND FITTINGS



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ST012-FORMER WILLIAMS AIR FORCE BASE
MESA, ARIZONA
TYPICAL WELLHEAD CONNECTION DETAIL

SIZE	FILE NO.	DWG NO.	REV
D	C105	C105	C

SCALE: DNS DSN SHEET 1 OF 1

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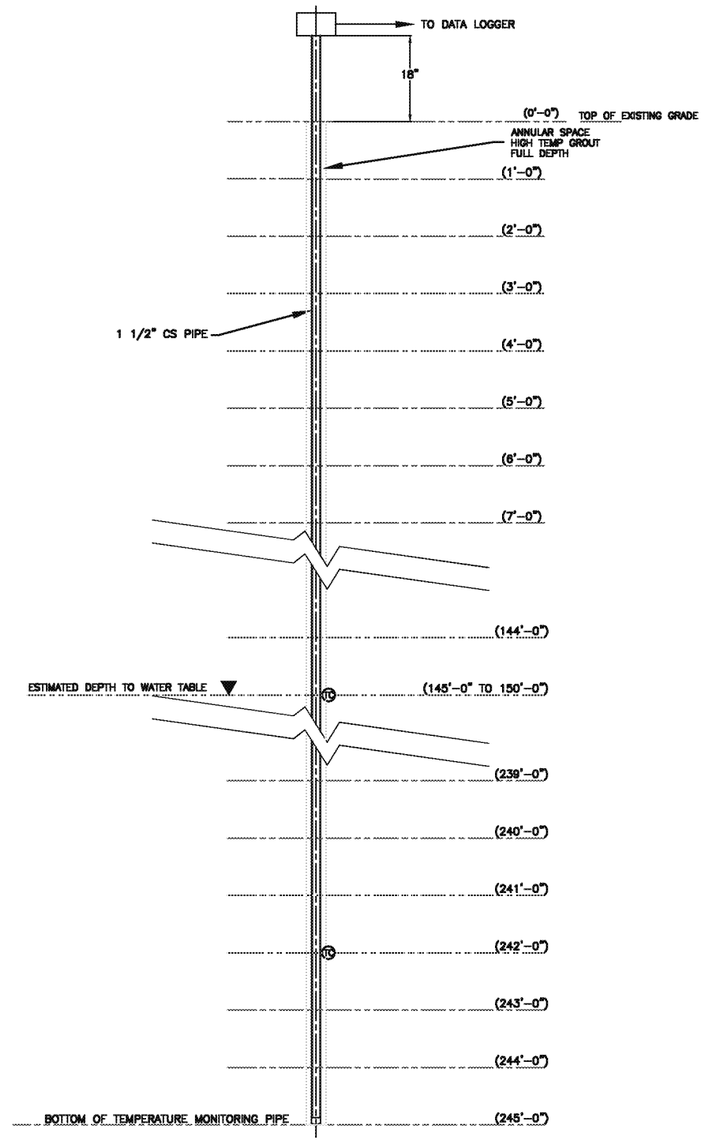
TEMPERATURE MONITORING POINT DETAIL

QTY (16)
1 1/2" SCH 40, C.S. PIPE WITH THREADED END
END CAP WITH SEALED JOINTS (TEFLON TAPE & TEFLON PASTE)

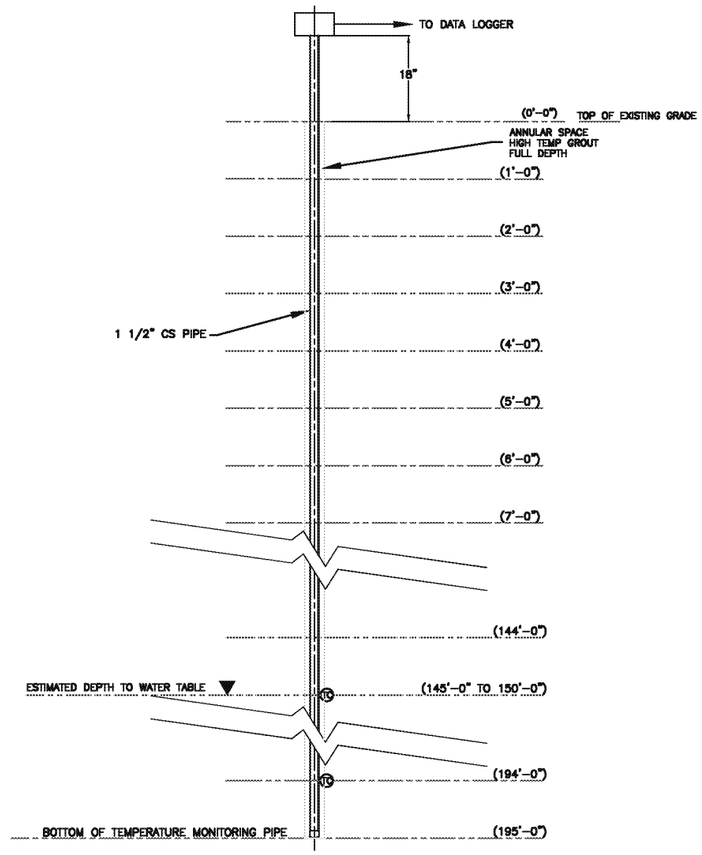


4" DIA. BOREHOLE (MIN.)

TEMPERATURE SENSORS AT
100', 120', 130', 140', 145, 150', 155', 160', 165', 170'. 175', 180', 185'. 190', 195',
200', 205', 210', 215', 220', 225', 230', 235', 242' BGS.

TEMPERATURE MONITORING POINT DETAIL

QTY (1) [ST012-TMP-01]
1 1/2" SCH 40, C.S. PIPE WITH THREADED END
END CAP WITH SEALED JOINTS (TEFLON TAPE & TEFLON PASTE)



4" DIA. BOREHOLE (MIN.)

TEMPERATURE SENSORS AT
100', 120', 130', 140', 145, 150', 155', 160', 165', 170'. 175', 180', 185'. 190', 194' BGS

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D	08/30/13	DC	DB	SG	100% DESIGN SUBMITTAL	SM	
C	07/16/13	DC	DB	SM	WORKING COPY FOR RDRA WORKPLAN		
B	06/21/13	DB	JG	SG	PRELIMINARY FOR 90% DESIGN		
A	05/02/13	BC			PRELIMINARY FOR 60% DESIGN		

TERRATHERM

ST012-FORMER WILLIAMS AIR FORCE BASE
MESA, ARIZONA
TMP MONITORING WELL DETAILS

SIZE	FILE NO.	DWG NO.	REV
D	C106	C106	D

SCALE: AS SHOWN | DNS | DSN | SHEET 1 OF 1

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ELECTRICAL ONELINE LEGEND (SMART SYMBOL)

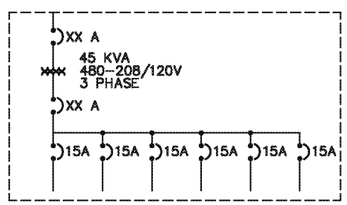
TERRATHERM FREQUENTLY USED TERMS AND SYMBOLS

A	– AMPERE
AMP	– AMPERE
ATS	– AUTOMATIC TRANSFER SWITCH
C.S.	– CARBON STEEL
DP	– DISTRIBUTION PANEL
FLA	– FULL LOAD AMPS. MOTOR FLA ARE SPECIFIED PER NEC 430.250
GFCI	– GROUND FAULT CIRCUIT INTERRUPTER
KVA	– KILOVOLT–AMPERE
KW	– KILOWATTS
KWHR	– KILOWATT–HOUR
LC	– LOAD CENTER
LCP	– LOCAL CONTROL PANEL
MSWB	– MAIN SWITCHBOARD
OWS	– OIL WATER SEPARATOR
SCR	– SILICON CONTROLLED RECTIFIER
T(XXX)	– TERRATHERM EQUIPMENT IDENTIFICATION NUMBER
V	– VOLTS
VFD	– VARIABLE FREQUENCY DRIVE
XX/XXX	– PLACE HOLDER – INFORMATION TO BE ADDED FOR SPECIFIC PROJECT

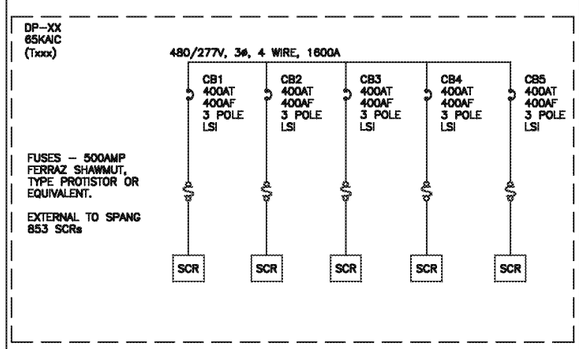
- WIRE TERMINATION / CONNECTION POINT
- ELECTRICAL CONDUCTOR / WIRE
- SEMI–CONDUCTOR FUSE
- HEATER ELEMENT AS REPRESENTED IN ONELINE. LETTER IN HEXAGON DENOTES HEATER TYPE.
- HEAT TRACE FOR PIPING
- VFD — XX HP — VARIABLE FREQUENCY DRIVE(VFD) WITH DISCONNECT SWITCH AT PANEL. VFD RATING AS NOTED
- XX — FLA XXX — MOTOR. HORSEPOWER AS INDICATED IN CIRCLE. FULL LOAD AMPS (FLA) AS NOTED PER APPLICABLE NEC TABLE.
- XX KW — STANDBY GENERATOR. KW RATING AS NOTED.
- XXX : XXX V — VOLTAGE TRANSFORMER, TYPICALLY USED FOR METERING. VOLTAGE RATIO AS NOTED.
- XXX : 5 A — CURRENT TRANSFORMER, TYPICALLY USED FOR METERING. CURRENT TRANSFORMER RATIO AND POLARITY AS NOTED.
- M — ENERGY METER (KWHR) MODEL AS NOTED
- KVA, PRI_VOLT:480/277V, %Z — POWER TRANSFORMER WITH PRIMARY VOLTS, SECONDARY VOLTS, KVA RATINGS, AND % IMPEDANCE AS NOTED
- EQUIPMENT SKID BOUNDARY
- ATS–1, XXX A, N, E, L — AUTOMATIC TRANSFER SWITCH. SWITCH AMP RATING AS NOTED
- RATED HP @460V, FLA X – X, XX AMPS MAX — UL COMBINATION STARTER TYPE E, SELF–PROTECTED OR TYPE F. FULL LOAD AMP RATING ADJUSTABLE IN SPECIFIED RANGE.

ELECTRICAL ONELINE LEGEND (SMART SYMBOL – INTEGRATED EQUIPMENT)

CB #, AMP, 3 POLES	LOW VOLTAGE AIR CIRCUIT BREAKER WITH RATING AND NUMBER OF POLES AS NOTED. NON–ADJUSTABLE TYPE.
CB #, XX AT, XX AF, 3 POLES	LOW VOLTAGE AIR CIRCUIT BREAKER WITH RATING AND NUMBER OF POLES AS NOTED. TRIP RATING ADJUSTABLE TYPE.
CB #, XX AT, XX AF, 3 POLES, LSIG	LOW VOLTAGE AIR CIRCUIT BREAKER WITH RATING AND NUMBER OF POLES AS NOTED. TRIP RATING ADJUSTABLE TYPE. PROTECTION TO BE SPECIFIED AS REQUIRED.
CB #, XX AT, XX AF, 3 POLES, LSIG	LOW VOLTAGE AIR CIRCUIT BREAKER WITH RATING AND NUMBER OF POLES AS NOTED. TRIP RATING ADJUSTABLE TYPE. PROTECTION TO BE SPECIFIED AS REQUIRED. DRAWOUT TYPE.
CB #, XX AT, XX AF, 3 POLES, LSIG	MEDIUM VOLTAGE VACUUM CIRCUIT BREAKER WITH RATING AND NUMBER OF POLES AS NOTED. TRIP RATING ADJUSTABLE. PROTECTION TO BE SPECIFIED AS REQUIRED. DRAWOUT TYPE.
XXX AMP FUSE TYPE	FUSE RATING AND TYPE AS NOTED.
XXX A – SWITCH, XXX AMP FUSE FUSE_TYPE	FUSED DISCONNECT SWITCH WITH SWITCH RATING, FUSE RATING AND TYPE AS NOTED.



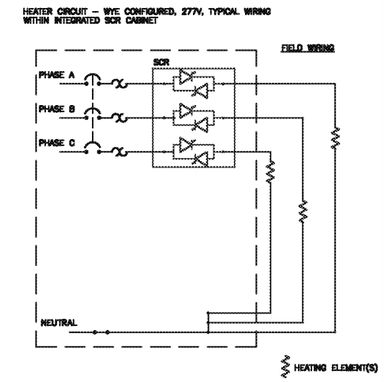
INTEGRATED PANEL WITH TRANSFORMER ASSEMBLY. PRIMARY AND SECONDARY BREAKERS AS NOTED. DISTRIBUTION PANEL CONTAINS BREAKERS AS NOTED.



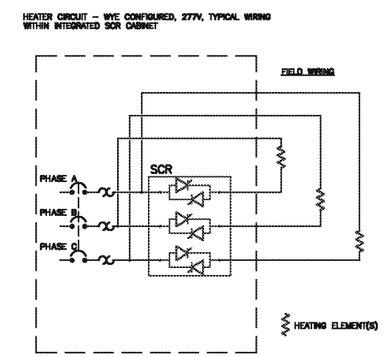
INTEGRATED DISTRIBUTION PANEL WITH BUILT–IN SCR CABINETS / ZONES. EACH ZONE HAS CUSTOMIZABLE PROTECTION FOR THE HEATER CIRCUIT AND THE SCR.

SCR POWER WIRING SCHEMATICS

HEATER CIRCUIT – WYE CONFIGURED, 277V



HEATER CIRCUIT – INSIDE DELTA CONFIGURED, 480V



- GFCI WP — GROUND FAULT CIRCUIT INTERRUPTER DUPLEX OUTLET WITH WEATHERPROOF COVER.
- EMERGENCY STOP – PUSHBUTTON STATION
- LIGHT POLE WITH GFCI DUPLEX RECEPTACLE

GENERAL NOTES

THE FOLLOWING NOTES ARE APPLICABLE TO ALL ELECTRICAL DRAWINGS, OR E–SERIES, UNLESS SPECIFICALLY STATED OTHERWISE ON THE SPECIFIC DRAWING. THE FOLLOWING IS NOT AN ALL–INCLUSIVE LIST OF RELEVANT CODE APPLICABLE TO THIS PROJECT BUT IS INTENDED TO HIGHLIGHT THE MAJOR SECTIONS ONLY.

GENERAL NOTES:

1. TERRATHERM WILL PROVIDE ALL FLEXIBLE CORDS AND CONNECTORS FOR EQUIPMENT SHOWN ON DRAWING. CONTRACTOR MAY BE REQUESTED TO PROVIDE ADDITIONAL MATERIAL ON A T&M BASIS AS SITE CONDITION CHANGES.
2. TERRATHERM'S ELECTRICAL DESIGNS ARE BASED ON ARTICLE 590, TEMPORARY INSTALLATION, OF THE NATIONAL ELECTRIC CODE, 2011. ALL TEMPORARY WIRING AND EQUIPMENT WILL BE REMOVED AT THE CONCLUSION OF THE PROJECT. ALL CABLE SHALL BE LISTED FOR HARD OR EXTRA–HARD USAGE PER ARTICLE REQUIREMENT.
3. TYPE "W" AND TYPE "G–GC" ARE CLASSIFIED FOR EXTRA HARD USAGE PER NEC TABLE 400–4. TYPE "W" AND TYPE "G–GC" CABLE AMPACITY ARE SPECIFIED PER NEC ARTICLE 400–5(A)(2) USING 75 DEGREE C COLUMN F3 FOR THREE–CONDUCTOR (3/C) CABLES. COLUMN D1 IS USED FOR SINGLE–CONDUCTOR (1/C) WHERE THE CONDUCTOR IS NOT IN PHYSICAL CONTACT WITH EACH OTHER.
4. ALL CABLE SHALL BE BOTTOM ENTRY WHEREVER PRACTICAL. PER NEC 110.14, ALL TERMINALS OF EQUIPMENT >100A ARE ASSUMED TO BE 75C RATED UNLESS OTHERWISE NOTED.
5. GROUNDING SHALL BE INSTALLED PER NEC ARTICLE 250 – "GROUNDING AND BONDING FOR ALL EQUIPMENT". ROUTE ALL HEATER CIRCUIT EQUIPMENT GROUNDS WITH THE HEATER CIRCUIT CONDUCTORS TO EACH WELLHEAD. REFERENCE TYPICAL GROUNDING DETAILS FOR ADDITIONAL INFORMATION.
6. THE GROUNDING ELECTRODE CONDUCTOR FOR A SEPARATELY DERIVED SYSTEM (TRANSFORMER) SHALL BE INSTALLED AT THE FIRST DISCONNECTING MEAN PER NEC ARTICLE 250.30.
7. GENERATOR SHALL BE WIRED PER NEC ARTICLE 702, OPTIONAL STANDBY SYSTEMS. THE GENERATOR WILL BE WIRED TO A THREE (3) POLE TYPE AUTOMATIC TRANSFER SWITCH (ATS) AND SHOULD BE WIRED AS A NON–SEPARATELY DERIVED SYSTEM, I.E. DO NOT BOND NEUTRAL AT GENERATOR. WIRE EMERGENCY STOP SIGNAL TO PREVENT GENERATOR START DURING AN EMERGENCY. EMERGENCY STOP SIGNAL SHALL ALSO BE WIRED TO SHUNT TRIP THE MAIN BREAKER(S).
8. MAINTAIN WORKING CLEARANCE PER NEC ARTICLE 110.26 – "SPACES ABOUT ELECTRICAL EQUIPMENT".
9. ALL POWER DISTRIBUTION EQUIPMENT SHALL BE UL LISTED OR CERTIFIED BY A 3RD PARTY NRTL.
10. ALL PROCESS EQUIPMENT CONTROL PANELS SHALL BE BUILT TO APPLICABLE UL STANDARDS SUCH AS UL 508, UL 698. EQUIPMENT MAY BE FIELD EVALUATED BY A NRTL IF THE ABOVE STANDARD IS NOT AVAILABLE.
11. EQUIPMENT WITH "A" AND "B" TAG SUCH AS P–101A AND P–101B ARE NON–COINCIDENTAL LOADS.
12. USE THE FOLLOWING COLOR CODES FOR CONDUCTOR IDENTIFICATION:

	208Y / 120 VOLT	480 / 277 VOLT
PHASE A	BLACK	BROWN
PHASE B	RED	ORANGE
PHASE C	BLUE	YELLOW
NEUTRAL	WHITE	GRAY

13. ALL WORK SHALL CONFORM TO THE LATEST LOCAL, STATE AND FEDERAL REQUIREMENTS AS INTERPRETED BY THE AUTHORITY HAVING JURISDICTION

SITE SPECIFIC NOTES:

1. AMPACITIES OF CABLE ARE CORRECTED FOR AN MAX AMBIENT TEMPERATURE OF 110 DEGREE F
2. THE AVAILABLE FAULT CURRENT IS ASSUMED TO BE < 65KA. EXACT NUMBERS TO BE PROVIDED BY UTILITY

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REVISIONS

REV	DATE	BY	CHK	ENG	DESCRIPTION	APPROVED
D	08/30/13	DC	SW	WL	100% DESIGN SUBMITTAL	SM
C	07/16/13	WL	SW	WL	WORKING COPY FOR RDRA WORKPLAN	
B	06/21/13	WL	SW	WL	PRELIMINARY FOR 90% DESIGN	
A	05/02/13	WL	SW	WL	PRELIMINARY FOR 60% DESIGN	

TERRATHERM

ST012–FORMER WILLIAMS AIR FORCE BASE
MESA, ARIZONA
ELECTRICAL LEGEND

SIZE	FILE NO.	DWG NO.	REV
D	E100	E100	D

SCALE: NTS DNS SHEET 1 OF 1

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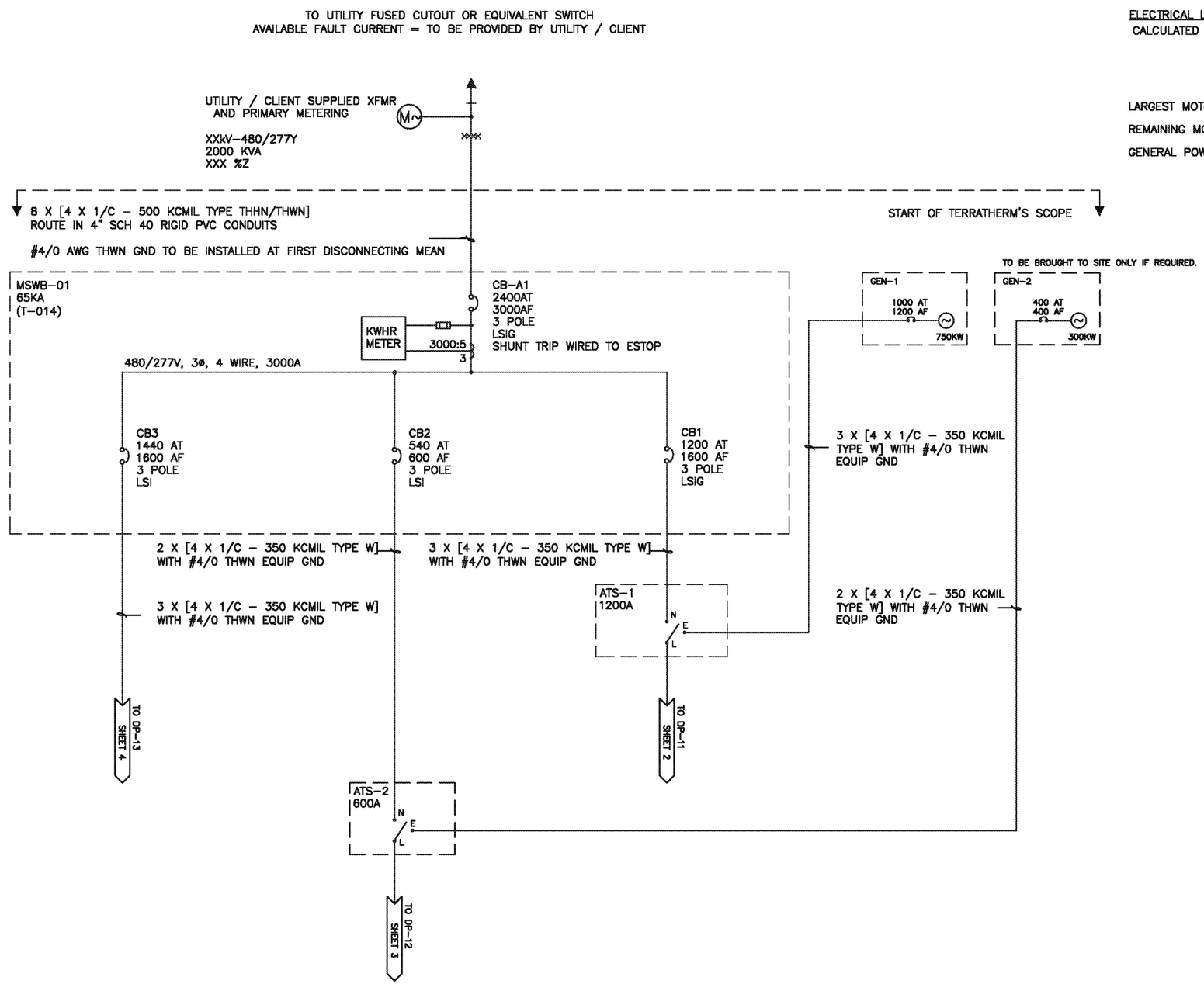

ELECTRICAL LOAD SUMMARY
CALCULATED PER NEC 430.24. ROUNDING PER NEC 220.5(B)

	CONNECTED LOAD		LOAD MULTIPLIER		DESIGN LOAD
LARGEST MOTOR LOAD (100A, NAPL COND. SYS.)	100 A	X	1.25	=	125 A
REMAINING MOTOR LOAD	1798 A	X	1.0	=	1798 A
GENERAL POWER (CONTINUOUS)	51 A	X	1.25	=	64 A
SUB–TOTAL LOAD				=	1987 A
10% CONTINGENCY ON LARGEST LOAD				=	87 A
TOTAL DESIGN LOAD				=	2073 A, 1724 KVA

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REVISIONS

REV	DATE	BY	CHK	ENG	DESCRIPTION		APPROVED
D	7/30/13	WL	SLW	WL	FOR ELECTRICAL CONTRACTOR SOW		
C	07/16/13	WL	SW	WL	WORKING COPY FOR RDRA WORKPLAN		
B	06/21/13	WL	SW	WL	PRELIMINARY FOR 90% DESIGN		
E	8/30/13	TJM	MM	WL	100% DESIGN SUBMITTAL	SM	

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ST012–FORMER WILLIAMS AIR FORCE BASE
MESA, ARIZONA
ELECTRICAL ONELINE

SIZE	FILE NO.	DWG NO.	REV
D	E101	E101	E

SCALE: AS SHOWN | DNS | SHEET 1 OF 6

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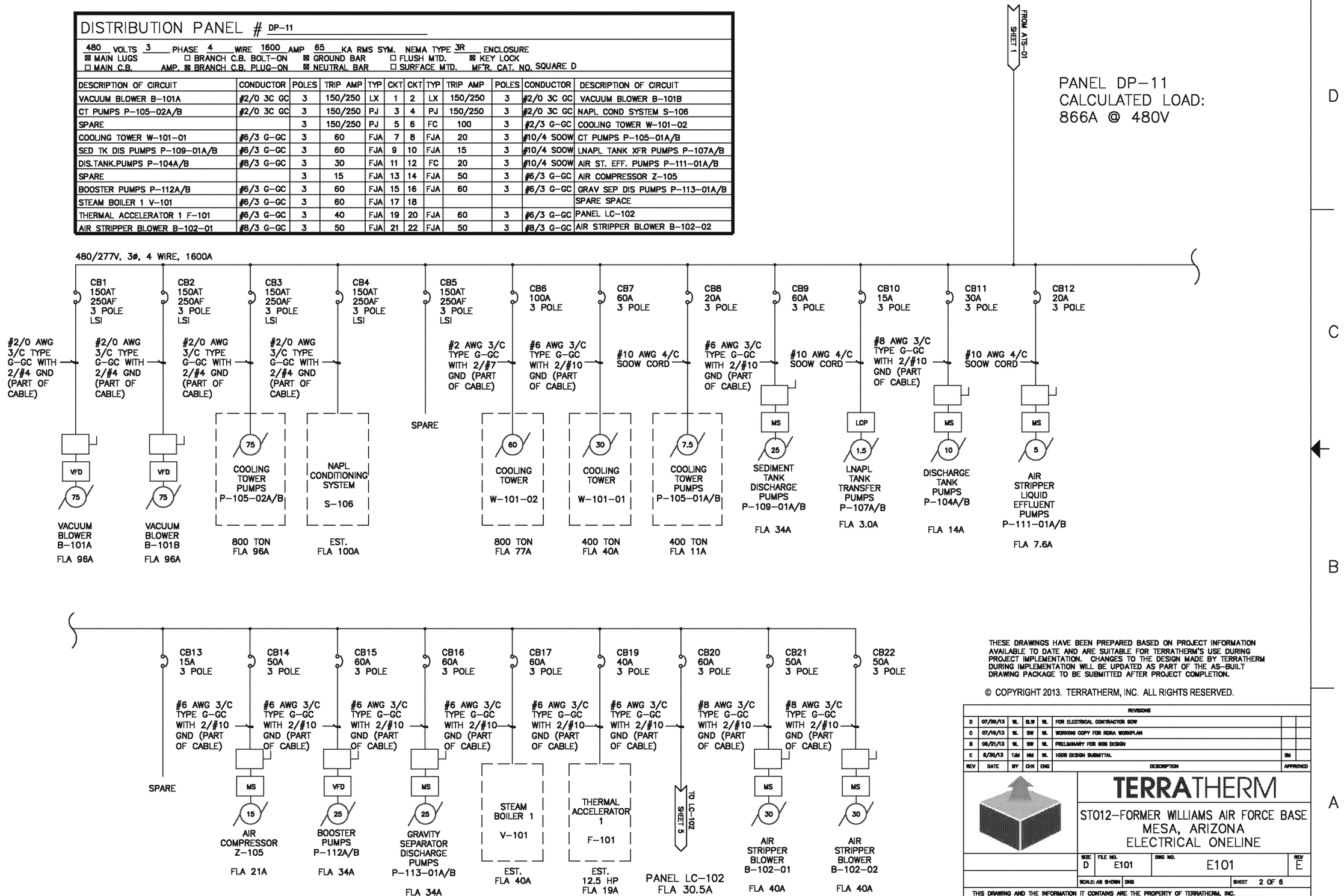
DISTRIBUTION PANEL # DP-11

480 VOLTS 3 PHASE 4 WIRE 1600 AMP 65 KA RMS SYM. NEMA TYPE 3R ENCLOSURE
☒ MAIN LUGS ☐ BRANCH C.B. BOLT-ON ☒ GROUND BAR ☐ FLUSH MTD. ☒ KEY LOCK
☐ MAIN C.B. AMP. ☒ BRANCH C.B. PLUG-ON ☒ NEUTRAL BAR ☐ SURFACE MTD. MF'R. CAT. NO. SQUARE D

DESCRIPTION OF CIRCUIT	CONDUCTOR	POLES	TRIP AMP	TYP	CKT	CKT	TYP	TRIP AMP	POLES	CONDUCTOR	DESCRIPTION OF CIRCUIT
VACUUM BLOWER B-101A	#2/0 3C GC	3	150/250	LX	1	2	LX	150/250	3	#2/0 3C GC	VACUUM BLOWER B-101B
CT PUMPS P-105-02A/B	#2/0 3C GC	3	150/250	PJ	3	4	PJ	150/250	3	#2/0 3C GC	NAPL COND SYSTEM S-106
SPARE		3	150/250	PJ	5	6	FC	100	3	#2/3 G-GC	COOLING TOWER W-101-02
COOLING TOWER W-101-01	#6/3 G-GC	3	60	FJA	7	8	FJA	20	3	#10/4 SOOW	CT PUMPS P-105-01A/B
SED TK DIS PUMPS P-109-01A/B	#6/3 G-GC	3	60	FJA	9	10	FJA	15	3	#10/4 SOOW	LNAPL TANK XFR PUMPS P-107A/B
DIS.TANK.PUMPS P-104A/B	#8/3 G-GC	3	30	FJA	11	12	FC	20	3	#10/4 SOOW	AIR ST. EFF. PUMPS P-111-01A/B
SPARE		3	15	FJA	13	14	FJA	50	3	#6/3 G-GC	AIR COMPRESSOR Z-105
BOOSTER PUMPS P-112A/B	#6/3 G-GC	3	60	FJA	15	16	FJA	60	3	#6/3 G-GC	GRAV SEP DIS PUMPS P-113-01A/B
STEAM BOILER 1 V-101	#6/3 G-GC	3	60	FJA	17	18					SPARE SPACE
THERMAL ACCELERATOR 1 F-101	#6/3 G-GC	3	40	FJA	19	20	FJA	60	3	#6/3 G-GC	PANEL LC-102
AIR STRIPPER BLOWER B-102-01	#8/3 G-GC	3	50	FJA	21	22	FJA	50	3	#8/3 G-GC	AIR STRIPPER BLOWER B-102-02



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REVISIONS

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D	07/29/13	WL	SLW	WL	FOR ELECTRICAL CONTRACTOR SOW	
C	07/16/13	WL	SW	WL	WORKING COPY FOR RDRA WORKPLAN	
B	06/21/13	WL	SW	WL	PRELIMINARY FOR 90% DESIGN	
E	8/30/13	TJM	NM	WL	100% DESIGN SUBMITTAL	SM

TERRATHERM

ST012-FORMER WILLIAMS AIR FORCE BASE
MESA, ARIZONA
ELECTRICAL ONELINE

SIZE D | FILE NO. E101 | DWG NO. E101 | REV E
SCALE: AS SHOWN | DNS | SHEET 2 OF 6

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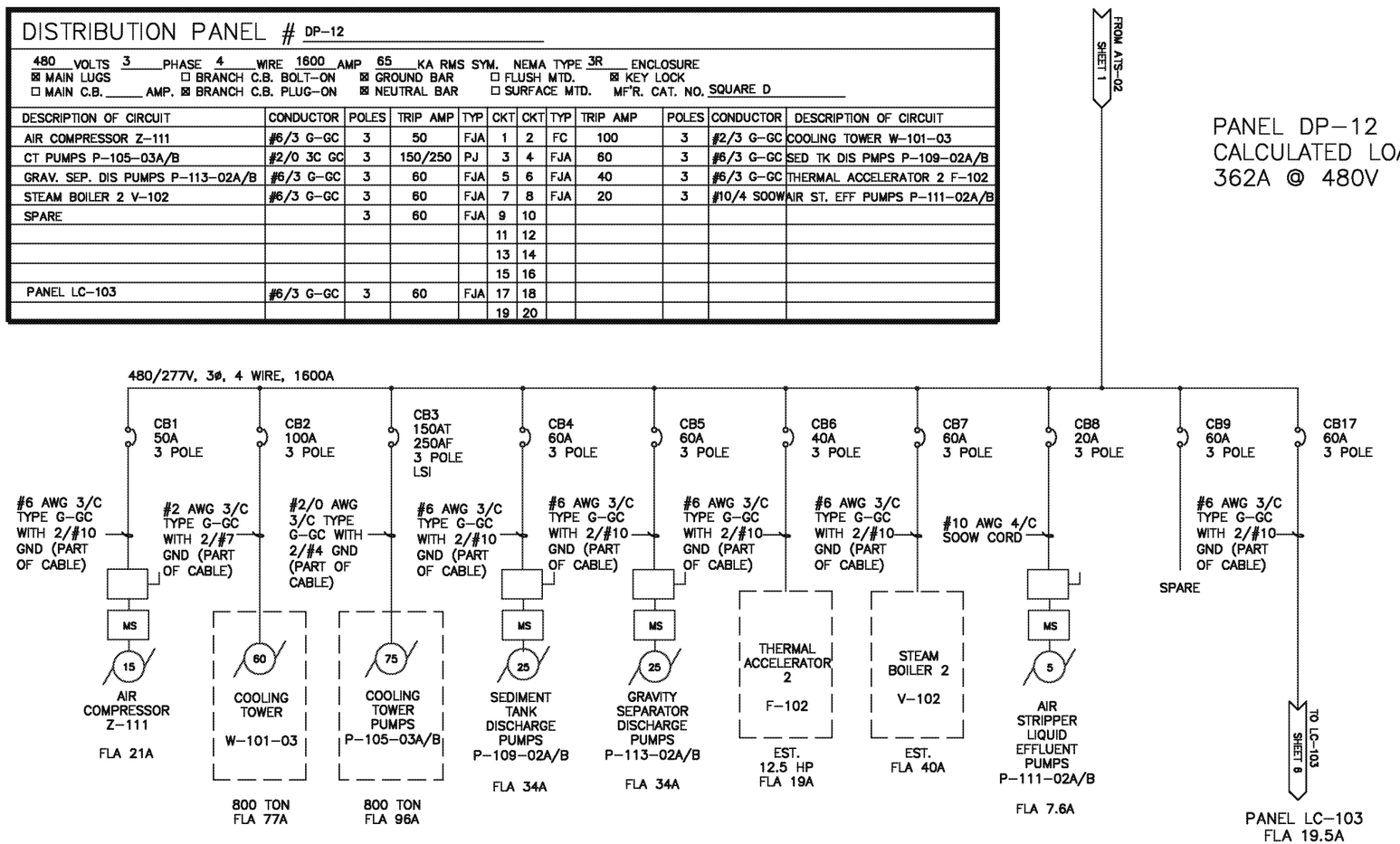
DISTRIBUTION PANEL # DP-12

480 VOLTS 3 PHASE 4 WIRE 1600 AMP 65 KA RMS SYM. NEMA TYPE 3R ENCLOSURE

☒ MAIN LUGS ☐ BRANCH C.B. BOLT-ON ☒ GROUND BAR ☐ FLUSH MTD. ☒ KEY LOCK

☐ MAIN C.B. _____ AMP. ☒ BRANCH C.B. PLUG-ON ☒ NEUTRAL BAR ☐ SURFACE MTD. MF'R. CAT. NO. SQUARE D

DESCRIPTION OF CIRCUIT	CONDUCTOR	POLES	TRIP AMP	TYP	CKT	CKT	TYP	TRIP AMP	POLES	CONDUCTOR	DESCRIPTION OF CIRCUIT
AIR COMPRESSOR Z-111	#6/3 G-GC	3	50	FJA	1	2	FC	100	3	#2/3 G-GC	COOLING TOWER W-101-03
CT PUMPS P-105-03A/B	#2/0 3C GC	3	150/250	PJ	3	4	FJA	60	3	#6/3 G-GC	SED TK DIS PMPS P-109-02A/B
GRAV. SEP. DIS PUMPS P-113-02A/B	#6/3 G-GC	3	60	FJA	5	6	FJA	40	3	#6/3 G-GC	THERMAL ACCELERATOR 2 F-102
STEAM BOILER 2 V-102	#6/3 G-GC	3	60	FJA	7	8	FJA	20	3	#10/4 SOOW	AIR ST. EFF PUMPS P-111-02A/B
SPARE		3	60	FJA	9	10					
					11	12					
					13	14					
					15	16					
PANEL LC-103	#6/3 G-GC	3	60	FJA	17	18					
					19	20					



PANEL DP-12
CALCULATED LOAD:
362A @ 480V

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TERRATHERM

ST012-FORMER WILLIAMS AIR FORCE BASE
MESA, ARIZONA
ELECTRICAL ONELINE

SIZE	FILE NO.	DWG NO.	REV
D	E101	E101	E

SCALE: AS SHOWN | DNS | SHEET 3 OF 6

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DISTRIBUTION PANEL # DP-13

480 VOLTS 3 PHASE 4 WIRE 1600 AMP 65 KA RMS SYM. NEMA TYPE 3R ENCLOSURE

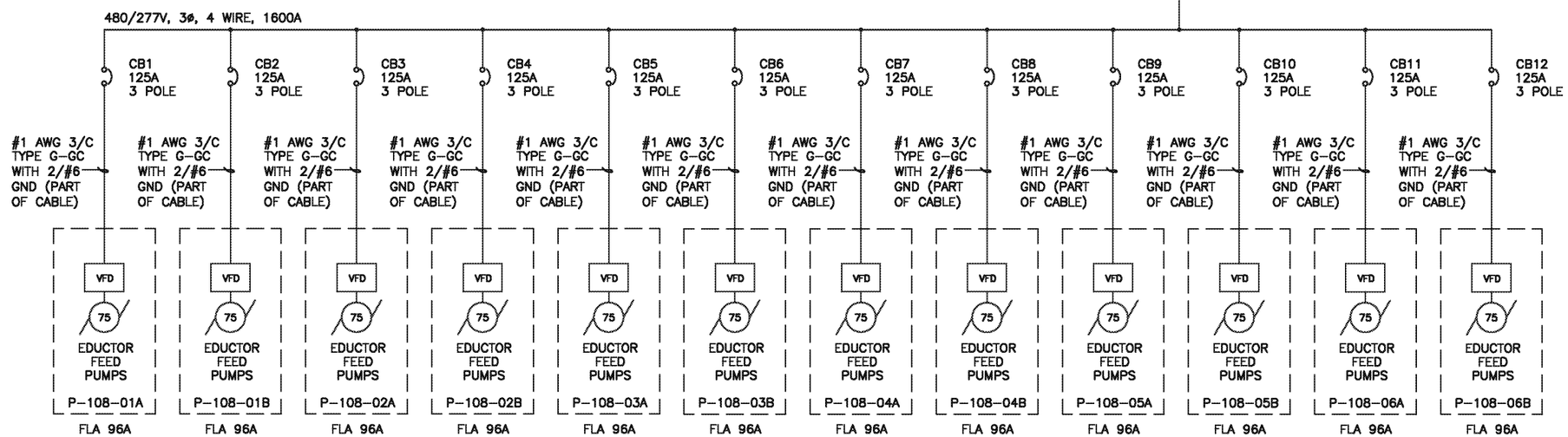
☒ MAIN LUGS ☐ BRANCH C.B. BOLT-ON ☒ GROUND BAR ☐ FLUSH MTD. ☒ KEY LOCK

☐ MAIN C.B. _____ AMP. ☒ BRANCH C.B. PLUG-ON ☒ NEUTRAL BAR ☐ SURFACE MTD. MF'R. CAT. NO. SQUARE D

DESCRIPTION OF CIRCUIT	CONDUCTOR	POLES	TRIP AMP	TYP	CKT	CKT	TYP	TRIP AMP	POLES	CONDUCTOR	DESCRIPTION OF CIRCUIT
ED. FEED PUMPS P108-01A	#1/3 G-GC	3	125	FJA	1	2	FJA	125	3	#1/3 G-GC	ED. FEED PUMPS P108-01B
ED. FEED PUMPS P108-02A	#1/3 G-GC	3	125	FJA	3	4	FJA	125	3	#1/3 G-GC	ED. FEED PUMPS P108-02B
ED. FEED PUMPS P108-03A	#1/3 G-GC	3	125	FJA	5	6	FJA	125	3	#1/3 G-GC	ED. FEED PUMPS P108-03B
ED. FEED PUMPS P108-04A	#1/3 G-GC	3	125	FJA	7	8	FJA	125	3	#1/3 G-GC	ED. FEED PUMPS P108-04B
ED. FEED PUMPS P108-05A	#1/3 G-GC	3	125	FJA	9	10	FJA	125	3	#1/3 G-GC	ED. FEED PUMPS P108-05B
ED. FEED PUMPS P108-06A	#1/3 G-GC	3	125	FJA	11	12	FJA	125	3	#1/3 G-GC	ED. FEED PUMPS P108-06B
					13	14					
					15	16					
					17	18					
					19	20					

FROM MSWB-01 CB-3 SHEET 1

PANEL DP-13
CALCULATED LOAD:
768A @ 480V



NOTE: THE EDUCTOR SYSTEMS' CONTROL CIRCUITRIES ARE INTERLOCKED SUCH THAT ONLY 8 PUMPS MAY RUN SIMULTANEOUSLY

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TERRATHERM

ST012-FORMER WILLIAMS AIR FORCE BASE
MESA, ARIZONA
ELECTRICAL ONELINE

SIZE	FILE NO.	DWG NO.	REV
D	E101	E101	E

SCALE: AS SHOWN | DNS | SHEET 4 OF 6

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PANEL LC-102

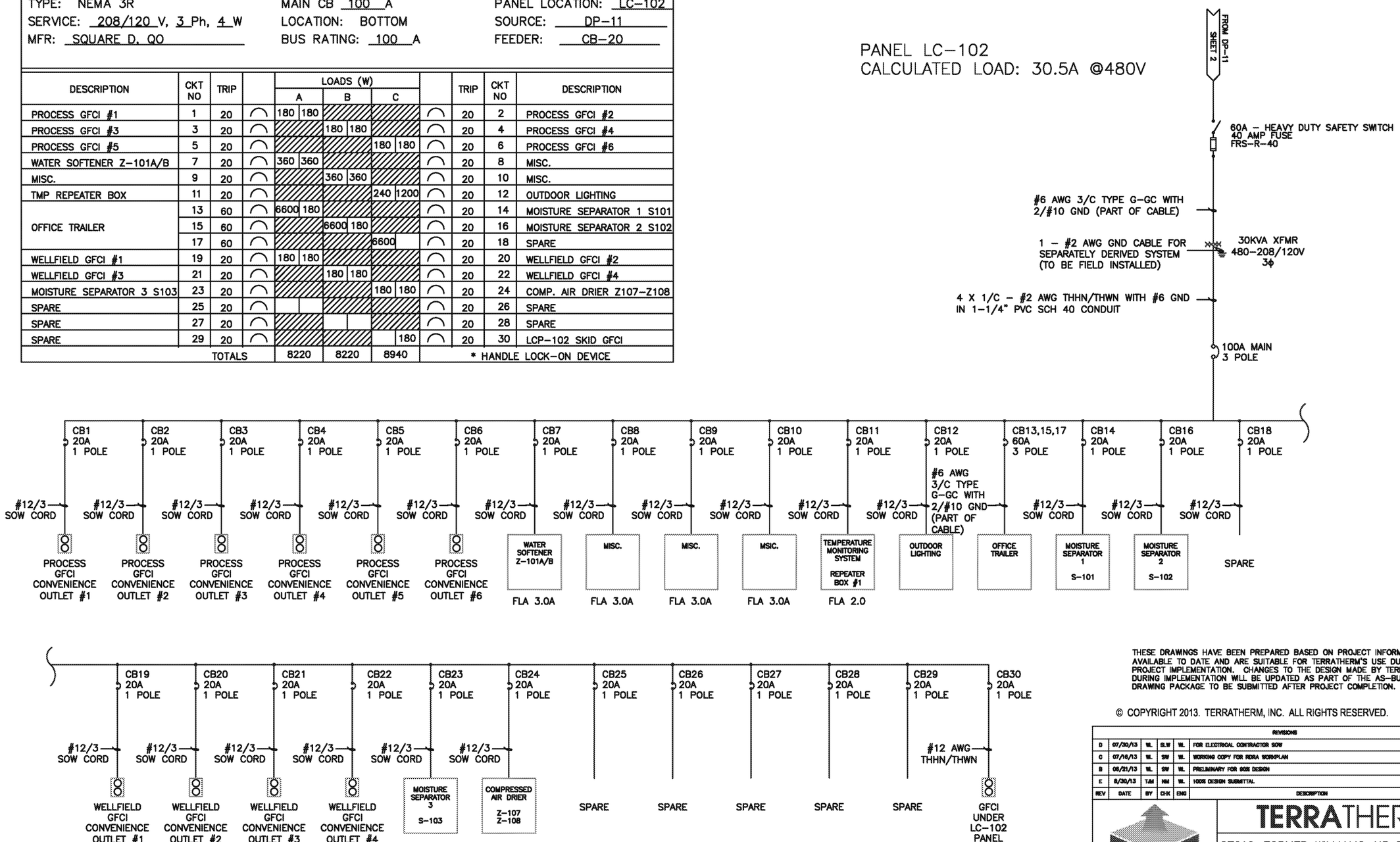
TYPE: NEMA 3R
SERVICE: 208/120 V, 3 Ph, 4 W
MFR: SQUARE D, QO

MAIN CB 100 A
LOCATION: BOTTOM
BUS RATING: 100 A

PANEL LOCATION: LC-102
SOURCE: DP-11
FEEDER: CB-20

DESCRIPTION	CKT NO	TRIP		LOADS (W) A		LOADS (W) B		LOADS (W) C			TRIP	CKT NO	DESCRIPTION
PROCESS GFCI #1	1	20		180	180						20	2	PROCESS GFCI #2
PROCESS GFCI #3	3	20				180	180				20	4	PROCESS GFCI #4
PROCESS GFCI #5	5	20						180	180		20	6	PROCESS GFCI #6
WATER SOFTENER Z-101A/B	7	20		360	360						20	8	MISC.
MISC.	9	20				360	360				20	10	MISC.
TMP REPEATER BOX	11	20						240	1200		20	12	OUTDOOR LIGHTING
OFFICE TRAILER	13	60		6600	180						20	14	MOISTURE SEPARATOR 1 S101
	15	60				6600	180				20	16	MOISTURE SEPARATOR 2 S102
	17	60						6600			20	18	SPARE
WELLFIELD GFCI #1	19	20		180	180						20	20	WELLFIELD GFCI #2
WELLFIELD GFCI #3	21	20				180	180				20	22	WELLFIELD GFCI #4
MOISTURE SEPARATOR 3 S103	23	20						180	180		20	24	COMP. AIR DRIER Z107-Z108
SPARE	25	20									20	26	SPARE
SPARE	27	20									20	28	SPARE
SPARE	29	20								180	20	30	LCP-102 SKID GFCI
TOTALS				8220		8220		8940			* HANDLE LOCK-ON DEVICE		

PANEL LC-102
CALCULATED LOAD: 30.5A @480V



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REVISIONS

REV	DATE	BY	CHK	ENG	DESCRIPTION		APPROVED
D	07/30/13	WL	SLW	WL	FOR ELECTRICAL CONTRACTOR SOW		
C	07/16/13	WL	SW	WL	WORKING COPY FOR RDRA WORKPLAN		
B	06/21/13	WL	SW	WL	PRELIMINARY FOR 90% DESIGN		
E	8/30/13	TJM	MM	WL	100% DESIGN SUBMITTAL	SM	

TERRATHERM

ST012-FORMER WILLIAMS AIR FORCE BASE
MESA, ARIZONA
ELECTRICAL ONELINE

SIZE	FILE NO.	DWG NO.	REV
D	E101	E101	E

SCALE: AS SHOWN | DNS | SHEET 5 OF 6

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PANEL LC–103

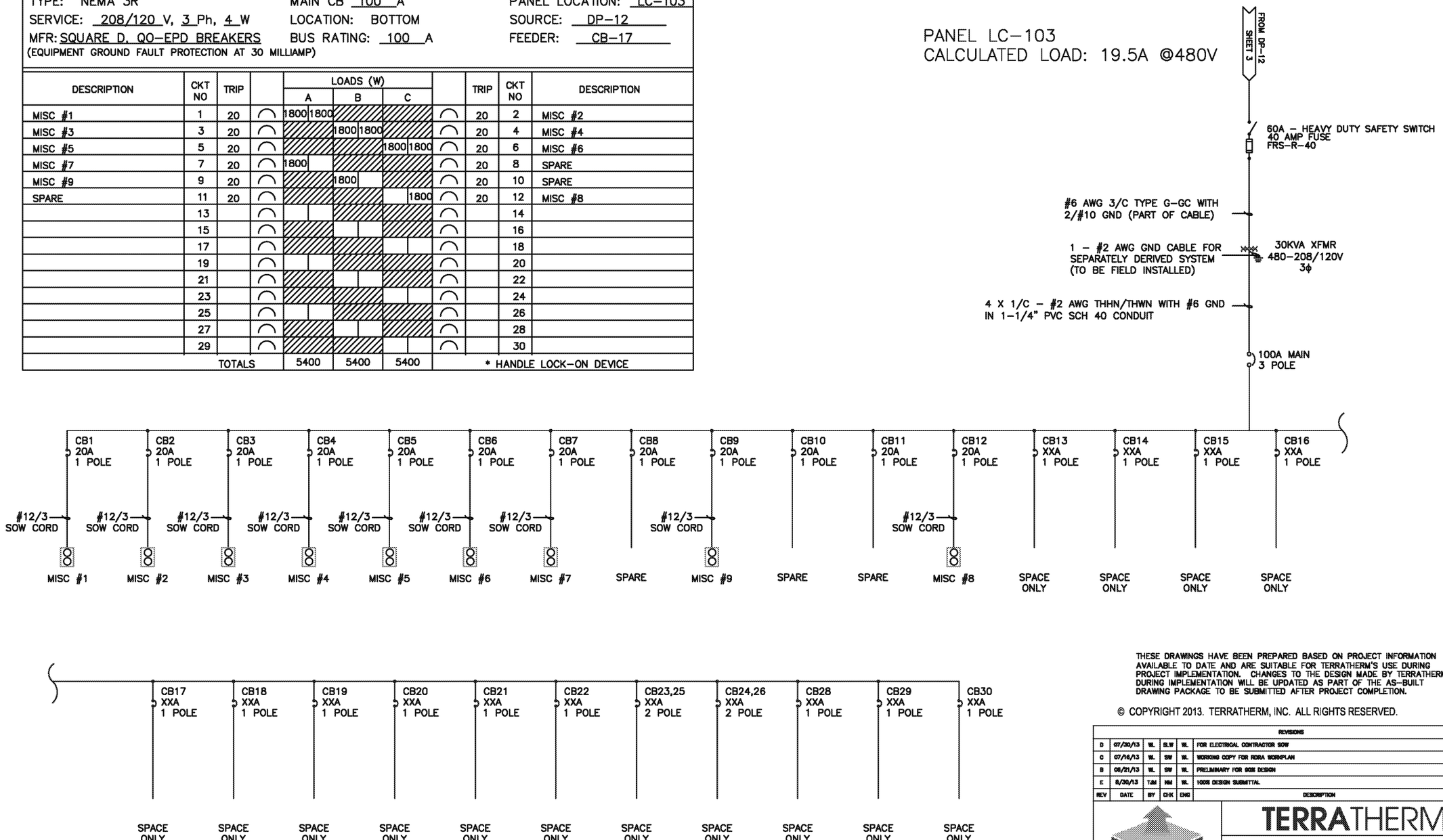
TYPE: NEMA 3R
SERVICE: 208/120 V, 3 Ph, 4 W
MFR: SQUARE D, QO–EPD BREAKERS
(EQUIPMENT GROUND FAULT PROTECTION AT 30 MILLIAMP)

MAIN CB 100 A
LOCATION: BOTTOM
BUS RATING: 100 A

PANEL LOCATION: LC–103
SOURCE: DP–12
FEEDER: CB–17

DESCRIPTION	CKT NO	TRIP		LOADS (W) A	LOADS (W) B	LOADS (W) C		TRIP	CKT NO	DESCRIPTION
MISC #1	1	20		1800	1800			20	2	MISC #2
MISC #3	3	20			1800	1800		20	4	MISC #4
MISC #5	5	20				1800	1800	20	6	MISC #6
MISC #7	7	20		1800				20	8	SPARE
MISC #9	9	20			1800			20	10	SPARE
SPARE	11	20					1800	20	12	MISC #8
	13								14	
	15								16	
	17								18	
	19								20	
	21								22	
	23								24	
	25								26	
	27								28	
	29								30	
TOTALS				5400	5400	5400		* HANDLE LOCK–ON DEVICE		

PANEL LC–103
CALCULATED LOAD: 19.5A @480V



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REVISIONS

REV	DATE	BY	CHK	ENG	DESCRIPTION		APPROVED
D	07/30/13	WL	SLW	WL	FOR ELECTRICAL CONTRACTOR SOW		
C	07/16/13	WL	SW	WL	WORKING COPY FOR RDRA WORKPLAN		
B	06/21/13	WL	SW	WL	PRELIMINARY FOR 90% DESIGN		
E	8/30/13	TJM	NM	WL	100% DESIGN SUBMITTAL	SM	

TERRATHERM

ST012–FORMER WILLIAMS AIR FORCE BASE
MESA, ARIZONA
ELECTRICAL ONELINE

SIZE	FILE NO.	DWG NO.	REV
D	E101	E101	E

SCALE: AS SHOWN | DNS | SHEET 6 OF 6

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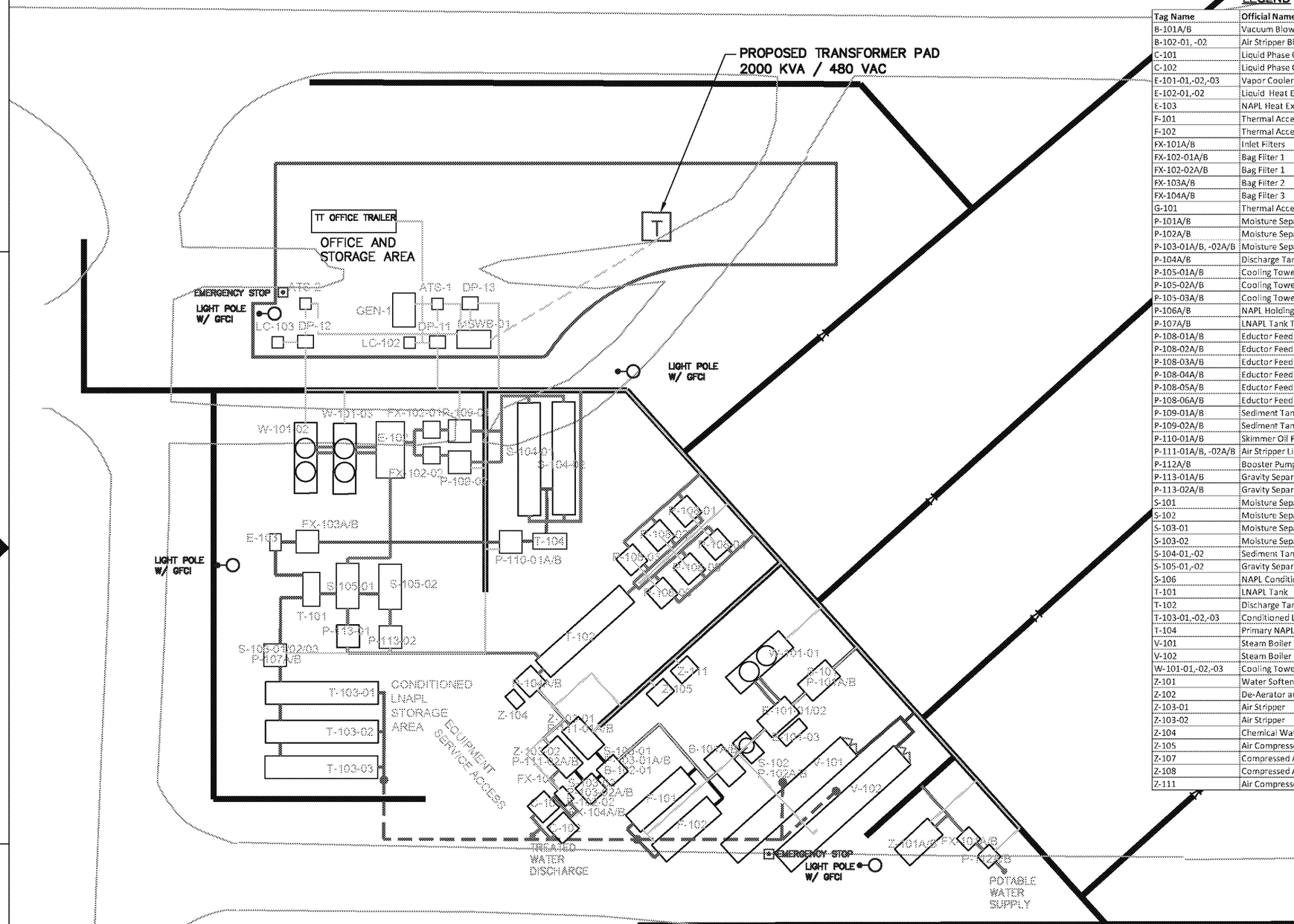

LEGEND

Tag Name	Official Name
B-101A/B	Vacuum Blower
B-102-01, -02	Air Stripper Blower
C-101	Liquid Phase Carbon Vessel 1
C-102	Liquid Phase Carbon Vessel 2
E-101-01,-02,-03	Vapor Cooler
E-102-01,-02	Liquid Heat Exchanger
E-103	NAPL Heat Exchanger
F-101	Thermal Accelerator 1
F-102	Thermal Accelerator 2
FX-101A/B	Inlet Filters
FX-102-01A/B	Bag Filter 1
FX-102-02A/B	Bag Filter 1
FX-103A/B	Bag Filter 2
FX-104A/B	Bag Filter 3
G-101	Thermal Accelerator Burner
P-101A/B	Moisture Separator 1 Pumps
P-102A/B	Moisture Separator 2 Pumps
P-103-01A/B, -02A/B	Moisture Separator 3 Pumps
P-104A/B	Discharge Tank Pumps
P-105-01A/B	Cooling Tower Pumps
P-105-02A/B	Cooling Tower Pumps
P-105-03A/B	Cooling Tower Pumps
P-106A/B	NAPL Holding Tanks Pumps
P-107A/B	LNAPL Tank Transfer Pumps
P-108-01A/B	Eductor Feed Pumps
P-108-02A/B	Eductor Feed Pumps
P-108-03A/B	Eductor Feed Pumps
P-108-04A/B	Eductor Feed Pumps
P-108-05A/B	Eductor Feed Pumps
P-108-06A/B	Eductor Feed Pumps
P-109-01A/B	Sediment Tank Discharge Pumps
P-109-02A/B	Sediment Tank Discharge Pumps
P-110-01A/B	Skimmer Oil Pumps
P-111-01A/B, -02A/B	Air Stripper Liquid Effluent Pumps
P-112A/B	Booster Pumps
P-113-01A/B	Gravity Separator Discharge Pumps
P-113-02A/B	Gravity Separator Discharge Pumps
S-101	Moisture Separator 1
S-102	Moisture Separator 2
S-103-01	Moisture Separator 3
S-103-02	Moisture Separator 3
S-104-01,-02	Sediment Tank W/Oil Skimmer
S-105-01,-02	Gravity Separator
S-106	NAPL Conditioning System
T-101	LNAPL Tank
T-102	Discharge Tank
T-103-01,-02,-03	Conditioned LNAPL Tank
T-104	Primary NAPL Recovery Tank
V-101	Steam Boiler 1
V-102	Steam Boiler 2
W-101-01,-02,-03	Cooling Tower
Z-101	Water Softener
Z-102	De-Aerator and Softener
Z-103-01	Air Stripper
Z-103-02	Air Stripper
Z-104	Chemical Water Treatment
Z-105	Air Compressor
Z-107	Compressed Air Drier
Z-108	Compressed Air Drier
Z-111	Air Compressor

PROPOSED ELECTRICAL POWER CABLE ROUTING

PRIMARY WELLFIELD PIPING

TREATMENT EQUIPMENT VAPOR PIPING

TREATMENT EQUIPMENT LIQUID PIPING

TREATMENT EQUIPMENT STEAM PIPING

TREATMENT EQUIPMENT LNAPL PIPING

BURIED LNAPL PIPING

N

APPROX. SCALE

0 20 40 60 80 FT

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NOTES:
ALL CABLES EXPOSED TO PEDESTRIAN OR VEHICULAR TRAFFIC SHALL BE PROTECTED WITH PROPER CABLE PROTECTION.

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REVISIONS

REV	DATE	BY	CHK	ENG	DESCRIPTION	APPROVED
B	09/30/13	DC	NM	WL	100% DESIGN SUBMITTAL	SM
A	07/22/13	DC		WL	PRELIMINARY	

TERRATHERM

ST012–FORMER WILLIAMS AIR FORCE BASE
MESA, ARIZONA
ELECTRICAL LAYOUT

SIZE	FILE NO.	DWG NO.	REV
D	E102	E102	B

SCALE: AS SHOWN | DNS | SHEET 1 OF 1

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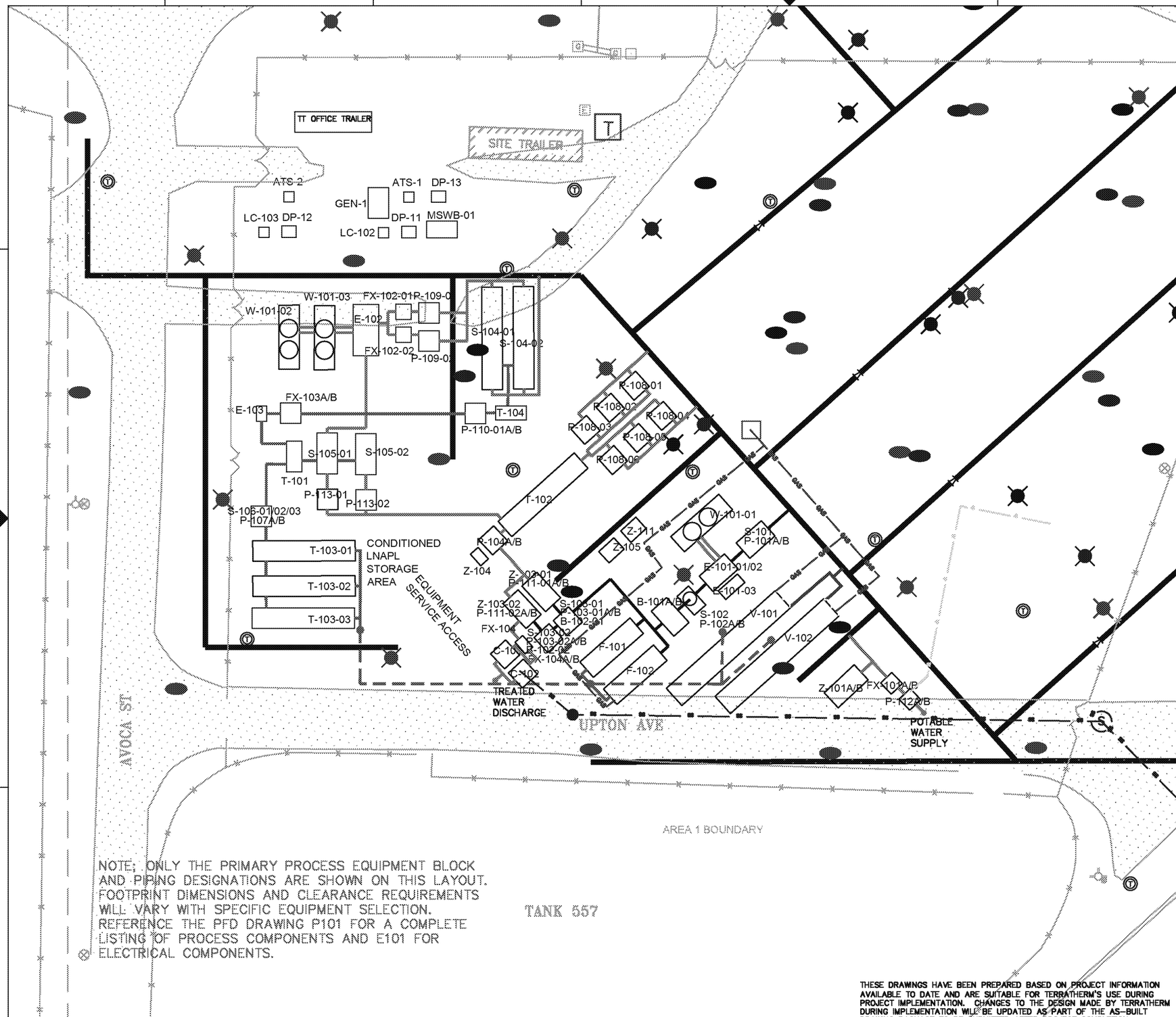

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NOTE; ONLY THE PRIMARY PROCESS EQUIPMENT BLOCK AND PIPING DESIGNATIONS ARE SHOWN ON THIS LAYOUT. FOOTPRINT DIMENSIONS AND CLEARANCE REQUIREMENTS WILL VARY WITH SPECIFIC EQUIPMENT SELECTION. REFERENCE THE PFD DRAWING P101 FOR A COMPLETE LISTING OF PROCESS COMPONENTS AND E101 FOR ELECTRICAL COMPONENTS.

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REVISIONS

REV	DATE	BY	CHK	ENG	DESCRIPTION	APPROVED
F	12/20/13	DC	DB	DM	REMOVED SECONDARY CONTAINMENT	
E	10/01/13	DC	DB	SG	UPDATED PER COMMENTS	

TERRATHERM

ST012–FORMER WILLIAMS AIR FORCE BASE
MESA, ARIZONA
MECHANICAL EQUIPMENT LAYOUT

SIZE	FILE NO.	DWG NO.	REV
D	M101	M101	F

SCALE: DNS SHEET 1 OF 1

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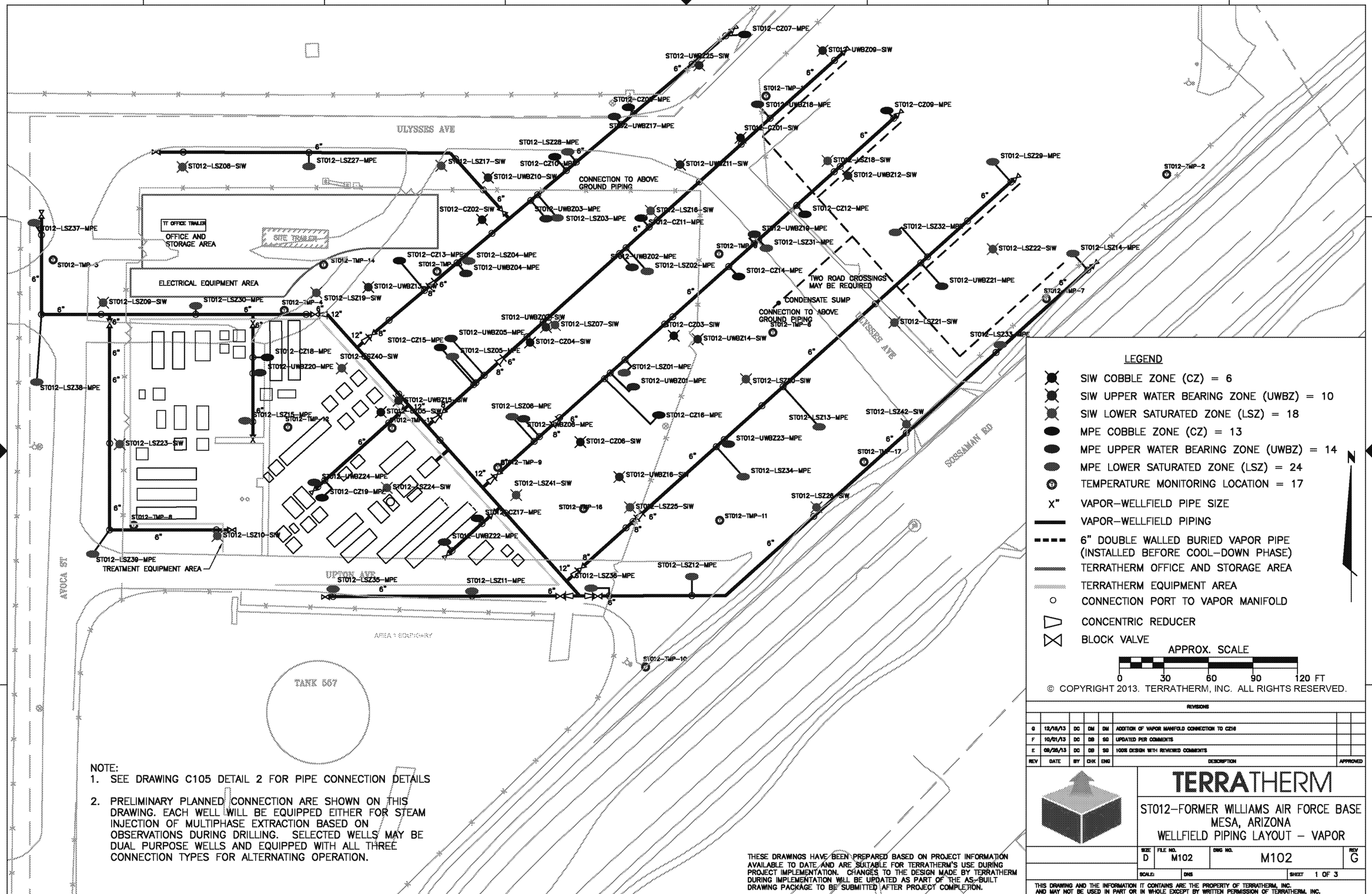

NOTE:
1. SEE DRAWING C105 DETAIL 2 FOR PIPE CONNECTION DETAILS
2. PRELIMINARY PLANNED CONNECTION ARE SHOWN ON THIS DRAWING. EACH WELL WILL BE EQUIPPED EITHER FOR STEAM INJECTION OF MULTIPHASE EXTRACTION BASED ON OBSERVATIONS DURING DRILLING. SELECTED WELLS MAY BE DUAL PURPOSE WELLS AND EQUIPPED WITH ALL THREE CONNECTION TYPES FOR ALTERNATING OPERATION.

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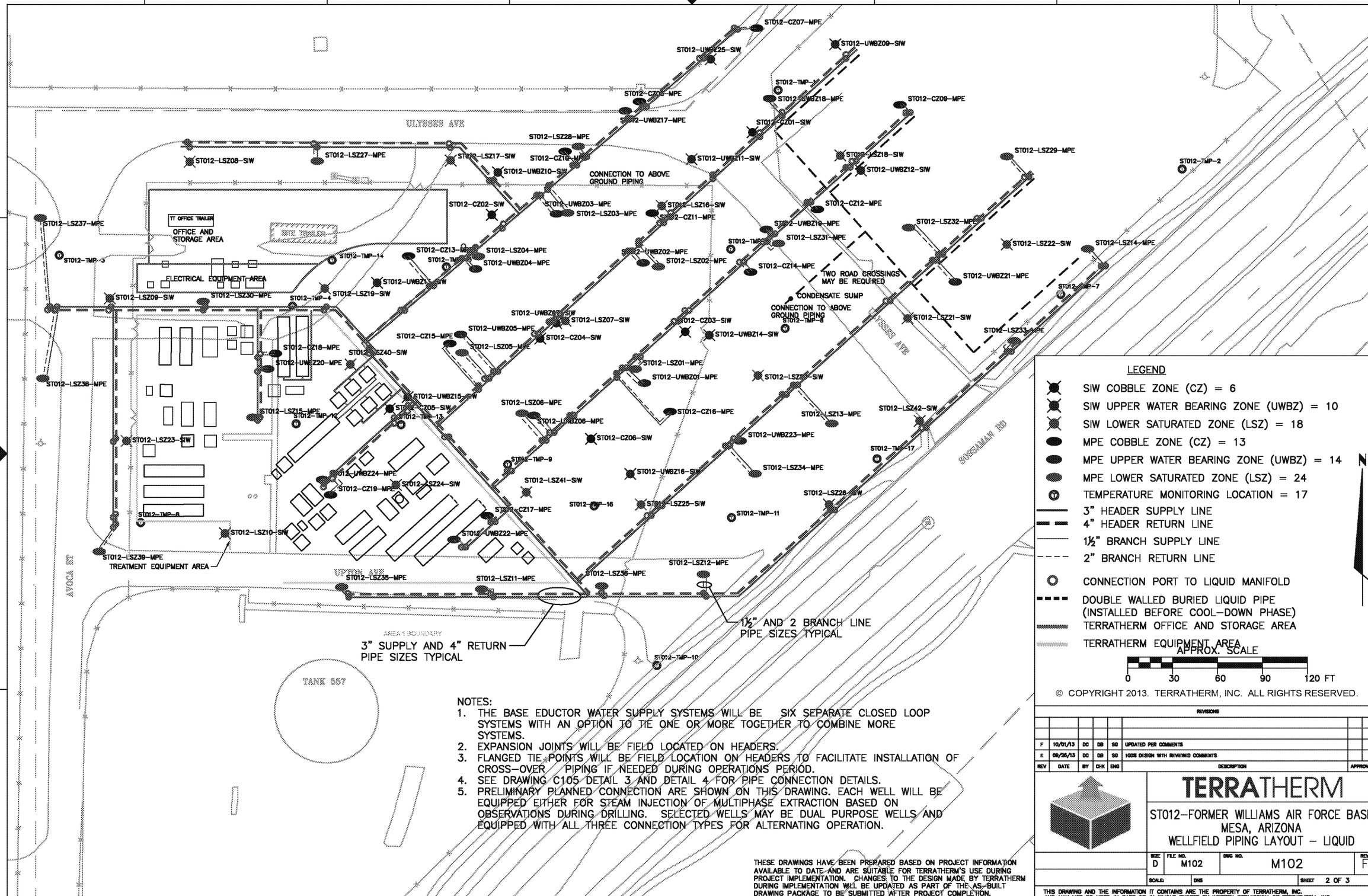

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NOTES:

1. THE BASE EDUCTOR WATER SUPPLY SYSTEMS WILL BE SIX SEPARATE CLOSED LOOP SYSTEMS WITH AN OPTION TO TIE ONE OR MORE TOGETHER TO COMBINE MORE SYSTEMS.
2. EXPANSION JOINTS WILL BE FIELD LOCATED ON HEADERS.
3. FLANGED TIE POINTS WILL BE FIELD LOCATION ON HEADERS TO FACILITATE INSTALLATION OF CROSS-OVER PIPING IF NEEDED DURING OPERATIONS PERIOD.
4. SEE DRAWING C105 DETAIL 3 AND DETAIL 4 FOR PIPE CONNECTION DETAILS.
5. PRELIMINARY PLANNED CONNECTION ARE SHOWN ON THIS DRAWING. EACH WELL WILL BE EQUIPPED EITHER FOR STEAM INJECTION OF MULTIPHASE EXTRACTION BASED ON OBSERVATIONS DURING DRILLING. SELECTED WELLS MAY BE DUAL PURPOSE WELLS AND EQUIPPED WITH ALL THREE CONNECTION TYPES FOR ALTERNATING OPERATION.

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REVISIONS

REV	DATE	BY	CHK	ENG	DESCRIPTION	APPROVED
F	10/01/13	DC	DB	SG	UPDATED PER COMMENTS	
E	09/25/13	DC	DB	SG	100% DESIGN WITH REVIEWED COMMENTS	

TERRATHERM

ST012-FORMER WILLIAMS AIR FORCE BASE
MESA, ARIZONA
WELLFIELD PIPING LAYOUT – LIQUID

SIZE	FILE NO.	DWG NO.	REV
D	M102	M102	F

SCALE: DNS SHEET 2 OF 3

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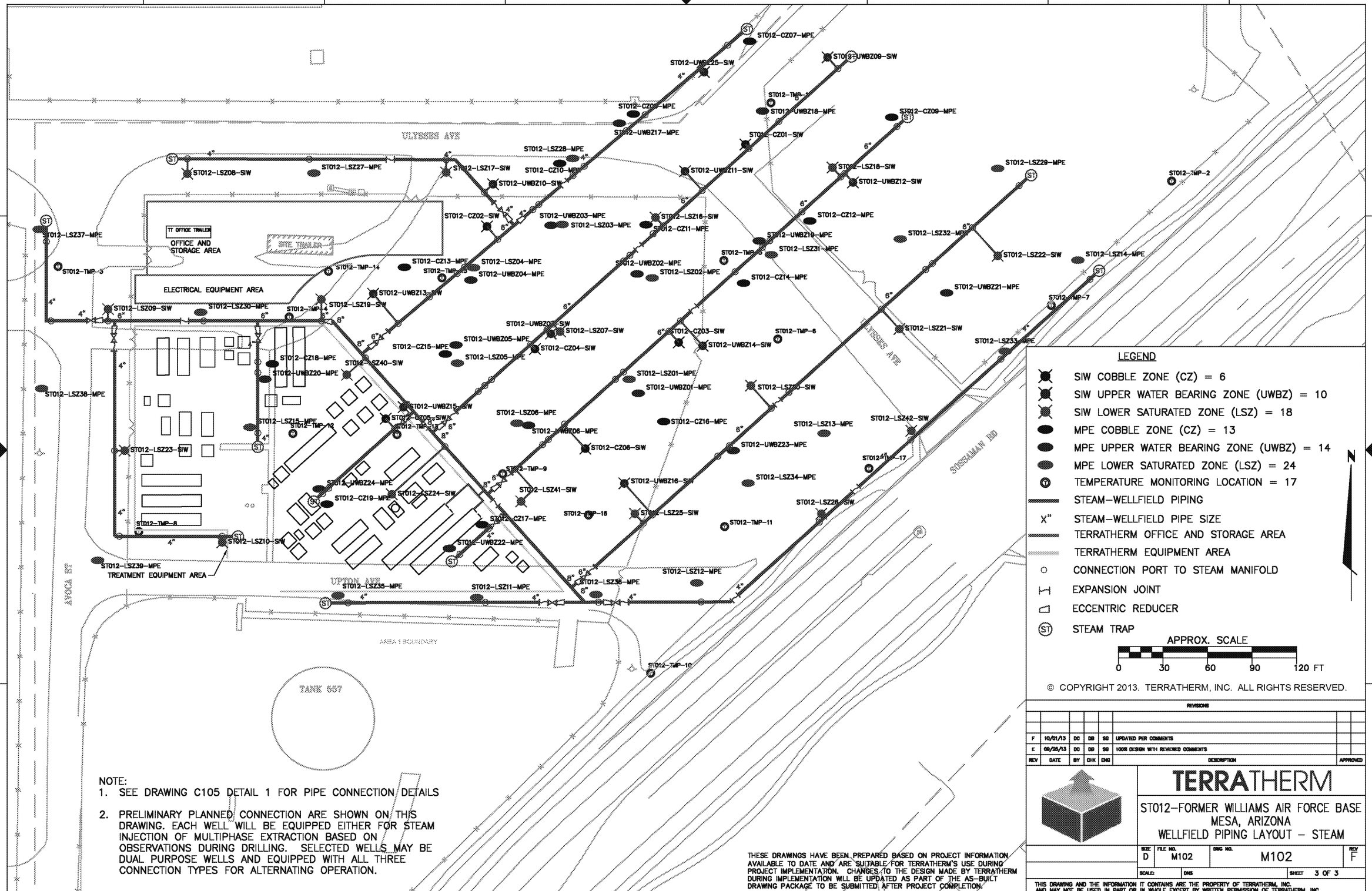

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NOTE:
1. SEE DRAWING C105 DETAIL 1 FOR PIPE CONNECTION DETAILS
2. PRELIMINARY PLANNED CONNECTION ARE SHOWN ON THIS DRAWING. EACH WELL WILL BE EQUIPPED EITHER FOR STEAM INJECTION OF MULTIPHASE EXTRACTION BASED ON OBSERVATIONS DURING DRILLING. SELECTED WELLS MAY BE DUAL PURPOSE WELLS AND EQUIPPED WITH ALL THREE CONNECTION TYPES FOR ALTERNATING OPERATION.

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REVISIONS

REV	DATE	BY	CHK	ENG	DESCRIPTION	APPROVED
F	10/01/13	DC	DB	SG	UPDATED PER COMMENTS	
E	09/25/13	DC	DB	SG	100% DESIGN WITH REVIEWED COMMENTS	

TERRATHERM

ST012-FORMER WILLIAMS AIR FORCE BASE
MESA, ARIZONA
WELLFIELD PIPING LAYOUT - STEAM

SIZE	FILE NO.	DWG NO.	REV
D	M102	M102	F

SCALE: DNS SHEET 3 OF 3

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NATURAL GAS B/L
WATER B/L
P-112A/B
FX-101A/B
Z-101A/B
V-101
V-102
COMBUSTION AIR IN B/L
CONDITIONED LNAPL TANK (T-103-01,-02,-03) P101 - SHEET 2
FROM MOISTURE SEPARATOR 3 (S-103-01,-02) P101 - SHEET 2
FROM COOLING TOWER (W-101-01,-02,-03) P101 - SHEET 2
TO COOLING TOWERS (W-101-01,-02,-03) P101 - SHEET 2
TO ATMOSPHERE B/L
TO ATMOSPHERE B/L
TO ATMOSPHERE B/L
F-101
F-102
BLOWDOWN TO DISCHARGE P101 - SHEET 2
B-101A/B
E-101-01
E-101-02
E-101-03
S-101
S-102
P-101A/B
P-102A/B
TO COOLING TOWERS (W-101-01,-02,-03) P101 - SHEET 2
TO SEDIMENT TANK WITH OIL SKIMMER (S-104-01,-02) P101 - SHEET 2
TO SEDIMENT TANK WITH OIL SKIMMER (S-104-01,-02) P101 - SHEET 2
TO SEDIMENT TANK WITH OIL SKIMMER (S-104-01,-02) P101 - SHEET 2
STEAM INJECTION WELL (34 TOTAL)
MULTI-PHASE EXTRACTION WELL (51 TOTAL)
FROM EDUCTOR FEED PUMPS (P-108-01A/B thru P108-06A/B) P102 - SHEET 2

B-101A/B	VACUUM BLOWER
E-101-01,-02,-03	VAPOR COOLER
F-101	THERMAL ACCELERATOR 1
F-102	THERMAL ACCELERATOR 2
FX-101A/B	INLET FILTER
P-101A/B	MOISTURE SEPARATOR 1 PUMPS
P-102A/B	MOISTURE SEPARATOR 2 PUMPS
P-112A/B	BOOSTER PUMPS
S-101	MOISTURE SEPARATOR 1
S-102	MOISTURE SEPARATOR 2
V-101	STEAM BOILER PACKAGE 1
V-102	STEAM BOILER PACKAGE 2
Z-101A/B	WATER SOFTENER

LEGEND

- VAPOR STREAM
- LIQUID STREAM
- S STEAM STREAM
- (X) STREAM NUMBER
- B/L BATTERY LIMITS

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REVISIONS

REV	DATE	BY	CHK	ENG	DESCRIPTION	APPROVED
D	08/30/13	DC	SR	SG	100% DESIGN SUBMITTAL	SM
C	07/16/13	TJM	SR	SM	WORKING COPY FOR RDRA WORKPLAN	
B	06/21/13	DC	SR	SG	PRELIMINARY FOR 90% DESIGN	
A	05/03/13	DC	SR	SM	PRELIMINARY FOR 60% DESIGN	

TERRATHERM

ST012-FORMER WILLIAMS AIR FORCE BASE
MESA, ARIZONA
PROCESS FLOW DIAGRAM

SIZE	FILE NO.	DWG NO.	REV
D	P101	P101	D

SCALE: NTS DNS SHEET 1 OF 3

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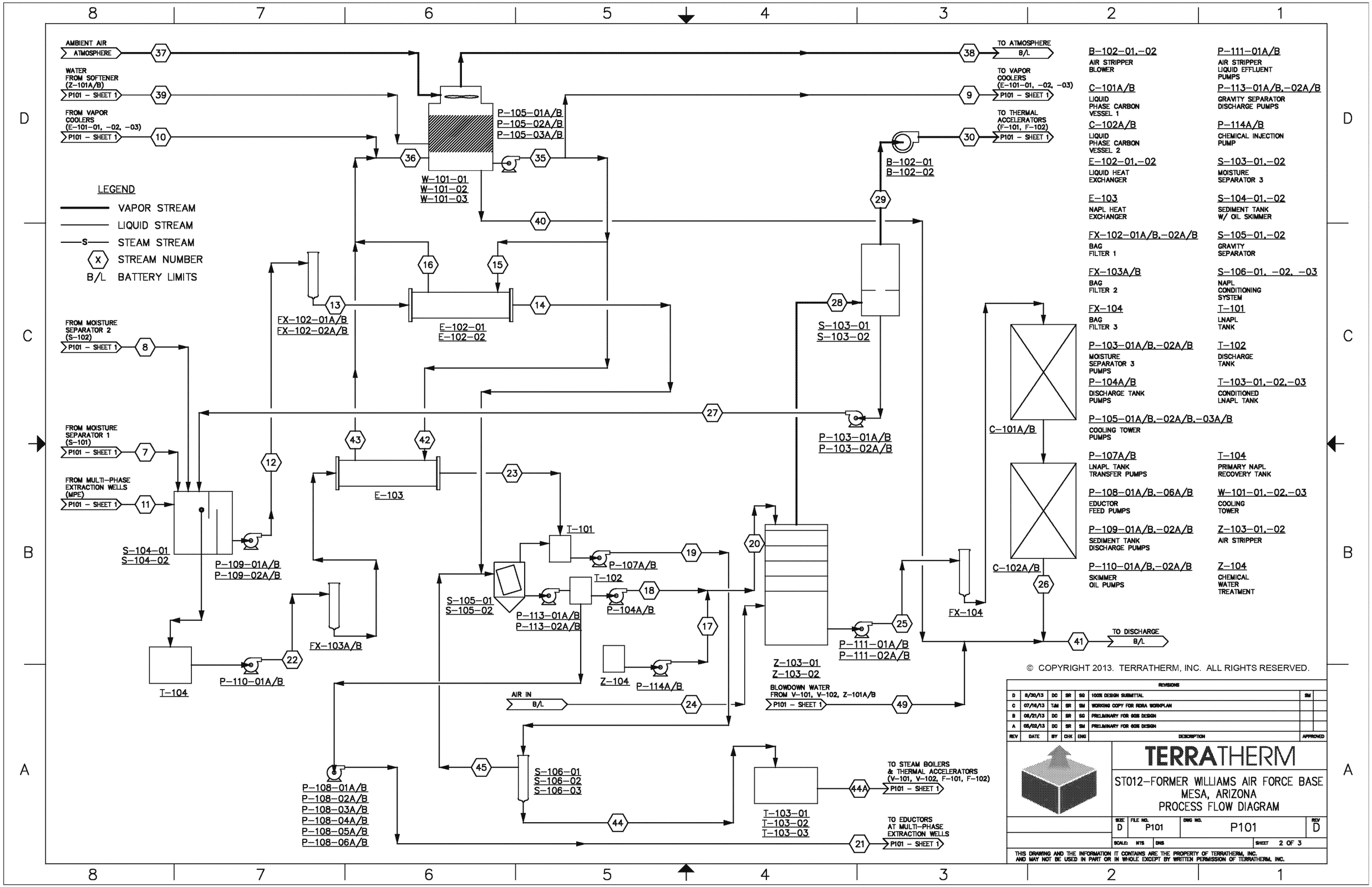
AMBIENT AIR
ATMOSPHERE
37
WATER FROM SOFTENER (Z-101A/B)
P101 – SHEET 1
39
FROM VAPOR COOLERS (E-101-01, -02, -03)
P101 – SHEET 1
10
TO ATMOSPHERE
B/L
38
TO VAPOR COOLERS (E-101-01, -02, -03)
P101 – SHEET 1
9
TO THERMAL ACCELERATORS (F-101, F-102)
P101 – SHEET 1
30
P-105-01A/B
P-105-02A/B
P-105-03A/B
36
35
W-101-01
W-101-02
W-101-03
B-102-01
B-102-02
29
40
LEGEND
VAPOR STREAM
LIQUID STREAM
STEAM STREAM
STREAM NUMBER
B/L BATTERY LIMITS
16
15
13
14
FX-102-01A/B
FX-102-02A/B
E-102-01
E-102-02
28
S-103-01
S-103-02
FROM MOISTURE SEPARATOR 2 (S-102)
P101 – SHEET 1
8
27
P-103-01A/B
P-103-02A/B
C-101A/B
FROM MOISTURE SEPARATOR 1 (S-101)
P101 – SHEET 1
7
43
42
12
23
E-103
FROM MULTI-PHASE EXTRACTION WELLS (MPE)
P101 – SHEET 1
11
S-104-01
S-104-02
P-109-01A/B
P-109-02A/B
T-101
20
19
P-107A/B
T-102
S-105-01
S-105-02
P-113-01A/B
P-113-02A/B
18
P-104A/B
17
C-102A/B
26
FX-104
25
P-111-01A/B
P-111-02A/B
41
TO DISCHARGE
B/L
FX-103A/B
22
P-110-01A/B
T-104
Z-104
P-114A/B
Z-103-01
Z-103-02
AIR IN
B/L
24
BLOWDOWN WATER FROM V-101, V-102, Z-101A/B
P101 – SHEET 1
49
45
S-106-01
S-106-02
S-106-03
P-108-01A/B
P-108-02A/B
P-108-03A/B
P-108-04A/B
P-108-05A/B
P-108-06A/B
44
T-103-01
T-103-02
T-103-03
44A
TO STEAM BOILERS & THERMAL ACCELERATORS (V-101, V-102, F-101, F-102)
P101 – SHEET 1
21
TO EDUCTORS AT MULTI-PHASE EXTRACTION WELLS
P101 – SHEET 1
B-102-01,-02
AIR STRIPPER BLOWER
C-101A/B
LIQUID PHASE CARBON VESSEL 1
C-102A/B
LIQUID PHASE CARBON VESSEL 2
E-102-01,-02
LIQUID HEAT EXCHANGER
E-103
NAPL HEAT EXCHANGER
FX-102-01A/B,-02A/B
BAG FILTER 1
FX-103A/B
BAG FILTER 2
FX-104
BAG FILTER 3
P-103-01A/B,-02A/B
MOISTURE SEPARATOR 3 PUMPS
P-104A/B
DISCHARGE TANK PUMPS
P-105-01A/B,-02A/B,-03A/B
COOLING TOWER PUMPS
P-107A/B
LNAPL TANK TRANSFER PUMPS
P-108-01A/B,-06A/B
EDUCTOR FEED PUMPS
P-109-01A/B,-02A/B
SEDIMENT TANK DISCHARGE PUMPS
P-110-01A/B,-02A/B
SKIMMER OIL PUMPS
P-111-01A/B
AIR STRIPPER LIQUID EFFLUENT PUMPS
P-113-01A/B,-02A/B
GRAVITY SEPARATOR DISCHARGE PUMPS
P-114A/B
CHEMICAL INJECTION PUMP
S-103-01,-02
MOISTURE SEPARATOR 3
S-104-01,-02
SEDIMENT TANK W/ OIL SKIMMER
S-105-01,-02
GRAVITY SEPARATOR
S-106-01, -02, -03
NAPL CONDITIONING SYSTEM
T-101
LNAPL TANK
T-102
DISCHARGE TANK
T-103-01,-02,-03
CONDITIONED LNAPL TANK
T-104
PRIMARY NAPL RECOVERY TANK
W-101-01,-02,-03
COOLING TOWER
Z-103-01,-02
AIR STRIPPER
Z-104
CHEMICAL WATER TREATMENT
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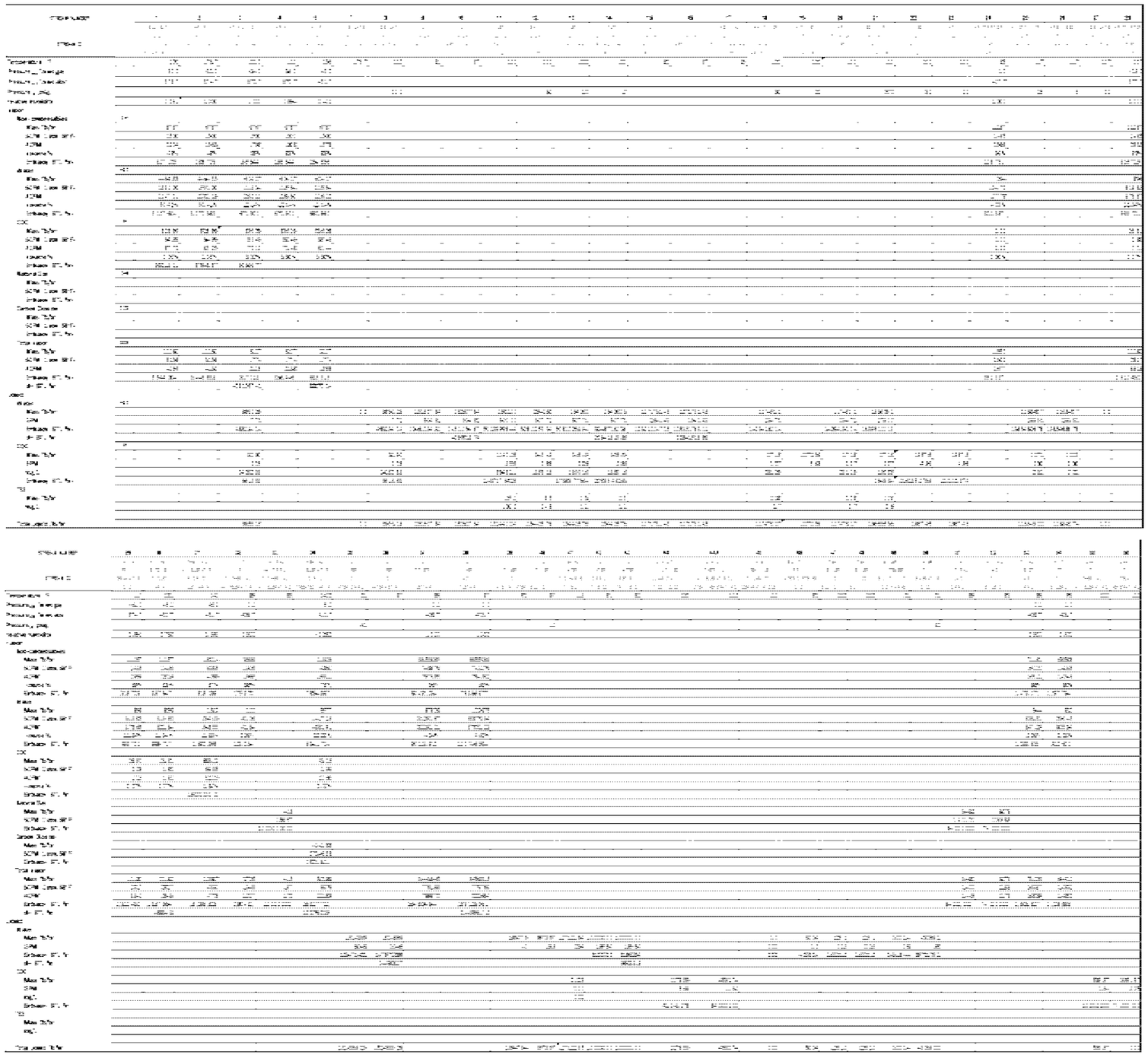

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NATURAL GAS B/L (51)
WATER B/L
P-112A/B
FX-101A/B
Z-101A/B (50)
COMBUSTION AIR IN B/L (53)
CONDITIONED LNAPL TANK (T-103-01,-02,-03) P101 - SHEET 2 (44A)
FROM MOISTURE SEPARATOR 3 (S-103-01,-02) P101 - SHEET 2 (30)
FROM COOLING TOWER (W-101-01,-02,-03) P101 - SHEET 2 (9)
FROM EDUCTOR FEED PUMPS (P-108-01A/B thru P108-06A/B) P102 - SHEET 2 (21)
STEAM INJECTION WELL (34 TOTAL)
MULTI-PHASE EXTRACTION WELL (51 TOTAL)
S-101
E-101-01
E-101-02
E-101-03
B-101A/B
S-102
P-102A/B
P-101A/B
V-101
V-102
F-101
F-102
TO COOLING TOWERS (W-101-01,-02,-03) P101 - SHEET 2 (39)
TO ATMOSPHERE B/L (33)
TO ATMOSPHERE B/L (54)
TO ATMOSPHERE B/L (34)
BLOWDOWN TO DISCHARGE P101 - SHEET 2 (10)
TO COOLING TOWERS (W-101-01,-02,-03) P101 - SHEET 2 (8)
TO SEDIMENT TANK WITH OIL SKIMMER (S-104-01,-02) P101 - SHEET 2 (7)
TO SEDIMENT TANK WITH OIL SKIMMER (S-104-01,-02) P101 - SHEET 2 (11)

B-101A/B	VACUUM BLOWER
E-101-01,-02,-03	VAPOR COOLER
F-101	THERMAL ACCELERATOR 1
F-102	THERMAL ACCELERATOR 2
FX-101A/B	INLET FILTER
P-101A/B	MOISTURE SEPARATOR 1 PUMPS
P-102A/B	MOISTURE SEPARATOR 2 PUMPS
P-112A/B	BOOSTER PUMPS
S-101	MOISTURE SEPARATOR 1
S-102	MOISTURE SEPARATOR 2
V-101	STEAM BOILER PACKAGE 1
V-102	STEAM BOILER PACKAGE 2
Z-101A/B	WATER SOFTENER

CLASS 1, ZONE 0
CLASS 1, ZONE 1/ DIV 1
CLASS 1, ZONE 2/ DIV 2

NOTES:
1. SOLID LINE REPRESENTS AREA INSIDE THE PIPE.
2. DASHED LINE REPRESENTS AREA OUTSIDE AND AROUND THE PIPE.

LEGEND
VAPOR STREAM
LIQUID STREAM
S STEAM STREAM
(X) STREAM NUMBER
B/L BATTERY LIMITS

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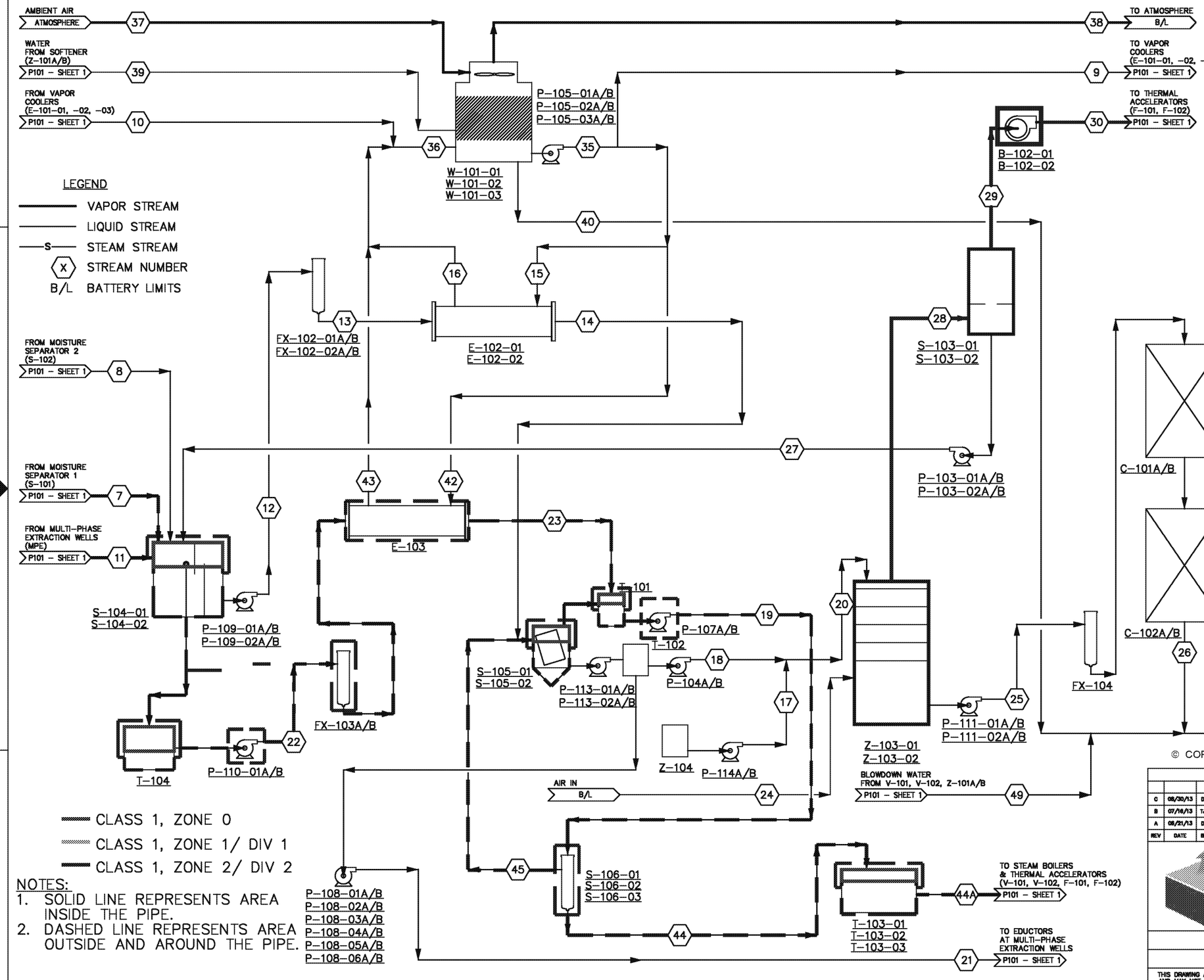

B-102-01,-02
AIR STRIPPER BLOWER

C-101A/B
LIQUID PHASE CARBON VESSEL 1

C-102A/B
LIQUID PHASE CARBON VESSEL 2

E-102-01,-02
LIQUID HEAT EXCHANGER

E-103
NAPL HEAT EXCHANGER

FX-102-01A/B,-02A/B
BAG FILTER 1

FX-103A/B
BAG FILTER 2

FX-104
BAG FILTER 3

P-103-01A/B,-02A/B
MOISTURE SEPARATOR 3 PUMPS

P-104A/B
DISCHARGE TANK PUMPS

P-105-01A/B,-02A/B,-03A/B
COOLING TOWER PUMPS

P-107A/B
LNAPL TANK TRANSFER PUMPS

P-108-01A/B,-06A/B
EDUCTOR FEED PUMPS

P-109-01A/B,-02A/B
SEDIMENT TANK DISCHARGE PUMPS

P-110-01A/B
SKIMMER OIL PUMPS

P-111-01A/B
AIR STRIPPER LIQUID EFFLUENT PUMPS

P-113-01A/B,-02A/B
GRAVITY SEPARATOR DISCHARGE PUMPS

P-114A/B
CHEMICAL INJECTION PUMP

S-103-01,-02
MOISTURE SEPARATOR 3

S-104-01,-02
SEDIMENT TANK W/ OIL SKIMMER

S-105-01,-02
GRAVITY SEPARATOR

S-106-01, -02, -03
NAPL CONDITIONING SYSTEM

T-101
LNAPL TANK

T-102
DISCHARGE TANK

T-103-01,-02,-03
CONDITIONED LNAPL TANK

T-104
PRIMARY NAPL RECOVERY TANK

W-101-01,-02,-03
COOLING TOWER

Z-103-01,-02
AIR STRIPPER

Z-104
CHEMICAL WATER TREATMENT

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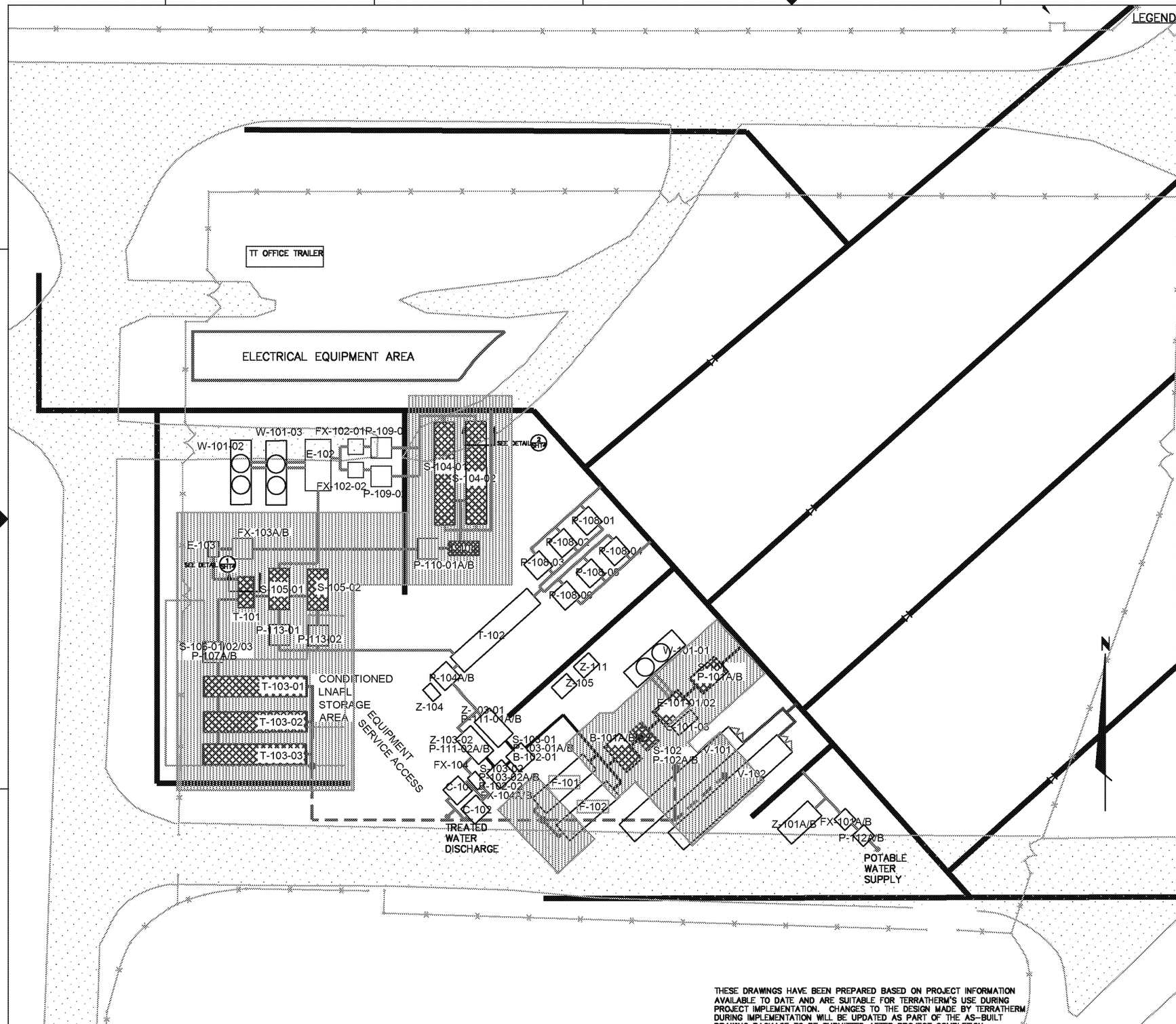

LEGEND

Tag Name	Official Name
B-101A/B	Vacuum Blower
B-102-01, -02	Air Stripper Blower
C-101	Liquid Phase Carbon Vessel 1
C-102	Liquid Phase Carbon Vessel 2
E-101-01,-02,-03	Vapor Cooler
E-102-01,-02	Liquid Heat Exchanger
E-103	NAPL Heat Exchanger
F-101	Thermal Accelerator 1
F-102	Thermal Accelerator 2
FX-101A/B	Inlet Filters
FX-102-01A/B	Bag Filter 1
FX-102-02A/B	Bag Filter 1
FX-103A/B	Bag Filter 2
FX-104A/B	Bag Filter 3
G-101	Thermal Accelerator Burner
P-101A/B	Moisture Separator 1 Pumps
P-102A/B	Moisture Separator 2 Pumps
P-103-01A/B, -02A/B	Moisture Separator 3 Pumps
P-104A/B	Discharge Tank Pumps
P-105-01A/B	Cooling Tower Pumps
P-105-02A/B	Cooling Tower Pumps
P-105-03A/B	Cooling Tower Pumps
P-106A/B	NAPL Holding Tanks Pumps
P-107A/B	LNAPL Tank Transfer Pumps
P-108-01A/B	Eductor Feed Pumps
P-108-02A/B	Eductor Feed Pumps
P-108-03A/B	Eductor Feed Pumps
P-108-04A/B	Eductor Feed Pumps
P-108-05A/B	Eductor Feed Pumps
P-108-06A/B	Eductor Feed Pumps
P-109-01A/B	Sediment Tank Discharge Pumps
P-109-02A/B	Sediment Tank Discharge Pumps
P-110-01A/B	Skimmer Oil Pumps
P-111-01A/B, -02A/B	Air Stripper Liquid Effluent Pumps
P-112A/B	Booster Pumps
P-113-01A/B	Gravity Separator Discharge Pumps
P-113-02A/B	Gravity Separator Discharge Pumps
S-101	Moisture Separator 1
S-102	Moisture Separator 2
S-103-01	Moisture Separator 3
S-103-02	Moisture Separator 3
S-104-01,-02	Sediment Tank W/Oil Skimmer
S-105-01,-02	Gravity Separator
S-106	NAPL Conditioning System
T-101	LNAPL Tank
T-102	Discharge Tank
T-103-01,-02,-03	Conditioned LNAPL Tank
T-104	Primary NAPL Recovery Tank
V-101	Steam Boiler 1
V-102	Steam Boiler 2
W-101-01,-02,-03	Cooling Tower
Z-101	Water Softener
Z-102	De-Aerator and Softener
Z-103-01	Air Stripper
Z-103-02	Air Stripper
Z-104	Chemical Water Treatment
Z-105	Air Compressor
Z-107	Compressed Air Drier
Z-108	Compressed Air Drier
Z-111	Air Compressor

PRIMARY WELLFIELD PIPING

TREATMENT EQUIPMENT VAPOR PIPING

TREATMENT EQUIPMENT LIQUID PIPING

TREATMENT EQUIPMENT STEAM PIPING

TREATMENT EQUIPMENT LNAPL PIPING

BURIED LNAPL PIPING

CLASS 1 ZONE 0 AREA

CLASS 1 ZONE 2 AREA

SEE SHEET 4 FOR ELEVATION EXTENTS OF CLASSIFIED AREAS.

ADDITIONAL CLASSIFIED AREAS AROUND PIPING WILL BE DELINEATED BASED ON POTENTIAL LEAK POINTS

APPROX. SCALE

0 20 40 60 80 FT

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AREA CLASSIFICATION SITE OVERVIEW

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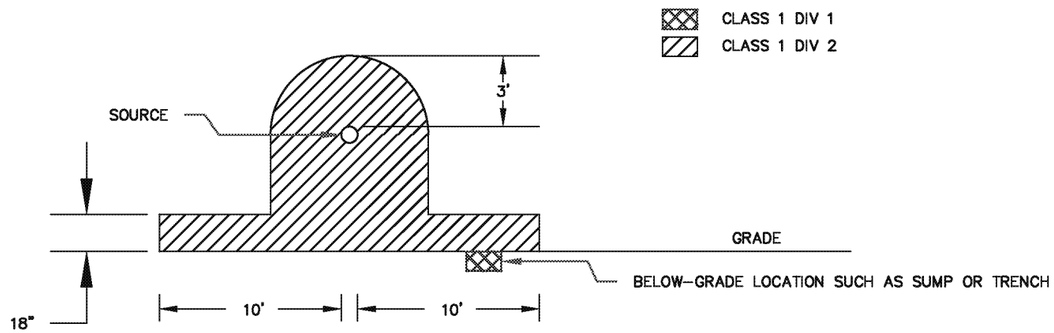
TYPICAL PIPING CLASSIFICATION DETAILS (1)

NOT TO SCALE
BASED ON FIGURE 5.10.1(B) OF NFPA 497



TYPICAL OIL WATER SEPARATOR CLASSIFICATION DETAILS (2)

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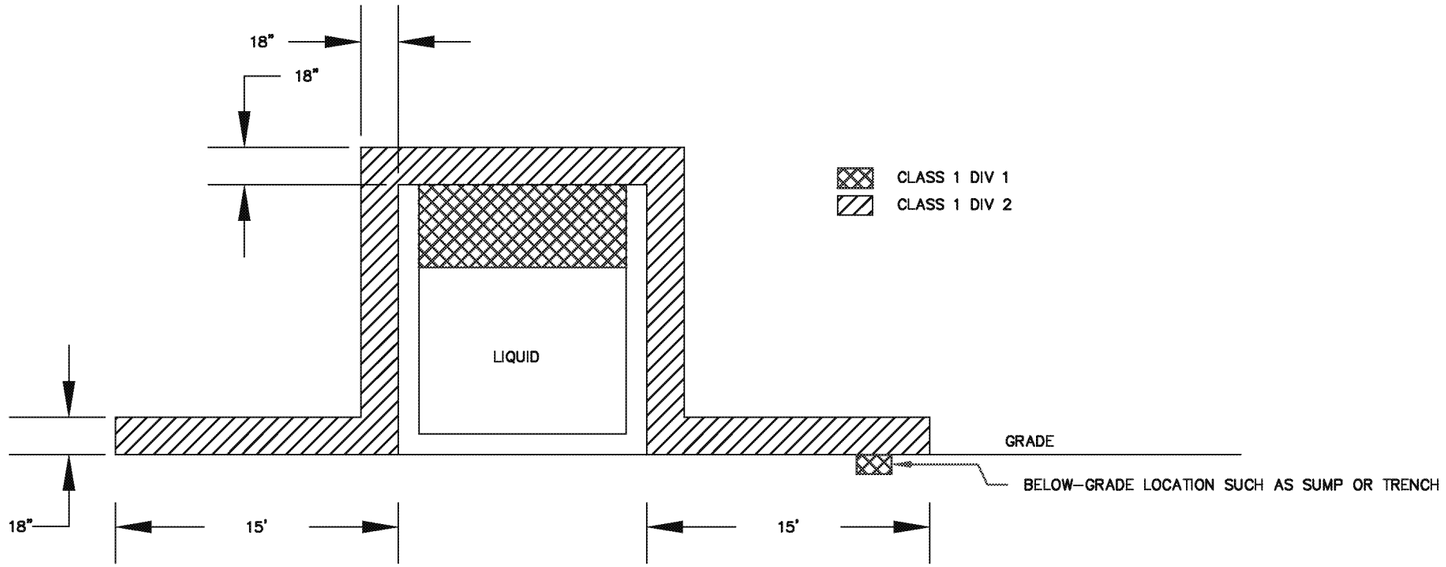
BASED ON FIGURE 5.10.7 OF NFPA 497



AREA CLASSIFICATION NOTES:

1. AREA CLASSIFICATIONS WERE DETERMINED BASED ON GUIDELINES FROM NFPA 497. BASED ON THE FOLLOWING SYSTEM DESIGN PARAMETERS. GUIDELINES FOR SMALL / MODERATE WERE REFERENCED.

- PROCESS EQUIPMENT SIZE = < 25,000 GAL
- PRESSURE = < 100 PSI
- FLOW RATE = < 500 GPM
- VAPOR DENSITY OF JP4 = 7.5

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AREA CLASSIFICATION SITE OVERVIEW

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APPENDIX D

SEE DESIGN REPORT

Steam Enhanced Extraction
Williams Air Force Base
Mesa, Arizona
December 2013

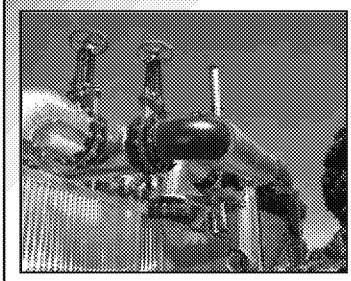
Design for SEE Treatment at the Former Williams Air Force Base ST012

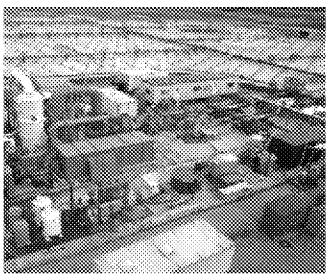
Prepared for:

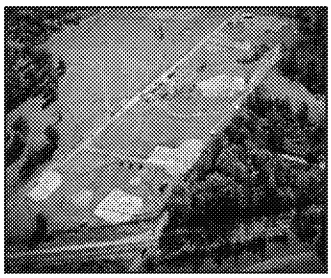
AMEC

Project No.: 91011110001-2102.2131.2121

S100.02







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Contents

1 EXECUTIVE SUMMARY 1
2 INTRODUCTION 3
2.1 Design Report Format 3
2.2 Overview of In Situ Thermal Approach 3
2.3 Objectives 4
3 UNDERSTANDING OF THE SITE 6
3.1 Site Background 6
3.2 Target Treatment Zone Delineation 6
3.3 Mass Estimate 8
4 TECHNOLOGY OVERVIEW 9
4.1 SEE Background 10
4.2 Remediation Mechanisms 12
5 THERMAL SYSTEM DESIGN 14
5.1 Overall Thermal Concept 14
5.2 Steam Injection and Extraction System 17
5.3 Numerical Calculations of Heating 19
5.3.1 Introduction 19
5.3.2 Treatment Area Size and Geology 20
5.3.3 Input Parameters and Energy Balance 24
5.3.4 Temperature Progression 25
5.3.5 Operational Durations 27
5.3.6 Energy Demand 27
5.3.7 Effluent Treatment System Design Parameters 28
5.3.8 Utility Demand 29
5.4 Wellfield Design and Installation 30

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5.4.1 Surveying 34
5.4.2 Drilling and Well Installation Methods 34
5.5 Steam and Liquid Conveyance 35
5.6 Mechanical and Electrical Installation 35
5.7 Site Specific Considerations 36
5.7.1 Temporary Facilities and Laydown Area 36
5.7.2 Site Preparation 36
5.7.3 Utilities 36
5.7.4 Existing Infrastructure in Treatment Area 36
5.7.5 HAZOP Findings 36
5.8 Process Flow Diagram 37
5.8.1 Process Equipment Control System Description 37
5.8.2 Control System and Interlocks 37
5.9 Vapor Treatment System 38
5.9.1 Moisture Separator 1 (S-101) 39
5.9.2 Vapor Coolers (E-101 -01, -02, -03) 39
5.9.3 Cooling Towers (W-101 -01, -02, -03) 40
5.9.4 Moisture Separator 2 (S-102) 40
5.9.5 Vacuum Blowers (B-101A/B) 41
5.9.6 Thermal Accelerators (F-101 and F-102) 41
5.10 Liquid Treatment System 42
5.10.1 Eductor Feed Pumps (P-108-01A/B - 06A/B) 43
5.10.2 Sediment Tanks with Oil Skimmers (S-104 -01, -02) 43
5.10.3 Bag Filters 1 (FX-102 -01A/B – 02A/B) 44
5.10.4 Liquid Heat Exchangers (E-102 -01, -02) 44
5.10.5 Gravity Separators (S-105 -01, -02) and Discharge Tank (T-102) 45

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5.10.6 Chemical Water Treatment (Z-104) ... 45
5.10.7 Air Strippers (Z-103 -01, -02) ... 45
5.10.8 Moisture Separator 3 (S-103 -01, -02) ... 46
5.10.9 Bag Filter 3 (FX-104) ... 46
5.10.10 Liquid Phase Carbon Vessels 1 and 2 (C-101 A/B and C-102A/B) ... 46
5.11 NAPL Conditioning System ... 47
5.11.1 Primary NAPL Recovery Tank (T-104) and Bag Filters 2 (FX-103A/B) ... 48
5.11.2 NAPL Heat Exchanger (E-103) ... 48
5.11.3 NAPL Conditioning System (S-106), LNAPL Tank (T-101), and Conditioned LNAPL Tanks (T-103 -01, -02, -03) ... 48
5.11.4 LNAPL Conveyance System ... 49
5.12 Steam Generation System ... 49
5.12.1 Booster Pumps (P-112A/B) and Inlet Filters (FX-101A/B) ... 49
5.12.2 Water Softener (Z-101 A/B) ... 49
5.12.3 Steam Boiler Packages 1 and 2 (V-101 and V-102) ... 49
5.13 Treatment System Summary ... 50
5.14 Electrical Distribution Systems ... 53
5.14.1 Instrumentation and DataCom Wiring ... 54
5.14.2 Backup Power ... 54
5.15 Area Classification ... 55
5.15.1 Vapor Releases ... 56
5.15.2 Liquid Releases ... 58
5.15.3 Reference Drawings ... 58
5.16 Construction Management ... 58
6 THERMAL REMEDIATION OPERATIONS ... 60
6.1 Final Designation of Injection and Extraction Wells ... 60

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6.2 Thermal System Startup 61
6.2.1 Meeting and Readiness Review 61
6.2.2 Commissioning 62
6.2.3 Steam Boiler Inspection and Commissioning 62
6.3 Thermal System Operations 63
6.3.1 Hydraulic/Pneumatic Control 63
6.3.2 Steam Injection 63
6.3.3 Flushing and LNAPL Removal Optimization 64
6.3.4 Pressure Cycling and Vaporization 64
6.3.5 Cool Down 65
6.4 LNAPL Reuse 65
6.5 Decommissioning and Demobilization 65
6.6 Waste Disposal 66
6.7 Site Restoration 67

List of Figures

Figure 3.1 Aerial Extent of the Three Treatment Areas
Figure 3.2 Lower Extent of the TTZ
Figure 4.1 Steam Enhanced Extraction Technology Schematic
Figure 4.2 Simplified Steam Generation System Schematic
Figure 4.3 Steam Injection Well Equipped with Pressure Regulator and Metering
Figure 5.1 Thermal Treatment Areas Used in the Numerical Simulation
Figure 5.2 Numerical Model Layers and Geology
Figure 5.3 Average Temperature Curves for Layers 2 to 8 during Thermal Treatment
Figure 5.4 Conceptual Well Construction Diagrams of Steam Injection and Multi-Phase Extraction Wells
Figure 5.5 Conceptual Well Construction Diagram of Temperature Monitoring Points

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List of Tables

Table 5.1 Predicted Peak Steam Injection Rates for the Three Zones at the Site
Table 5.2 Predicted Peak Extraction Rates from the Three Zones at the Site
Table 5.3 Area and Volume of the Thermal Treatment Zone
Table 5.4 Starting Parameters for Model Layers
Table 5.5 Volume and Heat Capacity
Table 5.6 Energy Balance
Table 5.7 Overview of Operational Sequences
Table 5.8 Steam and Power Usage
Table 5.9 Process Equipment
Table 5.10 Water and Vapor Discharge and Fresh Water Usage
Table 5.11 Design Specifications – Vapor Treatment System
Table 5.12 Design Specifications – Liquid Treatment System
Table 5.13 Design Specifications – NAPL Conditioning System
Table 5.14 Design Specifications – Steam Generation and Water Conditioning System
Table 5.15 Physical Properties of Primary Site Contaminant
Table 5.16 Area Classification Vapor Conclusions

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List of Acronyms and Abbreviations

%	Percent
"wc	Inches of water column
°F	Degrees Fahrenheit
°C	Degrees Celsius
acfm	Actual Cubic Feet Per Minute
AHA	Activity Hazard Analysis
AIC	Ampere Interrupting Capacity
ANSI	American National Standards Institute
AZ	Arizona
bgs	Below Ground Surface
BTU	British Thermal Unit
BTU/lbs	British Thermal Unit per pound
cf	Cubic Feet
cSt	Centistokes
CPVC	Chlorinated Polyvinyl Chloride
cy	Cubic Yards
CZ	Cobble Zone
dBA	Decibel
DNAPL	Dense Non-Aqueous Phase Liquid
DRE	Destruction and Removal Efficiency
FID	Flame Ionization Detector
ft	Feet
ft^2	Square Feet
gpm	Gallons per Minute
GFCI	Ground Fault Circuit Interrupter
HASP	Health and Safety Plan
HAZOP	Hazard and Operability Analysis
HP	Horsepower
HZ	Heated Zone
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers

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I/O	Input/Output
JP-4	Jet Propellant Grade 4 Fuel
kAIC	Thousand Amps Interrupting Capacity
kVA	Kilovolt-Ampere
kW	Kilowatt
kWh	Kilowatt Hours
lbs	Pounds
lbs/hr	Pounds per Hour
LEL	Lower Explosive Limit
LNAPL	Light Non-Aqueous Phase Liquid
LPZ	Lower Permeable Zone
LSZ	Lower Saturated Zone
M&E	Material and Energy
MCP	Master Communication Panel
MMBT	Million British Thermal Units
MMBTU/Hr	Million British Thermal Units per Hour
MPE	Multi-Phase Extraction
NAPL	Non-Aqueous Phase Liquids
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NOx	Nitrogen Oxides
OU-2	Operational Unit 2
OWS	Oil Water Separator
P&ID	Piping and Instrumentation Diagram
PFD	Process Flow Diagram
PLC	Programmable Logic Controller
PPE	Personal Protective Equipment
psi(a)	Pounds per Square Inch (Atmosphere)
RD/RAWP	Remedial Design/Remedial Action Work Plan
scfm	Standard Cubic Feet per Minute
SEE	Steam Enhanced Extraction
SIWs	Steam Injection Wells
ppm	Parts per Million

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SVE	Soil Vapor Extraction
SVOC	Semi-Volatile Organic Compound
TEE	Thermal Enhanced Extraction
TPH-DRO	Total Petroleum Hydrocarbons as Diesel Range Organics
TPH-GRO	Total Petroleum Hydrocarbons as Gasoline Range Organics
TTZ	Target Treatment Zone
UL	Underwriters Laboratories
USEPA	United States Environmental Protection Agency
UWBZ	Upper Water Bearing Zone
V	Volts
VOC	Volatile Organic Compound
yds	Yards

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1 EXECUTIVE SUMMARY

This report presents the design for the implementation of Steam Enhanced Extraction (SEE) (Design Report) to thermally enhance light non-aqueous phase liquid (LNAPL) removal and reduce benzene concentrations in the soil and groundwater at the ST012 site at Former Williams Air Force Base in Mesa, Arizona (the Site).

The target treatment zone (TTZ) is approximately 410,000 cubic yards (cy). The volume of the TTZ was expanded since the Conceptual Design based on information gathered during the Pre-Design Investigation. SEE will be used to heat the TTZ to boiling temperatures between 100 and 140 degrees Celsius (°C) (target treatment temperature varies by injection depth interval). Three distinct layers will be targeted for thermal treatment within the TTZ. All injection and extraction wells will be constructed so that they can serve as injection, extraction, or dual purpose wells as needed during operation to maintain containment of contaminants. The design basis for construction, placement, and operation of extraction and injection wells was based on the conceptual design as refined by results of the Pre-Design Investigation as described in the Remedial Design/Remedial Action Work Plan (RD/RAWP). Additional information collected during well installation will be used to evaluate the exact use of each of the operational wells. In the current design, soil vapor and groundwater extraction will be accomplished from 51 multiphase extraction (MPE) wells at three distinct extraction intervals located within the TTZ. A total of 34 steam injection wells (SIWs) will be used to inject steam at a total rate of approximately 50,000 pounds per hour into the TTZ. Seventeen temperature monitoring wells will yield data to support and optimize the steam injection/extraction strategy at the Site.

The site contaminants are petroleum hydrocarbons resulting from weathered jet propellant grade 4 (JP-4) and aviation gasoline historic spills at the Site. The main goal of SEE treatment is to thermally enhance LNAPL recovery of the petroleum hydrocarbons, and to reduce the concentration of benzene in the source area. Volatile components of the petroleum hydrocarbons (e.g., benzene) will primarily be removed by vaporization and vapor extraction. The LNAPL will be made less viscous through SEE treatment and will be pushed by the steam injection toward the extraction wells for removal from the TTZ. The extracted fluids will be collected in a manifold piping system and conveyed to the on-site process treatment system. Treatment consists of condensation, phase separation and conditioning of the recovered weathered JP-4 to be reused to fuel process treatment equipment onsite. The liquids separated from the recovered fuel will be

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treated on-site in an air stripper and subsequently polished using liquid carbon before being discharged to the sanitary sewer.

Vapors will be extracted from the subsurface under vacuum and routed to a vapor treatment system consisting of multiple sequential treatment components to provide appropriate treatment and provide excess treatment capacity during peak loading. Primary vapor treatment will be provided by duplex thermal accelerators.

A mass and energy balance was performed based on Site data and predicted an operational duration of approximately 422 days to achieve heating in the TTZs and allow for pressure cycling and other activities to optimize contaminant removal. During the operational phase, approximately 320 million pounds (lbs) of steam will be injected into the subsurface while 98 million gallons of liquids will be extracted to recover LNAPL and dissolved contaminants while maintaining hydraulic control.

TerraTherm Operators will perform daily monitoring, inspection, and system maintenance activities. Field data will be collected daily and documented using a web-based data collection system to allow tracking by the TerraTherm project management and engineering team. Monitoring and sampling will be conducted and used to track and optimize remedial progress. Monitoring will include measurement of subsurface temperatures, steam injection rates, extraction rates and the pressure, flow rates, and liquid levels throughout the process treatment system. Screening level measurements will be collected to assess the mass removal rate during operations and to document compliance with applicable vapor and liquid discharge limits as required.

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2 INTRODUCTION

This report presents the design for the implementation of SEE at the ST012 site at the Former Williams Air Force Base in Mesa, Arizona.

2.1 Design Report Format

This report is divided into the following sections:

1. Understanding of the Site
2. Technology Overview
3. Thermal System Design
4. Thermal Remediation Operations

2.2 Overview of In Situ Thermal Approach

The Site was added to the National Priorities List in 1989. The ST012 Site is classified as Operational Unit 2 (OU-2) for cleanup purposes. The ST012 Site, the former Liquid Fuels Storage Facility, has had historic releases of both JP-4 and aviation gasoline. The U.S. Environmental Protection Agency (USEPA) estimates that as many as 12 million gallons of contaminants may be in the soil and groundwater at the Site. Previously and currently implemented remedial activities at the Site include full-scale Soil Vapor Extraction (SVE) to address vadose zone contamination and pilot-scale Thermal Enhanced Extraction (TEE) to address petroleum contaminants in groundwater.[1]

The Site footprint is approximately 199,000 square feet (ft^2) encompassing three distinct steam injection intervals: the cobble zone (CZ) with a vertical extent of approximately 145-160 feet (ft) below ground surface (bgs), the upper water bearing zone (UWBZ) with a vertical extent of approximately 160-195 ft bgs, and the lower saturated zone (LSZ) with a vertical extent of approximately 210-245 ft bgs. The CZ and UWBZ have the same foot print of 71,923 ft^2 and the LSZ has an area of 185,025 ft^2. The TTZ volume is approximately 410,000 cy.

The design of the thermal wellfield includes the following components:

- 34 SIWs injecting steam from 145-160 ft bgs in the CZ; 160-195 ft bgs in the UWBZ and 210-245 ft bgs in the LSZ;

[1] Arizona Department of Environmental Quality, Former Williams AFB NPL Site – 01/2011, December 8, 2011, http://www.azdeq.gov/environ/waste/sps/download/phoenix/wafb.pdf.

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- 51 MPE wells for hydraulic and pneumatic control screened in the same intervals at the SIWs by zone, respectively;
- Seventeen temperature monitoring wells each with up to eight vertical temperature measurement points of varying depths throughout the TTZ; and,
- All SIWs and MPEs will be constructed so that they can be used as either injection or extraction wells as needed during operation. The final use for each well will be determined after well installation is complete and use may also vary during the course of the SEE operations depending on the operational strategy. Additionally, all SIWs and MPEs will be equipped with the infrastructure for co-located temperature monitoring sensors to measure the temperatures at the top, middle and bottom of the injection and extraction screens if required. Co-located temperature monitoring sensors will be permanently installed for the 18 deep SIWs in the LSZ and will monitor the temperature at the top, middle and bottom of these wells. Two mobile temperature arrays will be used to monitor temperatures in the remaining deep, intermediate and shallow MPEs and SIWs.

Thermal operations are predicted to last approximately 422 days. During this period, hydraulic and pneumatic control will be maintained by extraction of water and vapors. These fluids are treated on-site in a robust treatment system.

2.3 Objectives

The main objective of SEE is to thermally enhance LNAPL recovery of the petroleum hydrocarbons at the Site and to reduce concentrations of benzene in the source area. Volatile components of the petroleum hydrocarbons (e.g., benzene) will primarily be removed by vaporization and vapor extraction. The LNAPL will be made less viscous through SEE treatment and will be pushed by the steam injection toward the extraction wells for removal from the TTZ.

An average reduction of the benzene mass in the TEE pilot test of 66 percent (%) was reported.[2] Due to the higher temperatures, the longer duration, and the pressure cycling of the proposed SEE implementation, it is anticipated that a better than 99% reduction of the volatile organic compounds (VOC) constituents such as benzene will occur. The removal in the low-permeability zones will be lower, and it is difficult to predict exactly what average reduction will be achieved. However, TerraTherm expects to achieve at least a 90% reduction in these zones, and thereby an overall mass reduction for benzene of 95% or higher is anticipated for this Site.

[2] BEM Systems, Draft Phase I Thermal Enhanced Extraction (TEE) Pilot Test Performance Evaluation Report, June 2010, Page ES-17.

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While every effort will be made to heat and treat the TTZ uniformly, there is the potential that Site contaminant mass exists outside and surrounding the TTZ. Site contaminant mass outside the TTZ may enter the TTZ due to the inward gradients and flow created through the extraction at the Site during SEE implementation resulting in higher concentrations at the perimeter of the TTZ than in the middle.

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3 UNDERSTANDING OF THE SITE

3.1 Site Background

The ST012 site is located on the Former Williams Air Force Base in Mesa, Arizona. The majority of the Site is bordered to the north by Ulysses Avenue (a portion of the TTZ within the CZ and UWBZ crosses Ulysses Avenue to the north), to the west by South Avoca Street, to the east by South Sossaman Road and to the south by East Upton Avenue (unused road). The Phoenix-Mesa Gateway Airport is located to the east of the Site.

3.2 Target Treatment Zone Delineation

The horizontal extents of the three treatment areas are shown in Figure 3.1.

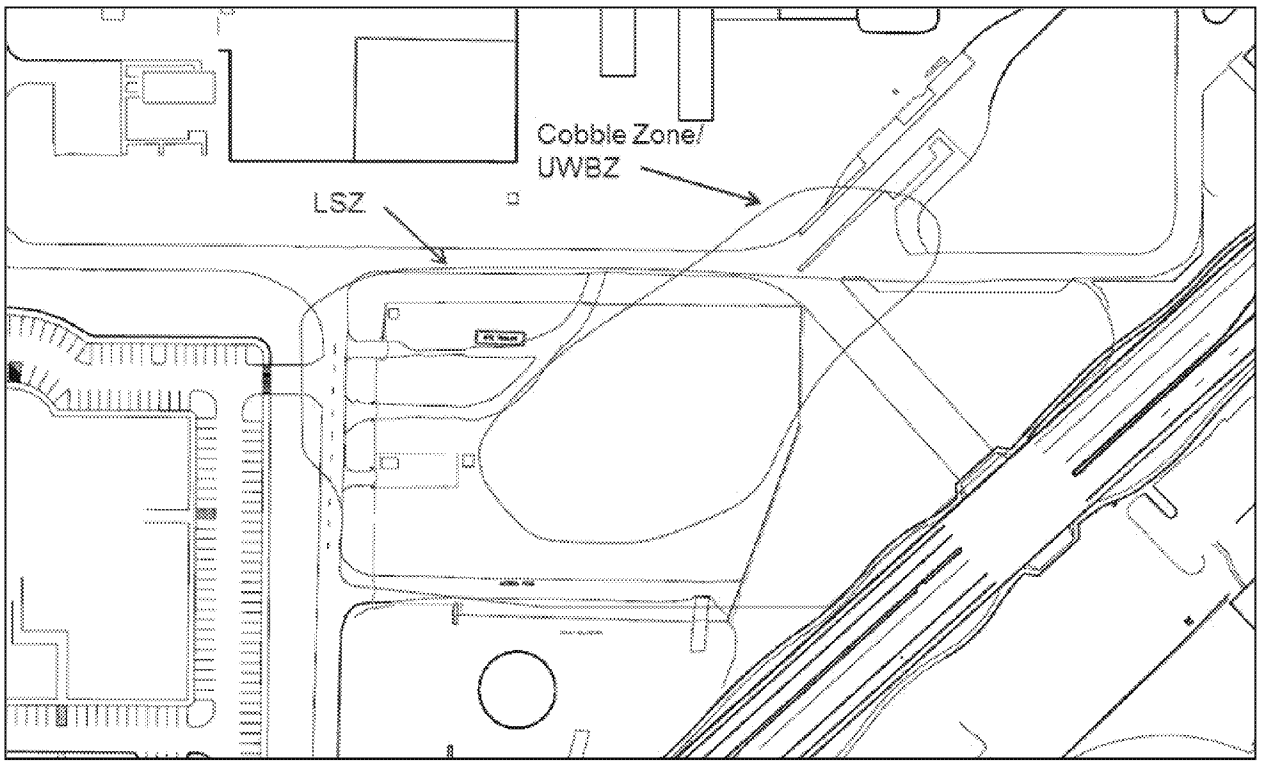

Figure 3.1 Aerial Extent of the Three Treatment Areas

The CZ area is 71,923 ft^2 with a treatment depth of 145-160 ft bgs. The UWBZ has the same footprint and a vertical extent from 160-195 ft bgs. The LSZ has an area of 185,025 ft^2 and extends from 210-245 ft bgs. Note, the actual depth of the LSZ will be determined during well installation.

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A 15 ft thick lower permeability zone (LPZ) is located between the UWBZ and the LSZ. Steam is not expected to homogenously heat the LPZ, but the zone will be heated partly by thermal conduction from the hot layers above and below it. In the conceptual site model, one half of the LPZ was included in the UWBZ while the other half was included in the LSZ. Thus, the two layers have a vertical extent from 160-202.5 ft bgs and 202.5-245 ft bgs.

The groundwater level at the Site has never been measured deeper than 232 ft bgs since the time of the original fuel releases. As such, and supported by the Pre-Design Investigation results, the fuel as an LNAPL has not migrated deeper than 232 ft bgs. Therefore, the lower extent of the TTZ has been defined as 240 ft bgs as indicated in Figure 3.2.

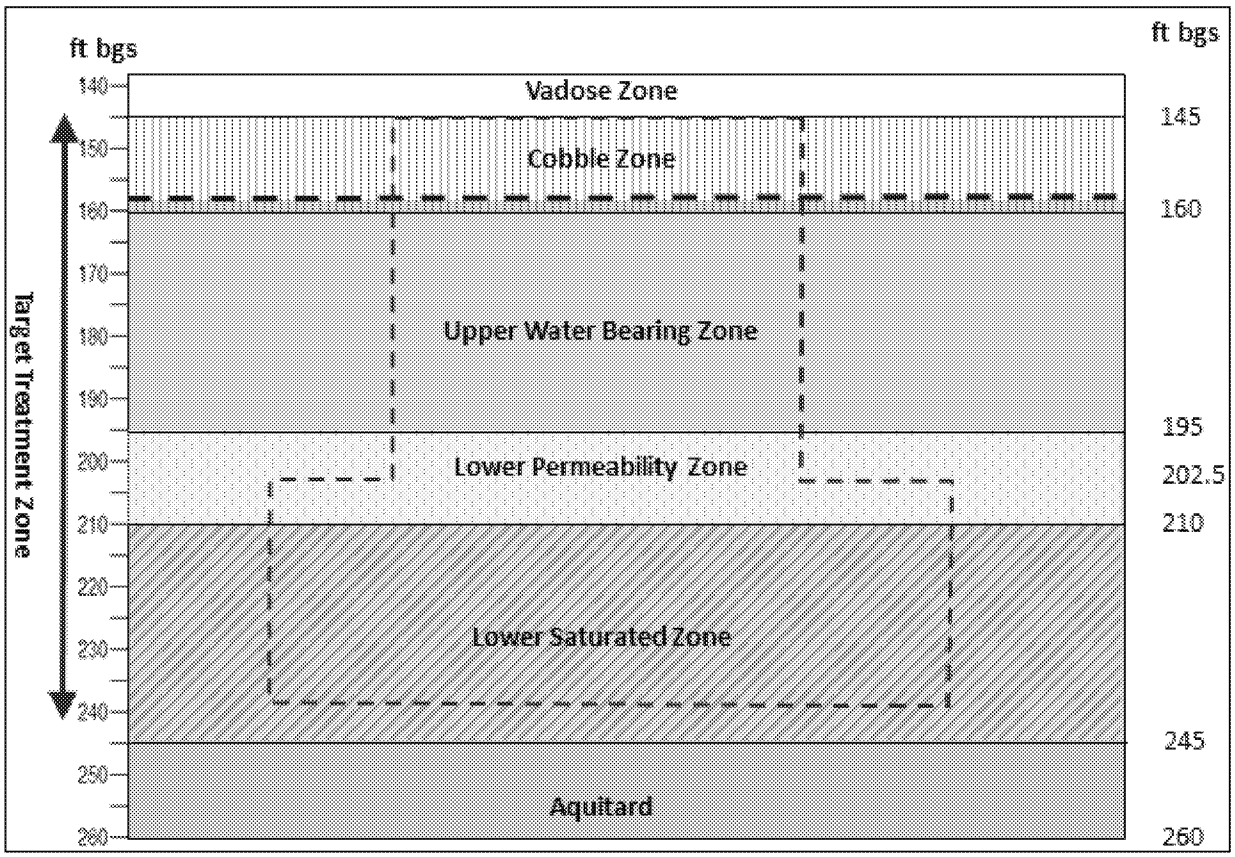

Figure 3.2 Vertical Extent of the TTZ

The treatment volume is approximately 40,000 cy in the CZ, 110,000 cy in the UWBZ and 257,000 cy in the LSZ for a total of approximately 410,000 cy.

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3.3 Mass Estimate

Based on data collected during the Pre-Design Investigation, there is estimated to be up to 1,600,000 gallons of JP-4 fuel in the saturated zone. Historical estimates have ranged from 84,000 gallons to 11,100,000 gallons of JP-4 fuel in the subsurface. The system is designed to treat a maximum of approximately 2,000,000 gallons (13,140,000 lbs) of non-aqueous phase liquid (NAPL).

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4 TECHNOLOGY OVERVIEW

SEE will be implemented at the Site. Figure 4.1 below provides a generic sketch of the SEE technology including the steam generation equipment, wellfield infrastructure, and treatment equipment typically used for liquid and vapor treatment.

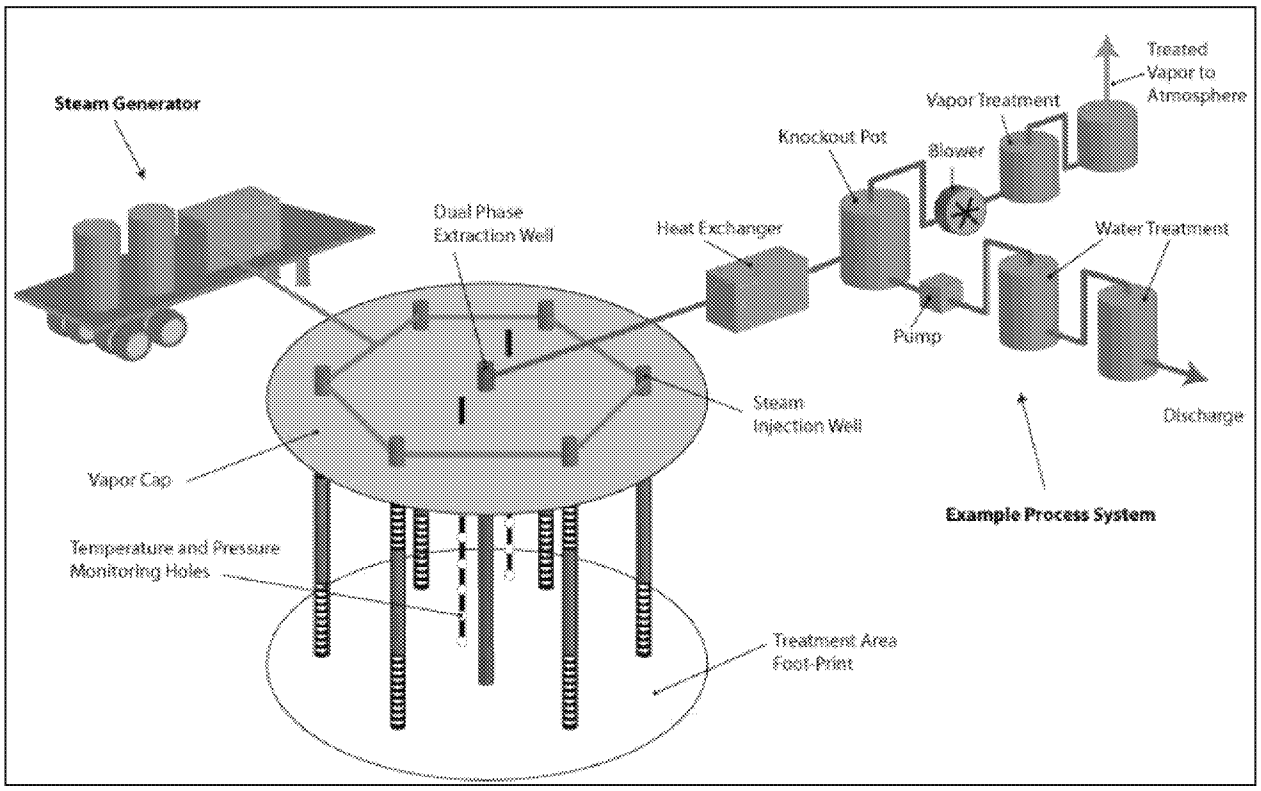

Figure 4.1 Steam Enhanced Extraction Technology Schematic (not specific to the actual site)

The major equipment involved in this type of system includes:

- A steam generation and injection system including a water conditioning system, steam boilers, steam conveyance manifold and pressure regulation valves;
- Wells and borings including SIWs, MPE wells, and temperature monitoring points;
- Fluids recovery system including conveyance piping for extracted vapor and groundwater; and,
- Treatment system for extracted fluids (LNAPL), vapor and liquids, as required).

Additional background information on the SEE technology is provided below.

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4.1 SEE Background

SEE involves the installation of a network of injection and extraction wells, injection of steam produced by a steam generator into the wells, and extraction of hot fluids that will be subsequently treated onsite and discharged.[3] The injection of steam is a stable and predictable process. The steam propagation is governed by heat transfer to the formation, which has been studied intensively for oil recovery and has been applied to remediation applications for over 20 years. SEE is particularly well suited for application in high permeability zones bounded by lower permeability regions. As an example, it was used as part of the successful dense non-aqueous phase liquid (DNAPL) remedy at the Young-Rainey STAR Center located in Largo, FL (to heat the sand zone above the Hawthorn clay); Heron et al. 2005,[4] and at a Confidential site in Pennsylvania where a volume of 72,000 cy was treated successfully using SEE with injection of steam both into a deep sand aquifer and an upper sand unit, separated by a confining unit similar to the one at this Site. SEE has been demonstrated to be capable of remediating the full range of VOCs and semi-volatile organic compounds (SVOCs). It provides particular effectiveness for compounds with low absorptivity such as the Site contaminants, due to the water exchange and the fluid circulation applied to heat the Site and maintain hydraulic control.

A general schematic of a steam generation system is provided in Figure 4.2. The fuel source can be natural gas, propane, or diesel. For this Site, two steam boilers will be utilized and natural gas will be used for supplemental fuel. The primary fuel that will be used for the steam boilers is recovered LNAPL from the Site. The steam boilers selected for the SEE implementation are packaged units equipped with de-aerators and water softeners.

[3] Davis, E.L. (1998): *Steam injection for soil and aquifer remediation.* US EPA Issue paper EPA/540/S-97/505.

[4] Heron, G., Carroll, S., and Nielsen, S.G.D., 2005. Full-Scale Removal of DNAPL Constituents using steam enhanced extraction and electrical resistance heating. Ground Water Monitoring and Remediation, 25(4): 92-107.

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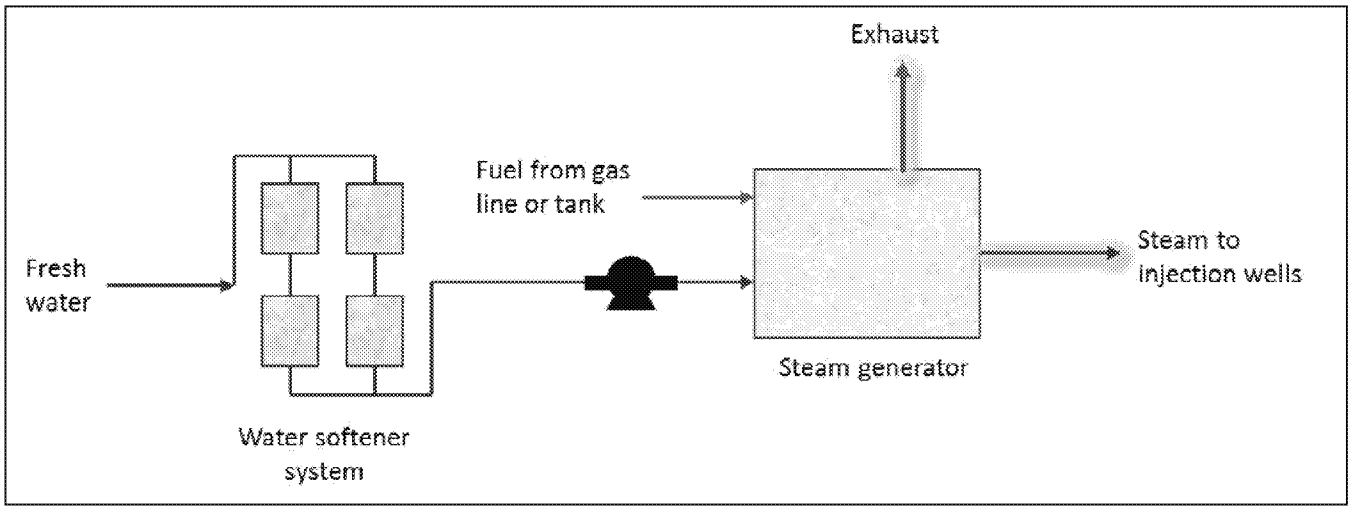

Figure 4.2 Simplified Steam Generation System Schematic

A representative figure of steam injection using simple steel wells and wellhead assemblies is shown in Figure 4.3. As steam is injected into the TTZ, fluids are extracted from surrounding extraction wells and a steam zone is created between the injection and extraction wells. After the steam zone is fully formed, periodic pressure cycling will be conducted by varying the injection pressure and rates, concurrent with varying the applied vacuum. Pressure cycling has been demonstrated to improve removal rates for target constituents dramatically, further enhancing remediation.

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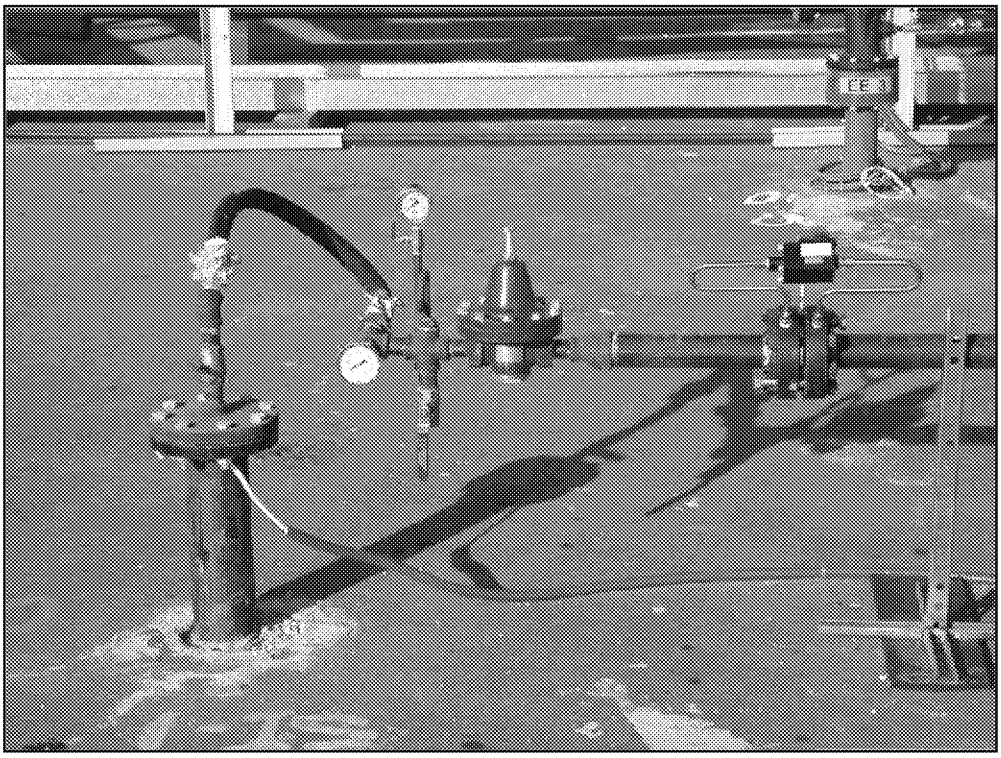

Figure 4.3 Steam Injection Well Equipped with Pressure Regulator and Metering

4.2 Remediation Mechanisms

Heating the subsurface to temperatures around the boiling point of water can lead to significant changes in the thermodynamic conditions in the subsurface and can make LNAPL more mobile/removable. The major effects of heating are:

- The vapor pressure of the LNAPL increases markedly with temperature. As the subsurface is heated from ambient temperature to temperatures in the range of 212 degrees Fahrenheit (°F) (100°C), the vapor pressure of the LNAPL constituents will typically increase between 10 and 30-fold.[5]
- Adsorption coefficients are reduced moderately during heating, leading to an increased rate of desorption of Site contaminants from the soil.[6]

[5] Udell, K.S. 1996. Heat and Mass Transfer in Clean-up of Underground Toxic Wastes. In *Annual Reviews of Heat Transfer*, Vol. 7, Chang-Lin Tien, Ed.; Begell House, Inc.: New York, Wallingford, UK: 333-405.

[6] Heron, G., M. Van Zutphen, T.H. Christensen, and C.G. Enfield. 1998. Soil heating for enhanced remediation of chlorinated solvents: A laboratory study on resistive heating and vapor extraction in a silty, low-permeable soil contaminated with trichloroethylene. *Environmental Science and Technology*, 32 (10): 1474-1481.

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- Viscosity of LNAPL is reduced by heating. The higher the initial viscosity, the greater the reduction. For JP4 with American Petroleum Institute gravity around 40-50, the viscosity typically is reduced by a factor of greater than 50 when heated to the boiling point. Laboratory results conducted on JP-4 collected at the Site showed a viscosity of 1.3 centistokes (cSt) at 40°C.
- LNAPL-water interfacial tensions are typically reduced, which can lead to improved recovery as a liquid.
- The reduced saturation in the steam zone enhances pneumatic ventilation and thus the mass removal from the contaminated zones.
- The solubility increases when JP-4 fuel is heated, thus leading to a higher mass removal in the water phase.
- Boiling of LNAPL in the presence of water occurs at temperatures below the boiling point of water.[7]

In summary, application of thermal energy (heat) and steam will lead to removal of the contaminants as an LNAPL phase, as a vapor phase, and as dissolved contaminants in the extracted groundwater at the Site. Capture of all the mobilized phases will be ensured by the extraction of liquids (LNAPL and groundwater) and vapors (steam and air). Such capture has been documented at multiple sites treated with thermal technologies. The extraction system designed for this Site has sufficient capacity to extract and treat water and vapors such that capture is ensured.

[7] DeVoe, C., and K.S. Udell, 1998. Thermodynamic and Hydrodynamic behavior of water and DNAPLs during heating, In *Proceedings from the First Conference on Remediation of Chlorinated and Recalcitrant Compounds*, May 18-21, Monterey CA, Battelle Press 1 (2): 61-66.

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5 THERMAL SYSTEM DESIGN

5.1 Overall Thermal Concept

SEE will be used to thermally treat the 95 foot (ft) thick zone of the TTZ with a network of vertical SIWs. The injection wells will be spaced approximately 80 ft apart in the CZ and in the UWBZ and approximately 100 ft apart in the LSZ. Steam will be injected into the subsurface at the Site to heat the TTZ to the boiling point of water, 212°F (100°C). Since the boiling point of water increases with depth, the expected boiling point at the bottom of the TTZ is 284°F (140°C).

Site contaminants will be mobilized as an LNAPL phase and volatilized and steam stripped from the soils and recovered via a network of vertical MPE wells and subsequently treated with a vapor and liquid treatment system. Fugitive emissions will be prevented by maintaining negative pressures across most of the TTZ and keeping the existing shallow SVE system operational. In addition, most vapor collection piping will be operated under a net negative pressure (until the inlet of the thermal accelerators), so if there were any minute leaks, they will be into the piping, not out of the system. TerraTherm will provide a backup electrical generator and transfer switch so that in the event of a loss of grid power, one steam boiler and the vapor collection and treatment system will continue running. Once the buildup of the steam zone has begun in the subsurface, it is important to maintain steam injection (even at a minimum) to prevent the premature collapse of the steam zone.

At any site, the completeness of heating as measured by the temperatures achieved within the TTZ is governed in part by the site hydrogeology. For SEE, large zones of low-permeability materials (silt or clay lenses or layers) may not be heated as effectively as the permeable zones. Steam override (when the steam bubble rises above the intended treatment interval) can also affect the ability to reach target temperatures in permeable zones where the vertical permeability is significant. As a result, the completeness of heating, and the associated achievement of the conditions necessary for effective reduction of LNAPL concentrations will have some uncertainty associated with it.

The well spacing and expected effectiveness of thermal treatment at the Site is derived from the data collected in the TEE pilot test. The TEE pilot test was performed using two injection wells in the center of a 70-ft radius circle, surrounded by six extraction well clusters. Lessons learned from the pilot include:

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- The steam injection rates achieved were in the 1,000-2,500 pounds per hour (lbs/hr) range per injection well screen, and the steam migrated mainly in a horizontal direction away from the screens. This is positive and therefore TerraTherm will use roughly the same injection well intervals for full-scale treatment. Note that the water table rise has added an additional need to treat part of the CZ, thus an additional level of wells above the interval treated in the TEE pilot was added. TerraTherm will also use similar steam injection rates, balanced to get the most uniform heating possible. The balance will be kept by adjusting the individual steam injection rates and pressures, based on observed flow and temperatures during operation.

- The temperatures observed during the TEE pilot indicated that the low permeability zones in some parts of the TTZ acted as barriers to the steam flow. The low-permeability zone below the CZ seemed to contain the steam from the UWBZ, as evidenced by the slow heating of this layer, and minimal heating of the CZ. For full scale, more steam is needed per unit volume, and a longer steam injection period is needed to increase the heating of the moderately permeable zones.

- The radius of influence of the steam was close to 70 ft during the pilot test (steam from the center injection cluster reached locations near the perimeter extraction wells, with maximum calculated radii of 72 and 79 ft, respectively for the LSZ and UWBZ.[8] For full-scale SEE treatment, all extraction wells will be surrounded by several injection wells and receive steam from more than one side. The SEE design includes well spacings in the range of 80-100 ft (lower spacing in the less permeable UWBZ), assuming that the longer duration of steam injection will be sufficient to get steam breakthrough.

- It is understood that some local zones may not allow for steam injection or penetration at the same rates as observed during the pilot test. Such zones will likely be dominated by low permeability, and therefore also believed to be less important for the long-term fate and transport at the Site. As such, a more conservative well spacing or an increased number of injection screens per location were not justified given substantially higher cost (drilling and well materials).

[8] BEM Systems, Draft Phase I Thermal Enhanced Extraction (TEE) Pilot Test Performance Evaluation Report, June 2010, Page ES-10

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The LNAPL and benzene removal percentages during the pilot test were modest. With the full-scale SEE approach, the thermal treatment will be much more aggressive:

- Steam will in general surround each extraction well and mobilize LNAPL and vaporize contaminants to the extraction wells (except in the CZ and certain areas of the LSZ, where extraction wells have been added along the perimeter, and less effective displacement and recovery is expected if significant LNAPL is present due to steam not fully surrounding the perimeter extraction wells).

- Steam breakthrough to the extraction wells will be achieved by injection of more steam into each injection well for a longer period of time, thus allowing for a more complete sweep and higher average temperatures.

- The TEE pilot test data indicate removal of between 12 and 20% of the starting LNAPL volume in the test cell.[9] With full-scale SEE, a much more complete sweep is expected, and the LNAPL displacement to the extraction wells will be more complete. Instead of ceasing steam injection prior to steam breakthrough at the extraction wells and transitioning to air injection (as was done in the TEE pilot test), the majority of the LNAPL will be recovered as a liquid.

- The TEE pilot test data also indicate an average reduction of the benzene mass of 66%.[10] Due to the higher temperatures, the longer duration, and the pressure cycling for full scale SEE implementation, better than 99% reduction of the VOC constituents such as benzene is anticipated for the permeable zones contacted by the steam. The removal in the low-permeability zones will be lower, and it is difficult to predict exactly what the average site-wide reduction will be; however, TerraTherm expects to achieve at least a 90% reduction in these zones, and thereby anticipates a TTZ-wide mass reduction for benzene of 95% or higher.

- In the TEE pilot test, a total of 13,121 million British Thermal Units (MBTU) of energy were injected into the subsurface as steam.[11] The target volume for the TEE pilot test cell was

[9] BEM Systems, Draft Phase I Thermal Enhanced Extraction (TEE) Pilot Test Performance Evaluation Report, June 2010, Page ES-16.
[10] BEM Systems, Draft Phase I Thermal Enhanced Extraction (TEE) Pilot Test Performance Evaluation Report, June 2010, Page ES-17.
[11] BEM Systems, Draft Phase I Thermal Enhanced Extraction (TEE) Pilot Test Performance Evaluation Report, June 2010, Page 67.

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approximately 46,000 cy.[12] Using an enthalpy of vaporization of 971 BTU/lbs for steam yields an average steam usage of approximately 300 lbs per cy soil treated in the pilot test. By comparison, the full-scale remediation steam usage estimate is 320,000,000 lbs to treat the approximate 410,000 cy TTZ, corresponding to approximately 780 lbs steam per cy of soil treated. This comparison shows that more than twice the amount of steam will be injected per cy of soil for the full-scale versus the TEE pilot, thus supporting the robust full-scale SEE approach.

- In the event that substantial LNAPL is discovered during well installation at a planned injection well location, SIWs and MPE wells will be constructed to serve as either extraction or injection wells to avoid spreading contamination by injecting steam in a highly contaminated area. In such a case, steam will be injected for a short period to preheat the area surrounding the steam well prior to turning the well into an extraction well to recover the LNAPL surrounding the well. This method is called cyclic steam injection or "huff-and-puff". If the LNAPL present in the vicinity of the well is deemed to be substantial, as much LNAPL as possible may be extracted prior to adding any steam to the well to limit the potential for spreading any LNAPL even during the initial huff-and-puff cycle.

- Pressure cycling will be conducted after steam breakthrough to the extraction wells – allowing for steam stripping and vaporization of the majority of the volatile fraction from the LNAPL inside or near the steam zone. This will allow for removal of benzene and other volatile constituents not only from the permeable zones, but also from the lower permeability layers surrounding the steam zone.

In general, the full-scale SEE approach targets higher temperatures, more aggressive steam sweep, more complete LNAPL displacement to extraction wells, and a longer and more effective vaporization period than the TEE pilot test. This is all intended to lead to a much more effective removal of both LNAPL and benzene.

5.2 Steam Injection and Extraction System

As stated previously, steam injection will be utilized to heat the TTZ in the CZ, UWBZ and LSZ. Steam will be injected from three different screen interval depths. The steam wells are described further in Section 5.4.

[12] BEM Systems, Draft Phase I Thermal Enhanced Extraction (TEE) Pilot Test Performance Evaluation Report, June 2010, ES-7.

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To ensure complete heating of the target interval to the bottom of the Site, the SIWs will be screened 5 ft below the bottom of the TTZ. A total of 34 steam injectors are designed to deliver a total of approximately 48,800 lbs/hr of steam during peak operations, with 6,300 lbs/hr, 8,750 lbs/hr and 33,750 lbs/hr of steam injected to the CZ, UWBZ and LSZ, respectively. Table 5.1 below shows the predicted peak injection rates in each of the three treatment zones.

Table 5.1 Predicted Peak Steam Injection Rates for the Three Zones at the Site

Zone	Predicted peak injection rate [lbs/hr]	Number of injection wells [-]	Predicted peak injection rate per well [lbs/hr]
CZ	6,300	6	1,050
UWBZ	8,750	10	875
LSZ	33,750	18	1,875
Total	48,800	34	

Steam will be provided by two portable, dual-fuel fired steam boiler packages. Water supply for the steam boilers will be from a new temporary water service connected to the City of Mesa water system. AMEC will provide the water hookup for the TerraTherm system.

A network of 51 MPE wells spread throughout the interior of the TTZ will be used to extract LNAPL, groundwater and vapors from the subsurface to ensure that an inward hydraulic gradient is maintained throughout the SEE operational period. Additionally, provisions have been included to allow for some of the perimeter wells to be operated in an alternating injection/extraction mode. This huff and puff operational mode will be utilized if LNAPL is identified at perimeter well locations during installation to minimize the risk of spreading the LNAPL through steam injection.

The MPE wells are screened at the same intervals as the SIWs.

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Table 5.2 below shows the predicted peak extraction rates from each of the three zones at the Site.

Table 5.2 Predicted Peak Extraction Rates from the Three Zones at the Site

Zone	Peak extraction rate [gpm]	Number of extraction wells [-]	Predicted peak extraction rate per well [gpm]
CZ	30	13	2.3
UWBZ	45	14	3.2
LSZ	151	24	6.3
Total	227	51	

It is anticipated that a peak liquid extraction rate of approximately 227 gallons per minute (gpm) will be facilitated by the MPE wells and delivered to the aboveground liquid treatment system. The operational objective will be to ensure that a net positive extraction rate is maintained such that more water is extracted as steam and hot water from the subsurface than is delivered to the TTZ (by both influx and the active steam injection). This will ensure that an inward hydraulic gradient is maintained and prevent unwanted migration of mobilized Site contaminants or heated water away from the TTZ. The anticipated 227 gpm peak liquid extraction rate from the MPE wells is approximately 2.3 times the expected peak steam liquid injection rate of 48,800 lbs/hr (approximately 98 gpm). Further evaluation of containment at these rates is provided in RD/RAWP Appendix E.

5.3 Numerical Calculations of Heating

5.3.1 Introduction

Numerical water and energy balance calculations were conducted as part of the design effort to investigate the importance of groundwater flux, water and steam extraction rates, steam injection well spacing and steam injection rates for the temperatures that can be achieved in situ. The Site consists of multiple zones with different soil properties (porosity, saturation, groundwater flux), and thus so-called "black-box" models are not fully sufficient for estimating the heat progression at a site like this. Therefore, a water and energy balance code has been developed by TerraTherm to simulate the addition, removal, and loss of energy in each layer of the Site separately, with the layers exchanging both fluids (water, steam) and energy along their boundaries. The calculations

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also estimate heat losses along the top, sides, and bottom of the TTZ and the impact of groundwater flow into the treatment area, such that relatively accurate total energy demands are derived.

The model is based on simplified mass and energy balance principles relevant for SEE operation. The model can include up to nine layers each with different model input and derived parameters including:

- Surface area;
- Depth;
- Area of perimeter;
- Porosity;
- Initial saturation;
- Initial bulk density;
- Initial heat capacity; and,
- Initial thermal conductivity.

During the simulations, parameters such as thermal conductivity and heat capacity are adjusted automatically as the water saturation changes, based on published equations for these parameters. This means, for instance, that as the water saturation in a zone decreases due to the steam replacing the water in the pore spaces, the water saturation is reduced, and therefore both the heat capacity and thermal conductivity are reduced, such that only the remaining water contributes to these parameters. This gives a more realistic prediction of the heat migration than if constant values for the thermal conductivity were assumed.

The results of the numerical simulations have served as the basis for the design of the thermal treatment system at the Site. The model setup is further described below.

5.3.2 Treatment Area Size and Geology

The Site footprint is approximately 199,000 ft^2 encompassing three distinct steam injection intervals: the CZ with a vertical extent of approximately 145-160 ft bgs, the UWBZ with a vertical extent of approximately 160-195 ft bgs, and the LSZ with a vertical extent of approximately 210-245 ft bgs.

As previously discussed and shown in Figure 3.2, the LPZ is located between the UWBZ and the LSZ. Since steam is not expected to homogenously heat the LPZ, the zone will instead be heated partly by thermal conduction from the hot layers above and below it. One half of the LPZ was included in the UWBZ while the other half was included in the LSZ in the energy balance

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calculations for the Site. Thus, the two layers have a vertical extent from 160-202.5 ft bgs and 202.5-245 ft bgs in the calculations.

The CZ and UWBZ have the same footprint of 71,923 ft^2 while the LSZ has an area of 185,025 ft^2. Table 5.3 shows the estimated thermal treatment area and volume based on the location of the contaminants and the zone definitions described above.

Table 5.3 Area and Volume of the Thermal Treatment Zone

Location	Area [ft^2]	Treatment Depth [ft]	Volume [cy]
CZ	71,923	145-160 ft bgs	39,957
UWBZ (and top half of LSZ)	71,923	160-202.5 ft bgs	113,212
LSZ (and bottom half of LSZ)	185,025	202.5-240 ft bgs	256,979
Total	**199,029**		**410,149**

The treatment areas used in the numerical model are shown in Figure 5.1.

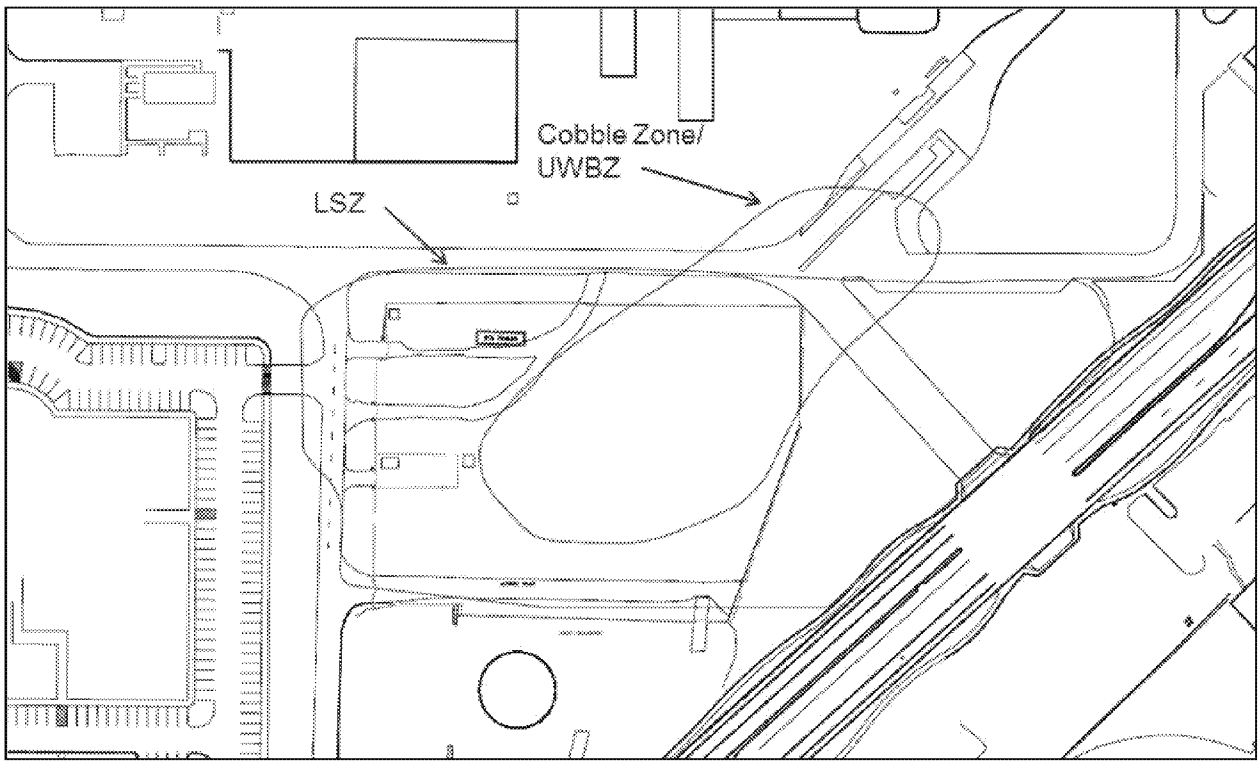

Figure 5.1 Thermal Treatment Areas Used in the Numerical Simulation

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The TTZ was divided into nine layers based on simplifying the predominant geological properties present at the Site and the assumed contaminant distribution in the numerical model. Both the UWBZ and the LSZ include two layers due to the thickness of these units. Layers 2 through 7 in the numerical model are all within the TTZ (except the bottom 5 ft of Layer 7), while the remaining layers are outside of the TTZ. Layer 1 represents the vadose zone above the TTZ, while layers 8 and 9 represent the aquitard underlying the TTZ. The layers and simplified geology in the numerical model are shown in Figure 5.2.

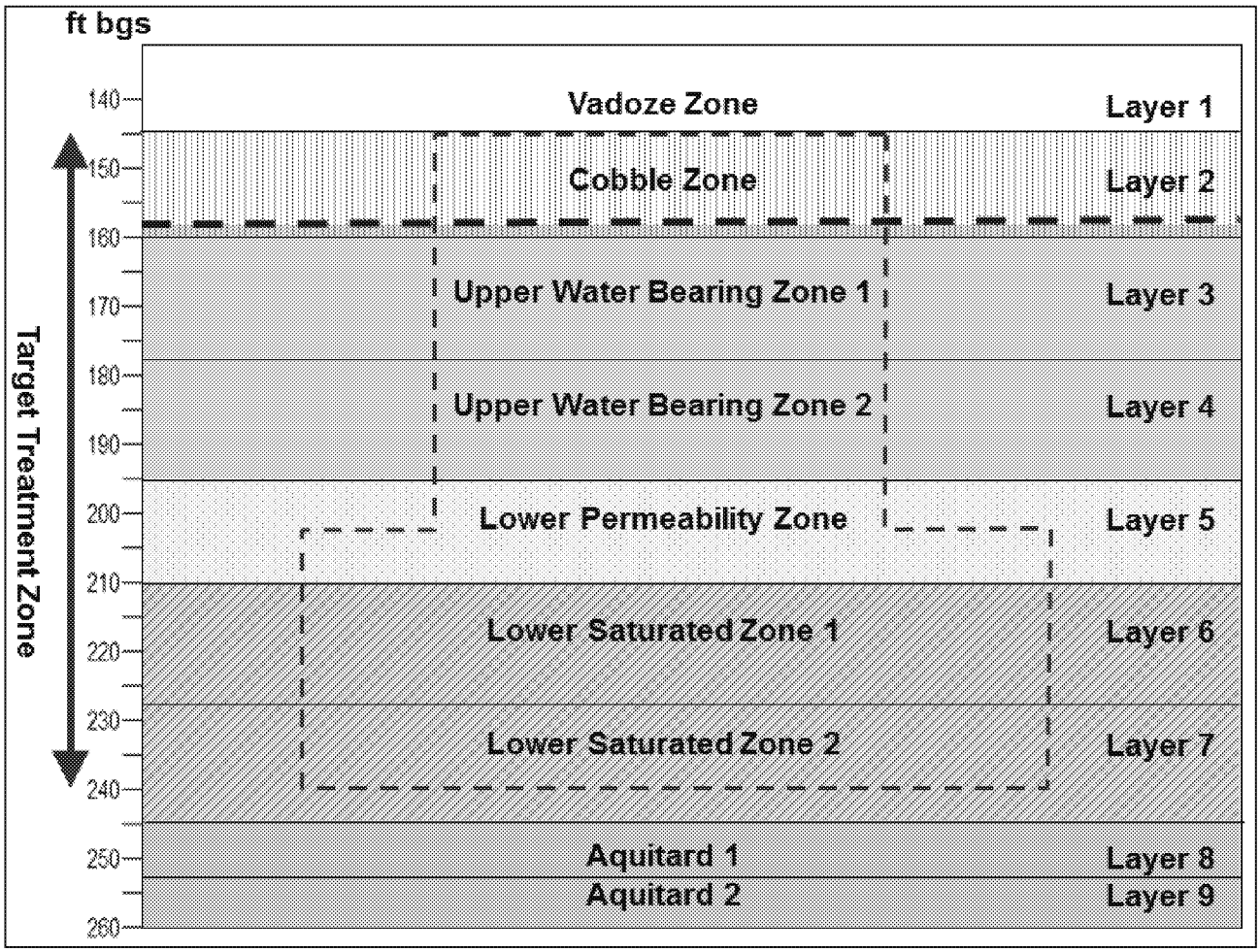

Figure 5.2 Numerical Model Layers and Geology

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Input values for porosity and initial saturation for each of the model layers served as the starting basis for the energy balance calculations conducted in the model and are shown in Table 5.4.

Table 5.4 Starting Parameters for Model Layers

Layer	Geology	Top [ft]	Bottom [ft]	Thickness [ft]	Estimated water influx [gpm]*	Initial saturation [-]
Layer 1	Vadose Zone	135	145	10	-	0.8
Layer 2	Cobble Zone, coarse-grained layer	145	160	15	10.6	1.0
Layer 3	UWBZ 1, interbedded coarse and fine grained layers	160	177.5	17.5	4.1	1.0
Layer 4	UWBZ 2, interbedded coarse and fine grained layers	177.5	195	17.5	6.7	1.0
Layer 5	Lower permeability zone, silty clay layer	195	210	15	-	1.0
Layer 6	LSZ 1, interbedded coarse and fine grained layers	210	227.5	17.5	23.1	1.0
Layer 7	LSZ 2, interbedded coarse and fine grained layers	227.5	245	17.5	23.1	1.0
Layer 8	Aquitard 1, confining low permeability layer	245	252.5	7.5	-	1.0
Layer 9	Aquitard 2, confining low permeability layer	252.5	260	7.5	-	1.0

*The influx was calculated for each model layer by taking the estimated water influx from upgradient under natural gradients, adding the expected net injection rate of water (as steam) during operation and subsequently assuming an additional 150% for additional groundwater pulled in to maintain containment.

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Please note that a porosity value of 0.30 was assumed for all layers[13] in Table 5.4 while an ambient temperature of 15˚C was conservatively assumed for all layers. The initial saturation in the lower part of the vadose zone was estimated to be 0.8. Also, it was conservatively assumed that the CZ will be fully saturated at the start-up of steam operations, which may not represent actual conditions.

5.3.3 Input Parameters and Energy Balance

Tables 5.5 and 5.6 provide summaries of the heat capacity in the modeled zones and the model energy balance calculations. Note that the Total Volume in the Heated Zone (HZ) (615,149 cy) listed in Table 5.5 is the total heated volume, which is larger than the treated volume (410,149 cy) because the steam front extends above, below and outside of the TTZ to ensure complete heating of the soil within the TTZ. Results of the steam model were used to estimate the extent of the HZ. The model calculates heat capacity and energy input based on the volume and mass of entire HZ.

Table 5.5 Volume and Heat Capacity

Heat Capacity	Number	Unit
Total volume, TTZ	410,149	cy
Total volume, HZ	615,149	cy
Solids volume, HZ	428,066	cy
Air volume, HZ	3,625	cy
Water volume, HZ	183,457	cy
Soil weight, HZ	1,910,336,000	lbs soil
Water weight, HZ	308,949,000	lbs water
Soil heat capacity, HZ	477,584,000	BTU/F
Water heat capacity, HZ	308,949,000	BTU/F
Total heat capacity, HZ	786,533,000	BTU/F

While the soil within the HZ comprises six times the weight of the water within the TTZ, the heat capacity of the water in the HZ is only 35% less than that of the soil. Thus, it is apparent that the heat capacity of the water in the HZ, and therefore the flux of water moving through the HZ, is a critical consideration in the design of the thermal remediation system at this Site.

[13] BEM Systems, Draft Phase I Thermal Enhanced Extraction (TEE) Pilot Test Performance Evaluation Report, June 2010, Page 63 and 65.

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Table 5.6 shows the energy added to the HZ by the SIWs, along with energy removed from the HZ as both liquid water and steam by the vapor and liquid extraction systems, and estimated energy losses through the top, bottom and sides of the HZ. As indicated by the values in Table 5.6, the extraction of hot water and steam vapors necessary to control the steam injection process and for removal of the volatilized Site contaminants results in removal of a significant portion of the injected energy.

Table 5.6 Energy Balance

Energy Balance	kW	BTU/hr
Steam energy input, average	11,282	38,520,000
Steam energy removal, average	698	2,383,000
Water energy removal, average	3,425	11,695,000
Heat loss top, average	916	3,129,000
Heat loss bottom, average	1,501	5,124,000
Heat loss sides, average	1,091	3,724,000
Net energy injection	3,651	12,466,000

5.3.4 Temperature Progression

Figure 5.3 shows the predicted average temperature in the TTZ as a function of time. The heat-up and boiling of soil pore water occur simultaneously as the heat front moves away from the SIWs. The last regions to boil and achieve sufficient steam stripping and contaminant removal are the coolest locations within the TTZ between the SIWs. The model predicts after 332 days of operation the steam system will be shut off and the extraction system will remain in operation during a 90-day cool-down and post treatment extraction period to day 422 of operation.

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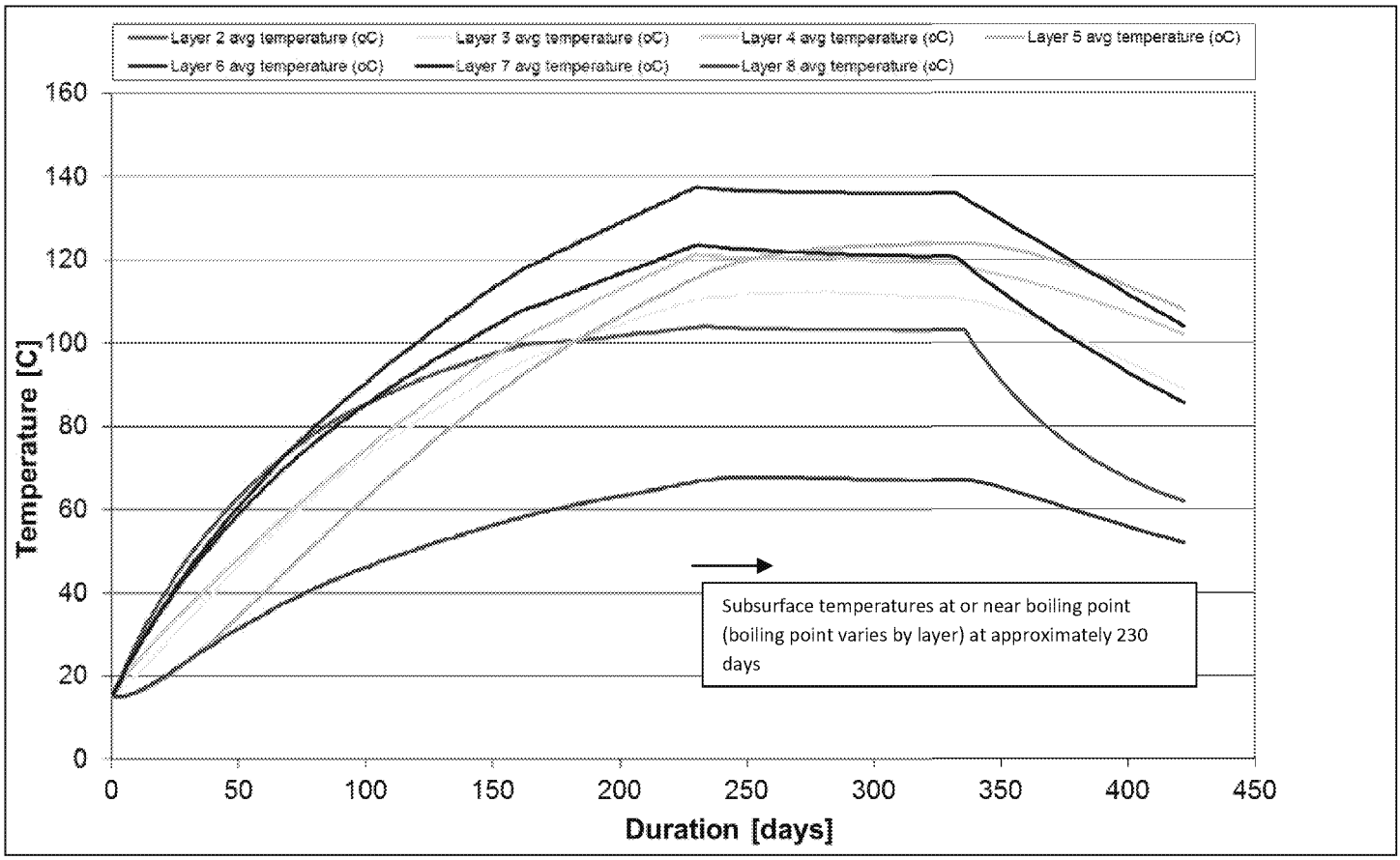

Figure 5.3 Average Temperature Curves for Layers 2 to 8 during Thermal Treatment

(Note: Layer 5 is the LPZ; only the top part of Layer 7 is in the TTZ and Layer 8 is below the TTZ)

The boiling point temperature increases with depth at the Site due to the increased pressure (hydrostatic head) in the formation. The boiling point in the unsaturated vadose zone of the model (layer 1) is 100˚C (212˚F) while the boiling point in Layer 7 in the LSZ is 140˚C (284˚F).

The results of the base simulation indicate that the entire TTZ (Layers 2 through 7) will reach the boiling point in approximately 230 days of steam injection, except for Layer 5 (the LPZ) where steam is not injected. In the model, Layer 5 is heated indirectly by thermal conduction from the layers above and below it. Layer 5 reaches a maximum temperature of approximately 124˚C (255˚F) toward the end of the operational phase. The boiling point at depth for Layer 5 is 131˚C (268˚F) according to the model.

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In the model, Layer 7 is located from 227.5 – 245 ft bgs with a boiling point of 140˚C (284˚F). The bottom 5 ft from 240 – 245 ft bgs of layer 7 is below the TTZ and is not expected to reach boiling point temperatures. This is the reason why the average graph showing Layer 7 temperature in Figure 5.3 does not reach boiling point temperatures. The highest average temperature achieved in Layer 7 is 124°C (which is not the boiling point at depth). Boiling point temperatures are expected to be achieved within the TTZ (i.e., above 240 ft bgs).

5.3.5 Operational Durations

Based on the model calculations, the operational durations for the Site have been estimated. The operational sequence is shown in Table 5.7.

Table 5.7 Overview of Operational Sequences

Phase	Steam and power usage	Duration [days]
Phase 1	Shake-down and initial heat-up	80
Phase 2	Heatup	150
Phase 3	Boiling, steam stripping and pressure cycling	102
Phase 4	Post treatment extraction	90
	Total	422

The operational phases are explained further in Section 7.3.2. The estimated total period of operation is approximately 422 days (~14 months), including startup/shakedown, heating, sampling and post-treatment vapor extraction. The thermal heating system is operated with the objective of optimizing the subsurface heating and contaminant removal process. The operational plan is flexible, allowing for adjustments based on observed hydraulic responses, heating progression, and contaminant extraction rates.

5.3.6 Energy Demand

The numerical energy balance calculation accounts for the following:

- Energy input by the steam injection system;
- Heat losses to the surrounding areas (sides and through top and bottom of the TTZ);
- Removal of energy from the Site by extraction of heated steam vapors; and,
- Removal of energy from the Site by extraction of heated groundwater.

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Table 5.8 summarizes the steam injected by the steam system throughout the duration of the thermal treatment operation. In addition, the power that will be used by the process treatment system has also been estimated, based on an estimated peak power demand of 1600 kilowatt (kW) and requiring a 2000 volt-amperes (kVA) power supply transformer.

Table 5.8 Steam and Power Usage

Steam and power usage	Duration [days]	Estimated steam injected [lbs]	Power usage treatment and steam system [kWh]
Shake-down and initial heat-up	80	93,696,000	2,150,000
Heatup, period	150	171,581,000	4,032,000
Boiling, steam stripping and pressure cycling	102	54,080,000	2,742,000
Initial cool-down	90	-	2,419,000
Total	**422**	**319,357,000**	**11,343,000**

Based on the numerical calculations, it is estimated that the total steam energy input during operations is approximately 320 million lbs of steam. The power usage for the SEE system is estimated to be approximately 11.3 million kilowatt hours (kWh).

5.3.7 Effluent Treatment System Design Parameters

The energy balance calculations in the numerical model are used to calculate values for vapor and liquid extraction rates necessary to maintain capture and optimize the treatment. Tables 5.9 and 5.10 present design parameters and effluent discharge estimates resulting from the numerical model calculations.

Based on the calculated values, the vapor treatment system will be designed to treat an influent wellfield flow rate of up to 3,200 standard cubic feet per minute (scfm). After the condensing front end of the vapor treatment system, an expected 1,740 scfm of primarily non-condensable vapors will remain to be treated. The 1,740 scfm from the wellfield is then combined with an estimated 2,000 scfm from the air strippers, and the combined 3,740 scfm are treated in the thermal accelerators.

The front end of the liquid treatment system will be designed to treat approximately 508 gpm of extracted liquids and condensate. After treatment to remove LNAPL and sediment, motive water for the MPE eductors (273 gpm) will be recirculated to the MPE wells via eductor pumps. The remaining water stream (227 gpm) will be further treated to meet wastewater discharge requirements. The water treatment system will be designed to handle a minimum flow of 235

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gpm, which includes condensate from the vapor collection system. The equipment selection is further described in Sections 5.9 and 5.10.

Table 5.9 Process Equipment

Process Equipment, vapor	Estimate Based on Model	Units
Wellfield vapor extraction rate, max total	3,200	scfm
Wellfield non-condensable vapor, max	1,500	scfm
Wellfield condensable vapor (steam), max	1,700	scfm
Wellfield condensable vapor (steam), max	4,465	lbs/hr
Wellfield flow after condensation	1,740	scfm
Flow from air stripper	2,000	scfm
Flow to thermal accelerator	3,740	scfm
Process Equipment, liquid	**Estimate Based on Model**	**Units**
Wellfield liquid extraction rate, max	227	gpm
Wellfield eductor pumps motive water flow	273	gpm
Wellfield steam extraction rate, if condensed, max	8	gpm
Water treatment rate, until eductor motive flow return, max	508	gpm
Water treatment rate to air stripper	235	gpm

5.3.8 Utility Demand

The estimated water and vapor discharge and fresh water usage requirements are shown in Table 5.10.

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Table 5.10 Water and Vapor Discharge and Fresh Water Usage

Project period	Duration	Water discharge			Fresh water usage		Stack vapor discharge	
	[days]	Average wellfield extraction rate (steam and MPE water) [gpm]	Estimated blow-down (boilers, softeners and cooling tower) [gpm]	Total volume [gallons]	Average rate [gpm]	Total volume [gallons]	Average stack discharge rate [scfm]	Total volume [million cf]
Shake-down and initial heat-up	80	229.5	20.5	28,800,000	138	15,861,000	6,400	737
Heatup, period 2	150	222.7	20.5	52,545,000	135	29,247,000	6,400	1,382
Boiling, steam stripping and pressure cycling	102	85.1	20.5	15,505,000	84	12,370,000	6,400	940
Initial cool-down	90	82.9	20.5	13,400,000	40	5,184,000	6,400	829
Total	422			110,250,000		62,662,000		3,889

Over the course of the thermal treatment, an estimated 110 million gallons of treated water are expected to be discharged to the sewer.

An estimated 3,889 million cubic feet (cf) of vapor is expected to be discharged from the stack during operation. This number includes the natural gas and combustion air added at the thermal accelerators as well as air discharged and treated from the air stripper.

The estimated fresh water usage for steam generation and cooling tower makeup water is expected to be 63 million gallons.

5.4 Wellfield Design and Installation

The TTZ extends from 145-160 in the CZ, 160-195 in the UWBZ and 210-245 ft bgs in the LSZ. Steam will be injected from wells screened across the treatment depths in all areas.

Hydraulic control will be maintained by groundwater extraction from MPE wells located across the TTZ. Pneumatic control will be maintained by vacuum applied to the MPE wells. Operation of the hydraulic control system will be optimized to extract the minimum required flow to maintain the

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necessary extraction and containment, while minimizing the amount of excess energy (heat) removed from the subsurface.

The existing SVE system manifold piping is constructed of chlorinated polyvinyl chloride (CPVC). The deep SVE wells (screened 135-165 ft bgs) within the TTZs will be retrofitted by AMEC with metal valves rated for 150 pounds per square inch (psi) and will not be operated during SEE operations. Five new SVE wells co-located with temperature monitoring points will be connected to the SVE conveyance piping and SVE conveyance piping on the southeast portion of the Site will be re-routed along the Site perimeter fence and/or subsurface to the existing SVE treatment equipment. AMEC will complete the SVE system modifications and operate the SVE system during SEE operations.

Drawing C103 (found in Appendix C of the RD/RAWP) depicts the proposed thermal wellfield. Please note that SIWs may be converted into MPE wells and vice versa during construction as more subsurface information is gained during well installation. Thus, each well will be constructed for both injection and extraction. This flexible strategy is described in Section 6.

The wells shown are as follows:

- 18 LSZ SIWs. These wells supply heat to the LSZ. The wells are screened from 210-245 ft bgs. Each injection well has three thermocouples installed to monitor the temperature at the top, middle and bottom of the injection screen.

- 10 UWBZ SIWs. These wells supply heat to the UWBZ. The wells are screened from 170-195 ft bgs. Each injection well has the infrastructure installed to allow for the installation of three thermocouples to monitor the temperature at the top, middle and bottom of the injection screen. Please note that the UWBZ injection and extraction screen depths have been shortened to end at 170 ft bgs so that they do not interfere with the injection/extraction intervals in the CZ above. The interval from 160-170 ft bgs is heated indirectly by thermal conduction from the layers above and below it

- 6 CZ SIWs. These wells supply heat to the CZ. The wells are screened from 145-160 ft bgs. Each injection well is equipped with the infrastructure for a collocated TMP to be installed for temperature measurements to be collected to monitor the temperature at the top, middle and bottom of the injection screen.

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- 24 LSZ MPE wells recovering fluids and screened from 210-245 ft bgs. Each MPE well is equipped with the infrastructure for a collocated TMP to be installed for temperature measurements to be collected to monitor the temperature at the top, middle and bottom of the extraction screen.

- 14 UWBZ MPE wells recovering fluids and screened from 170-195 ft bgs (see note on UWBZ screen interval above). Each MPE well is equipped with the infrastructure for a collocated TMP to be installed for temperature measurements to be collected to monitor the temperature at the top, middle and bottom of the extraction screen.

- 13 CZ MPE wells recovering fluids and screened from 145-160 ft bgs. Each MPE well is equipped with the infrastructure for a collocated TMP to be installed for temperature measurements to be collected to monitor the temperature at the top, middle and bottom of the extraction screen.

- 17 temperature monitoring strings instrumented with up to 24 thermocouples per location.

Figures 5.4 and 5.5 below show the conceptual well construction drawings for the operational wells in the treatment area. Refer to Drawings C104 through C106 in Appendix C of the RD/RAWP for details.

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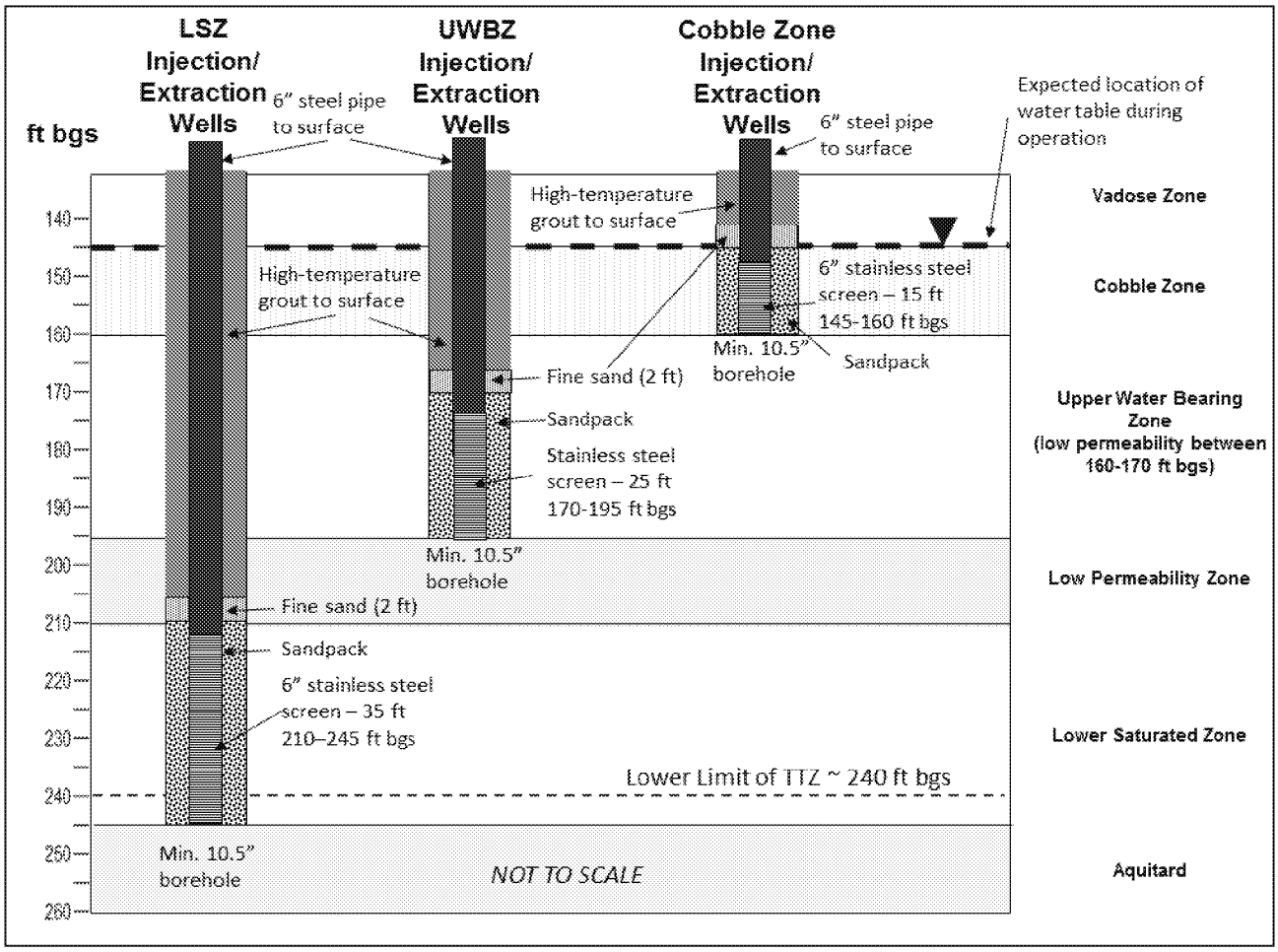

Figure 5.4 Conceptual Well Construction Diagrams of Steam Injection and Multi-Phase Extraction Wells

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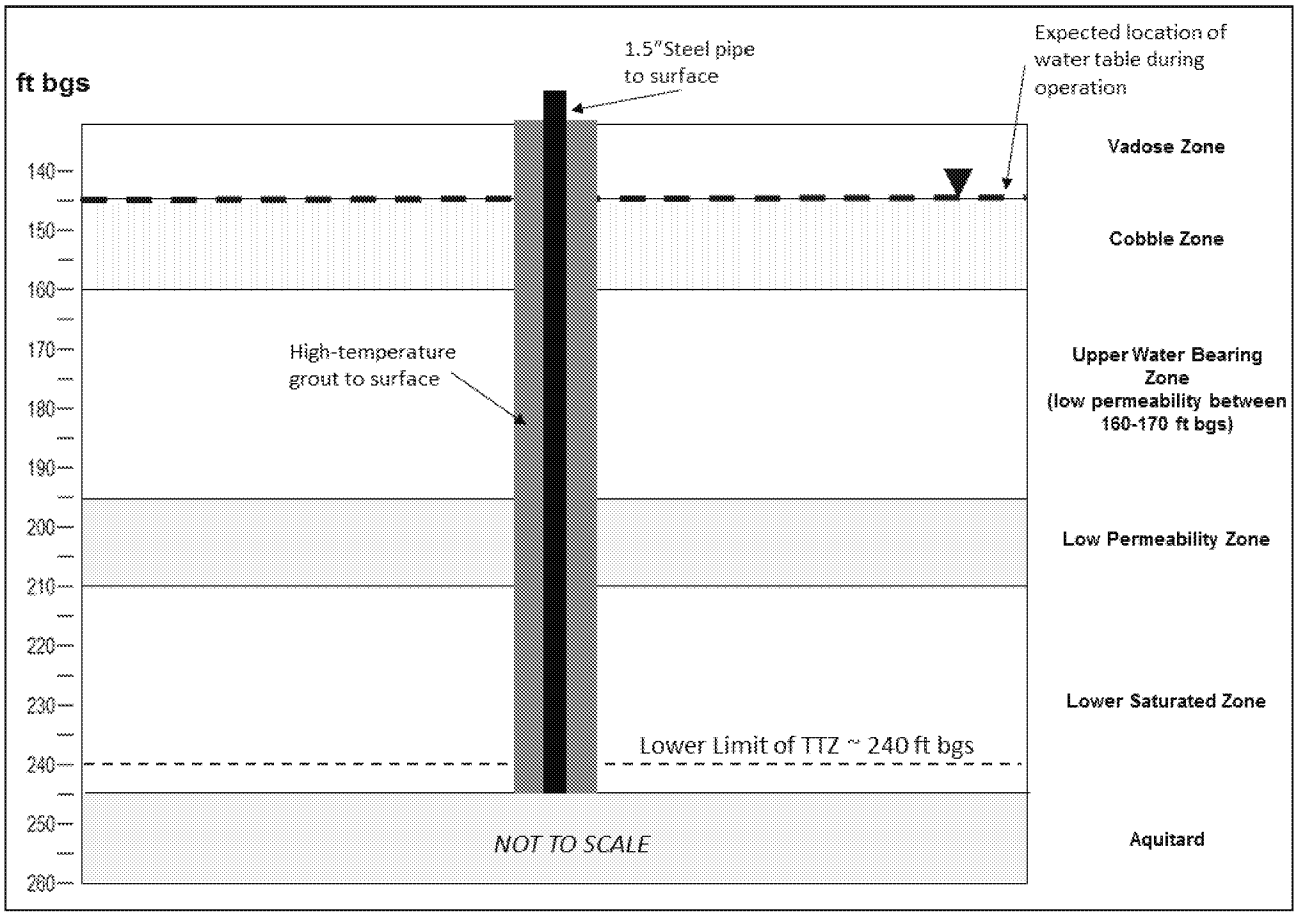

Figure 5.5 Conceptual Well Construction Diagram of Temperature Monitoring Points

5.4.1 Surveying

All SIWs, MPE wells, and temperature monitoring points to be installed in the ground will be surveyed by AMEC for plan location and elevation.

5.4.2 Drilling and Well Installation Methods

Rotosonic and air rotary drilling will be used by AMEC for the installation of the thermal wellfield (SIWs, MPEs, and temperature monitoring points). Rotosonic drilling will be used for the new wells installed in the LSZ TTZ to facilitate detailed geologic and contaminant observations with depth across the site. Air rotary will be used for the shallower (CZ and UWBZ) wells and for overdrilling of existing wells. The rigs will be set up and tooled to provide optimal drilling production rates and sufficient power to install the wells to the required depths.

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This approach greatly reduces the volume of cuttings generated as compared with hollow stem auger drilling and has been used successfully at other in situ thermal remediation sites. After achieving the desired final borehole depth, the well or monitoring point will be installed and the well pipe will be filled according to the design specifications for the particular type of well, as the casing is withdrawn. Additional drilling techniques may be utilized during well installation.

5.5 Steam and Liquid Conveyance

Due to the temporary nature of the thermal treatment system, the steam injection and liquid and vapor extraction wells are constructed as aboveground completions for ease of operation and maintenance. Vapor, liquid and steam manifold piping will be installed on the ground and/or on unistrut (or similar) pipe stands. Steam injection and eductor feed and return piping will consist of welded steel pipe, the steam injection piping will also be insulated for personnel protection and to minimize heat losses. Vapor conveyance piping will consist of fiberglass pipe. Connections to the individual wells will be made with temperature and chemical rated hose connections to allow for sufficient flexibility for thermal expansion during operation. If conveyance lines are required after the steam injection period is complete, conveyance piping to the cell phone lot will be buried so that Ulysses Avenue can be reopened (this is discussed further in Section 6.3.5).

5.6 Mechanical and Electrical Installation

For the electrical infrastructure, TerraTherm will provide a skid-mounted portable switchboard with National Electrical Manufacturers Association (NEMA) 3R (outdoor, weatherproof) rated equipment to serve as the main electrical service connection point. The system will be designed and factory-tested in accordance with applicable American National Standards Institute (ANSI), NEMA, Underwriters Laboratories (UL) and Institute of Electrical and Electronics Engineers (IEEE) standards.

TerraTherm and our subcontracted licensed electrician will run secondary conductors from breakers on the 3,200 amp main switchboard to downstream panel boards that feed the process treatment system components as shown on the Electrical Single Line Drawing (E101) in Appendix C of the RD/RAWP. The majority of the electrical panel boards and effluent treatment equipment proposed for use on this project are skid-mounted portable equipment, designed to be taken from site to site. Due to the temporary nature of the project, the majority of the equipment connections will be made using extra hard duty rated portable power cords (e.g., Type W cord, Type G cord, "mining cable") and other portable cords (e.g., Type SOW) suited for outdoor use in

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wet environments. All equipment will be installed, wired, and commissioned in accordance with the National Electrical Code (NEC).

5.7 Site Specific Considerations

A number of factors specific to the existing site conditions must be considered during implementation of the thermal treatment system.

5.7.1 Temporary Facilities and Laydown Area

Temporary facilities and material laydown areas will be set up following mobilization to the Site. Temporary facilities will include a construction trailer, storage containers, portable toilet, hand wash station, etc.

5.7.2 Site Preparation

As discussed below, a total of nine temporary spill containment berms will be mobilized to the Site for containment of various components of the vapor treatment, liquid treatment and NAPL conditioning systems. TerraTherm will install 3" lifts of pea gravel or similar under the areas where the temporary spill containment berms will be installed.

5.7.3 Utilities

Utility hookup as well as water discharge lines will be provided at the TerraTherm equipment pad by AMEC.

5.7.4 Existing Infrastructure in Treatment Area

Due to the pressurized steam that will be injected during SEE operations, existing wells located within the TTZ (including the horizontal wells and horizontal well drilling attempts) or within a 100 ft boundary around the TTZ will need to be over-drilled and abandoned with high temperature grout by AMEC. Any above grade infrastructure associated with the SVE system at the Site needs to be re-routed as well.

5.7.5 HAZOP Findings

A Hazard and Operability Analysis (HAZOP) was performed by TerraTherm and AMEC on June 27-28, 2013. The HAZOP was based on TerraTherm's preliminary design for SEE Treatment. During the HAZOP, TerraTherm and AMEC evaluated each major piece of equipment in the design and identified the hazards associated with the equipment and the related consequences if a hazard were to be triggered. In addition, the existing safeguards to prevent the hazard of concern were evaluated. A risk ranking was then calculated based on the severity of a given hazard and the likelihood of the hazard occurring. Findings of the HAZOP have been incorporated into this design.

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5.8 Process Flow Diagram

A process flow diagram (PFD) including a material and energy (M&E) balance, has been developed based on the system design. Drawing P101 depicts the vapor and liquid sides of the PFD. The M&E balance has been developed based on the heat capacity and energy balance data as well as the thermal model output described in Section 5.3 of this document.

5.8.1 Process Equipment Control System Description

A Process and Instrumentation Diagram (P&ID) will be included in the Operations and Maintenance Manual that will be developed for the SEE implementation.

The process treatment system will be automated using a combination of programmable logic controllers (PLCs), relay based panels and distributed input/output (I/O) modules. The combination of local PLCs and I/O modules will monitor and control various system components, such as pumps and solenoids, based on flow, temperature, pressure and level inputs from various instruments and sensors. In some instances, distributed I/O modules may be added to a piece of rental equipment to ensure the safe and effective operations of the system.

In the event of an alarm or upset condition, the PLC where the alarm occurs will take immediate action to address the problem. As this happens, other PLCs on the peer-to-peer network will receive notification about this alarm condition, which, in turn will initiate any other required actions at their respective skids to bring the system into a safe condition. In addition, the Master Communication Panel (MCP) will notify the operations team of this alarm via text messages on their cell phones. Data from this network of PLCs are collected at regular intervals at the MCP. All data are then transmitted daily to TerraTherm's headquarters for further analysis.

5.8.2 Control System and Interlocks

The process treatment system is designed to treat the recovered vapor and liquid stream through the remediation process. The system consists of modular components forming multiple treatment trains that may be run in parallel for maximum capacity or run in the single train configuration to achieve maximum efficiency.

Due to this operational flexibility, the control system was designed using distributed control methodologies. The system may be broadly viewed as having four major components with individual and independent controllers that may work alone or in concert with other modules in the system. The four components are as follows:

- The Overall Plant (Utility/Infrastructure);

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- Boiler System;
- The Vapor System; and,
- The Liquid Treatment System/Eductors.

While these components act mostly independent of each other, the control system will collect all of the system alarms and notify the operation teams of any issues with the equipment. In order to accomplish this, each skid will have at a minimum a set of dry contacts for indicating the status of the equipment and a set of dry contacts that will take in a permissive signal from a coordinated PLC that will issue a command based on site/process/equipment conditions.

A PLC interlock table specifying alarm conditions for each of the major treatment skids together with the associated instrument identifier will be a component of the Operations and Maintenance Manual. The table also describes what other equipment skids (if any) will be affected by a given alarm condition and if the alarm will trigger a call-out to the system operators and/or project engineer.

A detailed description of the control system will be included in the project specific Operations and Maintenance Manual that will be completed prior to system commissioning.

5.9 Vapor Treatment System

The vapor treatment system components are mounted on skids with interconnecting piping. The system consists of the following major items. Design specifications can be found in Table 5.11 below. The tag numbers refer to the equipment names shown on Drawing P101:

- Moisture Separators (S-101 and S-102)
- Vapor Coolers (E-101 -01, -02, -03)
- Cooling Towers (W-101 -01, -02, -03)
- Vacuum Blowers (B-101A/B)
- Thermal Accelerators (F-101 and F-102)

Vapors extracted from the wellfield enter the moisture separator (S-101). Vapors from the moisture separator flow through a vapor cooler (E-101) followed by a second moisture separator (S-102), before entering the primary vacuum blowers (B-101 A/B). The wellfield vapors are then combined with the vapor flow from the air strippers and then pushed to the thermal accelerators (F-101 and F-102). Following treatment by combustion, the treated vapors are exhausted to the atmosphere.

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Many of the vapor treatment system components are specified to be rental equipment or purchased refurbished equipment. Therefore, the exact configuration and specifications described below are subject to change based on equipment availability.

TerraTherm will install a temporary secondary containment berm for the following vapor treatment system components:

- Moisture Separator 1 (S-101)
- Vapor Coolers (E-101 -01, -02, -03)
- Moisture Separator 2 (S-102)

5.9.1 Moisture Separator 1 (S-101)

After exiting the wellfield, the process vapor stream will be drawn through horizontal Moisture Separator 1 (S-101) to remove steam condensed in the vapor manifold and entrained liquid droplets. Water collected in the moisture separator will be pumped to the sediment tanks with oil skimmers (S-104 -01, -02).

The moisture separator is a skid-mounted, fiber reinforced plastic (FRP) vessel. A pair of parallel discharge pumps (P-101A/B) is connected to the liquid effluent port. The moisture separator has two nozzles for vapor inlet/outlet connections. The top port is the vapor discharge to the vapor coolers (E-101 -01, -02, -03). The moisture separator has a stilling well that houses side mounted level sensors and a sight glass for level monitoring. A man way is located on top of the moisture separator for inspection and cleaning of the vessel and servicing the demister pad.

Level sensors installed through the ports in the stilling well at the moisture separator provide discrete input signals to the local skid-mounted control panel. These operate the two moisture separator transfer pumps (P-101A/B) and provide a high-high level interlock alarm. Additionally, a low level switch controlling the transfer pumps provides an interlock in the event of no flow.

5.9.2 Vapor Coolers (E-101 -01, -02, -03)

After passing through the moisture separator (S-101), the air stream will pass through a set of parallel vapor coolers (E-101 -01, -02, -03). Two vapor coolers will be operating at all times with a third vapor cooler used as a supplemental unit during peak operations. The vapor will be cooled approximately 57°F (32°C) to a target temperature at approximately 120˚F (49°C). The heat exchangers use approximately 500 gpm of water from cooling tower W-101-01.

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5.9.3 Cooling Towers (W-101 -01, -02, -03)

Three packaged closed loop cooling towers (W-101 -01, -02, -03) will be used to provide non-contact cooling water for the vapor coolers (E-101 -01, -02, -03), liquid heat exchangers (E-102 -01, -02) and NAPL heat exchanger (E-103).

Cooling tower W-101-01 will supply cooling water for the vapor coolers, while cooling towers W-101-01 and -02 will supply cooling water to the liquid and NAPL heat exchangers.

The cooling towers will be self-contained units, with an expected total 2,000 tons of cooling capacity. The total 2,000 tons cooling capacity is comprised of two 800-ton units and the reuse of the 400-ton cooling tower that is currently located at the Site.

The packaged cooling tower units include recirculating pumps capable of pumping a minimum of 3,000 gpm combined and controls. The cooling towers are expected to require a combined total of 40 gpm makeup water.

5.9.4 Moisture Separator 2 (S-102)

To minimize condensate formation in the combustion process at the thermal accelerators the vapors will be drawn through a second moisture separator (S-102). Water collected in the moisture separator will be pumped to the sediment tanks with oil skimmers (S-104 -01, -02).

The moisture separator (S-102) is a skid-mounted, Teflon®-lined carbon steel vessel. A pair of parallel discharge pumps (P-102A/B) is connected to the liquid effluent port of each separator. The moisture separator has two nozzles for vapor inlet/outlet connections. The top port is the vapor discharge to the primary vacuum blowers (B-101A/B). The moisture separator has a stilling well that houses side mounted level sensors and a sight glass for level monitoring. The moisture separator includes a demister pad to prevent moisture carryover in the vapor exhaust. A man way is located on top of the moisture separator for inspection and cleaning of the vessel and servicing the demister pad.

Level sensors installed through the ports in the stilling well at the moisture separator provide discrete input signals to the local skid-mounted control panel. These operate the two moisture separator condensate transfer pumps (P-102A/B) and provide a high-high level interlock alarm. Additionally, a low level switch controlling the transfer pumps provides an interlock in the event of no flow.

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5.9.5 Vacuum Blowers (B-101A/B)

Vapors will be pulled from the moisture separator (S-102) and delivered to the thermal accelerators (F-101 and F-102) using vacuum blowers (B-101 A/B). The vacuum blowers are centrifugal type blowers, meeting the design conditions of 36 inches of water column ("wc) vacuum at 1,750 scfm of non-condensable vapors and discharge pressure of 45 "wc, which is sufficient to provide the required 30 "wc at the influent to the treatment system. The vacuum blowers will be configured in duplex fashion so that an installed spare is immediately available in the event that there is a problem with the primary blower. The vacuum blowers will be skid-mounted and individually packaged with isolation butterfly valves and discharge check valves. Operation of the vacuum blowers will be automatically controlled by a variable frequency drive to modulate speed and maintain the desired flow and vacuum.

Vacuum blower noise levels are predicted to be less than 101 decibels A scale (dBA) (free-field at one meter distance), at maximum performance. Operating noise levels will be lower when the vacuum blowers are operating at less than maximum required performance; however, it may still be appropriate to wear hearing protection when working in close proximity to the operating vacuum blowers. Appropriate signage will be installed on/around the vacuum blower skids and hearing protection will be available at the vacuum blower skids and in the job trailer.

5.9.6 Thermal Accelerators (F-101 and F-102)

The thermal accelerators, F-101 and F-102, are used to destroy the Site contaminants in a combustion process using either natural gas or recovered JP4 as burner fuel. Thermal accelerators are a thermal oxidizer that is configured to burn hydrocarbons at a higher concentration than conventional thermal oxidizers or internal combustion engines. A thermal accelerator has a different burner than a conventional thermal oxidizer. In a standard thermal oxidizer, the vapor stream is directed to the combustion chamber, while in a thermal accelerator, the vapor stream is directed first to the burner and then to the combustion chamber. Thermal accelerators are well suited to sites such as ST012 where LNAPL is present. The operating inlet temperature to the thermal accelerators is ~140°F and the outlet temperature is expected to be 1,200-1,500°F.

The thermal accelerators are the primary component of the proposed vapor treatment system. The two units proposed for use at this Site are each a nominal 2,300 scfm with a rated hydrocarbon Destruction and Removal Efficiency (DRE) of 99%. They are designed to automatically maintain a specific temperature profile within the thermal reaction zone (the chamber), up to a range of 1,400 – 1,800°F, which is above the auto-ignition point for natural gas. For this Site, a chamber temperature of 815°C (1,500°F) is expected to be required.

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The thermal accelerators automatically maintain the temperature profile through a proportioning valve that adjusts the mixture of supplemental fuel (natural gas or recovered JP-4) to maintain the reaction zone temperature profile. Within the reaction zone, they destroy Site contaminant vapors, yielding carbon dioxide and water vapor.

5.10 Liquid Treatment System

Groundwater from the MPEs, entrained liquids, and condensate generated in the vapor treatment system will be treated by the Liquid Treatment System by cooling, filtration, gravity separation, air stripping and liquid phase carbon. The liquid treatment system's components are mounted on skids with interconnecting piping. Design specifications can be found in Table 5.12 below. The tag numbers below refer to the equipment names shown on Drawing P101 in Appendix C of the RD/RAWP:

The liquid treatment system consists of the following major items:

- Eductor Feed Pump Skids (P-108-01A/B-06A/B)
- Sediment Tank with Oil Skimmer (S-104 -01, -02)
- Bag Filter 1 (FX-102 01A/B-02A/B)
- Liquid Heat Exchangers (E-102 -01, -02)
- Gravity Separators (S-105 -01, -02)
- Discharge Tank (T-102)
- Chemical Water Treatment (Z-104)
- Air Strippers (Z-103 -01, -02)
- Moisture Separator 3 (S-103 -01, -02)
- Bag Filter 3 (FX-104)
- Liquid Phase Carbon Vessels (C-101A/B and C-102A/B)

Some pieces of the liquid treatment system are specified to be rental equipment or purchased refurbished equipment. Therefore, the exact configuration and specifications described below are subject to change based on equipment availability.

TerraTherm has included secondary containment for the following equipment in this design:

- The two sediment tanks with oil skimmers (S-104 -01, -02) and the discharge tank (T-102) will come equipped with spill guards from the manufacturer.

TerraTherm will install a total of five temporary secondary containment berms for the following liquid treatment system components:

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- Eductor feed pump skids (P-108-01A/B - 06A/B)
- Sediment tank discharge pumps (P-109 -01, -02), bag filters 1 (FX-102 -01, -02) and liquid heat exchangers (E-102 -01, -02)
- Gravity separators (S-105 -01, -02) and associated gravity separator discharge pumps (P-113 -01, -02)
- Discharge tank pumps (P-104A/B) and chemical water treatment (Z-104)
- Air strippers (Z-103 -01, -02), air stripper liquid effluent pumps (P-111-01A/B), moisture separator 3 (S-103 -01, -02), moisture separator 3 pumps 8(P-103 -01A/B, -02A/B), bag filter 3 (FX-104) and liquid carbon vessels (C-101A/B and C-102A/B)

5.10.1 Eductor Feed Pumps (P-108-01A/B - 06A/B)

During the TEE pilot test, QED AP4 pneumatic pumps were used to extract groundwater from the shallow zone and Blackhawk piston pumps were used in the LSZ. Due to the low yield of groundwater, the Blackhawk pumps were replaced by Grundfos submersible multistage centrifugal high temperature pumps during the TEE pilot. The pumps used during the TEE pilot are not applicable for the full-scale SEE implementation due to the higher temperatures and higher extraction rates of the groundwater.

Based on a detailed evaluation of different pump options, an eductor feed pump system using water as the motive fluid was selected for the full scale implementation. Six eductor feed pump skids will be used to provide high pressure (500 psi) recirculated water for the motive fluid. Each skid will have duplex 75hp pumps with variable speed drives, pressure transducers, intake and discharge header valves and gauges to monitor pump operations. Each skid will service several wells, yielding a total net pumping rate of approximately 40 gpm per skid (240 gpm total capacity) using roughly the same amount of motive water.

5.10.2 Sediment Tanks with Oil Skimmers (S-104 -01, -02)

The eductors will deliver the extracted wellfield liquids to two sediment tanks with oil skimmers (S-104 -01, -02). The tanks are each 18,000-gallon, multi-chambered weir tanks allowing sediment settling, preliminary LNAPL separation and subsequent clear water evacuation to downstream treatment equipment. These tanks provide only rough LNAPL solids separation. Subsequent units provide additional removal. In TerraTherm's experience, 1-2 hours retention time is adequate; however, space is available for additional units if necessary. The sediment tanks with oil skimmers will also vent out any air pumped by the educator feed pumps. The vent lines will be run to the vapor treatment system to reduce fugitive emissions. The sediment tanks with oil skimmers include integral weirs that will facilitate separation as stated above. The primary chamber of each of the sediment tanks with oil skimmers is the largest allowing water delivered from the eductors

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to "settle", dropping out sediments that may have been drawn from the extraction wells. Two segregation weirs will trap LNAPL liquids in front of the first weir, and then clear water will pass beneath the second weir before finally flowing into the discharge chamber. Accumulated liquid in the discharge chamber will be pumped to downstream treatment equipment.

A float type oil skimmer will be installed in each of the sediment tanks with oil skimmers tanks to capture oil separated in the tanks. Any LNAPL separated in the oil skimmer will gravity feed to the primary NAPL recovery tank (T-104) and from there be pumped by the air operated diaphragm skimmer oil pumps (P-110-01A/B and -02A/B) through bag filter 2 (FX-103A/B) and the NAPL heat exchanger (E-103) to the LNAPL tank (T-101). Please see section 5.11 for further details.

A second set of sediment tank discharge pumps (P-109-01A/B and -02A/B) provide water evacuation through bag filter 1 (FX-102-01A/B, -02A/B) and the liquid heat exchanger (E-102-01, 02) to the gravity separator (S-105 -01, -02). These pumps are expected to be controlled by level switches located in the discharge chamber of the sediment tanks with oil skimmers. As the level in the discharge chamber rises and reaches the high level activation point, the sediment tank discharge pump will start pumping down the level. Once the liquid level reaches the low level deactivation point, the pump will stop. The process is repeated as more liquid enters the discharge chamber. If for some reason the liquid level continues to rise above the high level activation point, a secondary high-high level float switch is installed. If the liquid level reaches this sensor, the eductor wellfield will be disabled, interrupting liquid flow into the sediment tanks with oil skimmers.

5.10.3 Bag Filters 1 (FX-102 -01A/B – 02A/B)

The liquid from the sediment tanks with oil skimmers (S-104 -01, -02) will be pumped through bag filters 1 FX-102 -01, -02 to remove any coarse particles before entering the liquid heat exchangers. The liquid from the FX-102 will then be pumped to the liquid heat exchangers E-102 -01, -02.

5.10.4 Liquid Heat Exchangers (E-102 -01, -02)

The liquid heat exchangers (E-102 -01, -02) will receive the extracted liquid from the sediment tanks with oil skimmers at a design temperature of up to 200°F and cool the liquid to 120°F. The liquid heat exchangers are fitted with pressure and temperature gauges to monitor their operating conditions. Flow rate through the liquid heat exchangers is a function of the volume associated with the combined pump cycles of all eductor feed pumps that have delivered water to the

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sediment tanks with oil skimmers. The design flow rate for the liquid heat exchangers is 500 gpm. The cooling liquid for the liquid heat exchangers is delivered from cooling towers W-101 -02, -03.

5.10.5 Gravity Separators (S-105 -01, -02) and Discharge Tank (T-102)

The gravity separators (S-105 -01, -02) will capture LNAPL in the liquid stream. Internally, the gravity separators are equipped with separate LNAPL accumulation areas and coalescing pack, delineated by an underflow weir and an overflow weir. The separators have a vapor-tight cover vented to moisture separator 1 (S-101). Separated LNAPL will be stored in an LNAPL tank (T-101) prior to being discharged to the NAPL conditioning system (S-106). Water will flow by gravity to clear-water stilling chambers in the gravity separator.

Level sensors installed in each of the gravity separators will operate water transfer pumps. Once enough water has accumulated in the clear-water stilling chambers to reach the high level sensor, the transfer pump (P-113 -01A/B, -02A/B) is started, evacuating the water to the discharge tank (T-102) with a total capacity of 21,000 gallons. The pump will run until the liquid level reaches the low level sensor then the pump will stop. The process is repeated as water enters the clear-water stilling chambers.

The discharge tank (T-102) feeds the eductor pump skids (P-108-01A/B through P-108-06A/B) and the downstream treatment via the discharge tank pumps (P-104A/B).

5.10.6 Chemical Water Treatment (Z-104)

Hard scale buildup and biomass accumulation was observed in the water treatment system during the TEE pilot. The chemical water treatment unit (Z-104) is designed to address iron, hardness and bio-control issues. The chemical water treatment unit is comprised by one or more tank(s) with chemical metering pump(s) to provide the appropriate additive dosing.

To control iron related problems in the water system, reducing agents, sequestrants and dispersants will be added. If iron related bacteria are present in the treatment system, bio-control will be performed by injecting a small amount of bio-controlling agent when needed.

5.10.7 Air Strippers (Z-103 -01, -02)

Treated water from the chemical water treatment unit (Z-104) will be sent to air strippers (Z-103 -01, -02). This will reduce the VOC contaminant loading in the process water prior to the liquid carbon treatment. Air stripping is a treatment process by which the water is spread over a large surface for contact with air. The majority of the VOC contaminants in the water will transfer to the

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vapor phase. The now contaminated air will be fed to the thermal accelerators for destruction by combustion. The air strippers are expected to reduce the water contaminant loading to the final liquid carbon polish step by a factor of more than 100. The air strippers are designed to treat up to 300 gpm of liquid. After treatment, the liquids are pumped by the air stripper liquid effluent pumps (P-103 -01A/B, -02A/B) to the liquid carbon vessels. Removal of VOCs is estimated at 99% in the air strippers.

5.10.8 Moisture Separator 3 (S-103 -01, -02)

To minimize condensate formation in the combustion process of the thermal accelerators, the vapors exiting the air strippers will be drawn through moisture separator 3 (S-103 -01, -02). Water collected in the moisture separator 3 will be pumped by the moisture separator 3 pumps (P-103 -01A/B, -02A/B) to the sediment tanks (S-104 -01, -02) in the liquid treatment system.

Moisture separator 3 (S-103 -01, -02) are skid-mounted, Teflon® lined carbon steel vessels. A pair of parallel discharge pumps is connected to the liquid effluent port of each (P-103-01A/B, -02A/B). Moisture separator 3 has two nozzles for vapor inlet/outlet connections. The top port is the vapor discharge to the air stripper blowers B-102 -01, -02 and thermal accelerators F-101/102. Moisture separator 3 has a stilling well that houses side mounted level sensors and a sight glass for level monitoring. Moisture separator 3 includes a demister pad to prevent moisture carryover in the vapor exhaust. A man way is located on top of the moisture separator for inspection and cleaning of the vessel, and servicing the demister pad.

Level sensors installed through the ports in the stilling well at moisture separator 3 provide discrete input signals to the local skid-mounted control panel. These operate the two moisture separator transfer pumps (P-103-01A/B, -02A/B) and provide a high-high level interlock alarm. Additionally, a low level switch controlling moisture separator 3 pumps provides an interlock in the event of no flow.

5.10.9 Bag Filter 3 (FX-104)

The effluent liquids from the air strippers are then pumped to bag filter 3 (FX-104), which will provide protection for the final liquid phase carbon treatment.

5.10.10 Liquid Phase Carbon Vessels 1 and 2 (C-101 A/B and C-102A/B)

Four liquid phase carbon vessels (C-101A/B and C-102A/B) each containing 5,000 lbs of liquid carbon are provided for dissolved hydrocarbon removal. Two of the vessels are plumbed in series; the primary vessel will provide gross removal while the secondary vessel will polish the water prior

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to discharge to the sewer. The remaining two vessels will be on standby, ready to be put in operation if required.

The influent, midfluent and effluent of the liquid carbon vessels will be sampled to ensure breakthrough has not occurred. Once breakthrough does occur, the secondary vessel will become the primary treatment vessel and the spent carbon from the first vessel will be replaced. The liquid-phase carbon is provided as a polishing step for water treatment after VOC removal in the air strippers. Organics removal rates are estimated at 99% but will depend on influent characteristics during operation. Carbon treatment may not be required throughout the SEE operating period depending on the final discharge permit conditions and whether pesticides are detected in the extracted fluids.

5.11 NAPL Conditioning System

Recovered JP-4 fuel will be treated separately in a fuel conditioning system. The NAPL conditioning system's components are mounted on skids with interconnecting piping. Design specifications can be found in Table 5.13.

The primary components of the NAPL conditioning system are:

- Primary NAPL recovery tank (T-104)
- Bag filters 2 (FX-103 A/B)
- NAPL heat exchanger (E-103)
- LNAPL tank (T-101)
- NAPL conditioning system (S-106)
- Conditioned LNAPL tanks (T-103 -01, -02, -03)

Recovered LNAPL from the sediment tanks with oil skimmers will be filtered and cooled and then combined with the oil separated in the gravity separators. A NAPL conditioning system will then filter the recovered LNAPL further to remove any free water prior to discharge to one or more NAPL holding tanks.

The primary NAPL recovery tank (T-104) and the conditioned LNAPL tanks (T-103-01, -02, - 03) are all double-walled fuel storage tanks; therefore, additional secondary containment has not been provided for the tanks. The components in the NAPL conditioning system are further described below.

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5.11.1 Primary NAPL Recovery Tank (T-104) and Bag Filters 2 (FX-103A/B)

The LNAPL and any emulsions from the sediment tanks with oil skimmers (S-104 -01, -02) will be captured by a floating oil skimmer and gravity drain to a 2,000 gallon LNAPL recovery tank. From there the LNAPL will be pumped through bag filters 2 FX-103A/B by a pneumatic diaphragm pump to remove any coarse particles before entering the NAPL heat exchanger. The filtered LNAPL will then be pumped to the NAPL heat exchanger E-103. The bag filters FX-103A/B are designed for greater than 20 gpm capacity.

5.11.2 NAPL Heat Exchanger (E-103)

The NAPL heat exchanger (E-103) will receive the extracted LNAPL from the sediment tanks with oil skimmers at a design temperature of up to 200°F and cool the liquid to 120°F. The NAPL heat exchanger is fitted with pressure and temperature gauges to monitor the operating conditions of the heat exchanger. Flow rate through the NAPL heat exchanger is a function of the volume associated with the combined pump cycles of the two diaphragm pumps in the front end sediment tanks with oil skimmers. The area of the heat exchanger is 8 ft^2.

5.11.3 NAPL Conditioning System (S-106), LNAPL Tank (T-101), and Conditioned LNAPL Tanks (T-103 -01, -02, -03)

LNAPL skimmed from the gravity separators is collected in the LNAPL tank (T-101) and combined with the LNAPL skimmed from the front end sediment tanks with oil skimmers. The LNAPL will then be pumped to a skid mounted NAPL conditioning system, S-106, that is designed to purify the LNAPL for reuse as a secondary fuel in the steam boilers and thermal accelerators. The conditioning system is designed to NEC Class I, Division II specification. The system will begin purifying the LNAPL/water emulsions by pre-filtering particulates mixed in the stream that were not initially separated by gravity in the sediment tanks with oil skimmers, S-104 -01, -02, and gravity separators, S-105 -01, -02. The filtered LNAPL/liquid emulsion will go through dual coalescing, separation and polishing cartridges designed for up to 15 gpm. The coalescing filters are designed to increase the water droplet size allowing the water to settle in the sump of the NAPL conditioning system tank. Automatic water drains will open and empty the sump. The separated water will be returned to the water treatment system. The separated LNAPL remaining in the filter housing will pass through the hydrophobic polishing separation cartridge allowing only the JP-4 fuel to pass through to the LNAPL tank (T-101). Positive displacement pumps will be mounted on the skid to deliver the conditioned JP-4 fuel to the 20,000 gallon conditioned LNAPL tanks (T-103 -01, -02, -03). Based on the LNAPL production rate more than one LNAPL tank may be needed during operation.

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5.11.4 LNAPL Conveyance System

A conditioned NAPL conveyance piping system will be constructed of double walled fiberglass pipe and will extend from the conditioned LNAPL storage tanks to feed the steam boilers and thermal accelerators. The LNAPL conveyance piping system will be installed below grade and equipped with a leak detection sensor.

5.12 Steam Generation System

Two low NO_x emission portable steam boilers will generate the steam to be injected into the SIWs. The boiler steam discharge is delivered to the steam injection piping manifold. A water conditioning system is used to remove mineral hardness of the water and provide a steady feed water pressure to the boilers. Design specifications for the steam generation system can be found in Table 5.14.

The primary components of the steam generation system are:

- Booster pumps (P-112A/B);
- Inlet filters (FX-101A/B);
- Water softeners (Z-101A/B);
- Steam boiler packages 1 and 2 (V-101 and V102);
- Air compressors (Z-105 and Z-111); and
- Compressed air driers (Z-107 and Z-108)

5.12.1 Booster Pumps (P-112A/B) and Inlet Filters (FX-101A/B)

The boiler and cooling tower feed water will initially be brought up to pressure by a booster pump system. The water will then be filtered in inlet filters FX-101A/B to remove any coarse particles before entering their respective water conditioning systems.

5.12.2 Water Softener (Z-101 A/B)

Water softeners (Z-101A/B) will be used to prevent scaling in the cooling towers. Hard water from regeneration of the water softeners will be routed to the sewer. The water will have elevated total dissolved solids, calcium, magnesium, and sodium concentrations. The water softeners can provide softened water at a flow rate of 67 gpm.

5.12.3 Steam Boiler Packages 1 and 2 (V-101 and V-102)

Portable natural gas-fired low NO_x emission steam boilers 1 and 2 (V-101 and V-102) will supply steam for the remediation project. The steam boilers 1 and 2 will be configured with dual fuel burners to fire on either natural gas or JP4 as a fuel source. The steam boilers 1 and 2 are capable

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of providing an average steam delivery of more than 48,800 lb/hr. Steam boilers 1 and 2 will be inspected at the Site by a licensed boiler inspector prior to charging and pressurizing.

The steam boiler packages include integrated de-aerator and water softener systems providing conditioned water to the steam boilers. The softeners will be used to prevent scaling in the steam boilers. Hard water from regeneration of the water softeners will be routed to the sewer. The water will have elevated total dissolved solids, calcium, magnesium, and sodium concentrations. Prior to being used in the steam boilers, the boiler feed water will be preheated by a de-aerator to remove excess oxygen from the boiler feed water.

The steam boilers are rated for a maximum operating pressure of 250 pounds psi. The main steam manifold operates at 225 psi, and the safety valve (pressure relief) at each boiler outlet will be set for 250 psi while the steam manifold will be rated for 300 psi. Steam manifold piping will consist of welded carbon steel header pipes, insulated for both personnel protection and to minimize heat losses. Appropriate pressure and temperature rated steam hose and couplers will be used to connect from the manifold to the individual SIWs. Each steam well is outfitted with a pressure regulator and flow control valves, along with flow, pressure and temperature gauges. The pressure regulator will be used to reduce the operating manifold line pressure down to the desired injection pressure.

To supply the 48,800 lb/hr of steam for the injection to the subsurface, the steam boilers require a water supply capable of delivering a combined continuous water feed at a rate of approximately 98 gpm. All steam, blowdown, and utility lines will be pressure tested prior to starting the steam boilers.

5.13 Treatment System Summary

Tables 5.11-5.14 below provide the design specifications for the major pieces of equipment utilized for the SEE remediation at the Site. The tables present the design requirements for the vapor and liquid treatment systems, NAPL conditioning system and the steam generation and water pre-treatment systems. The major design requirements are also presented in the M&E balance on Drawing P101 in Appendix C of the RD/RAWP.

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Table 5.11 Design Specifications – Vapor Treatment System

Description	Instrument ID	Design requirement	Selected equipment rating
Moisture separator 1	S-101	3,200 scfm	3,900 scfm
Moisture separator 1 pumps	P-101 A/B	10 gpm	15 gpm
Heat exchangers	E-101 -01, -02, -03	1,200 ft^2	1,510 ft^2 (2 units each 540 ft^2 and 1 unit 430 ft^2)
Cooling tower	W-101 -01, -02, -03	1,633 tons	2,000 ton total capacity (3 units)
Cooling tower pumps	P-105	3,050 gpm	6,000 gpm (2 units each 2,400 gpm and one 1,200 gpm)
Moisture separator 2	S-102	1,780 scfm	3,500 scfm / 15 gpm
Moisture separator 2 pumps	P-102 A/B	7.7 gpm	15 gpm
Primary vacuum blowers	B-101 A/B	1,780 scfm	2,400 scfm
Thermal accelerators 1 and 2	F-101 and F-102	4,600 scfm	5,000 scfm (2 units each 2,500 scfm)

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Table 5.12 Design Specifications – Liquid Treatment System

Description	Inst. ID	Design requirement	Selected equipment rating
Eductor feed pumps	P-108 01A/B - 06A/B	273 gpm	420 gpm (6 units each 70 gpm @ 500 psi)
Sediment tanks with oil skimmers	S-104 -01, 02	30,000 gallons	36,000 gallons (2 units each 18,000 gallons)
Sediment tank discharge pumps	P-109 -01A/B and P-109 - 02A/B	508 gpm	550 gpm (2 units each 275 gpm @ 100 ft total dynamic head)
Bag filters 1	FX-102 -01A/B and FX-102 - 02A/B	508 gpm	600 gpm (2 units each 300 gpm)
Liquid heat exchangers	E-102 -01, -02	1,540 ft^2	1,702 ft^2 (2 units each 852 ft^2)
Gravity separators	S-105 -01, -02	508 gpm	600 gpm (2 units each 300 gpm)
Gravity separator discharge pumps	P-113 -01A/B and P-113 - 02A/B	508 gpm	550 gpm (2 units each 275 gpm)
Discharge tank	T-102	10,000 gallons	21,000 gallons
Discharge tank pumps	P-104A/B	235 gpm	275 gpm
Chemical water treatment	Z-104	Up to 200 ppm of additive addition	
Air strippers	Z-103 -01, -02	235 gpm, 99% VOC removal	300 gpm (2 units each 150 gpm)
Air stripper liquid effluent pumps	P-111 -01A/B and P-111 - 02A/B	234 gpm	300 gpm (2 units each 150 gpm)
Moisture separator 3	S-103	2,820 scfm	4,000 scfm (2 units each 2,000 scfm)
Moisture separator 3 pumps	P -103 -01A/B and P-103 - 02A/B	5 gpm	30 gpm (2 units each 15 gpm)
Bag filter 3	FX-104	234 gpm	#2 Size Bag Filters 330 gpm
Liquid phase carbon vessels 1 and 2	C-101A/B and C102A/B	234 gpm, 99% organics removal (polishing)	300 gpm (2 units each 5,000 lbs with 2 additional units on standby

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Table 5.13 Design Specifications – NAPL Conditioning System

Description	Instrument ID	Design requirement	Selected equipment rating
Primary NAPL recovery tank	T-104	1,000 gallons	2,000 gallons
Skimmer oil pumps	P-110 -01A/B	5 gpm	15 gpm
Bag filter 2	FX-103A/B	5 gpm	#2 size bag filters 20 gpm
NAPL heat exchanger	E-103	7 ft^2	8 ft^2
LNAPL tank	T-101	1,000 gallons	2,000 gallons
LNAPL tank transfer pumps	P-107A/B	6 gpm	15 gpm
NAPL conditioning system	S-106	6 gpm	15 gpm
NAPL holding tanks	T-103 -01, -02, -03	20,000 gallons	Flexible, at least 20,000 gallons

Table 5.14 Design Specifications – Steam Generation and Water Conditioning System

Description	Instrument ID	Design requirement	Selected equipment rating
Booster pumps	P-112A/B	138 gpm	250 gpm @ 80 psi
Inlet filters	FX-101A/B	138 gpm	#2 size bag filters 220 gpm
Water softener	Z-101A/B	40 gpm	67 gpm
Steam boilers 1 and 2	V-101 and V-102	48,800 lbs/hr	62,100 lbs/hr @ 250 psi (2 units each 31,050 lbs/hr)
Air compressors	Z-105 and Z-111	45 acfm @ 100 psig	104 acfm (2 units each 52 acfm @ 115 psig)
Compressed air driers	Z-107 and Z-108	Dry air for compressors	104 acfm (2 units each 52 acfm)

5.14 Electrical Distribution Systems

The electrical power distribution system consists of the following major components:

- Primary Switchboard rated at 480Y/277V, 3 phase, 4 wire, 65 thousand amps interrupting capacity (kAIC). Additional details of this switchboard are as follows:
    - 3200A rated switchboard with a 100% neutral buss. Rated for Service Entrance use. Skid mounted and rated for outdoor use (NEMA 3R). Switchboard is designed and factory-tested in accordance with applicable ANSI, NEMA, UL and IEEE standards
    - (1) 3200A Main Breaker, with adjustable trip settings (adjustable long time, short time , instantaneous and ground fault protection settings)

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- Main Breaker is equipped with shunt trip such that an emergency stop will remove power to all equipment.
- (3) Branch circuit breakers (minimum) with adjustable trip setting (adjustable long time, short time, and instantaneous protection). The branch breaker's rating plug will be sized for the specific load.

- (1) Automatic Transfer Switch; 480 volt (V), 800A.
- (3) Distribution Switchboard 480Y/277V, 3 Phase, 4 Wire, 65kAIC for power feed to process equipment.
- (2) Locally mounted and wired 30kVA 480-208/120V three phase transformer and 240/120V load center. The panel will be used to supply power for controls and auxiliary components such as panel heaters, lighting, ground fault circuit interrupter (GFCI) convenience receptacles, etc.)

The service drop, including transformer for the power supply, will be provided by AMEC.

5.14.1 Instrumentation and DataCom Wiring

Installation practices for low voltage instrumentation and communications wiring in the field will ensure that cabling is protected from excessive temperatures and mechanical abrasion. To the extent practicable, all instrumentation wiring will be kept separated from high voltage power cabling. Instrumentation wiring should never be bundled with or routed parallel with high voltage cabling. Where wiring must cross high voltage cabling, it should be at right angles and with as much physical separation as possible.

5.14.2 Backup Power

One 750 kW standby generator will be wired to an automatic transfer switch to ensure continued operation of the thermal treatment process equipment at a reduced capacity in the event of a power failure. Once the system has been transferred to run on generator power, normal start-up procedures can then be followed to restart the treatment systems. If it is activated, the emergency stop system will prevent the generator from starting. In general, the following major equipment will be operational using the standby generator:

- Vacuum Blowers (B-101A/B);
- Cooling Towers (W-101-1, W-101-2);
- NAPL Conditioning System (S-106);
- Liquid Transfer Pumps (P-104A/B, P-105-1A/B, P-105-2A/B, P-107A/B, P-109-1A/B, P-111-1A/B, P-112A/B, P-113-1A/B;
- Air Stripper Blower (B-102-1, B-102-2);

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- Air Compressor (Z-105);
- One steam boiler (V-101); and,
- One thermal accelerator (F-101).

5.15 Area Classification

The design of any electrical installation must be based on the physical setting in which the electrical equipment will be installed. An Area Classification assessment is performed to determine if any specific hazards exist whereby electrical systems in the subject area could provide a source of ignition and create a risk for fire or explosion. The assessment considers the presence of flammable or explosive materials in the work area, and whether these materials may share the space occupied by electrical equipment under expected operating conditions, or in a failure scenario.

An area classification review has been conducted for the SEE project based on two industry guidance documents. IEC standard IEC 60079-10 (Explosive Atmospheres – Part 10-1: Classification of Areas – Explosive Gas Atmospheres) was applied to operational scenarios related to the potential release of explosive vapor. National Fire Protection Association (NFPA) 497 (Recommended Practice for the Classification of Flammable Liquids, Gases, or Vapors and of Hazardous Location for Electrical Installations in Chemical Process Areas) was applied to operational scenarios related to the potential release of flammable liquids under a range of ventilation scenarios. The NFPA standards very much represent the project's actual handling and storage of JP-4, but the somewhat unique condition of processing hot vapors containing JP-4 required additional consideration in the analysis.

As part of this review, research was conducted on the physical properties of Jet Fuel JP-4 which is the primary contaminant for the Site. Table 5.15 is the compilation of this research.

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Table 5.15 Physical Properties of Primary Site Contaminant

Parameter	Jet Fuel JP-4
Flashpoint, °F	-10 to 30
Vapor Pressure, psia	2-3 (at 100°F)
Boiling Point, °F	135-518
Auto Ignition Temperature, °F	464
Published LEL, % by volume	1.3
Group & Temperature Class	Class I, Division D*

*Jet Fuel JP-4 is considered a Class I flammable liquid because it has a flash point below 100°F and a vapor pressure below 40 psi at atmosphere (psia) at 100°F.

Major chemical compounds that makeup Jet Fuel JP-4 fall under Group Division D per NFPA 497.

5.15.1 Vapor Releases

For the evaluation of vapors using the IEC standard, five "Release of Source" scenarios have been identified and listed below:

1. Inside the pipes containing vapors from the well field and under pressure or vacuum service.
2. Releases from pipes containing vapor from the well field and under vacuum service.
3. Releases from pipes containing vapor from the well field and under pressure service.
4. Inside the pipes containing vapor from the air stripper.
5. Releases from pipes containing vapor from the air stripper.

Per the recommended practice standard, the "grade of release", "degree ventilation" and "availability of ventilation" for the five scenarios were used to determine the zone classifications. These zone classifications will dictate how electrical systems are to be configured in different areas of the Site. The extent of the zones (classified areas) has been determined by calculation of the projected release rate of gas or liquid, the LEL of chemical compounds and the ventilation rate per the standard's presented model and equations.

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The conclusions to this analysis are presented in Table 5.16 below

Table 5.16 Area Classification Vapor Conclusions

Source of release	Grade of release	Degree of ventilation	Availability of ventilation	Type of zone	Clearance distance
1. Inside well field pipe	continuously	low	n/a	zone 0	inside
2. Release from vacuum pipe	secondary	medium	good	zone 2	1.5 feet
3. Release from pressure pipe	secondary	medium	good	zone 2	2.5 feet
4. Inside air stripper pipe	secondary	low	n/a	zone 2	inside
5. Release from air stripper pipe	secondary	medium	good	zone 2	1.0 feet

Note: the "clearance distances" do not represent the distance out from the entire length of the pipe, but distance out from the higher potential failure points at pumps, valves and fittings.

The applicable codes referenced above determine the physical limits of the classified areas that surround any potential leakage source of flammable liquids or vapors. Any electrical equipment related to process operations in these classified areas must be:

- Physically located outside the classified area;
- Include only intrinsically safe circuits that are incapable of generating a spark (ignition source); or,

Enclosures housing electrical equipment must be sealed and designed to withstand an internal explosion (NEMA 7 rated), or in the case of a zone 2 installation, purged with clean air from a non-classified source to prevent hazardous vapors from coming into contact with electrical equipment.The type of motors to be installed in different areas at the Site will also depend on the area classification where the motor is to be installed.

In general, explosion-proof motors will be installed in zone zero and zone one areas. All other locations will use totally enclosed fan cooled motors.

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5.15.2 Liquid Releases

NPFA-497's Figure 5.9.6 was used to best represent the hazardous (classified) location area around the JP-4 liquid handling equipment and storage tanks. This figure from the recommended practice standard notes a zone 1 area inside the tanks and 3 foot radius from any vapor ventilation port. The zone 2 area extends past the zone 1 area and is defined as a 5 foot radius from any vapor ventilation port and 10 foot out by 1.5 foot above grade from any part of the tank(s) or pumps.

5.15.3 Reference Drawings

An "Area Classification" Drawing P103 is presented in Appendix C of the RD/RAWP. This drawing identifies the piping and equipment by its zone classifications.

5.16 Construction Management

TerraTherm will provide oversight and construction labor during the construction and installation of the SEE system. TerraTherm will have a construction manager and additional TerraTherm personnel onsite during system construction. AMEC will be overseeing the drilling and well installation work, while TerraTherm personnel will oversee the installation of the steam, liquid and vapor piping system installations. TerraTherm will subcontract the piping installation to licensed Arizona (AZ) contractors. TerraTherm personnel will make the final individual MPE and SIW wellhead connections to the manifold lines as appropriate. Additionally, TerraTherm personnel will install the eductor feed pumps while a subcontractor will install the pumping feed/return loop.

During process equipment installation, TerraTherm personnel will place and secure all process and pumping equipment. Interconnecting piping will be installed by TerraTherm personnel or licensed contractors as appropriate (i.e., welded pipe will be installed by a licensed AZ contractor). Additionally, TerraTherm will oversee a licensed AZ electrical contractor in the connection to the secondary side of the AMEC-provided transformer through the wiring of the process treatment, steam generation, and NAPL conditioning equipment.

The process treatment, steam generation, and NAPL conditioning equipment are primarily comprised of rental equipment. TerraTherm personnel will configure the process control system that collects inputs from the various steam generation, fuel management and effluent treatment system components to enable full process control. Additionally, TerraTherm personnel will operate the SEE system. TerraTherm's lead operator will manage the personnel onsite during the operation phase, while TerraTherm's project manager and project engineer will provide overall project management and control.

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During demobilization, TerraTherm's construction manager will provide onsite management for TerraTherm or subcontracted laborers to perform decontamination and disassembly of equipment. Licensed contractors will be utilized where needed (i.e., power disconnect from the transformer).

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6 THERMAL REMEDIATION OPERATIONS

Thermal treatment operations are estimated to last approximately 422 days. In general, the process treatment system operation will be controlled and monitored by the PLC. Steam injection will be monitored manually (manual adjustment of injection pressures). The SEE system operators will monitor the system throughout the operation and balance injection and/or extraction flows and pressures, and monitor/adjust the operation of the process treatment equipment to maintain optimum performance. Adjustments to the system operation will be made in consultation with the TerraTherm project manager and project engineer.

6.1 Final Designation of Injection and Extraction Wells

The operational wells are constructed identically, such that observations during drilling and after well construction can be made. Such observations include:

- Visual observation of LNAPL in cuttings/cores collected during drilling;
- Analytical data for soil samples (benzene and total petroleum hydrocarbon [TPH] samples at the depths with highest FID screening concentrations of soil cores in each installed well);
- Observations during well development (LNAPL presence, flow rate);
- Accumulation of LNAPL in the well;
- Benzene and TPH concentrations in the water in each well.

These data will be used to determine which wells are too heavily contaminated to become a steam injection well at the start of operations. Wells with significant LNAPL presence, or high dissolved benzene concentrations, may be designated as extraction wells.

TerraTherm, in consultation with AMEC, the Air Force, the USEPA, and the Arizona Department of Environmental Quality, will use all available information to finalize the pattern of injection and extraction wells in each of the three intervals, according to these principles:

- A regular pattern is preferred, where each extraction well is surrounded by injection wells, and vice versa;
- The TEE pilot wells will be used in their original configuration;
- Relatively clean boundary wells will be used for steam injection; and,
- Boundary wells with substantial LNAPL presence or high benzene concentrations will be used as extraction wells.

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In some instances, there may be too many wells with high LNAPL or benzene concentrations grouped together. If it is necessary eventually to inject steam in some of these wells, an initial program will be used to minimize the risk of spreading by injection into such a well. The program will consist of the following:

- First, LNAPL and groundwater is extracted from the well for several weeks, preferably until the LNAPL recovery drops to a low level;
- Steam is then injected for 1-2 weeks. Subsurface temperature, perimeter water levels, and MPE well extraction (changes in LNAPL quantity or PID readings) will be used to track steam movement to maintain containment during this injection ;
- Extraction is resumed, and the recovery of LNAPL is tracked, where possible by collecting liquid samples into transparent jars to observe any phase separation or screening of the jar headspace;
- When the mass removal declines, steam injection is repeated;
- If the previous extraction events lead to removal of substantial LNAPL quantities, and the benzene concentrations remain high, the cycle may be repeated one or more times; and,
- Once limited LNAPL recovery occurs following a steam injection cycle, the well is then ready for continuous steam injection.

Due to the uncertain nature of each well's behaviour, the operators and technical team will work closely together to optimize this critical phase of the project.

6.2 Thermal System Startup

6.2.1 Meeting and Readiness Review

Before operations begin, a readiness review meeting and inspection will be held at the Site. The following will be performed:

- Review of the entire treatment area;
- Review of effluent treatment system;
- Review of operations plan;
- Review of health and safety plan (HASP), job hazard analyses;
- Review of detailed data collection schedule and forms;
- Review of sampling and analysis schedule;
- Review of staffing plan; and,
- Discussion about uncertainties and contingencies.

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It is anticipated that this will facilitate start-up of the thermal treatment system a few days following the meeting.

6.2.2 Commissioning

The purpose of the commissioning is to inspect, test and calibrate the SEE system, including all materials and equipment in the wellfield and the process equipment. This phase is intended to locate and correct any bugs or deficiencies in the system and will help ensure a smooth transition to full, normal operation. Clean water and air will be used to operate the system. Data collection procedures will be tested and verified. The project-specific data website will be made operational.

Commissioning activities will include:

- Test all major pipelines;
- Leak-check vapor and liquid transfer lines;
- Test effluent treatment system with clean water and vapor;
- Check all motors for proper rotation;
- Verify and calibrate all instrument signals;
- Verify all analog and discrete signals to/from the PLC;
- Verify proper pre-commissioning of boilers;
- Set all valves to the proper pre-start positions; and,
- Collect background temperature and water level data.

During shakedown, all interlocks shall be tested and verified using simulated alarm conditions by utilizing the diagnostic features of the sensors or by simulating the condition during a water test. All test results shall be documented per TerraTherm internal standard procedures.

6.2.3 Steam Boiler Inspection and Commissioning

The steam boilers will be registered with the National Board of Boiler and Pressure Vessel Inspectors. The steam boilers will be inspected, operated and maintained throughout the life of the project in compliance with regulations stated in the Arizona Boiler Rules Title 20, Chapter 5, Article 4 "Arizona Boilers and Lined Hot Water Heaters" (Boiler Rules). Standards in the Boiler Rules comply with American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Codes and the American National Standard Institute (ANSI) Controls for Safety Devices for Automatically Fired Boilers.

All controls, safety devices and instrumentation installed on/within the steam boilers will meet the requirements of the NFPA 85, ASME CSD-1 Controls and Safety Devices for Automatically Fired

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Boilers, National Board Inspection Code ANSI/NB-23 and state requirements. TerraTherm's System Operator will demonstrate the operational qualification requirements as stated in the Arizona Boiler Rules, Section R20-417C and D.

6.3 Thermal System Operations

6.3.1 Hydraulic/Pneumatic Control

During the startup phase, hydraulic control of the TTZ will be established by application of a vacuum and extraction of liquid (and any accumulated LNAPL) from the MPE wells. Performance of the effluent treatment system for separation and treatment of vapors and liquids will be verified by process monitoring and sampling. Once hydraulic control has been established in each of the three depth intervals, and it is documented that the process treatment system meets the required criteria, the steam injection system will be brought on line. During operations, pneumatic control will be verified by measurement of vacuum applied to the wells (later during steam injection temperature profiles will provide additional indication of pneumatic control). Hydraulic control will be verified by ensuring net water removal from the Site and groundwater elevation monitoring outside the TTZs. Liquid removal rates will be set to ensure that liquid extraction is at least 1.5 times the net water injection rate via steam to ensure hydraulic containment of the TTZ.

6.3.2 Steam Injection

After hydraulic control is established, steam injection will begin in the LSZ perimeter injection wells, and those wells which need to be developed for continuous steam injection. Where injection wells are located on the perimeter of the zone, the steam sweeps out around the injection wells and will form a ring of steam around the TTZ boundary, pushing inward towards the outermost extraction wells. The steam zones are predicted to reach the extraction wells after approximately 60-90 days of injection. Once this occurs at individual extraction wells (as evidenced by the temperature of the extracted liquids and vapors approaching 100°C), the nearby injection rates in the steam wells will be reduced, so a sustained steam flow to the wells is attained.

After 10-20 days of perimeter steam injection in the LSZ, the internal LSZ steam wells will be brought online. Injection continues until steam breakthrough is observed in the internal extraction wells, and then the rates are reduced in individual steam injection wells. During this period, rates may be adjusted between wells, with the objective of achieving as uniform a heating as possible, and steam break-through in as many extraction wells as practical.

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The deep LSZ steam injection allows the team to observe whether steam flows upward through the LPZ into the UWBZ. The temperature profiles will be used to assess this. Where steam flows at a substantial rate, indicated by rapid temperature increases in the UWBZ, this may affect the strategy for injection and extraction in the UWBZ.

After a period of approximately 30 days of injection in the LSZ, steam injection is initiated in the UWBZ and the CZ. Similar strategies to the ones presented for the LSZ will be used, with potential modifications based on the observations from the first 30 days of operation.

At or around day 120 of operation, it is expected that steam break-through is achieved or close to being achieved throughout the LSZ TTZ. This may occur some weeks later in the UWBZ and CZ.

6.3.3 Flushing and LNAPL Removal Optimization

With relatively constant steam injection into all the injection wells, and operation of the MPE wells for optimal LNAPL removal, a period of steam flushing and LNAPL removal is expected. During this phase, individual MPE well pumping rates may be adjusted to maximize the LNAPL removal. Steam injection rates may be varied between wells to optimize the heating and the mass removal. Once the recovery of liquid LNAPL starts to diminish (which may occur in some zones and not in others), this phase is ended.

6.3.4 Pressure Cycling and Vaporization

During this phase, removal of COCs via vaporization is optimized. Pressure cycles, each lasting between 15 and 30 days, will be induced by varying the steam injection rates. During the pressurization period, steam is injected at the maximum rates across a section of the TTZ, while extraction continues. The completion of a pressurization period is indicated by the extraction well temperature rising to near boiling point temperatures, and the flow of steam from the extraction wells, with an increase in the total steam flow to the treatment system. The depressurization period involves turning down the rate of steam injection to less than 50% of the maximum. During this phase, the pressure and temperatures in the TTZ decrease, and steam is formed in situ by the boiling of hot fluids in zones which are being depressurized. It is anticipated that between 5 and 10 pressure cycles, each lasting between 15 and 30 days, will be implemented. The value of the cycling will be evaluated based on trends in mass removal, primarily vapor phase concentrations of the COCs, including benzene.

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6.3.5 Cool Down

Once SEE treatment is considered complete, the steam injection system will be turned off. The extraction and treatment systems will continue to extract and treat vapors and liquids to allow for partial cool down and to ensure capture of steam and vapors in the subsurface. During this phase, both vapor and groundwater treatment systems will operate and the subsurface temperature monitoring will continue. This phase is expected to last approximately 90 days.

In an effort to provide unrestricted access to the Phoenix-Mesa Gateway Airport Cell Phone Parking Lot, once the steam injection period is complete, the steam injection manifold connection across East Ulysses Avenue will be disconnected and the eductor feed/return lines and vapor extraction piping will be relocated below grade. Prior to the cool down period, one to two corridors approximately 3 ft wide and 18" deep will be installed across East Ulysses Avenue and connect to the Cell Phone Parking Lot. The final number of corridors required will be dependent upon the final operational configuration of the wells located within the Cell Phone Parking Lot. A 4" sand layer will be installed in the bottom of the corridor and overlain by the eductor feed/return and vapor extraction pipe spools. The pipe spools will be covered in a 4" layer of sand. Next, suitable native fill (i.e., soil free of rock and degradable materials) will be installed over the pipe bedding and compacted on 6" lifts to grade. Road plates will be installed over the top of the compacted trenches and pinned in place. A sump will also be installed to allow for condensate collection and removal.

Following the cooling period, the extraction and treatment systems will be shut down and decommissioning will begin and the corridor(s) installed in East Ulysses Avenue will be returned to its pre-disturbed condition.

6.4 LNAPL Reuse

TerraTherm has included the provision for recovered LNAPL to be conditioned and reused for fueling the steam boilers and thermal accelerators. The actual production rate of the LNAPL during operations is unknown. The LNAPL will be separated, conditioned and stored onsite. AMEC is currently researching options for excess LNAPL reuse. TerraTherm's Operations and Maintenance Manual that will be prepared prior to thermal treatment system startup will include LNAPL storage provisions, procedures and an estimated reuse schedule.

6.5 Decommissioning and Demobilization

The decommissioning and demobilization phase includes removal of the wellheads, meter runs, steam hoses, and monitoring hardware from each well. The downhole pump components (water

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line) will be removed. The wells will be left in place with suitably sealed end caps pending future abandonment by AMEC.

The steam, vapor and liquid conveyance piping and pumps skids will be disconnected and decontaminated as required.

The process treatment equipment and associated interconnecting piping will be decontaminated and disassembled working from the wellfield inlet toward the process treatment effluent to be able to process as much decontamination fluid through the system as possible. When it is no longer possible to process the decontamination fluids, they will be drummed, labeled and appropriately stored to await disposal by AMEC (estimated generation of five to ten drums of decontamination fluid). Non-hazardous waste and scrap materials will be loaded into dumpsters for appropriate off-site disposal or recycling. AMEC-owned equipment will be left onsite. TerraTherm-owned equipment will be returned to TerraTherm's Gardner, MA facility. Rental equipment and temporary facilities will be returned to vendors as appropriate.

6.6 Waste Disposal

Wastes generated during the thermal remediation process may include the following and are anticipated to be handled as indicated:

- Drill cuttings – to be characterized and shipped off-site for appropriate waste disposal by AMEC;
- Recovered LNAPL (if any) – See Section 6.4 above;
- Spent media (e.g., liquid carbon, filter bags) – liquid carbon to be characterized and regenerated by carbon vendor (assume non-hazardous), filter bags to be characterized and shipped off-site for appropriate waste disposal by AMEC;
- Decontamination fluids – processed through the SEE liquid treatment system prior to discharge. Once system has been disassembled and this is no longer possible, decontamination fluids will be drummed for characterization and shipped off-site for disposal by AMEC;
- Used personal protective equipment (PPE) – PPE not in contact with Site fluids will be disposed of as construction waste, PPE in contact with Site fluids will be drummed for characterization and shipped off-site for appropriate waste disposal by AMEC; and,
- Normal construction debris – disposed of as construction waste.

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6.7 Site Restoration

Site restoration or grading following thermal treatment and demobilization will be performed by AMEC.

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APPENDIX E

ENHANCED BIOREMEDIATION AND SEE CONTAINMENT MODELING REPORT

ENHANCED [redacted] AND SEE CONTAINMENT MODELING REPORT
FORMER LIQUID FUELS STORAGE AREA
SITE ST012
FORMER WILLIAMS AIR BASE
MESA, ARIZONA

TABLE OF CONTENTS

1.0 INTRODUCTION 1-1
1.1 Modeling Objectives 1-1
1.2 Report Organization 1-2
2.0 GROUNDWATER FLOW MODEL 2-1
2.1 Conceptual Site Model for Groundwater Flow 2-1
2.2 Model Domain and Grid 2-1
2.3 Hydrogeologic Properties 2-1
2.4 Boundary and Initial Conditions 2-4
3.0 GROUNDWATER FLOW MODEL CALIBRATION 3-1
4.0 ENHANCED BIOREMEDIATION SYSTEM GROUNDWATER FLOW MODEL 4-1
4.1 EBR Well Field Design 4-1
4.2 EBR Remediation Flow Rate Design 4-4
4.3 EBR Remediation Model Results 4-7
4.4 EBR Flow Model Conclusions 4-7
4.5 EBR Performance Objective and Monitored Natural Attenuation 4-7
4.5.1 LNAPL and Contaminant Initialization 4-8
4.5.2 Transport Parameter Discussion 4-11
4.5.3 Biodegradation Parameter Estimates 4-11
4.5.4 Model Stress Periods 4-12
4.5.5 Aerobic EBR Estimates 4-13
4.5.6 Sulfate EBR Estimates 4-14
5.0 STEAM ENHANCED EXTRACTION CONTAINMENT 5-1
5.1 Groundwater Flow Model for SEE Simulation 5-1
5.1.1 SEE Well Layout 5-1
5.1.2 SEE Groundwater Flow Model Extraction and Injection Rates 5-5
5.1.3 SEE Groundwater Flow Model Results 5-8
5.2 Site Model for Subsurface Air Flow 5-9
5.2.1 Model Domain and Grid 5-9
5.2.2 Material Properties and Boundary Conditions 5-9
5.2.3 SEE Well Layout 5-10
5.2.4 SEE Subsurface Air Flow Model Extraction and Injection Rates 5-10
5.2.5 SEE Air Flow Model Results 5-13
5.3 Assumptions and Limitations 5-14
6.0 REFERENCES 6-1

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LIST OF TABLES

Table E-2.1 Hydrogeologic Properties Summary 2-3
Table E-2.2 Hydrogeologic Properties Summary 2-5
Table E-4.1 EBR Well Design in Cobble Zone 4-2
Table E-4.2 EBR Well Design in UWBZ 4-3
Table E-4.3 EBR Well Design in LSZ 4-4
Table E-4.4 EBR Design Flow Rates in Cobble Zone 4-5
Table E-4.5 EBR Design Flow Rates in UWBZ 4-5
Table E-4.6 EBR Design Flow Rates in LSZ 4-6
Table E-4.7 Predicted TEA Travel and Mixing Times by Zone 4-7
Table E-4.8 Estimated LNAPL Volume in EBR Treatment Zones Following SEE Treatment 4-9
Table E-4.9 Initial LNAPL Saturation and Corresponding Component Concentration in LNAPL 4-10
Table E-4.10 Physiochemical Parameters of Hydrocarbon Contamination 4-10
Table E-4.11 Maximum Utilization Rates for Electron Acceptors – CZ, UWBZ, LPZ 4-11
Table E-4.12 Maximum Utilization Rates for Electron Acceptors - LSZ 4-11
Table E-4.13 Electron Acceptor Use Coefficient and Electron Acceptor Half-Saturation Constant 4-12
Table E-4.14 Predicted Maximum and Average Dissolved Benzene Concentrations Following Aerobic EBR 4-13
Table E-4.15 Predicted Maximum and Average Dissolved Benzene Concentrations Following Sulfate-Reducing EBR 4-15
Table E-5.1 SEE Well Design in CZ 5-2
Table E-5.2 SEE Well Design in UWBZ 5-3
Table E-5.3 SEE Well Design in LSZ 5-4
Table E-5.4 SEE Design Groundwater Flow Rates in CZ 5-5
Table E-5.5 SEE Design Groundwater Flow Rates in UWBZ 5-6
Table E-5.6 SEE Design Groundwater Flow Rates in LSZ 5-7
Table E-5.7 SEE Design Air Pressures at Well Screens in CZ 5-11
Table E-5.8 SEE Design Air Pressures at Well Screens in UWBZ 5-11
Table E-5.9 SEE Design Air Pressures at Well Screens in LSZ 5-12

ED_005025_00013386-00539

LIST OF FIGURES

Figure E2.1 Model Grid Layout
Figure E2.2 Model Layers
Figure E2.3 Saturated Conductivity Distribution in the Upper Water Bearing Zone
Figure E2.4 Saturated Conductivity Distribution in the Lower Saturated Zone
Figure E4.1 Conceptual Enhanced Bioremediation Well Field Layout
Figure E4.2 Cobble Zone Recirculation System Pathlines
Figure E4.3 Upper Water Bearing Zone Recirculation System Pathlines
Figure E4.4 Lower Saturated Zone Recirculation System Pathlines
Figure E5.1 SEE Well Field Layout - Cobble Zone
Figure E5.2 SEE Well Field Layout - Upper Water Bearing Zone
Figure E5.3 SEE Well Field Layout - Lower Saturated Zone
Figure E5.4 Hydraulic Head – Cobble Zone
Figure E5.5 SEE Recirculation System Pathlines – Cobble Zone
Figure E5.6 Hydraulic Head – Upper Water Bearing Zone
Figure E5.7 SEE Recirculation System Pathlines - Upper Water Bearing Zone
Figure E5.8 Hydraulic Head - Lower Saturated Zone
Figure E5.9 SEE Recirculation System Pathlines - Lower Saturated Zone
Figure E5.10 Cobble Zone Normalized Air Heads
Figure E5.11 Upper Water Bearing Zone Normalized Air Heads
Figure E5.12 Lower Saturated Zone Normalized Air Heads

ED_005025_00013386-00540

ACRONYMS AND ABBREVIATIONS

%	percent
µg/L	micrograms per liter
3D	three dimensional
AFB	Air Force base
AMEC	AMEC Environment & Infrastructure, Inc.
BEM	BEM Systems, Inc.
COC	chemical of concern
CSM	conceptual site model
CZ	Cobble Zone
DO	dissolved oxygen
EBR	enhanced bioremediation
FFS	Focused Feasibility Study
ft/day	feet per day
ft^2/hr	square feet per hour
ftH_2O	feet of water column
g/L	grams per liter
inHg	inch(es) of Mercury
LNAPL	light non-aqueous phase liquid
LPZ	Low Permeability Zone
LSZ	Lower Saturated Zone
mg/L	milligrams per liter
MNA	monitored natural attenuation
RD/RAWP	Remedial Design and Remedial Action Work Plan
R-T	reactive-transport
SEE	steam enhanced extraction
ST012	Site ST012, Former Liquid Fuels Storage Area
TEA	terminal electron acceptor
TEE	thermal enhanced extraction
TTZ(s)	thermal treatment zone(s)
UWBZ	Upper Water Bearing Zone

ED_005025_00013386-00541

1.0 INTRODUCTION

This report describes the construction of comprehensive numerical groundwater and air flow models for the Former Liquid Fuels Storage Area (ST012) at the former Williams Air Force Base (AFB) located in Mesa, Arizona. ST012 consists of approximately 13 acres within the former Williams AFB. Multiple documented and undocumented fuel spills comprised of jet petroleum grade 4 and aviation gasoline have contaminated soil and groundwater (BEM Systems, Inc. [BEM], 2010). Residual contamination in the source areas include light non-aqueous phase liquid (LNAPL) in the vadose zone and in the saturated zone below the water table.

This modeling effort has been developed in support of the Remedial Design to assess hydraulic containment and capture of LNAPL and contaminated groundwater during implementation of the two-step active remediation program, which will consist of steam enhanced extraction (SEE) followed by enhanced bioremediation (EBR). The model is also being used to help understand and design the EBR program which will be operated until the final monitored natural attenuation (MNA) step will be implemented to achieve the cleanup levels for ST012 groundwater specified in the Record of Decision Amendment 2.

1.1 Modeling Objectives

The objectives for the flow models are as follows:

- Groundwater Flow Model – The groundwater flow model has two primary objectives. It is used to assist in the design of the conceptual EBR system where groundwater is extracted and injected to add and distribute terminal electron acceptor (TEA) and other bioamendments (if needed) to the treatment zone. It is also used to establish the saturated treatment zone/conditions for assessment of the containment of the SEE remediation.
- Air Flow Model – The air flow model is used to further assess containment of the SEE remediation. Using the groundwater flow model under liquid flow regime proposed in the SEE design as the initial condition, air is injected and extracted to approximate the movement of pressurized steam from injection to extraction wells.

This effort utilizes as a starting point the groundwater flow model from the previous fate and transport study presented in the Focused Feasibility Study (FFS) (AMEC Environment & Infrastructure, Inc. [AMEC], 2012) that was developed to determine the average dissolved phase benzene concentration at year 2030 within the portions of the aquifer subject to SEE treatment and containing residual LNAPL (source zone). The estimated remedial timeframe of 20 years established in the ROD would result in achieving cleanup levels by 2033. As a conservative approach to evaluation of remedy implementation the modeling presented in the FFS and this appendix evaluates a goal of achieving cleanup levels by the end of 2030 (17 years). For this study, the flow portion of that model was updated with recently developed data on the hydrostratigraphy of the aquifers and was re-calibrated to better match observed historical trends in heads and head gradients.

ED_005025_00013386-00542

The model results are deterministic and subject to uncertainty associated with the actual subsurface structure and assumptions for model variables used to define physical and chemical processes and phenomena. AMEC has made conservative, albeit realistic, assumptions and estimates for model variables considering our understanding of these processes and phenomena as well as studies and modeling work conducted by others. Further, for conceptual EBR layouts and modeling, AMEC has used conservative interpretations of LNAPL extent to verify efficacy of implementation under more extreme conditions than may actually be present.

1.2 Report Organization

This report describes the two models constructed for this effort; the first is the groundwater flow model and the second is an air flow model. The groundwater flow model is used to support design and operation of both the EBR system and, in part, the containment of the SEE system. The groundwater flow model is used to establish the initial conditions of the SEE containment model and the air flow model is used to approximate the flow of steam from injection point. The air flow model also simulates the extraction of soil gasses through multi-phase (eductor-driven) extraction wells.

Section 2.0 describes the groundwater flow model, its basis in the conceptual site model (CSM), and the key variables used in the model. Section 3.0 presents the calibration of the groundwater flow model. Section 4.0 evaluates preliminary EBR approaches based on assumed conditions following SEE treatment. Section 5.0 uses the groundwater flow model and an air flow model to evaluate containment of fluids during implementation of SEE.

ED_005025_00013386-00543

2.0 GROUNDWATER FLOW MODEL

The groundwater flow model created for this project uses a well-documented and well-accepted finite-difference code called MODFLOW-SURFACT, an enhanced version of the widely used U.S. Geological Survey program. The groundwater flow model created for this project is roughly based on the model created for the Thermal Enhanced Extraction (TEE) Pilot Test Report (BEM, 2010) using most of the same data and model variables, but with additional information recently developed based on the Pre-Design Investigation (presented in Section 3.2.1 and 3.2.1.1 of the Remedial Design and Remedial Action Work Plan [RD/RAWP]) on the configuration and thicknesses of the hydrostratigraphic units and the extent of the separate phase LNAPL. The model was created using the Groundwater Vistas, version 5, software.

2.1 Conceptual Site Model for Groundwater Flow

This CSM presents an outline of the current understanding of ST012's physical conditions at the level of detail to support the modeling. It is recognized that heterogeneous physical conditions at ST012 and the limited information on fuel releases and occurrence in the subsurface limit the model's ability to represent the ST012 system in detail. However, the CSM serves as a useful and necessary tool for development of the assessment and has been used to aid in development of the reactive-transport (R-T) model to estimate plume longevity through EBR and natural attenuation following active remediation by steam flushing. A summary CSM description is provided in Section 2.1 of the main body text of the RD/RAWP and additional detail is provided in the FFS (AMEC, 2012). Results of the Pre-Design Investigation are presented in Appendix A of the RD/RAWP and Section 3 of the RD/RAWP provides discussion of how the Pre-Design Investigation results were incorporated in the interpreted LNAPL distribution.

2.2 Model Domain and Grid

The model domain consisted of a 3,180-foot wide by 2,760-foot long area centered on the observed ST012 plumes (Figure E-2.1). The grid was aligned to facilitate simulation of the generally west to east trending observed hydraulic gradient (BEM, 2010). The model layering is shown in Figure E-2.2. Compared with the R-T model presented in the FFS report (AMEC, 2012), the model grid was refined from 20-foot by 20-foot cells to 5-foot by 5-foot cells in the area of interest near the center of the grid. Additionally, the number of model layers was increased from 6 to 13 to specify the location of remediation well screens, as well as to provide refinement to the visualization of simulation results. The vadose zone was split from one into five layers while the Cobble Zone (CZ), Low Permeability Zone (LPZ), and Lower Saturated Zone (LSZ) were all split from one layer into two layers. Further division of the CZ, Upper Water Bearing Zone (UWBZ), LPZ, and LSZ layers was later made as described in Section 4.1

2.3 Hydrogeologic Properties

Hydraulic conductivity, storage, and unsaturated properties are summarized for all layers in Table E-2.1. The horizontal-to-vertical anisotropy in hydraulic conductivity was assigned a value of 10:1 to represent the lower effective permeability in the direction perpendicular to layering. For UWBZ and LSZ layers the hydraulic conductivity field was set up as shown in Figure E-2.3

ED_005025_00013386-00544

and Figure E-2.4, respectively. These hydraulic conductivity fields were copied from Figures M.3.2.1 and M.3.2.2 in Appendix M of the TEE Pilot Test Report (BEM, 2010). Slug test results from the Pre-Design Investigation were lower but sufficiently close (i.e., less than a factor 2 different, except ST012-LSZ14 which was a factor of ~13) to the hydraulic conductivity field from the TEE Pilot Test Report such that changes to the hydraulic conductivity field were not warranted. The horizontal conductivity of the CZ was set at 70 feet per day (ft/day). The selection of this conductivity was based on literature review as well as model calibration to transient water level rise and gradients observed in the CZ. While the overall pattern of heterogeneity in the plan view is exactly the same as was developed by BEM (2010), the top and bottom elevations for each layer were revised from the feasibility study transport model to honor previous and pre-design investigation well logs which precisely identified the elevations at which the hydrogeologic units changed for each characterization well location. These lithologic breaks were interpolated over space using the three dimensional (3D) visualization code TECPLOT; and, the MODFLOW model layering was refined to honor these interpolated hydrostratigraphic unit breaks.

ED_005025_00013386-00545

Table E-2.1 Hydrogeologic Properties Summary

Layer	Hydrostratigraphic Unit	Unsaturated Properties				Saturated Conductivity (ft/day)			Confined Specific Storage	Porosity
		Alpha	Beta	Residual Saturation	Brooks-Corey Number	Kx	Ky	Kz		
1	Unsaturated Zone	0.8	1.4	0.111	8	13	13	1.3	$1.00x10^{-05}$	0.30
2	Unsaturated Zone	0.8	1.4	0.111	8	13	13	1.3	$1.00x10^{-05}$	0.30
3	Unsaturated Zone	0.8	1.4	0.111	8	13	13	1.3	$1.00x10^{-05}$	0.30
4	Unsaturated Zone	0.8	1.4	0.111	8	13	13	1.3	$1.00x10^{-05}$	0.30
5	Unsaturated Zone	0.8	1.4	0.111	8	13	13	1.3	$1.00x10^{-05}$	0.30
6	Cobble Zone	0.8	1.4	0.111	8	70	70	7	$1.00x10^{-05}$	0.30
7	Cobble Zone	0.8	1.4	0.111	8	70	70	7	$1.00x10^{-05}$	0.30
8	Upper Water Bearing Zone	0.8	1.4	0.111	8	1	1	0.1	$1.00x10^{-05}$	0.30
9	Upper Water Bearing Zone	0.8	1.4	0.111	8	range 1 to 10	range 1 to 10	range 0.1 to 1.0	$1.00x10^{-05}$	0.30
10	Low Permeability Zone	0.256	1.32	0.111	9.25	$1.00x10-^{07}$	$1.00x10^{-07}$	$1.00x10^{-08}$	$1.00x10^{-07}$	0.30
11	Low Permeability Zone	0.256	1.32	0.111	9.25	$1.00x10^{-07}$	$1.00x10^{-07}$	$1.00x10^{-08}$	$1.00x10^{-07}$	0.30
12	Lower Saturated Zone	0.8	1.4	0.111	8	range 1 to 12	range 1 to 12	range 0.1 to 1.2	$1.00x10^{-05}$	0.30
13	Lower Saturated Zone	0.8	1.4	0.111	8	range 1 to 12	range 1 to 12	range 0.1 to 1.2	$1.00x10^{-05}$	0.30

Notes:
ft/day – feet per day

1. Modeling efforts conducted by others have considered considerably higher ratios of horizontal to vertical hydraulic conductivities at ST012 (e.g., CDM 2005 modeling effort considered a 250:1 ratio of Kh:Kv). AMEC has elected to consider a Kh:Kv ratio of 10:1. Keeping in mind the purpose of the model, a lower Kh:Kv ratio (which yields a higher Kv) is more conservative because it permits more movement of groundwater between the treated and untreated layers. Additionally, the basis for the 10:1 selection for a Kh:Kv ratio is a default, acceptable values commonly applied to interbedded unconsolidated units consistent with ST012.
2. The range of hydraulic conductivity values and distribution used to describe the UWBZ and LSZ are from the TEE Pilot Test Report (BEM 2010). The hydraulic conductivity values and distributions were built based on results from hydrogeologic testing and gauging data in that they provide a simulated groundwater pressure calibrated to observe gauging data. Since the model focuses on source term natural attenuation, using these calibrated hydraulic conductivity fields limits advection and is thereby more conservative than a single-value higher conductivity zone.
3. Model layer top and bottom elevations match the variations in surface contacts estimated/interpreted as discussed in Section 3.2.1 of the RD/RAWP.
4. The value of the hydraulic conductivity for the Low Permeability Zone was determined through trial & error adjustment during model calibration.

ED_005025_00013386-00546

2.4 Boundary and Initial Conditions

Model perimeter boundaries used included No-Flow (or inactive) cells and time-varying constant head boundaries.

The values and locations of the perimeter were determined based on the observed hydraulic gradients across the site (Figure E-2.1) and between well triplets (e.g., three wells with a given hydrostragraphic zone to yield a gradient and flow direction; see Table E-2.2 for well names in triplets) in the LSZ and UWBZ as reported by others (BEM 2010, Figures M.2.2.1.1 and 2.2.2.1), as well as the history of the water table rise at the site since 1990 (BEM 2010, Figure 2.1.2.1). To match the unique transient hydraulic gradients for the well triplets in the LSZ and UWBZ, time-varying constant heads were applied on all perimeter cells in the LSZ and UWBZ. This was accomplished using MODFLOW's CHD package, with the perimeter assigned heads calibrated to observed gradients at key times for each of the LSZ and UWBZ, and the CHD package interpolated boundary heads for those time intervals between the key times. These observed gradients for well triplets are provided in the TEE Pilot Test Report (BEM, 2010). Key gradient values at select times were selected from these charts to fix the time-varying CHD boundary condition as summarized on Table E-2.2.

The reported downward vertical gradient between the layers across the LPZ of approximately 0.1 feet per foot was also addressed in our CHD setup. The aquitard layer at the bottom of the LSZ and unsaturated zone layers above the water table were simulated as No-Flow boundaries.

No recharge or evapotranspiration was modeled; however, the model does incorporate the rising groundwater table which has been calibrated based on historic rate of rise through 2012 and projects future rise based on the most recent rate (1.67 feet per year).

ED_005025_00013386-00547

252 **Table E-2.2 Hydrogeologic Properties Summary**

Hydrostratigraphic Unit	Calibration Well Triplet	Date	Hydraulic gradient	
			Magnitude (feet per foot)	Direction (degrees)
Upper Water Bearing Zone	1 wells used: N-2, N-8, and N-13	Mar-97	0.0052	1.7
		Aug-97	0.0054	-1.0
		Apr-98	0.0082	-33.2
		Mar-99	0.0060	5.4
		Apr-00	0.0061	6.5
		Mar-01	0.0058	4.4
		Mar-02	0.0056	0.6
		Oct-03	0.0116	22.9
		Nov-04	0.0072	4.3
		Nov-05	0.0078	28.2
		Aug-06	0.0098	27.2
		Feb-08	0.0123	30.2
		Nov-10	0.0052	19.8
		Nov-11	0.0043	19.3
		Nov-12	0.0049	27.9
Lower Saturated Zone	1 wells used: W-24, W-26, and W-29	Jul-93	0.0053	3.5
		Sep-93	0.0034	-22.6
		Dec-93	0.0034	-37.7
		Mar-94	0.0034	-19.9
		Jul-94	0.0041	-23.9
		Jan-95	0.0050	-1.8
		Apr-96	0.0055	-1.0
		Mar-97	0.0054	-1.2
		Sep-97	0.0054	-2.6
		Apr-98	0.0055	-2.3
		Apr-99	0.0058	-0.4
		Apr-00	0.0078	11.3
		Mar-01	0.0054	12.6
		Apr-02	0.0053	2.3
		Oct-03	0.0140	24.4
		Nov-04	0.0152	30.5
		Dec-06	0.0183	39.3
		Feb-09	0.0156	41.5
		Apr-09	0.0147	38.5
		May-09	0.0138	9.5
		Jun-09	0.0094	24.7
Lower Saturated Zone	2 Wells used: W-30, W-7, and W-24	Sep-91	0.0060	-14.3
		Mar-92	0.0057	-16.5
		Apr-93	0.0051	-14.1
		Apr-94	0.0052	-0.8
		Feb-95	0.0062	-26.3
		Feb-96	0.0056	-15.9
		Mar-97	0.0056	-17.5
		Apr-98	0.0085	-25.4
		Feb-99	0.0047	-0.4
		Apr-00	0.0049	-8.7
		Mar-01	0.0064	-28.6
		Apr-02	0.0055	-28.3
		Oct-03	0.0047	-15.5
		Dec-04	0.0042	-12.6
		Nov-10	0.0032	-42.8
		Nov-11	0.0030	-42.8

3.0 GROUNDWATER FLOW MODEL CALIBRATION

Calibration of the water flow involved adjusting the perimeter constant head boundaries and the vertical conductivity of the LPZ. The observed gradients to which the model was calibrated are summarized in Table E-2.2. The heterogeneous hydraulic conductivity field that was adopted from the calibrated model in Appendix M of the TEE Pilot Test Report (BEM, 2010) creates non-uniformities in the groundwater flow pattern which are only partially influenced by the model boundary constant head conditions. The vertical conductivity of the LPZ strongly impacted the amount of hydraulic communication between the UWBZ and the LSZ. When the Kv of the LPZ was too high, strong communication between these two zones would make it impossible for the observed gradients for the well triplets in the UWBZ and LSZ to vary semi-independently as was observed, computed, and presented in Appendix M of the TEE Pilot Test Report (BEM, 2010).

The procedure to calibrate the perimeter boundary heads for each discrete time snapshot for each hydrostratigraphic unit (UWBZ and LSZ) involved the following multi-step iterative process:

1. Fixing the heads in each corner of the domain and defining the constant heads along each perimeter boundary by linearly interpolating between the corner heads, the initial values for the corner heads resulted in an average gradient across the domain equal to the well triplet gradient (Figure M.2.2.1; BEM, 2010).
2. Running the model under steady-state conditions for those specified boundary heads.
3. Computing the simulated gradient (both direction and magnitude) for the well triplets.
4. If the computed gradient and flow direction for the steady-state model closely matched the gradients and flow direction reported in Appendix M of the TEE Pilot Test Report (BEM, 2010), proceed to Step 5; if the simulated gradient and flow direction were not within 10 percent (%) and 5-degrees, respectively, of the observed values (by date), the fixed corner head values were adjusted in the direction to force the simulated well triplet gradient and flow direction to more closely mimic the gradient computed (BEM, 2010), and return to Step 2.
5. These values were fixed as the constant heads for that hydrostratigraphic zone (either the UWBZ or the LSZ) for that discrete step in time.
6. Use MODFLOW's time-variant CHD package to linearly interpolate the evolution of the perimeter fixed heads over those time intervals between each discrete time snapshot.

Once these perimeter boundary heads were determined in this manner, the full model was run in transient mode, and the evolution of the simulated gradient and flow direction over time were computed and compared to the observed gradient and flow direction evolution (Table E-2.2). When doing this, it was discovered that the time-varying conditions in the UWBZ and LSZ significantly impacted the simulated gradients when the vertical conductivity of the LPZ was greater than 10^{-3} ft/day. Therefore, the Kz of the LPZ was fixed at this lower value, and the six-step procedure above was repeated. This model calibration process confirmed the relative "tightness" of the LPZ as a confining unit for the LSZ.

ED_005025_00013386-00549

4.0 ENHANCED BIOREMEDIATION SYSTEM GROUNDWATER FLOW MODEL

The approach to remediating the LNAPL impacted zones outside the SEE treatment zones combines the technologies of groundwater recirculation with the addition of TEA, and plume containment, followed by a period of natural attenuation and groundwater monitoring.

Conceptually, the EBR system will consist of an interlaced network of injection and extraction wells screened in the three water-bearing, LNAPL-impacted hydrostratigraphic zones outside the SEE thermal treatment zones (TTZs). An example of what the EBR well field might look like after initiating SEE and completion of the EBR Field Test Plan is shown in Figure E-4.1. Layout of this conceptual EBR well field was performed using the groundwater flow model described above. The layout is conservative in nature, designed to address areas of suspected residual LNAPL that exist outside of the SEE TTZs. Data collected during and following SEE treatment may modify the extent of EBR treatment required, potentially including areas with the TTZs. Final selection of TEA could also allow increased spacing of wells; however, the spacing evaluated in this analysis is expected to work with any of the TEAs under consideration.

4.1 EBR Well Field Design

Remediation well spacing and positioning; screen placement; and injection/extraction rates for the conceptual EBR system were designed using the groundwater flow model. A typical five-point pattern, a square treatment cell consisting of a centrally located injection well surrounded by four extraction wells, on 60-foot spacing was used for the conceptual layout of the UWBZ and LSZ well fields. Although these units have different hydrogeologic properties, the 60-foot spacing was determined to yield a sufficient mixing time and dispersion between injection and extraction in each zone and allow for the collocation of wells within single boreholes thereby minimizing the cost and impact of drilling.

This 60-foot well spacing was determined to be optimal by an iterative process using the groundwater flow model to assess various configurations of the well fields within the geometry of the treatment areas. Beyond an approximate well spacing of 75 feet results from the model revealed that sufficient extraction pumping could not be achieved because of limitations associated with the permeability and storage of the aquifer and subsequent loss of injectate to the natural gradients in these gaps between extraction well capture zones. At well spacings between 65 feet and 75 feet the average travel time between injection and extraction well ranged between approximately 400 and 500 days in the UWBZ and LSZ. Dropping the well spacing to 60 feet across the two zones nearly halved the travel time between wells revealing that at 60-foot spacing in the UWBZ and LSZ, there is communication between injection fronts and extraction well cone of depression flow fields. Furthermore, assuming a transverse dispersivity of 20 feet a 60-foot well spacing is advantageous for a five spot pattern considering the anticipated mixing during and following active injection and extraction. As discussed in the main body text of the RD/RAWP, dispersivity for each hydrogeologic unit will be refined using inject-withdraw tests and these results as well as results from the SEE treatment will be used to refine the EBR design including well spacing and placement.

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In the CZ, because of the high conductivity, the five-spot pattern was not effective; instead a sweeping injection front is used with three injection wells upgradient and two extraction wells downgradient of the LNAPL-impacted zone outside the SEE treatment zone.

The remediation-well screen sections; both injection and extraction, located in the CZ and LSZ span the entire LNAPL-impacted zone. The remediation well screen sections in the UWBZ were refined based on particle tracking analysis conducted using the groundwater flow model. Initially the remediation well screens were positioned across the entire thickness of the UWBZ (similar to wells in other zones); however, due to the high conductivity of the overlying CZ a large portion of injected liquids traveled rapidly upwards exiting into the CZ. Using an iterative process with the 3D groundwater flow model, the injection well screens and flow rates in the UWBZ were adjusted until particle traces of flow from injection wells were contained in the UWBZ. Ultimately, the top of the well screen section for each UWBZ injection well is set in layers 20 feet below the top of the CZ/UWBZ interface. The bottom of the UWBZ injection wells extend to the bottom of the hydrostratigraphic unit. Extraction well screen sections in the UWBZ extend from 10 feet below the CZ/UWBZ interface to the bottom of the unit. The actual design of steam injection wells and extraction wells includes screen sections that extend from about 10 feet below the CZ/UWBZ interface to the bottom of the UWBZ. This configuration is consistent with the design used during the TEE Pilot Test.

Tables E-4.1, E-4.2, and E-4.3 summarize the horizontal well location, screen location, by model layer, and well type for the EBR wells in the CZ, UWBZ, and LSZ, respectively. The vertical resolution of the model grid was increased in the CZ, UWBZ and LSZ by splitting each layer (6 through 9, 12, and 13) in half. This yielded six additional layers (2 more in each hydrostratigraphic zone). This layer splitting is analogous to refinement of the horizontal grid in that it provides higher resolution in the numerical solution but did not alter the model structure with respect to geology or groundwater.

Table E-4.1 EBR Well Design in Cobble Zone

Well Type	Well Name	Easting (feet)	Northing (feet)	Model Layer at Top of Screen Section	Model Layer at Bottom of Screen Section
Extraction	CZ-Ext-w1	774392.617	837874.824	6	9
Extraction	CZ-Ext-w2	774392.270	837815.101	6	9
Extraction	CZ-Inj-w1	774332.374	837844.615	6	9
Injection	CZ-Inj-w2	774313.103	837884.372	6	9
Injection	CZ-Inj-w3	774312.235	837805.205	6	9

Notes:
EBR – enhanced bioremediation

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Table E-4.2 EBR Well Design in UWBZ

Well Type	Well Name	Easting (feet)	Northing (feet)	Model Layer at Top of Screen Section	Model Layer at Bottom of Screen Section
Extraction	UWBZ-Ext-w1	774332.450	837964.928	11	13
Extraction	UWBZ-Ext-w2	774332.450	837844.928	11	13
Extraction	UWBZ-Ext-w3	774452.450	838084.928	11	13
Extraction	UWBZ-Ext-w4	774452.450	837844.928	11	13
Extraction	UWBZ-Ext-w5	774572.450	837844.928	11	13
Extraction	UWBZ-Ext-w6	774692.450	837964.928	11	13
Extraction	UWBZ-Ext-w7	774692.450	837844.928	11	13
Extraction	UWBZ-Ext-w8	774812.450	838084.928	11	13
Extraction	UWBZ-Ext-w9	774812.450	837964.928	11	13
Extraction	UWBZ-Ext-w10	774212.450	837964.928	11	13
Extraction	UWBZ-Ext-w11	774212.450	837844.928	11	13
Extraction	UWBZ-Ext-w12	774212.450	837724.928	11	13
Extraction	UWBZ-Ext-w13	774332.450	837724.928	11	13
Extraction	UWBZ-Ext-w14	774452.450	837724.928	11	13
Extraction	UWBZ-Ext-w15	774572.450	837724.928	11	13
Extraction	UWBZ-Ext-w16	774812.450	837844.928	11	13
Injection	UWBZ-Inj-w1	774272.450	837904.928	12	13
Injection	UWBZ-Inj-w4	774632.450	837904.928	12	13
Injection	UWBZ-Inj-w6	774752.450	838024.928	12	13
Injection	UWBZ-Inj-w10	774392.450	837784.928	12	13
Injection	UWBZ-Inj-w11	774512.450	837784.928	12	13
Injection	UWBZ-Inj-w12	774632.450	837784.928	12	13
Injection	UWBZ-Inj-w5	774752.450	837904.928	12	13
Injection	UWBZ-Inj-w2	774272.450	838024.928	12	13
Injection	UWBZ-Inj-w3	774392.450	838024.928	12	13
Injection	UWBZ-Inj-w7	774152.450	837904.928	12	13
Injection	UWBZ-Inj-w8	774152.450	837784.928	12	13
Injection	UWBZ-Inj-w9	774272.450	837784.928	12	13

Notes:
EBR – enhanced bioremediation
UWBZ – Upper Water Bearing Zone

ED_005025_00013386-00552

Table E-4.3 EBR Well Design in LSZ

Well Type	Well Name	Easting (feet)	Northing (feet)	Model Layer at Top of Screen Section	Model Layer at Bottom of Screen Section
Extraction	LSZ-Ext-w1	773972.450	837964.928	16	19
Extraction	LSZ-Ext-w2	774092.450	837964.928	16	19
Extraction	LSZ-Ext-w3	774092.450	837844.928	16	19
Extraction	LSZ-Ext-w4	774212.450	838084.928	16	19
Extraction	LSZ-Ext-w5	774699.779	837717.885	16	19
Extraction	LSZ-Ext-w6	774692.450	837604.928	16	19
Extraction	LSZ-Ext-w7	774812.450	837724.928	16	19
Extraction	LSZ-Ext-w8	774812.450	837604.928	16	19
Extraction	LSZ-Ext-w9	774212.450	837964.928	16	19
Extraction	LSZ-Ext-w10	774212.450	837844.928	16	19
Extraction	LSZ-Ext-w11	774212.450	837724.928	16	19
Extraction	LSZ-Ext-w12	774332.450	837724.928	16	19
Extraction	LSZ-Ext-w13	774452.450	837724.928	16	19
Extraction	LSZ-Ext-w14	774572.450	837724.928	16	19
Extraction	LSZ-Ext-w15	774812.450	837844.928	16	19
Injection	LSZ-Inj-w1	774032.450	838024.928	16	19
Injection	LSZ-Inj-w2	774032.450	837904.928	16	19
Injection	LSZ-Inj-w3	774152.450	838024.928	16	19
Injection	LSZ-Inj-w4	774152.450	837664.928	16	19
Injection	LSZ-Inj-w5	774635.891	837660.246	16	19
Injection	LSZ-Inj-w6	774752.450	837664.928	16	19
Injection	LSZ-Inj-w7	774752.450	837784.928	16	19
Injection	LSZ-Inj-w8	774152.450	837904.928	16	19
Injection	LSZ-Inj-w9	774152.450	837784.928	16	19
Injection	LSZ-Inj-w10	774272.450	837784.928	16	19
Injection	LSZ-Inj-w11	774392.450	837784.928	16	19
Injection	LSZ-Inj-w12	774512.450	837784.928	16	19
Injection	LSZ-Inj-w13	774632.450	837784.928	16	19

Notes:
EBR – enhanced bioremediation
LSZ – Lower Saturated Zone

4.2 EBR Remediation Flow Rate Design

Injection and extraction flow rates for each conceptual EBR well were also designed considering the following:

- The combined extraction rates from a given hydrostratigraphic zone exceed the injection rate to facilitate containment of the injected treatment solutions;
- The rates of injection to or extraction from a given well are divided equally over the hysrostratigaphic unit but are weighted based on the transmissivity of the formation across the remediation-well screen interval;

ED_005025_00013386-00553

- The average travel time from injection to extraction well (metric for evaluating mixing and diffusion of TEA in recirculation setting) and distribution of injected liquids is sufficient to deliver and react TEA to the impacted area considering the utilization rate of the TEA and delivery of the target mass of TEA over a maximum of 18 months of continuous recirculation.

Tables E-4.4, E-4.5, and E-4.6 provide the final design flow rates for the injection and extraction wells in the CZ, UWBZ, and LSZ respectively.

Table E-4.4 EBR Design Flow Rates in Cobble Zone

Well Type	Well Name	Volumetric Flow Rate	
		(cubic feet per day)	(gallons per minute)
Extraction	CZ-Ext-w1	-1,661	-8.63
Extraction	CZ-Ext-w2	-1,226	-6.37
Extraction	CZ-Inj-w1	502	2.61
Injection	CZ-Inj-w2	665	3.45
Injection	CZ-Inj-w3	565	2.94

Notes:
EBR – enhanced bioremediation

Table E-4.5 EBR Design Flow Rates in UWBZ

Well Type	Well Name	Volumetric Flow Rate	
		(cubic feet per day)	(gallons per minute)
Extraction	UWBZ-Ext-w1	-1,077	-5.6
Extraction	UWBZ-Ext-w2	-835	-4.34
Extraction	UWBZ-Ext-w3	-1,172	-6.09
Extraction	UWBZ-Ext-w4	-1,086	-5.64
Extraction	UWBZ-Ext-w5	-1,167	-6.06
Extraction	UWBZ-Ext-w6	-1,179	-6.13
Extraction	UWBZ-Ext-w7	-970	-5.04
Extraction	UWBZ-Ext-w8	-1,113	-5.78
Extraction	UWBZ-Ext-w9	-1,095	-5.69
Extraction	UWBZ-Ext-w10	-1,080	-5.61
Extraction	UWBZ-Ext-w11	-1,159	-6.02
Extraction	UWBZ-Ext-w12	-1,356	-7.05
Extraction	UWBZ-Ext-w13	-1,071	-5.56
Extraction	UWBZ-Ext-w14	-1,025	-5.32
Extraction	UWBZ-Ext-w15	-1,062	-5.52
Extraction	UWBZ-Ext-w16	-879	-4.57
Injection	UWBZ-Inj-w1	944	4.91
Injection	UWBZ-Inj-w4	1,476	7.67
Injection	UWBZ-Inj-w6	1,408.92	7.32
Injection	UWBZ-Inj-w10	782	4.06
Injection	UWBZ-Inj-w11	1,414	7.35

ED_005025_00013386-00554

Well Type	Well Name	Volumetric Flow Rate	
		(cubic feet per day)	(gallons per minute)
Injection	UWBZ-Inj-w12	1,367	7.1
Injection	UWBZ-Inj-w5	693	3.6
Injection	UWBZ-Inj-w2	693	3.6
Injection	UWBZ-Inj-w3	693	3.6
Injection	UWBZ-Inj-w7	693	3.6
Injection	UWBZ-Inj-w8	693	3.6
Injection	UWBZ-Inj-w9	693	3.6

Notes:
EBR – enhanced bioremediation
UWBZ – Upper Water Bearing Zone

Table E-4.6 EBR Design Flow Rates in LSZ

Well Type	Well Name	Volumetric Flow Rate	
		(cubic feet per day)	(gallons per minute)
extraction	LSZ-Ext-w1	-2,139	-11.11
extraction	LSZ-Ext-w2	-832	-4.32
extraction	LSZ-Ext-w3	-1,663	-8.64
extraction	LSZ-Ext-w4	-382	-1.98
extraction	LSZ-Ext-w5	-960	-4.99
extraction	LSZ-Ext-w6	-494	-2.57
extraction	LSZ-Ext-w7	-490	-2.55
extraction	LSZ-Ext-w8	-486	-2.52
extraction	LSZ-Ext-w9	-404	-2.1
extraction	LSZ-Ext-w10	-398	-2.07
extraction	LSZ-Ext-w11	-338	-1.76
extraction	LSZ-Ext-w12	-469	-2.44
extraction	LSZ-Ext-w13	-518	-2.69
extraction	LSZ-Ext-w14	-496	-2.58
extraction	LSZ-Ext-w15	-518	-2.69
injection	LSZ-Inj-w1	987	5.13
injection	LSZ-Inj-w2	1,986	10.32
injection	LSZ-Inj-w3	631	3.28
injection	LSZ-Inj-w4	304	1.58
injection	LSZ-Inj-w5	769	4
injection	LSZ-Inj-w6	379	1.97
injection	LSZ-Inj-w7	391	2.03
injection	LSZ-Inj-w8	645	3.35
injection	LSZ-Inj-w9	297	1.54
injection	LSZ-Inj-w10	289	1.5
injection	LSZ-Inj-w11	460	2.39
injection	LSZ-Inj-w12	381	1.98
injection	LSZ-Inj-w13	1,144	5.94

Notes:
EBR – enhanced bioremediation
LSZ – Lower Saturated Zone

ED_005025_00013386-00555

4.3 EBR Remediation Model Results

Using the 3D groundwater flow model with particle tracking; the flow rates in the tables above; and the remediation well field layout shown in Figure E-4.1, the average and standard deviation of the travel and mixing time for TEA administered to each zone was estimated. The results of particle tracking from injection well to extraction well for the CZ, UWBZ, and LSZ are shown in Figures E-4.2, E-4.3, and E-4.4, respectively. The average and standard deviation of the estimated TEA travel and mixing times for each zone are summarized in Table E-4.7 below.

Table E-4.7 Predicted TEA Travel and Mixing Times by Zone

Zone	Average Travel and Mixing Time (days)	Standard Deviation (days)
CZ	26	5.5
UWBZ	235	170
LSZ	185	77

Notes:
CZ – Cobble Zone
LSZ – Lower Saturated Zone
TEA - terminal electron acceptor
UWBZ – Upper Water Bearing Zone

4.4 EBR Flow Model Conclusions

The groundwater flow model provided a means to assess the following:

1. The horizontal layout of injection and extraction wells across the LNAPL treatment zone outside the SEE treatment zone;
2. The anticipated extraction and injection flow rates to achieve both containment during treatment and an acceptable/reasonable travel and mixing time for bioamendment addition; and
3. The effects of heterogeneities in the material types with the UWBZ and LSZ, the variation in hydrostratigraphic one geometry, and the distribution of LNAPL on the conceptual well field and design flow rates.

As described in Sections 2 and 3 of this Modeling Report, the model also simulates the transient rising water table at the site and thereby provides a means to assess the effect of the rising water and imposed vertical gradients on the final design of the EBR system.

4.5 EBR Performance Objective and Monitored Natural Attenuation

The performance objective for EBR is to complete active remediation post SEE to address residual contamination, primarily outside the TTZs, to reach conditions such that natural

ED_005025_00013386-00556

attenuation processes can achieve cleanup levels within the 20-year remedial timeframe. The practical design basis to meet this objective is dependent on the selection of TEA. If oxygen is selected as the TEA, the design basis within the EBR treatment zones will be to decrease the contaminants in all phases such that dissolved chemicals of concern (COCs) are at or below cleanup levels by the end of about 18 months of active recirculation. This 18 month period was used in the modeling to evaluate substrate dosage required to achieve the cleanup levels in the 20 year timeframe. It is anticipated that the final design will further evaluate 18 month period and consider active recirculation for up to 3 years. Since the rate of oxygen utilization in the biodegradation of dissolved petroleum hydrocarbons outpaces the rate of dissolution of LNAPL in each of the three hydrostratigrpahic units, once active recirculation is stopped the remaining oxygen plus the natural flux of oxygen into the system will be depleted and the subsurface will revert to anaerobic conditions prior to all LANPL being depleted. During this transition period a rebound of dissolved-phase COCs is expected. Continued LNAPL depletion and biodegradation following active EBR will transition primarily to anaerobic pathways which will achieve cleanup levels about 15 years following termination of active EBR.

If sulfate is selected as the TEA, the design basis will be to deliver and distribute sulfate to the EBR treatment areas such that a sufficient amount of sulfate is present following 18 months of active recirculation to support continued reduction of contaminants in all phases such that dissolved COCs are at or below cleanup levels within about 15 years following the end of active recirculation. Similar to oxygen, the sulfate recirculation period may be further evaluated in the final design and could extend up to 3 years. This design basis assumes that elevated sulfate concentrations will be sustained for a prolonged period after recirculation ceases based on the relatively high solubility of sulfate and the slower utilization rate by sulfate-reducing bacteria compared to aerobic bacteria. Continued degradation during MNA will remain anaerobic, sustained by the inflow of electron acceptors with groundwater from upgradient of ST012. Other design criteria common to either TEA approach are as follows:

1. Mix and homogenize the contaminant within the treatment zone to facilitate greater contact between aquifer-borne bacteria;
2. Distribute TEA throughout the treatment zone; and
3. Assess and amend, if necessary, for essential nutrients and minerals.

4.5.1 LNAPL and Contaminant Initialization

As discussed previously, the extent and overall saturation of LNAPL in the hydrostratigraphic units has been estimated. Table E-4.8 provides a summary of the estimated volume of LNAPL and LNAPL saturation percentages in each of the EBR treatment areas by [redacted] unit and the LPZ separating the UWBZ from the LSZ. The LNAPL saturation percentages were calculated using the TPH analytical data from the PDI, including samples from SEE TTZs in addition to samples from EBR treatment zones, but they are assumed to be representative of saturation percentages in the EBR treatment zones following SEE treatment.

ED_005025_00013386-00557

Table E-4.8 Estimated LNAPL Volume in EBR Treatment Zones Following SEE Treatment

Zone	LNAPL Volume (gallons)[1]	LNAPL Saturation[2] (%)
CZ	6,290	1.53%
UWBZ	340,525	6.27%
LPZ	30,416	0.59% – 1.19%
LSZ	105,861	2.65%

Notes:
[1]Based on RD/RAWP Appendix B for conservative LNAPL interpretation for LNAPL outside of the TTZs in the EBR treatment zones assuming no removal outside the TTZs during SEE.
[2]Calculated LNAPL saturation from Pre-Design Investigation results (see RD/RAWP Appendix B)
% – percent
CZ – Cobble Zone
LNAPL – light non-aqueous phase liquid
LPZ – Low Permeability Zone
LSZ – Lower Saturated Zone
SEE – steam enhanced extraction
UWBZ – Upper Water Bearing Zone

For the purpose of assessing EBR, the extent of the LNAPL impacted areas in the three EBR treatment zones is shown in Figure E-4.1 as the LNAPL extent outside the SEE treatment zones. LNAPL within the TTZ was assumed to be reduced by 90% (e.g., the saturation of LNAPL in the LSZ following SEE treatment was assumed to be 0.265%). The initial saturation of LNAPL in the LPZ was estimated based on a 50% reduction of LNAPL within the area of overlapping SEE TTZs between the UWBZ and the LSZ. The LNAPL saturation in the LPZ outside this overlapping region was assumed to remain at 1.19%, the calculated value for initial conditions prior to any treatment.

The NAPL was split into two components, benzene and all other constituents in the LNAPL. The benzene fraction of the LNAPL was estimated based on a reduction factor following remediation and the pre-TEE mass fractions provided in the TEE Pilot Test Report (BEM, 2010). Within the layers where SEE is being applied the benzene reduction factor applied was 90%. Within the LPZ, between the overlapping LSZ and UWBZ SEE treatment areas, the benzene reduction factor applied was 50%. Initial benzene and LNAPL saturations by hydrostratigraphic zone are shown in Table E-4.9 below.

The combined effect of the assumed LNAPL saturation reductions and the assumed reduction of benzene fraction in the LNAPL that remains after SEE, results in a benzene mass reduction following SEE of approximately 99% in the UWBZ and LSZ TTZs, 75% in the LPZ between the two TTZs, and 0% outside of the TTZs as the starting point for the EBR modeling.

ED_005025_00013386-00558

Table E-4.9 Initial LNAPL Saturation and Corresponding Component Concentration in LNAPL

Layer	LNAPL Saturation Post SEE	Concentration of Benzene in LNAPL post SEE (lbs/ft^3)[1]	Concentration of Other LNAPL Constituents (lbs/ft^3)
CZ - TTZ	0.153%	0.0053	49.11
CZ - EBR	1.53%	0.0527	49.07
UWBZ - TTZ	0.627%	0.00216	49.11
UWBZ - EBR	6.27%	0.216	48.96
LPZ – BETWEEN SEE	0.59%	0.0206	49.08
LPZ – OUTSIDE SEE	1.19%	0.0412	49.07
LSZ – TTZ	0.265%	0.00913	49.10
LSZ – EBR	2.65%	0.0913	49.04

Notes:
[1]Benzene faction is assumed at 10 percent of the value observed fraction in samples from the TEE pilot test report (BEM, 2010)
% – percent
CZ – Cobble Zone
EBR – Enhance Bioremediation
lbs/ft^3 – pounds per cubic foot
LNAPL – light non-aqueous phase liquid
LPZ – Low Permeability Zone
SEE – steam enhanced extraction
TTZ – thermal treatment zone
UWBZ – Upper Water Bearing Zone

Contaminant physiochemical parameters used are summarized in Table E-4.10 below.

Table E-4.10 Physiochemical Parameters of Hydrocarbon Contamination

Parameter (unit)	Benzene	Remaining Hydrocarbons
Diffusion In Water (ft^2/day)	7.91×10^{-4}	2.48×10^{-4}
Diffusion In Air (ft^2/day)	8.27	2.65
Diffusion In LNAPL (ft^2/day)	7.91×10^{-4}	2.48×10^{-4}
Air-Water Partitioning Coefficient	2.78	0.283
LNAPL-Water Partitioning Coefficient	177.0	199.8
Density of Pure Phase (lbs/ft^3)	57.7	49.13

Notes:
ft^2/day – square feet per day
lbs/ft^3 – pounds per cubic foot
LNAPL – light non-aqueous phase liquid

ED_005025_00013386-00559

4.5.2 Transport Parameter Discussion

Longitudinal, horizontal, and vertical dispersivity were estimated at 10, 1, and 0.1 feet, respectively for the CZ, UWBZ, and LSZ. The longitudinal, horizontal, and vertical dispersivity were estimated at 0.5, 0.03, and 0.01 feet, respectively for the LPZ. An effective porosity of 0.30 and bulk density of 1.90×10^6 grams per cubic meter were specified (BEM, 2010). The sorption parameters for benzene and the remainder of the petroleum hydrocarbons were taken from the previous modeling effort (BEM, 2010).

4.5.3 Biodegradation Parameter Estimates

Biodegradation processes in the model include aerobic respiration and the anaerobic processes including nitrate-, iron-, and sulfate-based respiration. Biodegradation is only applied to dissolved-phase solute, and is applied as an instantaneous reaction following convergence of phase equilibrium at each time-step in the model. Calibrated Monod Kinetic rate constants including maximum utilization rates and half-saturation values as well as electron acceptor use coefficients for benzene, remaining hydrocarbons, and electron acceptors were used as published in the TEE Pilot Test Report (BEM, 2010). Inhibition was not considered in the model. Tables E-4.11, E-4.12, and E-4.13 below provide a summary of the biodegradation parameter estimates utilized in the model.

Table E-4.11 Maximum Utilization Rates for Electron Acceptors – CZ, UWBZ, LPZ

Electron Acceptor	Maximum Specific Utilization Rates (1 per day)	
	Benzene	Remaining Fraction of Hydrocarbons
Oxygen	7.50×10^{-2}	1.00×10^{-1}
Nitrate	0.0	1.25×10^{-2}
Iron(ferric)	6.25×10^{-4}	0.0
Sulfate	8.75×10^{-4}	6.25×10^{-4}

Notes:
CZ – Cobble Zone
LPZ – Low Permeability Zone
UWBZ – Upper Water Bearing Zone

Table E-4.12 Maximum Utilization Rates for Electron Acceptors - LSZ

Electron Acceptor	Maximum Specific Utilization Rates (1 per day)	
	Benzene	Remaining Fraction of Hydrocarbons
Oxygen	1.50×10^{-1}	2.00×10^{-1}
Nitrate	2.50×10^{-3}	3.75×10^{-2}
Iron(ferric)	6.75×10^{-3}	0.0
Sulfate	1.75×10^{-2}	1.25×10^{-2}

Notes:
LSZ – Lower Saturated Zone

ED_005025_00013386-00560

Table E-4.13 Electron Acceptor Use Coefficient and Electron Acceptor Half-Saturation Constant

Parameter	Use Coefficient (grams of EA/grams of Hydrocarbon)	Half Saturation Constant (mg/L)	Observed EA Change –between upgradient and source area (mg/L)
Oxygen	3.0	1.0	6.0
Nitrate	3.2	1.0	18.0
Iron (ferric)	28	N/A	10
Sulfate	4.0	1.0	200

Notes:
mg/L – milligrams per liter
EA – Electron Acceptor

The half saturation constant for total dissolved hydrocarbons was established at 5.0 milligrams per liter (mg/L). Further examination of the electron-acceptor and petroleum hydrocarbon half saturation constants reveals the source-area biodegradation rate (within the area containing LNAPL and depleted oxygen, nitrate, and sulfate) is first-order, first controlled by depleted electron acceptors followed by depleted substrate (dissolved hydrocarbons).

The biodegradation rate constants shown above, including the TEA utilization rates (Table E-4.10, Table E-4.11); half-saturation constants (Table E-4.12); and the dissolved hydrocarbon half saturation constant discussed above are based on ambient conditions under natural flux. Enhancement of the flux of TEAs into the system and increased flow of fresh water into the system will likely alter these constants, driving utilization rates up and half-saturation concentrations down. Biomass yield is also predicted to increase under enhancement. Furthermore, the heat added to the subsurface by SEE is anticipated to temporarily raise temperatures in the nearby EBR treatment zones for an extended period of time following the cessation of steam injection. This added heat is also anticipated to increase utilization rates and lower half-saturation constants.

4.5.4 Model Stress Periods

Two model stress periods were assessed. The first model stress period consisted of active pumping and recirculation from November 2015 through April 2017 (18 months of recirculation). The November 2015 start corresponds approximately with the cessation of active pumping at the SEE TTZs, although the final EBR design will further evaluate the start date. The second model stress period was under ambient groundwater flow from 2017 to 2031. Prior to initiating the model stress period start date the model was run up to November 2015 to approximate the location of the water table. This water table pressure was set as the starting point for the model in 2015 at the end of active remediation.

ED_005025_00013386-00561

4.5.5 Aerobic EBR Estimates

Enhanced aerobic bioremediation was assessed using the groundwater flow model with R-T as defined above. During the EBR recirculation phase, injected water or injectate was assumed to be clean (void of hydrocarbon contamination) and amended with dissolved oxygen (DO). The DO concentration in the injectate was estimated by an iterative process using the model. DO in the injectate in each treatment zone was adjusted up or down depending on the maximum benzene predicted by the model in 2031, following both stress periods. By this method it was determined that a minimum injectate DO concentration of 11.4 mg/L, 15.8 mg/L, and 14.1 mg/L in the CZ, UWBZ, and LSZ, respectively, would be required to achieve an end goal of benzene concentrations at or below the remedial goal by the end of 2030. To achieve these DO concentrations a feedstock of oxygen from a source such as liquid hydrogen peroxide or gaseous ozone would be required.

The predicted maximum and average dissolved benzene concentrations at the end of active EBR recirculation and in 2031 in each of the three hydrostratigraphic zones are shown in Table E-4.14. Table E-4.14 also shows the predicted average and maximum dissolved benzene concentrations one year following the cessation of active EBR recirculation.

Table E-4.14 Predicted Maximum and Average Dissolved Benzene Concentrations Following Aerobic EBR

Hydrostratigraphic Zone	Date (month/year)	Predicted Benzene Concentration (µg/L)		Notes
		Average	Maximum	
Cobble Zone	04/2017	0.89	1.2	End of EBR Recirculation/TEA Addition
	04/2018	0.71	1.2	One year following end of EBR
	01/2031	0.06	0.47	~15 years following EBR
Upper Water Bearing Zone	04/2017	0.51	2.2	End of EBR Recirculation/TEA Addition
	04/2018	81	380	One year following end of EBR
	01/2031	1.2	4.4	~15 years following EBR
Lower Saturated Zone	04/2017	0.19	2.2	End of EBR Recirculation/TEA Addition
	04/2018	18	170	One year following end of EBR

ED_005025_00013386-00562

Hydrostratigraphic Zone	Date (month/year)	Predicted Benzene Concentration (µg/L)		Notes
		Average	Maximum	
	04/2031	0.85	5.1	~15 years following EBR

Notes:
~ - approximately
µg/L – micrograms per liter
EBR – enhanced bioremediation
TEA – terminal electron acceptor

Immediately following aerobic EBR (Table E-4.14) the model predicts that dissolved benzene concentrations are below approximately 2 micrograms per liter (µg/L). Within one year following EBR dissolved benzene concentrations rebound and the maximum concentration of benzene is predicted to peak at approximately 400 µg/L. By 2031, the benzene concentrations in each of the hydrostratigrapic zones are predicted to be equal or below 5 µg/L.

4.5.6 Sulfate EBR Estimates

Enhanced sulfate reduction bioremediation was assessed using the groundwater flow model with R-T as defined above. A key aspect of evaluating sulfate as a potential TEA will be observing a marked increase in utilization compared with the rate shown in Table E-4.11. In addition to an increase in utilization, another key aspect in evaluating sulfate as a potential TEA will be observing a decrease in both the TEA and dissolved petroleum hydrocarbon half saturation. It is anticipated that a combination of these key aspects will yield a significantly higher, zero-order biodegradation rate over a greater range of substrate concentration under sulfate amended conditions. For the purpose of this assessment; and, without in-situ tests to provide a sulfate utilization rate and/or a decrease in half saturation constants under sulfate amended conditions, the utilization rate of sulfate was increased 10 fold from that value shown in Table E-4.11. Additionally, the oxygen, nitrate, and iron TEA utilization under natural flux were not considered. It is assumed that sulfate reducing bacteria biomass in the presence of high concentrations of sulfate will experience exponential growth and this will increase the efficiency and utilization of sulfate for petroleum hydrocarbon biodegradation. During the EBR recirculation phase, injected water was assumed to be clean (void of hydrocarbon contamination) and amended with dissolved sulfate. The sulfate concentration in the injectate was estimated by an iterative process using the model. Sulfate in the injectate in each treatment zone was adjusted up or down depending on the maximum benzene predicted by the model at the end of 2031, following both stress periods. By this method it was determined that a minimum injectate sulfate concentration of 4.8 grams per liter (g/L), 28.0 g/L, and 11.6 g/L in the CZ, UWBZ, and LSZ, respectively, would be required to achieve an end goal of benzene concentrations at or below the remedial goal by the end of 2030. To achieve these sulfate concentrations in the injected water a feedstock of sulfate salts (e.g.; sodium sulfate) mixed into the injected water would be required.

The predicted maximum and average dissolved benzene concentrations at the end of active EBR recirculation and in 2031 in each of the three hydrostratigraphic zones are shown in Table

ED_005025_00013386-00563

E-4.15. Table E-4.15 also shows the predicted average and maximum dissolved benzene concentrations eight years following the cessation of active EBR recirculation.

Table E-4.15 Predicted Maximum and Average Dissolved Benzene Concentrations Following Sulfate-Reducing EBR

Hydrostratigraphic Zone	Date (month/year)	Predicted Benzene Concentration (µg/L)		Notes
		Average	Maximum	
Cobble Zone	04/2017	21	27	End of EBR Recirculation/TEA Addition
	04/2025	1.25	7.8	~8 years following EBR
	01/2031	0.08	0.95	~15 years following EBR
Upper Water Bearing Zone	04/2017	210	1,400	End of EBR Recirculation/TEA Addition
	04/2025	5.5	9.5	~8 years following EBR
	01/2031	1.0	3.3	~15 years following EBR
Lower Saturated Zone	04/2017	31	270	End of EBR Recirculation/TEA Addition
	04/2025	1.9	6.8	~8 years following EBR
	04/2031	0.64	2.8	~15 years following EBR

Notes:
~ - approximately
µg/L – micrograms per liter
EBR – enhanced bioremediation
TEA – terminal electron acceptor

Immediately following sulfate-reducing EBR recirculation (Table E-4.15) the model predicts that dissolved benzene concentrations are below approximately 27 µg/L in the CZ, 1,400 µg/L in the UWBZ, and 270 µg/L in the LSZ. Within eight years following sulfate-reducing EBR dissolved benzene concentrations drop and the maximum concentration of benzene predicted in the UWBZ is 9.5 µg/L. By 2031, the benzene concentrations in each of the hydrostratigrapic zones are predicted to be below 5 µg/L.

ED_005025_00013386-00564

5.0 STEAM ENHANCED EXTRACTION CONTAINMENT

Groundwater and air-phase flow modeling studies were conducted for this project to evaluate the groundwater heads and flow paths around and between injection and extraction wells and the radius of influence of vapor phase flow occurring due to steam injection and multiphase extraction. This modeling methodology was selected over non-isothermal, multiphase modeling of steam injection with phase change, because it is relatively simple to implement and has an efficient solution compared to modeling of steam. Considering the uncertainty in hydraulic and thermal properties of the medium, the extra level of effort and complexity of non-isothermal multiphase modeling was not justified.

The finite-difference code called MODFLOW-SURFACT was used to conduct air phase flow modeling. MODFLOW-SURFACT has the capability of simulating saturated or unsaturated flow of water as well as of air, in a decoupled manner (i.e., it does not solve for both air and water flow simultaneously). For water flow simulations, the code assumes that air remains at atmospheric pressure conditions, which leads to the Richards equation for saturated-unsaturated flow of water. For air flow simulations, the code assumes that water remains at water-pressure conditions that are input to the code, and which were obtained from the water flow simulation. The models were created using the Groundwater Vistas, version 6, software. .

5.1 Groundwater Flow Model for SEE Simulation

The groundwater flow model described above in Sections 2.0 and 3.0 with layer refinement described in Section 4.0 was used to simulate SEE flow at the site. The subsections below describe the model design of the SEE well field, the simulated injection and extraction flow rates, and the results of the groundwater flow model for simulation of the SEE flow field.

5.1.1 SEE Well Layout

SEE injection and extraction wells were placed in the model in each of the three hydrostratigraphic zones as shown in Figures E-5.1, E-5.2, and E-5.3. Tables E-5.1, E-5.2, and E-5.3 summarize the horizontal well location, screen location, by model layer, and well type for the SEE wells in the CZ, UWBZ, and LSZ, respectively.

ED_005025_00013386-00565

Table E-5.1 SEE Well Design in CZ

Well Type	Well Name	Easting (feet)	Northing (feet)	Model Layer at Top of Screen Section	Model Layer at Bottom of Screen Section
Extraction	ST012-CZ07	774695.790	838139.769	6	9
Extraction	ST012-CZ08	774616.423	838097.489	6	9
Extraction	ST012-CZ09	774791.553	838088.540	6	9
Extraction	ST012-CZ10	774567.845	838057.322	6	9
Extraction	ST012-CZ11	774628.697	838014.141	6	9
Extraction	ST012-CZ12	774736.254	838018.642	6	9
Extraction	ST012-CZ13	774463.119	837987.471	6	9
Extraction	ST012-CZ14	774691.673	837976.728	6	9
Extraction	ST012-CZ15	774490.686	837929.081	6	9
Extraction	ST012-CZ16	774637.865	837883.632	6	9
Extraction	ST012-CZ17	774515.676	837814.100	6	9
Extraction	ST012-CZ18	774374.312	837922.409	6	9
Extraction	ST012-CZ19	774411.134	837827.930	6	9
Injection	ST012-CZ01	774692.997	838070.159	6	9
Injection	ST012-CZ02	774518.887	838014.983	6	9
Injection	ST012-CZ03	774648.039	837936.919	6	9
Injection	ST012-CZ04	774551.175	837932.424	6	9
Injection	ST012-CZ05	774450.668	837885.518	6	9
Injection	ST012-CZ06	774585.098	837865.395	6	9

Notes:
CZ – Cobble Zone
SEE – steam enhanced extraction

ED_005025_00013386-00566

Table E-5.2 SEE Well Design in UWBZ

Well Type	Well Name	Easting (feet)	Northing (feet)	Model Layer at Top of Screen Section	Model Layer at Bottom of Screen Section
Extraction	ST012-UWBZ17	774609.288	838086.271	11	13
Extraction	ST012-UWBZ18	774704.517	838086.419	11	13
Extraction	ST012-UWBZ03	774561.999	838015.721	11	13
Extraction	ST012-UWBZ04	774507.953	837979.060	11	13
Extraction	ST012-UWBZ02	774619.950	837982.985	11	13
Extraction	ST012-UWBZ19	774702.208	838005.300	11	13
Extraction	ST012-UWBZ20	774369.140	837912.386	11	13
Extraction	ST012-UWBZ05	774497.987	837935.133	11	13
Extraction	ST012-UWBZ21	774828.513	837970.342	11	13
Extraction	ST012-UWBZ06	774546.846	837881.025	11	13
Extraction	ST012-UWBZ01	774620.793	837902.614	11	13
Extraction	ST012-UWBZ22	774493.500	837798.191	11	13
Extraction	ST012-UWBZ23	774684.822	837863.988	11	13
Extraction	ST012-UWBZ24	774399.497	837836.288	11	13
Injection	ST012-UWBZ25	774656.018	838126.491	11	13
Injection	ST012-UWBZ09	774748.279	838128.827	11	13
Injection	ST012-UWBZ10	774522.893	838043.366	11	13
Injection	ST012-UWBZ11	774652.268	838052.116	11	13
Injection	ST012-UWBZ12	774765.393	838044.616	11	13
Injection	ST012-UWBZ13	774442.268	837969.616	11	13
Injection	ST012-UWBZ07	774561.643	837942.116	11	13
Injection	ST012-UWBZ14	774664.143	837934.616	11	13
Injection	ST012-UWBZ15	774458.292	837874.835	11	13
Injection	ST012-UWBZ16	774587.279	837820.567	11	13

Notes:
SEE – steam enhanced extraction
UWBZ – Upper Water Bearing Zone

ED_005025_00013386-00567

Table E-5.3 SEE Well Design in LSZ

Well Type	Well Name	Easting (feet)	Northing (feet)	Model Layer at Top of Screen Section	Model Layer at Bottom of Screen Section
Extraction	ST012-LSZ27	774402.235	838051.064	16	19
Extraction	ST012-LSZ28	774576.517	838060.680	16	19
Extraction	ST012-LSZ29	774862.781	838054.055	16	19
Extraction	ST012-LSZ30	774325.964	837957.285	16	19
Extraction	ST012-LSZ04	774509.810	837987.198	16	19
Extraction	ST012-LSZ03	774569.486	838016.302	16	19
Extraction	ST012-LSZ02	774630.159	837980.291	16	19
Extraction	ST012-LSZ31	774710.301	837995.949	16	19
Extraction	ST012-LSZ32	774797.248	838006.575	16	19
Extraction	ST012-LSZ14	774916.883	837992.281	16	19
Extraction	ST012-LSZ05	774498.973	837922.931	16	19
Extraction	ST012-LSZ06	774539.116	837882.485	16	19
Extraction	ST012-LSZ01	774614.652	837912.028	16	19
Extraction	ST012-LSZ33	774867.880	837930.902	16	19
Extraction	ST012-LSZ15	774352.839	837879.711	16	19
Extraction	ST012-LSZ34	774694.750	837842.230	16	19
Extraction	ST012-LSZ13	774746.020	837875.690	16	19
Extraction	ST012-LSZ35	774418.447	837766.540	16	19
Extraction	ST012-LSZ11	774511.990	837765.067	16	19
Extraction	ST012-LSZ36	774592.159	837767.135	16	19
Extraction	ST012-LSZ12	774660.201	837774.942	16	19
Extraction	ST012-LSZ37	774217.478	838011.467	16	19
Extraction	ST012-LSZ38	774218.909	837905.931	16	19
Extraction	ST012-LSZ39	774256.511	837790.175	16	19
Injection	ST012-LSZ08	774317.057	838050.472	16	19
Injection	ST012-LSZ17	774491.373	838051.311	16	19
Injection	ST012-LSZ16	774632.405	838020.980	16	19
Injection	ST012-LSZ18	774751.643	838054.616	16	19
Injection	ST012-LSZ09	774263.616	837959.240	16	19
Injection	ST012-LSZ19	774407.268	837965.866	16	19
Injection	ST012-LS07	774569.768	837943.366	16	19
Injection	ST012-LSZ20	774696.643	837907.741	16	19
Injection	ST012-LSZ21	774796.643	837945.866	16	19
Injection	ST012-LSZ22	774862.893	837995.241	16	19
Injection	ST012-LSZ23	774274.768	837863.991	16	19
Injection	ST012-LSZ24	774454.768	837834.616	16	19
Injection	ST012-LSZ25	774618.518	837821.491	16	19
Injection	ST012-LSZ26	774744.143	837821.491	16	19
Injection	ST012-LSZ10	774340.554	837802.251	16	19

Notes:
SEE – steam enhanced extraction
LSZ – Lower Saturated Zone

ED_005025_00013386-00568

The well placement and screen section placement accurately represents the SEE design presented.

5.1.2 SEE Groundwater Flow Model Extraction and Injection Rates

Approximation of the SEE flow rates using the groundwater flow model were based on the following:

1. Extraction Flow Rates: Extraction well flow rates were based on the expected design flow range from each well. First, the midpoint of the range of design flow rates from extraction wells in a given zone (CZ, UWBZ, and LSZ) was multiplied by the number of extraction wells in the zone to yield the expected total extraction flow rate. Next, the transmissivity across each extraction well screen was estimated as the product of the length of the screen section multiplied by the hydraulic conductivities across the screen section. The weighted transmissivity of each extraction well in a given zone was then calculated as the transmissivity across a given well divided by the sum of transmissivities across all extraction wells in the zone. Lastly, this weighted transmissivity for a well in given zone was then multiplied by the total extraction flow rate in the zone to yield a groundwater extraction rate for each extraction well.
2. Injection Flow Rates: Injection well flow rates were derived from the expected design mass flow rate of steam per well per zone. The steam mass flow rate was converted to an equivalent water volumetric flow rate using the ambient density of liquid water.

Tables E-5.4 and E-5.5 provide a summary of the extraction and injection flow rates used in the groundwater simulation.

Table E-5.4 SEE Design Groundwater Flow Rates in CZ

Well Type	Well Name	Volumetric Flow Rate	
		(cubic feet per day)	(gallons per minute)
Extraction	ST012-CZ07	716	3.72
Extraction	ST012-CZ08	631	3.28
Extraction	ST012-CZ09	620	3.22
Extraction	ST012-CZ10	681	3.54
Extraction	ST012-CZ11	433	2.25
Extraction	ST012-CZ12	660	3.43
Extraction	ST012-CZ13	953	4.95
Extraction	ST012-CZ14	626	3.25
Extraction	ST012-CZ15	793	4.12
Extraction	ST012-CZ16	672	3.49
Extraction	ST012-CZ17	710	3.69
Extraction	ST012-CZ18	658	3.42
Extraction	ST012-CZ19	489	2.54
Injection	ST012-CZ01	404	2.10
Injection	ST012-CZ02	404	2.10
Injection	ST012-CZ03	404	2.10

ED_005025_00013386-00569

Well Type	Well Name	Volumetric Flow Rate	
		(cubic feet per day)	(gallons per minute)
Injection	ST012-CZ04	404	2.10
Injection	ST012-CZ05	404	2.10
Injection	ST012-CZ06	404	2.10

Notes:
CZ – Cobble Zone
SEE – steam enhanced extraction

Table E-5.5 SEE Design Groundwater Flow Rates in UWBZ

Well Type	Well Name	Volumetric Flow Rate	
		(cubic feet per day)	(gallons per minute)
Extraction	ST012-UWBZ17	1,165	6.05
Extraction	ST012-UWBZ18	1,124	5.84
Extraction	ST012-UWBZ03	1,130	5.87
Extraction	ST012-UWBZ04	822	4.27
Extraction	ST012-UWBZ02	1,174	6.10
Extraction	ST012-UWBZ19	882	4.58
Extraction	ST012-UWBZ20	462	2.40
Extraction	ST012-UWBZ05	837	4.35
Extraction	ST012-UWBZ21	574	2.98
Extraction	ST012-UWBZ06	882	4.58
Extraction	ST012-UWBZ01	891	4.63
Extraction	ST012-UWBZ22	857	4.45
Extraction	ST012-UWBZ23	489	2.54
Extraction	ST012-UWBZ24	447	2.32
Injection	ST012-UWBZ25	337	1.75
Injection	ST012-UWBZ09	337	1.75
Injection	ST012-UWBZ10	337	1.75
Injection	ST012-UWBZ11	337	1.75
Injection	ST012-UWBZ12	337	1.75
Injection	ST012-UWBZ13	337	1.75
Injection	ST012-UWBZ07	337	1.75
Injection	ST012-UWBZ14	337	1.75
Injection	ST012-UWBZ15	337	1.75
Injection	ST012-UWBZ16	337	1.75

Notes:
SEE – steam enhanced extraction
UWBZ – Upper Water Bearing Zone

ED_005025_00013386-00570

Table E-5.6 SEE Design Groundwater Flow Rates in LSZ

Well Type	Well Name	Volumetric Flow Rate	
		(cubic feet per day)	(gallons per minute)
Extraction	ST012-LSZ27	578	3.00
Extraction	ST012-LSZ28	880	4.57
Extraction	ST012-LSZ29	1,142	5.93
Extraction	ST012-LSZ30	375	1.95
Extraction	ST012-LSZ04	603	3.13
Extraction	ST012-LSZ03	872	4.53
Extraction	ST012-LSZ02	1,319	6.85
Extraction	ST012-LSZ31	1,088	5.65
Extraction	ST012-LSZ32	1,066	5.54
Extraction	ST012-LSZ14	963	5.00
Extraction	ST012-LSZ05	620	3.22
Extraction	ST012-LSZ06	649	3.37
Extraction	ST012-LSZ01	1563	8.12
Extraction	ST012-LSZ33	668	3.47
Extraction	ST012-LSZ15	183	0.95
Extraction	ST012-LSZ34	710	3.69
Extraction	ST012-LSZ13	758	3.94
Extraction	ST012-LSZ35	287	1.49
Extraction	ST012-LSZ11	229	1.19
Extraction	ST012-LSZ36	464	2.41
Extraction	ST012-LSZ12	452	2.35
Extraction	ST012-LSZ37	187	0.97
Extraction	ST012-LSZ38	379	1.97
Extraction	ST012-LSZ39	160	0.83
Injection	ST012-LSZ08	866	4.50
Injection	ST012-LSZ17	866	4.50
Injection	ST012-LSZ16	866	4.50
Injection	ST012-LSZ18	866	4.50
Injection	ST012-LSZ09	866	4.50
Injection	ST012-LSZ19	866	4.50
Injection	ST012-LS07	866	4.50
Injection	ST012-LSZ20	866	4.50
Injection	ST012-LSZ21	866	4.50
Injection	ST012-LSZ22	866	4.50
Injection	ST012-LSZ23	866	4.50
Injection	ST012-LSZ24	866	4.50
Injection	ST012-LSZ25	866	4.50
Injection	ST012-LSZ26	866	4.50
Injection	ST012-LSZ10	866	4.50

Notes:
SEE – steam enhanced extraction
LSZ – Lower Saturated Zone

ED_005025_00013386-00571

5.1.3 SEE Groundwater Flow Model Results

Simulated hydraulic heads and pathlines for each of the hyrostratigraphic zones are provided in Figures E-5.4 through E-5.9. Containment of SEE operations within the planned treatment zones, including an additional 30 to 40 feet for the heating zones within each hydrostratigraphic zone was predicted by the model. Details of the results in each zone follow:

1. Cobble Zone: In the CZ the groundwater flow model results show that the hydrostatic heads provide containment within and around the planned treatment zone (Figure E-5.4). An approximate 2 to 4 feet deep area of depression within and around the SEE well field in the CZ is predicted by the model. Particle tracking from injection wells in the CZ (Figure E-5.5) show that all injectate is captured by the extraction wells. The CZ particle tracking results suggest that tuning of the extraction and injection wells will be required to distribute steam throughout the planned treatment zone in the CZ; especially in the upgradient portions of the planned treatment zone.

2. Upper Water Bearing Zone: In the UWBZ the groundwater flow model results show that the hydrostatic heads provide containment within and around the planned treatment zone (Figure E-5.6). An approximate 5 feet deep area of depression surrounding the SEE well field in the UWBZ is predicted by the model. Particle tracking from injection wells in the UWBZ (Figure E-5.7) show that all injectate is captured by the extraction wells. Similar to the results of the CZ particle tracking, the UWBZ particle tracking results suggest that tuning of the extraction and injection wells will be required to distribute steam throughout the planned treatment zone.

3. Lower Saturated Zone: In the LSZ the groundwater flow model results show that the hydrostatic heads provide containment within and around the planned treatment zone (Figure E-5.8). An approximate 8 feet deep area of depression surrounding the SEE well field in the majority of the LSZ is predicted by the model. In the western, upgradient portion of the SEE LSZ well field, the area of depression is less consistent and pronounced; some pressure mounds are predicted above static around the western most injection wells. Comparing this area with the remainder of the SEE LSZ treatment area reveals two factors resulting in the elevated pressures in these areas as follows: 1) the LSZ aquifer materials around these injection wells is lower in permeability compared with other portions of the LSZ; and, 2) the transmissivity across the upgradient extraction wells is lower compared with other portions of the LSZ. Particle tracking from injection wells in the LSZ (Figure E-5.9) show that all injectate is captured by the extraction wells. Compared with the particle tracking results from the CZ and UWBZ, particle tracking results in the LSZ show a better distribution of the injectate based on the initial flow design. Furthermore, the western, upgradient area which contained injection pressure mounds showed compete containment of the injectate based on particle tracking. In the northeastern portion of the LSZ SEE well field the particle tracking results suggest that tuning of the extraction and injection wells will be required in this area to distribute steam throughout.

ED_005025_00013386-00572

5.2 Site Model for Subsurface Air Flow

The air flow model of the site uses the same geological CSM as for the groundwater flow model. The geologic layering and stratigraphy at ST012 has been detailed in reference to the groundwater flow model, in Section 2.0. Characteristics of the CSM for air flow modeling include the following:

- The water levels at the site were obtained from the water flow simulation which includes extraction of water and injection of water based on the SEE design extraction flow and mass steam injection rates. The water level elevations at the last time-step of the simulation were used as the current state of water for air flow simulations.
- Hydraulic properties of the medium were the same as for the calibrated water flow simulation. MODFLOW-SURFACT internally performs the conversion of water phase conductivity to air phase conductivity values.
- The unsaturated zone parameter values of the subsurface materials (the van Genuchten moisture retention coefficients and the Brooks-Corey relative permeability coefficient) were the same as for the calibrated water flow simulation. MODFLOW-SURFACT internally uses air-phase relative permeability curves when solving for air phase flow.
- Air exists within the subsurface at atmospheric pressure conditions initially. The ground surface was prescribed as an atmospheric pressure boundary condition that allows air to flow in and out across the land surface due to the steam injection and vapor extraction operations.
- Air injection rates reflect the design injection rates for steam. Assumptions include non-isothermal flow without phase change of steam to water. Air is extracted at the suction pressure applied to the dual phase pumps. The quantity of vapor thus extracted is computed by the model under the prescribed suction pressure conditions.
- The air flow model was run under steady-state conditions. Preliminary simulations indicated that air would stabilize to steady-state conditions within a few weeks and hence the long-term evaluation of air flow pathways was considered for this analysis.

5.2.1 Model Domain and Grid

The model domain and grid structure is the same, cell-by-cell, as the groundwater flow model. The only difference between the structures of the two model resides in the layering. Model layers refined in the EBR design model were used for the air flow model.

5.2.2 Material Properties and Boundary Conditions

Hydraulic conductivity, storage, and unsaturated properties are the same as for the water flow simulation. Layers 12 and 13 representing the UWBZ, and layers 16 through 19 representing the LSZ are heterogeneous. Note that the moisture retention curves are also the same as for the water flow model and thus air saturations are the same in both models when air is at atmospheric conditions. Air saturation is computed as one minus water saturation. Also, for air flow, the MODFLOW-SURFACT code uses relative permeability functions for air (k_{ra}), given for

ED_005025_00013386-00573

the Brooks-Corey relationship as $k_{ra} = S_{ea}^2 (1 - S_e^{(n-2)})$, where S_{ea} is an effective air saturation defined analogously to the effective water saturation, and n is the Brooks-Corey exponent (HydroGeoLogic Inc, 1991).

No-Flow boundary conditions were specified along lateral edges of the model domain. The top model boundary is provided at an atmospheric pressure boundary condition. Injection of air was provided as a prescribed inflow rate boundary condition via the WELL boundary package of MODFLOW-SURFACT. The extraction wells were provided a fixed negative air pressure boundary condition.

5.2.3 SEE Well Layout

SEE injection and extraction wells were placed in the model in a similar fashion as described in the groundwater model (Section 5.1.1; Figures E-5.1, E-5.2, and E-5.3; and, Tables E-5.1, E-5.2, and E-5.3).

5.2.4 SEE Subsurface Air Flow Model Extraction and Injection Rates

Simulating the movement of steam in the subsurface using air at standard temperature is an approximation that is conservative when considering the application of the model to investigate containment of the SEE process. The ratio of density and dynamic viscosity (density:viscosity) of steam flowing at saturation temperature in the CZ, UWBZ, and LSZ are approximately 1.75 square feet per hour (ft^2/hr), 2.57 ft^2/hr, and 5.46 ft^2/hr, respectively. The density:viscosity ratio for air flowing at standard temperature in the CZ, UWBZ, and LSZ are approximately 2.56 ft^2/hr, 3.88 ft^2/hr, and 5.99 ft^2/hr, respectively. Since the ratio of fluid density to dynamic viscosity are the independent fluid terms in conductivity, comparison of these ratios reveal similarities or differences between using one fluid to approximate the flow of another in a porous medium. Within the range of pressures and temperatures that the steam is planned for application in the subsurface; air, at in-situ pressures and at ambient, standard temperature, provides a reasonable approximation. Since the density:viscosity ratio for air is between approximately 8% and 34% greater than the comparable density:viscosity ratio for steam, using air provides a conservative approximation when evaluating steam flow.

Air flow to and from extraction and injection wells were simulated by establishing pressures below and above ambient at each well dependent on the groundwater elevations predicted using the groundwater flow model. Since the groundwater flow model predicted that the groundwater pressures would be below static across the entire well field, even at injection wells, a baseline elevation in each hydrostratigraphic zone was established to estimate injection and extraction pressures. This baseline elevation in each hydrostratigraphic unit was calculated as the elevation at the midpoint between the shallowest drawdown at any extraction well and the shallowest drawdown at any injection well predicted by the groundwater model. Injection well pressures and extraction well vacuums were calculated as hydrostatic equivalent well screen air pressures equal to the drawdowns and mounds relative to the mean baseline elevation. Tables E-5.7, E-5.8, and E-5.9 provide a summary of the well screen air pressures above or below hydrostatic used to simulate vapor extraction and steam flow in each of the hydrostratigraphic zones.

ED_005025_00013386-00574

863 **Table E-5.7 SEE Design Air Pressures at Well Screens in CZ**

Well Type	Well Name	Well Screen Air Pressure (feet water column relative to atmospheric)
Extraction	ST012-CZ07	-5.0
Extraction	ST012-CZ08	-7.8
Extraction	ST012-CZ09	-2.6
Extraction	ST012-CZ10	-8.2
Extraction	ST012-CZ11	-3.9
Extraction	ST012-CZ12	-6.4
Extraction	ST012-CZ13	-3.6
Extraction	ST012-CZ14	-5.8
Extraction	ST012-CZ15	-6.4
Extraction	ST012-CZ16	-4.1
Extraction	ST012-CZ17	-4.3
Extraction	ST012-CZ18	-0.2
Extraction	ST012-CZ19	-1.4
Injection	ST012-CZ01	0.3
Injection	ST012-CZ02	0.3
Injection	ST012-CZ03	0.7
Injection	ST012-CZ04	0.3
Injection	ST012-CZ05	2.1
Injection	ST012-CZ06	1.8

864 **Notes:**
865 CZ – Cobble Zone
866 SEE – steam enhanced extraction

867 **Table E-5.8 SEE Design Air Pressures at Well Screens in UWBZ**

Well Type	Well Name	Well Screen Air Pressure (feet water column relative to atmospheric)
Extraction	ST012-UWBZ17	-16.6
Extraction	ST012-UWBZ18	-16.6
Extraction	ST012-UWBZ3	-7.3
Extraction	ST012-UWBZ4	-7.3
Extraction	ST012-UWBZ2	-11.5
Extraction	ST012-UWBZ19	-11.5
Extraction	ST012-UWBZ20	-3.4
Extraction	ST012-UWBZ5	-7.3
Extraction	ST012-UWBZ21	-14.7
Extraction	ST012-UWBZ6	-7.3
Extraction	ST012-UWBZ1	-16.6
Extraction	ST012-UWBZ22	-5.5
Extraction	ST012-UWBZ23	-10.3
Extraction	ST012-UWBZ24	-7.3
Injection	ST012-UWBZ25	3.7
Injection	ST012-UWBZ09	5.0

ED_005025_00013386-00575

Well Type	Well Name	Well Screen Air Pressure (feet water column relative to atmospheric)
Injection	ST012-UWBZ10	1.7
Injection	ST012-UWBZ11	0.6
Injection	ST012-UWBZ12	4.3
Injection	ST012-UWBZ13	4.5
Injection	ST012-UWBZ7	3.7
Injection	ST012-UWBZ14	0.9
Injection	ST012-UWBZ15	3.7
Injection	ST012-UWBZ16	3.7

Notes:
SEE – steam enhanced extraction
UWBZ – Upper Water Bearing Zone

Table E-5.9 SEE Design Air Pressures at Well Screens in LSZ

Well Type	Well Name	Well Screen Air Pressure (feet water column relative to atmospheric)
Extraction	ST012-LSZ27	-7.25
Extraction	ST012-LSZ28	-7.25
Extraction	ST012-LSZ29	-7.25
Extraction	ST012-LSZ30	-7.25
Extraction	ST012-LSZ04	-20.7
Extraction	ST012-LSZ03	-18.8
Extraction	ST012-LSZ2	-7.25
Extraction	ST012-LSZ31	-7.25
Extraction	ST012-LSZ32	-7.25
Extraction	ST012-LSZ14	-22.4
Extraction	ST012-LSZ05	-20.7
Extraction	ST012-LSZ06	-21.5
Extraction	ST012-LSZ1	-22.4
Extraction	ST012-LSZ33	-7.25
Extraction	ST012-LSZ15	-7.25
Extraction	ST012-LSZ34	-20.9
Extraction	ST012-LSZ13	-22.4
Extraction	ST012-LSZ35	-10.0
Extraction	ST012-LSZ11	-22.4
Extraction	ST012-LSZ36	-19.7
Extraction	ST012-LSZ12	-22.4
Extraction	ST012-LSZ37	-0.42
Extraction	ST012-LSZ38	-0.49
Extraction	ST012-LSZ39	-0.35
Injection	ST012-LSZ08	16.00
Injection	ST012-LSZ17	5.16
Injection	ST012-LSZ16	16.00
Injection	ST012-LSZ18	3.96

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Well Type	Well Name	Well Screen Air Pressure (feet water column relative to atmospheric)
Injection	ST012-LSZ09	16.00
Injection	ST012-LSZ19	6.77
Injection	ST012-LS07	0.13
Injection	ST012-LSZ20	0.13
Injection	ST012-LSZ21	2.80
Injection	ST012-LSZ22	4.19
Injection	ST012-LSZ23	17.21
Injection	ST012-LSZ24	9.49
Injection	ST012-LSZ25	0.58
Injection	ST012-LSZ26	5.18
Injection	ST012-LSZ10	16.00

Notes:
SEE – steam enhanced extraction
LSZ – Lower Saturated Zone

5.2.5 SEE Air Flow Model Results

Simulated air pressure heads for each of the hyrostratigraphic zones are provided in Figures E-5.10 through E-5.12. Containment of SEE operations within the planned treatment zones within each hydrostratigraphic zone was predicted by the model. Details of the results in each zone follow:

1. Cobble Zone: In the CZ the air-flow model results show that the air pressure heads are contained within the planned treatment zone (Figure E-5.10). An approximate pressure drop below atmospheric equal to approximately 6% of the maximum applied wellhead vacuum, which was set at approximately 8.2 feet of water column (ftH_2O)/7.25 inches of mercury (inHg) (see Table E-5.7) is predicted by the model.

2. Upper Water Bearing Zone: In the UWBZ the air-flow model results show that the air pressure heads are contained within the planned treatment zone (Figure E-5.11). An approximate pressure drop below atmospheric equal to approximately 6% of the maximum applied wellhead vacuum, which was set at approximately 16.6 ftH_2O/14.7 inHg (see Table E-5.8) is predicted by the model.

3. Lower Saturated Zone: In the LSZ the air-flow model results show that the air pressure heads are contained within the planned treatment zone (Figure E-5.12). An approximate pressure drop below atmospheric equal to approximately 6% of the maximum applied wellhead vacuum, which was set at approximately 12.4 ftH_2O/11.0 inHg (see Table E-5.9) is predicted by the model. Similar to the results of the SEE groundwater flow model in the western, upgradient portion of the SEE LSZ well field the vacuum field is less pronounced; some pressure mounds are predicted above the mean hydrostatic baseline elevation around the western most injection wells.

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5.3 Assumptions and Limitations

The air flow model has been developed with the objective of evaluating the subsurface behavior of the vapor phase, subject to injection and extraction of steam. Several assumptions have been implemented in developing the model including discrete representations of the saturated/unsaturated groundwater and air flow system in space and time. A zonal approach has been used to representing the aquifer properties. Thus, gross heterogeneities have been averaged into zonal properties that represent known/estimated aquifer properties within the zone and water level elevations at the site during the calibration period. Soil moisture and relative permeability relationships are also averaged for the representative soils at the site.

The air flow model was simulated in a decoupled manner from flow of water. Thus, the state of water in the system is considered static when air flow is simulated. This is complementary to the Richards equation for solving flow of water in a saturated/unsaturated system where the state of air is considered static. Including these factors into a simulation would require multi-phase, non-isothermal simulations with significantly larger efforts and a much expanded set of parameters and variables that have large variations and uncertainties in their ranges.

Regardless of the level of model sophistication, geological complexity adds a high degree of uncertainty to any prediction that is based on assumed geologic interpretations. Also, modification of the number of wells, locations of wells, and pumping rates should be expected as additional subsurface information is obtained and as experience is gained from monitoring actual system performance during operations. As with every model, there is uncertainty associated with its predictions and these uncertainties should be considered when using the model to guide site management strategies.

ED_005025_00013386-00578

6.0 REFERENCES

AMEC Environment & Infrastructure, Inc. (AMEC), 2012. *Final Focused Feasibility Study, Remedial Alternatives for Operable Unit 2, Site ST012, Former Williams AFB, Mesa, Arizona*. 27 November 2012.

BEM Systems Inc. (BEM), 2010. *Technical Evaluation Report of Phase I TEE Pilot Test Performance Evaluation Report.*

HydroGeoLogic, Inc., 1991. MODFLOW-SURFACT, Version 3. Documentation and Users Guide. 548 p.

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FIGURES

Legend

- CZ LNAPL extent
- UWBZ LNAPL extent
- LSZ LNAPL extent
- LSZ SEE Treatment Zone
- CZ/UWBZ SEE Treatment Zone
- ST012 Site
- Model Grid

Notes: CZ - Cobble Zone
UWBZ - Upper Water Bearing Zone
LSZ - Lower Saturated Zone
LNAPL - Light Non-Aqueous Phase Liquid

0 200 400 800 Feet

N

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MODEL GRID LAYOUT

FIGURE
E-2.1

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PM: EW
Date: 12/20/2013
Scale: 1" = 400 feet

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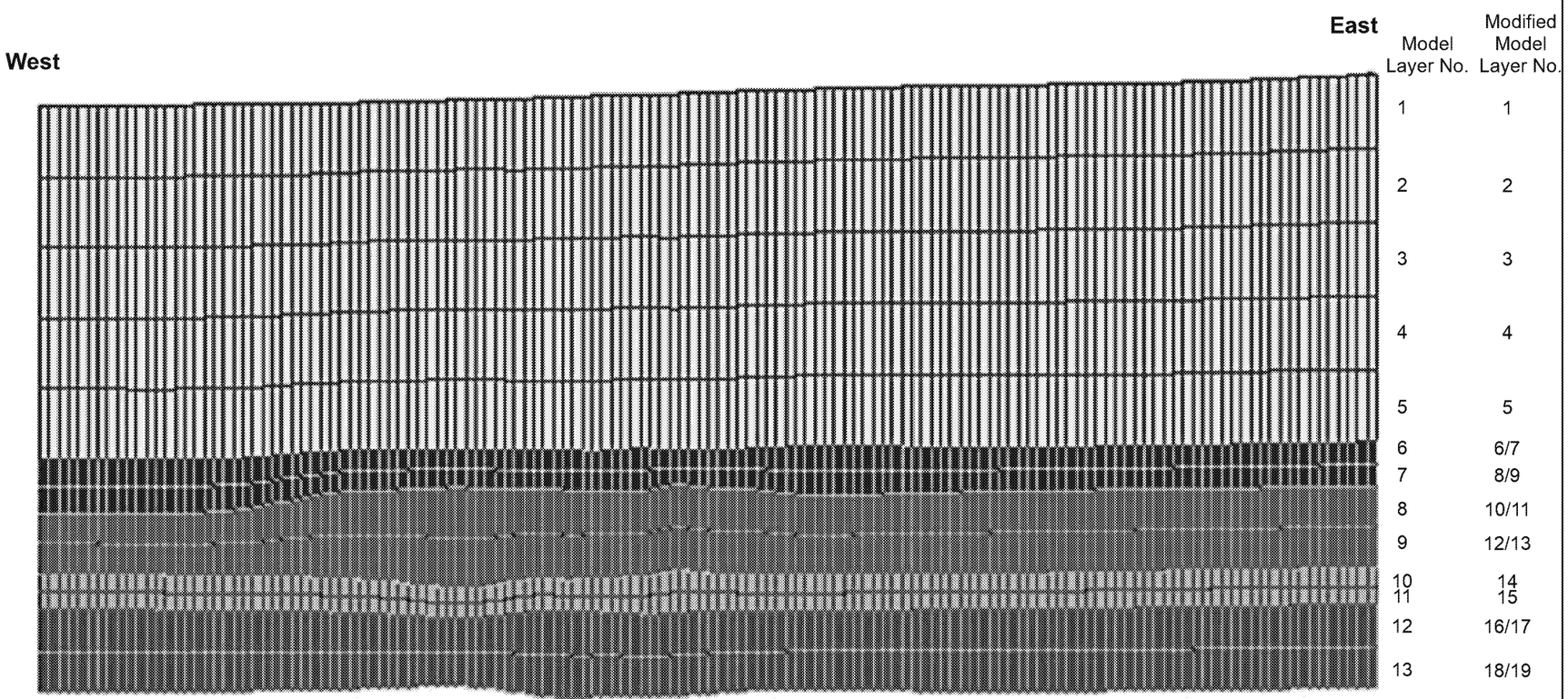

Legend

Model Unit

- Unsaturated Zone
- Cobble Zone
- Upper Water Bearing Zone
- Low Permeability Zone
- Lower Saturated Zone

Notes: Cross Section not to scale
Vertical Exaggeration ~5X

Section represents model slice through center of site ST012.

Model layer elevations vary with hydrostratigraphic contacts.

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Model Layers

FIGURE
E-2.2

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Legend

- CZ LNAPL extent
- UWBZ LNAPL extent
- LSZ LNAPL extent
- LSZ SEE Treatment Zone
- CZ/UWBZ SEE Treatment Zone
- ST012 Site

Saturated Conductivity

Kxy, Kz (ft/day)

- 1, 0.1
- 2, 0.2
- 3, 0.3
- 4, 0.4
- 5, 0.5
- 6, 0.6
- 7, 0.7
- 8, 0.8
- 9, 0.9
- 10, 1

Notes: CZ - Cobble Zone
UWBZ - Upper Water Bearing Zone
LSZ - Lower Saturated Zone
LNAPL - Light Non-Aqueous Phase Liquid
Source: Appendix M of the Technical Evaluation Report of Phase I TEE Pilot Test Performance Evaluation

0 200 400 800 Feet

N

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SATURATED CONDUCTIVTY DISTRIBUTION IN THE UPPER WATER BEARING ZONE

FIGURE **E-2.3**

Job No. 9101110001
PM: EW
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Scale: 1" = 400 feet

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Legend

- CZ LNAPL extent
- UWBZ LNAPL extent
- LSZ LNAPL extent
- LSZ SEE Treatment Zone
- CZ/UWBZ SEE Treatment Zone
- ST012 Site

Saturated Conductivity

Kxy, Kz (ft/day)

- 1, 0.1
- 2, 0.2
- 3, 0.3
- 4, 0.4
- 5, 0.5
- 6, 0.6
- 7, 0.7
- 8, 0.8
- 9, 0.9
- 10, 1
- 11, 1.1
- 12, 1.2

Notes: CZ - Cobble Zone
UWBZ - Upper Water Bearing Zone
LSZ - Lower Saturated Zone
LNAPL - Light Non-Aqueous Phase Liquid
Source: Appendix M of the Technical Evaluation Report of Phase I TEE Pilot Test Performance Evaluation

0 200 400 800 Feet

N

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SATURATED CONDUCTIVTY DISTRIBUTION IN THE LOWER SATURATED ZONE

FIGURE **E-2.4**

Job No.
PM: 9101110001
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Scale: 1" = 400 feet

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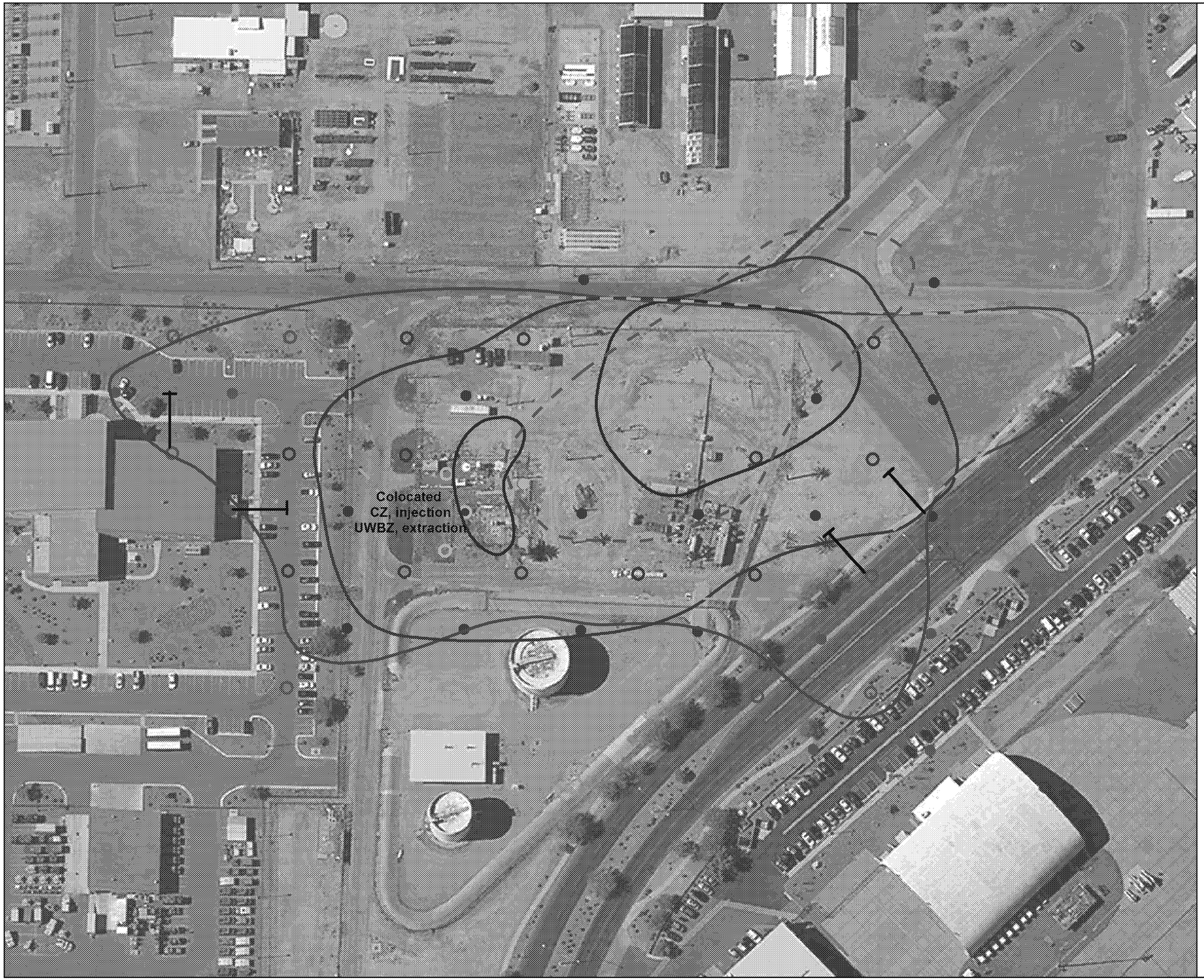

Legend

Remediation Well Zone, Type

- CZ, extraction
- CZ, injection
- LSZ, extraction
- LSZ, injection
- UWBZ and LSZ, extraction
- UWBZ and LSZ, injection
- UWBZ, extraction
- UWBZ, injection
- CZ LNAPL extent
- UWBZ LNAPL extent
- LSZ LNAPL extent
- LSZ SEE Treatment Zone
- CZ/UWBZ SEE Treatment Zone
- Sloped Well

Notes: SEE - Steam Enhanced Extraction
CZ - Cobble Zone
LSZ - Lower Saturated Zone
UWBZ - Upper Water Bearing Zone
LNAPL - Light Non-Aqueous Phase Liquid

0 100 200 Feet

N

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CONCEPTUAL ENHANCED BIOREMEDIATION WELL FIELD LAYOUT

FIGURE **E-4.1**

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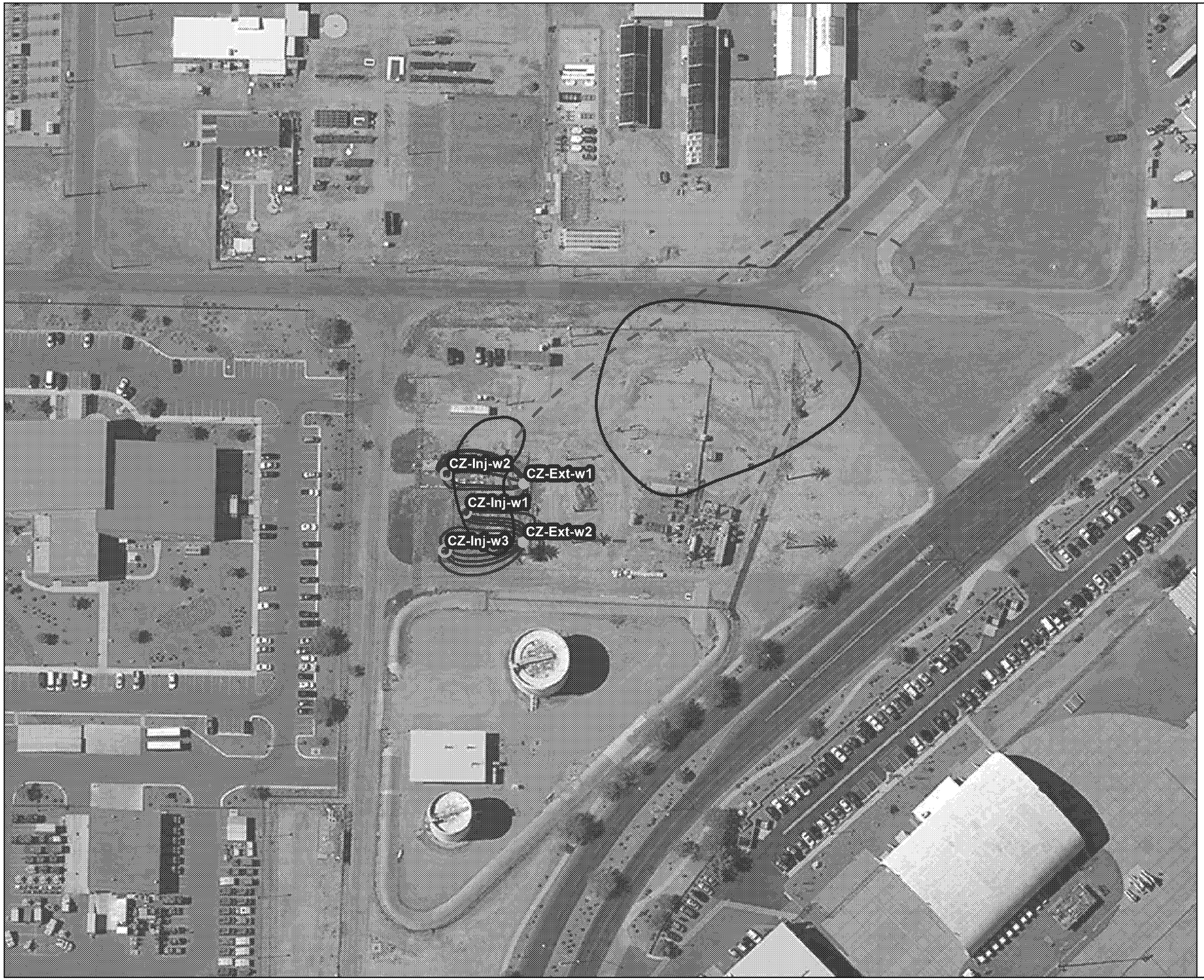

Legend

Remediation Well Zone, Type

- CZ, extraction
- CZ, injection
- CZ Pathlines
- CZ LNAPL extent
- CZ/UWBZ SEE Treatment Zone

Notes: SEE - Steam Enhanced Extraction
CZ - Cobble Zone
UWBZ - Upper Water Bearing Zone
LNAPL - Light Non-Aqueous Phase Liquid

0 100 200 Feet

N

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COBBLE ZONE RECIRCULATION SYSTEM PATHLINES

FIGURE **E-4.2**

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Scale: 1" = 100 feet

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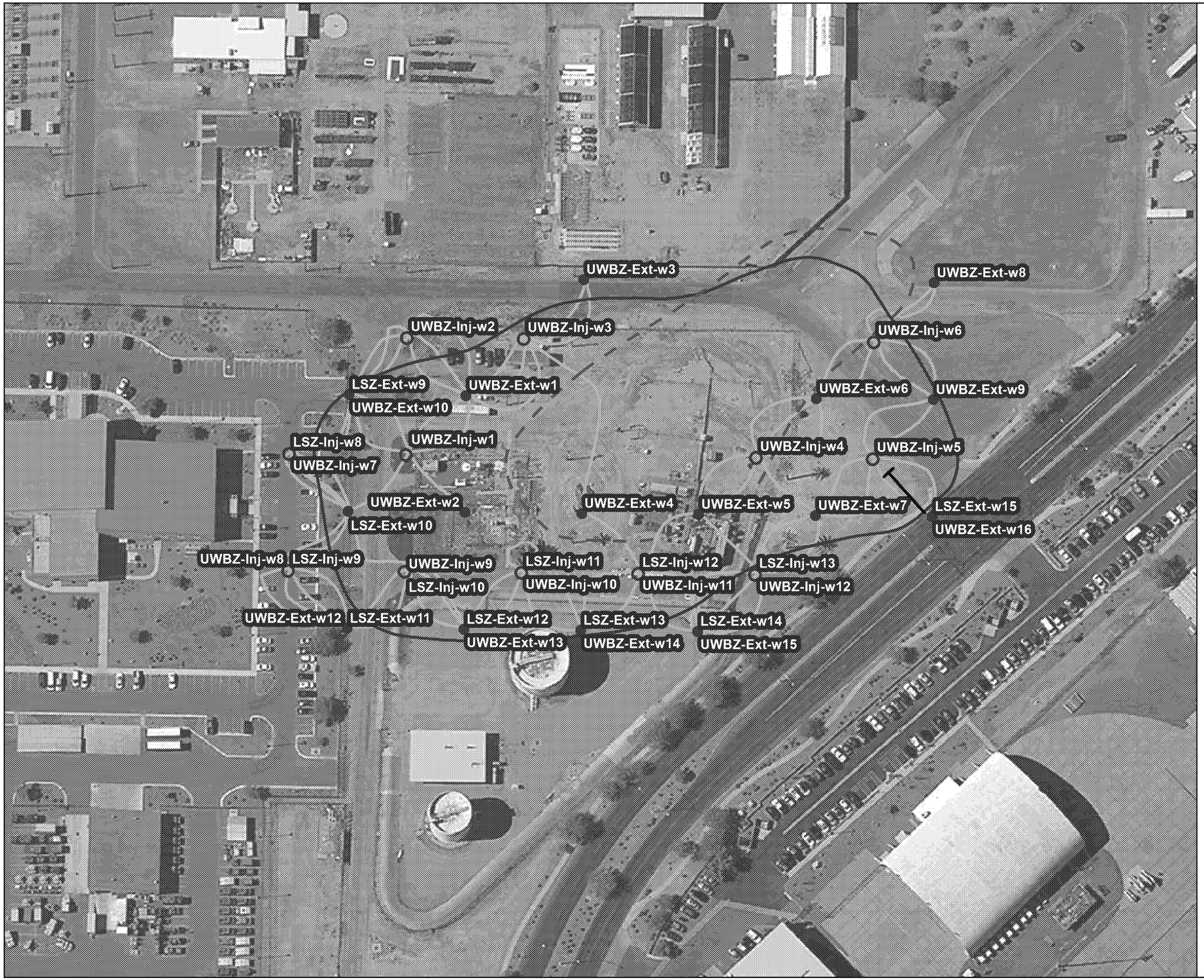

Legend

UWBZ_and_LSZ_Limits Layer

- CZ/UWBZ SEE Treatment Zone

Remediation Well Zone, Type

- UWBZ and LSZ, extraction
- UWBZ and LSZ, injection
- UWBZ, extraction
- UWBZ, injection
- UWBZ Pathlines
- UWBZ LNAPL extent
- CZ/UWBZ SEE Treatment Zone
- Sloped Well

Notes: SEE - Steam Enhanced Extraction
CZ - Cobble Zone
LSZ - Lower Saturated Zone
UWBZ - Upper Water Bearing Zone
LNAPL - Light Non-Aqueous Phase Liquid

0 100 200 Feet

N

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UPPER WATER BEARING ZONE RECIRCULATION SYSTEM PATHLINES

FIGURE **E-4.3**

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PM: EW
Date: 12/20/2013
Scale: 1" = 100 feet

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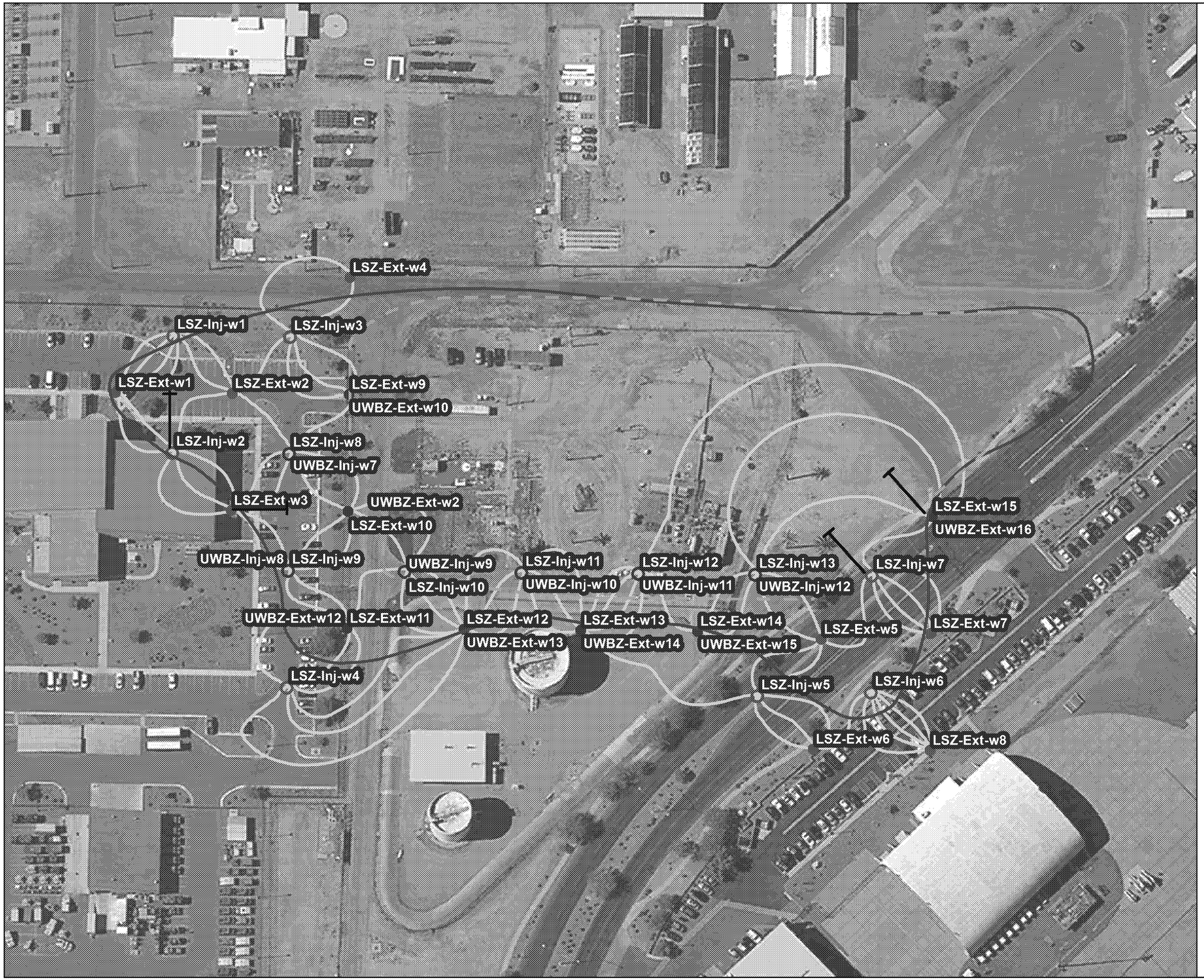

Legend

Remediation Well Zone, Type

- LSZ, extraction
- LSZ, injection
- UWBZ and LSZ, extraction
- UWBZ and LSZ, injection
- LSZ Pathlines
- LSZ LNAPL extent
- LSZ SEE Treatment Zone
- Sloped Well

Notes: SEE - Steam Enhanced Extraction
LSZ - Lower Saturated Zone
UWBZ - Upper Water Bearing Zone
LNAPL - Light Non-Aqueous Phase Liquid

0 100 200 Feet

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LOWER SATURATED ZONE RECIRCULATION SYSTEM PATHLINES

FIGURE **E-4.4**

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Legend

Remediation Well Zone, Type

- CZ, Extraction
- CZ, Injection
- CZ LNAPL extent
- CZ/UWBZ SEE Treatment Zone

Notes: SEE - Steam Enhanced Extraction
CZ - Cobble Zone
UWBZ - Upper Water Bearing Zone
LNAPL - Light Non-Aqueous Phase Liquid

0 100 200 Feet

N

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SEE WELL FIELD LAYOUT
COBBLE ZONE

FIGURE
E-5.1

Job No. 9101110001
PM: EW
Date: 12/20/2013
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Legend

Remediation Well Zone, Type

- UWBZ, Extraction
- UWBZ, Injection
- UWBZ LNAPL extent
- CZ/UWBZ SEE Treatment Zone

Notes: SEE - Steam Enhanced Extraction
CZ - Cobble Zone
UWBZ - Upper Water Bearing Zone
LNAPL - Light Non-Aqueous Phase Liquid

0 100 200 Feet

N

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SEE WELL FIELD LAYOUT
UPPER WATER BEARING ZONE

FIGURE
E-5.2

Job No. 9101110001
PM: EW
Date: 12/20/2013
Scale: 1" = 100 feet

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Legend

Remediation Well Zone, Type

- LSZ, Extraction
- LSZ, Injection
- LSZ LNAPL extent
- LSZ SEE Treatment Zone

Notes: SEE - Steam Enhanced Extraction
LSZ - Lower Saturated Zone
LNAPL - Light Non-Aqueous Phase Liquid

0 100 200 Feet

N

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SEE WELL FIELD LAYOUT
LOWER SATURATED ZONE

FIGURE
E-5.3

Job No. 9101110001
PM: EW
Date: 12/20/2013
Scale: 1" = 100 feet

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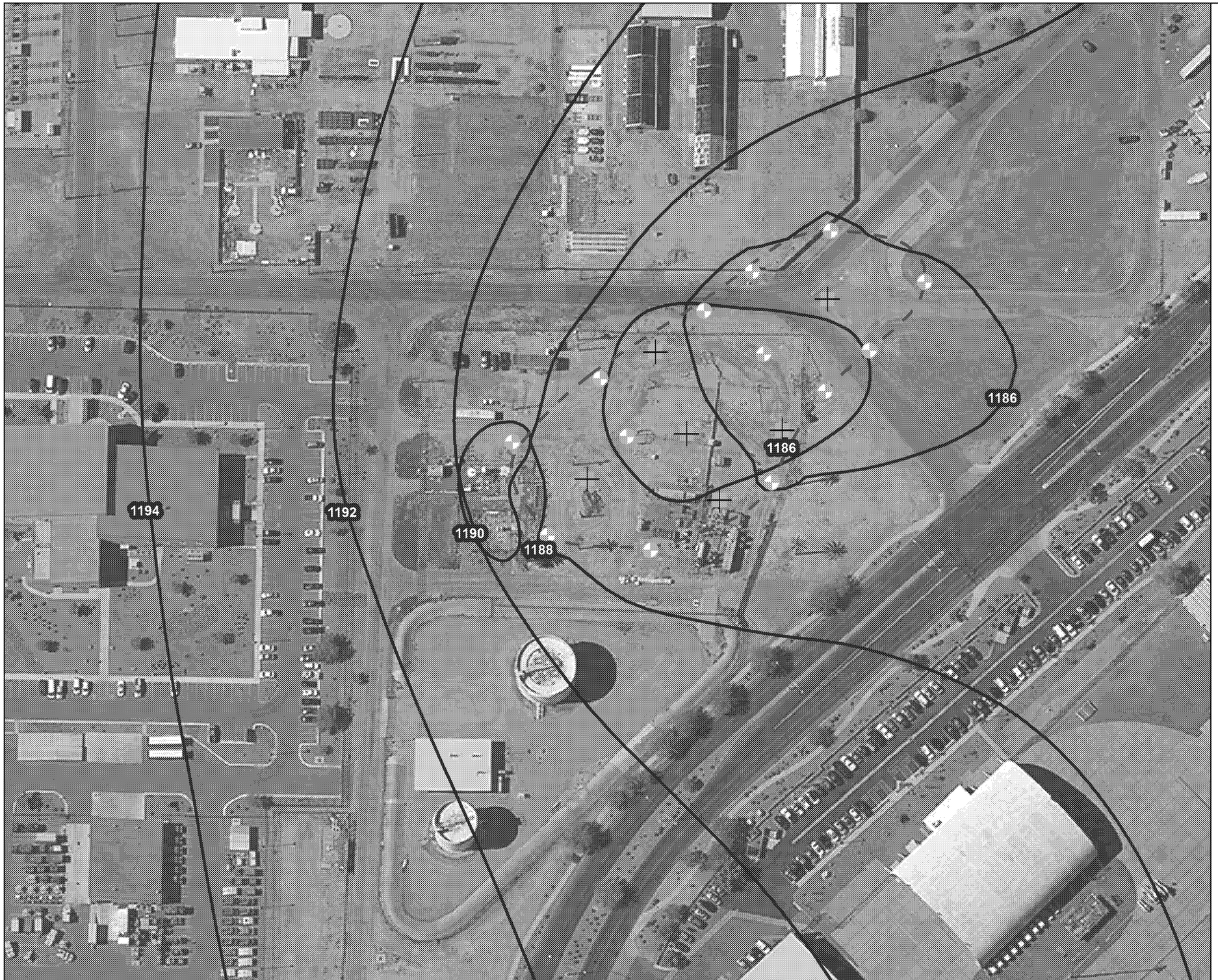

Legend

Remediation Well Zone, Type

- CZ, Extraction
- CZ, Injection
- CZ Heads (ft)
- CZ LNAPL extent
- CZ/UWBZ SEE Treatment Zone

Notes: SEE - Steam Enhanced Extraction
CZ - Cobble Zone
UWBZ - Upper Water Bearing Zone
LNAPL - Light Non-Aqueous Phase Liquid

Contour Interval: 2 Feet

0 100 200 Feet

N

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Mesa, Arizona

HYDRAULIC HEAD
COBBLE ZONE

FIGURE
E-5.4

Job No. 9101110001
PM: EW
Date: 12/20/2013
Scale: 1" = 100 feet

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Legend

Remediation Well Zone, Type

- CZ, Extraction
- CZ, Injection
- CZ Pathlines
- CZ LNAPL extent
- CZ/UWBZ SEE Treatment Zone

Notes: SEE - Steam Enhanced Extraction
CZ - Cobble Zone
UWBZ - Upper Water Bearing Zone
LNAPL - Light Non-Aqueous Phase Liquid

0 100 200 Feet

N

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SEE RECIRCULATION SYSTEM PATHLINES COBBLE ZONE

FIGURE **E-5.5**

Job No.	9101110001
PM:	EW
Date:	12/20/2013
Scale:	1" = 100 feet

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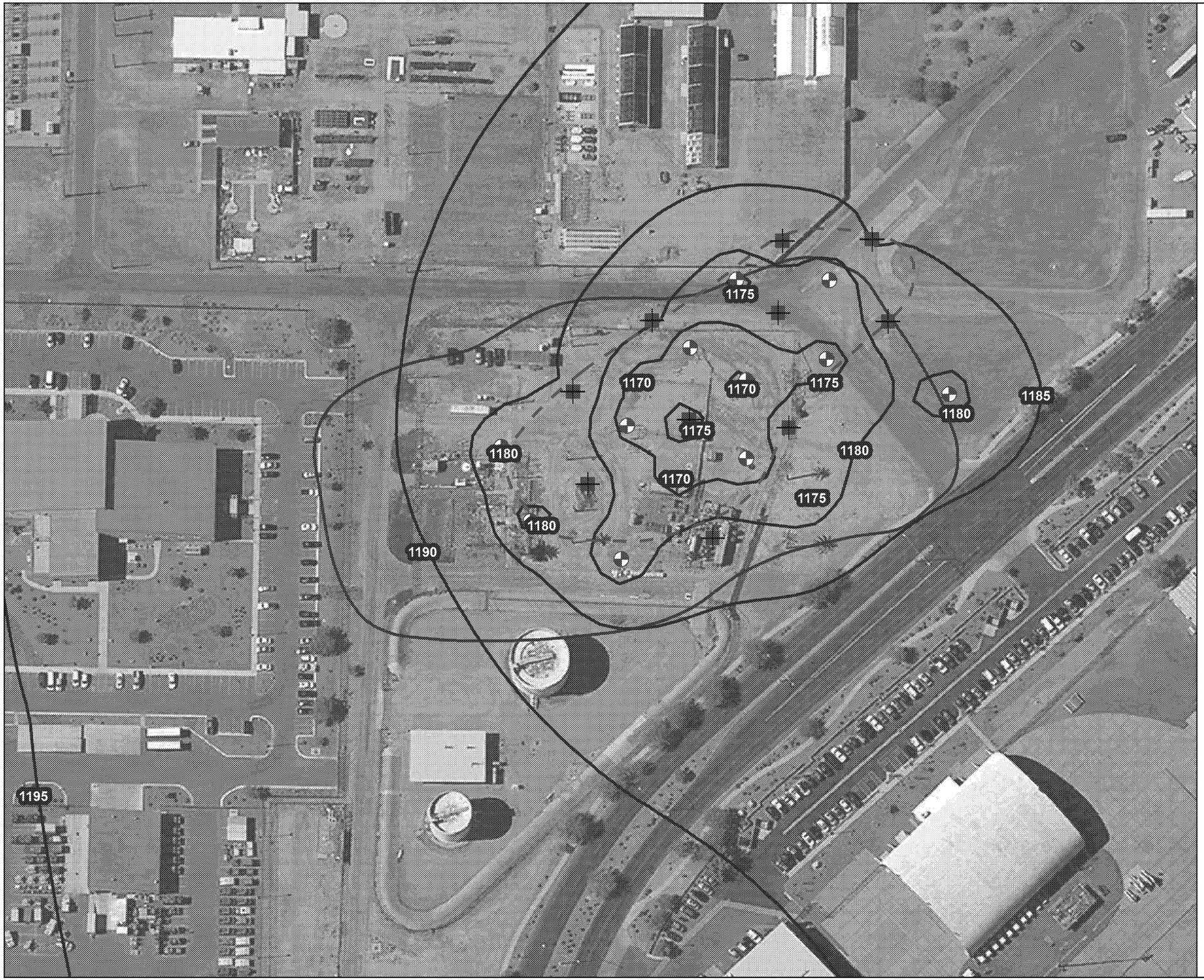

Legend

Remediation Well Zone, Type

- UWBZ, Extraction
- UWBZ, Injection
- UWBZ Heads (ft)
- UWBZ LNAPL extent
- CZ/UWBZ SEE Treatment Zone

Notes: SEE - Steam Enhanced Extraction
CZ - Cobble Zone
UWBZ - Upper Water Bearing Zone
LNAPL - Light Non-Aqueous Phase Liquid

Contour Interval: 5 Feet

0 100 200 Feet

N

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HYDRAULIC HEAD
UPPER WATER BEARING ZONE

FIGURE
E-5.6

Job No. 9101110001
PM: EW
Date: 12/20/2013
Scale: 1" = 100 feet

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Legend

Remediation Well Zone, Type

- UWBZ, Extraction
- UWBZ, Injection
- UWBZ Pathlines
- UWBZ LNAPL extent
- CZ/UWBZ SEE Treatment Zone

Notes: SEE - Steam Enhanced Extraction
CZ - Cobble Zone
UWBZ - Upper Water Bearing Zone
LNAPL - Light Non-Aqueous Phase Liquid

0 100 200 Feet

N

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SEE RECIRCULATION SYSTEM PATHLINES UPPER WATER BEARING ZONE

FIGURE **E-5.7**

Job No. 9101110001
PM: EW
Date: 12/20/2013
Scale: 1" = 100 feet

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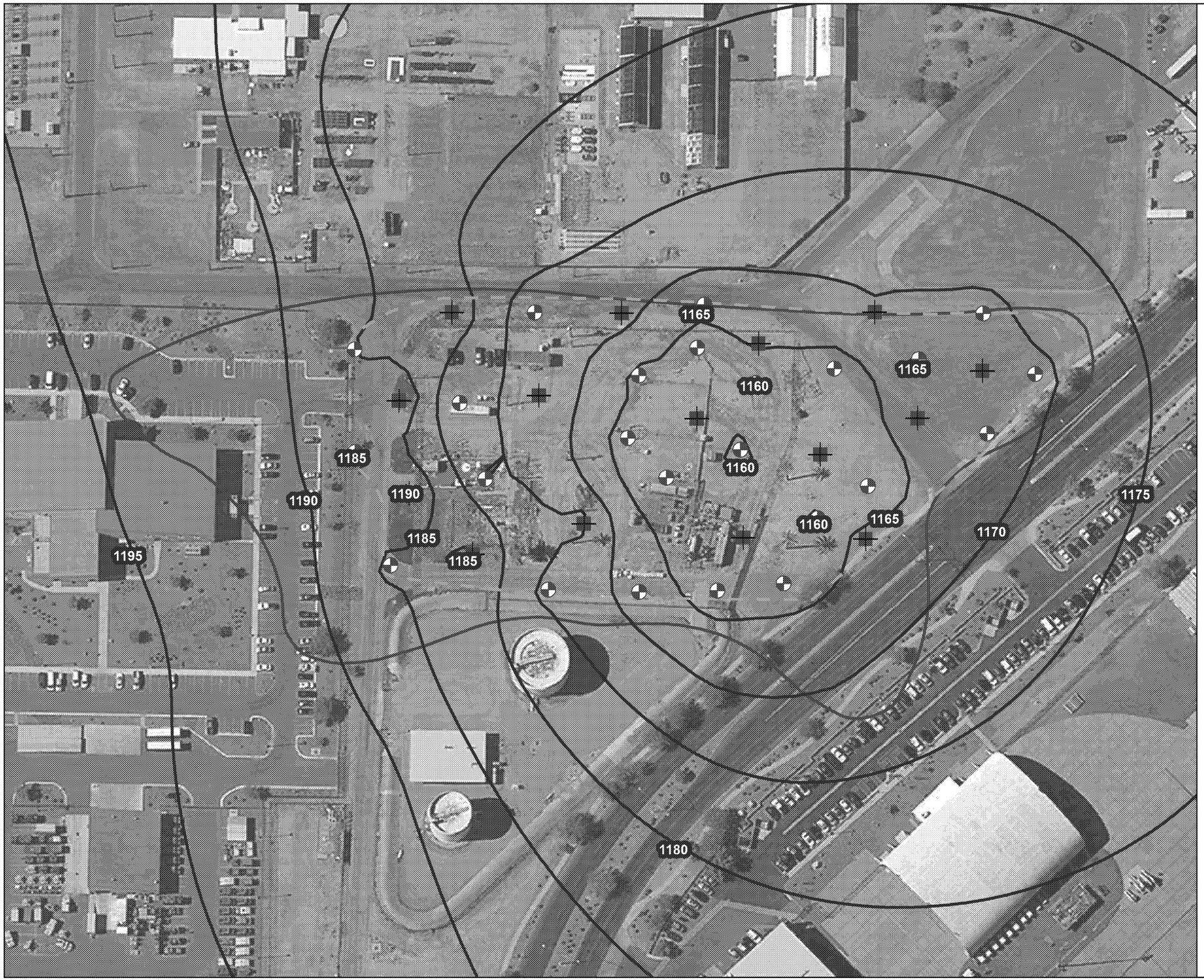

Legend

Remediation Well Zone, Type

- LSZ, Extraction
- LSZ, Injection
- LSZ Heads (ft)
- LSZ LNAPL extent
- LSZ SEE Treatment Zone

Notes: SEE - Steam Enhanced Extraction
LSZ - Lower Saturated Zone
LNAPL - Light Non-Aqueous Phase Liquid

Contour Interval: 5 Feet

0 100 200 Feet

N

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Former Williams Air Force Base
Mesa, Arizona

HYDRAULIC HEAD
LOWER SATURATED ZONE

FIGURE
E-5.8

Job No.	9101110001
PM:	EW
Date:	12/20/2013
Scale:	1" = 100 feet

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Legend

Remediation Well Zone, Type

- LSZ, Extraction
- LSZ, Injection
- LSZ Pathlines
- LSZ LNAPL extent
- LSZ SEE Treatment Zone

Notes: SEE - Steam Enhanced Extraction
LSZ - Lower Saturated Zone
LNAPL - Light Non-Aqueous Phase Liquid

0 100 200 Feet

N

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Remedial Design/Remedial Action Work Plan
Former Williams Air Force Base
Mesa, Arizona

SEE RECIRCULATION SYSTEM PATHLINES LOWER SATURATED ZONE

FIGURE **E-5.9**

Job No. 9101110001
PM: EW
Date: 12/20/2013
Scale: 1" = 100 feet

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Legend

Remediation Well Zone, Type

CZ, Extraction

CZ, Injection

Air pressure head normalized to maximum injection/extraction wellhead pressure

Contour

CZ LNAPL extent

CZ/UWBZ SEE Treatment Zone

Notes: SEE - Steam Enhancement Extraction
CZ - Cobble Zone
UWBZ - Upper Water Bearing Zone
LNAPL - Light Non-Aqueous Phase Liquid

Negative normalized pressure values represent vacuum field
Positive normalized pressure values represent injected air field

0 100 200 Feet

N

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Mesa, Arizona

COBBLE ZONE NORMALIZED AIR HEADS

FIGURE **E-5.10**

Job No. 9101110001
PM: EW
Date: 12/20/2013
Scale: 1" = 200 feet

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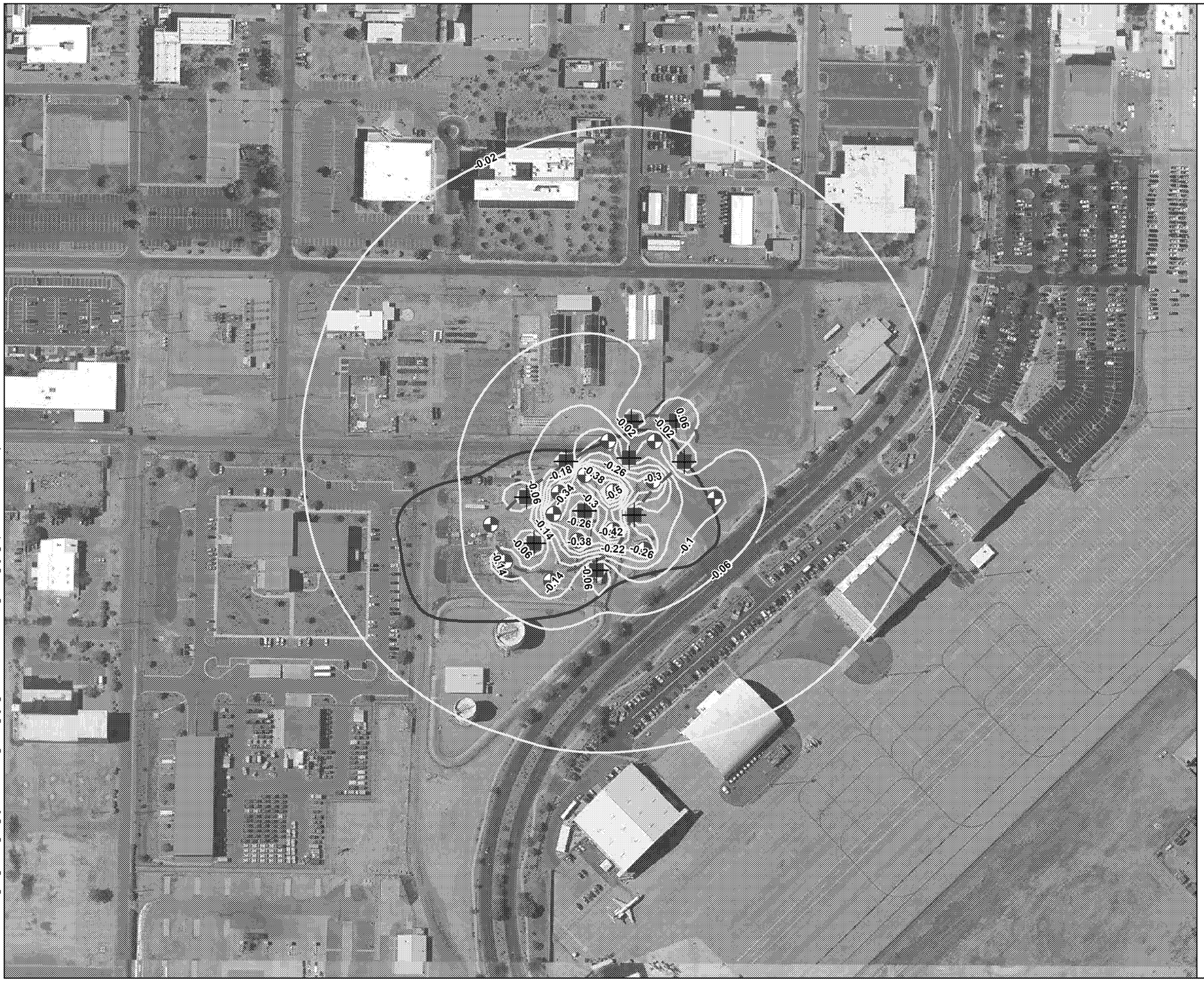

Legend

Remediation Well Zone, Type

- UWBZ, Extraction
- UWBZ, Injection

Air pressure head normalized to maximum injection/extraction wellhead pressure

- Contour
- CZ/UWBZ SEE Treatment Zone
- UWBZ LNAPL extent

Notes: SEE - Steam Enhancement Extraction
CZ - Cobble Zone
UWBZ - Upper Water Bearing Zone
LNAPL - Light Non-Aqueous Phase Liquid

Negative normalized pressure values represent vacuum field
Positive normalized pressure values represent injected air field

0 100 200 Feet

N

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UPPER WATER BEARING ZONE NORMALIZED AIR HEADS

FIGURE **E-5.11**

Job No.	9101110001
PM:	EW
Date:	12/20/2013
Scale:	1" = 200 feet

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Legend

Remediation Well Zone, Type

LSZ, Extraction

LSZ, Injection

Air pressure head normalized to maximum injection/extraction wellhead pressure

Contour

LSZ SEE Treatment Zone

LSZ LNAPL extent

Notes: SEE - Steam Enhancement Extraction
LSZ - Lower Saturated Zone
LNAPL - Light Non-Aqueous Phase Liquid

Negative normalized pressure values represent vacuum field
Positive normalized pressure values represent injected air field

0 100 200 Feet

N

Draft Final
Remedial Design/Remedial Action Work Plan
Former Williams Air Force Base
Mesa, Arizona

LOWER SATURATED ZONE NORMALIZED HEADS

FIGURE **E-5.12**

Job No. 9101110001
PM: EW
Date: 12/20/2013
Scale: 1" = 200 feet

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APPENDIX F

PERMIT DOCUMENTATION

mesa·az
WATER RESOURCES
mesaaz.gov

640 N Mesa Dr
PO Box 1466
Mesa, Arizona 85211-1466

December 13, 2011

Michelle Lewis
Air Force Real Property Agency (AFRPA)
3411 Olson St.
McClellan, CA. 95652

Dear Ms. Lewis:

Based upon the Permit Application submitted by URS Group, Inc. (URS) on the behalf of the U.S. Air Force the City of Mesa has issued the enclosed Permit (#M-5863-1213) for your review. This Permit regulates wastewater discharges from the groundwater remediation system located at (Williams Gateway Airport) 7411 E. Ulysses, to the City of Mesa's Sanitary Sewer System. All discharges, actions, and reports shall be in accordance with the terms and conditions of this Permit.

The City of Mesa would like to thank you for the openness in communication and the cooperative effort throughout the permitting process. This attitude enabled both URS Group Inc. and the City of Mesa to develop a Permit that meets both of our needs.

If you wish to appeal any provisions of the Permit, please file a written petition within 20 days of its receipt. If you have any further questions, please contact me at (480) 644-5773.

Sincerely,

Vince Jordan
Industrial Pretreatment Inspector

VJ: mz

Enclosure

480.644.4444 (tel)
480.644.2768 (fax)

CLASS II
INDUSTRIAL WASTEWATER DISCHARGE PERMIT

PERMIT NO. M- 5863-1213

In accordance with the provisions of Title 8, Chapter 4 of the Mesa City Code:

WILLIAMS AIR FORCE BASE SITE ST-012
GROUNDWATER REMEDIATION PROJECT
7411 E. ULYSSES
MESA, ARIZONA 85212

is hereby authorized to discharge process wastewater from the above identified facility, through the compliance point(s) identified herein into the City of Mesa's sewer system in accordance with the conditions set forth in this Permit. Compliance with this Permit does not relieve the Permittee of the obligation to comply with any or all applicable pretreatment regulations, standards, or requirements under local, State, or Federal laws, including any such regulations, requirements, standards, or laws that may become effective during the term of this Permit.

Noncompliance with any term or condition of this Permit shall constitute a violation of Title 8, Chapter 4 of the Mesa City Code.

This Permit becomes effective December 13, 2011 shall expire at midnight on December 12, 2013, and is nontransferable by the Permittee.

If the Permittee wishes to continue to discharge after the expiration date of this Permit, an application must be filed for a renewal permit in accordance with Section 8-4-17, a minimum of 60 days prior to the expiration date.

By: Susan Miller

Susan Miller, P.E.
Assistant Director-Water
Water Resources Department

Issued this 12th day of December 2011
2011

CONTENTS OF PERMIT

PART 1	-	Definitions	Page 3
PART 2	-	Acronyms	Page 5
PART 3	-	Discharge Limitations	Page 6
PART 4	-	Categorical Definition and Limitations	Page 9
PART 5	-	Special Conditions	Page 10
PART 6	-	General Prohibitions	Page 12
PART 7	-	Reporting Requirements	Page 14
PART 8	-	Standard Conditions	Page 17

PART 1 – DEFINITIONS

1. **Best Management Practices (BMP):** Schedules of activities, pollution treatment practices or devices, prohibition of practices, general good housekeeping practices, pollution prevention, waste minimization, educational practices, maintenance procedures, and other management practices or devices to prevent or reduce the amount of pollutants entering the sanitary sewer system, surface water, air, land or groundwater. Best Management Practices may include a physical, chemical, structural or managerial practice or device that can help to achieve compliance with this chapter.

2. **Bypass** – The intentional diversion of wastewater from any portion of a pretreatment process.

3. **Cooling Water** – The clean water discharged from any heat transfer system.

4. **Composite Sample** - A combination of individual samples obtained at regular intervals over a specified time frame. The volume of each individual sample shall be either proportional to the flow rate during the sample period (flow composite), or constant and collected at equal time intervals during the composite period (time composite).

5. **Daily Maximum Limitation** - The maximum allowable discharge of pollutants during a 24 hour period. Where daily maximum limitations are expressed in units of mass, the daily discharge is the total mass discharged over the course of the day. Where daily maximum limitations are expressed in terms of a concentration, the daily discharge is the arithmetic average measurement of the pollutant concentration derived from all measurements taken that day.

6. **Grab Sample** – A sample that is taken from a wastestream on a one-time basis with no regard to the flow of the wastestream and without consideration of time. The collection of the sample is not to exceed fifteen (15) minutes.

7. **Hazardous Waste** – As defined by 40-CFR-261 (Identification and Listing of Hazardous Waste).

8. **Instantaneous Effluent Limitation** - The maximum allowable concentration in the discharge at any time as measured in a grab sample.

9. **Monthly Average Effluent Limitation** – The arithmetic average value of all samples taken in a calendar month for an individual pollutant parameter. The monthly average of all grab samples taken in a given calendar month, or the average of all composite samples taken in a given calendar month.

10. **Pass-Through** – A discharge which exits the POTW into waters of the United States in quantities or concentrations which, alone or in conjunction with a discharge from other sources, is a cause of a violation of any requirement of the POTW's NPDES Permit (including an increase in the magnitude or duration of a violation) or which contributes to a violation of an applicable numeric or narrative water quality standard.

11. **pH Violation** – A violation occurs when the pH range set forth by this permit exceeds in any magnitude, the set ranges (upper and lower limit) as established in this permit. If the exceedance does not last for a period greater than or equal to 15 minutes, the City Manager can determine what enforcement actions, if any, to take as described in the City of Mesa Enforcement Response Guide, provided the permittee can establish the duration and cause of the exceedance. Any exceedance shall be reported as required in Part 7(B) of this permit.

12. **Process Wastewater** – Any water which, during manufacturing or processing, comes into direct contact with or results from the production or use of any raw material, intermediate product, finished product, by-product, or waste product. (Excluding sanitary, non-contact cooling, and boiler blow down wastewater)

13. **Representative Sample** – A sample portion of material or waste stream that is as nearly identical in content and consistency as possible to that in the larger body of material or waste stream being sampled.

14. **Reserved** - A condition or part of a permit which has been saved for future use or special purpose.

15. **Severe Property Damage** – Substantial physical damage to property, damage to treatment facilities which cause them to become inoperable, or substantial and permanent loss of natural resources which can reasonably be expected to occur in the absence of a bypass. Severe property damage does not mean economic loss caused by delays in production.

PART 2 - ACRONYMS

- **BAT** – Best Available technology Economically Achievable (applies to non-conventional and toxic pollutants)
- **BMP** - Best Management Practices
- **BMR** - Baseline Monitoring Report
- **BOD_5** - 5-day Biochemical Oxygen Demand
- **BPJ** - Best Professional Judgement
- **CFR** - Code of Federal Regulations
- **CIU** - Categorical Industrial User
- **COD** - Chemical Oxygen Demand
- **CWA** - Clean water Act
- **CWF** - Combined Wastestream Formula
- **EPA** - Environmental Protection Agency
- **ERP** - Enforcement Response Plan
- **GPD** - Gallons per Day
- **IU** - Industrial User
- **MAHL** - Maximum Allowable Headwork Loading
- **MAIL** - Maximum Allowable Industrial Loading
- **MGD** - Million Gallons per Day
- **MG/L** - Milligram per Liter
- **AZPDES** - Arizona Pollution Discharge Elimination System
- **P2** - Pollution Prevention
- **POTW** - Publicly Owned Treatment Works
- **SIU** - Significant Industrial User
- **SLCP** - Slug Load Control Plan
- **SNC**- Significant Non-Compliance
- **TOMP** - Toxic Organic Management Program
- **TSS** - Total Suspended Solids
- **TTO** - Total toxic Organic
- **UG/L** - Micro Grams per Liter
- **WWTP** - Wastewater Treatment Plant

PART 3 - DISCHARGE LIMITS AND MONITORING REQUIREMENTS

A. The following process operations are conducted at the facility and result in the discharge of wastewater through the compliance sampling point described in Part 3.B:

Groundwater will be pumped from six extraction wells then treated by an oil/water separator, through a bag and cartridge filter followed by two 3,000-lb Granular Activated Carbon (GAC) vessels in series. The discharge will consist of treated groundwater from the extraction system.

In addition, condensate from the vapor extraction system and purge water from periodic groundwater sampling activities may be routed through the treatment system prior to discharge.

B. Wastewater resulting from the operations identified in Part 3.A of this Permit shall be discharged into the City of Mesa's sewer system through **COMPLIANCE SAMPLING POINT 001,** as follows:

The final discharge point is located on the eastside of the site with the final discharge to Sossaman Rd.

C. Discharges through the compliance sampling point (Part 3.B) must be monitored during the frequencies defined in (Table 1, Page 7).

Table 1
Compliance Sampling Point 001 - Effluent Limitations [1] and Sampling Requirements [2]

Parameter	Daily Maximum	Monthly Average	Minimum Sampling Frequency	Sample Collection Method [3]
Flow	100,000 gpd [4]	Report	Daily	Meter
pH [5]	5.0 - 10.5	N/A	Reserved[6]	Grab
Ammonia	Reserved[6]	Reserved [6]	Reserved[6]	Grab
Arsenic (T)	0.13	N/A	Reserved[6]	Grab
Benzene	35 [7]	N/A	Quarterly	Grab
Boron (T)	Reserved [6]	N/A	Reserved[6]	Grab
Cadmium (T)	0.047	N/A	Reserved[6]	Grab
Chloroform	2000 [7]	N/A	Quarterly	Grab
Chromium (T)	Reserved [6]	N/A	Reserved[6]	Grab
Copper (T)	1.5	N/A	Reserved[6]	Grab
Cyanide (A)	Reserved [6]	N/A	Reserved[6]	Grab
Cyanide (T)	2.0	N/A	Reserved[6]	Grab
Fluoride (T)	Reserved [6]	N/A	Reserved[6]	Grab
Lead (T)	0.41	N/A	Reserved[6]	Grab
Mercury (T)	0.0023	N/A	Reserved[6]	Grab
Nickel (T)	Reserved [6]	N/A	Reserved[6]	Grab
Selenium (T)	0.10	N/A	Reserved[6]	Grab
Sulfides (T)	Reserved [6]	N/A	Reserved[6]	Grab
Silver (T)	1.2	N/A	Reserved[6]	Grab
Zinc (T)	3.5	N/A	Reserved[6]	Grab
EPA Method SW8270	Reserved [6]	N/A	Quarterly	Grab
EPA Method SW8260	Reserved [6]	N/A	Quarterly	Grab
EPA Method SW8081	Reserved [6]	N/A	Quarterly	Grab

1. Unless otherwise noted, all limitations are expressed in concentration units of milligrams per liter (mg/L).

2. Unless otherwise noted, all sampling of the discharge to evaluate compliance must be conducted at the compliance sampling point described in Part 3.B. Representative samples shall be used to determine compliance for parameters subject to a daily effluent limit.

3. Sampling and analysis shall be performed in accordance with techniques prescribed in 40-CFR-Part 136 or when the Approval Authority determines that Part 136 sampling and analytical techniques are inappropriate, sampling and analysis shall be performed by using validated analytical methods or any other applicable procedures, including procedures suggested by the Utilities Manager or other parties, approved by the Approval Authority.

4. This is a *maximum* daily discharge from the outfall as expressed in gallons per day. An exceedance by any amount shall constitute a violation of this permit. Flow recordings shall be a 24-hour period beginning at midnight each day.

5. The standard for pH is an instantaneous effluent limitation as measured by standard units.

6. A condition or part of a permit, which has been saved for future use or special purpose.

7. Limits are expressed in the total form as micrograms per liter (ug/L).

8. Sampling and analysis shall be consistent with "Note 3". The Permittee shall require the laboratory performing the analysis to achieve the *lowest* detection limit achievable.

PART 4 - CATEGORICAL

Not Applicable.

PART 5 – SPECIAL CONDITIONS

A. Discharge Requirements

The permittee shall follow all discharge conditions specified below:

1. All remediated groundwater shall be treated through a Granular Activated Carbon (GAC) system prior to final discharge at outfall 001.

2. Written approval from the City of Mesa is required to discharge all off-site purged groundwater and shall be treated through the on-site treatment system prior to final discharge at outfall 001.

B. Discharge Monitoring Requirements

The permittee shall ensure that all treated discharge meet the specified requirements below:

1. The discharge shall have a pH between 5.0 and 10.5 as measured by standard units.

2. The daily volume shall be recorded continuously during all discharges.

3. Required quarterly sampling identified in Part 3, Table 1 shall be conducted after the GAC vessels.

4. Monitoring records shall be maintained in accordance with conditions of this permit.

5. This information shall be submitted with your semi-annual reporting as defined Part 7(A)(4) of this permit.

C. Discharge Requests

1. Prior to the discharge of any new pollutant and/or off-site purged groundwater to Mesa's sanitary sewer collection system, the Permittee shall, in accordance with Mesa City Code, Title 8, Chapter 4, Section 17(F), submit a written request containing the following information:

   a) Identify the location/s of off-site purged groundwater wells.

   b) Specify the exact quantities (gallons) and the discharge frequencies for off-site purged groundwater.

   c) Include all analytical data of the individual pollutants and the amounts (mg/L) and/or (ug/L) that will be associated with the discharge.

2. The Permittee shall not commence with a discharge that contains a new pollutant and/or off-site purged groundwater until written permission is received from the City of Mesa.

D. Discharge Metering Equipment Required

1. The Permittee shall provide and maintain a flow meter at compliance Outfall 001.

   In the event, flow-monitoring equipment is used specifically for sewer billing, the City of Mesa shall calibrate and maintain the secondary flow measuring equipment at the Permittee's expense.

   a) In the event of discharge metering equipment failure required by this permit, the Permittee shall notify the City of Mesa as required in Part 7(B) of this permit.

PART 6 – GENERAL PROHIBITIONS

The Permittee shall comply with the general user prohibitions of Section 8-4-15(A) of the Mesa City Code, and shall not discharge any water or wastewater, or cause to be discharged at any entry point into the public sewer system, any of the following:

A. Wastewater which could cause interference or pass-through with POTW operations.

B. Unless otherwise approved by the City Manager, storm water, surface water, ground water, roof runoff, subsurface drainage, single-pass cooling water, or condensate that may constitute inflow.

C. Pollutants which create a fire or explosion hazard to the POTW. In no case shall pollutants be discharged with a closed cup flashpoint less than 140 degrees Fahrenheit (60 degrees Centigrade); or pollutants which cause an exceedance of ten percent of the lower explosive limit (lel) at any point within the POTW for any single reading or more than five percent for any two consecutive readings.

D. Solid or viscous pollutants, animal fats, oils and grease, non-biodegradable cutting oil, or products of mineral oil origin in amounts that will cause interference or pass-through or that will cause obstruction to the flow in sewers or other interference or damage with the system or treatment plant.

E. Any water or wastewater containing a toxic, radioactive, poisonous, or other substance in sufficient quantity to injure or interfere with any POTW process, cause corrosive structural damage, constitute a hazard to humans, or create any hazard to the POTW or in the receiving water of the POTW; or pollutants which result in the presence of toxic gases, vapors, or fumes within the POTW in a quantity that may cause acute worker health and safety problems.

F. Any water or wastewater with a temperature greater than 150 degrees Fahrenheit or heat in amounts which will inhibit biological activity in the POTW resulting in interference, but in no event, heat in such quantities that the temperature at the head works of the POTW exceeds 104 degrees Fahrenheit (40 degrees Centigrade).

G. Wastewater that has been diluted in any way as a substitute for pretreatment, for the purpose of obtaining compliance with any categorical standard or pretreatment requirement imposed by this Permit except where dilution is expressly authorized by any categorical standard.

H. Wastewater that could cause a violation of any categorical standard or pretreatment requirement.

I. Any water or wastewater, other than domestic wastewater, that exhibits a characteristic of a hazardous waste, or contains a substance that is listed as a hazardous waste pursuant to either Arizona Administrative Code R18-8-261 or Title 40-CFR, Part 261, whichever is applicable, whether or not the discharge is otherwise subject to hazardous waste regulations. The City Manager may allow a discharge of such wastes if, upon written request of the affected person, the City Manager determines that the discharge would not cause interference or pass-through with POTW operations.

J. Any of the following ***prohibited*** substances:

4,4'-DDE
4,4'-DDT
Aldrin
BHC-Alpha
BHC-Beta
BHC-Gamma (Lindane)
Heptachlor
Heptachlor epoxide
Polychlorinated biphenyl compounds

PART 7 – REPORTING REQUIREMENTS

All reporting (including written notifications, oral notification and compliance monitoring reports) required by this Permit shall, unless otherwise specified, be addressed to:

City of Mesa
Industrial Pretreatment Section
Water Resources Department
P.O. Box 1466
Mesa, Arizona 85211-1466

During normal business hours (7:00 a.m.--3:30 p.m.), the City of Mesa's Industrial Pretreatment Section should be notified by telephone at (480) 644-2484. At all other times notification is to be made by telephone at (480) 644-2262 or by facsimile (FAX) at (480) 644-4554.

A. Monitoring Reports

Periodic reports on continued compliance are due no later than the ***15th day of June and December of each year***. All reports shall, at a minimum contain:

1. The nature and concentration of all pollutants in the effluent for which sampling and analyses were performed during the six months preceding the reporting month.

2. Wastewater flows on the days samples were collected.

3. Total, maximum and average daily flows for the reporting period for Outfall 001.

4. Sampling requirements identified in Part 3 Table 1.

5. Analytical data collected monthly between GAC vessels shall be submitted monthly for the first six months of this permit.

6. Certification of Accuracy Statement as shown in Part 8, Section D(4) of this Permit.

7. If applicable, copies of notifications identified in Part 8(B)(4) of this permit.

8. If applicable, copies of *any* Pollution Prevention Plan updates, Best Management Practices, communication concerning changes to the plan and/or annual reports required in Part 8(B)(4) of this permit.

B. Notification of Noncompliance

As defined by Mesa City Code Title 8, Chapter 4, Section 17(I), the Permittee shall immediately notify the City of Mesa upon becoming aware of a discharge which is known or suspected to be in violation with any effluent limitation or provisions of this permit or which may be a problem-causing discharge to the POTW. A problem-causing discharge may not have caused an actual limit violation, but had a characteristic of the General Prohibitions of Part 6 of this permit. The discharge may also be an accidental discharge, an operational upset, or a slug load. The notification shall include location of discharge, date and time thereof, type of wastewater including the concentration and volume, and corrective action taken.

C. Written Report on Noncompliance Resulting From a Slug Discharge or Operations Upset

Within ten calendar days of becoming aware of a violation of any limitation or prohibition specified in this permit, of a slug load, or an operational upset, the Permittee shall submit a detailed written report to the Industrial Pretreatment Supervisor. For the purpose of this section, a slug discharge is any discharge of a non-routine, episodic nature, including, but not limited to, an accidental spill, a non-customary batch discharge, or any discharge of a pollutant to the POTW in such volume or strength as to cause interference. In particular, any pollutant concentration, quantity, or flow rate which, during any period of 15 minutes or more is greater than five times any discharge limitation of this permit, or the average 24 hour concentration, quantity or flow rate for such pollutant during normal operations. The detailed written report shall contain:

1. A description of the causes(s) of the violation or discharge. If the cause of the incident has not been definitively determined, the report shall propose a detailed plan and schedule describing the steps to be taken to determine the cause.

2. The location of discharge, type, concentration, and volume of discharge.

3. Duration of the discharge, including exact dates and times of the discharge, and if the discharge continues, the time by which compliance is reasonably expected to occur.

4. All steps to be taken to reduce, eliminate, and prevent a recurrence of the discharge.

D. Automatic Resampling

1. If the results of the Permittee's self-monitoring indicate a violation has occurred, the Permittee must repeat the sampling and pollutant analysis and submit, in writing, the results of this second analysis within 30 days of becoming aware of the violation.

   a). The Permittee shall conduct a minimum of four consecutive days of monitoring. All monitoring shall be representative of the Permittee's flow and consistent with all conditions of this permit.

2. The Permittee is not required to resample if the City obtained a sample at the same discharge point for the same pollutant between the time the Permittee performed its sampling and the time the Permittee receives the results of sampling.

PART 8 – STANDARD CONDITIONS

A. General Conditions

1. Severability

The provisions of this permit are severable. If any provisions of this permit, or the applications of any provisions of this permit to any circumstance are held invalid, the application of such provisions to other circumstances and the remainder of this permit shall not be affected thereby.

2. Duty to Comply

The Permittee must provide all pretreatment necessary to comply with all the categorical and pretreatment requirements imposed by this permit and Title 8, Chapter 4 of the Mesa City Code. Failure to comply with the requirements of this permit and Title 8, Chapter 4 of the Mesa City Code may be grounds for administrative action, or enforcement proceedings including civil or criminal penalties, suspension or revocation of this permit, termination of POTW services, and restricting or otherwise limiting allowable discharges.

3. Duty to Mitigate

The Permittee shall take all reasonable steps to minimize or correct any adverse impact to the public treatment plant or the environment resulting from noncompliance with this permit, including such accelerated or additional monitoring as necessary to determine the nature and impact of the noncompliance discharge.

4. Permit Action

This permit may be modified, revoked and reissued, or terminated for good causes including, but not limited to, the following:

a) To incorporate any new or revised Federal, State, or local pretreatment standards or requirements;

b) Material or substantial alterations or additions to the discharger's operation processes, discharge volume, or character which were not covered in the effective permit;

c) A change in any condition that requires either a temporary or permanent reduction or elimination of the authorized discharge;

d) Information indicating that the permitted discharge poses a threat to the City's collection and treatment system, POTW personnel, or the receiving water;

e) Violation of any term or conditions of this permit;

f) Obtaining this permit by misrepresentation or failure to disclose fully all-relevant facts;

g) Revision of a grant of variance from such categorical standards pursuant to Title 40-CFR-403.13; or

h) Upon request of the Permittee, provided such request does not create a violation of any existing applicable requirements, standards, laws, or rules and regulations.

The filing of a request by the Permittee for a permit, revocation and reissuance, termination, or a notification of planned changes or anticipated noncompliance does not stay any permit conditions.

5. Property Rights

The issuance of this permit does not convey any property rights of any sort or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights, nor any violation of Federal, State, or local laws or regulations.

6. Permit Not Transferable

Class II Industrial Wastewater Discharge Permits are issued to a specific user for a specific operation and are not assignable to another user or transferable to any other location. In the event of sale or transfer of ownership, the Permittee must provide a copy of this permit to the purchaser and give written notification to the Industrial Pretreatment Section prior to the effective date of sale or ownership transfer. **THE PURCHASER, OR NEW OWNER, MUST OBTAIN A PERMIT TO DISCHARGE INDUSTRIAL WASTEWATER TO MESA'S SANITARY SEWER.**

7. Duty to Reapply

If the Permittee wishes to continue to discharge industrial wastewater that is regulated by this permit after the expiration date of the permit, the Permittee **must submit an application for a new permit at least 60 days before the expiration date of this permit**, unless a written request is timely submitted for an extension and approved by the Assistant Water Director.

8. Continuation of Expired Permits

An expired permit will continue to be effective and enforceable until the permit is reissued if:

a) The Permittee has submitted a complete permit application at least sixty (60) days prior to the expiration date of the user's existing permit.

b) The failure to reissue the permit, prior to the expiration of the previous permit, is not due to any act or failure to act on the part of the Permittee.

9. Dilution

The Permittee shall not increase the use of potable or process water or, in any way, attempt to dilute an effluent as a partial or complete substitute for adequate treatment to achieve compliance with the limitations contained in this permit.

B. Operation and Maintenance of Pollution Controls

1. Proper Operation and Maintenance

The Permittee shall at all times properly operate and maintain facilities and systems of treatment and control (and related appurtenances) which are installed or used by the Permittee to achieve compliance with the conditions of this permit. Proper operation and maintenance includes, but is not limited to: effective performance, adequate funding, adequate operator staffing and training, and adequate laboratory and process controls, including appropriate quality assurance procedures. This provision requires the operation of backup or auxiliary facilities or similar systems only when necessary to achieve compliance with the conditions of the permit.

2. Duty to Halt or Reduce Activity

Upon reduction of efficiency of operation, or loss or failure of all or part of the treatment facility, the Permittee shall, to the extent necessary to maintain compliance with its permit, control its production or discharges (or both) until operation of the treatment facility is restored or an alternative method of treatment is provided. This requirement applies, for example, when the primary source of power of the treatment facility fails or is reduced. It shall not be a defense for a Permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit.

3. Bypass of Treatment Facilities

a) Permittee may allow a bypass to occur which **DOES NOT** result in any violation of this permit, but only if it is also for essential maintenance to assure efficient operation. These bypasses are not subject to the notice and prohibition section of the subpart.

b) Notice

(i) If Permittee knows in advance of the need of a bypass, it shall submit prior written notice to the City, if possible, at least ten days before the date of the bypass.

(ii) Permittee shall submit oral notice to the Industrial Pretreatment Section of an unanticipated bypass that results in violations of this Permit immediately after Permittee becomes aware of the bypass. Permittee shall also provide written notice of the bypass within five days of the time the Permittee becomes aware of the bypass. The written notice shall contain a description of the bypass and its cause, the duration of the bypass, including exact dates and times, and if the bypass has not been corrected, the anticipated time it is expected to continue, and steps taken or planned to reduce, eliminate, and prevent the recurrence of the bypass. Permittee may submit a written request to the Industrial Pretreatment Section for a waiver of this written notice requirement which may only be granted by the Industrial Pretreatment Section if the oral report has been received immediately as stated above.

c) Prohibition of bypass

Bypass is prohibited unless:

(i) Bypass was unavoidable to the loss of life, personal injury, or severe property damage;

(ii) There were no feasible alternatives to the bypass, such as the use of auxiliary treatment facilities, retention of untreated wastes, or maintenance during normal periods of equipment downtime. This condition is not satisfied if adequate backup equipment should have been installed in the exercise of reasonable engineering judgment to prevent a bypass which occurred during normal periods of equipment downtime and preventive maintenance; and

(iii) Permittee submitted notices as required under subparagraphs 3.c.

4. Hazardous Waste Discharge Requirements

If the Permittee has a discharge into the POTW of a substance, which, if ***otherwise disposed*** of would be a hazardous waste under 40-CFR-Part 261. The Permittee, prior to the commencement of this discharge shall:

a) Submit a written request to the City Manager to allow the discharge if it will not cause interference or pass-through.

b) Notify the EPA regional Waste Management Division Director (RCRA), and State of Arizona hazardous waste authorities in writing of the intent to discharge. Submit a copy of these requests to the City Manager for verification.

c) Written notification required in Part 8, B(4)(a and b) shall include:

i. Name of hazardous waste
ii. EPA hazardous waste number
iii. Type of discharge (continuous, batch or other)
iv. Hazardous constituents
v. Estimation of current mass and concentration of constituents
vi. Estimation of mass of constituents expected in the following 12 months

d) Written notification shall be made for *each* hazardous waste discharged.

e) If a new EPA or State regulation establishes a hazardous characteristic or substance that applies to *any* discharge, notice is required within 90 days of the regulation.

f) Written notification must include submittal of a Source Reduction Plan as defined by Mesa City Code Title 8, Chapter 4, Section 17(M)(7) and Section 18(A)(8). The Permittee can submit an *approved* State of Arizona Department of Environmental Quality, Pollution Prevention Plan (P2) in place of a Source Reduction Plan. The City will review this plan to determine if it meets the requirements of Mesa City Code.

g) The Permittee shall submit copies of *any* updates, communication concerning changes to their ADEQ P2 Plan and/or annual reports to the Industrial Pretreatment Section within 30 days of such submittal to ADEQ.

h) If there is to be a substantial change in volume or character of pollutants in a discharge (including hazardous wastes which have been notified as defined in 40-CFR-403.12p), promptly notify the City Manager in advance of such discharge.

5. Removed Substances

Solids, sludges, filter backwash, or other pollutants removed in the course of treatment or control of wastewater shall be disposed of in accordance with Section 405 of the Clean Water Act and Subtitles C and D of the Resource Conservation and Recovery Act.

C. Monitoring and Records

1. Representative Sampling

Samples and measurements taken as required herein shall be representative of the volume and nature of the monitored discharge. All samples shall be taken at the monitoring points specified in this Permit and, unless otherwise specified, before the effluent joins or is diluted by any other waste stream, body of water or substance. All equipment used for sampling and analysis must be routinely calibrated, inspected and maintained to ensure their accuracy. Monitoring points shall not be changed without notification to, and the approval of, the City of Mesa.

2. Flow Measurements

If flow measurement is required by this permit, the appropriate flow measurement devices and methods consistent with approved scientific practices shall be selected and used to ensure that the accuracy of the measurements are consistent with the accepted capability of the type of device. Devices selected shall be capable of measuring flows with a maximum deviation of less than 10 percent from true discharge rates throughout the range of expected discharge volumes.

3. Notification of Employees

As defined by Mesa City Code Title 8, Chapter 4, Section 17(Q), the Permittee shall inform their employees of the existence of this permit. At least one copy of this permit shall be permanently and conspicuously posted by the Permittee. The Permittee shall provide a copy of this permit to *each* employee working in or with pretreatment operations.

4. Analytical Methods to Demonstrate Continued Compliance

All sampling and analysis required by this permit shall be performed in accordance with the techniques prescribed in Title 40-CFR, Part 136 and amendments thereto, otherwise approved by EPA, or as specified in this permit. All analyses to demonstrate compliance shall be performed by an environmental laboratory licensed by the State of Arizona pursuant to A.R.S. Section 36-495 et. seq.

5. Additional Monitoring by the Permittee

If the Permittee monitors any pollutant more frequently than required by this permit, using test procedures identified in Part 8-(C)(4) of this permit, the results of this monitoring shall be included in the Permittee's self-monitoring reports.

6. Inspection and Entry

The Permittee shall allow the City of Mesa or an authorized representative, upon the presentation of credentials and other documents as may be required by law, to:

a) Enter upon the Permittee's premises where a regulated facility or activity is located or conducted, or where records must be kept under the conditions of this permit;

b) Have access to and copy, at reasonable times, any records that must be kept under the conditions of this permit;

c) Inspect at reasonable times any facilities, equipment (including monitoring and control equipment), practices, or operations regulated or required under this permit;

d) Sample or monitor, for the purposes of assuring permit compliance, any substances or parameters at any location; and

e) Inspect any production, manufacturing, fabricating, or storage area where pollutants, regulated under the permit, could originate, be stored, or be discharged to the sewer.

7. Retention of Records

The Permittee shall retain records of all monitoring information, including all calibration and maintenance records and all original strip chart recordings for continuous monitoring, instrumentation, copies of all reports required by this permit, and records of all data used to complete the application for this permit for a period of at least three years from the date of the sample, measurement, report or application. This period may be extended by request of the City of Mesa at any time.

8. Record Contents

Records of sampling and analyses shall include:

a) The date, exact place, time, and methods of sampling or measurements, and sample preservation techniques or procedures;

b) Who performed the sampling or measurements;

c) The date(s) analyses were performed;

d) Who performed the analyses;

e) The analytical techniques or methods used; and

f) The results of such analyses.

9. Falsifying Information

Knowingly making any false statement on any report or other document required by this permit or knowingly rendering any monitoring device or method inaccurate is a crime and may result in the imposition of criminal sanctions and/or civil penalties.

D. Additional Reporting Requirements

1. Planned Changes

The Permittee shall give written notice to the City of Mesa 90 days prior to any facility expansion, production increase, or process modification which results in *new* or substantially increased discharges or a *change* in the nature of the discharge.

Prior to commencement of a discharge, the facility must receive written approval from the City Manager; and

2. Anticipated Potential Noncompliance

The Permittee shall give a 90-day advance notice to the City of Mesa of any planned changes in the permitted facility or activity, which may result in noncompliance with permit requirements.

3. Duty to Provide Information

The Permittee shall furnish to the City of Mesa, within 30 days, any information which the City of Mesa may request to determine whether cause exists for modifying, revoking and reissuing, terminating this permit, or to determine compliance with this permit. The Permittee shall also furnish to the City of Mesa, upon request, copies of records required to be kept by this permit.

4. Signatory Requirements

All applications, reports, or information submitted to the City of Mesa must contain the following certification statement and be signed as required in Sections (a), (b), (c) or (d) below:

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

a) By a responsible corporate officer, if the Industrial User submitting the reports is a corporation. For the purpose of this paragraph, a responsible corporate officer means:

   (i) A president, secretary, treasurer, or vice-president of the corporation in charge of a principal business function, or any other person who performs similar policy or decision-making functions for the corporation;

   (ii) The manager of one or more manufacturing, production, or operation facilities employing more than 250 persons or having gross annual sales or expenditures exceeding $25 million (in second-quarter 1980 dollars), if authority to sign documents has been assigned or delegated to the Manager in accordance with corporate procedures.

b) By a general partner or proprietor if the Industrial User submitting the reports is a partnership or sole proprietorship, respectively.

c) By a duly authorized representative of the individual designated in paragraph (a) or (b) of this section if:

   (i) The authorization is made in writing by the individual described in paragraph (a) or (b);

   (ii) The authorization specifies either an individual or a position having responsibility for the overall operation of the facility from which the industrial discharge originates, such as the position of plant manager, operator of a well, or a well field superintendent, or a position of equivalent responsibility for environmental matters for the company; and

   (iii) The written authorization is submitted to the City.

d) If an authorization under paragraph (c) of this section is no longer accurate because a different individual or position has responsibility for the overall operation of the facility or overall responsibility for the environmental matters for the company, a new authorization satisfying the requirements of paragraph (c) of this section must be submitted to the City prior to or together with any reports to be signed by an authorized representative.

5. Annual Publication

A list of all industries which were in significant noncompliance during the twelve (12) previous months shall be annually published by the City of Mesa in the largest daily newspaper within its service areas. Accordingly, the Permittee is apprised that noncompliance with this permit may result in publication of its name in an appropriate newspaper.

6. Civil and Criminal Liability for Violations

Nothing in this permit shall be construed to relieve the Permittee from administrative, civil and/or criminal penalties for noncompliance under Title 8, Chapter 4 of the Mesa City Code. A Permittee who violates permit conditions may be subject to imprisonment and/or fines up to $25,000 per day per violation. The Permittee may also be subject to sanctions under State and/or Federal law.

7. Recovery of Costs Incurred

In addition to administrative, civil and/or criminal liability, the Permittee violating any of the provisions of this permit or Title 8, Chapter 4 of the Mesa City Code, or causing damage to or otherwise inhibiting the City of Mesa wastewater disposal system shall be liable to the City of Mesa for any expense, loss, or damage caused by such violation or discharge. The

City of Mesa shall bill the Permittee for the costs incurred by the City of Mesa for any cleaning, repair, or replacement work caused by the violation or discharge. Refusal to pay the assessed costs shall constitute a separate violation of Title 8, Chapter 4 of the Mesa City Code.

8. Reimbursement of Expenses

The permittee shall reimburse the City for all expenses reasonably incurred by the City for any of the following purposes:

a) Pursuant to Mesa City Code Title 8, Chapter 4, Section 17(K), insuring the Permitees compliance;
b) Determining the impact of a discharge or a pollutant;
c) Modifying permits associated with POTW operations; or,
d) Performing additional monitoring to assess or determine compliance.

APPENDIX G

WELL INSTALLATION AND ABANDONMENT TABLE

Table G-1
Steam Enhanced Well Summary

Well ID	NORTHING	EASTING	EXISTING / PROPOSED	DESCRIPTION OF EXISTING WELL	COMMENTS
INJECTION WELL'S - COBBLE ZONE (145' - 160'): 6 New Wells					
ST012-CZ01	838070.159	774692.997	DRILL NEW WELL		
ST012-CZ02	838014.983	774518.887	DRILL NEW WELL		
ST012-CZ03	837936.919	774648.039	DRILL NEW WELL		
ST012-CZ04	837932.424	774551.175	DRILL NEW WELL		
ST012-CZ05	837885.518	774450.668	DRILL NEW WELL		
ST012-CZ06	837865.395	774585.098	DRILL NEW WELL		
EXTRACTION WELL'S - COBBLE ZONE (145' - 160'): 13 New Wells					
ST012-CZ07	838139.769	774695.790	DRILL NEW WELL		
ST012-CZ08	838090.670	774617.472	DRILL NEW WELL		
ST012-CZ09	838088.540	774791.553	DRILL NEW WELL		
ST012-CZ10	838057.322	774567.845	DRILL NEW WELL		
ST012-CZ11	838020.980	774632.405	DRILL NEW WELL		
ST012-CZ12	838018.642	774736.254	DRILL NEW WELL		
ST012-CZ13	837987.471	774463.119	DRILL NEW WELL		
ST012-CZ14	837976.728	774691.673	DRILL NEW WELL		
ST012-CZ15	837929.081	774490.686	DRILL NEW WELL		
ST012-CZ16	837883.632	774637.865	DRILL NEW WELL		
ST012-CZ17	837814.100	774515.676	DRILL NEW WELL		
ST012-CZ18	837922.409	774374.312	DRILL NEW WELL		
ST012-CZ19	837827.930	774411.134	DRILL NEW WELL		
INJECTION WELL'S - UPPER WATER BEARING ZONE (170' - 195'): 8 New Wells, 2 Existing Wells					
ST012-UWBZ07	837942.116	774561.643	USE EXISTING UWBZ07	168' to 195' - 5" Sch 40 Steel	Use 5" well from TEE Pilot Test
ST012-UWBZ09	838128.827	774748.279	USE EXISTING UWB09	170.2' to 195.2' - 6" 304SS	Installed during pre-design investigation
ST012-UWBZ10	838043.366	774522.893	DRILL NEW WELL		
ST012-UWBZ11	838052.116	774652.268	DRILL NEW WELL		
ST012-UWBZ12	838044.616	774765.393	DRILL NEW WELL		
ST012-UWBZ13	837969.616	774442.268	DRILL NEW WELL		
ST012-UWBZ14	837934.616	774664.143	DRILL NEW WELL		
ST012-UWBZ15	837893.314	774462.616	DRILL NEW WELL		
ST012-UWBZ16	837841.938	774611.372	DRILL NEW WELL		
ST012-UWBZ25	838118.930	774665.120	DRILL NEW WELL		
EXTRACTION WELL'S - UPPER WATER BEARING ZONE (170' - 195'): 2 New Wells, 6 New Wells from Well to be Abandoned, 6 Existing Wells					
ST012-UWBZ01	837902.614	774620.793	USE EXISTING UWBZ01	165' to 200' - 6" Sch 40 Steel	Use 5" well from TEE Pilot Test
ST012-UWBZ02	837982.985	774619.950	USE EXISTING UWBZ02	165' to 201' - 6" Sch 40 Steel	Use 5" well from TEE Pilot Test
ST012-UWBZ03	838015.721	774561.999	USE EXISTING UWBZ03	170' to 197' - 5" Sch 40 Steel	Use 5" well from TEE Pilot Test
ST012-UWBZ04	837979.060	774507.953	USE EXISTING UWBZ04	171' to 198' - 5" Sch 40 Steel	Use 5" well from TEE Pilot Test
ST012-UWBZ05	837935.133	774497.987	USE EXISTING UWBZ05	170' to 197' - 5" Sch 40 Steel	Use 5" well from TEE Pilot Test
ST012-UWBZ06	837881.025	774546.846	USE EXISTING UWBZ06	170' to 197' - 5" Sch 40 Steel	Use 5" well from TEE Pilot Test
ST012-UWBZ17	838084.438	774608.017	ON EXISTING ST012-W07	210' to 250' - 4" PVC / 304 SS	Overdrill to remove well and replace with new.
ST012-UWBZ18	838092.707	774704.467	ON EXISTING ST012-RB-1A	160' to 195' - 4" Sch 80 PVC	Overdrill to remove well and replace with new.
ST012-UWBZ19	838005.300	774702.208	DRILL NEW WELL		
ST012-UWBZ20	837912.386	774369.140	ON EXISTING ST012-DPE02 4"	130' to 172' - 4" Sch 40 PVC	Overdrill to remove well and replace with new.
ST012-UWBZ21	837970.342	774828.513	DRILL NEW WELL		
ST012-UWBZ22	837798.191	774493.500	ON EXISTING ST012-W05	211' to 251' - 4" PVC / 304 SS	Overdrill to remove well and replace with new.
ST012-UWBZ23	837863.988	774684.822	ON EXISTING ST012-W08	213' to 253' - 4" PVC / 304 SS	Overdrill to remove well and replace with new.

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Table G-1
Steam Enhanced Well Summary

Well ID	NORTHING	EASTING	EXISTING / PROPOSED	DESCRIPTION OF EXISTING WELL	COMMENTS
ST012-UWBZ24	837838.215	774405.770	ON EXISTING ST012-MPC02	Vapor Probes 25' to 200', Six screens, 1" Sch 80 PVC	Overdrill to remove well and replace with new.
INJECTION WELL'S - LOWER SATURATED ZONE (210' - 245'): 9 New Wells, 6 Existing Wells					
ST012-LSZ07	837943.366	774569.768	USE EXISTING LSZ07	205' to 245' - 5" Sch 40 Steel	Use 5" well from TEE Pilot Test
ST012-LSZ08	838050.472	774317.057	USE EXISTING LSZ08	206.75' to 241.75' - 304SS	Installed during pre-design investigation
ST012-LSZ09	837959.240	774263.616	USE EXISTING LSZ09	205.5' to 240.5' - 304SS	Installed during pre-design investigation
ST012-LSZ10	837802.251	774340.554	USE EXISTING LSZ10	205.5' to 240.5' - 304SS	Installed during pre-design investigation
ST012-LSZ16	838040.241	774657.298	USE EXISTING LSZ16	210.4' to 245.4' - 304SS	Installed during pre-design investigation
ST012-LSZ17	838051.311	774491.373	USE EXISTING LSZ17	206.2'to 241.8' - 304SS	Installed during pre-design investigation
ST012-LSZ18	838054.616	774751.643	DRILL NEW WELL		
ST012-LSZ19	837965.866	774407.268	DRILL NEW WELL		
ST012-LSZ20	837907.741	774696.643	DRILL NEW WELL		
ST012-LSZ21	837945.866	774796.643	DRILL NEW WELL		
ST012-LSZ22	837995.241	774862.893	DRILL NEW WELL		
ST012-LSZ23	837863.991	774274.768	DRILL NEW WELL		
ST012-LSZ24	837834.616	774454.768	DRILL NEW WELL		
ST012-LSZ25	837821.491	774618.518	DRILL NEW WELL		
ST012-LSZ26	837821.491	774744.143	DRILL NEW WELL		
ST012-LSZ40	837915.091	774424.394	DRILL NEW WELL		
ST012-LSZ41	837829.776	774541.846	DRILL NEW WELL		
ST012-LSZ42	837877.423	774804.696	DRILL NEW WELL		
EXTRACTION WELL'S - LOWER SATURATED ZONE (210' - 245'): 12 New Wells, 1 New Well from Well to be Abandoned, 11 Existing Wells					
ST012-LSZ01	837912.028	774614.652	USE EXISTING LSZ01	203' to 243' - 5" Sch 40 Steel	Use 5" well from TEE Pilot Test
ST012-LSZ02	837980.291	774630.159	USE EXISTING LSZ02	204' to 244' - 5" Sch 40 Steel	Use 5" well from TEE Pilot Test
ST012-LSZ03	838016.302	774569.486	USE EXISTING LSZ03	206' to 246' - 5" Sch 40 Steel	Use 5" well from TEE Pilot Test
ST012-LSZ04	837987.198	774509.810	USE EXISTING LSZ04	206' to 246' - 5" Sch 40 Steel	Use 5" well from TEE Pilot Test
ST012-LSZ05	837922.931	774498.973	USE EXISTING LSZ05	206' to 246' - 5" Sch 40 Steel	Use 5" well from TEE Pilot Test
ST012-LSZ06	837882.485	774539.116	USE EXISTING LSZ06	206' to 246' - 5" Sch 40 Steel	Use 5" well from TEE Pilot Test
ST012-LSZ11	837765.067	774511.990	USE EXISTING LSZ11	206.4' to 241.4' - 304SS	Installed during pre-design investigation
ST012-LSZ12	837774.942	774660.201	USE EXISTING LSZ12	207' to 243' - 304SS	Installed during pre-design investigation
ST012-LSZ13	837875.690	774746.020	USE EXISTING LSZ13	207.5' to 242.5' - 304SS	Installed during pre-design investigation
ST012-LSZ14	837992.281	774916.883	USE EXISTING LSZ14	204.8' to 239.8' - 304SS	Installed during pre-design investigation
ST012-LSZ15	837879.711	774352.839	USE EXISTING LSZ15	205.5' to 240.5' - 304SS	Installed during pre-design investigation
ST012-LSZ27	838051.064	774402.235	DRILL NEW WELL		
ST012-LSZ28	838060.680	774576.517	DRILL NEW WELL		
ST012-LSZ29	838054.055	774862.781	DRILL NEW WELL		
ST012-LSZ30	837957.285	774325.964	DRILL NEW WELL		
ST012-LSZ31	837995.949	774710.301	DRILL NEW WELL		
ST012-LSZ32	838006.575	774797.248	DRILL NEW WELL		
ST012-LSZ33	837930.902	774867.880	DRILL NEW WELL		
ST012-LSZ34	837842.230	774694.750	DRILL NEW WELL		
ST012-LSZ35	837766.540	774418.447	DRILL NEW WELL		
ST012-LSZ36	837767.135	774592.159	DRILL NEW WELL		
ST012-LSZ37	838011.467	774217.478	ON EXISTING ST012-U13	160' to 195' - 4" Sch 80 PVC	Overdrill to remove well and replace with new.
ST012-LSZ38	837905.931	774218.909	DRILL NEW WELL		
ST012-LSZ39	837790.175	774256.511	DRILL NEW WELL		

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Table G-1
Steam Enhanced Well Summary

Well ID	NORTHING	EASTING	EXISTING / PROPOSED	DESCRIPTION OF EXISTING WELL	COMMENTS
TEMPERATURE MONITORING POINTS (Temp Sensors from 100' - 242'): 5 New Probes and 12 from Wells to be Abandoned (including 5 with co-located SVE Wells)					
ST012-TMP01	838098.22	774710.19	ON EXISTING ST012-RB-1C	207' to 242' - 4" Sch 80 PVC	Overdrill to remove well and replace with new.
ST012-TMP02	838045.53	774980.08	DRILL NEW WELL		
ST012-TMP03	837988.01	774229.97	DRILL NEW WELL		
ST012-TMP04 / SVE10	837954.02	774385.74	ON EXISTING ST012-W32	203' to 238' - 4" PVC / SS	Overdrill to remove well and replace with new. See detail for additional information for co-located SVE
ST012-TMP05 / SVE11	837992.01	774678.51	ON EXISTING ST012-N13	164' to 242' - 4" Sch 40 PVC	Overdrill to remove well and replace with new. See detail for additional information for co-located SVE
ST012-TMP06	837939.10	774714.82	ON EXISTING ST012-W03	215' to 255' - 4" PVC / 304 SS	Overdrill to remove well and replace with new.
ST012-TMP07	837961.81	774898.98	ON EXISTING ST012-RB-2C	207-242' to 195' - 4" Sch 80 PVC	Overdrill to remove well and replace with new.
ST012-TMP08	837809.46	774284.36	DRILL NEW WELL		
ST012-TMP09	837848.36	774529.50	ON EXISTING ST012-N06	168' to 228' - 6" Sch 40 Steel	Overdrill to remove well and replace with new.
ST012-TMP10	837714.07	774629.16	DRILL NEW WELL		
ST012-TMP11	837812.77	774679.02	ON EXISTING ST012-PD-S/D	216' to 232' - 5" Sch 80 PVC / 304 SS two screens	Overdrill to remove well and replace with new.
ST012-TMP12 / SVE12	837875.48	774388.15	ON EXISTING ST012-MPB02	Vapor Probes 25' to 200', Six screens, 1" Sch 80 PVC	Overdrill to remove well and replace with new. See detail for additional information for co-located SVE
ST012-TMP13/SVE 13	837874.84	774458.29	ON EXISTING ST012-W01	209' to 249' - 4" PVC / 304 SS	Overdrill to remove well and replace with new.
ST012-TMP14	837984.72	774412.18	ON EXISTING ST012-MPC01	Vapor Probes 25' to 200', Six screens, 1" Sch 80 PVC	Overdrill to remove well and replace with new. See detail for additional information for co-located SVE
ST012-TMP15 / SVE14	837980.27	774488.58	ON EXISTING ST012-DPE01 4" / SE 2" / SW 2"	25' to 240', Three Screens, 2" PVC (2) and 4" SS (1)	Overdrill to remove well and replace with new. See detail for additional information for co-located SVE
ST012-TMP16	837820.57	774587.28	ON EXISTING ST012-W09	211' to 251' - 4" PVC / 304 SS	Overdrill to remove well and replace with new.
ST012-TMP17	837852.04	774776.25	DRILL NEW WELL		
ADDITIONAL WELLS TO BE ABANDONED: 6 Vertical Wells and 2 Horizontal Wells to be Abandoned					
ST012-MPA02	837909.59	774388.93		Vapor Probes 25' to 200', Six screens, 1" Sch 80 PVC	
ST012-PA	837792.07	574609.21		203.1' to 227.7' - 4" 304 SS	
ST012-PB	837773.34	574716.76		210.4' to 229.6' - 4" 304SS	
ST012-RB-2A	837956.06	774892.74		160' to 195' - 4" Sch 80 PVC	
ST012-U36	838207.20	774761.48		160' to 195' - 4" Sch 80 PVC	
ST012-W13	838010.30	774190.71		209' to 249' - 4" PVC / 304SS	
ST012-HW1	837924.31	573667.36		Screened at 235' for 500 feet - 6" 304 SS, Horizontal Well	
ST012-HW2	837960.79	573720.93		Screened at 219' for 422 feet - 5.44" 304 SS, Horizontal Well	
RETROFIT THE FOLLOWING MONITORING AND VAPOR EXTRACTION WELLS TO ADD HIGH PRESSURE VALVES TO INSURE THAT NO STEAM/HEAT ESCAPES: 25 Wells					
ST012-MWN01A	837950.00	774520.07		172' to 197' - 2" 304 SS	
ST012-MWN01B	837949.72	774520.04		205' to 220' - 2" 304 SS	
ST012-MWN01C	837957.24	774520.80		231' to 256' - 2" 304 SS	
ST012-MWN02A	837968.88	774555.67		168' to 198' - 2" 304 SS	
ST012-MWN02B	837968.82	774555.39		206' to 221' - 2" 304 SS	
ST012-MWN02C	837962.68	774551.02		229.5' to 249.5' - 2" 304 SS	
ST012-MWN03A	838003.36	774559.11		171.5' to 196.5' - 2" 304 SS	
ST012-MWN03B	838008.36	774559.40		205' to 220' - 2" 304 SS	

ED_005025_00013386-00634

Table G-1
Steam Enhanced Well Summary

Well ID	NORTHING	EASTING	EXISTING / PROPOSED	DESCRIPTION OF EXISTING WELL	COMMENTS
ST012-MWN03C	838001.55	774565.87		230.5' to 245.5' - 2" 304 SS	
ST012-MWN04A	837970.82	774601.98		172' to 197' - 2" 304 SS	
ST012-MWN04B	837970.71	774601.73		206' to 221' - 2" 304 SS	
ST012-MWN04C	837963.43	774603.38		230' to 245' - 2" 304 SS	
ST012-MWN05A	837914.76	774522.39		171' to 196' - 2" 304 SS	
ST012-MWN05B	837914.77	774522.71		203' to 220' - 2" 304 SS	
ST012-MWN05C	837920.82	774519.80		230' to 250' - 2" 304 SS	
ST012-MWN06A	837938.63	774585.63		171.5' to 196.5' - 2" 304 SS	
ST012-MWN06B	837938.48	774585.34		205' to 220' - 2" 304 SS	
ST012-MWN06C	837933.18	774585.52		229.5' to 244.5' - 2" 304 SS	
ST012-SVE01 Deep	837991.33	774546.03		135' to 165' - 3" 304 SS	
ST012-SVE02 Deep	837973.39	774688.16		135' to 165' - 3" 304 SS	
ST012-SVE03 Deep	837990.84	774459.41		135' to 165' - 3" 304 SS	
ST012-SVE04 Deep	838026.31	774361.96		135' to 165' - 3" 304 SS	
ST012-SVE05 Deep	837917.49	774324.47		135' to 165' - 3" 304 SS	
ST012-SVE06 Deep	837810.67	774313.69		135' to 165' - 3" 304 SS	
ST012-SVE07 Deep	837912.05	774498.38		135' to 165' - 3" 304 SS	

Note: Well construction details for the new wells and temperature monitoring points are detailed on the Construction Drawings (Appendix C).

ED_005025_00013386-00635

APPENDIX H

QAPP/SAP WORKSHEETS

UFP-QAPP CROSSWALK

Worksheet No.	Required Information	Crosswalk to Related Information			
		Included in this Work Plan	Cross Reference to Related Information Provided in this Work Plan	Not Included in this Work Plan	Reasoning
A. Project Management					
Documentation					
1	Title and Approval Page, Table of Contents, Acronyms and Abbreviations, and Executive Summary		i to vii (executive summary not provided due to brief content in Sections 1 and 2)	✓	Document Title Page, Table of Contents, and Acronyms and Abbreviations provide equivalent content. Work Plan is brief enough that Executive Summary is unnecessary.
2	QAPP/SAP Identifying Information	✓			
3	Distribution List		Air Force cover letter accompanying the Final Work Plan	✓	Cover letter accompanying the Work Plan provides distribution
4	Project Personnel Sign-Off Sheet	✓			
Project Organization					
5	Project Organizational Chart	✓			
6	Communication Pathways			✓	The communication pathways are presented in the program document (AMEC, 2012c).
7	Personnel Responsibilities and Qualifications Table	✓			
8	Special Personnel Training Requirements Table	✓			

ED_005025_00013386-00637

Worksheet No.	Required Information	Crosswalk to Related Information			
		Included in this Work Plan	Cross Reference to Related Information Provided in this Work Plan	Not Included in this Work Plan	Reasoning
Project Planning/Problem Definition					
9	Project Planning Session Documentation (including Data Needs tables) Project Scoping Session Participants Sheet	✓			
10	Problem Definition, Site History, and Background. Site Maps (historical and present)		Section 1.0	✓	The information is provided at the beginning of the Work Plan to introduce the background and objectives
11	Site-Specific Project Quality Objectives	✓			
12	Measurement Performance Criteria	✓			
13	Sources of Secondary Data and Information Secondary Data Criteria and Limitations Table			✓	The secondary data criteria and limitations are presented in the program document (AMEC, 2012c).
14	Summary of Project Tasks		Section 4.0	✓	The information is provided in the Work Plan to highlight the project tasks.
15	Reference Limits and Evaluation Table	✓			
16	Project Schedule/Timeline Table		✓		The information is provided in Figure 6-1 of the RD/RAWP.
B. Measurement Data Acquisition					
Sampling Tasks					
17	Sampling Design and Rationale	✓			

ED_005025_00013386-00638

Worksheet No.	Required Information	Crosswalk to Related Information			
		Included in this Work Plan	Cross Reference to Related Information Provided in this Work Plan	Not Included in this Work Plan	Reasoning
18	Sampling Locations and Methods/SOP Requirements Table Sample Location Map(s)	✓			
19	Analytical Methods/SOP Requirements Table	✓			
20	Field QC Sample Summary Table	✓			
21	Project Sampling SOP References Table	✓			
	Sampling SOPs		Work Plan specific addendums to SOPs provided in Attachment A	✓	Complete SOPs are provided in Attachment A of the program document (AMEC, 2012c).
22	Field Equipment Calibration, Maintenance, Testing, and Inspection Table			✓	Instrument operation and calibration procedures are provided in the appropriate SOPs, which are included in Attachment A of the program document (AMEC, 2012c).
Analytical Tasks					
23	Analytical SOPs Analytical SOP References Table			✓	Analytical SOPs are provided in Attachment C of the program document (AMEC, 2012c).

ED_005025_00013386-00639

Worksheet No.	Required Information	Crosswalk to Related Information			
		Included in this Work Plan	Cross Reference to Related Information Provided in this Work Plan	Not Included in this Work Plan	Reasoning
24	Analytical Instrument Calibration Table			✓	Analytical instrument calibration procedures are included in Attachment C of the program document (AMEC, 2012c).
25	Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table			✓	Test America's QA Program is included in Attachment C of the program document (AMEC, 2012c).
Sample Collection					
26	Sample Handling System, Documentation Collection, Tracking, Archiving, and Disposal Sample Handling Flow Diagram			✓	Procedures for sample handling are provided in SOP No. 15, *Sample Handling*, in Attachment A of the program document (AMEC, 2012c).
27	Sample Custody Requirements, Procedures/SOPs Sample Container Identification Example Chain-of-Custody (CoC) Form and Seal			✓	Sample custody requirements are provided in the program document (AMEC, 2012c).
QC Samples					
28	QC Samples Table Screening/Confirmatory Analysis Decision Tree			✓	Analytical laboratory QC sample requirements are provided with the analytical laboratory SOPs in Attachment C of the program document (AMEC, 2012c).

ED_005025_00013386-00640

Worksheet No.	Required Information	Crosswalk to Related Information			
		Included in this Work Plan	Cross Reference to Related Information Provided in this Work Plan	Not Included in this Work Plan	Reasoning
Data Management Tasks					
29	Project Documents and Records Table			✓	The Project Documents and Records Table is provided in the program document (AMEC, 2012c).
30	Analytical Services Table Analytical and Data Management SOPs			✓	The analytical services table is provided on Program QAPP Worksheet No. 30 (AMEC, 2012c).
C. Assessment Oversight					
31	Planned Project Assessments Table Audit Checklists			✓	The Planned Project Assessments Table is provided in the Program QAPP (AMEC, 2012c).
32	Assessment Findings and Corrective Action Responses Table			✓	Assessment findings and corrective action responses are provided in the program document (AMEC, 2012c).
33	QA Management Reports Table	✓			
D. Data Review					
34	Verification (Step I) Process Table			✓	Program QAPP Worksheet No. 34 directly references Program QAPP Worksheet No. 31, *Planned Project Assessments Table*, (AMEC, 2012c).

ED_005025_00013386-00641

Worksheet No.	Required Information	Crosswalk to Related Information			
		Included in this Work Plan	Cross Reference to Related Information Provided in this Work Plan	Not Included in this Work Plan	Reasoning
35	Validation (Steps IIa and IIb) Process Table			✓	Program QAPP Worksheet No. 35 directly references Program QAPP Worksheet No. 31, *Planned Project Assessments Table* (AMEC, 2012c).
36	Validation (Steps IIa and IIb) Summary Table			✓	The Analytical Data Validation (Steps IIA and IIB) Summary Table is provided in the Program QAPP (AMEC, 2012c).
37	Usability Assessment			✓	The Usability Assessment is provided in the Program QAPP (AMEC, 2012c).

ED_005025_00013386-00642

QAPP/SAP WORKSHEET NO. 2 – QAPP/SAP IDENTIFYING INFORMATION

Site Name/Project Name: **Former Williams AFB**
Operable Unit: **Site Wide**
Contractor Name: **AMEC Environment & Infrastructure (AMEC)**
Contract Number: **FA8903-09-D-8572**
Contract Title: **PERFORMANCE-BASED REMEDIATION TASK ORDER FORMER WILLIAMS AFB, ARIZONA Contract FA8903-09-D-8572-0002**

1. This Work Plan was prepared in accordance with the requirements of the *Uniform Federal Policy for Quality Assurance Plans (UFP–QAPP)* (IDQTF, 2005); *EPA Guidance on Systematic Planning using the Data Quality Objectives Process*, *EPA QA/G-4* (EPA, 2006a); *EPA Guidance on Systematic Planning using the Data Quality Objectives Process, (QA/R-5)* (EPA, 2006b); and *Department of Defense Quality Systems Manual for Environmental Laboratories, Version 4.2* (DoD, 2010).

2. Identify regulatory program: National Contingency Plan; Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)

3. Identify approval entity: Site-specific UFP–QAPP documents and appropriate addendums must be approved by AFCEC, ADEQ, and U.S. EPA Region 9.

4. This is a site-specific UFP–QAPP.

5. List dates of scoping sessions that were held:

Scoping Session	Date
60% Design Meeting	May 9, 2013

6. List dates and titles of any QAPP documents written for previous site work that are relevant to the current investigation.

Title	Date
Performance Based Remediation Program QAPP and SOPs (AMEC)	July 2012
Appendix G, Quality Assurance Project Plan, Final ST012 Phase 1 Thermal Enhanced Extraction (TEE) Pilot Test Work Plan (BEM)	November 2007

7. List organizational partners (stakeholders) and connection with lead organization:

Air Force Civil Engineer Center - lead
U. S. Environmental Protection Agency, Region 9 – regulator
Arizona Department of Environmental Quality - regulator

ED_005025_00013386-00643

8. Lead organization

Air Force Civil Engineer Center

9. If any required UFP–QAPP elements or required information are not applicable to the project or are provided elsewhere, then note the omitted elements and provide an explanation for their exclusion below:

Any worksheets not included in this Work Plan refer to and adopt the worksheets provided in the Program QAPP (AMEC, 2012c).

ED_005025_00013386-00644

QAPP/SAP WORKSHEET NO. 4 - PROJECT PERSONNEL SIGN-OFF SHEET

Name	Organization/Title/Role	Signature/E-mail Receipt	Date Read
Kevin Garrett	AMEC/QA Lead and Project Chemist		
Everett Wessner	AMEC/Project Manager		
Don Smallbeck	AMEC/Project Technical/Regulatory Lead		
Stuart Pearson	AMEC/RD/RA Lead		
Jim Clarke	AMEC/Investigation Lead		
Michelle Barker	AMEC/Data Manager		
Shanda Wagner, Emily Corkery, or Gwen Minnier	AMEC/Field Lead		
Devon Phelan	TerraTherm Project Manager		
Michelle Johnston	TestAmerica Project Manager		
Catherine Jerrard	AFCEC/Project Manager		

4.1 Modifications to the Approved Work Plan

This Work Plan will be used to implement only the site-specific tasks described herein as a one-time event. Therefore, modifications to this Work Plan are not anticipated once the Work Plan is finalized following review by AFCEC, EPA, and ADEQ. Changes in SOPs or sample analysis procedures adopted finalized in revisions to the Program QAPP will be adopted into this Work Plan. Only the following activities will require a Work Plan modification addendum submittal:

- Changes in data quality objectives (DQOs) and measurement performance criteria (MPC)

Changes in procedure will only be implemented after formal approval is received from the AMEC Project Manager and AMEC QA Lead. Verbal approval may be necessary to expedite project execution. Verbal approvals will be documented and submitted for formal approval as soon as possible.

ED_005025_00013386-00645

QAPP/SAP WORKSHEET NO. 5 - PROJECT ORGANIZATIONAL CHART

The project organization for investigation and remediation activities, work plan preparation and project execution tasks is provided below. The project will be performed by AMEC, under contract to AFCEC. AMEC will be the Project Manager, and is completing the work under the CERCLA with regulatory oversight provided by the EPA and the ADEQ. Descriptions of the key project personnel for the AFCEC and AMEC Teams are provided in Worksheet No. 7.

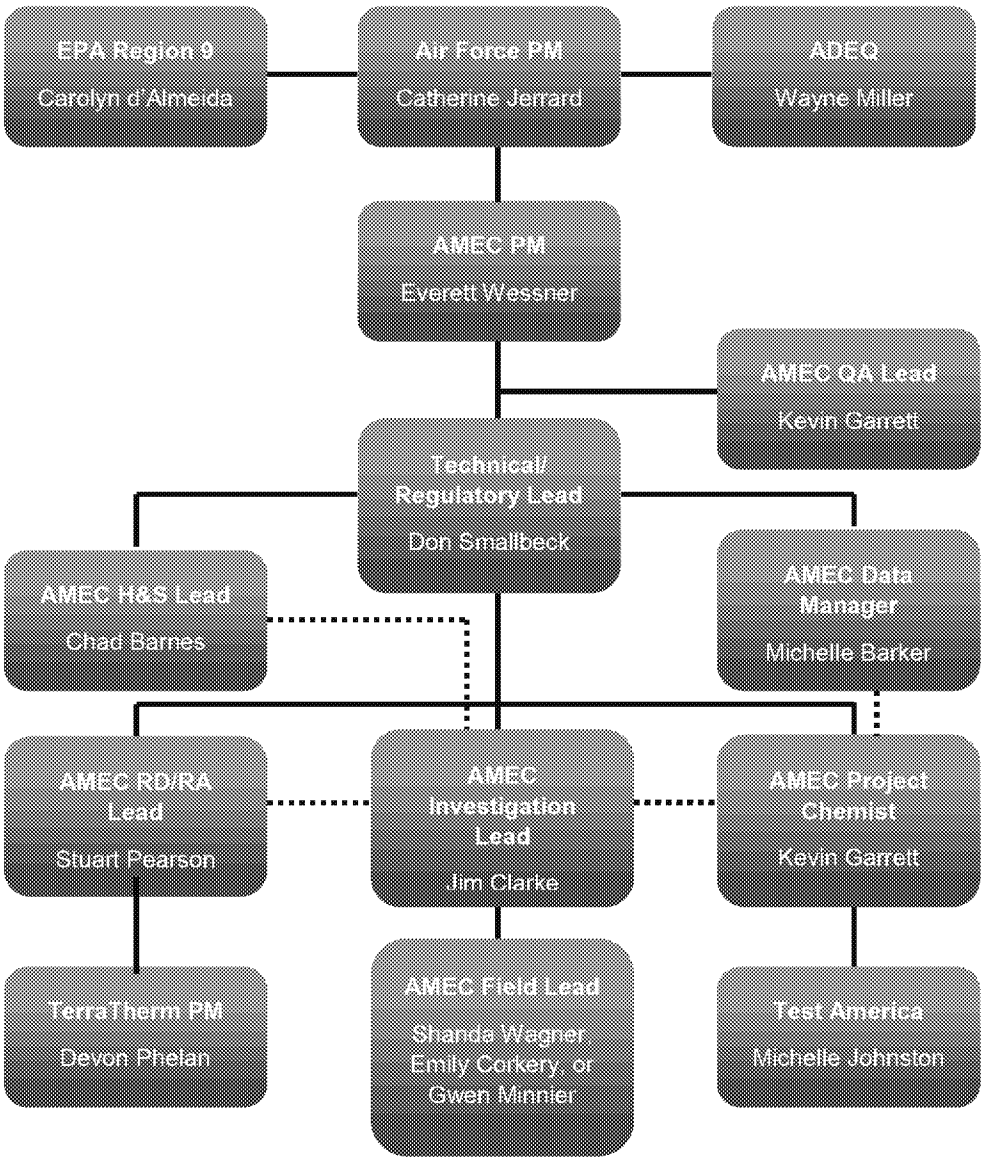
AMEC will procure subcontractors to complete specific field activities associated with completing the investigation and remediation activities described in this work plan. These subcontractors include:

- consulting subcontractors (i.e., TerraTherm);
- drilling companies for borings and well installations;
- utility clearance companies; and
- analytical laboratory services.

Analytical services will be provided by Test America or an alternate National Environmental Laboratory Accreditation Program accredited laboratory capable of required analysis. On-site screening data will be used to make internal decisions during field efforts, such as which soil interval in a boring to collect samples from for off-site analysis. Drilling services will be performed by an Arizona-licensed driller. These personnel will also perform their activities in accordance with applicable site and task specific work plans. The subcontractors performing work under the direction of AMEC will be required to comply with this Work Plan.

ED_005025_00013386-00646

Site-Specific Project Organization Chart



———	Lines of Authority
·····	Lines of Communication
ADEQ	Arizona Department of Environmental Quality
EPA	United States Environmental Protection Agency
H&S	Health and Safety
PM	Project Manager
QA	Quality Assurance
RD/RA	Remedial Design/Remedial Action

ED_005025_00013386-00647

QAPP/SAP WORKSHEET NO. 7 - PERSONNEL RESPONSIBILITIES AND QUALIFICATIONS TABLE

Name	Title/Role	Certifications and Registrations	Organizational Affiliation	Responsibilities
Catherine Jerrard	Project Manager		AFCEC	Oversee project, financial, schedule, and technical day-to-day management of the project.
Everett Wessner	Project Manager	RPG, PMP	AMEC	Oversee project to ensure compliance with project objectives.
Don Smallbeck	Technical/ Regulatory Lead		AMEC	Oversee technical activities, review documents and lead regulatory activities
Kevin Garrett	QA Lead; Project Chemist;	PhD, PE, PMP	AMEC	Oversee laboratory QA/QC program to insure laboratory and data reporting QA/QC requirements are achieved.
Stuart Pearson	RD/RA Lead	PE	AMEC	Coordinate analyses with lab chemists, ensure the scope is followed, QA data packages, communicate with sampling contractor staff.
Jim Clarke	Investigation Lead	RG	AMEC	Coordinate drilling and analytical laboratory subcontracts and resources. Day-to-day communication with the Field Lead and coordination with team for decisions.
Shanda Wagner, Emily Corkery, or Gwen Minnier	Field Lead		AMEC	Implement Work Plan activities in the field. Oversee well installation. Log borings. Coordinate collection and shipping of samples.
Chad Barnes	Health & Safety	PE	AMEC	Oversee project health and safety.
Michelle Barker	Data Manager		AMEC	Project Data Management

Notes:
PE – Professional Engineer
PMP – Project Management Professional
RG – Registered Geologist
RPG – Registered Professional Geologist

ED_005025_00013386-00648

QAPP/SAP WORKSHEET NO. 8 – SPECIAL PERSONNEL TRAINING REQUIREMENTS TABLE

The only quality related specialized training associated with this work will be for the construction of remediation wells with particular emphasis on the mixing and application of the high temperature grout. This training will be provided by a representative of the subcontractor, TerraTherm during installation of the first remediation well. AMEC geologists or engineers responsible for overseeing the well installation as well as drilling contractor personnel shall be trained. Once trained by TerraTherm, AMEC personnel may train others in the installation methods. Training will be documented in the following table in the field copy of this Work Plan. Safety training requirements and documentation are described in the ST012 HASP.

Specialized Training – Title or Description of Course	Training Provider	Training Date	Personnel Receiving Training	Personnel Titles/ Organizational Affiliation	Signature of Trainer
injection/extraction well installation	TerraTherm Name:_____				
injection/extraction well installation					
injection/extraction well installation					
injection/extraction well installation					
injection/extraction well installation					

ED_005025_00013386-00649

QAPP/SAP WORKSHEET NO. 9 - PROJECT SCOPING SESSION PARTICIPANTS SHEET

A preliminary investigation scope was introduced and discussed during the 60% Design Meeting on May 9, 2013. The minutes, presentation slides, and attendance sheet for this meeting follow.

ED_005025_00013386-00650

ATTACHMENT A

PROJECT SCOPING INFORMATION
60% DESIGN MEETING – MAY 2013

Former Williams AFB Full Scale SEE Implementation
60% Design Review Meeting Agenda – 5/9/13

GO TO MEETING INFORMATION:

Please join my meeting.
https://global.gotomeeting.com/join/339432605

2. Use your microphone and speakers (VoIP) - a headset is recommended. Or, call in using your telephone.

Dial +1 (630) 869-1015
Access Code: 339-432-605
Audio PIN: Shown after joining the meeting

Meeting ID: 339-432-605

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AGENDA:

Arrive at TT @ 9:00

9:00-9:15 – TT provided coffee/muffins

60% SEE Implementation Design Review (~3 hours)

- SEE Implementation Design Summary
- SEE Implementation Goals/Objectives
- Wellfield Configuration – Review Wellfield and Well Detail Drawings
- Downhole Pump Selection Review
- Existing SVE System Material of Construction Compatibility
- Current Operational Strategy (discuss specific strategy for NE corner of TTZ)
- Current TTZ Configuration and Required Modifications – AMEC to present any changes to currently configured TTZ based on delineation results

Break (10-15 mins) - Flexible

- Vapor Treatment System Review – Review Preliminary PFD, P&ID
- Backup Vapor Treatment System Contingency
- TEE Pilot Equipment Reuse
- Liquid Treatment System – Review Preliminary PFD, P&ID
- NAPL Conditioning System
- Electrical One-Line Package
- Mass and Energy Balance Outputs and Preliminary Utility Specifications and Estimates

ED_005025_00013386-00652

- Potential NAPL Generation Curve

Lunch (12 – 1:00) – Working lunch with in-house sandwiches (***please advise of any dietary restrictions***)

Continued 60% SEE Implementation Design Review (~1.5 - 2 hours)

- NAPL Treatability Study Test Results
- Proposed Operational Sampling Plan
- Sidewalk Closure and Alternatives
- Remaining Concerns/Uncertainties
- 5/15/13 BCT Meeting Preparation

Discussion, questions, next steps (~1-1.5 hours)

ED_005025_00013386-00653

Participant List – 60% ST012 Design Meeting, May 9, 2013

Name	Affiliation
Stuart Pearson	AMEC
Tony Donovan	AMEC
Jamie Welch	AMEC
Don Smallbeck	AMEC
Devon Phelan	TerraTherm
Steffen Griepke	TerraTherm
Gorm Heron	TerraTherm
Jim Galligan	TerraTherm
Steve McInerney	TerraTherm
Kelly Presco	TerraTherm

ED_005025_00013386-00654

QAPP/SAP WORKSHEET NO. 11 - PROJECT QUALITY OBJECTIVES/ SYSTEMATIC PLANNING PROCESS STATEMENTS

Project quality objectives (PQOs) define the type, quantity, and quality of data that are needed to answer specific environmental questions and support proper environmental decisions. To develop the PQOs, the DQO planning process described in the U.S. EPA "Guidance on Systematic Planning Using the Data Quality Objectives Process, U.S. EPA QA/G-4" (U.S. EPA, 2006a) is used. The U.S. EPA QA/G-4 document suggests seven steps to be followed to develop project DQOs (performance and acceptance criteria) that clarify the study objectives, define the appropriate type of data, and specify tolerable levels of potential decision errors that will be used as the basis for establishing the quality and quantity of data needed to support environmental decisions.

Step 1 – Problem Definition

This RD/RAWP provides the design details and the remedial action implementation for the installation and operation of a steam enhanced groundwater extraction system followed by in-situ enhanced bioremediation. The proposed sampling and investigation activities in this RD/RAWP are designed to achieve the following objectives:

- Verify the extents of LNAPL relative to the proposed extents of treatment.
- Verify compliance with SEE system discharge permits.
- Calculate the quantity of LNAPL mass removed through SEE system operation.
- Evaluate the potential migration of LNAPL and dissolved phase contamination beyond the perimeter of the treatment zone during SEE system operation.
- Evaluate progress of SEE treatment and determine when to transition to EBR.

Note, annual groundwater monitoring is addressed in t he ST012 Groundwater Monitoring Work Plan.

Step 2 – Decision Statement

The data from the investigations, baseline sampling, and remedial performance monitoring prescribed in this RD/RAWP are being generated to support the implementation of the steam enhanced groundwater extraction system and in-situ enhanced bioremediation. Visual logs and soil, groundwater, and vapor data, will be generated from the investigation described in this Work Plan. The data will be evaluated relative to the objectives identified in worksheet #17.

The decision statements for this Work Plan are:

- Is LNAPL present (either residual or free product) at the well locations within the treatment area prior to SEE system operation? If present at a location, what is the vertical extent of the LNAPL?

ED_005025_00013386-00655

- Do dissolved phase benzene and TPH concentration data indicate presence of possible LNAPL at the well locations within the treatment area prior to SEE system operation?
- Do dissolved phase benzene and TPH concentration data indicate reduction of possible LNAPL at the well locations within the treatment area during SEE system operation?
- Do system process samples indicate compliance with discharge requirements, and what is the system's contaminant mass removal totals and efficiency?
- Does SEE system operation mobilize LNAPL off-site as indicated by groundwater monitoring wells around the perimeter of the treatment zone?
- Do vapor phase benzene and TPH concentration data indicate reduction of possible LNAPL at the well locations within the treatment area after SEE system operation?
- Have subsurface temperature goals been achieved?
- Has pressure cycling been completed showing diminished enhancement of VOC removal with further cycles?
- Has mass removal decreased, following pressure cycling, to rates less than or equal to the peak mass removal rate?
- Have dissolved phase benzene concentrations achieved the performance criteria for transition to EBR?
- Has steam injected at the site approached amounts predicted by the thermal modeling?

Step 3 – Decision Inputs

Qualitative (visual notes from soil logging and dye test kit results) and screening level quantitative data (PID measurements) will be the primary input for decisions relative to LNAPL presence/absence. TPH results for soil will supplement qualitative results. VOC and TPH results for air along with LNAPL recovery and dissolved phase VOC concentrations will be the primary input for decisions relative to system performance and discharge compliance. Detection of LNAPL through well gauging and analysis for VOC and TPH in groundwater sampling will be the primary inputs for decisions relative to migration of LNAPL and dissolved phase contamination beyond the treatment zone. Temperature goals will be monitored through thermocouples installed throughout the site (not detailed further in the QAPP/SAP). Pressure cycling evaluations and mass removal rates will be evaluated through LNAPL quantity tracking (not detailed further in the QAPP/SAP), flame ionization detector monitoring (not detailed further in the QAPP/SAP), supplemented with operational samples collected for laboratory analysis. Steam injection will be monitored through process instrumentation.

The analytical data will be validated and data usability will be assessed. The analyte concentrations at each monitoring well will be tabulated and included in monitoring reports to document the extent of contamination. Analytical concentrations for soil, groundwater, and air will be compared with the

ED_005025_00013386-00656

project action limits (PAL) (defined below), and concentrations exceeding the PAL will be identified in the reports. Project-specific measurement and data management and validation criteria, requirements, and PALs are presented in the following list of worksheets:

- Measurement performance criteria are described in QAPP/SAP Worksheet #12.
- Project documentation including the monitoring reports and recordkeeping is described in QAPP/SAP Worksheet #33.
- PALs are presented in QAPP/SAP Worksheet #15.
- Sampling design and rationale are presented in QAPP/SAP Worksheet #17.
- Well locations and sampling methods are listed in QAPP/SAP Worksheet #18.
- Analytical group, methods, and requirements for sample bottleware, preservation, and holding times are listed in QAPP/SAP Worksheet #19.
- Sample custody and sample management is described in QAPP/SAP Worksheet #27.
- Data verification and validation are described in QAPP/SAP Worksheets #34 through #36.
- Data usability assessment is described in QAPP/SAP Worksheet #37.

PALs are federal, state, or site-specific benchmarks that decision-makers use as the basis for evaluating RAs. PALs were based on the ROD (IT, 1992), RODA (IT, 1996), and RODA2 (AF, 2013) for ST012.

PALs determine the analytical methods and the project quantitation limits (PQLs) that laboratories must achieve to ensure that analytical sensitivity is below the PALs. In order to compensate for potential analytical inaccuracy near the PQL, the PQLs are set at three to five times below the PAL, if technically achievable. The PQLs and corresponding PAL are included in QAPP/SAP Worksheet #15.

Step 4 – Study Boundaries

The study areas of primary interest are the CZ, UWBZ. and LSZ treatment areas and the groundwater monitoring wells within approximately 100 feet of the treatment area perimeter. Worksheet #17 provides the rationale for selection of study areas.

Step 5 – Decision Rules

A combination of qualitative data (e.g., visual logs and dye test kit results), quantitative data that provides a direct indication of LNAPL (e.g., TPH and benzene soil analytical results), and indirect quantitative data (e.g., PID readings, dissolved phase benzene and TPH concentrations) will be used to assess the horizontal and vertical presences of residual NAPL. Visual observations of LNAPL, positive dye test results, soil TPH concentrations greater than 1,000 mg/kg, dissolved TPH concentrations greater than 25,000 µg/L, and dissolved benzene concentrations greater than 5,000

ED_005025_00013386-00657

µg/L would be strong indicators of LNAPL presence. Visual observations of staining, soil TPH concentrations between 100 and 1,000 mg/kg, dissolved TPH concentrations between 5,000 and 25,000, and dissolved benzene concentrations between 1,000 and 5,000 µg/L would be indicators of possible LNAPL presence. Absence of visual indicators, negative dye test results, soil TPH concentrations below 100 mg/kg, dissolved TPH concentrations below 5,000 µg/L, and dissolved benzene concentrations below 1,000 µg/L would be indicators of no or limited residual LNAPL. Weekly observation and sampling of monitoring wells at the perimeter of the treatment boundary would be indicators of LNAPL migration from the treatment zone.

Destruction removal efficiencies for the thermal accelerators will be compared to a requirement of 90% and GAC effluent concentration will be compared to the updated discharge permit to evaluate compliance. Treatment progress will be assessed as described in the RD/RAWP.

Any increased presence of LNAPL in wells outside the TTZ will result in reevaluation of the steam injection/extraction operations.

Step 6 – Limits on Decision Errors

Sufficient numbers of samples, appropriate analytical and field methods, and appropriate QA/QC protocols will be applied to minimize errors that may affect future use of the data and subsequent decision making. Analytical methods at the concentrations of interest are reliable. Qualitative data (e.g., visual records) and screening data (e.g., PID screenings) will supplement quantitative data (laboratory data) to limit decision errors.

Step 7 – Sample Design

The sample design was developed in consultation with the EPA, ADEQ, and AFCEC. The sampling design and rationale are presented in Worksheet #17, and the sampling methods are identified in Worksheet #18 and the monitoring well locations are shown on the design drawings.

ED_005025_00013386-00658

QAPP/SAP WORKSHEET NO. 12 - MEASUREMENT PERFORMANCE CRITERIA TABLE

12.1 Measurement Performance Criteria Table – Soil Analytical

Matrix	Soil
Analytical Group	TPH (JP-4), VOCs
Concentration Level	High

Sampling Procedure	Analytical Method / SOP	Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)
SOP No. 10B	EPA Method 8260 – VOCs EPA Method 8015M – TPH – JP-4	Precision	RPD ≤ 25% VOCs RPD ≤ 50% TPH	Laboratory control sample duplicates.	A
		Accuracy/Bias	±30% - VOCs 30-102% TPH	Laboratory audit samples	A
		Accuracy/Bias – Contamination	No target analytes > quantitation limit	Equipment, field, and laboratory blanks	S&A
		Representativeness	Contamination of sample or extract with a target analyte	Laboratory Method Blank	A
		Comparability	Qualitative measure for field sampling and analytical procedures	Industry standard methods, QAPP compliance	S&A
		Sensitivity	Verification of accurate assessment of data at the MDL where the MDL meets project objectives	In control calibrations, MBs, current and valid MDL for the matrix/method.	A
		Completeness	90-95%	Number of valid samples	S&A

Notes:

SOP - standard operating procedure
EPA - United States Environmental Protection Agency
VOCs - volatile organic compounds
MDL - method detection limit
MB - method blank
RPD - relative percent difference
TPH - total petroleum hydrocarbons

ED_005025_00013386-00659

12.2 Measurement Performance Criteria Table – Water Analytical[1]

Matrix	Water
Analytical Group	TPH (JP-4), VOCs
Concentration Level	High

Sampling Procedure	Analytical Method / SOP	Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)
SOP No. 10D	EPA Method 8260 – VOCs EPA Method 8015M – TPH-JP4	Precision	RPD ≤ 25% VOCs RPD ≤ 30% TPH	Laboratory control sample duplicates.	A
		Accuracy/Bias	±30% VOCs 30-102% TPH	Laboratory audit samples	A
		Accuracy/Bias – Contamination	No target analytes > quantitation limit	Equipment, field, and laboratory blanks	S&A
		Representativeness	Contamination of sample or extract with a target analyte	Equipment Blank , Field Blank, Laboratory Method Blank	S&A
		Comparability	Qualitative measure for field sampling and analytical procedures	Industry standard methods, QAPP compliance	S&A
		Sensitivity	Verification of accurate assessment of data at the MDL where the MDL meets project objectives	In control calibrations, MBs, current and valid MDL for the matrix/method.	A
		Completeness	90-95%	Number of valid samples	S&A

Notes:

SOP - standard operating procedure
EPA - United States Environmental Protection Agency
VOCs - volatile organic compounds
MDL - method detection limit
MB - method blank
RPD - relative percent difference
TPH - total petroleum hydrocarbons

[1]Measurement performance criteria are not required for water discharge unless specifically defined in the updated permit.

ED_005025_00013386-00660

12.3 Measurement Performance Criteria Table – Air Analytical

Matrix	Air/Vapor
Analytical Group	TPH (JP-4), VOCs (BTEX)
Concentration Level	Low

Sampling Procedure	Analytical Method / SOP	Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)
SOP No. 21	EPA Method TO-3 – TPH-Gasoline Range Organics EPA Method TO-15 – TPH EPA Method TO-17 – TPH-Diesel Range Organics	Precision	RPD ≤ 25%	Laboratory control sample duplicates.	A
		Accuracy/Bias	±20% TPH ±30% - VOCs	Laboratory audit samples	A
		Completeness	90-95%	Number of valid samples	S&A
		Representativeness	Contamination of sample or extract with a target analyte	Laboratory Method Blank	A
		Comparability	Qualitative measure for field sampling and analytical procedures	Industry standard methods, QAPP compliance	S&A
		Sensitivity	Verification of accurate assessment of data at the MDL where the MDL meets project objectives	In control calibrations, MBs, current and valid MDL for the matrix/method.	A
QAPP Worksheet No. 22	VOCs – PID & FID	Accuracy	±10% of span gas	Field Calibration	A
		Sensitivity	5 ppm of zero	Field Calibration	A

Notes:

SOP - standard operating procedure
EPA - United States Environmental Protection Agency
VOCs - volatile organic compounds
MDL - method detection limit
MB - method blank
RPD - relative percent difference
TPH - total petroleum hydrocarbons

ED_005025_00013386-00661

QAPP/SAP WORKSHEET NO. 15 – REFERENCE LIMITS AND EVALUATION

The analytes listed in the following tables will be analyzed using EPA analytical methods. The analyses will be performed in accordance with EPA SW-846 (EPA, 2008) and laboratory SOPs. Reporting limits (RLs) will be dependent on the technical limitations of the analytical methods and matrices. The laboratory will conduct studies to establish method detection limits (MDLs) and achievable quantitation limits (QLs) for each analyte listed in the following table. The MDLs and QLs will be as low as practically achievable for any given matrix. Every effort will be made to have the detection limit lower than the maximum contaminant level or site-specific cleanup criteria.

In soil benzene and total petroleum hydrocarbons (TPH) will be the target analytes for this remedial action. There are no project action levels (PALs) for saturated soil so PALs for vadose zone soils at ST012 are listed. TPH and the VOC contaminants of concern (COCs) and contaminants of potential concern (COPCs) from the OU-2 ROD Amendment 2 are the target analytes for groundwater. TPH and the VOCs benzne, ethylbenzene, toluene, and xylenes are the target analytes for air.

ED_005025_00013386-00662

15.1 Target Analytes and Associated Site-Specific Cleanup Criteria (Soil)

Analysis	Method	Parameter[1]	CAS Number	Target Reporting Limits Soil - µg/kg	Approximate MDLs Soil - µg/kg	Project Action Levels[2] Soil - µg/kg
Volatile Organic Compounds	8260	Benzene	71-43-2	5	0.47	5,000 (vadose zone)
Total Petroleum Hydrocarbon – Jet Fuels (JP-4)	8015M	TPH-JP4	various	10,000	678	2,000,000 (vadose zone)

Notes:

[1]Target analytes include only benzene and TPH based on the project objectives. Other COPCs have been identified at ST012 and are documented in the ROD (IT, 1992), and the OU-2 ROD Amendment (IT, 1996) and the OU-2 ROD Amendment 2 (AFCEC, 2013). Analytical results for other VOC COCs/COPCs will be reported.

[2]Project action levels listed based on OU-2 ROD Amendment 1 cleanup levels for deep vadose zone soil. MDLs will achieve these project action levels as well as applicable risk screening levels for benzene (EPA regional screening level for benzene is 1.1 mg/kg for residential and 5.4 mg/kg for industrial use; ADEQ soil remediation level for benzene is 0.65 mg/kg for residential and 1.4 mg/kg for industrial use.

CAS - Chemical Abstract Service, MDL - Method detection limit, NA - not applicable, µg/kg - micrograms per kilogram

ED_005025_00013386-00663

15.2 Target Analytes and Associated Site-Specific Cleanup Criteria (Groundwater)

Analysis[1,2]	Method	Parameter[3]	CAS Number	Target Reporting Limits Water - µg/L	Approximate MDLs Water - µg/L	Project Action Levels[4] Water - µg/L
Volatile Organic Compounds	8260	Benzene	71-43-2	1	0.16	5
		1,2-Dichloroethane	107-06-2	1	0.13	5
		Ethylbenzene	100-41-4	1	0.16	700
		Methylene Chloride	75-09-2	5	0.32	5
		Naphthalene	91-20-3	1	0.22	28
		Tetrachloroethene	127-18-4	1	0.20	5
		Toluene	108-88-3	1	0.17	1,000
		Trichlorofluoromethane	75-69-4	2	0.29	1,100
		Total Xylenes	various	2	0.19	10,000
Total Petroleum Hydrocarbon	8015M	Gasoline Range Organics	various	25	10	NA
		Diesel Range Organics		250	32.6	NIR

Notes:

[1]Target limits for process samples for water discharge will be defined in the updated industrial wastewater discharge permit when available.

[2]There are no target limits associated with LNAPL analysis

[3]Target analytes include only VOC COCs/COPCs and TPH based on the project objectives. Other COPCs have been identified at ST012 and are documented in the ROD (IT, 1992) and the OU-2 ROD Amendment 2 (AFCEC, 2013). The semivolatile and inorganic COPCs are addressed as part of the annual groundwater monitoring and are not covered by these QAPP worksheets. Target reporting limits, MDLs, and project action levels for those are documented in the Groundwater Monitoring Work Plan.

[4]Project action levels listed based on OU-2 ROD Amendment 2 cleanup levels).

CAS - Chemical Abstract Service, MDL - Method detection limit, NA - not applicable, µg/L - micrograms per liter

ED_005025_00013386-00664

15.3 Target Analytes and Associated Site-Specific Cleanup Criteria (Air)

Analysis	Method	Parameter[1]	CAS	Target Reporting Limits (ppbv)	Approximate MDL (ppbv)	Screening Value[2] (ppbv)
Air – TPH Gasoline	TO-3	TPH-Gasoline	N/A	1	0.5	N/A
Air - VOCs	TO-15	Benzene	71-43-2	4	1.5	N/A
		Ethylbenzene	100-41-4	4	1	N/A
		Toluene	108-88-3	4	1	N/A
		m&p-Xylene	179601-23-1	4	1.5	N/A
		o-Xylene	95-47-6	4	1	N/A
		Xylenes (total)	1330-20-7	4	1	N/A
Air – TPH Diesel	TO-17	TPH-Diesel	N/A	1	0.5	N/A

Notes:

[1]Target analytes include the fuel compounds benzene, toluene, ethylbenzene, and xylenes, although all VOC results will be reported

[2]Screening levels do not apply. Results will be used to calculated destruction removal efficiency of off-gas treatment systems.

CAS - Chemical Abstract Service, MDL - Method detection limit, NA - not applicable, ppbv - parts per billion by volume

ED_005025_00013386-00665

QAPP/SAP WORKSHEET NO. 17 - SAMPLING DESIGN AND RATIONALE

The objectives of this project are to:

- Supplement existing data on subsurface geology and LNAPL distribution during remedial construction to support development of the remedial operational strategies during implementation of the design. This objective is further refined to:
  - Evaluate the horizontal presence or absence of LNAPL (either residual or free product) around the perimeter of the treatment area.
  - Where LNAPL is identified, characterize the vertical extent of the LNAPL to refine the target treatment zone.
  - Where LNAPL is identified, use TPH analytical results to estimate the fraction of soil porosity occupied by residual LNAPL and refine the conceptual understanding of contaminant mass present in the treatment zone.
  - Identify the soil stratigraphy at investigation locations so that the interrelationships between NAPL distribution and soil strata can be evaluated as part of the RD/RAWP.
  - Supplement annual groundwater monitoring data with additional dissolved phase benzene and TPH data to be used as indicators of possible LNAPL presence.
- To complete boring locations as remediation wells (extraction, injection, and/or monitoring) that can be incorporated into the final remedy.
- To collect operational data to verify compliance with permits and, where permits are not formally required to verify compliance with substantive requirements.
- To verify the SEE operation do not mobilize contamination in an uncontrolled nature outside of the treatment area.
- To monitor progress of remediation support decision making regarding transitions to ERB.

The sampling program was developed based on input from TerraTherm, who completed the remedial design for the SEE system, AMEC engineers with experience implementing the existing annual groundwater monitoring program administered by AMEC, and on a review of data for LNAPL distribution to identify where to monitor for potential unintended migration of LNAPL outside the limits of the treatment areas during active remediation that could result in an expansion of the dissolved phase plume.

17.1 Selection of Sampling and Monitoring Locations

The selection of monitoring locations presented in this Work Plan is focused on system sample locations as described in the SAP in Section 5.6 of the RD/RAWP. This allows data to be collected concerning the removal of LNAPL, SEE system efficiency, and reduction of the dissolved phase plume while verifying there is no LNAPL migration off-Site. Also, the collection of observational data from soil borings of installed wells will allow for additional data to be

ED_005025_00013386-00666

collected on the extents of contamination in the treatment area and refine the eventual estimate of contaminant mass removed by the SEE system.

17.1.1 SEE System Process Monitoring Locations

Please refer to Section 5.6 of the RD/RAWP for a description of the system process monitoring locations and the rationale for each location.

17.1.2 Perimeter Monitoring Locations

Potential perimeter monitoring locations were indentified along Sossaman Road to the southeast of the treatment area, as well as along the north, south, and west boundaries of the site. Specific well locations include the following:

- ST012-C02
- ST012-U02
- ST012-W34
- ST012-W37
- ST012-U37
- ST012-RB-3A
- ST012-RB-3C
- ST012-W24
- ST012-W36
- ST012-U38
- ST012-W38
- ST012-U12
- ST012-U11
- ST012-W11
- ST012-W12
- ST012-W30

These wells will be gauged for LNAPL weekly with VOC and TPH analysis in groundwater performed monthly.

17.2 Selection of Monitoring and Sampling Activities

Sonic drilling is proposed to provide access to a continuous core of soil for observations and sample collection. This will allow visual observation of soil stratigraphy and monitoring of PID concentrations throughout the boring to facilitate targeted collection of soil samples for dye screening tests.

Groundwater samples collected from selected wells via low-flow techniques will be analyzed for TPH and VOCs as well and benzene results will be compared to the Worksheet 15 PAL. LNAPL gauging of new wells as part of sampling will also provide additional insight into existing LNAPL conditions.

ED_005025_00013386-00667

QAPP/SAP WORKSHEET NO. 18 - SAMPLING LOCATIONS AND METHODS/SOP REQUIREMENTS TABLE

The sampling locations and specific methods and SOPs are listed in the following tables. Groundwater samples will be collected at least one week after well development. Attachment A of the Program QAPP provides the program sampling SOPs (AMEC, 2012c). Project-specific SOPs are provided at the end of this appendix.

Table 18.1 – Pre-SEE Soil Sampling					
Sampling Location ID Number[1]	Analytical Groups or Field Tests	Matrix	Method	Number of Samples (identify field duplicates)[2]	SOP Reference[3]
ST012-LSZ18	Benzene (VOCs) TPH-JP4	Soil	EPA 8260B and EPA 8015M	1	SOP 10B
ST012-LSZ19	Benzene (VOCs) TPH-JP4	Soil	EPA 8260B and EPA 8015M	1+ field duplicate	SOP 10B
ST012-LSZ20	Benzene (VOCs) TPH-JP4	Soil	EPA 8260B and EPA 8015M	1	SOP 10B
ST012-LSZ21	Benzene (VOCs) TPH-JP4	Soil	EPA 8260B and EPA 8015M	1	SOP 10B
ST012-LSZ22	Benzene (VOCs) TPH-JP4	Soil	EPA 8260B and EPA 8015M	1	SOP 10B
ST012-LSZ23	Benzene (VOCs) TPH-JP4	Soil	EPA 8260B and EPA 8015M	1	SOP 10B
ST012-LSZ24	Benzene (VOCs) TPH-JP4	Soil	EPA 8260B and EPA 8015M	1	SOP 10B
ST012-LSZ25	Benzene (VOCs) TPH-JP4	Soil	EPA 8260B and EPA 8015M	1	SOP 10B
ST012-LSZ26	Benzene (VOCs) TPH-JP4	Soil	EPA 8260B and EPA 8015M	1	SOP 10B
ST012-LSZ27	Benzene (VOCs) TPH-JP4	Soil	EPA 8260B and EPA 8015M	1	SOP 10B
ST012-LSZ28	Benzene (VOCs) TPH-JP4	Soil	EPA 8260B and EPA 8015M	1	SOP 10B
ST012-LSZ29	Benzene	Soil	EPA 8260B	1+ field	SOP 10B

ED_005025_00013386-00668

Table 18.1 – Pre-SEE Soil Sampling					
Sampling Location ID Number[1]	**Analytical Groups or Field Tests**	**Matrix**	**Method**	**Number of Samples** (identify field duplicates)[2]	**SOP Reference[3]**
	(VOCs) TPH-JP4		and EPA 8015M	duplicate	
ST012-LSZ30	Benzene (VOCs) TPH-JP4	Soil	EPA 8260B and EPA 8015M	1	SOP 10B
ST012-LSZ31	Benzene (VOCs) TPH-JP4	Soil	EPA 8260B and EPA 8015M	1	SOP 10B
ST012-LSZ32	Benzene (VOCs) TPH-JP4	Soil	EPA 8260B and EPA 8015M	1	SOP 10B
ST012-LSZ33	Benzene (VOCs) TPH-JP4	Soil	EPA 8260B and EPA 8015M	1	SOP 10B
ST012-LSZ34	Benzene (VOCs) TPH-JP4	Soil	EPA 8260B and EPA 8015M	1	SOP 10B
ST012-LSZ35	Benzene (VOCs) TPH-JP4	Soil	EPA 8260B and EPA 8015M	1	SOP 10B
ST012-LSZ36	Benzene (VOCs) TPH-JP4	Soil	EPA 8260B and EPA 8015M	1	SOP 10B
ST012-LSZ38	Benzene (VOCs) TPH-JP4	Soil	EPA 8260B and EPA 8015M	1	SOP 10B
ST012-LSZ39	Benzene (VOCs) TPH-JP4	Soil	EPA 8260B and EPA 8015M	1	SOP 10B
ST012-LSZ40	Benzene (VOCs) TPH-JP4	Soil	EPA 8260B and EPA 8015M	1	SOP 10B
ST012-LSZ41	Benzene (VOCs) TPH-JP4	Soil	EPA 8260B and EPA 8015M	1	SOP 10B
ST012-LSZ42	Benzene (VOCs) TPH-JP4	Soil	EPA 8260B and EPA 8015M	1	SOP 10B

Notes:

[1] Well locations are provided in the design drawings (Appendix C of RD/RAWP).

[2] Field duplicates may be collected from another well based on field conditions at the time of the sampling event.

[3] SOPs for groundwater well sampling are discussed above in Worksheet #14 and #21.

ED_005025_00013386-00669

Table 18.2 – Pre-SEE Groundwater Sampling					
Sampling Location ID Number[1]	**Analytical Groups or Field Tests**	**Matrix**	**Method**	**Number of Samples** (identify field duplicates)[2]	**SOP Reference**[3]
ST012-CZ01	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1 + 1 field duplicate	SOP 10D
ST012-CZ04	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1	SOP 10D
ST012-CZ05	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1	SOP 10D
ST012-CZ07	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1	SOP 10D
ST012-CZ08	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1	SOP 10D
ST012-CZ10	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1	SOP 10D
ST012-CZ12	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1	SOP 10D
ST012-CZ13	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1	SOP 10D
ST012-CZ16	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1	SOP 10D
ST012-CZ17	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1	SOP 10D
ST012-CZ18	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1	SOP 10D
ST012-CZ19	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1	SOP 10D
ST012-UWBZ03	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1	SOP 10D
ST012-UWBZ07	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1	SOP 10D

ED_005025_00013386-00670

Table 18.2 – Pre-SEE Groundwater Sampling					
Sampling Location ID Number[1]	**Analytical Groups or Field Tests**	**Matrix**	**Method**	**Number of Samples** (identify field duplicates)[2]	**SOP Reference**[3]
ST012-UWBZ09	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1	SOP 10D
ST012-UWBZ11	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1	SOP 10D
ST012-UWBZ12	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1	SOP 10D
ST012-UWBZ13	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1 + 1 field duplicate	SOP 10D
ST012-UWBZ14	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1	SOP 10D
ST012-UWBZ15	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1	SOP 10D
ST012-UWBZ16	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1	SOP 10D
ST012-UWBZ17	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1	SOP 10D
ST012-UWBZ20	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1	SOP 10D
ST012-UWBZ21	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1	SOP 10D
ST012-UWBZ22	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1	SOP 10D
ST012-UWBZ23	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1 + 1 field duplicate	SOP 10D
ST012-UWBZ24	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1	SOP 10D
ST012-LSZ02	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1	SOP 10D

ED_005025_00013386-00671

Table 18.2 – Pre-SEE Groundwater Sampling					
Sampling Location ID Number[1]	**Analytical Groups or Field Tests**	**Matrix**	**Method**	**Number of Samples** (identify field duplicates)[2]	**SOP Reference**[3]
ST012-LSZ04	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1	SOP 10D
ST012-LSZ05	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1	SOP 10D
ST012-LSZ10	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1	SOP 10D
ST012-LSZ11	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1	SOP 10D
ST012-LSZ12	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1	SOP 10D
ST012-LSZ14	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1	SOP 10D
ST012-LSZ15	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1	SOP 10D
ST012-LSZ18	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1 + 1 field duplicate	SOP 10D
ST012-LSZ20	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1	SOP 10D
ST012-LSZ21	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1	SOP 10D
ST012-LSZ24	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1	SOP 10D
ST012-LSZ26	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1	SOP 10D
ST012-LSZ27	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1	SOP 10D
ST012-LSZ28	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1 + 1 field duplicate	SOP 10D

ED_005025_00013386-00672

Table 18.2 – Pre-SEE Groundwater Sampling					
Sampling Location ID Number [1]	**Analytical Groups or Field Tests**	**Matrix**	**Method**	**Number of Samples** (identify field duplicates)[2]	**SOP Reference** [3]
ST012-LSZ29	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1	SOP 10D
ST012-LSZ30	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1	SOP 10D
ST012-LSZ33	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1	SOP 10D
ST012-LSZ35	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1	SOP 10D
ST012-LSZ36	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1	SOP 10D
ST012-LSZ37	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1	SOP 10D
ST012-LSZ38	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1 + 1 field duplicate	SOP 10D
ST012-LSZ39	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1	SOP 10D
ST012-LSZ41	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1	SOP 10D
ST012-LSZ42	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1	SOP 10D

Notes:

[1] Well locations are provided in the design drawings (Appendix C of RD/RAWP).

[2] Field duplicates may be collected from another well based on field conditions at the time of the sampling event.

[3] SOPs for groundwater well sampling are discussed above in Worksheet #14 and #21.

[4] Groundwater samples collected per SOP 10D must be collected by low flow methods.

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Table 18.3 – Monthly Perimeter Well Sampling During Operation					
Sampling Location ID Number[1]	**Analytical Groups or Field Tests**	**Matrix**	**Method**	**Number of Samples** (identify field duplicates)[2]	**SOP Reference**[3]
ST012-C02	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1 + field duplicate	SOP 10D
ST012-U02	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1	SOP 10D
ST012-W34	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1	SOP 10D
ST012-W37	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1	SOP 10D
ST012-U37	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1	SOP 10D
ST012-RB-3A	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1	SOP 10D
ST012-RB-3C	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1	SOP 10D
ST012-W24	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1	SOP 10D
ST012-W36	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1	SOP 10D
ST012-U38	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1+1 field duplicate	SOP 10D
ST012-W38	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1	SOP 10D
ST012-U12	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1	SOP 10D
ST012-U11	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1	SOP 10D
ST012-W11	VOCs TPH-JP4	GW	EPA 8260B and	1	SOP 10D

ED_005025_00013386-00674

Table 18.3 – Monthly Perimeter Well Sampling During Operation					
Sampling Location ID Number[1]	**Analytical Groups or Field Tests**	**Matrix**	**Method**	**Number of Samples** (identify field duplicates)[2]	**SOP Reference**[3]
			EPA 8015M		
ST012-W12	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1	SOP 10D
ST012-W30	VOCs TPH-JP4	GW	EPA 8260B and EPA 8015M	1	SOP 10D

Notes:

[1] Well locations are provided in the design drawings (Appendix C of RD/RAWP).

[2] Field duplicates may be collected from another well based on field conditions at the time of the sampling event.

[3] SOPs for groundwater well sampling are discussed above in Worksheet #14 and #21.

[4] Groundwater samples collected per SOP 10D must be collected by low flow methods.

Table 18.4 – Process Sampling During Operation to Support Remediation Decisions					
Sampling Location ID Number[1]	**Analytical Groups or Field Tests**	**Matrix**	**Method**	**Number of Samples** (identify field duplicates)[2]	**SOP Reference**[1]
Thermal Accelerator Influent	BTEX (VOCs) TPH-GRO and/or TPH-DRO	Vapor	TO-15 TO-3M and/orTO-17M	15 months +6 (assumed) weeks during peak	SOP 21
Thermal Accelerator #1 Effluent	BTEX (VOCs) TPH-GRO and/or TPH-DRO	Vapor	TO-15 TO-3M and/or TO-17M	15 months	SOP 21
Thermal Accelerator #2 Effluent	BTEX (VOCs) TPH-GRO and/or TPH-DRO	Vapor	TO-15 TO-3M and/or TO-17M	15 months	SOP 21
GAC Influent	VOCs Pesticides/PCBs Oil&Grease	Liquid	EPA 8260B EPA 8081/8082 EPA 1664	15 months	SOP 10
GAC Midfluent	VOCs Pesticides/PCBs Oil&Grease	Liquid	EPA 8260B EPA 8081/8082 EPA 1664	15 months	SOP 10
GAC Effluent	VOCs Pesticides/PCBs Oil&Grease	Liquid	EPA 8260B EPA 8081/8082 EPA 1664	15 months	SOP 10
LNAPL Storage	Water and sediment	Liquid	(ASTM D1796/D2709	15 months +6 (assumed)	SOP 10

ED_005025_00013386-00675

Table 18.4 – Process Sampling During Operation to Support Remediation Decisions					
Sampling Location ID Number[1]	**Analytical Groups or Field Tests**	**Matrix**	**Method**	**Number of Samples** (identify field duplicates)[2]	**SOP Reference[1]**
Tank	Viscosity (kinematic) @ 40°C Density Flash point Heat of combustion by bomb calorimeter Carbon/Hydrogen/Nitrogen Sulfur by EDXRF Oxygen by pyrolysis/IR PIANO forensic hydrocarbon characterization (GC/FID)		(ASTM D445) (ASTM D1475) (small scale closed cup: ASTM D3828) (ASTM D4809) (ASTM D5291 (ASTM D4294) (ASTM D5373)	weeks during peak	
Influent to water treatment	VOCs TPH – only as need determined by TerraTherm	Liquid	(8260B) (8015M)	15 months (assumed)	SOP 10 or to be developed SOP for sampling from hot extraction lines depending on operating temperatures
Extraction Manifolds (exact locations to be determined in field)	VOCs TPH – only as need determined by TerraTherm	Liquid	(8260B) (8015M)	At a minimum as needed at end of process to support transition decision making	To be developed for O&M Plan (sampling from hot extraction lines)
Individual MPE Wells	VOCs TPH – only as need determined by TerraTherm	Liquid	(8260B) (8015M)	At a minimum as needed at end of process to support transition decision making	To be developed for O&M Plan (sampling from hot extraction lines)

Notes:
[1] SOPs for groundwater well sampling are discussed above in Worksheet #14 and #21.
[2] Field duplicates may be collected from another well based on field conditions at the time of the sampling event.

ED_005025_00013386-00676

QAPP/SAP WORKSHEET NO. 19 - ANALYTICAL SOP REQUIREMENTS TABLE

Analytical Parameter	Analytical Method	Matrix	Holding Time (from sample date)	Preservation
VOCs	EPA 8260B	Aqueous	14 days	HCl, pH < 2, zero headspace and 4 □C
		Solid	Freeze within 48 hours at lab, 14 days for analysis	4 □C, DI H_2O
	EPA TO-15	Gas	30 days	None
Total Petroleum Hydrocarbon – JP-4	EPA 8015M	Aqueous	Extract within 14 days; analyze within 40 days	4 □C
		Solid	Extract within 14 days; analyze within 40 days	4 □C
	TO-3	Gas	30 days	None
	TO-17	Gas	30 days	None

Notes:
Analysis by EPA Method 8015M must use a JP-4 standard.

DI H_2O - de-ionized water
EPA - Environmental Protection Agency
HCl - Hydrochloric acid
°C - Degrees Celsius

ED_005025_00013386-00677

QAPP/SAP WORKSHEET NO. 20 – FIELD QUALITY CONTROL SAMPLE SUMMARY TABLE

Medium/ Matrix	Analytical Parameter	No. of Field Duplicate Pairs	Organic		Inorganic		No. of Trip Blanks	No. of Equip. Blanks (1)
			No. of MS	No. of MSD	No. of MS	No. of Duplicates		
Soil	All (except waste disposal parameters)	10 %	5 %	5 %	5 %	5 %	1 per cooler containing VOCs	5 %
Groundwater	All (except waste disposal parameters)	10 %	5 %	5 %	5 %	5 %	1 per cooler containing VOCs	5 %
Process Air Samples	All(2)	0%	0%	0%	0%	0%	0%	0%
Process Liquid Samples	All(2)	0%	0%	0%	0%	0%	0%	0%

Notes:
% - percent
Conc. - concentration
Equip. - equipment
MS - matrix spike
MSD - matrix spike duplicate
No. - number
VOCs - volatile organic compounds

(1) Equipment blanks will be collected at a frequency of 5 percent (1:20) per equipment type.
(2) Process samples used to monitor remediation progress and demonstrate discharge requirements will not require field quality control samples unless specifically called for a permit or equivalent requirement.

ED_005025_00013386-00678

QAPP/SAP WORKSHEET NO. 21 - PROJECT SAMPLING SOP REFERENCES TABLE

SOPs and requirements for conducting field investigation and other quality related activities under the program have been developed. The following SOPs are applicable to the investigation work in this Work Plan.

SOP Number	Title
1	Equipment Decontamination
2	Documentation of Field Activities
3	Utility Clearance
4	Drilling
4F	Sonic Drilling
6	Monitoring Well Construction
7A	Monitoring Well Development
7B	Remediation Well Development
8	Water Level Measurement
10	Sampling
10B	Subsurface Soil Sampling
10D	Low Flow Groundwater Purging and Sampling
11	Borehole Logging Manual Logging Borehole geophysics
12	Well Abandonment
12B	Horizontal Well Abandonment
13	Land Surveying
ST012-05	Field Characterization of Non-Aqueous Phase Liquids
21	Air Sampling

Attachment A of the Program QAPP contains the detailed SOPs (AMEC, 2012c). Modified versions of SOP 1, SOP 7A and 7B, SOP 9, SOP 10D, and SOP 12B and site-specific SOP ST012-05 are attached at the end of this Appendix. Attachment B of the Program QAPP contains the Arizona Drilling Requirements including well construction standards, special drilling requirements for areas with groundwater contamination, and well abandonment.

Prior to conducting field investigation activities, field personnel will document that they have read the appropriate sections of this Work Plan. The Task Lead will identify sections of the Work Plan that must be reviewed prior to conducting a specific field activity and will include at a minimum, applicable investigation techniques and procedures, decontamination procedures, field CoC procedures and IDW handling.

ED_005025_00013386-00679

QAPP/SAP WORKSHEET NO. 33 - QA MANAGEMENT REPORTS TABLE

Reports for a variety of quality-related activities will be provided to scientists and managers at appropriate levels of the project organization. Reports include data records provided to the FOL, QA Lead, Project Managers, and agency representatives.

A summary of field and project reports is presented below:

QC Report Type	Generated By	Distributed To	Frequency
Field Instrument Calibration	Field Technicians	FOL	Daily during sampling event
Sample Field Data Records	Field Technicians	FOL	Per sample
Offsite Lab Analytical Documentation	Subcontractor	AMEC QA Lead	Per sample delivery group
Data Validation Report	AMEC QA Lead (or designated representative)	Included in Report	Each investigation
Investigation Reports	PM/Authors	AMEC, AFCEC, EPA, ADEQ	Working Copy – AFCEC Draft, Draft Final, Final – EPA and ADEQ
Corrective Action	Any Team Member	Project Team	As needed

33.1 Project Deliverables

Preparation of a construction completion report will begin following completion of the activities specified in this Work Plan. The report will contain a field investigation activity summary, data quality evaluations, chemical data presentation, boring logs, well completion diagrams, as-built construction drawings, and an LNAPL removal assessment. A Working Copy of the Construction Completion Report will be submitted to AFCEC for review. Revisions resulting from this review will be incorporated into a final Construction Completion Report, which will be available to EPA and ADEQ. SEE operational data will be made available as available and will be formally presented as quarterly O&M reports. The following will be posted to the AMEC document exchange SharePoint site:

- Weekly summary progress reports
- Unvalidated data upon receipt from the laboratory
- Summary data tables as needed to support operational changes and transition decisions

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Former Williams Air Force Base

Standard Operating Procedure No. 1
for
Equipment Decontamination

Prepared by:

AMEC
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4600 East Washington Street
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Revision 2
January 2014

TABLE OF CONTENTS

Page

1.0 PURPOSE AND SCOPE 1

2.0 MATERIALS AND EQUIPMENT 1

3.0 PROCEDURES 1
- 3.1 Small Sampling Equipment Decontamination 2
  - 3.1.1 Soil Sampling Equipment 2
  - 3.1.2 Groundwater Sampling Equipment 2
- 3.2 Monitoring Equipment Decontamination 3
- 3.3 Large Equipment Decontamination 4
- 3.4 Decontamination of Equipment in Contact With Light Non-Aqueous Phase Liquid (LNAPL) 4
- 3.5 Decontamination Documentation 4

ACRONYMS AND ABBREVIATIONS

AFB	Air Force Base
EPA	United States Environmental Protection Agency
HASP	Health and Safety Plan
IDW	Investigation-derived waste
LNAPL	light non-aqueous phase liquid
ppm	parts per million
PID	Photoionization detector
PPE	Personal Protection Equipment
QAPP	Performance Based Remediation Program Quality Assurance Project Plan and Standard Operating Procedures, Former Williams Air Force Base, Mesa, Arizona (AMEC 2012)
SOP	Standard Operating Procedure

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1.0 PURPOSE AND SCOPE

This Standard Operating Procedure (SOP) provides technical guidance and methods that will be used to conduct decontamination of investigation equipment during environmental investigations at Williams Air Force Base (AFB). This SOP serves as a supplement to the investigation specific work plans and is intended to be used in conjunction with the other SOPs in this volume.

2.0 MATERIALS AND EQUIPMENT

The following materials and equipment may be needed for equipment decontamination.

- Monitoring equipment and personal protective equipment (PPE) as outlined in the Site-Specific Health and Safety Plan (HASP).
- Decontamination equipment and supplies (e.g., wash/rinse tubs, brushes, Liquinox®, plastic sheeting, paper towels, sponges, disposable wipes, garden-type water sprayers, large plastic bags, potable water, distilled water and/or deionized water)High pressure washer/steamer
- Drums or other approved water-tight containers for containing decontamination sediment and fluids
- Materials necessary to construct an investigation site-specific decontamination facility, if required (e.g., heavy plastic sheeting, berming materials, sump pump, water tanks, roll-off bins)

3.0 PROCEDURES

The following procedures will be implemented to prevent cross-contamination between sampling points and exploration locations. Sampling methods will use disposable or dedicated sampling tools and materials whenever possible to minimize generating liquid investigative derived waste (IDW). Non-disposable sampling, drilling, and excavation equipment will be decontaminated upon arrival to the site (if required), prior to leaving the site, and between sampling activities at different explorations. All equipment will be decontaminated between each exploration.

A temporary decontamination pad will be constructed at a central location. Other temporary decontamination pads may be constructed closer to exploration areas, as necessary. The pads will be surrounded on three sides with a berm, and will be lined with a high density polyethylene plastic of sufficient thickness to be puncture resistant. A berm will be constructed at the front opening to prevent decontamination fluid from draining into and infiltrating the ground surface around the pad. Water and sediment generated during decontamination will be containerized and handled as IDW material. All IDW will be handled in accordance with IDW management procedures presented in the Performance Based Remediation Program Quality Assurance Project Plan (QAPP) and standard operating procedures (SOPs) (collectively referred to as the QAPP/SOP)[1] SOP No. 16, *Investigative-Derived Waste Management.*

[1]AMEC Environment & Infrastructure, Inc. (AMEC) 2012. Performance Based Remediation Program Quality Assurance Project Plan (QAPP) and Standard Operating Procedures (SOPs) (QAPP/SOP), Former Williams Air Force Base, Mesa, Arizona.

ED_005025_00013386-00683

Equipment rinsate blanks will be collected in order to verify the adequacy of the decontamination process. For soil and groundwater sampling equipment, reagent-grade deionized water will be poured over the sampling equipment and collected in appropriate sample containers. For soil gas sampling equipment, a sample of purified air will be drawn through the decontaminated sampling equipment and analyzed by United States Environmental Protection Agency (EPA) method TO-15. Equipment rinsate blank frequency will be as indicated in QAPP worksheet No. 20, *Field Quality Control Sample Summary Table*.

3.1 Small Sampling Equipment Decontamination

Non-disposable sampling equipment will be decontaminated after collection of each sample. The small sampling equipment is sub-divided as follows.

3.1.1 Soil Sampling Equipment

Soil sampling equipment may consist of split-spoon samplers, trowels, and hand augers (SOP No.'s 10A and 10B). Decontamination will be performed prior to collection of each sample as follows:

- Wipe remaining surface debris, if any, with clean paper towel (or equivalent disposable material).
- Wash object with a non-phosphate detergent (Liquinox® or equivalent) and potable water.
- Flush with potable water. Rinse object with distilled/deionized water.

Prior to intrusive drilling, down-hole sampling, and excavation, visual inspection of equipment will be documented in the field logbook. Sample containers will be wiped clean after sampling and before being moved to the sample handling and shipping area. Sample handling and shipping areas will be cleaned and wiped down daily, when in use.

3.1.2 Groundwater Sampling Equipment

Groundwater sampling is performed at the following sites; ST-012, ST-035, SS-017, and LF-004. Groundwater sampling procedures are provided in SOP Numbers 10D, 10E, and 10F. Groundwater samples will be collected using passive diffusive bag (PDB) samplers, non-dedicated pumps, depth-specific sampling systems (Hydropunch®, Simulprobe®, or equivalent), and disposable bailers. Decontamination procedures for each of these sampling systems are described in the following sub-sections.

3.1.2.1 PDB Sampling

PDB sampling (SOP No. 10E) will be used to collect groundwater samples at sites ST-012 and LF-004. The PDB samplers are obtained new from the laboratory and dedicated lines are used to install the PDB samplers. Therefore, sampler decontamination is not required for groundwater sampling at ST-012 and LF-004.

ED_005025_00013386-00684

3.1.2.2 Non-Dedicated Sampling Pumps

Non-dedicated bladder sampling pumps will be used to collect groundwater samples at sites ST-035 and SS-17 (SOP No. 10D). In order to minimize decontamination requirements, dedicated sample tubing is used for each well. Additionally, where possible, the wells are sampled in order of least contaminated to most contaminated based on recent groundwater analytical results. Prior to collecting a sample, the bladder pump will be decontaminated in the same manner as the soil sampling equipment described in Section 3.1.1. The dedicated tubing will be attached to the well cap and will remain in the well between sampling events. In order to remove effects from the previous sampling event, the dedicated tube will be flushed with a solution of potable water and Liquinox®.

3.1.2.3 Depth-Specific Groundwater Sampling Equipment

Depth-specific groundwater sampling (Hydropunch®, Simulprobe®, or equivalent) may be utilized to evaluate the vertical groundwater contaminant profile during drilling of borings (SOP No. 10C). This data may be used to determine well construction specifications. This equipment is used in a similar manner as a split-spoon sampler. Therefore, prior to collecting the sample the equipment will be decontaminated in the same manner as a split-spoon soil sampler (see Section 3.1.1). The Hydropunch® requires use of a small diameter disposable bailer that is lowered through the A/W rod to collect a sample.

3.1.2.4 Bailers

Groundwater samples may be collected using bailers. All bailers that may be utilized for sampling purposes will be disposable. Therefore, decontamination of bailers is not required. However, any reels, rope, or like-materials to be reused with the disposable bailers will be decontaminated between uses.

3.2 Monitoring Equipment Decontamination

If monitoring equipment (e.g., photoionization detector [PID]) is likely to become contaminated, it will be protected from contamination by covering as much of the instrument as possible with plastic without hindering the operation of the unit. The PID, for example, can be placed in a clear plastic bag, which allows for reading of the scale and operation of the controls. The sensor on the PID can be partially wrapped, keeping the sensor tip and discharge port clear.

After the monitoring equipment is taken from the exploration area, the potentially contaminated protective coverings will be removed and disposed in the appropriate containers. Any direct or obvious contamination will be brushed or wiped with a disposable paper wipe. The units will be taken inside, placed in a clean plastic tub, and wiped off with damp, disposable wipes. The units will be checked, covered, and recharged for the next day's operation.

Other monitoring equipment that require decontamination are water level probes, oil/water interface probes, and water parameter probes/flow-through cells. This equipment will be decontaminated in the same manner as soil sampling equipment prior to use at a well.

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3.3 Large Equipment Decontamination

Large equipment will be decontaminated between exploration locations using high-pressure steam as necessary. Drilling rigs, tools, and equipment will be decontaminated by the Drilling Subcontractor before mobilizing to and/or from the site. A decontamination SOP will be obtained from the selected drilling contractor prior to drill operations and will be reviewed.

If any of the procedures described in this section are observed to be either inappropriate, inadequate, or impractical, an alternate procedure will be documented in the field logbook, along with a description of the circumstances requiring its use.

3.4 Decontamination of Equipment in Contact With Light Non-Aqueous Phase Liquid (LNAPL)

If any equipment comes in contact with wells that contain any amount of light non-aqueous phase liquid (LNAPL), it shall first be decontaminated using an ACS Grade 66 or 33 percent (%) strength methanol. All materials in contact with the LNAPL shall be fully immersed in the methanol and let to soak for a minimum of five minutes. After soaking, standard decontamination procedures as described in previous sections on this SOP shall be completed. Once all decontamination activities have been completed, a PID shall be used to check the equipment for any presence of petroleum products. If the PID reading is greater than 0.5 parts per million (ppm) then the decontamination procedures above shall be repeated until the PID reading is less than 5 ppm.

3.5 Decontamination Documentation

Field personnel will be responsible for documenting proper sampling and heavy equipment decontamination. The purpose of documentation is to demonstrate in the written field record that decontamination was performed in accordance with this SOP. Decontamination activities will be documented at least each day they are performed. The documentation will be recorded in a logbook or on appropriate project forms (i.e., boring log, sample field data sheets). The information recorded concerning decontamination will include:

- Date and times of decontamination
- Location of decontamination activities (i.e., sample site, central decontamination facility)
- Decontamination personnel and materials
- Decontamination steps/observations
- Other applicable information

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Former Williams Air Force Base

Standard Operating Procedure No. 7A
for
Monitoring Well Development

Prepared by:

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TABLE OF CONTENTS

Page

1.0 PURPOSE AND SCOPE 1
1.1 Objective 1
1.2 Equipment 1

2.0 PROCEDURES 1
2.1 Swab Development 2
2.2 Well Bailing 2
2.3 Pump Development 3
2.4 Development Parameters 3
2.5 Documentation 5

ACRONYMS AND ABBREVIATIONS

AMEC	AMEC Environment & Infrastructure, Inc.
ft	feet
gpm	gallons per minute
IDW	investigation-derived waste
ml/L	milliliters per liter
NAPL	Non-Aqueous Phase Liquid
NTU	nephelometric turbidity unit
SC	specific capacity
SOP	Standard Operating Procedure

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1.0 PURPOSE AND SCOPE

This Standard Operating Procedure (SOP) describes the protocol to be followed during the development of monitoring wells. As the work progresses and if warranted, appropriate revisions to this standard operating procedure may be made by the project manager. Detailed procedures in this protocol may be superseded by applicable regulatory requirements.

1.1 Objective

The objectives of monitoring well development are to remove sediment that may have accumulated during well installation, to consolidate the filter pack around the well screen, and to enhance the hydraulic connection between the target zone and the well.

1.2 Equipment

The following equipment may be used during well development. Site-specific conditions may warrant addition or deletion of items from this list.

- Dual-swab block on a perforated section of pipe
- An electric submersible pump and bailer;
- Container for purge water (drums or fractionation tank);
- Container with known volume (e.g., 5-gallon bucket) for flow estimation and sediment removal measurements;
- Water level indicator;
- Imhoff cone (for measuring sediment content);
- Stopwatch or timer;
- Well Development Record form;
- Field notebook; and
- Pens.

2.0 PROCEDURES

The following methods will be employed for monitoring well development. Monitoring well development shall be performed, as soon as practical, after well installation but not sooner than 48 hours following placement of the uppermost grout seal. Weather conditions may increase grout set time and, consequently, further delay development. The primary objective of well development of environmental monitoring wells is to remove formation materials from the screen and drilling additives (if used) to ensure that an appropriate hydraulic connection is established so that the well will serve its intended purpose to provide water quality and/or head elevation head data. Well development takes on more significance for wells intended for water supply or hydraulic control. Development of monitoring wells shall be accomplished using the following methods (ordered in occurrence).

ED_005025_00013386-00689

All non-dedicated equipment used for development shall be thoroughly decontaminated prior to initial use and between each successive well site in accordance with SOP No. 01, *Equipment Decontamination*. Purge water and decontamination solutions will be handled and disposed of as outlined in SOP No. 16, *Investigation-Derived Waste Management*. All investigation-derived waste (IDW) shall be handled and disposed of in accordance with SOP No. 16, *Investigation-Derived Waste Management*.

2.1 Swab Development

Monitoring well development shall start using swab techniques. A dual-swab block situated on a perforated section of pipe of sufficient design to meet its intended purpose shall be inspected by AMEC personnel prior to use. The diameter of the swabs shall not be more than ¼-inch greater or ⅛-inch less than the casing inner diameter. The length of perforated pipe between the swabs shall be approximately 5-feet long (see sample photo below).

Swab development shall proceed from the bottom of the screen to the top of the screen at a rate of **no less than <u>7.5 minutes</u> per submerged linear foot of screen**. Additional time may be required if deemed necessary by the AMEC field manager. Swabbing alone will not result in purging of fluids at the surface; therefore, the collection of water quality parameters does not apply. It may be necessary to perform additional swabbing if the minimum sediment remaining criteria is not met following bailing (see Section 2.2).

If drilling additives (polymers or muds) were used during drilling of the well borehole, then an AMEC approved non-phosphoric dispersant (e.g., Baroid Aqua-Clear® PFD) shall be added to the well to assist in removing said additives. Any chemical additives used should be applied using the volumes and methods recommended by the manufacturer.

2.2 Well Bailing

Following completion of swab development as described in Section 2.1 of this SOP, bailing shall be conducted to remove any accumulated sediments from the bottom of the well. The purpose of the post swab development bailing is to remove larger grained sediments (e.g., gravels and sands) which can cause clogging issues during pump development (see Section 2.3). Collection of water quality parameters during bailing are **<u>not</u>** required because the primary goal of bailing is to remove large grained sediments, not fluid removal. However, the volume of total sediment removed shall be estimated using a 5-gallon bucket. Sediment estimates shall be collected by measuring the cumulative inches of sediment in the bucket prior to transferring the contents of each bucket "dump" to the identified disposal point.

Bailing shall continue until sediment thickness remaining in the well is **equal to or less than one percent of the entire screen length**. An example calculation is provided below:

- Tagged (measured) depth to top of sediment or bottom of well after bailing[1] = 199.5 feet (ft)
- Total well depth (recorded during well construction) = 200 ft
- Total screen length (recorded during well construction) = 50 ft

[1]Field measurements of total well depth and top of sediment remaining shall be measured by the pump contractor using an AMEC approved tagging device.

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- Thickness of sediment in well = 200 ft – 199.5 ft = 0.5 ft
- Percent (%) of sediment vs. length of well screen = (0.5 ft ÷ 50 ft) × 100 = 1%

In the example above, the minimum sediment remaining criteria has been met at 1%.

2.3 Pump Development

Following completion of initial bailing activities as described in Section 2.2 of this SOP, pump development shall be conducted. Pump development is intended to further agitate/develop the well screen, and remove small grained materials (e.g., silt and fine sand) from the well which bailing does not typically accomplish. The pump shall be an electrical submersible type equipped with an electrical control box and/or discharge valve that provides ability to control the flow rate.

Water levels shall be collected periodically during pump development to determine the well's specific capacity (SC). A well's SC is calculated by taking the flow rate divided by the amount of observed drawdown. An example calculation is provided below:

- Pump rate = 10 gallons per minute (gpm)
- Observed drawdown = 5 ft
- SC = 10 gpm/5 ft = 2 gpm/ft

In the example above, the water level in this well drops 1 foot at a pumping rate of 2 gpm. The SC calculation shall be used to establish the **maximum pumping rate** for development without drawing the water table below the pump intake. **The maximum pumping rate should be adjusted as development progress if the SC value changes by ±10%**. Pump development shall start from the bottom of the well and continue to approximately 5 feet above the top of the uppermost well screen until the criteria listed in Section 2.4 of this SOP have been met.

Following completion of pump development, the bottom of the well shall be measured by the pump contractor using an AMEC approved tagging device. The tagged depth reading shall be recorded by AMEC personnel on the appropriate field log. If the sediment thickness remaining in the well is **equal to or less than one percent of the entire screen length**, then additional bailing is not necessary. If **greater than 1%**, then the bailing procedures described in Section 2.2 shall be repeated until the sediment thickness remaining in the well is **equal to or less than one percent of the entire screen length**.

2.4 Development Parameters

During pump development, the following field parameters shall be monitored and recorded on the appropriate field logs:

- Sediment content (measured in milliliters per liter [ml/L]) using an Imhoff cone. Approximately 15 minutes is required following collection of the sample to take the sediment reading;
- Turbidity (to be measured only when the water starts becoming opaque and/or clear) using a hand-held turbidity meter;
- Conductivity, pH, and temperature, using a hand-help water quality meter;

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- Color, clarity, and odor (e.g., clear and odorless, or opaque with strong fuel odor, etc.) using the unaided eye and a clear glass jar; and
- Volume of total fluid (gallons) and sediments (measured in inches using a 5-gallon bucket) removed.

The above parameters shall be taken approximately every 15 minutes or as required as conditions during development predicate.

A remediation well is considered fully developed when all the following criteria are met:

- Sediment content is ≤1 ml/L;
- Turbidity is ≤40 nephelometric turbidity units (NTU);
- When two consecutive readings of conductivity, pH, and temperature are within ±5% of one another;
- The well water is clear or slightly opaque to the unaided eye; and
- The total volume of water removed from the well is ≥five times the well volume.

Well volume can be calculated in gallons using the following equation:

$$\mathbf{V = H \times F}$$

Where:

V = one well volume (gallons)
H = the difference between the depth of the well and depth of water (ft)
F = Gallons per linear foot of casing

F can be calculated from the following equation:

$$\mathbf{F\ (gal/ft^3) = ([D^2]\ X\ 0.005454)\ X\ 7.481}$$

Where:

D = the inside diameter of the well casing (inches)

Common F factors for various size casings are provided below:

Diameter of Casing (D) (inches)	F Factor (gallons/ft)
1.5	0.09
2.0	0.16
3.0	0.37
4.0	0.65
6.0	1.47

These criteria may be modified with approval by the field manager. Should the recharge to the well be so slow that the required volume cannot be removed in 2 to 3 consecutive hours, if the water

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remains discolored, or excess sediment remains after the five-volume removal, the project team shall terminate purging and/or discuss other options for improving water quality. Limited development may be specified when gross contamination is observed (e.g., the presence of Non-Aqueous Phase Liquid [NAPL]).

2.5 Documentation

The following data shall be recorded for development:

- Well designation (name/identification);
- Date of well installation;
- Date of development;
- Static water level before and after development;
- Quantity of standing water in well prior to development;
- Depth from top of well casing to bottom of well;
- Screen lengths and depths;
- Depth from top of well casing to top of sediment inside well, before and after development;
- Physical character of removed water, including changes during development in clarity, color, particulates, and odor;
- SC of the well measured during pump development
- Type and size/capacity of swab tool, pump, and bailer used, and photographs of each device;
- Height of well casing above/below ground surface;
- Pump development rates; and
- Quantity of cumulative sediment and water removed and time for removal.

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Former Williams Air Force Base

Standard Operating Procedure No. 7B
for
Remediation Well Development

Prepared by:

AMEC
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January 2014

TABLE OF CONTENTS

Page

1.0 PURPOSE AND SCOPE 1
1.1 Objectives 1
1.2 Equipment 1

2.0 PROCEDURES 1
2.1 Swab and Airlift Development 2
2.1.1 Special Conditions 4
2.2 Well Bailing 4
2.3 Pump Development 5
2.4 Development Parameters 5
2.5 Documentation 7

ACRONYMS AND ABBREVIATIONS

AMEC	AMEC Environment & Infrastructure, Inc.
ft	Feet
gpm	gallons per minute
IDW	Investigation-derived waste
ml/L	Milliliters per liter
NAPL	Non-Aqueous Phase Liquid
NTU	Nephelometric turbidity unit
SC	Specific capacity
SOP	Standard Operating Procedure

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1.0 PURPOSE AND SCOPE

This standard Operating Procedure (SOP) describes the protocol to be followed during the development of remediation wells. As the work progresses and if warranted, appropriate revisions to this SOP may be made by the project manager. Detailed procedures in this protocol may be superseded by applicable regulatory requirements.

1.1 Objectives

The objectives of remediation well development are to remove sediment that may have accumulated during well installation, to consolidate the filter pack around the well screen, and to enhance the hydraulic connection between the target zone and the well.

1.2 Equipment

The following equipment may be used during remediation well development. Site-specific conditions may warrant addition or deletion of items from this list.

- Dual-swab block on a perforated section of pipe equipped with an air line to facilitate simultaneous swab and airlift development;
- Air compressor with the capacity to facilitate simultaneous swab and airlift development for the well being developed;
- An electric submersible pump and bailer;
- Container for purge water (drums or fractionation tank);
- Container with known volume (e.g., 5-gallon bucket) for flow estimation and sediment removal measurements;
- Water level indicator;
- Imhoff cone (for measuring sediment content);
- Stopwatch or timer (to estimate flow rates);
- Well Development Record forms;
- Field notebook; and
- Pens.

2.0 PROCEDURES

The following methods will be employed for remediation well development. Remediation well development shall be performed, as soon as practical, after well installation but not sooner than 48 hours following placement of the uppermost grout seal. The primary objective of well development of environmental remediation wells is to remove formation materials from the screen and drilling

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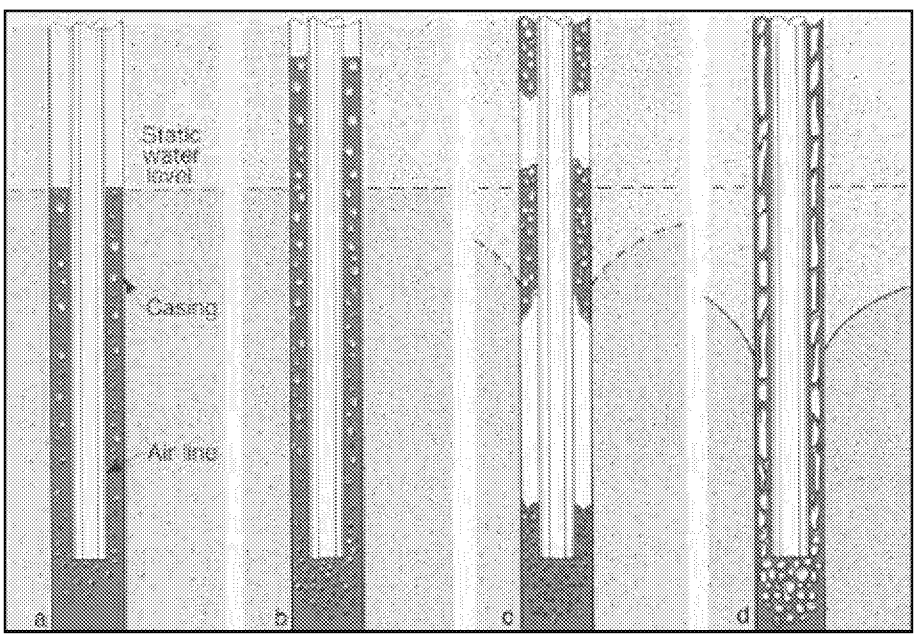
additives (if used) to maximize injection and/or extraction potential. Development of remediation wells shall be accomplished using the following methods (ordered in occurrence).

All non-dedicated equipment used for development shall be thoroughly decontaminated prior to initial use and between each successive well site in accordance with SOP No. 01, *Equipment Decontamination*. Purge water and decontamination solutions will be handled and disposed of as outlined in SOP No. 16, *Investigation-Derived Waste Management.* All investigation-derived waste (IDW) shall be handled and disposed of in accordance with SOP No. 16, *Investigation-Derived Waste Management*.

2.1 Swab and Airlift Development

Remediation well development shall start with simultaneous swab and airlift techniques. The diagram below illustrates how multiphase flow (water and air) occur in the casing during air development.



a. Introduction of a small volume of air under the static water level causes little change in the water level in the well. In this case, the air pressure available is just sufficient to overcome the head exerted by the water column.
b. As air volume increases, the column becomes partly aerated. Displacement of the water by the air causes the water column to rise in the casing. Drawdown does not change because no pumping is occurring.
c. Further increase in the air volume causes aerated slugs of water to be lifted irregularly out of the top of the casing. Between surges, the water level in the casing falls to (approximately) the static water level.
d. If enough air is available, the aerated water will continually flow out the top of the casing. With average submergence and total lift, the volume of air versus water is about 10 to 1.

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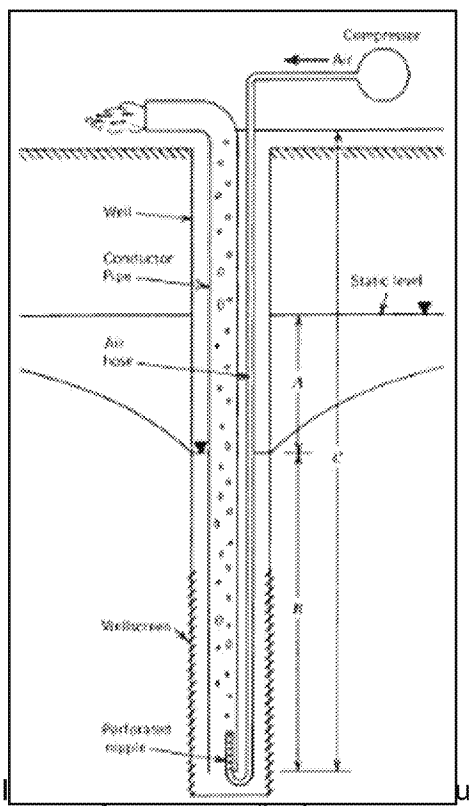
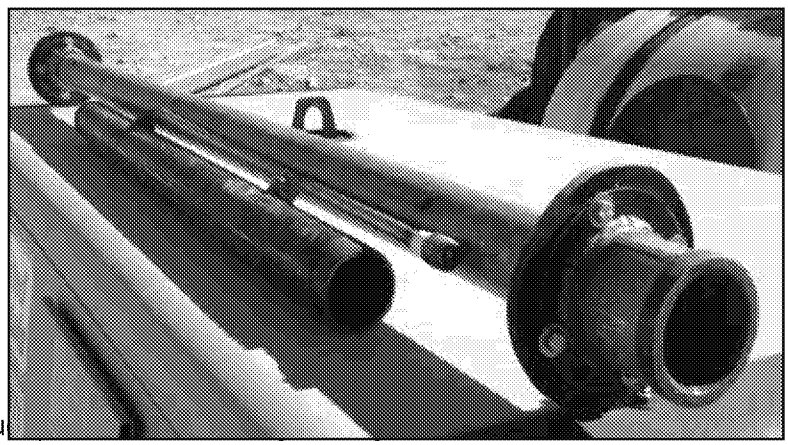
Higher air volumes may actually increase the pumping rate somewhat, but still higher rates may actually reduce the flow rate because flow into the well is impeded by the excessive air volume.

The percent of tool submergence, total lift, and capacity of the air compressor will control the relative proportion of air and water for a particular well. In the illustration below, ***B*** is the ***submergence*** of the air lift and ***C*** is the ***total height to the discharge point***. The ratio ***B/C*** is termed the ***submergence ratio*** and is critical to air lift performance. At lower ***submergence ratios*** the air lift becomes inefficient, and below a ratio of about 0.4 it essentially ceases to function (see Section 2.1.1 for procedures to be conducted when air lifting is not appropriate). The table to the right of the illustration below gives the pressure and volume of air required as various depths and ***submergence ratios***. A dual-swab block situated on a perforated section of pipe equipped with an air line of sufficient design to meet its intended purpose shall be inspected by AMEC personnel prior to use. The diameter of the swabs shall not be more than ¼-inch greater or ⅛-inch less than the casing inner diameter. The length of perforated pipe between the swabs shall be approximately 5-feet long (see sample photo below).

Swab and airlift development shall proceed from the bottom of the screen to the top of the screen at a rate of **no less than <u>7.5 minutes</u> per submerged linear foot of screen**. Additional time may be required if development water does not meet the criteria listed in Section 2.4 of this SOP. The required water quality monitoring parameters are included in Section 2.4 of this SOP.



Lift C (ft) (m)	Total depth C (ft) (m)	Submergence B (ft) (m)	Submergence ratio B/C	ft³ of air per gallon of water (m³ of air per liter of water)	Starting pressure psi (kPa)
25 (7.62)	34 (10.3)	29 (8.8)	0.84	0.22 (16.5 × 10⁻³)	13 (89.6)
25 (7.62)	78 (24.2)	53 (16.1)	0.68	0.12 (9.0 × 10⁻³)	23 (158.6)
25 (7.62)	104 (31.7)	79 (24.1)	0.76	0.07 (5.2 × 10⁻³)	34 (234.4)
50 (15.2)	102 (31.1)	52 (15.8)	0.51	0.40 (29.9 × 10⁻³)	23 (158.6)
50 (15.2)	143 (43.6)	93 (28.3)	0.65	0.23 (17.2 × 10⁻³)	40 (275.8)
50 (15.2)	179 (54.6)	129 (39.3)	0.72	0.15 (11.2 × 10⁻³)	56 (386.1)
100 (30.5)	189 (57.6)	89 (27.1)	0.47	0.70 (52.4 × 10⁻³)	38 (262.0)
100 (30.5)	250 (76.2)	150 (45.7)	0.60	0.37 (27.7 × 10⁻³)	65 (448.2)
100 (30.5)	309 (92.3)	209 (63.7)	0.67	0.27 (20.2 × 10⁻³)	88 (606.7)
150 (45.7)	263 (80.2)	113 (34.4)	0.43	0.95 (71.1 × 10⁻³)	49 (337.8)
150 (45.7)	333 (101.5)	183 (55.8)	0.55	0.49 (36.7 × 10⁻³)	79 (544.7)
150 (45.7)	395 (120.4)	245 (74.7)	0.62	0.37 (27.7 × 10⁻³)	106 (730.8)



AMEC approved non-phosphoric dispersant (e.g., Baroid Aqua-Clear® PFD) shall be added to

the well to assist in removing said additives. Any chemical additives used should be applied using the volumes and methods recommended by the manufacturer. Once the development water meets the criteria listed in Section 2.4 of this SOP, bailing shall be conducted (see Section 2.2).

2.1.1 Special Conditions

"Special Conditions", as they pertain to swab and air lift development, means there is an inadequate column of water in the well to achieve swab and airlift development, and/or the well diameter is too small to allow the insertion of an appropriate swab and airlift tool. Under special conditions, the screened portion of the well shall be swabbed (without airlifting) at rate of **no less than 2 minutes per submerged linear foot of screen**. A dual-swab block with the same configuration as previously specified may be used to achieve the swab development, or a separate dual-swab block tool may be used as long as it has been inspected and approved by AMEC personnel prior to said use. Swabbing alone will not result in purging of fluids at the surface; therefore, the collection of water quality parameters does not apply. All other procedures described in this SOP shall still apply to wells with special conditions.

2.2 Well Bailing

Following completion of swab and air lift development as described in Section 2.1 of this SOP, bailing shall be conducted to remove any accumulated sediments from the bottom of the well. The purpose of the post air lift and swab development bailing is to remove larger grained sediments (e.g., gravels and sands) which can cause clogging issues during pump development (see Section 2.3). Collection of water quality parameters during bailing are **not** required because the primary goal of bailing is to remove large grained sediments, not fluid removal. However, the volume of total sediment removed shall be estimated using a 5-gallon bucket. Sediment estimates shall be collected by measuring the cumulative inches of sediment in the bucket prior to transferring the contents of each bucket "dump" to the identified disposal point.

Bailing shall continue until sediment thickness remaining in the well is **equal to or less than one percent of the entire screen length**. An example calculation is provided below:

- Tagged (measured) depth to top of sediment or bottom of well after bailing[1] = 199.5 feet (ft)
- Total well depth (recorded during well construction) = 200 ft
- Total screen length (recorded during well construction) = 50 ft
- Thickness of sediment in well = 200 ft – 199.5 ft = 0.5 ft
- Percent (%) of sediment vs. length of well screen = (0.5 ft ÷ 50 ft) × 100 = 1%

In the example above, the minimum sediment remaining criteria has been met at 1%.

[1]Field measurements of total well depth and top of sediment remaining shall be measured by the pump contractor using an AMEC approved tagging device.

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2.3 Pump Development

Following completion of initial bailing activities as described in Section 2.2 of this SOP, pump development shall be conducted. Pump development is intended to further agitate/develop the well screen, and remove small grained materials (e.g., silt and fine sand) from the well which bailing does not typically accomplish. The pump shall be an electrical submersible type equipped with an electrical control box and/or discharge valve that provides ability to control the flow rate. The maximum pump capacity shall be able to achieve flow rates equal to or greater than those achieved during swab and airlift development.

Water levels shall be collected periodically during pump development to determine the well's specific capacity (SC). A well's SC is calculated by taking the flow rate divided by the amount of observed drawdown. An example calculation is provided below:

- Pump rate = 10 gallons per minute (gpm)
- Observed drawdown = 5 ft
- SC = 10 gpm/5 ft = 2 gpm/ft

In the example above, the water level in this well drops 1 foot at a pumping rate of 2 gpm. The SC calculation shall be used to establish the **maximum pumping rate** for development without drawing the water table below the pump intake. **The maximum pumping rate should be adjusted as development progress if the SC value changes by ±10%**. Pump development shall start from the bottom of the well and continue to approximately 5 feet above the top of the uppermost well screen until the criteria listed in Section 2.4 of this SOP have been met.

Following completion of pump development, the bottom of the well shall be measured by the pump contractor using an AMEC approved tagging device. The tagged depth reading shall be recorded by AMEC personnel on the appropriate field log. If the sediment thickness remaining in the well is **equal to or less than one percent of the entire screen length**, then additional bailing is not necessary. If **greater than 1%**, then the bailing procedures described in Section 2.2 shall be repeated until the sediment thickness remaining in the well is **equal to or less than one percent of the entire screen length**.

2.4 Development Parameters

During swab and airlift and pump development, the following field parameters shall be monitored and recorded on the appropriate field logs:

- Sediment content (measured in milliliters per liter [ml/L]) using an Imhoff cone. Approximately 15 minutes is required following collection of the sample to take the sediment reading;
- Turbidity (to be measured only when the water starts becoming opaque and/or clear) using a hand-held turbidity meter;
- Conductivity, pH, and temperature, using a hand-help water quality meter;

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- Color, clarity, and odor (e.g., clear and odorless, or opaque with strong fuel odor, etc.) using the unaided eye and a clear glass jar; and
- Volume of total fluid (gallons) and sediments (measured in inches using a 5-gallon bucket) removed.

The above parameters shall be taken approximately every 15 minutes or as required as conditions during development predicate.

A remediation well is considered fully developed when all the following criteria are met:

- Sediment content is ≤1 ml/L;
- Turbidity is ≤40 nephelometric turbidity units (NTU);
- When two consecutive readings of conductivity, pH, and temperature are within ±5% of one another;
- The well water is clear or slightly opaque to the unaided eye; and
- The total volume of water removed from the well is ≥five times the well volume.

Well volume can be calculated in gallons using the following equation:

$$\mathbf{V = H \times F}$$

Where:

V = one well volume (gallons)
H = the difference between the depth of the well and depth of water (ft)
F = Gallons per linear foot of casing

F can be calculated from the following equation:

$$\mathbf{F\ (gal/ft^3) = ([D^2] \times 0.005454) \times 7.481}$$

Where:

D = the inside diameter of the well casing (inches)

Common F factors for various size casings are provided below:

Diameter of Casing (D) (inches)	F Factor (gallons/ft)
1.5	0.09
2.0	0.16
3.0	0.37

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4.0	0.65
6.0	1.47

These criteria may be modified with approval by the field manager. Should the recharge to the well be so slow that the required volume cannot be removed in 2 to 3 consecutive hours, if the water remains discolored, or excess sediment remains after the five-volume removal, the project team shall terminate purging and/or discuss other options for improving water quality. Limited development may be specified when gross contamination is observed (e.g., the presence of Non-Aqueous Phase Liquid [NAPL]).

2.5 Documentation

The following data shall be recorded for development:

- Well designation (name/identification);
- Date of well installation;
- Date of development;
- Static water level before and after development;
- Quantity of standing water in well prior to development;
- Depth from top of well casing to bottom of well;
- Screen lengths and depths;
- Depth from top of well casing to top of sediment inside well, before and after development;
- Physical character of removed water, including changes during development in clarity, color, particulates, and odor;
- SC of the well measured during pump development;
- Type and size/capacity of swab and airlift tool, pump, and bailer used, and photographs of each device;
- Height of well casing above/below ground surface;
- Air lift and pump development rates; and
- Quantity of cumulative sediment and water removed and time of removal.

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Former Williams Air Force Base

Standard Operating Procedure No. 9
for
Aquifer Tests

Prepared by:

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January 2014

TABLE OF CONTENTS

Page

1.0 INTRODUCTION 1

2.0 METHODS 1
- 2.1 Slug Tests 1
  - 2.1.1 Procedure 1
  - 2.1.2 Rising or Falling Head Tests Equipment 1
  - 2.1.3 Rising or Falling Head Tests 2
  - 2.1.4 Pneumatic Rising Head Tests Equipment 5
- 2.2 Step-Rate Drawdown Tests 7
  - 2.2.1 Objective 8
  - 2.2.2 Equipment 8
  - 2.2.3 Procedure 9
- 2.3 Constant Rate Drawdown Tests 11
  - 2.3.1 Equipment 11
  - 2.3.2 Procedures 11

ACRONYMS AND ABBREVIATIONS

AF	Air Force
AFB	Air Force Base
AMEC	AMEC Environment & Infrastructure, Inc.
FID	Flame ionization detector
ID	Identification
PID	Photoionization detector
PVC	Polyvinyl chloride
SOP	Standard Operating Procedure

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1.0 INTRODUCTION

AMEC Environment & Infrastructure, Inc. (AMEC) has prepared this Standard Operating Procedure (SOP) to direct field personnel to describe the methods and general procedures for conducting aquifer tests in wells that produce groundwater.

The objectives of aquifer tests include identifying aquifer properties such as recharge, drawdown, storativity, transmissivity, specific and sustained yield, hydraulic conductivity, and aquifer boundaries. Knowledge of these properties is essential to the understanding of aquifer characteristics for the configuration of remediation or ground water supply systems.

2.0 METHODS

Four methods for obtaining aquifer test data from wells producing groundwater are discussed in this section of the SOP. While various other methods exist, these were deemed the most appropriate and/or most likely to occur given AMEC's knowledge of groundwater contamination conditions at the former Williams Air Force Base (AFB), Mesa, Arizona, and the individual objectives of each site where groundwater contamination is being addressed, or may be in the future.

2.1 Slug Tests

The objective of slug testing is to obtain an order of magnitude estimate of aquifer hydraulic conductivity in the immediate vicinity of the tested well. This objective requires knowledge of aquifer geology and well geometry, as well as the collection of sufficient test data to allow estimation of aquifer hydraulic characteristics. A slug test can be performed as a rising head or falling head test, and is one of several wellpoint hydraulic conductivity measurement techniques that can be employed using a single well with limited effort. Alternative wellpoint tests may be more appropriate for high yield formations, and can be conducted by extracting water at a constant rate, or maintaining the water level in monitoring well at a constant drawdown, similar to a step test.

2.1.1 Procedure

Procedures for conducting three types of slug tests are described below, including:

- Rising or falling head tests in wells screened below the water table;
- Rising head tests in wells screened across the water table; and,
- Pneumatic rising head tests in highly transmissive sand and gravel aquifers.

2.1.2 Rising or Falling Head Tests Equipment

The following equipment is necessary to perform a rising or falling head slug test in a monitoring well. Site specific conditions may warrant the use of additional equipment.

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- Water level measuring device;
- Bailer;
- Slug bar;
- Rope or wire;
- Slug test data form (pressure transducers will be used in lieu of the form in some cases);
- Field logbook;
- Electronic data logger;
- Pressure transducer and conductor cable;
- Stop watch or watch with a built-in timer;
- Duct tape;
- Well completion diagrams; and,
- Decontamination equipment.

The slug bar may be constructed of solid or hollow plastic, such as polyvinyl chloride (PVC) or metal such as aluminum or steel (depending upon the chemical environment in the well). If hollow, the slug bar will be filled with silica sand or other inert material to add weight. The slug bar should be of sufficient size to cause a minimum of two feet of displacement in a well. For a two-inch diameter well, the slug bar should be no more than 1.5 inches in diameter and a minimum of 3.6 feet long. For a four-inch diameter well, the slug bar should be no more than 3 inches in diameter and a minimum of 3.6 feet long. The slug bar should be securely fastened to a nylon rope or wire.

2.1.3 Rising and Falling Head Tests

In any well where the screen extends above the water table, a rising head test should be used.

2.1.3.1 Falling Head Tests

The following procedures should be utilized for conducting a **falling head slug test**.

1. Note the physical condition of the well, including damage, deterioration, and signs of tampering.
2. Open the well cap. Note any unusual odors, sounds, or difficulties in opening the well. Record organic vapor reading with a suitable calibrated organic vapor screening device (photoionization detector [PID] or flame ionization detector [FID]). The PID or FID will be calibrated per manufacturer specifications.
3. Lower a decontaminated water level measuring device into the well to determine the static water level.
4. Measure the depth to the bottom of the well and the inside diameter of the well casing.

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5. If using a pressure transducer connected to a data logger, lower the pressure transducer into the well to a sufficient depth in the well so that the transducer will be below the maximum depth reached by the slug bar.

6. Secure the pressure transducer to the side of the well in a manner that ensures no disturbance or movement of the transducer cable. The transducer cable should lie flat along the side of the well riser, so that disturbance by the slug bar will be minimized. Do not bend the transducer cable or a kink will develop in the cable that will cut off the pressure equalization vent tube in the cable, which may prevent the transducer from operating.

7. Allow the pressure transducer to temperature equilibrate a minimum of 15 minutes before connecting it to the data logger and starting the test.

8. Allow the water level in the well to recover to static level after emplacement of the pressure transducer, prior to starting the test.

9. Determine the distance from the top of the well riser to the water surface in the well and add one foot to this length. The resulting length is the amount of wire or rope needed so that the slug bar or bailer will be submerged a minimum of one foot when it is placed in the well. A loop should be placed in the rope or wire at this length and a strong metal rod or wooden stick placed and secured through the loop. If the bottom of the well is less than this length added to the length of the slug bar or bailer, the length of the rope or wire should be adjusted so that the slug bar will be no less than one foot above the top of the pressure transducer when the bar is dropped in the well.

10. If using a data logger, program it to record logarithmically, with a maximum time interval of no more than one minute between readings. Set the data logger to record relative change in head only, not absolute head.

11. If depth readings are to be recorded manually (this procedure is recommended only in aquifers suspected of having low hydraulic conductivity, less than 5 feet per day), readings should be taken every 10 seconds for the first minute of the test, every 30 seconds for the first 5 minutes and every minute until 10 minutes. Thereafter, readings may be taken every 5 minutes for the duration of the test. If the well has not recovered within one hour, readings may be taken every 0.5 hour until 2 hours. This process will require two people during the first 10 minutes of the test, a person to act as time keeper/data recorder and a person to measure depth to water.

12. Place the slug or bailer in the well until the bottom of the displacement device is no more than 6 inches above the water level in the well. The person holding the device should be holding the rope or wire by the rod or stick.

13. To start the test, the person holding the slug bar will signal the person operating the data logger and rapidly lower the device into the well until the stick or rod is resting on the well riser. **The slug bar should not be dropped**. The data logger is started as soon as the slug bar is lowered.

14. The test will be run until the well has recovered to 90 percent of static water level. If 90 percent recovery has not occurred within 2 hours, the test may be stopped. Field conditions and time constraints may warrant stopping the test in less than 2 hours.

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15. All equipment (pressure transducer and cable, water level measurement device and slug bar or bailer) shall be decontaminated before repeating the test in another well.

16. Download the data logger to a computer or to hard copy to ensure that the data is not inadvertently lost. If the data were recorded manually, calculate the relative change in head by subtracting the recorded depths to water from initial static water level and record the absolute value of that change, for each time-depth data pair.

2.1.3.2 Rising Head Tests

The following procedures should be utilized for conducting a **rising head slug test**. Note, the test may be started after completion of a falling head test in a well screened below the water table (described previously). The steps are essentially the same as those for a falling head test, except that the test is started only after a displacement device has been placed in the well and the water level in the well has recovered back to static conditions. If this test is performed after a falling head test, begin with step #11.

1. Note the physical condition of the well, including damage, deterioration, and signs of tampering.
2. Unlock the protective cap on the well.
3. Open the well cap. Note any unusual odors, sounds, or difficulties in opening the well. Record organic vapor reading with a suitable calibrated organic vapor screening device (PID or FID). The PID or FID will be calibrated per manufacturer specifications.
4. Lower a decontaminated water level measuring device into the well to determine the static water level.
5. Measure the depth to the bottom of the well and the inside diameter of the well casing.
6. If using a pressure transducer connected to a data logger, lower the pressure transducer into the well to a sufficient depth in the well so that the transducer will be below the maximum depth reached by the slug bar.
7. Secure the pressure transducer to the side of the well using duct tape. The transducer cable should lie flat along the side of the well riser, so that disturbance by the slug bar will be minimized. Do not bend the transducer cable or a kink will develop in the cable that will cut off the pressure equalization vent tube in the cable, which will prevent the transducer from operating.
8. Allow the pressure transducer to temperature equilibrate a minimum of 15 minutes before connecting it to the data logger and starting the test.
9. Allow the water level in the well to recover to static level after emplacement of the pressure transducer, prior to starting the test.
10. Determine the distance from the top of the well riser to the water surface in the well and add one foot to this length. The resulting length is the amount of wire or rope needed so that the slug bar or bailer will be submerged a minimum of one foot when it is placed in the well. A loop should be placed in the rope or wire at this length and a strong metal rod or wooden stick placed and secured through the loop. If the bottom of

ED_005025_00013386-00708

the well is less than this length added to the length of the slug bar or bailer, the length of the rope or wire should be adjusted so that the slug bar will be no less than one foot above the top of the pressure transducer when the bar is placed in the well.

11. If using a data logger, program it to record logarithmically, with a maximum time interval of no more than one minute between readings. Set the data logger to record relative change in head only, not absolute head.
12. If depth readings are to be recorded manually (this procedure is recommended only in aquifers suspected of having low hydraulic conductivity, less than 5 feet per day), readings should be taken every 10 seconds for the first minute of the test, every 30 seconds for the first 5 minutes and every minute until 10 minutes. Thereafter, readings may be taken every 5 minutes for the duration of the test. This process will require two personnel during the first 10 minutes of the test, a person to act as time keeper/data recorder and a person to measure depth to water.
13. To start the test, the person holding the rope or wire attached to the slug bar will signal the person operating the data logger and rapidly remove the device from the well. The slug bar should be removed rapidly but smoothly so that water sloshing in the well is minimized. The data logger is started immediately when the slug bar is removed.
14. The test will be run until the well has recovered to 90 percent of static water level. If 90 percent recovery has not occurred within 2 hours, the test may be stopped. Field conditions and time constraints may warrant stopping the test in less than 2 hours.

2.1.4 Pneumatic Rising Head Tests

2.1.4.1 Pneumatic Rising Head Test Equipment

The following equipment should be utilized when conducting a pneumatic rising head slug test. Site specific conditions may warrant the use of additional equipment.

- Water level measuring device (acoustic water level recorder preferred);
- Slug test data sheet;
- Field logbook;
- Electronic data logger;
- Pressure transducer(s) and conductor cable;
- Stop watch or watch with a built-in timer;
- Duct tape;
- Pressure tight "tree" assembly;
- Short length (6-inches) of flexible rubber hose whose inside diameter is the same as the outside diameter of the well riser;
- Two 2- or 4-inch diameter hose clamps; and,
- Compressor or compressed air tank with hose and appropriate adapters.

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The pressure-tight "tree" assembly is a device placed on the top of the well that will accomplish the following (a "tree" consist of a several tees in series with the top leg of the tee connected to a pressure source, a side leg of the tee connected to a pressure relief valve, and another leg used to run the pressure transducer cable down the well):

- Form a pressure seal between the well and the atmosphere;
- Allow the injection of compressed air into the well via an air hose connected to a compressor or compressed air tank;
- Provide a pressure-tight passage for a pressure transducer cable and the water level meter if used for confirmation measurements; and,
- Allow for rapid well depressurization.

If the top of the riser is threaded, the device may be screwed onto the riser, if the threads are wrapped with Teflon tape. If the threaded end of the riser has been cut off, a slip coupling will need to be placed over the base of the tree and the top of the riser. A small length of flexible rubber hose the same inside diameter as the outside diameter of the coupling will be slipped over the coupling and secured in place with tightly closed hose clamps to form a pressure tight seal between the riser and the well.

2.1.4.2 Procedures

The following procedures should be utilized for conducting a **pneumatic rising head slug test**. Note that the test may be started after completion of a falling head test in a well screened below the water table (described previously). The rising head test using pneumatic equipment follows the same procedure described above for rising head tests except that no slug bar or bailer is used.. If this test is performed after a falling head test, begin with step #11.

1. Note the physical condition of the well, including damage, deterioration, and signs of tampering.
2. Unlock the protective cap on the well.
3. Open the well cap. Note any unusual odors, sounds, or difficulties in opening the well. Record organic vapor reading with a suitable calibrated organic vapor screening device (PID or FID). The PID or FID will be calibrated per manufacturer specifications.
4. Lower a decontaminated water level measuring device into the well to determine the static water level.
5. Measure the depth to the bottom of the well and the inside diameter of the well casing.
6. If using a pressure transducer connected to a data logger, lower the pressure transducer into the well to a sufficient depth in the well so that the transducer will be below the maximum depth reached by the slug bar.
7. Secure the pressure transducer to the side of the well using duct tape. The transducer cable should lie flat along the side of the well riser, so that disturbance by the slug bar will be minimized. Do not bend the transducer cable or a kink will develop in the cable

ED_005025_00013386-00710

that will cut off the pressure equalization vent tube in the cable, which will prevent the transducer from operating.

8. Allow the pressure transducer to temperature equilibrate a minimum of 15 minutes before connecting it to the data logger and starting the test.

9. Allow the water level in the well to recover to static level after emplacement of the pressure transducer, prior to starting the test.

10. Determine the distance from the top of the well riser to the water surface in the well and add one foot to this length. The resulting length is the amount of wire or rope needed so that the slug bar or bailer will be submerged a minimum of one foot when it is placed in the well. A loop should be placed in the rope or wire at this length and a strong metal rod or wooden stick placed and secured through the loop. If the bottom of the well is less than this length added to the length of the slug bar or bailer, the length of the rope or wire should be adjusted so that the slug bar will be no less than one foot above the top of the pressure transducer when the bar is placed in the well.

11. If using a data logger, program it to record logarithmically, with a maximum time interval of no more than one minute between readings. Set the data logger to record relative change in head only, not absolute head.

12. If depth readings are to be recorded manually (this procedure is recommended only in aquifers suspected of having low hydraulic conductivity, less than 5 feet per day), readings should be taken every 10 seconds for the first minute of the test, every 30 seconds for the first 5 minutes and every minute until 10 minutes. Thereafter, readings may be taken every 5 minutes for the duration of the test. If the well has not recovered within one hour, readings may be taken every 0.5 hour until six hours and one hour thereafter. This process will require two personnel during the first 10 minutes of the test, a person to act as time keeper/data recorder and a person to measure depth to water.

13. Ensure a tight seal of the tree at the well head, start the data logger and pressurize the well so that a water level displacement of 2 to 10 feet is recorded on the transducer. Hold or adjust the pressure on the well so that a relatively stable displacement is achieved, and then open the depressurization valve to allow the groundwater level to begin recovering.

14. The test will be run until the well has recovered to 90 percent of static water level. If 90 percent recovery has not occurred within 2 hours, the test may be stopped. Field conditions and time constraints may warrant stopping the test in less than 2 hours.

2.2 Step-Rate Drawdown Tests

A step-rate drawdown test is similar to a constant-rate drawdown test except that the pumping rate is systematically increased in a series of several steps of approximately equal duration. The basic requirement is to maintain constant-discharge during each step and obtaining frequent water-level measurements in the pumping well and observation wells. Although a step test is often used to determine well yield, a step test may be used to determine the hydraulic conductivity of an aquifer as an alternative to slug testing. A step test may be performed as a

ED_005025_00013386-00711

series of steps (i.e., incrementally increasing pumping rates) or be performed using only a single step (i.e., a constant pumping rate).
This SOP assumes that step-rate drawdown tests are performed in a pumping well that is surrounded by observations (non-pumping) wells; however, a step-rate drawdown test can be performed using a single well and such a test can be used to determine hydraulic conductivity using time-drawdown or recovery data, which are not affected by well-losses.

Generally, step-rate drawdown tests are conducted during a single day with each pumping step consisting of a 1-hour to 2-hour period. Consistent time intervals permit easy comparison of the drawdown data. Step-rate drawdown tests are used to determine the specific capacity of a pumping well, optimum pumping rates, and the percentage of turbulent and laminar flow occurring at a pumping well. Step-rate drawdown test data should also be used (ideally) to determine the optimal pumping rate for a constant-rate test at the same well. Under ideal, laminar-flow conditions, the drawdown in a pumping well is directly proportional to the discharge. If the flow is not entirely laminar, meaning that some turbulent flow also occurs, the drawdown will be proportional to the discharge rate raised to some power. Analytical equations have been developed to estimate the percentage of laminar versus turbulent flow from pumping wells. From such analyses a long-term test discharge rate can be selected that will avoid excessive turbulent flow.

2.2.1 Objective

The objectives of step-rate drawdown tests include estimating aquifer drawdown, hydraulic conductivity values, and well efficiency. Step-rate drawdown test data is also used to determine the optimal pumping rate for constant-rate drawdown tests (at the same well).

2.2.2 Equipment

The following equipment may be used when conducting step-rate drawdown tests. Site-specific conditions may warrant addition to, or deletion of items from this list.

- Field logbook or pump test log;
- Water level indicators;
- Water Level Record forms (see SOP No. 2, *Field Documentation*);
- Pressure transducers;
- Data logging equipment;
- Field printer;
- Lap-top computer;
- Plastic zip ties;
- Alconox, liquinox, or other non-phosphate concentrated laboratory grade soap;
- Deionized water;
- Submersible pump with flow regulator and foot valve, and tubing;

ED_005025_00013386-00712

- Generator;
- Heavy duty extension cords;
- Polyethylene sheeting;
- Large capacity barrels (alternately holding tanks);
- Necessary personal protective equipment (gloves, eyewear, tyvek suits);
- Portable radios;
- Well completion logs;
- Well keys;
- Flow meter/graduated bucket; and,
- Stopwatch.

All equipment associated with the testing activities shall be decontaminated in accordance with the procedures provided in SOP No. 01, *Decontamination.*

2.2.3 Procedure

The following general procedures should be used for conducting step-tests. Alterations of these general procedures may be necessary in order to accommodate site specific conditions and data requirements.

Step-tests should follow the set-up procedures listed below in order to consistently record the desired data as accurately as possible.

1. Determine the appropriate lengths of transducer cables based on the distances from pumping to observation wells. Based on the well geometries, determine the appropriate pressure-rated transducer, number of logging channels needed, required pump hosing length, pump capacity and type, minimum and maximum anticipated pumping rates. Identify the test control location and create a pre-test schematic of where the wells are, depth of transducer and pump settings, where the water will be discharged or containerized, and how the test can be implemented efficiently before going into the field. If vented transducers are used, variations in atmospheric pressure will automatically be accounted for; however, if the tested aquifer is susceptible to atmospheric pumping, monitoring of atmospheric pressure may be required to help interpret water level data.

2. Conduct decontamination of all downhole test equipment and wrap all equipment in polyethylene sheeting or bags. These should be dedicated and labeled for the intended wells.

3. Following any required air/explosion monitoring, measure water levels in all of the wells to be monitored during the test. Record the water levels in the logbook or on the pump test log. It is recommended that the water levels be monitored for a sufficient

ED_005025_00013386-00713

period of time prior to the test to identify any trends of rising or falling water levels due to nearby supply wells, tidal influence or surface water bodies.

4. Set and secure the pump in the pumping well at the planned depth and allow for stabilization of the displaced water level caused by its insertion. The generator should be filled with gasoline at a remote down-wind location and extension cord run to this location. Record the pump depth in the logbook or on the pump test log. Monitor the water level in the pumping well to ensure that static levels are attained.

5. Secure the transducers with plastic zip ties in the desired wells at the planned depths as identified in the pre-test schematic. Set all transducers in the wells for a minimum of two hours to allow for adaptation to ground water temperature and cable stretch. The transducer in the pumping well should be set above the pump. Run all of the transducer cables to the test control location and connect them to the data logger in the desired channel(s). Record the transducer depths in the logbook or on the pump test log.

6. While the transducers are becoming stable, programming of the data logger for each channel should be completed with the specific parameters for each transducer. Scale factors, linearity, offset, well identification (ID), reference level, and type of reading (surface or top of casing) should be selected. These parameters are specific to each transducer and data logger and are usually clearly identified on the wheel and cable for each transducer. *After programming, each transducer should be tested for accuracy by raising it a known distance and verifying that the change in measured water level corresponds with this distance. If a long term pumping test is conducted (i.e. several weeks) checking transducers in this manner once per week is warranted.*

7. The data logger should be programmed to collect readings at the desired interval(s) for the entire duration of the test including recovery. The test should be programmed to allow for logging of water levels during the drawdown and recovery stages using the logarithmic option recommended with most data loggers. The actual log scale can also be modified to suit the needs of the test if desired. The data logger should be programmed to start pat the initiation of the pre-test phase for an ample period of time to allow for the collection of static water level conditions at the well site(s). One week is considered sufficient for the pre-test (non-pumping) phase. Record the programmed duration in the logbook or on the pump test log.

8. Once the test equipment is ready, the entries, well IDs, and parameters for each channel should then be double checked for accuracy. The connections to all channels should be checked by communication with each individual transducer.

9. The startup of the pump should be synchronized with the logging of water level data. The rate of pumping should be set at the desired rate. The rate should be stabilized as quickly as possible to promote accurate data analysis. Direct the discharge to the appropriate containers, if required, or to a location outside of the anticipated cone of influence. The pumping rate should be measured and recorded routinely during initial

ED_005025_00013386-00714

pumping to confirm that the rate is stable. All adjustments to the rate should be recorded. Record the actual start time and pumping rate of the test in the logbook or on the pump test log.

10. Monitor the channels of the data logger to read the transducers. Look for drawdown in the pumping well to confirm operation. Monitor the transducers in the observation wells to confirm their operation. Manual measurement of the water levels should be performed periodically to confirm the accuracy of the transducer data.

11. Increase pumping rates at the required frequency.

12. If a recovery test also planned, shut down the pump, record the time and allow the water level in the pumping well to recover to 95 percent (or greater) of static levels while the transducer and data logger collect the recovery data.

13. Once the test is completed, remove, and decontaminate all downhole equipment.

2.3 Constant Rate Drawdown Tests

The objectives of constant-rate drawdown tests include identifying aquifer properties of recharge, drawdown, storativity, transmissivity, specific and sustained yield, and aquifer boundaries. Data obtained from constant-rate drawdown tests are considered more reliable than data obtained from step-drawdown tests because the are designed (ideally) to stress the aquifer being tested at a pumping rate, and for a duration of time, which are intended to identify and assess potential boundary conditions (aquifer dewatering, recharge zones, local variability in hydraulic conductivities, etc.). Knowledge of these hydrologic parameters is essential and aids in the understanding of aquifer characteristics for the configuration of remediation or ground water supply systems.

2.3.1 Equipment

The equipment used for constant-rate drawdown tests is essentially the same as when conducting step-rate drawdown tests (see Section 2.2.2). All equipment associated with the testing activities shall be decontaminated in accordance with the procedures provided in SOP No. 01, *Decontamination*.

2.3.2 Procedures

The general procedures for conducting a constant-rate drawdown [redacted] essentially the same as when conducting [redacted] step-rate drawdown test (see Section 2.2.3), but instead of increasing pumping rates throughout the test, it is important to maintain a constant pumping rate for the duration of the test.

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Former Williams Air Force Base

Standard Operating Procedure No. 10D
for
Low Flow Groundwater Purging and Sampling

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TABLE OF CONTENTS

Page

1.0 PURPOSE AND SCOPE 1

2.0 METHODS 1

2.1.1 Equipment 1

2.1.2 Procedure 3

2.1.3 Quality Assurance/Quality Control (QA/QC) Procedures and Samples 7

3.0 SAMPLING WELLS WITH LIGHT NON-AQUEOUS PHASE LIQUID (LNAPL) 7

4.0 DOCUMENTATION 8

ACRONYMS AND ABBREVIATIONS

AMEC	AMEC Environment & Infrastructure, Inc.
DO	Dissolved oxygen
FID	Flame ionization detector
HASP	Health and Safety Plan
ID	Identification
IDW	Investigation-derived waste
JHA	Job Hazard Analysis
LNAPL	light non-aqueous phase liquid
L/min	Liters per minute
mV	Millvolts
NAPL	Non-Aqueous Phase Liquid
NTUs	Nephelometric Turbidity Units
ORP	Oxidation-reduction potential
PVC	Polyvinyl chloride
PID	Photoionization detector
PPE	Personal Protection Equipment
QA	Quality assurance
QAPP/SOP	Performance Based Remediation Program Quality Assurance Project Plan and Standard Operating Procedures, AMEC 2012
QC	Quality control
SOP	Standard Operating Procedure
SVOC(s)	Semivolatile organic compound(s)
VOC(s)	Volatile organic compound(s)

ED_005025_00013386-00717

1.0 PURPOSE AND SCOPE

The purpose of this Standard Operating Procedure (SOP) is to describe the general methodology for collecting groundwater samples using low flow purging and sampling. This SOP applies to all personnel who collect and/or handle groundwater samples during site activities.

2.0 METHODS

2.1.1 Equipment

The following equipment and supplies will be used to purge and sample groundwater at the site.

2.1.1.1 Major Equipment Items

- Variable-rate, submersible pump/hose assembly with control unit, or bladder pump with control unit;
- Electrical generator if required, and extension cord;
- Air compressor or other air supply if required, and/or Gasoline and oil (for generator, if used);
- Soapy water mixture containers;
- Potable water containers;
- Deionized water containers; and,
- Purge water drums or purge water tank.

2.1.1.2 Equipment Support Items

- Drum liners;
- Trash bags;
- Plastic sheeting
- Decontamination tub;
- Low phosphate detergent, such as Liquinox;
- Gloves (nitrile rubber);
- Graduated 5-gallon buckets and/or graduated cylinder;
- Folding table;
- Folding chairs;
- Paper towels;

ED_005025_00013386-00718

- Calculator; and
- Digital watch with stopwatch function.

2.1.1.3 Sampling Supplies

- Written description of wells including identification (ID) numbers, maps, well locations, elevations, well construction details, and (if available) records of previous development and/or purging and sampling;
- Well keys;
- Sample containers and applicable preservative;
- Chain-of-custody forms;
- Sample labels;
- Field data forms;
- Ice chest;
- Ice for sample preservation;
- Ziploc® bags;
- Field logbook; and
- Pen and waterproof permanent marker.

2.1.1.4 Monitoring Equipment

- Electronic water level indicator and, when necessary, oil/water interface probe;
- Water quality sampling field instrumentation (e.g., pH, temperature, specific conductance [conductivity], turbidity, dissolved oxygen [DO], oxidation/reduction potential [ORP] probes); and
- Photoionization detector (PID) or flame ionization detector (FID), if required.

2.1.1.5 Health and Safety Items

- First aid kit and emergency eye-wash kit;
- Fire extinguisher;
- The Site-specific Health and Safety Plan (HASP) and Job Hazard Analysis (JHA), Material Safety Data Sheet/emergency information packet (route to hospital, phone contacts); and
- Field radio or cell phone.

ED_005025_00013386-00719

2.1.2 Procedure

This method is used to collect groundwater samples from existing wells. Every effort will be made during well construction to minimize the amount of silt and clay that enters the well casing by choosing appropriate screen and filter pack material. However, it should be anticipated that turbidity in groundwater monitoring wells may be a concern. To obtain representative groundwater samples, disturbances of the water in the well should be kept to a minimum. The reasoning behind the use of low-flow sampling techniques to sample monitoring wells is to minimize physical disturbance (turbulence) at the sampling point and chemical changes (aeration) in the medium. Another benefit of low-flow sampling techniques is the total volume of water purged is minimized. For the purposes of this procedure, "low-flow pumps" are defined as dedicated or portable bladder pumps, or variable speed submersible pumps. Practical operational flow rates for these sampling devices range from 0.1 liters per minute (L/min) to greater than 1 L/min. If low-flow procedures are not possible or practical or a project specific need requires it, the standard three-well volume purge and sampling procedures may be used (see SOP No. 10E).

2.1.2.1 General Equipment Decontamination

Before purging or sampling, all pumps and hoses, water level measurement devices, and any other sampling equipment that may come in contact with the sample will be decontaminated. If new dedicated equipment is used, it should be thoroughly decontaminated and rinsed with distilled water before placement in the well. While decontamination of the pump/hose assembly may generally be performed at a central decontamination area, mobile decontamination supplies will be made available so that some accessory equipment (e.g., electronic water level indicators) can be decontaminated in the field. Each piece of purging or sampling equipment will be decontaminated prior to and between sampling operations and wells. Purge water and decontamination solutions will be handled and disposed of as outlined in SOP No. 16, *Investigation-Derived Waste Management*. The procedures specified in SOP No. 01, *Equipment Decontamination,* will be followed for decontamination of field equipment and for personnel decontamination.

2.1.2.2 Measurement of Water Quality Parameters and Instrument Calibration

Electronic equipment used during purging and sampling may include a PID, FID, Multi-Gas Meter, a water level indicator, an oil/water interface probe, water quality measurement devices for temperature and pH, conductivity, turbidity, DO, and ORP. Before going into the field, the Field Task Leader will verify that these instruments are operating properly. Each probe of the water quality-measuring device must be calibrated prior to its use and checked at the beginning and end of each day for maintenance of calibration. Calibration procedures will follow the manufacturer's instructions. The PID or FID will be calibrated daily using standard calibration gas as specified by the manufacturer. If instrument readings become erratic during normal operations, recalibration will be conducted.

ED_005025_00013386-00720

Person(s) responsible for calibrating equipment will complete the equipment specific calibration form, which includes identifying calibration standards and affixing a signature to the form. Field measurements for temperature, pH, turbidity, conductivity, DO, and ORP will be made in accordance with procedures outlined in SOP No. 17, *Field Measurements*, along with the manufacturer's instructions.

2.1.2.3 Low-Flow Methodology

The purpose of well purging is to remove stagnant water from the well and obtain a representative water sample from the geologic formation being sampled while minimizing disturbance of the water column during sample collection. Using the low-flow purging methodology, the well will be purged until field parameters (pH, temperature, turbidity, DO, ORP, and conductivity) have stabilized. Readings will be taken at a rate commensurate for the flow involved, but no sooner than every three minutes. Low-flow purging rates on the order of 0.1 - 1.0 L/min will be used depending on the site-specific hydrogeology. If drawdown exceeds 0.3 feet during purging, the purge rate should be lowered and the drawdown re-evaluated during the next measurement interval. Multiple iterations may be necessary (continuing to lower the purge rate if needed down to 0.1 L/min or the least practical rate) with at least 3-5 minutes to observe and evaluate the drawdown before abandoning the low-flow purge method in favor of a total well volume purge method. If the drawdown still exceeds 0.3 feet once the appropriate purge rate is found, the low flow purge rate may still be acceptable if the other water quality parameters are stable. If drawdown continues to exceed 0.3 feet and the other water quality parameters are unstable, then the Total Well Volume Methodology will be followed. Background wells being sampled for metals must attain a turbidity of 10 Nephelometric Turbidity Units (NTUs) or less before sample collection unless a written variance (on a well-specific basis) is acquired. The turbidity goal for non-background samples is 15 NTU, but samples with higher turbidity are acceptable if turbidity readings are stabilized and the other conditions of low-flow purging have been met. Purge water will be managed as outlined in SOP No. 16, *Investigation-Derived Waste Management.* Necessary precautions will be taken to prevent spilling of potentially contaminated water. The water will need to be containerized and appropriately disposed or treated prior to discharge.

2.1.2.3.1 Low-Flow Purging

For standard low-flow well purging, the following steps will be performed at each well:

- The condition of the well completion (outer well casing, concrete well pad, protective posts, well label) and any unusual conditions of the area around the well will be noted on the monitor well purging form. The well may also be photographed. Any deficiencies encountered will be reported to the Site Manager on the same working day.
- Set up and establish the exclusion zone around the work area, using traffic cones and caution tape where necessary.

ED_005025_00013386-00721

- Don personal protective equipment (PPE) as specified in the Health and Safety Plan (HASP).
- If elevated volatile organic compounds (VOCs) are expected based upon historical analytical results, open the well cap and immediately check for VOC vapors in the well casing. Record this reading on the Monitoring Well Purging Form (See SOP No. 2, *Documentation of Field Activities*).
- Note if the reference point (measuring point) on the well is present. This is usually an indelible mark or V-notch cut in the top of the well casing. If this point is missing, make one on the north side of the well casing.
- The depth of the static water level will be measured with a water level indicator (to the nearest 0.01 foot) in accordance with SOP No. 8, *Water Level Measurement*. If a high concentration of organic vapors is detected in the well, an oil/water interface probe will be used to determine the presence of an immiscible non-aqueous phase liquids (NAPL).
- The total depth of the well will be measured from the same measuring point on the casing with a water level indicator and recorded. It is critical that the distance between the water sensor (zero point) and the end of the water level indicator probe be measured independently and added to each total depth measurement.
- Slowly lower the pump or pump tubing into the well casing to 5 feet below the water table or, in instances where the well screen is submerged, 5 feet below the top of the screen. Reinsert the water level indicator to monitor water levels during purging. Note: Sample pump elevations may be stipulated by a site-specific work plan. If so, that site-specific work plan will be considered the prevailing document.
- Start the pump. As soon as water is discharging, adjust the pump speed to a rate between 0.1 – 1.0 L/min that is suitable to create minimal drawdown. During purging and sampling, the maximum allowable drawdown is 0.3 feet (see Section 2.1.2.3).
- Using a stopwatch and some type of graduated cylinder, measure the pumping rate. Monitor the water level, pumping rate, cumulative volume withdrawn, and field parameters (temperature, pH, turbidity, conductivity, DO, and ORP) approximately every 3 to 5 minutes.
- A flow-through cell will be used in conjunction with the water quality meter, with inflow at the bottom of the cell and outflow at the top.
- Low-flow purging is complete only when all required field parameters have stabilized (temperature, pH, turbidity, conductivity, DO, and ORP). Stabilization is achieved when three consecutive readings show temperature is within ± 3%, conductivity is within ± 3%, pH values are within ± 0.1 pH unit, turbidity and DO are within ± 10%, and ORP is within ± 10 millivolts (mV). Background wells must be 10 NTUs or less before sample collection unless a written variance (on a well-specific basis) is acquired. The Site Manager/Field Task Leader has the responsibility of determining if redevelopment of any monitoring well is necessary and appropriate. If the parameters do not stabilize, a maximum of 6 well casing volumes will be purged prior to sampling.

- After low-flow purging is complete, collect the groundwater sample per the steps described in Section 2.1.2.3.2.

2.1.2.3.2 Low-Flow Sampling

Using low-flow sampling procedures, samples for chemical analysis will be collected immediately following purging. The water quality samples will be taken from within the well screen interval. The following sampling procedure will be used at each well:

- After the monitoring well is considered purged and before filling sample vials, the water quality meter and any other instruments or hardware (e.g., flow meters, couplings, etc.) will be disconnected from the sampling tube.
- Immediately following purging, the pump will be used to collect the groundwater sample. The pump should not be moved between purging and sampling, unless a peristaltic pump is used.
- Identification labels for sample bottles will be filled out or preprinted and attached to sample bottles for each well prior to collecting samples.
- The individual sample bottles should be filled in the order given below:
- - Volatile organic compounds (VOCs),
- - Semi-volatiles organic compounds (SVOCs),
- - Other organic parameters,
- - Metals (inorganics),
- - Inorganic anions,
- - Other parameters, and
- - Field test parameters (e.g., pH, conductivity, and temperature).
- Sample vials will be filled using a steady, laminar stream of water to the extent practicable; samples should be discarded and a new sample collected if excessive pulsing or surging occurs during sampling. Furthermore, aeration of the sample will be reduced by slightly tilting the sample bottle so that the stream flows down the side of the vial.
- VOC sample vials should be completely filled so the water forms a convex meniscus at the top, then capped so that no air space exists in the vial. Turn the vial over and tap it to check for bubbles in the vial. If air bubbles are observed in the sample vial, discard the vial and collect another sample.
- Fill containers for SVOCs, inorganics, inorganic anions, and other parameter analyses until almost full. Samples will be preserved and managed as detailed in the Performance Based Remediation Program Quality Assurance Project Plan and Standard Operating

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Procedures (QAPP/SOP [AMEC, 2012])[1]. The time of sampling will be recorded. When collecting samples using preservatives, the pH should be periodically checked. For non-VOC samples, a small amount of the preserved sample should be poured from the sample container directly onto the pH strip (rather than dipping the strip into the sample container, which can contaminate the sample). For VOCs, the pH check is best accomplished by filling an extra vial during collection, ensuring it is not overfilled, then dipping a pH strip into the sample vial to check that the sample is at or below the maximum pH allowed. This vial would then be disposed of as investigation-derived waste (IDW).

- After the samples have been collected, they should immediately be placed in an ice-filled cooler until relinquished to the on-site laboratory or shipped to the appropriate laboratory for analysis. Sample bottles may become warm in the field when left in the sun or in the field vehicle; therefore, an effort will be made to ensure that sample containers are kept on ice to prevent warming of the bottles to prevent a loss of volatiles.
- After collection of the samples, the water quality meter will be reconnected to the purge-line, and final post sampling water quality measurements will be recorded.
- After removing the pump and equipment from the well, replace and lock the well cap.

2.1.3 Quality Assurance/Quality Control (QA/QC) Procedures and Samples

The well sampling order will be dependent on expected levels of contamination in each well, if known, and will be estimated prior to sampling. To the extent practicable, sampling will progress from the least contaminated well to the most contaminated. QA/QC samples will be collected during groundwater sampling according to the QAPP/SOP (AMEC, 2012)[1]. QA/QC samples may be labeled with QA/QC identification numbers (or fictitious identification numbers if blind submittal is desired), and sent to the laboratory with the other samples for analyses.

3.0 SAMPLING WELLS WITH LIGHT NON-AQUEOUS PHASE LIQUID (LNAPL)

This section provides the SOPs and the equipment required for sampling wells with the presence of light non-aqueous phase liquid (LNAPL).

For wells with any detected presence of LNAPL, a “mini-well” shall be constructed to allow the insertion of the sample pump into the water column of the affected well so that it does not come in contact with the LNAPL. The mini-well shall be constructed from new 2-inch inside diameter flush threaded polyvinyl chloride (PVC) tubing. Each section of PVC tubing shall be 10 feet or greater in length. A non-permeable barrier such as a non-lubricated latex condom, saran wrap, or other like material, shall be fastened on the lowermost section of tubing with a plastic zip tie, such that the opening is fully covered. The PVC shall then be lowered to at least five feet or greater below the measured depth of the LNAPL. When the final depth setting has been

[1] AMEC 2012. Performance Based Remediation Program Quality Assurance Project Plan and Standard Operating Procedures, Former Williams Air Force Base, Mesa, Arizona.

ED_005025_00013386-00724

reached, the top section of PVC shall be secured to the top of the monitoring well with a suitable clamping device.

A piercing device(s) (such as stainless steel skewers) shall then be placed on the sample pump such that when lowered into the mini-well it will pierce the protective barrier on the lowest most section of PVC. When sampling has been completed, the PVC shall be completely removed, labeled with the well identification, and decontaminated per the LNAPL procedures described in SOP No. 01, Equipment Decontamination. Also, while the sample pump and piercing devices should not come in contact with LNAPL using the mini-well approach, in order to conform to the most conservative decontamination procedures, both shall also be decontaminated per the LNAPL procedures described in SOP No. 01, Equipment Decontamination. The non-permeable barrier and the zip ties shall be disposed of as IDW per SOP No. 16, *Investigation-Derived Waste Management*.

4.0 DOCUMENTATION

Field notes will be kept in a bound field logbook as required by SOP No. 02, *Documentation of Field Activities* and on a Monitoring Well Purging Form (attached to SOP No. 2). The following information will be recorded on the Monitoring Well Purging Form using waterproof ink:

- Names of sampling personnel;
- Weather conditions;
- Project title;
- Location and well number;
- Date and time of sampling;
- Condition of the well;
- Initial and final static water level, total well depth;
- VOC vapor measurements;
- Method of purging;
- Volume of water purged before sampling;
- Purge start/stop times;
- Pumping rate, if applicable;
- Field parameter measurements during purging;
- Method of sample collection;
- Sample identification numbers;
- Photo documentation, if applicable;
- QA/QC samples collected; and
- Irregularities or problems.

Equipment decontamination and calibration information will be recorded in the field logbook.

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Former Williams Air Force Base

Standard Operating Procedure No. 12B
for
Horizontal Well Abandonment for Steam Treatment Zones

Prepared by:

AMEC
Environment & Infrastructure
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January 2014

TABLE OF CONTENTS

Page

1.0 PURPOSE AND SCOPE 1

2.0 PROCEDURE 1
- 2.1 Preparation 1
- 2.2 Materials 2
- 2.3 Well Abandonment 2
  - 2.3.1 Casing Perforation and Removal 2
  - 2.3.2 Grouting 3
  - 2.3.3 Surface Completion Removal 6

3.0 DOCUMENTATION 6

ATTACHMENTS

Attachment A – ADWR Well Abandonment Handbook

ACRONYMS AND ABBREVIATIONS

ADWR	Arizona Department of Water Resources
ft	feet
ft^3	cubic feet
NOI	Notice of Intent
SEE	steam enhanced extraction
SOP	Standard Operating Procedure

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1.0 PURPOSE AND SCOPE

The purpose of this Standard Operating Procedure (SOP) is to ensure that horizontal wells that are constructed of materials that are not compatible with the temperatures encountered with steam enhanced extraction (SEE) are properly decommissioned to minimize the potential pathway for preferential migration of steam, poor quality water, and contaminants, and thereby eliminate a possible hazard to human health and the environment.

This SOP applies to all personnel abandoning horizontal wells in preparation for SEE treatment. This SOP applies specifically to horizontal wells HW-1 and HW-2 that will be completely abandoned. This SOP describes the minimum acceptable practices. Specific state and local regulations must be reviewed to ensure different or more stringent requirements that may exist are met.

2.0 PROCEDURE

Information regarding the well condition, details of construction, total depth, current water level, and existence of any obstructions that could interfere with the process of filling and sealing the well will be determined prior to initiating abandonment procedures. Well construction diagrams will be obtained and reviewed. Downhole videos or photographs may be required to ascertain the current well condition and construction techniques used. Wells will be abandoned in accordance with state and local rules and regulations. Legal authorization from the Arizona Department of Water Resources (ADWR) is required to abandon most types of wells in the State of Arizona. The types of wells for which abandonment authority from the ADWR is required are described in the ADWR Well Abandonment Handbook in Attachment A. The process that must be followed to obtain well abandonment authority is also included in the body of the handbook. ADWR's well abandonment rule requires that well abandonment be accomplished "through filling or sealing the well, so as to prevent the well, including the annular space outside the casing, from being a channel allowing the vertical movement of water".

The following procedures will be followed to ensure the proper abandonment of horizontal wells.

2.1 Preparation

Prior to commencing the abandonment operations, a Notice of Intent (NOI) to abandon a well will be submitted to ADWR for each of the two registered wells and the NOIs will need to be approved by ADWR. Approved documentation of the procedures and materials used to abandon wells will be maintained on site during abandonment procedures.

Upon mobilization, the existing pump and pump output piping, as well as any other interior well materials, such as wiring, safety cables, or other casing will be removed. A borehole camera survey to observe the well interior will be performed to assure that the well is free of obstructions and is in a ready condition to continue with abandonment.

ED_005025_00013386-00728

2.2 Materials

The sealer materials to be used must be suitable for the high-temperature environmental that will be induced by the SEE. The specified high-temperature grout is a mixture of type G or H cement and silica flour, which is suitable for sealing small openings in the screen and casing, penetrating annular space outside of the screen and casing, and filling voids in the surrounding formation. When applied under pressure, it is effective for sealing wells under artesian pressure or those encountering more than one aquifer. Special care must be taken to ensure that upper groundwater zones are securely cased off during sealing of lower zones.

2.3 Well Abandonment

Abandonment of the wells will be in general conformance with Alternative Abandonment Method Number 3, described in the ADWR Well Abandonment Handbook, which is applicable to wells located in areas with water quality contamination issues. Additionally the top 20 feet (ft) of casing will follow the Surface Casing Non-Removal Option described in the Handbook. These methods and their applicability to these horizontal wells are described further in the following sections.

2.3.1 Casing Perforation and Removal

HW-1: The solid casing above the screened section is an 11-inch diameter steel riser that was placed inside an 18-inch diameter borehole. There is no record of how the annulus around the casing was backfilled during construction of the well. Therefore the casing will be perforated prior to filling with cement grout as follows:

1. Set up the rig on the bore. Adjust rig mast angle to match well entry angle.
2. Set a mechanical or pneumatic pipe perforator at the base of the solid casing, and make three to four columns of perforations in the steel riser from this point, back towards the wellhead up to 2 ft below ground surface. Each column of perforations will have approximately five perforations per foot. Each perforation is from 1/16 inch to 1/8 inch in width and approximately one inch in length. This operation will perforate the solid riser pipe between the screened interval and the ground surface, ensuring that grout enters any non-collapsed borehole annulus that may remain around the well casing.
3. Remove perforator.
4. Excavate to expose, cut and remove casing to a minimum depth of 2 ft below grade.

HW-2: The solid casing above the screened section of HW-2 includes a solid 8 5/8-inch diameter steel casing and an inner 5-inch stainless steel riser. The annulus outside of the outer casing was incased in cement grout during construction, therefore the outer casing will not be perforated. The inner riser, however, will be perforated as follows to enable grout to enter the void space between the inner and outer casings:

1. Set up the rig on the bore. Adjust rig mast angle to match well entry angle.

ED_005025_00013386-00729

2. Set a mechanical or pneumatic pipe perforator at the base of the inner riser pipe and make 3-4 columns of perforations in the steel riser from this point, back towards the wellhead up to 2 ft below ground surface. Each column of perforations will have approximately five perforations per foot. Each perforation is from 1/16 inch to 1/8 inch in width and approximately one inch in length. This operation will perforate the solid inner riser pipe between the screened interval and the ground surface, ensuring that grout enters any void space between the inner and outer risers.
3. Remove Perforator.
4. Excavate to expose, cut and remove casing to a minimum depth of 2 ft below grade.

2.3.2 Grouting

The wells must be completely filled with high temperature grout. Materials or mixtures must be emplaced under sufficient pressure to fill all voids.

1. In order to properly fill the horizontal section of the well with high-temperature grout, the drilling contractor will advance drill rods with a downhole grouting tip from the open casing end to the full length of the bore. The rods will be used as a tremie pipe to ensure that continuous grouting is performed for the full length of the well.
2. The drill rods will then be connected to high pressure grout pumps provided by the grouting subcontractor. The grouting subcontractor will then pump grout through the rods to the far end of the horizontal section of the well. For HW-1, additional pressure will be added at the beginning in attempts to push grout past the end of the screened section into the exit portion of the original borehole that was backfilled with sand during construction.
3. Commence grouting while withdrawing drill rods. The grout pumping will be conducted in segments based on a pre-determined volume for the segment. These calculations will be performed by a qualified geologist or licensed well driller. These calculations will be recorded in the field logbook. After the pre-determined volume of grout has been pumped for a section, drill rods will be withdrawn from the well. This process will be repeated until the entire well has been grouted. The rods will be cleaned and stacked as they are removed. The well will be grouted in a single operation, from the screened section to the surface. Since the screened section is over 200 ft below the ground surface, the grout in this section will be subject to substantial static head pressure, pushing the grout through the casing perforations into any available void spaces that may exist.

   Calculations will be made to determine the estimated volume of high-temperature grout needed prior to abandonment. Calculations will assume all voids inside the wells and all pore space outside the well within the diameter of the borehole will be filled with grout. The following formulas will be used:

Horizontal Section of Well (to be used for each well):

$$V_{GH} = \pi(D_S/2)^2L + P_s \{\pi[(D_{SP}/2)^2 - (D_S/2)^2]L\} + P_G \{\pi[(D_{HB}/2)^2 - (D_{SP}/2)^2]L\}$$

Where:

V_{GH}	=	Volume of grout the horizontal section (cubic feet [ft^3])
L	=	Length of section (ft)
D_S	=	Diameter of screen (ft)
D_{SP}	=	Diameter of sand-pack (ft)
D_{HB}	=	Diameter of original horizontal borehole (ft)
P_s	=	Porosity of sandpack (assume 0.45)
P_G	=	Porosity of surrounding soil (assume 0.3)

Vertical Section of Well HW-1 (applicable for the angled and curved portion of the well):

$$V_{GV} = \pi(D_C/2)^2L + P_G \{\pi[(D_{VB}/2)^2 - (D_C/2)^2]L\}$$

Where:

V_{GV}	=	Volume of grout for the vertical section (ft^3)
L	=	Length of section (ft)
D_C	=	Diameter of casing (ft)
D_{VB}	=	Diameter of original vertical borehole (ft)
P_G	=	Porosity of surrounding soil (assume 0.3)

Vertical Section of Well HW-2 (applicable for the angled and curved portion of the well):

$$V_{GV} = \pi(D_{R1}/2)^2L + \{\pi[(D_C/2)^2 - (D_{R2}/2)^2]L\}$$

Where:

V_{GV}	=	Volume of grout for the vertical section (ft^3)
L	=	Length of section (ft)
D_{R1}	=	Inside diameter of inner riser (ft)
D_{R2}	=	Outside diameter of inner riser (ft)
D_C	=	Inside of outer casing (ft)

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The following tables present the range of anticipated volumes of grout required for each foot for both the horizontal and vertical portions of HW-1 and HW-2:

	Horizontal Section		
	Units	**HW-1**	**HW-2**
L	ft	1	1
D_s	ft	0.50	0.34
D_{SP}	ft	0.90	0.45
D_{HB}	ft	1.50	0.66
P_s		0.45	0.45
P_G		0.30	0.30
Calculated Volume	ft^3	0.73	0.17
Minimum Volume	ft^3	0.20	0.09
Maximum Volume	ft^3	1.77	0.34

Notes:

1. The minimum volumes assume that only the inside of the screen would be filled with grout. The maximum volumes assume that the entire volume of the original borehole would be filled.

ft = feet
ft^3 = cubic feet

	Vertical Section		
	Units	**HW-1**	**HW-2**
L	ft	1	1
D_c	ft	0.90	0.72
D_{R1}	ft	N/A	0.42
D_{R2}	ft	N/A	0.46
D_{VB}	ft	1.50	N/A
P_G		0.30	N/A
Calculated Volume	ft^3	0.97	0.38
Minimum Volume	ft^3	0.63	0.31
Maximum Volume	ft^3	1.77	0.41

Notes:

1. The minimum volume for HW-1 assumes that only the inside of the casing would be filled the grout. The maximum volume for HW-1 assumes that the entire volume of the original borehole would be filled.
2. The thickness of the inner riser of HW-2 is unknown. The calculated volume assumes that the thickness is 0.25 inches. The minimum volume assumes that the pipe is 1-inch thick and that it would be filled both inside and outside. The maximum volume assumes the thickness of the inner pipe is negligible, and that the entire outer casing will be filled.

ft = feet
ft^3 = cubic feet

The above volumes will be compared to the actual amount of material used. If the amount used is less than the calculated amount, the Project Geologist will be required to evaluate the cause of the discrepancy and whether additional actions are warranted.

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4. Backfill the excavated area around the cut casing end with grout, to an elevation above the end of the cut-off pipe. At the base of the surface excavation excavate or, alternatively, form up with plywood or other forms or bulkheads, a small receptacle at the end of the cut riser pipe. This contained area will be constructed with a volume of approximately one cubic yard of grout to cap the end of the pipe and the surrounding area. This volume will be placed as the grouting operation in the well itself is completed. Allow time for settlement, and top off grout the following day to cover exposed pipe annulus.
5. Backfill the remaining excavated trench with compacted soil, using a backhoe or excavator and a plate compactor.

All information regarding horizontal well abandonment including calculated volumes versus actual grout used must be recorded in the field logbook.

2.3.3 Surface Completion Removal

The well pad, bollards, and any other surface materials will be removed to a minimum of 3 ft below grade. If necessary, clean fill material will be added to bring the ground surface to the same grade as the surrounding materials. The ground surface will be replaced to match the surrounding ground conditions (e.g., gravel driving surface).

3.0 DOCUMENTATION

Approved Abandonment NOI forms will be onsite during implementation of the work and abandonment completion reports will be filed within 30 days of completing the work.

All abandonment procedures will be documented in accordance with SOP No. 02, *Documentation of Field Activities.*

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ATTACHMENT A
ADWR WELL ABANDONMENT HANDBOOK

SECURING ARIZONA'S WATER FUTURE

ADWR

ARIZONA DEPARTMENT OF WATER RESOURCES

WELL ABANDONMENT HANDBOOK

SEPTEMBER 2008

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WELL ABANDONMENT HANDBOOK

September 2008

Janet Napolitano, Governor
State of Arizona

Herbert R. Guenther, Director
Arizona Department of Water Resources

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September 25, 2008

Janet Napolitano
Governor

Herbert R. Guenther
Director

SUBSTANTIVE POLICY STATEMENT WELL ABANDONMENT HANDBOOK

I. BACKGROUND

The Arizona Department of Water Resources ("Department") is required by Arizona Revised Statute (A.R.S.) § 45-594(A) to adopt rules establishing construction standards for wells, including the abandonment of existing wells. The Department adopted such rules effective March 5, 1984, and amended the rules effective June 18, 1990. The well abandonment rule is set forth in Arizona Administrative Code ("A.A.C.") R12-15-816.

Pursuant to A.A.C. R12-15-816(G), the Department's well abandonment rule requires that the abandonment of a well be accomplished "through filling or sealing the well so as to prevent the well, including the annular space outside the casing, from being a channel allowing the vertical movement of water." Although the rule specifies the materials that must be used to fill or seal the well if it penetrates a single or multiple aquifer, the rule does not specify the materials that should be used if the well does not penetrate an aquifer or if groundwater or vadose zone contamination exists at or near the well site. Additionally, the rule does not prescribe a method for emplacing fill or seal materials in a well to ensure that water does not move vertically through the well after abandonment.

The Director has determined that the Department should provide additional written guidance to the public on well abandonment. The purpose of the written guidance is not to change any of the requirements in the Department's well abandonment rule or to impose any additional requirements. Instead the written guidance is intended to assist well owners and well drillers in complying with A.A.C. R12-15-816(G) by informing them of fill materials and emplacement methods the Department considers to be adequate to seal a well in a manner that will prevent the well from being a channel allowing the vertical movement of water under various aquifer and vadose zone conditions. By following the written guidance, a person will be assured of complying with A.A.C. R12-15-816(G).

II. WELL ABANDONMENT THAT CONFORMS WITH THE APPLICABLE PROCEDURES IN THE ATTACHED WELL ABANDONMENT HANDBOOK WILL BE DEEMED TO BE IN COMPLIANCE WITH A.A.C. R12-15-816(G)

To assist well owners and well drillers in complying with A.A.C. R12-15-816, the Director issues the attached Well Abandonment Handbook as a substantive policy statement. The Handbook sets forth procedures for abandoning a well under most aquifer and vadose zone conditions, including special conditions not addressed in the Department's well abandonment rule. A person who abandons a well in conformance with the applicable procedures outlined in the Handbook will be deemed to be in compliance with A.A.C. R12-15-816(G).

III. EFFECTIVE DATE

This substantive policy statement rescinds and replaces the previous substantive policy statement dated September 20, 2001, and shall become effective immediately. The Director may modify or revoke this policy at any time.

Dated this 3rd day of October, 2008.

Herbert R. Guenther
Director
Arizona Department of Water Resources

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Table of Contents

I. Introduction 1

II. Overview of the Well Abandonment Process 2

III. Surface Seal Requirements Applicable to the Upper 20 Feet of All Wells to be Abandoned and Special Requirements for Debris-Filled or Obstructed Wells 5

A. Surface Seal Requirements 5

Surface Casing Removal Option 5

Surface Casing Non-Removal Option 5

B. Special Requirements for Debris Filled or Obstructed Wells 5

IV. Abandonment Methods 5

A. Standard Abandonment Method 5

B. Alternative Abandonment Methods 6

Alternative 1 – *Applies to wells that do not penetrate aquifers, including wells that have gone dry, and no vadose zone contamination issues exist* 6

Alternative 2 – *Applies to wells that do not penetrate aquifers, including wells that have gone dry, and vadose zone contamination issues exist* 6

Alternative 3 – *Applies to wells that penetrate single or multiple aquifers, and water quality contamination issues exist* 6

Alternative 4 – *Applies to wells that penetrate a single aquifer only without vertical flow components, and no water quality contamination issues exist* 8

Alternative 4 (Variance Option) 8

Alternative 5 – *Applies to wells that penetrate single or multiple aquifers with vertical flow components, and no water quality* 9

Alternative 5 (Variance Option 1) 9

Alternative 5 (Variance Option 2) 9

References 12

APPENDIX A – A.A.C. R12-15-816, The ADWR Well Abandonment Rule 13

APPENDIX B – Definitions 15

APPENDIX C – Questions and Answers about the Abandonment Handbook 19

Figure 1 Well Abandonment Process 4

Figure 2 Alternative Abandonment Methods Applicable to Five Commonly Occurring Vadose Zone and Aquifer Conditions 7

Table 1 Acceptable Well Abandonment Materials and Mixtures 11

ED_005025_00013386-00739

I. Introduction

The Arizona Department of Water Resources ("ADWR") regulates the abandonment of wells in Arizona. ADWR adopted a rule setting forth requirements for well abandonment in 1984 and amended the rule in 1990. The amended rule is published in the Arizona Administrative Code ("A.A.C.") as Rule R12-15-816. A copy of the rule is attached to this Handbook as Appendix A.

ADWR's well abandonment rule requires that well abandonment be accomplished "through filling or sealing the well so as to prevent the well, including the annular space outside the casing, from being a channel allowing the vertical movement of water." A.A.C. R12-15-816(G). The rule prescribes the fill materials that must be used in certain aquifer conditions. A.A.C. R12-15-816(H). The rule also requires the filing of a pre-abandonment notice with ADWR (unless the well is a new well being abandoned in the course of drilling the well) and the filing of post-abandonment reports. A.A.C. R12-15-816(B), (E) and (F).

The purpose of this Handbook is to provide a step-by-step guide to the abandonment of a well in a manner that complies with ADWR's well abandonment rule. The Handbook describes the abandonment process from the filing of a Notice of Intention to Abandon with ADWR prior to commencing abandonment, to the filing of post-abandonment reports by the well owner and well driller. Most importantly, the Handbook describes procedures that may be used to adequately abandon a well, including fill materials and emplacement methods.

A standard abandonment method is described that may be used for any well, regardless of the aquifer and vadose zone conditions applicable to the well. Five alternative abandonment methods are also described for five different vadose zone and aquifer conditions. In most cases, the alternative abandonment method will be less expensive than the standard method. However, a well owner may need to demonstrate to ADWR that the well to be abandoned falls within the condition to which the alternative method applies before that method may be used. For that reason, the abandonment process may take longer if an alternative abandonment method is requested.

The well abandonment methods described in this Handbook are presented in much greater detail than in ADWR's well abandonment rule. However, the Handbook is not intended to change any of the requirements in the rule or to impose any additional requirements. The purpose of including the abandonment methods in the Handbook is to assist well owners and well drillers in complying with A.A.C. R12-15-816(G) by informing them of fill materials and emplacement methods ADWR considers to be adequate to seal a well in a manner that will prevent the well from being a channel allowing the vertical movement of water. A person who abandons a well in accordance with the applicable well abandonment method described in this Handbook will be assured of complying with A.A.C. R12-15-816(G).

The next section presents an overview of the abandonment process. Section III describes surface seal requirements for the upper 20 feet of all wells and special requirements for debris-filled or obstructed wells. Section IV describes the standard abandonment method and the five alternative methods. Appendix B contains definitions of terms used in this Handbook and Appendix C contains questions and answers regarding this Handbook.

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II. Overview of the Well Abandonment Process

Legal authorization from the ADWR is required to abandon most types of wells in the State of Arizona. The types of wells for which abandonment authority from ADWR is required are described in the question and answer section of this Handbook (Appendix C).

The process that must be followed to obtain well abandonment authority starts with the filing of a notice of intention to abandon a well (NOIA) (see Figure 1). NOIA forms may be obtained from the ADWR Groundwater Management Support Section office in Phoenix, or at local ADWR offices located in Prescott, Casa Grande, Tucson and Nogales. The NOIA form must be signed and filed by the well owner. However, the licensed well driller or a consultant may assist the well owner in filling out and filing the NOIA.

Information that must be submitted in the NOIA form includes the following:

- A well construction diagram showing all existing well construction features and the proposed abandonment specifications.
- A description of the type and condition of the casing. Although this information may not be completely known prior to abandonment, this description should be a "best estimate" of the conditions.
- A description of the proposed method of abandonment. The casing removal techniques (such as pulling by hydraulic jacks, overdrilling, etc.), or casing non-removal techniques (such as casing perforations, brushing, sonar jetting, etc.) must be described. If the casing is to be perforated, the perforation method, size, and intervals to be perforated must be described.
- A description of the method of emplacing the sealing or fill materials (such as "tremie pumped" or "pressure grouting", etc.).
- The specific type and estimated amount of grout material to be used, and the ratios of water, cement, and/or other grout materials.

If the well owner or well driller has any questions during the abandonment planning stages prior to submittal of the NOIA, it is recommended that they contact the ADWR Hydrology Division. ADWR will gladly work with the well owner or well driller to answer any questions and conduct a preliminary review of the proposed abandonment plan. ADWR may be contacted at:

602-771-8500
(Phoenix metro area)

1-800-352-8488
(outside metro Phoenix)

After the NOIA is filed, ADWR performs a completeness review of the notice (See Figure 1). The completeness review entails the examination of the NOIA to determine if all required information has been properly submitted. After the ADWR determines that the NOIA is complete, a substantive review is performed to determine whether the proposed abandonment methods and materials meet the requirements of the ADWR well abandonment rule (See Figure 1). If the standard method of abandonment described on page 5 of this Handbook is selected, which may be used for any well regardless of the aquifer and vadose zone conditions applicable to the well, the NOIA will be approved without further review.

If an alternative abandonment method is selected, the NOIA will receive additional substantive review to determine whether the

ED_005025_00013386-00742

well falls within the condition to which the alternative method applies and whether appropriate fill materials were chosen. During the review process ADWR may contact the well owner to request additional information or discuss modifications to the proposed abandonment plan, if necessary.

Once the proposed well abandonment methods and materials meet the requirements of the abandonment rule, a well abandonment authorization card is mailed to the designated well driller and well abandonment operations may begin (See Figure 1).

Within 30 days after a well is abandoned, the well owner is required to file a Well Owner's Notification of Abandonment; and the well drilling contractor is required to file a Well Abandonment Completion Report with ADWR which describes the actual methods and materials used to abandon the well (See Figure 1). Information that must be submitted in the Well Abandonment Completion Report includes the following:

- The specific type and amount of grout and/or fill materials used as well as the mixing ratio of water, cement and/or other grout materials used.
- A description of the type and condition of the casing.
- A description of the actual method of abandonment. The casing removal techniques (such as pulling by hydraulic jacks, overdrilling, etc.), or casing non-removal techniques (such as casing perforations, brushing, sonar jetting, etc.) must be described. If the casing was perforated, the perforation method, size, and intervals must be described.
- A description of the method of emplacing the sealing or fill materials (such as "tremie pumped" or "pressure grouting", etc.).
- The latitude, longitude and well elevation of the abandoned well, and the method used to determine these data. Latitude and longitude coordinates determined from readily available Global Positioning System (GPS) equipment are preferred because of the high level of accuracy and comparative ease of measurement. If GPS equipment is used to determine these coordinates, the general grade of equipment should be specified (for example: survey grade or hand-held). Latitude, longitude and well elevation coordinates may also be obtained from conventional surveying methods or through estimation from a topographic map.

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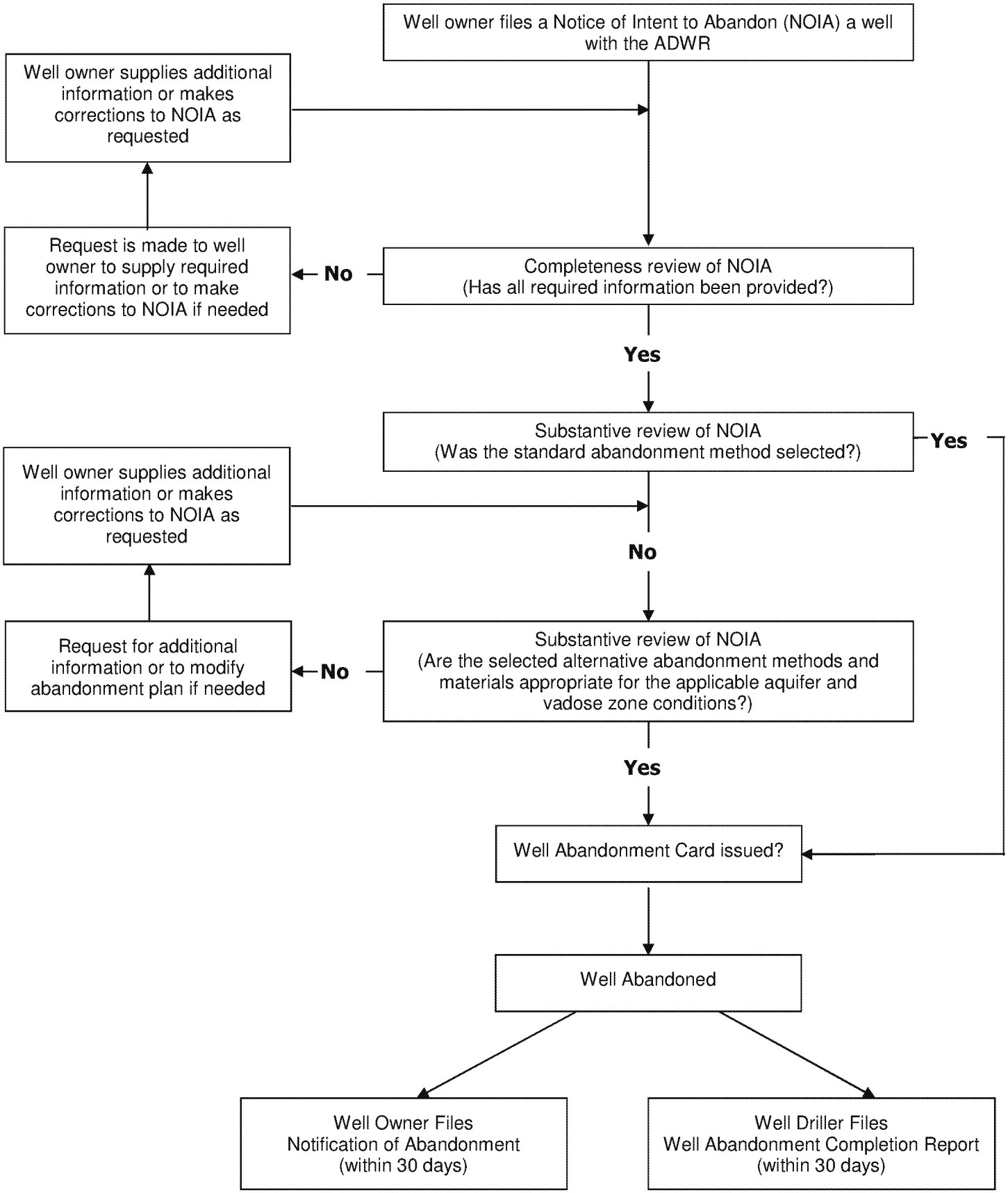
Figure 1
Well Abandonment Process



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III. Surface Seal Requirements Applicable to the Upper 20 Feet of All Wells to be Abandoned and Special Requirements for Debris-Filled or Obstructed Wells

In addition to the well sealing and abandonment methods and materials that are discussed in the following section, ADWR's well abandonment rule requires a cement grout surface seal (plug) to be installed in the upper 20 feet of any well that is abandoned. Special requirements may also be necessary if casing obstructions and/or debris hamper the abandonment of a well. These requirements are described below:

A. Surface Seal Requirements

Surface Casing Removal Option

If the casing is removed from the top 20 feet of the well, a cement grout plug must be set extending from two feet below the land surface to a minimum of twenty feet below the land surface, and the well must be backfilled above the top of the cement grout plug to the original land surface.

Surface Casing Non-Removal Option

If the casing is not removed from the top 20 feet of the well, a cement grout plug must be set extending from the top of the casing to a minimum of twenty feet below the land surface, and the annular space outside the casing must be filled with cement from the land surface to a minimum of twenty feet below the land surface.

B. Special Requirements for Debris Filled or Obstructed Wells

In situations where casing obstructions and/or debris hamper well abandonment, the problems should be indicated on the NOIA form. In most instances a reasonable attempt to clear debris and obstructions from the well will be required. However, site-specific conditions will determine the actual method of abandonment.

IV. Abandonment Methods

A. Standard Abandonment Method

The ADWR standard abandonment method meets the requirements of ADWR's well abandonment rule under any given combination of aquifer and vadose zone conditions. The standard abandonment method may be followed to obtain expedited processing of an NOIA and issuance of a well abandonment authority.

Under the standard abandonment method, the entire length of well casing must be removed or the entire length of the casing must be reperforated (from 20 feet above the highest historic water level to the total depth of the well) with a minimum of two cuts per foot. If it is determined that the disturbance of the casing and/or gravel packed zones would negatively influence the sealing of the well, then an appropriate alternative abandonment method must be used (see Figure 2 for examples).

The well must be completely filled with neat cement, cement-bentonite grout or, except where free-product contamination is present, high-solids bentonite grout (granular or powder mixtures) with a minimum of 25% solids by weight. Materials or mixtures must be emplaced under sufficient pressure to fill all voids, including all annular space(s), and displace water from the well. A tremie pipe must be used to emplace the grout from the bottom up. The end of the tremie pipe must remain in close proximity to the rising grout surface, as the grout is pumped into the well.

In order to receive expedited processing, the NOIA should be filled out completely, and the "Standard method" should be selected in the proposed well abandonment method section of the NOIA form. The specific type

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and estimated volume of grout material should be specified on the NOIA form. Any discrepancies between the estimated volume of grout to be used, and the actual amount of grout that was used for abandonment should be reported and explained on the Well Abandonment Completion Report.

B. Alternative Abandonment Methods

There are five alternatives to the standard abandonment method described above. Each alternative method is designed for a different vadose zone or aquifer condition, and only one alternative method is appropriate for a specific well. The conditions described at the beginning of each alternative and the depictions in Figure 2 should be carefully reviewed to determine the appropriate alternative method if the standard abandonment method is not selected. If an alternative method is selected, the method must be identified by number in the NOIA and the well owner may be required to submit information demonstrating that the applicable vadose zone or aquifer conditions exist for the well.

Alternative 1 – *Applies to wells that do not penetrate aquifers, including wells that have gone dry, and no vadose zone contamination issues exist.*

If the well does not penetrate an aquifer or has gone dry, and vadose zone contamination issues do not exist, the well must be filled with one or more of the following materials or mixtures: clean fine sand, cement grout (including neat cement grout, cement-bentonite grout and sand-cement grout), concrete grout, sand-bentonite grout, high-solids bentonite grout (granular or powder mixtures) with a minimum of 15% solids by weight, high-solids bentonite chips or high-solids bentonite pellets. See Table 1 for mixing ratios. High-solids bentonite chips and high-solids bentonite pellets must be hydrated to manufacturer's specifications. The materials or mixtures are recommended to exceed the casing volume by approximately 30 percent.

In the course of drilling a new well, the well may be abandoned using drill cuttings from the well being drilled if the well does not penetrate an aquifer, and no vadose zone contamination issues exist.

Alternative 2 – *Applies to wells that do not penetrate aquifers, including wells that have gone dry, and vadose zone contamination issues exist.*

If the well does not penetrate an aquifer or has gone dry, and vadose zone contamination issues exist, but there is no free-product contamination, the well must be filled with one or more of the following materials or mixtures: cement grout (including neat cement grout, cement-bentonite grout and sand-cement grout), concrete grout, sand-bentonite grout, high-solids bentonite grout (granular or powder mixtures) with a minimum of 15% solids by weight, high-solids bentonite chips or high-solids bentonite pellets. See Table 1 for mixing ratios. High-solids bentonite chips and high-solids bentonite pellets must be hydrated to manufacturer's specifications. The materials or mixtures are recommended to exceed the casing volume by approximately 30 percent.

If free-product contamination issues exist, the entire well must be sealed with neat cement grout.

Alternative 3 – *Applies to wells that penetrate single or multiple aquifers, and water quality contamination issues exist.*

If the well penetrates a single or multiple aquifer system and water quality contamination issues exist, then site-specific conditions will determine the appropriate seal material and emplacement method. The seal material must be no more permeable than the formation being sealed. A target

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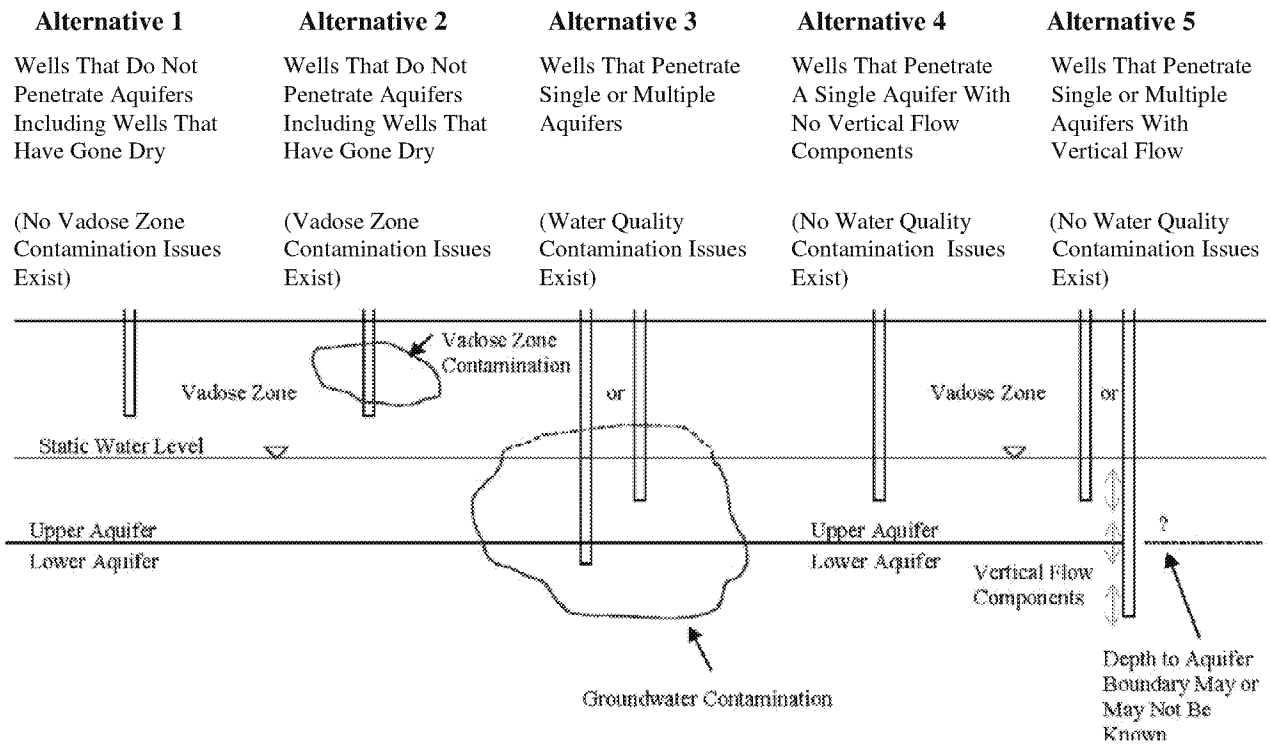
Figure 2
Alternative Abandonment Methods Applicable to Five Commonly Occurring Vadose Zone and Aquifer Conditions



hydraulic conductivity of 10^{-7} cm/s may be used for sealant materials. The types of acceptable materials or mixtures are: cement grout (including neat cement grout and cement bentonite grout), high-solids bentonite grout (granular or powder mixtures) with a minimum of 15% solids by weight, high-solids bentonite chips or high-solids bentonite pellets. See Table 1 for mixing ratios. A minimum of 15% bentonite solids will be acceptable in most cases. However, a higher minimum of bentonite solids may be required in areas of high water quality contamination. Acid resistant cement (see definitions) may be required in certain areas where corrosive (low pH) groundwater conditions are encountered. The materials or mixtures are recommended to exceed the casing volume by approximately 30 percent.

If there is no free-product contamination at the well site, the vadose zone portion of the well may be sealed with the same material that is used to seal the well below the water level. High-solids bentonite chips and high-solids bentonite pellets must be hydrated to manufacturer's specifications if used in the vadose zone. If free-product contamination issues exist, the vadose zone portion of the well must be sealed with neat cement grout.

Materials or mixtures must be emplaced under sufficient pressure to fill all voids, including all annular space(s), and displace water from the well. A tremie pipe must be used to emplace the grout from the bottom up. The end of the tremie pipe shall remain in close proximity to the rising grout surface as the grout is pumped into the well.

Except as provided below for recently constructed monitor wells, if the casing is not removed, either the entire length of the casing must be reperforated (from 20 feet

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above the highest historic water level to the total depth of the well), or the condition of the casing perforations must be determined by running a video log that must be submitted to the ADWR for review. If a video log demonstrates that the existing perforations are sufficiently open for grout to enter the annular space outside the casing, no additional perforations or casing treatments will be required. If the video log demonstrates that the existing perforations are not sufficiently open for grout to enter the annular space outside the casing, additional perforations and/or casing treatments such as mechanical brushing, scraping or sonic cleaning will be required, unless it is determined that disturbance of the casing and/or gravel packed zones would negatively influence the sealing of the well. Casing perforation and/or casing cleaning requirements for wells with water quality contamination issues will be made by ADWR on a case-by-case basis.

Wells requiring additional perforations must be perforated a minimum of two cuts per foot and sealed by pressure grouting. The intervals to be perforated must be determined based on site-specific information. However, if no vadose zone contamination issues exist, the perforations need only extend 20 feet above the static water level in the well.

Video logging and/or casing re-perforation may not be required in the case of the abandonment of recently constructed monitor wells. However, that determination must be made by ADWR on a case-by-case basis.

Alternative 4 – *Applies to wells that penetrate a single aquifer only without vertical flow components, and no water quality contamination issues exist.*

If the well penetrates an aquifer and hydrogeologic and stratigraphic information is available for the well at an acceptable level of confidence to determine that no aquifer boundaries and no vertical flow components exist within the length of the well, and if water quality contamination issues do not exist, the well must be filled with one or more of the following materials or mixtures: cement grout (including neat cement grout, cement-bentonite grout and sand-cement grout), concrete, high-solids bentonite grout (granular or powder mixtures) with a minimum of 15% solids by weight, high-solids bentonite chips, high-solids bentonite pellets, and sand-bentonite grout. See Table 1 for mixing ratios.

In the course of drilling a new well, the well may be abandoned using drill cuttings from the well being drilled if the well does not penetrate an aquifer, and no vadose zone contamination issues exist.

The vadose zone portion of these types of wells may be filled with any of the mixtures or materials described above or allowed in Alternative 1. High-solids bentonite chips and high-solids bentonite pellets must be hydrated to manufacturer's specifications if used in the vadose zone. The materials or mixtures are recommended to exceed the casing volume by approximately 30 percent.

Materials or mixtures must be emplaced under sufficient pressure to fill all voids, including all annular space(s), and displace water from the well. A tremie pipe must be used to emplace the grout from the bottom up. The end of the tremie pipe shall remain in close proximity to the rising grout surface as the grout is pumped into the well.

Alternative 4 (Variance Option)

A variance option is available to abandon wells that are 8 inches or greater in diameter and that fall under Alternative 4 aquifer conditions. Alternative 4 (Variance Option) allows the use of clean fine sand to fill the well.

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Please note that anyone wishing to use this alternative abandonment method must first apply to ADWR for a variance from the well abandonment rule.

Alternative 5 – *Applies to wells that penetrate single or multiple aquifers with vertical flow components, and no water quality contamination issues exist.*

If the well penetrates a single or multiple aquifer system with vertical flow components, and if water quality contamination issues do not exist, the well must be sealed to prevent the vertical migration of fluids with cement grout (including neat cement grout, cement-bentonite grout and sand-cement grout), high-solids bentonite grout (granular or powder mixtures) with a minimum of 15% solids by weight, high-solids bentonite chips or high-solids bentonite pellets of sufficient volume, density, and viscosity to prevent fluid communication between aquifers. See Table 1 for mixing ratios.

The vadose zone portion of this type of well may be filled with any of the mixtures or materials described above or allowed in Alternative 1. High-solids bentonite chips and high-solids bentonite pellets must be hydrated to manufacturer's specifications if used in the vadose zone. The materials or mixtures are recommended to exceed the casing volume by approximately 30 percent.

Materials or mixtures must be emplaced under sufficient pressure to fill all voids, including all annular space(s), and displace water from the well. A tremie pipe must be used to emplace the grout from the bottom up. The end of the tremie pipe shall remain in close proximity to the rising grout surface as the grout is pumped into the well.

If the casing is not removed, it is recommended, but not required, that the condition of the casing perforations be determined by running a video log. If the video log demonstrates that the existing perforations are sufficiently open for grout to enter the annular space between the casing and the well bore, no additional perforations or casing treatments are necessary. If the video log demonstrates that the existing perforations are not sufficiently open for grout to enter the annular space outside the casing, additional perforations and/or casing treatments such as mechanical brushing, scraping or sonic cleaning are recommended, unless it is determined that disturbance of the casing and/or gravel packed zones would negatively influence the sealing of the well. A well requiring additional perforations should be perforated a minimum of two cuts per foot and sealed by pressure grouting.

Alternative 5 (Variance Option 1)

Alternative 5 (Variance Option 1) is available to abandon wells that are 8 inches or greater in diameter and that fall under Alternative 5 aquifer conditions. Alternative 5 (Variance option 1) allows the use of alternating layers of 50 feet of clean, fine sand and 10 feet of one of the approved Alternative 5 materials or mixtures mentioned above.

Please note that anyone wishing to use this alternative abandonment method must first apply to ADWR for a variance from ADWR's well abandonment rule.

Alternative 5 (Variance Option 2)

Alternative 5 (Variance Option 2) is available to abandon wells that are 8 inches or greater in diameter and that fall under Alternative 5 aquifer conditions. Alternative 5 (Variance Option 2) allows the installation of seals at aquifer boundaries if boundaries exist and if hydrogeologic and stratigraphic information is available for the well at an acceptable level of confidence to determine the depth(s) of aquifer boundaries. Aquifer boundary seals must be composed of one of the approved Alternative 5 materials or mixtures mentioned above.

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Aquifer boundary seals must extend at least 50 feet above and 50 feet below aquifer boundaries to provide a reasonable level of confidence that the boundaries will be sealed. The intervals of the well above and below the seals must be filled with clean, fine sand or one of the approved Alternative 5 materials or mixtures mentioned above.

Please note that anyone wishing to use this alternative abandonment method must first apply to ADWR for a variance from ADWR's well abandonment rule.

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Table 1
Acceptable Well Abandonment Materials and Mixtures

Category	Specific Material	Mixing Ratio		Permeability (cm/sec)	Applicable Abandonment Methods	Special Considerations
		Solids	Water			
Cement, Sand, Concrete & Bentonite Mixtures [1]	Neat Cement **or** Neat Cement Grout	One 94 pound sack of cement	Not more than six (6) gallons water	10^{-5} To 10^{-7}	Standard Method and Alts. 1-5	Must be pumped with tremie pipe. Not for use in low pH environments.
	Concrete **or** Concrete Grout	Cement, sand and aggregate with no less than seven (7) 94 lb. sacks of cement per cubic yard of concrete	Not more than seven (7) gallons water per sack of cement	—	Alts. 1,2,4,5	Cannot be used under Alternative 2 if free-product contamination issues exist.
	Sand-Cement Grout	One part cement and no more than one part sand by volume	Not more than six (6) gallons water	$2x10^{-5}$ to $5x10^{-8}$	Alts. 1,2,4,5	Cannot be used under Alternative 2 if free-product contamination issues exist.
	Cement-Bentonite Grout	One sack of cement (94 lb.) & 3-5 lbs. bentonite	Not more than six and one-half (6.5) gallons water	10^{-5} to 10^{-11}	Standard Method and Alts. 1-5	Cannot be used under Alternative 2 if free-product contamination issues exist. Also cannot be used in vadose zone portion of an Alternative 3 well if free-product contamination issues exist.
	Sand-Bentonite Grout	Equal parts sand and bentonite by volume	Slightly more than one (1) gallon water per pound of sand	—	Alts. 1,2,4	May be difficult to pump; the sand may be dumped into place while the bentonite slurry is pumped via tremie pipe. Cannot be used under Alternative 2 if free-product contamination issues exist.
	Acid Resistant Cement (Pozzolanic Cement)	One sack of cement (94 lb.) and seventy-four (74) lbs. pozzolans (fly-ash, perlites, etc.) 2% to 6% of bentonite by weight is needed if perlites are used	Not more than ten (10) gallons of water per sack of cement	—	See special considerations	Typically used in areas where low pH groundwater is encountered. If perlites are used bentonite is needed to keep perlites from floating. Chemical admixtures and plastizers may be used to reduce viscosity.
Well Cuttings	Clean cuttings from the well being drilled and abandoned	NA	NA	—	Alts. 1,4	Only permissible for wells that do not penetrate aquifers or wells that only penetrate a single aquifer with no vertical flow components. No vadose zone and no water quality contamination issues may exist.
Forms of Bentonite [1,2]	High-Solids Bentonite Grout (powder or granular mixture) with a minimum 15% solids by weight Minimum grout density = 9.2 lbs./gallon	Fifty (50) lbs. dry bentonite powder (powder mixture) **or** One hundred fifty (150) lbs. granular bentonite & 1 qt. Polymer (granular mixture)	Thirty–four (34) gallons (powder mixture) **or** One hundred (100) gallons (granular mixture)	10^{-7} to 10^{-8}	Alts. 1-5	A minimum of 15% solids bentonite will be acceptable in most cases. However, a higher minimum of bentonite solids may be required in areas of high water quality contamination. Cannot be used under Alternative 2 if free-product contamination issues exist. Also cannot be used in vadose zone portion of an Alternative 3 well if free-product contamination issues exist. Granular mixtures generally require the addition of polymers.
	High-Solids Bentonite Grout (powder or granular mixture) with a minimum 25% solids by weight Minimum grout density = 10.0 lbs./gallon	Fifty (50) lbs. dry bentonite powder (powder mixture) **or** One hundred fifty (150) lbs. granular bentonite & 1 qt. Polymer (granular mixture)	Eighteen (18) gallons (powder mixture) **or** Fifty-four (54) gallons (granular mixture)	10^{-8} to 10^{-9}	Standard Method	Cannot be used if free-product contamination issues exist. Granular mixtures generally require the addition of polymers.
	High-Solids Bentonite Chips and Pellets	NA	NA	—	Alts. 1-5	Rate of pour should not exceed 50 lbs. / 5 minutes. Must be hydrated to manufacturer's specifications if used in vadose zone. Cannot be used under Alternative 2 if free-product contamination issues exist. Also cannot be used in vadose zone portion of an Alternative 3 well if free-product contamination issues exist.

Notes: 1) Additives will be considered on a case by case basis (i.e., fly ash, CaCl, etc.).
2) Manufacturer's specifications should be followed to achieve a minimum 15% and 25% solids mixtures–mixing ratios listed in this table are approximate.

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APPENDIX A – A.A.C. R12-15-816, The ADWR Well Abandonment Rule

R12-15-816. Abandonment

A. Well abandonment shall be performed only by a licensed well drilling contractor or single well licensee.

B. Except as provided in subsection (F) of this Section, the owner of a well shall file a notice of intent to abandon the well prior to abandonment, on a form prescribed and furnished by the Director, which shall include:

1. The name and mailing address of the person filing the notice.

2. The legal description of the land upon which the proposed well to be abandoned is located and the name and mailing address of the owner of the land.

3. The legal description of the location of the well on the land.

4. The depth, diameter and type of casing of the well.

5. The well registration number.

6. The materials and methods to be used to abandon the well.

7. When abandonment is to begin.

8. The name and well drilling license of the well drilling contractor or single well licensee who is to abandon the well.

9. The reason for abandonment.

10. Such other information as the Director may require.

C. The Director shall, upon receipt of a proper notice of intent to abandon, mail a well abandonment authorization card to the designated well drilling contractor or single well licensee.

D. Except as described in subsection (F) of this section, a well drilling contractor or a single well licensee may commence abandoning a well only if the driller has possession of an abandonment card at the well site, issued by the Director in the name of the driller, authorizing the abandonment of that specific well or wells in that specific location.

E. Within 30 days after a well is abandoned pursuant to this Section, the well drilling contractor or single well licensee shall file with the Director a Well Abandonment Completion Report on a form prescribed and furnished by the Director which shall include the date the abandonment of the well was completed and such other information as the Director may require.

F. In the course of drilling a new well, the well may be abandoned without first filing a notice of intent to abandon and without an abandonment card. If the well is abandoned pursuant to this subsection without first filing a notice of intent to abandon and without an abandonment card, the well drilling contractor or single well licensee shall provide the following information in the Well Abandonment Completion Report:

1. The legal description of the land upon which the well was abandoned and the name and the mailing address of the owner of the land.

2. The legal description of the location of the well on the land.

3. The depth, diameter and type of casing prior to abandonment.

4. The well registration number.

5. The materials and methods used to abandon the well.

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6. The name and well drilling license number of the well drilling contractor or single well licensee who abandoned the well.

7. The date of completion of the abandonment of the well.

8. The reason for abandonment.

9. Such other information as the Director may require.

G. The abandonment of a well shall be accomplished through filing or sealing the well so as to prevent the well, including the annular space outside the casing, from being a channel allowing the vertical movement of water.

H. A well not penetrating an aquifer shall include a surface seal which shall be accomplished as follows:

1. If the casing is removed from the top 20 feet of the well, a cement grout plug shall be set extending from two feet below the land surface to a minimum of twenty feet below the land surface, and the well shall be backfilled above the top of the cement grout plug to the original land surface.

2. If the casing is not removed from the top ten feet of the well, a cement grout plug shall be set extending from the top of the casing to a minimum of twenty feet below the land surface, and the annular space outside the casing shall be filled with cement from the land surface to a minimum of twenty feet below the land surface.

I. In addition to the surface seal required in subsection (H):

1. A well penetrating a single aquifer system shall be filled with cement grout, concrete, bentonite drilling muds, clean sand with bentonite, or cuttings from the well.

2. A well penetrating a single or multiple aquifer system with vertical flow components shall be sealed with cement grout or a column of bentonite drilling mud of sufficient volume, density, and viscosity to prevent fluid communication between aquifers.

J. Materials containing organic or toxic matter shall not be used in the abandonment of a well.

K. The owner or operator of the well shall notify the Director in writing no later than 30 days after abandonment has been completed. The notification shall include the well owner's name, the location of the well, and the method of abandonment.

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APPENDIX B – Definitions

For the purposes of this Handbook, the following terms have the following meanings:

Acid Resistant Cement (also known as Pozzolanic cement) (generic mixture): means a cement mixture that has improved resistance to corrosive fluids. Acid resistant cement is developed by adding silicious materials, pozzolans, to Portland cement. Pozzolans from both natural materials of volcanic origin such as perlites (volcanic ashes), heat treated clays, shales, tuffs, opaline cherts and diatomaceous earth, and artificial materials consisting of by-products from glass factories, furnace slag, and fly ash may be used. A common mixing ratio is 74 pounds of pozzolans per 94 pound sack of cement and not more than ten (10) gallons of water per sack of cement. If perlites are used, 2 to 6 percent of bentonite by weight is needed to keep the perlite from floating. Acid resistant cement is typically recommended for well abandonment material in areas where low pH groundwater is encountered (such as near some mine sites).

Aggregate (generic mixture): means sand or gravel with particle size up to ¼ inch.

Annular Space: "means the space between the outer well casing and the borehole wall. An annular space also means the space between an inner well casing and an outer well casing." **A.A.C. R12-15-801(1)**

Aquifer: "means an underground formation capable of yielding or transmitting usable quantities of water." **A.A.C. R12-15-801(2)**

Aquifer Boundary: means a vertical change in aquifer properties indicated by a difference in hydraulic conductivity between aquifer layers that is at least greater than two orders of magnitude (100 times greater).

Bentonite "means a colloidal clay composed mainly of sodium montmorillonite, a hydrated aluminum silicate." **A.A.C. R12-15-801(5)**

Cement Grout or Grout: "means cement mixed with no more than 50 percent sand by volume, and containing no more than six gallons of water per 94 pound sack of cement." **A.A.C. R12-15-801(15)**

Cement grout is sometimes referred to as "sand-cement grout", when sand is in the mixture.

Grout is often used as a synonym for slurry which is a generic term that means a thin mixture of liquid, commonly water, and any of several finely divided substances such as cement or clay particles.

Cement-Bentonite Grout (generic mixture): means a mixture of cement, bentonite and water at a ratio of 6.5 gallons of water per each 94 pound sack of cement with not more than 3 to 5 pounds of bentonite per sack of cement.

Concrete or Concrete Grout (generic mixture): means a mixture of cement, sand, coarse aggregate and water, with not less than seven (7) 94 pound sacks of cement per cubic yard of mixture and not more than seven (7) gallons of water per sack of cement.

Exploration Well: "means a well drilled in search of geophysical, mineralogical, or geotechnical data". **A.A.C. R12-15-801(13)**

Free-Product Contamination: means any known hazardous substance that is essentially immiscible (non-soluble) in water. Some typical examples of free-product contamination are gasoline and carbon tetrachloride.

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Hazardous Substance: has the same meaning prescribed by A.R.S. § 49-201.

High-Solids Bentonite Grout (granular or powder mixture) with a minimum of 15% solids by weight: means a mixture of granular bentonite or powder bentonite that yields a grout that has a minimum 15% bentonite solids by weight.

High-solids bentonite grout with a minimum of 15% solids by weight can be prepared from a mixture of granular bentonite (nominal 8 to 20-mesh particle size), water and polymer at a ratio of one hundred-fifty (150) pounds of granular bentonite and one hundred (100) gallons of water premixed with one (1) quart of polymer.

High-solids bentonite grout with a minimum of 15% solids by weight can also be prepared from a mixture of bentonite powder (nominal 200-mesh particle size) and water at a ratio of fifty (50) pounds of dry bentonite powder and thirty-four (34) gallons of water.

High-Solids Bentonite Grout (granular or powder mixture) with a minimum of 25% solids by weight: means a mixture of granular bentonite or powder bentonite that yields a grout that has a minimum 25% bentonite solids by weight.

High-solids bentonite grout with a minimum of 25% solids by weight can be prepared from a mixture of granular bentonite (nominal 8 to 20-mesh particle size), water and polymer at a ratio of one hundred-fifty (150) pounds of granular bentonite and fifty-four (54) gallons of water premixed with one (1) quart of polymer.

High-solids bentonite grout with a minimum of 25% solids by weight can also be prepared from a mixture of bentonite powder (nominal 200-mesh particle size) and water at a ratio of fifty (50) pounds of dry bentonite powder and eighteen (18) gallons of water.

High-Solids Bentonite Chips: means chips of coarse bentonite ranging in size from 0.25 to 0.75 inch.

High-Solids Bentonite Pellets: means pellets of fine compressed bentonite (200-mesh) ranging in size from 0.25 to 0.50 inch.

Neat Cement or Neat Cement Grout (generic mixture): means a mixture of one (1) 94 pound sack of cement with not more than six (6) gallons of clean water.

Pressure Grouting "means a process by which a grout is confined within the borehole or casing of a well by the use of retaining plugs, packers, or a displacing fluid by which sufficient pressure is applied to drive the grout into and within the annular space or interval to be grouted." **A.A.C. R12-15-801(23)**

Sand-Bentonite Grout (generic mixture): means a mixture of equal parts sand and bentonite by volume with slightly more than one (1) gallon of water per pound of sand.

Sand-Cement Grout (generic mixture): means a mixture of one 94 pound sack of Portland cement, sand and water in the proportion of not more than one (1) part by volume of sand to one (1) part of cement with not more than six (6) gallons of water per 94 pound sack of cement.

Sealing: means the conscious effort to construct a positive permanent barrier within a well that restricts or prohibits the vertical movement of groundwater and/or any other fluids or materials.

Vadose Zone Well "means a well constructed in the interval between the land surface and the top of the static water level. **A.A.C. R12-15-801(26)**

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Vadose Zone Contamination Issue: means any hazardous substance that is found in the vadose zone at or in the vicinity of the well at concentrations that exceed established state or federal standards.

Water Quality Contamination Issue: means any known hazardous substance that is found in groundwater at or in the vicinity of the well at concentrations that exceed established state or federal standards.

Well: means any man-made opening in the earth through which water may be withdrawn or obtained from beneath the surface of the earth including: 1) all water wells, monitor wells and piezometer wells; 2) geothermal wells for which the rules of the Arizona Oil and Gas Commission do not require the reinjection of all water associated with the geothermal resource to the producing strata; and 3) all exploration wells and grounding or cathodic protection holes, except those that are less than 100 feet in depth and do not encounter groundwater.

The question and answer section of this Handbook contains additional information concerning the types of wells that are subject to ADWR's well abandonment rule.

Well Abandonment "means the modification of the structure of a well by filling or sealing the borehole so that water may not be withdrawn or obtained from the well." **A.A.C. R12-15-801(28)**

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APPENDIX C – Questions and Answers about the Abandonment Handbook

Why was it necessary to provide a separate well abandonment Handbook when there is an existing well abandonment rule?

ADWR has become aware of some misunderstanding among well owners and well drillers concerning the requirements of the well abandonment rule, A.C.C. R12-15-816. This Handbook is intended to provide guidance to well owners and well drillers on what is required by the rule.

In addition, this Handbook describes the procedures and materials that should be used to abandon wells not detailed in the rule. The well abandonment rule requires a person abandoning a well to fill or seal the well in order to prevent the well, including the annular space outside the casing, from being a channel allowing the vertical movement of water. Any well owner or well driller who abandons a well in compliance with this Handbook will be deemed to be in compliance with this requirement.

Q. ***What types of wells are subject to ADWR's well abandonment rule?***

A. The well abandonment rule applies to man-made openings in the earth through which water may be withdrawn or obtained from beneath the surface of the earth, including all water wells, monitor wells and piezometer wells.

The well abandonment rule also applies to geothermal wells for which the rules and regulations of the Arizona Oil and Gas Commission do not require the reinjection of all waters associated with the geothermal resource to the producing strata, as well as exploration wells and grounding or cathodic protection holes greater than 100 feet in depth (regardless of whether they intercept groundwater).

Q. ***What types of openings in the earth are not subject to ADWR's well abandonment rule?***

A. The well abandonment rule does not apply to:

1. man-made openings in the earth not commonly considered to be wells, such as construction and mining blast holes, underground mines and mine shafts, open pit mines, tunnels, septic tank systems, caissons, basements, and natural gas storage cavities;

2. an injection well or vadose zone well that is subject to regulation by the Arizona Department of Environmental Quality (ADEQ), provided that ADEQ has issued a letter or other document asserting explicit regulatory authority over the well;

3. oil, gas, and helium wells drilled pursuant to the provisions of Title 27, Arizona Revised Statutes (wells regulated by the Arizona Oil and Gas Commission); and

4. boreholes in the earth less than 100 feet in depth which are made for purposes other than withdrawing or encountering groundwater (such as exploration wells and grounding or cathodic protection holes less than 100 feet in depth), except that if groundwater is encountered in the drilling of the borehole, the well abandonment rule will apply.

Although the well abandonment rule does not apply to these types of wells and boreholes, it is nevertheless recommended that unused wells or

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boreholes that are not regulated under ADWR's well abandonment rule be abandoned in a manner that will protect the aquifer.

Q. ***What is the benefit of abandoning an unused well, as opposed to capping the well (which is also allowed under ADWR's rules)?***

A. Proper well abandonment is favored over well capping for both environmental and safety reasons.

Unused and unabandoned wells constitute actual or potential environmental hazards because they can serve as vertical conduits for hazardous substances to cross-contaminate aquifers. For example, during the last several decades, serious and costly vertical cross-contamination of a multiple aquifer system has occurred through unabandoned conduit wells at the Indian Bend Wash Superfund site in Scottsdale, Arizona. Owners of unused, unabandoned wells should also realize that they may be held legally responsible for secondary contamination if it is demonstrated that their well served as a conduit for vertical cross-contamination of an aquifer system.

Public safety issues also favor well abandonment over well capping. Capped wells are often tampered with, and once the well cap is removed there is a real danger for humans or animals to fall into the well, or for the well to be used for the illegal disposal of hazardous materials.

Q. ***Why is it generally required to run a video log to determine the condition of the casing perforations in areas where water quality contamination exists if the casing is not ripped?***

A. Because significant conduit flow can occur through the annular space outside the casing, it is essential to seal this pathway to prevent potential vertical cross-contamination. Therefore, when water quality contamination issues exist, unless the well casing is removed or the casing is re-perforated over its entire length from 20 feet above the highest historic water level to the total depth of the well, the well owner must run a video log to determine whether the grout material can flow through the casing perforations and seal the annular space outside the casing.

Video logging and/or casing re-perforation may not be required in the case of the abandonment of recently constructed monitor wells. However, that determination must be made on a case-by-case basis.

In areas where water quality contamination issues do not exist, if the casing is not ripped, a video log is recommended, although not required, to determine perforation conditions. It is important to make sure that the well and the annular space outside the casing are properly abandoned even when there are no current water quality contamination issues. This is because the water could become contaminated in the future.

It should also be pointed out that additional benefits can be derived from running a video log. Those benefits may include: the determination of the structural integrity of the well casing, the presence of casing anomalies and obstructions, the presence of perched or cascading water, etc. This information can be very important in developing an effective abandonment design.

Q. ***Under what circumstances is it permissible to use drill cuttings to abandon a well?***

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A. In the course of drilling a new well, the well may be abandoned using drill cuttings from the well being drilled only if the well does not penetrate an aquifer or the well penetrates a single aquifer only, with no vertical flow components. Drill cuttings may only be used to abandon the well from which they were originally removed. Drill cuttings may not be used to abandon wells or boreholes that have water quality and/or vadose zone contamination issues.

Q. ***How can it be determined whether vertical flow components exist in an aquifer or aquifer system?***

A. The determination of vertical flow conditions in an aquifer can be a challenging task. However, vertical flow conditions can be assessed by evaluating water level data collected in piezometers or monitor wells that are completed at different depths within an aquifer or aquifer system at the same location. Vertical fluid movement can also be evaluated in non-pumping wells using various geophysical logging techniques such as flowmeter logging, spinner logging or tracer logging. The observation of cascading water or water seeping into a non-pumping well below static level is a clear indication of vertical flow conditions within the well.

Because unit-specific water level data are typically unavailable, and geophysical logging may be impractical or too costly, it is best to assume that most aquifers or aquifer systems have some component of vertical flow, and well abandonment methods and materials should be chosen accordingly.

Q. ***What should I do if I have further questions concerning a well abandonment project?***

A. Contact ADWR Hydrology Division at:

602-771-8500
(Phoenix metro area)

1-800-352-8488
(outside metro Phoenix)

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HYDROLOGY DIVISION

ADWR

ARIZONA DEPARTMENT OF WATER RESOURCES

SECURING ARIZONA'S WATER FUTURE

ADWR

ARIZONA DEPARTMENT OF WATER RESOURCES

3550 N CENTRAL AVENUE, SUITE 200
PHOENIX, ARIZONA
85012-2105

PHONE: 602-771-8500
1-800-352-8488

FAX: 602-771-8691

WEBSITE: http://www.azwater.gov

GREAT SEAL OF THE STATE OF ARIZONA
DITAT DEUS
1912

Former Williams Air Force Base

Standard Operating Procedure
for
Field Characterization of Non-Aqueous Phase Liquids

SOP-ST012-05

Prepared by:

AMEC
Environment & Infrastructure
4600 East Washington Street
Phoenix, Arizona 85034

January 2013

TABLE OF CONTENTS

Page

1.0 PURPOSE AND SCOPE 1

2.0 MATERIALS AND EQUIPMENT 1

3.0 PROCEDURES 1
- 3.1 Visually Inspect Soils Cores 1
- 3.2 Inspect Soils Cores with PID 1
- 3.3 Use Oil Screening Test Kit 1

ACRONYMS AND ABBREVIATIONS

AFB	Air Force Base
HASP	Health and Safety Plan
NAPL	non-aqueous phase liquid
PID	Photoionization detector
PPE	Personal Protection Equipment
SOP	Standard Operating Procedure

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1.0 PURPOSE AND SCOPE

This Standard Operating Procedure (SOP) provides technical guidance and methods that will be used to characterize non-aqueous phase liquids (NAPL) in soil core samples collected during environmental investigations at Williams Air Force Base (AFB). This SOP serves as a supplement to the investigation specific work plans and is intended to be used in conjunction with the other SOPs.

2.0 MATERIALS AND EQUIPMENT

The following materials and equipment are needed for field characterization of NAPL.

- Monitoring equipment and personal protective equipment (PPE) as outlined in the Site-Specific Health and Safety Plan (HASP).
- Oil screening test kits, such as, Oil-in-Soil™, OilScreenSoil™ (Sudan IV) ®, or comparable alternative.

3.0 PROCEDURES

Use the following procedures to evaluate soil cores for the presence of NAPL.

3.1 Visually Inspect Soils Cores

Visually inspect the soil cores for evidence of NAPL. Indicators of NAPL include seeing the product itself in the soil or a sheen or staining on the soils.

3.2 Inspect Soils Cores with PID

In addition to visually inspecting the soil core, use a photoionization detector (PID) to detect high concentrations of volatile compounds which may indicate the presence of NAPL. Readings in excess of 1,000 parts per million suggest the potential for NAPL in the soil core.

3.3 Use Oil Screening Test Kit

Where visual or PID indicators of NAPL exist in the soil core or as otherwise indicated in the work plan, use an oil screening test kit to confirm the presence of NAPL. Typical components of an oil screening test kit include a bottle to collect the soil sample, bottle labels indicating the proper amount of water and soil to fill the bottle with, a polystyrene ball to be placed inside the bottle, and hydrophobic dyes to highlight the presence of NAPL in a soil sample. While specific instructions on the use of an oil screening test kit may vary depending on the manufacturer, the following sample instructions describe the general test process:

1. Fill the bottle to the indicated line with soil from the soil core. Collect soils from sections of the core likely to contain NAPL based on visual and PID inspections.
2. Fill the bottle to the line indicated with potable water. Note that some test kits may include a water soluble dye to color the potable water and provide a backdrop for the hydrophobic dye which will highlight NAPL in the soil sample.

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3. Add the hydrophobic dye (e.g., Sudan IV) and cap the bottle. Shake the bottle to distribute the dye throughout the soil sample.
4. After approximately one to two minutes, inspect the bottle for signs of staining from the dye contacting the NAPL.
5. If no dye staining is immediately apparent, inspect the polystyrene components inside the bottle. NAPL commonly dissolves polystyrene, and any staining on the polystyrene therefore suggests the presence of NAPL in the soil sample.
6. Indicate on the soil drilling logs where screening tests NAPL was encountered based on the results of visual inspections, PID inspections, and oil screening test kits. Indicate the location of the soil core that was tested and the test results.

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APPENDIX I

SAMPLE TERRATHERM WEEKLY REPORT

Sample Progress Report

Thermally Enhanced Remediation at Your Site,

Your Site, USA

December 18, 2013

TERRATHERM

Think Thermal

1. Summary

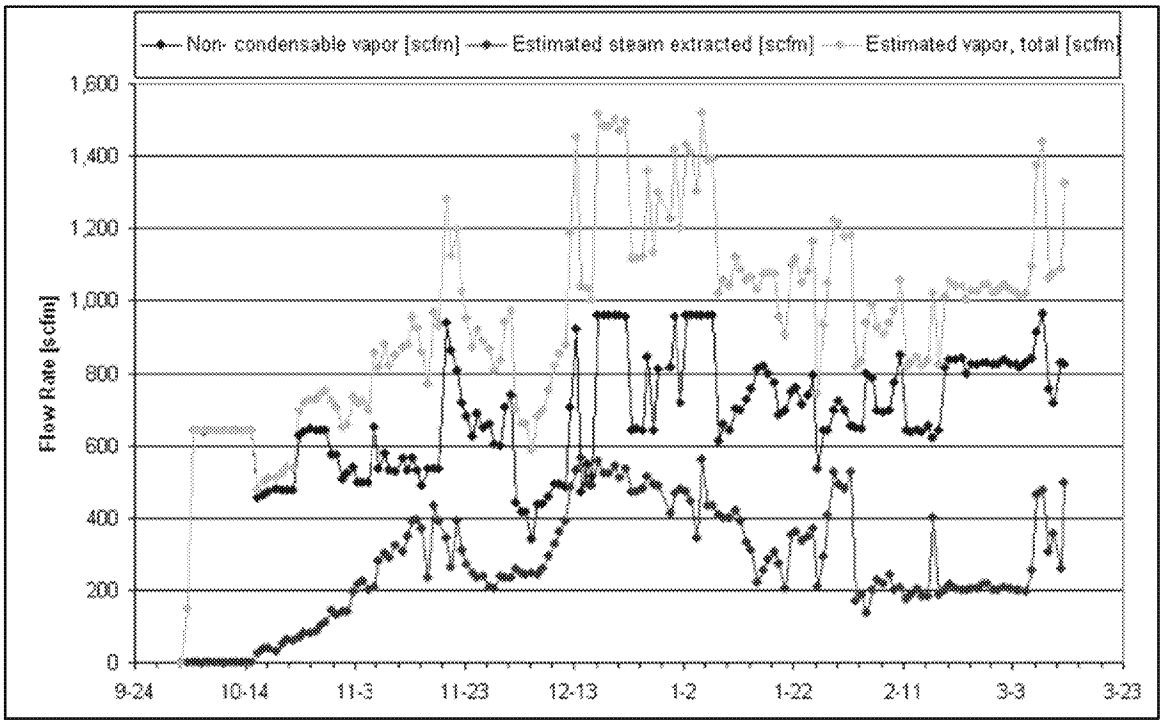
This report is intended to cover the period of operations from December X, 2013 through December Y, 2013. Temperature monitoring point data has been updated through December Z, 2013. The following table provides a summary of the project operational status.

Table 1. Project Summary

Type	Value	Unit
TTZ soil volume	13,387	cy
Area	23,078	ft2
Average depth	16	ft
Heating started	10-02-09	
Estimated total days of operation	150	
Estimated total energy usage (calcs)	5,400,000	kWh
Days of operation	161	days
Energy used to date	4,361,653	kWh
Injected energy per soil volume	244	kWh/cy
Water mass removal based on analytical data	7	lbs
Vapor mass removal based on PID	3,722	lbs
Average temperature TTZ	299	°F
Average power input last 24 hours	1323	kW
Average steam injection rate last 24 hours	0	lbs/hr
Average condensate production rate last 24 hours	2.8	gpm
Average vapor extraction rate (non condensable) last 24 hours	825	scfm

2. Vapor Extraction

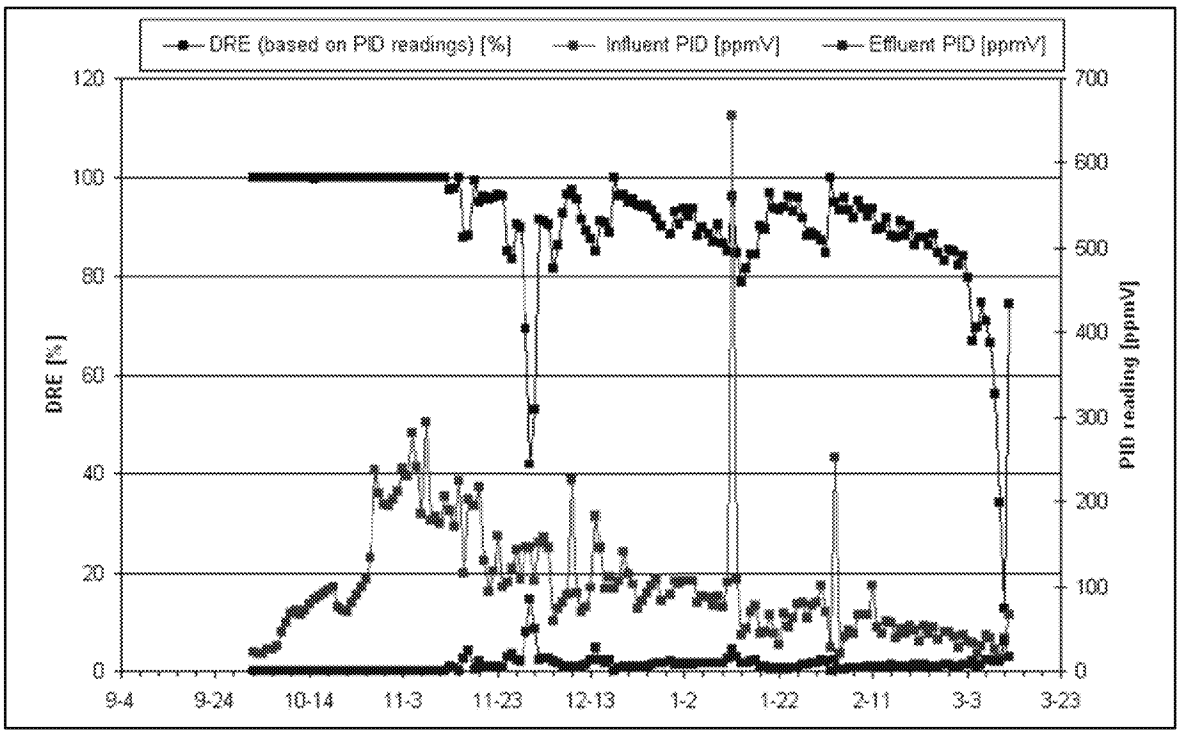
The graph below shows the vapor extraction rate from the site. Note that the estimated steam extraction rate is a calculated value based on the sum of water condensed out in the main manifold and the calculated humidity ratio in vapors drawn into the treatment system.



Graph 1. Vapor Extraction Rate

3. PID and DRE

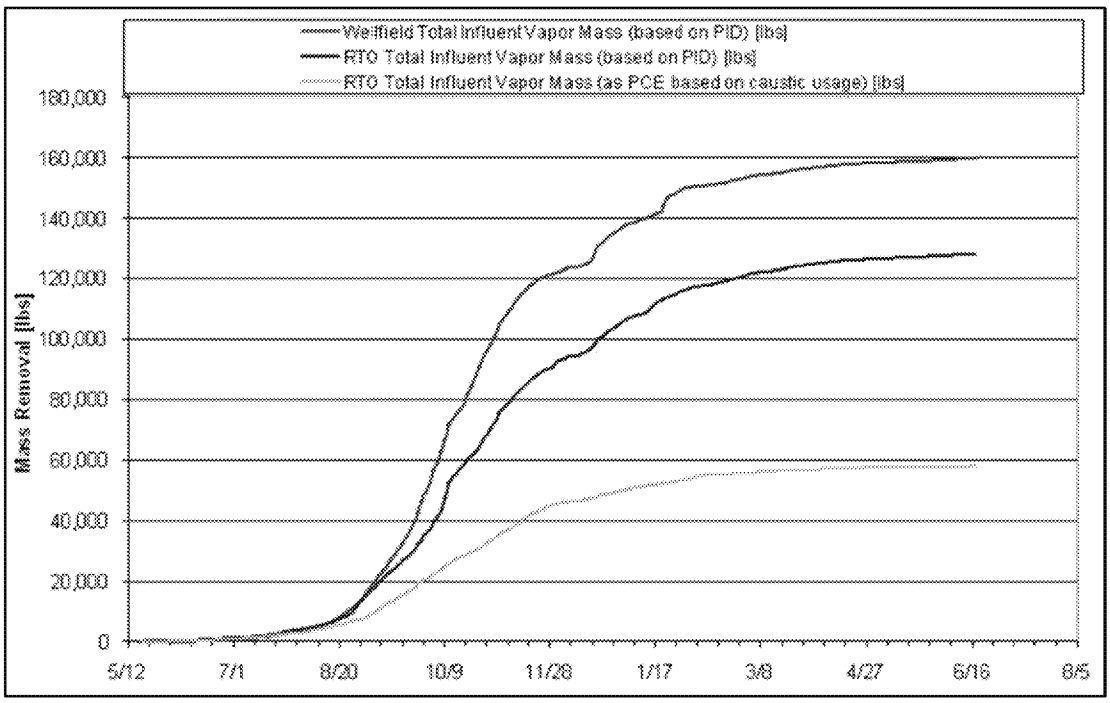
The following graph depicts the influent and effluent PID readings and the Destruction and Removal Efficiency (DRE) of the treatment system. Note that PID readings of 0.0 ppmV are shown in the graph as 0.01 ppm due to the logarithmic scale that doesn't allow display of 0-values.



Graph 2. Influent and Effluent PID Readings and Calculated DRE

4. Mass Removal

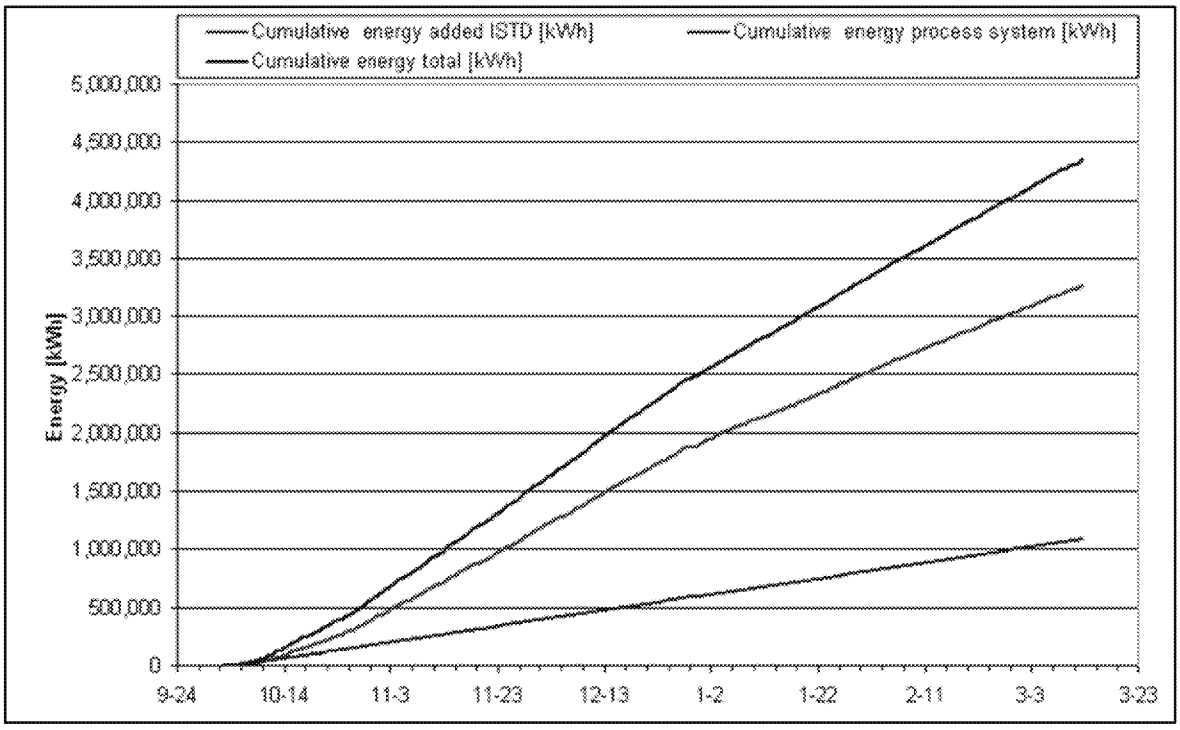
The mass removal is calculated by adjusting the wellfield PID reading based on the correction factors for each major COC identified in the most recent lab analysis. In addition, the mass removal calculation based on caustic usage at the site has been added to the graph below.



Graph 3. Mass Removal

5. Power Usage

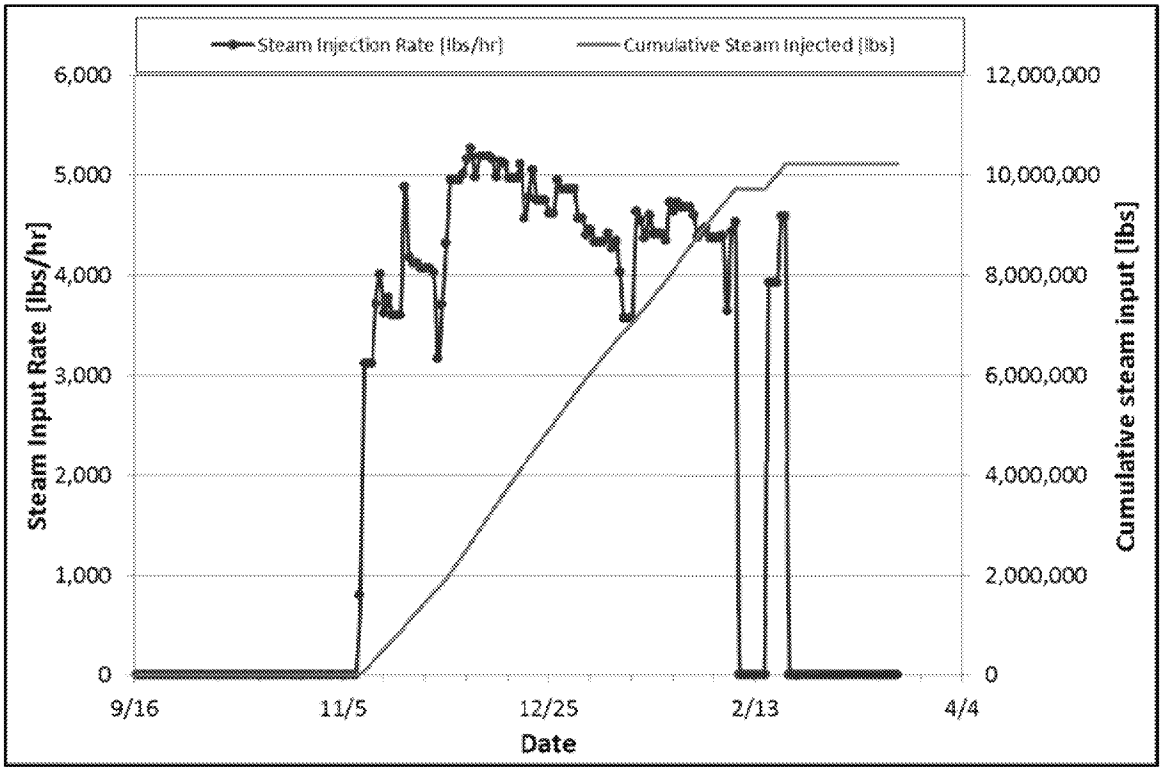
The cumulative power usage is shown below. The power used by the treatment system is an estimated value.



Graph 4. Cumulative Power Usage

6. Steam Injection

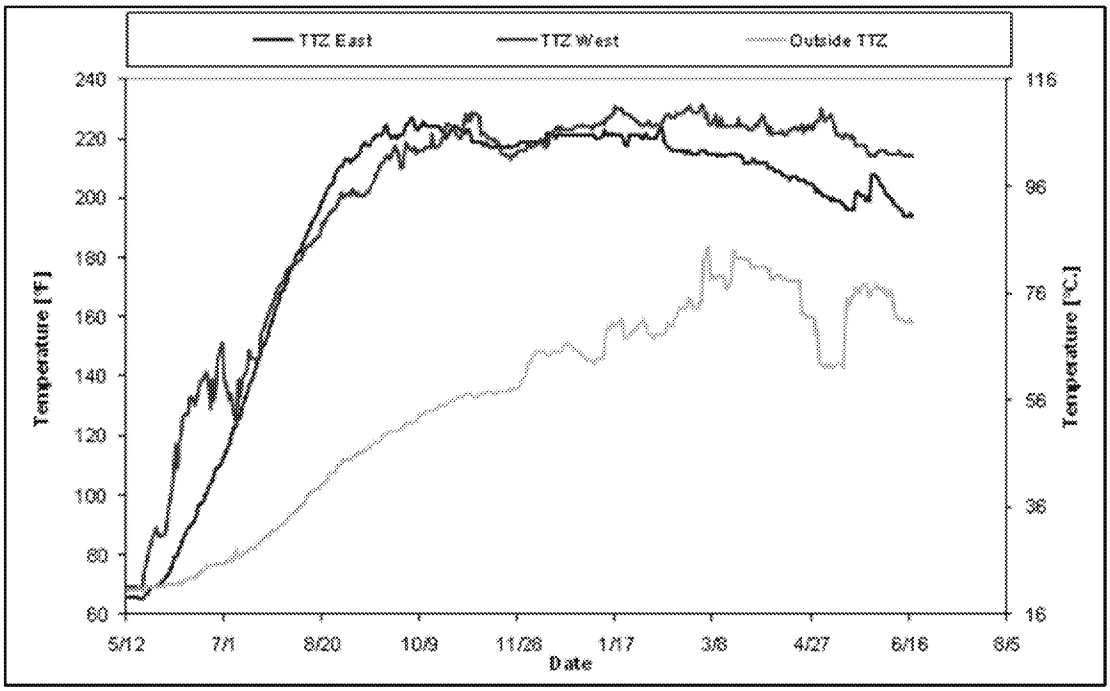
The steam input rate and cumulative steam injection to the site is shown below.



Graph 6. Steam Input Rate

7. Average Temperature

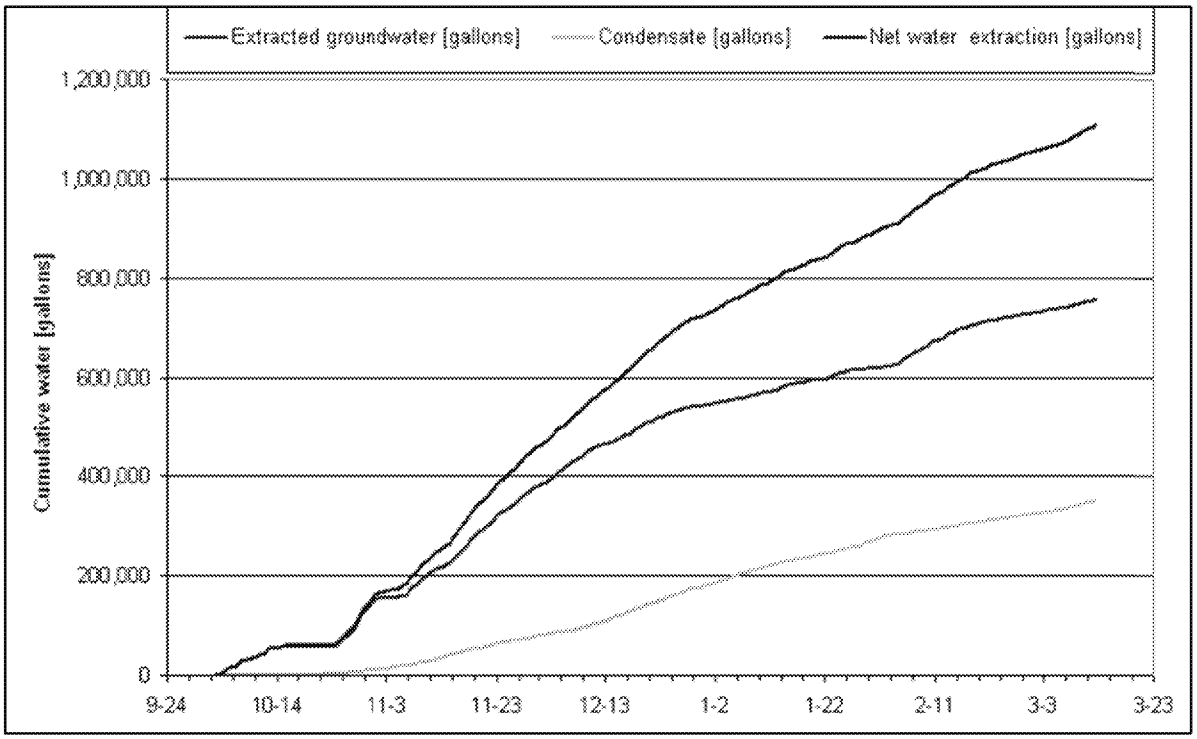
The average soil temperatures for the eastern and western part of the treatment area, as well as background temperatures outside of the treatment area, are shown in the graph below.



Graph 7. Average Soil Temperatures

8. Cumulative Water Balance

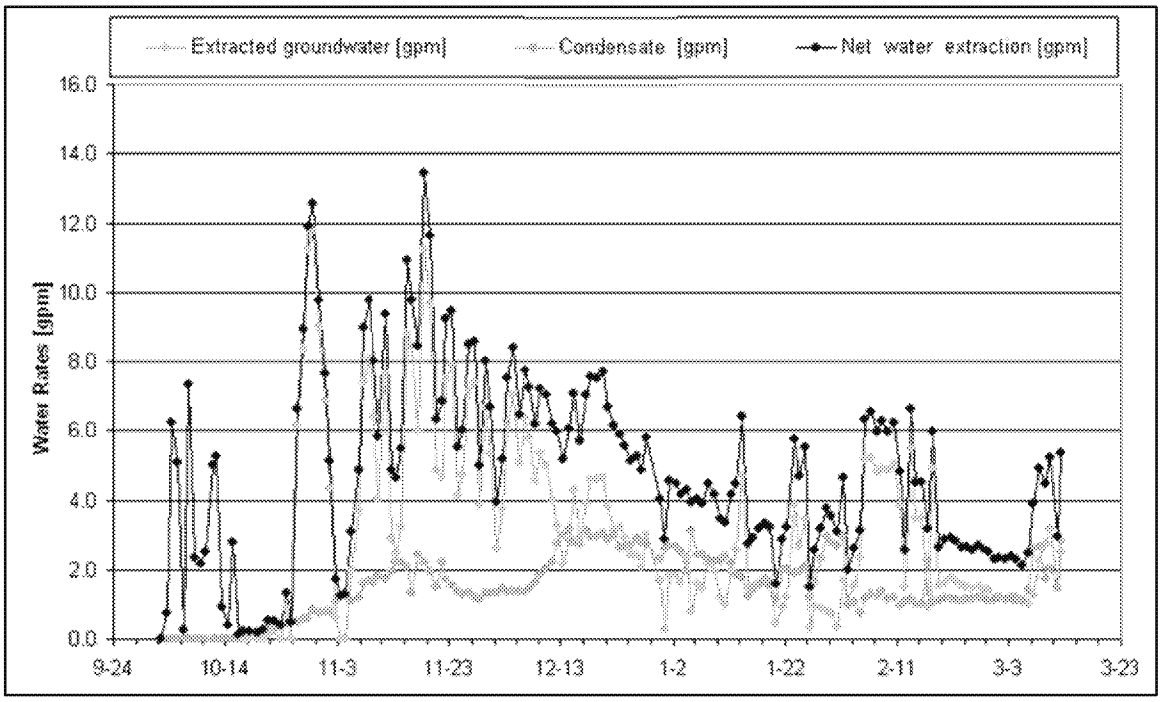
The cumulative water balance is shown below.



Graph 8. Cumulative Water Balance

9. Water Balance Rate

Water injection and extraction rates are shown in the graph below together with the calculated net water extraction rate.



Graph 9. Water Balance Rates

APPENDIX J

RESPONSE TO EPA AND ADEQ COMMENTS

RESPONSE TO EPA COMMENTS DATED 2 DECEMBER 2013
DRAFT REMEDIAL DESIGN AND REMEDIAL ACTION WORK PLAN, OPERABLE UNIT 2, ST012
FORMER WILLIAMS AFB, MESA, ARIZONA

Item	Page	Section	Line(s)	EPA Comment	Air Force (AF) Response to Comment (RTC)
General Comments					
1				Please note the new Guidance for Evaluating Completion of Groundwater Restoration Remedial Actions OSWER 9355.0-129 signed November 25, 2013 (enclosed) now specifies that post remediation monitoring data demonstrate attainment of Remedial Action Objectives on a well by well basis.	The published guidance is noted. Compliance with RAOs will be determined at the completion of the project. This guidance and others in effect at that time will be considered. The description provided in Section 2.2 for attaining cleanup levels is consistent with the new guidance. The fourth sentence of the last paragraph in Section 2.2 has been revised to: "In the absence of alternative mutual agreement between the AF, EPA and ADEQ, cleanup levels will be attained when monitoring results throughout the plume reach concentrations at or below the cleanup levels for a two year period of continued groundwater monitoring after the cleanup levels were initially achieved." This statement is the same as provided in Section 5.1 of OU-2 ROD Amendment 2.
2				EPA acknowledges that the SEE thermal treatment zone (TTZ) has already been expanded based on contamination found in borings installed during the pre-design investigation (as discussed in Section 3.2.2 of the RD/RAWP). However, a substantial amount of LNAPL will still remain unaddressed outside of the TTZ. According to Table 3-2 of the RD/RAWP, it is estimated that as much as 500,000 gallons of LNAPL	It is the intent of the remedy to address all of the areas with LNAPL that contribute to groundwater contamination with either SEE or EBR. The SEE TTZs are designed to address the highest concentrations of contaminant mass while EBR is used to address lower residual LNAPL contamination outside of the TTZs. The extent of LNAPL will continue to be refined as part of the implementation as additional data is

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Item	Page	Section	Line(s)	EPA Comment	Air Force (AF) Response to Comment (RTC)
				remain outside the TTZ. EPA recognizes that there are constraints on expanding the SEE TTZ in some areas, such as Sossaman Road to the east and the Army Reserve Center to the west. However, we remain concerned that the extremely large amount of LNAPL estimated to be outside of the TTZ will be a significant hindrance to obtaining the RODA2 remedial goals within the desired timeframe of 20 years. Consideration should be given to fully defining the extent of LNAPL at the site, and possible ways to expand the SEE TTZ and/or the Enhanced Bioremediation (EBR) treatment zone.	collected during drilling for SEE well installation and groundwater sampling, the EBR field test, and the final EBR design. The current EBR design extent is conceptual but is based on the more conservative potential LNAPL interpretation (i.e., higher LNAPL volume outside the SEE TTZ). While Table 3-2 indicates an estimated LNAPL volume of as much as 530,000 gallons outside the TTZ, this is the highest estimate based on a conservative distribution and literature saturation values. The LNAPL volume outside the TTZs is more likely a lower volume as represented by the range of values provided in Table 3-2 (140,000-530,000 gallons).
3				The criteria to be used to determine when to terminate steam injection and initiate EBR should be prescribed in the RD/RAWP. The criteria were discussed during the November 19, 2013 BCT meeting, and the points that were brought up during the discussion, which included the fact that multiple lines of evidence, not just criteria, will be considered when deciding when to terminate steam injection, need to be incorporated into the RD/RAWP. It should be made clear that first the temperature criteria must be met in the TTZ (excluding the low permeability zone (LPZ), which is not likely to take steam), and verified by the energy balance, and the pressure cycling completed (showing no	Multiple lines of evidence will be used to support the discussion to terminate steam injection. The criteria presented at the BCT are in the RD/RAWP (Section 4.2.4) and have been clarified further in a tabular format similar to the BCT meeting presentation. The first two paragraphs of Section 4.2.4 have been combined and modified as follows: “The overall strategy for the selected groundwater remedy is presented in Section 3.2.2. Multiple lines of evidence will be used to support the discussion to terminate steam injection and transition to EBR. The primary factors for making the determination to transition from SEE to EBR are achieving

Item	Page	Section	Line(s)	EPA Comment	Air Force (AF) Response to Comment (RTC)
				additional significant increases in effluent vapor phase concentrations when steam injection is reduced) before consideration is given to whether recovery has decreased sufficiently from the peak recovery rate to justify termination of steam injection. We discussed during the BCT meeting that the expectation is that the benzene target criteria of 100 to 500 µg/L is high (i.e., lower concentrations are expected to be achieved) in the interior portion of the TTZ, but that this target was chosen because the modeling predicted that benzene concentrations greater than 500 µg/L would not degrade within the timeframe for achieving remedial goals. It must also be recognized that even when the recovery rate falls below 10 percent of the peak recovery rate, significant contaminant mass may still be recovered, and consideration should be given to whether it is more effective to continue recovering that mass via SEE or to try to degrade it with EBR.	target subsurface temperatures and diminishing mass removal rates. Throughout steam injection, AMEC and TerraTherm will closely monitor the performance of the SEE system. Evaluations of thermal operation will be ongoing to determine when the transition to the next phase is warranted. The specific criteria that will be considered in the decision making process for transition are shown in Table 4-2. The criteria will be considered in total with the weight of evidence from these multiple lines being used for decisions." A new Table 4-2 with the SEE to EBR transition criteria has been provided to replace the bullets in Section 4.2.4. The table includes the previous information supplemented with additional clarification as discussed in the November BCT meeting. The temperature goal does apply throughout the TTZs as described (not including the LPZ) and will be verified by the energy balance. However, local low-permeability zones may limit achievement of temperature goals in some areas. If such areas are identified, shut-down of steam will only be considered after operational adjustments are made to attempt to achieve the temperature goal and pressure cycling is completed in the area. A criterion has been added that pressure cycling be performed prior to consideration of

Item	Page	Section	Line(s)	EPA Comment	Air Force (AF) Response to Comment (RTC)
					whether recovery has decreased sufficiently from the peak recovery rate to justify termination of steam injection. A clarifying statement has been added indicating that lower benzene concentrations are expected in the interior compared to the perimeter and to describe the connection between the 500 µg/L criteria and the natural attenuation modeling. Text has been added to clarify that operational mass removal rates may continue below the 10 percent goal depending on the significance of continued mass removal, the status of COC concentrations (e.g., benzene) in extracted fluids, and the need/ability for EBR to achieve further degradation based on data collected during the EBR field test.
4				The data requirements established by these criteria for terminating SEE operations should be included in the sampling and analysis plan. Monitoring during the pressure cycling phase and while evaluating the potential end of steam injection must be sufficient to demonstrate that pressure cycling has accomplished what it can. Also, it should demonstrate that mass still being recovered is mostly from outside of the TTZ.	The data requirements specifically tied to the shutdown criteria have been summarized in a new Table 5-2 in Section 5.6. Because the pressure cycling process results in the volatilization of contaminants upon release of the pressure, extracted vapors will be the primary source for measurement of pressure cycling effectiveness. Vapors will be primarily monitored with hand held devices with the objective to demonstrate diminishing returns from pressure cycles. Samples of extracted water will be used to evaluate the relative contribution of

Item	Page	Section	Line(s)	EPA Comment	Air Force (AF) Response to Comment (RTC)
					contamination from outside vs. inside the TTZs.
Specific Comments					
1				It would be helpful to have a figure (or figures) for each of the remedial zones that delineate the TTZ, the EBR area, and the soil and/or groundwater data from each boring or well around the perimeter of the TTZ and EBR area to give a visual presentation of the characterization data collected during the pre-design investigation, as well as historical data, that is being used to determine the TTZ and the treatment area for EBR.	Some of the information requested is presented in Appendix B; however, three additional figures (B-5, B-6, and B-7) have been developed for the CZ, UWBZ, and LSZ respectively and included in Appendix B that break out the TTZ and EBR zones. These figures also include the associated NAPL score results in 10-foot intervals.
2	3-9	3.3	768-770	It states that in perimeter wells that exhibit signs of LNAPL, cyclic steam injection will be used to avoid spreading contamination. However, extracting all recoverable LNAPL before injecting any steam, as outline on page 17 of TerraTherm's Design Report (Appendix D), is a more assured way of avoiding spreading contamination. Please revise this section to state that significant recoverable LNAPL will be recovered before cyclic steam injection is initiated. This will make this section consistent with lines 1251 – 1252 on page 4-5, which state that where LNAPL exists on the perimeter of the treatment zone, initial extraction is anticipated.	The intent of the section was to indicate that cyclic steam injection would begin with extraction until recoverable LNAPL is removed thus ensuring hydraulic capture. The subject text in the first paragraph after Table 3-5 has been revised as follows: "In such a well, following initial extraction to remove recoverable LNAPL, steam will be injected for a short period to preheat the area surrounding the steam well prior to returning the well to an extraction well to further recover the LNAPL surrounding the well. This method is called cyclic steam injection."

Item	Page	Section	Line(s)	EPA Comment	Air Force (AF) Response to Comment (RTC)
3	4-5	4.2.2	1249 - 1250	The lines state that injection strategies will be refined during the RD/RA phase to address potential LNAPL migration. This was discussed during the November 19, 2013 BCT meeting and it was agreed that an update to the RD/RAWP would be provided once the characterization/well installation is complete.	As discussed and agreed in the November BCT meeting, the Final RD/RAWP will be updated with an addendum identifying the initial operation strategy for extraction and injection wells following completion of well installation and initial baseline groundwater sampling. Well installation and baseline groundwater sampling is scheduled for completion in March 2014. The following text has been added to the end of Section 4.2.1.2: "Additional characterization of soil contamination, potential LNAPL distribution, and groundwater concentrations will be evaluated following well installation and baseline groundwater sampling. This data will be summarized and evaluated to establish the intial injection and extraction operational strategy for SEE and identify implications for the EBR design. These results and analysis will be summarized in an addendum to the Final RD/RAWP for Air Force and regulatory agency review prior to system startup."
4	4-7	First bullet	1303 - 1310	The bullet states that steam will be injected with the intent of creating a steam zone from the injection wells to the extraction wells. Breakthrough of steam at the extraction wells is critical for recovery of contaminants both as an LNAPL and in the vapor phase, thus, every effort should be made to ensure that steam breakthrough occurs in all areas	The text from this bullet has been moved to the new Table 4-2 and revised in response to general comment 3. The phrase, "with demonstration of breakthrough of steam to extraction wells," has been added to the corresponding discussion in the first row of Table 4-2.

ED_005025_00013386-00788

Item	Page	Section	Line(s)	EPA Comment	Air Force (AF) Response to Comment (RTC)
				of the TTZ (with the exception of the LPZ which may not accept enough steam for this to occur).	
5		5.6.3		It would be helpful to include a table that details all of the performance and operation monitoring to be done. The table should include baseline sampling to be done before SEE startup, the monitoring program to support the determination that steam injection should be terminated (see comment #2), monitoring to demonstrate that hydraulic and pneumatic control are being maintained, monitoring to demonstrate that LNAPL and dissolved contaminants are not being spread, sampling to document the amount of mass recovered, and monitoring to demonstrate that the discharge criteria are met. This would include all of the analytical samples to be obtained of extracted and treated vapors and groundwater, as well as screening samples of vapors and liquids from the manifolds and/or individual wellheads, and sampling to determine which wells are producing the LNAPL. Where flow rates must also be determined in order to calculate the amount of mass being recovered, these measurements should also be included in the table. The minimum frequency of each of these monitoring activities should also be clearly defined in the table.	Three tables (5-1, 5-3, and 5-4) have been added in Section 5.6 that summarize the sampling and analysis requirements. In addition, Table 5-2 has been added which summarizes the data that will be collected to support decisions for transition to EBR as it relates to the performance criteria identified in Section 4. Some flexibility is planned in the sampling of extracted liquids and vapors so that field personnel can select locations based on observations made during operations. In these cases, the general sampling intent is summarized.

ED_005025_00013386-00789

Item	Page	Section	Line(s)	EPA Comment	Air Force (AF) Response to Comment (RTC)
6	5-6	5.6.3	1721 - 1727	The last paragraph lists the wells to be gauged for groundwater elevation and LNAPL on a weekly basis. Please consider adding the following wells to the list: ST012-U13, ST012-U36, ST012-C02, ST012-RB-2A, and ST012-W12. Wells that are in the list but are more than 200 feet from the TTZ (i.e., ST012-C01), may potentially be dropped from the list of wells monitored. It is clear that some areas surrounding the lower saturated zone (LSZ) will not be monitored by these existing wells, for example, to the west of the TTZ.	U13, U36, and RB-2A are all being abandoned or overdrilled and replaced with a steam well due to proximity to, and incompatibility with, steam injection (see Design Drawings and Appendix G). C02 has been added. It is in close proximity to U02 which is to be monitored, but also includes screen in the CZ. W12 has also been added to the list (Drawing CS-101 and Figure 1-3 which show it as abandoned has been corrected). C01 has been dropped from the list due to its distant location from the TTZ. W30 has been added to the list to address the area to the west of the LSZ TTZ
7	5-2	5.7		(Note this is the second time this page number was used.) The section states that analytical data will be posted on the AMEC website only after the data will be validated, and will be reported only quarterly with the SVE reports. During SEE operations, conditions change quickly, and decisions about the operation of the system must be made quickly, based on all the data being collected. It is important to posted and make use of analytical data as soon as possible, even if it is not yet validated. This data should be included in weekly progress reports, with the data presented by TerraTherm. This will be especially important during the latter stages of the SEE process when termination of steam injection is being discussed.	Page numbering has been revised. In addition to the described formal reporting the following information will be provided via the sharepoint: • Analytical data will be posted on the sharepoint as soon as received from the laboratory. • Weekly operational reports providing operating data from the steam injection. • Data tables or other interpretive data analysis used to either optimize steam injection or support transition decisions.

Item	Page	Section	Line(s)	EPA Comment	Air Force (AF) Response to Comment (RTC)
					The following text has been added to the first sentence of the third paragraph in Section 5.7: "…to be posted on the AMEC SharePoint site." Text has been added to the end of the third paragraph in Section 5.7 and the appendix with sample report has been added: "A sample weekly report included in Appendix I provides the typical presentation detail provided in TerraTherm weekly reports. This sample will be tailored to the site-specific parameters for ST012." The beginning of the fourth paragraph has been modified as follows: "Analytical data generated during SEE operations will also be posted on the SharePoint site upon receipt. In addition, data tables or other interpretive data analysis used to either optimize steam injection or support transition decisions will be posted on the SharePoint site as needed to support these decisions. Validated data will be presented on a quarterly basis…"
8	14	Appendix D	3rd paragraph	The paragraph discusses site heterogeneity and steam flow properties that could lead to uneven distributions of heat in the subsurface, and concludes, "The	The proposed layout of temperature monitoring points provides a reasonable density for temperature monitoring at the site. In addition to the 17 individual TMPs

ED_005025_00013386-00791

Item	Page	Section	Line(s)	EPA Comment	Air Force (AF) Response to Comment (RTC)
				completeness of heating, and the associated achievement of the conditions necessary for effective reduction of LNAPL concentrations will have some uncertainty associated with it". That having been said, and knowing that this site is very heterogeneous and the well spacing to be used is large (minimum of 70 feet), consideration should be given to increasing the number of thermocouple strings in the TTZ to increase the probability of finding which areas are not heating as rapidly as the rest of the site, so that operational changes can be made in a timely manner to improve the uniformity of heating.	(equipped with 15-24 vertical temperature measurement locations per TMP) included in the design, each SIW and MPE well is equipped with the infrastructure for a co-located TMP to be installed for temperature measurements to be collected. Co-located TMPs will be permanently installed for the 18 deep SIWs in the LSZ and will monitor the temperature at the top, middle and bottom of these wells. Two mobile temperature arrays will be used to monitor temperatures in the remaining deep, intermediate and shallow MPEs and SIWs (top, middle and bottom depths). Temperature monitoring of the SIW/MPE wells, along with extracted fluid and vapor temperatures, will supplement the 17 individual TMPs to monitor temperature distribution at the site. It is expected that this density of temperature monitoring will be adequate to support identification of areas that are not heating uniformly. The last bullet in section 2.2 was updated as follows: "All SIWs and MPEs will be constructed so that they can be used as either injection or extraction wells as needed during operation. The final use for each well will be determined after well installation is complete and use may also vary during the course of the SEE operations depending on the operational strategy. Additionally, all SIWs and MPEs will be equipped with the infrastructure for co-

Item	Page	Section	Line(s)	EPA Comment	Air Force (AF) Response to Comment (RTC)
					located temperature monitoring points to be installed for temperature measurements to be collected.. Co-located temperature monitoring sensors (thermocouples) will be permanently installed for the 18 deep SIWs in the LSZ and will monitor the temperature at the top, middle and bottom of these wells. Two mobile temperature arrays will be used to monitor temperatures in the remaining deep, intermediate and shallow MPEs and SIWs." Also, in bullets 2 through 6 of Section 5.4 wording in 2nd sentence has been changed as follows: "Each MPE well is equipped with the infrastructure for a collocated TMP to be installed for temperature measurements to be collected to monitor…"
9	24	Appendix D	Last paragraph	Paragraph states "the CZ (Cobble Zone) was conservatively assumed to be fully saturated at start-up, which is why the air volume in the HZ is shown to be zero in Table 5.5". However Table 5.5 shows the air volume in the heated zone (HZ) to be 3,625 CY. Please clarify.	The sentence has been deleted.
10	41	Appendix D, Section 5.9.6		Please describe in more detail what a "thermal accelerator" is and how it differs from a thermal oxidizer.	The following has been added after the first sentence in this section: "Thermal accelerators are a thermal oxidizer

Item	Page	Section	Line(s)	EPA Comment	Air Force (AF) Response to Comment (RTC)
					that is configured to burn hydrocarbons at a higher concentration than conventional thermal oxidizers or internal combustion engines. A thermal accelerator has a different burner than a conventional thermal oxidizer. In a standard thermal oxidizer, the vapor stream is directed to the combustion chamber, while in a thermal accelerator, the vapor stream is directed first to the burner and then to the combustion chamber. Thermal accelerators are well suited to sites such as ST012 where LNAPL is present."
11	54	Appendix D, Section 5.14.2		What equipment will be powered by the standby generator? In other words, what equipment will be maintained operational during a power outage?	The electrical drawings show the specific equipment that is connected to the generator (see E101, sheets 1 and 2). The following text has been added to the end of this section: "In general, the following major equipment will be operational using the standby generator: • Vacuum Blowers (B-101A/B) • Cooling Towers (W-101-1, W-101-2) • NAPL Conditioning System (S-106) • Liquid Transfer Pumps (P-104A/B, P-105-1A/B, P-105-2A/B, P-107A/B, P-109-1A/B, P-111-1A/B, P-112A/B, P-113-1A/B, • Air Stripper Blower (B-102-1, B-102-2) • Air Compressor (Z-105) • One steam boiler (V-101)

Item	Page	Section	Line(s)	EPA Comment	Air Force (AF) Response to Comment (RTC)
					• One thermal accelerator (F-101)"
12		Appendix D, Section 5.15		Please define what is meant by "Area Classification", the information contained in Table 5.16, and the conclusions that were drawn based on this analysis in terms that those unfamiliar with the codes can understand.	An introduction paragraph has been added and the second paragraph modified to as follows: "The design of any electrical installation must be based on the physical setting in which the electrical equipment will be installed. An Area Classification assessment is performed to determine if any specific hazards exist whereby electrical systems in the subject area could provide a source of ignition and create a risk for fire or explosion. The assessment considers the presence of flammable or explosive materials in the work area, and whether these materials may share the space occupied by electrical equipment under expected operating conditions, or in a failure scenario. An area classification review has been conducted for the SEE project based on two industry guidance documents. IEC standard IEC 60079-10 (Explosive Atmospheres – Part 10-1: Classification of Areas – Explosive Gas Atmospheres) was applied to operational scenarios related to the potential release of explosive vapor. National Fire Protection Association (NFPA) 497 (Recommended Practice for the Classification of Flammable Liquids, Gases, or Vapors and of Hazardous Location for Electrical Installations in Chemical Process

Item	Page	Section	Line(s)	EPA Comment	Air Force (AF) Response to Comment (RTC)
					Areas) was applied to operational scenarios related to the potential release of flammable liquids under a range of ventilation scenarios. The NFPA standards very much represent the project's actual handling and storage of JP-4, but the somewhat unique condition of processing hot vapors containing JP-4 required additional consideration in the analysis." The following sentence has been added as the 2nd sentence in the 2nd paragraph of Section 5.15.1: "These zone classifications will dictate how electrical systems are to be configured in different areas of the Site." The following was added at the end of Section 5.15.1: "The applicable codes referenced above determine the physical limits of the classified areas that surround any potential leakage source of flammable liquids or vapors. Any electrical equipment related to process operations in these classified areas must be: • Physically located outside the classified area; • Include only intrinsically safe circuits that are incapable of generating a spark (ignition source); or, • Enclosures housing electrical equipment must be sealed and

Item	Page	Section	Line(s)	EPA Comment	Air Force (AF) Response to Comment (RTC)
					designed to withstand an internal explosion (NEMA 7 rated), or in the case of a zone 2 installation, purged with clean air from a non-classified source to prevent hazardous vapors from coming into contact with electrical equipment. The type of motors to be installed in different areas at the Site will also depend on the area classification where the motor is to be installed. In general, explosion-proof motors will be installed in zone zero and zone one areas. All other locations will use totally enclosed fan cooled motors."
13		Appendix E, Section 2		Section 2 states "the groundwater flow model created for this project is roughly based on the model created for the Thermal Enhanced Extraction (TEE) Pilot Test Report". However, Section 2 goes on to state, "these hydraulic conductivity fields were copied from Figures M.3.2.1 and M.3.2.2 in Appendix M of the TEE Pilot Test Report (BEM, 2010)" , and Section 3 states, "If the computed gradient and flow direction for the steady-state model closely matched the gradients and flow direction reported in Appendix M of the TEE Pilot Test Report…". These last two statements indicate a heavy reliance on the TEE model to develop and calibrate the present model. Comments	The model presented in the RD/RAWP relied on the hydraulic conductivity zones presented in Appendix M of the TEE Pilot Test Report. The site specific data; aquifer testing and analyses; and PEST calibration used to arrive at these conductivity zones was separate from the Groundwater Flow Model presented in Appendix C of the TEE Pilot Test Evaluation Report. The hydraulic conductivity zones that were adopted for use in the RD/RAWP groundwater flow model honor the understanding of the variability and distribution of hydraulic conductivities as well

Item	Page	Section	Line(s)	EPA Comment	Air Force (AF) Response to Comment (RTC)
				made by EPA on the TEE model pointed out that the model was not able to predict groundwater levels within the TEE pilot study area with sufficient accuracy to verify that hydraulic containment was achieved during the pilot study, which brings into questions the accuracy of the model. It is not clear from this modeling report that the model was sufficiently improved to provide reliable results for the present modeling efforts.	as the groundwater pressures observed over time at the site. Moreover, the model that was developed for use in the RD/RAWP is a three dimensional (3D) model of the entire saturated subsurface at ST012. Both of the groundwater flow models presented in the TEE Pilot Test Evaluation Report attempt to represent the LSZ and UWBZ as separate, decoupled 3D models. The groundwater flow model developed and used in the RD/RAWP combines each of the hydrostratigraphic units; LSZ, LPZ, UWBZ and CZ, as well as the vadose zone into one 3D model. The model was then calibrated using time-varying constant head boundaries as well as the hydraulic conductivity zones represented in the Appendix M TEE Pilot Test Report. As such the model in the RD/RAWP, while using the hydraulic conductivity fields from the TEE Pilot Test Evaluation Report, incorporates several improvements. The introductory paragraph of Section 2 in the Appendix has been revised as follows: “The groundwater flow model created for this project uses a well-documented and well-accepted finite-difference code called MODFLOW-SURFACT, an enhanced version of the widely used U.S. Geological Survey program. The groundwater flow model created for this project is roughly based on the fate and transport model created for the Thermal Enhanced Extraction (TEE) Pilot Test Report (Appendix M, BEM,

Item	Page	Section	Line(s)	EPA Comment	Air Force (AF) Response to Comment (RTC)
					2010) using most of the same data and model variables, but with several improvements incorporated including: (1) combining separate models for the UWBZ and LSZ from the TEE Pilot Test Report into one combined 3D model that incorporates all of the geologic zones of interest; (2) incorporation of additional information recently developed based on the Pre-Design Investigation (presented in Section 3.2.1 and 3.2.1.1 of the Remedial Design and Remedial Action Work Plan [RD/RAWP]) on the configuration and thicknesses of the hydrostratigraphic units; (3) recalibration using time varying constant head boundaries; and (4) incorporating the extent of the separate phase LNAPL. The model was created using the Groundwater Vistas, version 5, software."
14		Appendix E, Section 5		Section 5 describes groundwater flow modeling to demonstrate containment during SEE. However, the model fails to consider the formation of a steam zone in the subsurface as steam is injected, and the fact that steam will displace considerably more (approximately 1500 times more) groundwater than would be displaced by the same weight of water. Thus, it is not clear that the modeling, as it was performed, is meaningful to demonstrate containment during SEE operations. Monitoring of surrounding wells during operations will be a better (although not perfect) indication of	The groundwater and air flow models are an approximation of the anticipated flow regime; however, the groundwater flow model is an isothermic, single-phase flow model and the air flow model is isothermic. Injected steam, groundwater, LNAPL, and extracted fluids are all simulated as ambient temperature water in the groundwater flow model. Similarly the air flow model attempts to simulate steam flow as an ideal gas within the framework of the Richard's equation and partially water saturated porous media. Major assumptions for the flow models lead to limitations as described in the model report.

Item	Page	Section	Line(s)	EPA Comment	Air Force (AF) Response to Comment (RTC)
				whether or not containment is being maintained. The monitoring should be expanded to ensure that all areas where there is the potential for LNAPL to be pushed away from the TTZ are monitored (see comment #8).	As described in the comment, the difference volumetrically between the injected steam and equivalent weight of water is large and this leads to less conservatism in the approximation. On the other hand, by ignoring the increase in conductivity in the TTZ via heating and the rapid condensation of steam in and at the edges of the TTZ, the approximation overestimates the potential for flow from injection wells to escape the warmed TTZ and the gradients imposed at the extraction well locations. The approximations presented in the model report do not numerically simulate the increased conductivity due to temperature rise in the TTZ or the ambient temperature boundary at the edge of the TTZ. However, the model has some utility in assessing the expected flow regimes in the horizontal and vertical directions as well as the expected relative distributions of flow across and between the planned well fields. The primary means of assuring containment during SEE will be systematic startup procedures and continuous monitoring at sentinel wells and temperature monitoring locations. A description of this procedure is included in the RD/RAWP (Appendix D, Section 6.3). These procedures include bringing the SEE online in stages. Steam injection will be started in the LSZ and will not progress upwards to the UWBZ or CZ until containment is established and confirmed. Additionally, perimeter wells

Item	Page	Section	Line(s)	EPA Comment	Air Force (AF) Response to Comment (RTC)
					around the TTZ will be utilized as extraction wells to maintain hydraulic and NAPL containment.
15		Figures E-4.2 thru E-4.4		Based on the data collected during the pre-design investigation and during the current effort to install wells for the SEE system (data presented during the November 19, 2013 BCT meeting), it does not appear that the full extent of possible LNAPL is covered by the recirculation system for the EBR. There is the potential for significant contamination to be present to the south in the LSZ in the tank farm area based on the results at ST012-LSZ11 and ST012-LSZ39, and to the north, based on the results at ST012-LSZ7[sic, assumed to mean ST012-LSZ17]. The results for ST012-LSZ39 presented during the BCT also indicated the potential for LNAPL in the upper water bearing zone (UWBZ) in this area. Figure E-4.2 shows that the recirculation system does not cover the full extent of expected LNAPL in the cobble zone (CZ).	The RD/RAWP is based on the data available up through the PDI (i.e., it does not incorporate most recent data [e.g., ST012-LSZ39] which will be included in an addendum once drilling and initial groundwater sampling are complete). As indicated in Section 3.5 and Appendix E Section 4.0 of the RD/RAWP, the EBR design is conceptual at this time. Additional data collected prior to, during and at completion of SEE implementation, including the EBR Field Test, will be used to finalize the EBR layout.
16		Appendix E, Section 4.1		The section states, “The remediation well screen sections in the UWBZ were refined based on particle tracking analysis conducted using the groundwater flow model. Initially the remediation well screens were positioned across the entire thickness of the UWBZ… however, due to the high conductivity of the overlying CZ a large	The top of the screen section of injection well ST012-UWBZ07 used in the pilot test was installed at 168 feet below ground surface or around 10-feet below the interface between the UWBZ and CZ. This injection well approach/design is consistent with the findings in the model. Placement of the top of the screen of the injection wells in close

ED_005025_00013386-00801

Item	Page	Section	Line(s)	EPA Comment	Air Force (AF) Response to Comment (RTC)
				portion of injected liquids traveled rapidly upwards exiting into the CZ." This seems contradictory to the findings during the TEE pilot test, as interpreted by TerraTherm, "The low-permeability zone below the CZ seemed to contain the steam from the UWBZ, as evidenced by the slow heating of this layer, and minimal heating of the CZ." (Appendix D, p. 15)	proximity to the interface between the CZ and UWBZ promotes rapid transport of injectate into the UWBZ upwards and into the CZ. This is a result of the short distance to the CZ and the low relative permeability in the upper portion of the UWBZ. Placement of the top of the screen about 10 feet lower than the interface allows the top portion of the UWBZ to contain the steam as interpreted from the Pilot Test. The following was added to the end of 4th paragraph in Section 4.1: "The actual design of steam injection wells and extraction wells includes screen sections that extend from about 10 feet below the CZ/UWBZ interface to the bottom of the UWBZ. This configuration is consistent with the design used during the TEE Pilot Test."
17		Appendix E	Table E-4.8	Table E-4.8 is entitled, Estimated LNAPL Volume in EBR Treatment Zones Following SEE Treatment, however, the footnotes indicated the data in the table is based on the pre-design investigation report. Please clarify whether these volumes and saturations are pre- or post SEE treatment.	The volumes are estimated based on the PDI data and subtracting out the SEE treatment areas to estimate what will be left following SEE treatment. LNAPL volume located outside the SEE TTZs is assumed to remain the same before and after SEE. This has been clarified with the revision of Note 1 to: "Based on RD/RAWP Appendix B for conservative LNAPL interpretation for LNAPL outside of the TTZs in the EBR Treatment Zones assuming no removal outside the TTZs during SEE." Referring to

Item	Page	Section	Line(s)	EPA Comment	Air Force (AF) Response to Comment (RTC)
					the saturation percentages, the statements "prior to SEE" and "Pre SEE" were intended to demonstrate that the saturation percentages were calculated using PDI data, thus reflecting conditions prior to remedial action, and also included TPH samples from locations within future SEE TTZs. The statements "prior to SEE" and "Pre SEE" have been removed and the following sentence has been added prior to Table E-4.8 to clarify the nature of the saturation percentages: "The LNAPL saturation percentages were calculated using the TPH analytical data from the PDI, including samples from SEE TTZs in addition to samples from EBR treatment zones, but they are assumed to be representative of the EBR treatment areas following SEE treatment."
18		Appendix H, WS 11	Step 2	Step 2 lists one decision statement of the Work Plan as, "Do dissolved phase benzene and TPH concentration data indicate reduction of possible LNAPL at the well locations within the treatment area during the SEE system operation?" It is not clear that the sampling required to answer this question is included in the Sampling and Analysis Plan presented in Section 5.6.3 of the RD/RAWP, which only states that liquid samples "may be collected from individual MPE wells…" and does not state what analysis will be performed on the samples.	Additional detail on sampling strategy is as follows. Sampling begins with composite extracted fluids and vapors at the inlet to the treatment systems and vapor sampling by handheld devices throughout the manifolds. As remediation progresses, vapor and/or water samples will be collected from individual manifolds and, in some cases, individual wells to identify areas of the site that are taking longer to cleanup so that operational adjustments can be made. The sampling program is flexible to adapt to conditions observed during operation;

ED_005025_00013386-00803

Item	Page	Section	Line(s)	EPA Comment	Air Force (AF) Response to Comment (RTC)
					however, the general strategy will be outlined in the document. Sample results will be documented as described in the response to Comment 7 with expedited summaries provided near the end of the project to support decisions on steam termination. Tables 5-2, 5-3 and 5-4 were added to Section 5.6.3 to provide additional details on operational sampling. The following bullet has been added in Section 5.6.3 concerning liquid samples: "Extracted groundwater samples will be collected throughout operations to track progress of remediation and progress toward the benzene criteria for transition to EBR. Samples will be analyzed for VOCs by method 8260B. Some samples may also be sample for TPH by method 8015M. Samples will primarily be collected from the combined liquid at the inlet to the water treatment system; however, as progress approaches a decision for transition to EBR, samples may be collected from individual extraction manifolds and individual wells to evaluate what areas of the site and what individual wells are contributing the highest VOCs. Decisions on sample locations and frequency will be made by the operators."
19		Appendix H, WS 12		Another objective of the sampling, which does not appear to be included in the problem definition and decisions, should be to collect data to aid in determining when to	The comment pertains to worksheet 11. The following bullet has been added in Step 1: "Evaluate progress of SEE treatment and

Item	Page	Section	Line(s)	EPA Comment	Air Force (AF) Response to Comment (RTC)
				terminate steam injection and transition to EBR.	determine when to transition to EBR." In addition, the following bullets have been added in Step 2. • "Have subsurface temperature goals been achieved? • Has pressure cycling been completed showing diminished enhancement of VOC removal with further cycles? • Has mass removal decreased following pressure cycling to rates less than or equal to the peak mass removal rate? • Have dissolved phase benzene concentrations achieved the performance criteria for transition to EBR? • Has steam injected at the site approached amounts predicted by the thermal modeling?"
20		Appendix H, WS 12	Step 3	Step 3 states, "VOC and TPH results for air will be the primary input for decisions relative to system performance". However, LNAPL recovery and dissolved phase concentrations also will significantly affect decisions relative to system performance.	The comment pertains to worksheet 11. The sentence has been revised as follows: "VOC and TPH results for air along with LNAPL recovery and dissolved phase VOC concentrations will be the primary…" The following has been added to the end of the first paragraph in Step 3: "Temperature goals will be monitored

Item	Page	Section	Line(s)	EPA Comment	Air Force (AF) Response to Comment (RTC)
					through thermocouples installed throughout the site (not detailed further in the QAPP/SAP). Pressure cycling evaluations and mass removal rates will be evaluated through LNAPL quantity tracking (not detailed further in the QAPP/SAP), flame ionization detector monitoring (not detailed further in the QAPP/SAP), supplemented with operational samples collected for laboratory analysis. Steam injection will be monitored through process instrumentation."
21		Appendix H, WS 12	Step 4	Should the CZ be included in the Study Boundaries?	The comment pertains to worksheet 11. CZ has been added as part of the study area.
22		Appendix H, WS 12	Table 12.1	In the second column, should the EPA Method be 8260 rather than 8060?	The change has been made.
23		Appendix H, WS 15		Although naphthalene does not currently exceed cleanup criteria over large areas, it is possible that naphthalene concentrations in groundwater could increase following SEE treatment in areas that are not fully treated due to the fact that its effective solubility will increase after lower boiling compounds (such as benzene, toluene, ethyl benzene, and xylene) are substantially removed.	The AF acknowledges that the effective solubility of naphthalene in remaining LNAPL may increase as a result of volatilization of the lower boiling compounds and will be monitored and evaluated during SEE treatment. LNAPL mobilization to extraction wells due to viscosity reductions is expected to remove a significant mass of naphthalene as part of liquid removals from the site.
24		Appendix H, WS 18		Will groundwater samples from within the SEE TTZ be analyzed during and after SEE operations? This does not appear to be included in the tables, however, benzene concentrations are proposed as one line of	Baseline groundwater samples will be collected from each of the SEE wells prior to SEE implementation. The benzene performance metrics for transition from SEE to EBR will be based on extracted fluids from

ED_005025_00013386-00806

Item	Page	Section	Line(s)	EPA Comment	Air Force (AF) Response to Comment (RTC)
				evidence on which to decide when steam injection should be terminated; thus, groundwater samples must be obtained during SEE treatment to have this information available for decision making. Groundwater samples are generally also taken post-SEE operations in order to determine remaining contamination levels.	the SEE system. Sampling of extracted liquids will require a cooling loop. Separate groundwater monitoring wells and sampling is not recommended during SEE for safety reasons. Groundwater samples will be taken post SEE as part of EBR implementation and will be detailed in an update to the RD/RAWP with the final EBR design. Liquid samples to support the benzene performance metrics have been added to the end of Table 18.4. Item number 4 in Section 4.3 as modified to: ”Refine the EBR system design and document in an RD/RAWP update including well field and process equipment selection and groundwater sampling to evaluate post SEE conditions;”
25		Appendix H, WS 33, Section 33.1		How will SEE operation data be made available to the regulatory agencies? Due to the fact that operations proceed very quickly during thermal remediation, it is recommended that reporting be done at least monthly rather than quarterly during operations. More frequent communications are likely to be recommended as the system approaches diminishing returns, and discussions are underway on when to terminate steam injection.	The following text has been added at the end of worksheet 33: “The following will be posted to the AMEC document exchange sharepoint site: • Weekly summary progress reports • Unvalidated data upon receipt from the laboratory • Summary data tables as needed to support operational changes and transition decisions”

ED_005025_00013386-00807

RESPONSE TO ADEQ COMMENTS DATED 7 NOVEMBER 2013
DRAFT REMEDIAL DESIGN AND REMEDIAL ACTION WORK PLAN, OPERABLE UNIT 2, ST012
FORMER WILLIAMS AFB, MESA, ARIZONA

Item	Page	Section	Line(s)	ADEQ Comment	Air Force (AF) Response to Comment (RTC)
General Comments					
1				Actions and contingencies should be developed and implemented (as needed) to minimize contaminant mobilization away from capture and extraction areas.	Control of contaminant capture will be managed through operational approaches to steam injection and monitoring of temperature, hydraulic gradients, LNAPL presence, and benzene concentrations. Contingencies will consist of adjustments to steam injection, and, in some cases could include ceasing steam injection and implementing extraction in problem areas. Actions and contingencies to minimize contaminant mobilization away from capture and extraction areas have been summarized in Sections 4.2.2 and 5.8 with the following: "Monitoring of temperature within and at the perimeter of SEE, groundwater elevations and LNAPL accumulation outside the TTZ, and perimeter groundwater benzene concentrations will be used to demonstrate containment. Should loss of containment occur, steam injection in the area will be adjusted (reduced pressure or terminated). In some cases extraction may be increased in an area or a well may be converted from an injection to an extraction well. Monitoring will be performed to establish that containment has been re-established. If loss of containment continues, other actions may be considered in consultation with the Air Force and regulatory agencies."

ED_005025_00013386-00808

Item	Page	Section	Line(s)	ADEQ Comment	Air Force (AF) Response to Comment (RTC)
Specific Comments					
1	2-2	2.1	341	The text should refer to ROD Amendment 2.	The change has been made.
2	3-9	Table 3-5		The column 3 heading should be revised to read “Overall Ratio of Extraction to Injection”.	The change has been made.
3	3-10	3.3	814	Change “temperate” to “temperature”.	The change has been made.
4	4-6	4.2.3	1291	Change “ROAs” to “RAOs”.	The change has been made.
5	4-11	4.4.1	1486	The text should refer to ROD Amendment 2.	The change has been made.
6	5-2	5.6.5	1784	Change “ERB” to “EBR”.	The change has been made.
7	5-3	5.8	1820	Revise the text to read “…pathways to the surface”.	The change has been made.
8		Figures 3-4 thru 3-6		Indicate in the title block of each Figure that the recirculation pathlines are for the EBR system.	The changes have been made.
9		Appendix A	Attachment A.7	Change “min” to “sec” (three instances).	The changes have been made.
10	2	Appendix B	Item B	The text includes several grammatical and typographical errors.	The changes have been made.
11		Appendix B	Figure B-3	Add CZ/UWBZ, LSZ, and TTZ to the Figure notes.	The changes have been made.
12		Appendix B	Figures B-	The treatment zone boundaries should be	The figures have been updated.

ED_005025_00013386-00809

Item	Page	Section	Line(s)	ADEQ Comment	Air Force (AF) Response to Comment (RTC)
			3 and B-4	updated to show the revised and expanded zones.	
13		Appendix C	Drawing C103	Items in the legend should be revised to "Lower Saturated Zone *TTZ* Boundary" and "Upper Water Bearing Zone *TTZ* Boundary".	The revisions have been made.
14		Appendix C	Drawing M102	Well CZ16 is not shown connected to the wellfield piping.	The connection has been added.
15		Appendix D		List of figures includes Figures 5.6 and 5.7. However, Figure 5.5 is the last figure in the Section.	Figures 5-6 and 5-7 are not included in Appendix D and have been removed from the list of figures.
16	4-8	Appendix E	474	Words are missing from the end of the first sentence.	The phrase "to aerobic bacteria", has been added to the end of the sentence.
17	4-14	Appendix E		In the first paragraph, the discussion should reference table E-4.14 rather than Table E-4.13. In addition, the values cited in the text do not match those in Table E-4.14.	Table reference has been corrected. Text summarizes approximate values which are rounded to one significant digit compared to the table. Average concentration has been removed from the text.
18		Appendix G	Table G-1	The table should include a column describing the new well construction.	The purpose of the table is to establish the coordinates of the wells and identify new wells vs. wells installed at locations of existing wells. A note has been added to Table G-1 as follows: "Well construction details for the new wells and temperature monitoring points are detailed on the Construction Drawings (Appendix C)."

Item	Page	Section	Line(s)	ADEQ Comment	Air Force (AF) Response to Comment (RTC)
19		QAPP/SAP WS No. 2		Add ADEQ to Item #3.	The change has been made.
20		QAPP/SAP WS No. 12	Table 12-1	Change 8060 to 8260.	The change has been made.
21		QAPP/SAP WS No. 17, Section 17.1.2		The text states the listed wells are located along Sossaman Rd., although several of the wells are situated on the north, south, or west boundaries of the site. Please revise the text accordingly.	The change has been made to indicate perimeter monitoring wells are located on Sossaman Rd as well as on the north, south, and west boundaries of the site.
22	2	SOP No. 1, Section 3.0	Paragraph 3	The SOP specifies that equipment rinseate blanks will be collected to verify the adequacy of the decontamination process. The SOP should also specify the frequency of rinseate collection or refer to the applicable section of the QAPP or other document that does specify the frequency.	The following has been added to end of the paragraph: "Equipment rinsate blank frequency will be as indicated in QAPP worksheet No. 20, *Field Quality Control Sample Summary Table.*"
23	3	SOP No. 1, Section 3.1.2.4		This section should specify that any reels or rope, etc. that will be re-used with the disposable bailers will be decontaminated between uses.	The following text has been added: "However, any reels, rope, or like-materials to be reused with the disposable bailers will be decontaminated between uses."
24		SOP No. 2		SOP No. 2 indicates that a falling head test should not be completed in wells where the well is screened across the water table. This is due to the effect and influence of the filter pack as the rising water column saturates and then drains from the filter pack as well as possibly the unsaturated formation. We note that although a rising head test is certainly an acceptable alternative as suggested by the SOP, and	This comment pertains to SOP 9. Comment is acknowledged; however, AMEC preference will be to use rising head tests in these wells. Falling and rising head tests have been separated (see comment 26). The introduction to rising and falling head test tests (2.3.1) now indicates:

Item	Page	Section	Line(s)	ADEQ Comment	Air Force (AF) Response to Comment (RTC)
				may be preferable given the specifics of the well and aquifer, it is possible to conduct and successfully interpret falling head tests in wells screened across the water table. Multiple analytical solutions for slug test data, including the commonly used Bouwer and Rice method, provide corrections for effective casing radius to address this phenomenon, and research has indicated that traditional analytical methods, when corrected for effective casing radius, provide reasonable results for falling head tests in partially submerged wells.	"In any well where the screen extends above the water table, a rising head test should be used."
25	2	SOP No. 2, Section 2.1.2		Section includes a reference to the Slug Test Data Form. Include a copy of the form as an attachment to this SOP.	This comment pertains to SOP 9. Slug test data form has been provided. In some cases, pressure transducers will be used in lieu of the form. The following text has been added to the fifth bullet under Section 2.1.2: "(pressure transducers will be used in lieu of the form in some cases)"
26	2	SOP No. 2, Section 2.1.3		This section should be broken down into Section 2.1.3.1 Falling Head Tests, and Section 2.1.3.2 Rising Head Tests	This comment pertains to SOP 9. Section 2.1.3 of SOP No. 9 has been broken down into 2.1.3.1 Falling Head Tests and 2.1.3.2 Rising Head Tests.
27	5	SOP No. 2, Section 2.1.3		Item 12 states that if the water level has not recovered sufficiently within one hour, then measurements should continue at 0.5-hour intervals for 6 hours and at	This comment pertains to SOP 9. The sentence regarding taking readings at 0.5-hour intervals for six hours in item 12 has been deleted.

ED_005025_00013386-00812

Item	Page	Section	Line(s)	ADEQ Comment	Air Force (AF) Response to Comment (RTC)
				1-hour intervals thereafter. However, item 14 states that, if the water level has not recovered to within 90% of the pre-test measurement, the test may be stopped after 2 hours. One or both of these statements should be revised to ensure consistency.	
28	6	SOP No. 2, Section 2.1.4		The section should be revised as follows: **Section 2.1.4 Pneumatic Rising Head Tests,** followed by **Section 2.1.4.1 Pneumatic Rising Head Test Equipment,** followed by **Section 2.1.4.2 Procedures.** The new section 2.1.4.2 should describe in detail the progression of tasks required to complete the test, following the format of Section 2.1.3.	This comment pertains to SOP 9. Sections **2.1.4.1 Pneumatic Rising Head Test Equipment** and **2.1.4.2 Procedures** were added. The new section 2.1.4.2 describes in detail the progression of tasks required to complete the pneumatic rising head test following the format of Section 2.1.3.
29	10	SOP No. 2, Section 2.3.2		Add a statement that emphasizes the importance of maintaining a constant pumping rate for the duration of the test.	This comment pertains to SOP 9. The following statement was added to the existing sentence: “but instead of increasing the pumping rate throughout the test, it is important to maintain a constant pumping rate for the duration of the test.”
30	4	SOP No. 10D, Section 2.1.2.3		A total maximum drawdown of 0.3 feet may be difficult to achieve due to aquifer heterogeneity. The SOP should indicate that if drawdown exceeds 0.3 feet during purging, then the purge rate should be lowered and the drawdown re-evaluated during the next measurement interval.	SOP has been modified to include suggested change. The following text has replaced sentence 5 in this section. “If drawdown exceeds 0.3 feet during purging, the purge rate should be lowered and the drawdown re-evaluated during the next

Item	Page	Section	Line(s)	ADEQ Comment	Air Force (AF) Response to Comment (RTC)
				Multiple iterations may be necessary (continuing to lower the purge rate if needed down to 0.1 L/min or the least practical rate) with at least 3-5 minutes to observe and evaluate the drawdown before abandoning the low-flow purge method in favor of a total well volume purge method. Once the appropriate purge rate is found, the water level will often stabilize and cease to continue to drawdown, but this water level may exceed 0.3 feet drawdown from the water level at the start of the purge. This should be considered acceptable for low flow sampling and preferable to a total well volume purge method, especially if the other water quality parameters are stable. The overall goal is to minimize stress to the system and collect a representative sample.	measurement interval. Multiple iterations may be necessary (continuing to lower the purge rate if needed down to 0.1 L/min or the least practical rate) with at least 3-5 minutes to observe and evaluate the drawdown before abandoning the low-flow purge method in favor of a total well volume purge method. If the drawdown still exceeds 0.3 feet once the appropriate purge rate is found, the low flow purge rate may still be acceptable if the other water quality parameters are stable. If drawdown continues to exceed 0.3 feet and the other water quality parameters are unstable, then the Total Well Volume Methodology will be followed."
31	5	SOP No. 10D, Section 2.1.2.3.1	4th bullet	Include a statement describing the rationale for choosing 5-ft below the water table for placement of the pump. According to the US EPA, (see US EPA, 1996, *Low Flow (Minimal Drawdown) Ground-Water Sampling Procedures)*, the ideal pump intake location is near the middle, or slightly above the middle of the well screened interval. Setting the pump 5-ft below the water table may be appropriate for most of the Upper Unit wells where the screened interval intersects the water table. However, in wells that are affected by active remediation, it may be more	The criteria for pump placement during low flow sampling was established as a consistent methodology in current and prior ST012 groundwater monitoring plans to obtain representative samples for submerged and unsubmerged screens given the rising groundwater levels. Low flow sampling will be conducted within and around the TTZs prior to startup and outside the TTZs during operation. Sampling of individual wells within the TTZs is not recommended during active steam remediation due to safety concerns. Since the entire impacted saturated zone above the aquitard will be addressed by the zone of

Item	Page	Section	Line(s)	ADEQ Comment	Air Force (AF) Response to Comment (RTC)
				appropriate to set the pump intake within the zone of remediation.	remediation, the sampling procedure remains appropriate.
32	5	SOP No. 10D, Section 2.1.2.3.1	7th bullet	The discussion on field parameter stabilization should be modified to comply with US EPA guidance for low flow purging, which recommends that three successive readings should be within ± 3% for temperature, ± 3% for conductivity, ± 0.1 for pH, ± 10 mV for redox potential (ORP), and ± 10% for turbidity and DO (see US EPA, 1996, *Low Flow (Minimal Drawdown) Ground-Water Sampling Procedures, pg. 8;* and US EPA, 2010, *Low Stress (low flow) Purging and Sampling Procedure for the Collection of Groundwater Samples, pg. 17)*.	The bullet has been updated to be consistent with these guidelines.
33		SOP No. 10D, Section 2.1.2.3.1		The section should specify the use of a flow-through cell, with inflow at the bottom of the cell and outflow at the top, to be used in conjunction with the water quality meter. The text should include a statement that after collection of the samples, the water quality meter will be reconnected to the purge-line, and final post-sampling water quality measurements recorded.	A bullet has been added to section 2.1.2.3.1 as follows: "A flow-through cell will be used in conjunction with the water quality meter, with inflow at the bottom of the cell and outflow at the top." A bullet has also been added Section 2.1.2.3.2 as follows: "After collection of the samples, the water quality meter will be reconnected to the purge-line, and final post sampling water quality measurements will be recorded."