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**UNITED STATES AIR FORCE  
JOINT BASE ELMENDORF-RICHARDSON  
ALASKA**

***ENVIRONMENTAL RESTORATION PROGRAM***

**2016 ANNUAL REMEDIAL ACTION-OPERATIONS AND  
MONITORING REPORT FOR SELECT CERCLA SITES**

**FINAL**

**MAY 2018**





FINAL

2016 ANNUAL REMEDIAL ACTION-OPERATIONS AND  
MONITORING REPORT FOR SELECT  
CERCLA SITES

JOINT BASE ELMENDORF-RICHARDSON, ALASKA

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APPENDIX B — Land Use Control Inspection Forms

APPENDIX C — Analytical Laboratory Data Reports (on CD only)

Analytical Data Tables, Excel Spreadsheets (on CD only)

Analytical Data QA/QC Summary Report (JBER-E) and Analytical Data  
Quality Evaluation Report (JBER-R)

Alaska Department of Environmental Conservation Laboratory  
Data Review Checklists

Mann-Kendall Trend Test Analysis Records

Historical Data and Mann-Kendall Summary



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## LIST OF ACRONYMS

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°C	degree(s) Celsius
µg/g	microgram(s) per gram
µg/kg	microgram(s) per kilogram
µg/L	microgram(s) per liter
µmol/L	micromole(s) per liter
AAC	Alaska Administrative Code
ACM	asbestos-containing material
ADEC	Alaska Department of Environmental Conservation
AFCEC	Air Force Civil Engineer Center
AFCEE	Air Force Center for Environmental Excellence
AFID	Air Force Identification
AMSL	above mean sea level
ARAR	applicable or relevant and appropriate requirement
AVMA	Armored Vehicle Maintenance Area
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, total xylenes
CaCO <sub>3</sub>	calcium carbonate
CAH	chlorinated aliphatic hydrocarbon
CAIS	Chemical Agent Identification Set
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CH2M HILL	CH2M HILL Constructors, Inc.
cm/sec	centimeters per second
COC	contaminant of concern
COPC	contaminant of potential concern
COV	coefficient of variation
CRREL	Cold Regions Research and Engineering Laboratory
DCA	dichloroethane
DCE	dichloroethene
DD	Decision Document
DHC	dehalococcoides
DNAPL	dense non-aqueous phase liquid
DO	dissolved oxygen
DPW	Directorate of Public Works
DRO	diesel-range organics
EAFB	Elmendorf Air Force Base
EMCON	EMCON Alaska, Inc.
EOD	Explosive Ordnance Disposal
EPA	U.S. Environmental Protection Agency
ERD	enhanced reductive dechlorination
ERF	Eagle River Flats
ERPIMS	Environmental Restoration Program Information Management Systems
ESD	Explanation of Significant Difference
EVO	emulsified vegetable oil
FD	field duplicate



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## LIST OF ACRONYMS (CONTINUED)

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ft	feet (foot)
ft/ft	foot per feet
FTOC	from top of casing
GIS	geographic information system
GRO	gasoline-range organics
HVE	high-vacuum extraction
IC	institutional control
ID	identification
I-RACR	Interim Remedial Action Completion Report
JBER	Joint Base Elmendorf-Richardson
JBER-E	JBER-Elmendorf
JBER-R	JBER-Richardson
JP-4	Jet Propulsion Fuel Number 4
LOD	limit of detection
LSI	Limited Site Investigation
LTM	long-term management
LUC	land use control
MAROS	Monitoring and Remediation Optimization System
MCL	maximum contaminant level
MDL	maximum detection limit
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
mm	millimeter(s)
MNA	monitored natural attenuation
mS/cm	milliSiemen(s) per centimeter
mV	millivolt(s)
NCP	National Contingency Plan
ND	non-detect
NFA	No Further Action
NPL	National Priorities List
NST	no statistically significant trend
NTU	Nephelometric Turbidity Unit
OB/OD	Open Burn/Open Detonation
OES	Optimized Exit Strategy
ORP	oxidation-reduction potential
OU	Operable Unit
PAH	polycyclic aromatic hydrocarbon
PBC	Performance-Based Contract
PBR	Performance Based Remediation
PCA	tetrachloroethane
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
PDB	Passive Diffusion Bag Sampler
PFAS	per- and polyfluorinated compounds



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## LIST OF ACRONYMS (CONTINUED)

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POL	petroleum, oil, and lubricants
PQL	practical quantitation limit
PVC	polyvinyl chloride
QA	quality assurance
QC	quality control
RAO	remedial action objective
RA-O	remedial action-operation
RBC	risk-based concentration
RC	Response Complete
RCRA	Resource Conservation and Recovery Act
RI/FS	remedial investigation/feasibility study
ROD	Record of Decision
RPO	remedial process optimization
RRO	residual-range organics
SERA	State-Elmendorf Environmental Restoration Agreement
SOP	standard operating procedures
SVE	soil vapor extraction
SVOC	semivolatile organic compound
TAH	total aromatic hydrocarbons
TAqH	total aqueous hydrocarbons
TCA	trichloroethane
TCE	trichloroethene
TFH	total fuel hydrocarbons
TOC	total organic carbon
TSCA	Toxic Substances Control Act
U.S. Army	United States Army
UCL	upper confidence limit
UFP-QAPP	Uniform Federal Policy-Quality Assurance Project Plan
USACE	U.S. Army Corps of Engineers
USAF	United States Air Force
UST	underground storage tank
UU/UE	unlimited use/unrestricted exposure
UXO	unexploded ordnance
VC	vinyl chloride
VFA	volatile fatty acid
VI	vapor intrusion
VOC	volatile organic compound
WESTON®	Weston Solutions, Inc.
WP	white phosphorus



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## 1.0 INTRODUCTION

This report summarizes the 2016 annual long-term management (LTM) activities, including remedial action-operation (RA-O) and Record of Decision (ROD) requirements conducted at Joint Base Elmendorf-Richardson (JBER) Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) sites. The United States Air Force (USAF) has mandated a reduction of long-term environmental liabilities and life-cycle costs through accelerated cleanup of contaminated sites. In April 2012, Weston Solutions, Inc. (WESTON<sup>®</sup>) was awarded a Performance Based Remediation (PBR) contract from the Air Force Civil Engineer Center (AFCEC) (Contract Number FA8903-09-D-8589, Task Order No. 0016). The contract includes performing RA-O and ROD requirements at several JBER sites. The WESTON team performing the activities summarized in this report consists of WESTON and CH2M HILL Constructors, Inc. (CH2M HILL). WESTON executed project work on sites located within JBER-Elmendorf (JBER-E), and CH2M HILL executed project work on sites located within JBER-Richardson (JBER-R). Figure 1-1 provides the location of each CERCLA site discussed in this report.

The former Elmendorf Air Force Base (EAFB) was proposed for the National Priorities List (NPL) in 1989 and was placed on the NPL in August 1990. In November 1991, a Federal Facility Agreement was negotiated between the USAF, the United States Environmental Protection Agency (EPA), and the Alaska Department of Environmental Conservation (ADEC), establishing a procedural framework and schedule for all CERCLA activities conducted on EAFB.

Many contaminated sites within JBER are the result of contamination related to petroleum spills and releases; however, provisions within CERCLA sections 101(14) and 104(a)(2) exclude petroleum related contamination from CERCLA hazardous substance regulation. Therefore, most contaminated sites related to petroleum spills and releases within JBER are governed by State of Alaska cleanup regulations. Notable exceptions are the petroleum related sites: SD025, ST041, and WP014, which are currently regulated under CERCLA.

In October 1992, the State-Elmendorf Environmental Restoration Agreement (SERA) was signed between EAFB and the ADEC. This cooperative agreement addressed the cleanup and restoration of sites contaminated with petroleum, oil, and lubricants (POL). The USAF and ADEC later agreed that the agreement was no longer necessary, and it was dissolved in October 2002. JBER now addresses the cleanup of any petroleum releases following contaminated site regulations under 18 Alaska Administrative Code (AAC) 75 and underground storage tank (UST) regulations under 18 AAC 78.

In June 1993, Fort Richardson was proposed for placement on the NPL, and a Federal Facility Agreement was established in December 1994 to address the cleanup of source areas under the CERCLA regulations. In April 1993, the former Fort Richardson signed a two-party agreement with ADEC (State-Fort Richardson UST Compliance Agreement) to bring Fort Richardson into compliance with UST regulations; in May 1994, the State-Fort Richardson Environmental

Restoration Agreement (a two-party agreement with ADEC) was signed to address the cleanup of source areas with releases of POL.

As part of the 2005 Base Realignment and Closure Act, EAFB (now referred to as JBER-E) was slated for realignment with Fort Richardson Army Post (now referred to as JBER-R). JBER-R is located on the eastern half of the Installation and JBER-E occupies the western portion. In 2010, EAFB merged with Fort Richardson and the installation was renamed JBER. In this merger, the USAF assumed the responsibility for cleanup of sites formerly managed by the United States Army (U.S. Army) and all of the former Fort Richardson environmental restoration agreements with the regulatory agencies.

Similar to the 2012 through 2015 Annual Reports, this annual RA-O and monitoring report was streamlined and condensed due to the large volume of documents that will be prepared for these sites during the period of performance for the PBR contract. Additional site information, including previous investigations not provided in the 2012 through 2015 Annual Field Activities Reports is included in the following 2011 reports:

- *2011 JBER Zones 1, 2, and 3 Annual Report* (United States Air Force [USAF], 2012a).
- *2011 Groundwater Monitoring and Borehole Sampling, Three-Party Agreement Sites: Operable Unit B Poleline Road Disposal Area and OUE Armored Vehicle Maintenance Area* (USAF, 2012b).

## **1.1 PURPOSE AND SCOPE**

This annual RA-O and Monitoring report summarizes the environmental activities conducted in 2016 including sampling, analysis, debris removal, and land use control (LUC) inspections. Fieldwork conducted in 2016 followed the ADEC and EPA-approved *2015 Remedial Action-Operations and Monitoring Letter Work Plan Addendum* (USAF, 2015a) and the *Remedial Action-Operations Monitoring Letter Work Plan and Basewide Uniform Federal Policy-Quality Assurance Project Plan (UFP-QAPP) Addendum* (USAF, 2017a). These letter work plans referenced the procedures for performing fieldwork in the *Final Basewide UFP-QAPP, Revision 1, Joint Base Elmendorf-Richardson, Alaska* (Basewide UFP-QAPP) (USAF, 2014a). Laboratory quality assurance and control (QA/QC) criteria for this project are specified in the *Basewide UFP-QAPP 2016 Field Activities Overview*.

This section presents an overview of sampling activities, monitoring well maintenance and flagging activities, Site LF04 debris removal, and LUC inspections.

### ***1.1.1 Sampling Activities***

Groundwater, surface water and seep sampling at JBER was conducted following procedures outlined in standard operating procedures (SOPs) in the *Basewide UFP-QAPP* (USAF, 2014a). Field activities (e.g., sampling, field screening) were documented in logbooks and field forms and are included in Appendix A of this report. Electronic data were hand entered into Environmental Restoration Program Information Management Systems (ERPIMS).

Field parameters measured at the time of groundwater sample collection from monitoring wells include monitored natural attenuation (MNA) parameters pH, conductivity, dissolved oxygen (DO), oxidation-reduction potential (ORP), temperature and turbidity. MNA field parameters are presented in each site section.

In 2007, the USAF conducted a remedial process optimization (RPO) of the groundwater monitoring program at JBER-E. In the 2007 RPO evaluation, it was determined that EAFB had already begun optimizing the groundwater monitoring program by “developing criteria to rank groundwater plumes in terms of risk (in 2003),” “using simple mass-based methods to evaluate plume behavior (in 2005),” “focusing on managing risk of exposure rather than managing the contaminant plume (in 2006),” and had “dropping MNA parameters from the LF059 monitoring program (in 2006).” Following these RPO findings, a recommendation was made in the 2008 Zone 3 Annual Report (August 2009) to “reduce the frequency of laboratory MNA parameter collection to once every five years,” as this collection frequency was thought to be sufficient for evaluating conditions at each site. JBER-E will collect laboratory MNA parameters once every 5 years. Laboratory MNA parameters were collected in 2015. EPA requested this to be revised so the laboratory MNA sample timing coincided with the next Five-Year Review. Therefore, the next laboratory MNA sampling event for JBER-E will take place in 2017 to occur before the 2019 Five-Year review.

### **1.1.2 Monitoring Well Maintenance**

Monitoring well maintenance performed based on the observed condition of monitoring wells included replacement of well caps, locks or bolts. Monitoring wells with inner polyvinyl chloride (PVC) casings found to be frost heaved and which hindered the closing of the outer casing were cut down. A professional surveyor, licensed in the State of Alaska, determined the northing, easting, ground surface elevation, and top of casing elevation (as necessary) for all modified monitoring points. Well maintenance performed in 2016 is included in the individual Field Activities and Results sections for each site. Monitoring well survey data are in Appendix A.

### **1.1.3 Monitoring Well Flagging**

Monitoring wells located on JBER-E near roads or winter snowmobile trails are flagged seasonally with 8-foot tall orange snow poles for safety. Most snow poles were removed in the spring and reinstalled in October 2016. However, some were left in place for visibility to nearby construction activities or to enhance visibility of the monitoring well locations amid dense vegetation. All of the flags left in place were checked in fall 2016 to ensure they were in good condition. A list of flagged monitoring wells is included in Appendix A.

### **1.1.4 LF04 Erosion Survey and Debris Removal**

In accordance with the *Source LF04 Operations and Management Plan* (USAF, 2010a) and *LF04 Memorandum to the Site File* (USAF, 2008a) an erosion survey and debris removal was to be conducted on an annual basis. In accordance with recommendations made in the 2013 Five-Year Review, a *Memorandum to the Site File: Operable Unit 6* (USAF, 2016a) was prepared to reduce

the erosion survey and debris removal frequency at LF04 from annually to once every 3 years. During the 2016 field season exposed debris at the base of the LF04 bluff was surveyed, removed (where possible) and appropriately disposed of. The next erosion survey and debris removal is scheduled for the 2019 field season.

Access to the LF04 bluff area was coordinated with the Port of Anchorage before entering the secured site. Prior to LF04 site work, Base explosive ordnance disposal (EOD) personnel were asked to conduct a sweep of the area to identify and remove any potentially dangerous ordnance. Field personnel were also given unexploded ordnance (UXO) awareness training by EOD personnel prior to going onsite. After clearance and training by Base EOD, field personnel surveyed, classified and photographed all debris, and established its geodetic location. The discovery of any potential UXO is reported to Base EOD personnel. Nonhazardous debris that fell from the hillside was loaded onto vehicles for transport to an on-site staging area. Debris was then transferred to Anchorage Municipal Landfill. Field notes, a photograph log and disposal receipt are in Appendix A. Information regarding the 2016 erosion survey and debris removal is provided in Section 6.3.1.

#### ***1.1.5 Land Use Controls Inspection***

CERCLA sites require LUC inspections to ensure soils have not been disturbed and transported off-site without proper permits. Table 1-1 identifies groundwater monitoring and LUC inspection requirements, and Air Force and ADEC site status. These inspections include looking for evidence of excavation, drilling, monitoring well installation, groundwater usage, and/or damage to remedial systems and monitoring wells. LUC inspections were performed at each site from September to October 2016 in accordance with the *Final Land Use Controls Management Plan; Elmendorf Air Force Base, Alaska (USAF, 2003a)*. No significant LUC issues were identified. Table 1-2 lists the recommended future maintenance activities identified during the LUC inspections. These repairs will be addressed during the 2017 field season. The 2016 LUC Inspection Checklist forms and photograph logs for each site are in Appendix B.

#### ***1.1.6 Major 2016 Activities Not Included in this Report***

The following additional field activities occurred in 2016 outside of the PBR contract (Contract Number FA8903-09-D-8589, Task Order No. 0016):

- PFAS Site Inspections
- Vapor Intrusion Sampling
- Sampling of groundwater for 1,4-dioxane

Work was conducted under separate work plans and results will be provided in separate reports.

**Table 1-1 Land Use Control Inspections**

Site Name (AFID)	Groundwater Monitoring Required (Yes/No)	LUC Inspection Required (Yes/No)	Air Force/ADEC Site Status
<b>JBER-Elmendorf</b>			
DP098	Yes	Yes	RA-O / Active
FT023	Yes	Yes	RA-O / Active
LF002	No	Yes	RA-O / Cleanup Complete - ICs
LF003	No	Yes	RC (LTM) / Cleanup Complete - ICs
LF004	Yes	Yes	RA-O / Active
LF059	No	Yes	RA-O / Cleanup Complete - ICs
SD015	Yes	Yes	RA-O / Active
SD024	No	Yes	RA-O / Active
SD025	Yes	Yes	RA-O / Cleanup Complete - ICs
SD029	Yes	Yes	RA-O / Active
ST037	Yes	Yes	RA-O / Active
ST041	Yes	Yes	RA-O / Active
WP014	Yes	Yes	RA-O / Active
<b>JBER-Richardson</b>			
CG039	Yes	Yes	RA-O / Active
DA089	Yes	Yes	RC / Active
SS044 <sup>a</sup>	Yes	Yes	RC / Cleanup Complete - ICs
XE023	No	Yes	RC / Active
XU022	No	Yes	RC / Active

**Notes:**

<sup>a</sup> An Air Force administrative control manages PCBs remaining in soil above the levels for high-occupancy areas.  
 ADEC = Alaska Department of Environmental Conservation  
 AFID = Air Force Identification  
 IC = Institutional Control  
 LTM = long term management  
 RA-O = remedial action-operation  
 RC = response complete

**Table 1-2 Future Well Maintenance**

Site Name (AFID)	Monitoring Well ID	Repairs Required
<b>JBER-Elmendorf</b>		
DP098	41755WL-03	Replace bolt that is sheared off
DP098	41755WL-08	Well needs to be resurveyed
FT023	407MW-01	Requires outer monitoring well casing lid to be secured
<b>JBER -Richardson</b>		
CG039	AP-3745	Add fill to annular space, and add flagging for ease of locating
CG039	AP-3747	Replace 4-inch cap (currently missing).
CG039	AP-3982	Add fill to annular space
CG039	AP-4354	Add fill to annular space.
CG039	AP-4518	Replace 2-inch cap (currently missing), and add fill to annular space
DA089	AP-3774	Re-survey top of casing
DA089	AP-3870	Replace two protective bollards
DA089	AP-4411	Clean out bentonite from annular space, and add fill to annular space
SS044	AP-3231	Replace 2-inch cap (currently missing)

**Notes:**

AFID = Air Force Identification

## 1.2 JBER GEOLOGY, HYDROLOGY AND SURFACE HYDROLOGY

The geology that underlies JBER is complex. Glacial and related deposits including terminal moraines, ground moraines, glacial outwash plains, and alluvial fans are the dominant regional landforms. The most distinctive landforms at JBER are the Elmendorf Moraine, the Anchorage outwash plain, and the Mountain View alluvial fan that underlies most of JBER-R and encroaches on JBER-E. There are both significant geologic differences and common elements between JBER-E and JBER-R and the geology of each is described in more detail below.

### 1.2.1 JBER-E Geology

JBER-E is located within the Susitna Lowlands, a broad lowland area west of the Chugach Mountains (Warhaftig, 1965). The southern third of JBER-E lies on the Anchorage glaciofluvial outwash plain. The Elmendorf Moraine (a glacial end moraine) crosses JBER-E from the southwest to the northeast, and ground moraine and glaciofluvial soils (unconsolidated deposits between bedrock and the earth's surface) cover the northern portion of JBER-E. The Elmendorf Moraine borders the Mountain View Fan formation, which is a large alluvial fan that emanates from the Eagle River Valley. The Elmendorf Moraine borders the fan to the north and the fan slopes to the west-southwest and extends beyond the base (Hunter et al., 1999).

The runways and most of the JBER-E facilities lie on the relatively flat outwash plain. The outwash soils consist predominantly of sandy gravels and gravelly sands deposited by streams draining glaciers advancing out of the Knik and Matanuska valleys about 12,000 years ago. The outwash

varies in thickness across JBER-E, but tends to be relatively thin just south of the Elmendorf Moraine and increases to a thickness of up to about 60 feet near Ship Creek. Ship Creek, which flows roughly along the southern margin of JBER-E, has deposited an alluvial fan that overlies the outwash where the creek flows out of the Chugach Mountains to the east; and has eroded or incised into the outwash and deposited alluvial floodplain soils on top of the Bootlegger Cove Formation in its western reaches. The Elmendorf Moraine is a low, hummocky ridge composed of a heterogeneous mixture of sand, gravel, silt, and clay, with cobbles and boulders. The moraine was deposited by the glaciers advancing out of the Knik and Matanuska Valleys. The ground moraine north of the end moraine is dominated by low, rolling hills composed of materials similar to those forming the end moraine, and may be mantled with glaciofluvial soils. Fine-grained glacio-marine and glacio-lacustrine sediments of the Bootlegger Cove Formation underlie the outwash and the moraine.

The geotechnical properties of several of the primary JBER-E soil types have been characterized during site investigations. The data shows that the outwash and glaciofluvial soils have relatively low fines content, high bulk densities, and low moisture contents, while the moraine soils have higher silt and clay contents, and higher moisture contents, along with relatively high bulk densities.

### **1.2.2 JBER-R Geology**

The surficial and subsurface geology and stratigraphy of JBER-R are very complex because the area is covered by glacial, glacial-marine, and glaciofluvial deposits of Quaternary age (Hunter et al., 1999).

The geology underlying JBER-R consists of glacial deposits, alluvial deposits, and metamorphic rock. The northern and central portions of JBER-R consist of glacial sediments deposited in the Cook Inlet basin during a number of glacial periods. Specifically, terminal moraine deposits (the Elmendorf Moraine) are located directly northwest of the main cantonment area. These soils are composed of fine-grained, poorly sorted glacial materials with interbedded heterogeneous layers of boulders, cobbles, gravel, sand, silt, and clays. Alluvial deposits in the cantonment area are bounded by the Elmendorf Moraine to the northwest and metamorphic bedrock terrain to the southeast. Glacial outwash, alluvial fan, and fluvial deposits comprise the alluvial sediments that range from gravel in the eastern portion of the plain to sand in the southwestern portion. The cantonment area is composed of bedded deposits with well-sorted gravel (Hunter et al., 1999).

The Bootlegger Cove Formation was deposited in this region via glacial outwash deposits and consists primarily of thinly bedded, gray to light gray, silty clay and clayey silt. The Bootlegger Cove Formation is a common aquitard and confining unit in the area. The ground moraine and the Bootlegger Cove Formation form an irregular surface upon which the younger alluvial sediments were deposited (Hunter et al., 1999).

The Mountain View Fan formation is a large alluvial fan that emanates from the Eagle River Valley and extends under the JBER-R cantonment area. The Elmendorf Moraine borders the fan to the

north while low hills that protrude through younger glacial sediment border the fan to the south. These hills consist of ground moraine. The fan slopes to the west-southwest and extends beyond the base. The fan was likely deposited by ice-marginal, glacially fed streams, based on its composition (stratified outwash) during outburst flooding events from ice-dammed lakes in the Eagle River Valley. Beneath the Mountain View Fan lie older glacial and glacio-marine deposits (Hunter et al., 1999).

Mountains composed of metamorphic bedrock make up the south-central and southern areas of JBER-R (Hunter et al., 1999).

### **1.2.3 JBER-E Hydrology**

JBER-E is underlain by two aquifers: a shallow water table aquifer and a deeper, confined aquifer. The Bootlegger Cove Formation, which functions as an aquitard, separates the shallow water table aquifer from the deeper, confined aquifer across most of JBER-E. The shallow aquifer is not currently used as a water source on JBER-E. The deep aquifer serves as a secondary drinking water source for JBER-E, as well as for the Municipality of Anchorage when there is low stream flow (Freethey, 1976). Water used on JBER-E is supplied from either Ship Creek or the deep aquifer. There is no communication between shallow and deep aquifers on JBER-E. All references to groundwater in this document relate to the shallow aquifer, unless otherwise specifically identified. Groundwater flow in the outwash plain is generally toward the south or southwest, while groundwater flow in the moraine areas is more variable, and is best characterized using localized data.

The hydraulic conductivity of JBER-E soils has been measured during many site investigations. The data show that the outwash soils, the glaciofluvial soils north of the Elmendorf Moraine, the Ship Creek alluvium, and the Ship Creek alluvial fan have relatively high hydraulic conductivity values, while the moraine has variable but significantly lower hydraulic conductivity values. In general, the Bootlegger Cove Formation may be characterized as having a very low hydraulic conductivity (although interbedded sand layers exist within the formation).

### **1.2.4 JBER-R Hydrology**

One shallow and one deep groundwater system have been identified in the area of JBER-R (Freethey, 1976); however, three separate aquifer systems exist in the cantonment area, including a shallow unconfined system, a locally confined system, and a deeper confined system. Ship Creek is the primary drinking water source for JBER-R and the deep aquifer serves as a secondary drinking water source. Three standby water supply wells supplement the surface water system with a maximum of two of the wells in use at a time during peak demand. The water source for the standby wells is a confined aquifer in the Knik outwash deposit. A drinking water well with a single service connection to the Otter Lake Recreational facility serves a transient population.

The shallow aquifer occurs under unconfined conditions in the Anchorage Plain deposits and in unconfined to semiconfined conditions in the till of the Elmendorf Moraine. Shallow perched

groundwater of limited volume and extent exists in localized areas within the Elmendorf Moraine till deposits. Groundwater in the Anchorage Plain deposits occurs between 10 and 20 feet below ground surface (bgs). Flow in the Anchorage Plain is westerly along Ship Creek.

The next deeper aquifer system is approximately 80 feet below ground surface within the central part of the cantonment area. This aquifer changes from confined to semiconfined to unconfined, moving from south to north across the cantonment area. Groundwater flow in the deeper aquifer is generally to the northwest. However, localized groundwater flow directions vary widely in the central part of the cantonment area, where the hydraulic gradient is shallower and discontinuous fine-grained units are present at depth (Astley et al., 2000).

Groundwater in the deep confined system is at its shallowest depths (130 feet bgs) in the northern area of JBER-R. The flow in the deep confined system is generally toward Knik Arm in a westerly to northwesterly direction, with a hydraulic gradient between 0.02 and 0.0025 foot per foot (ft/ft). The deep aquifer occurs under confined conditions beneath areas where the Bootlegger Cove Formation is present. Where the Bootlegger Cove Formation is discontinuous, the underlying aquifer is a leaky, confined system.

### **1.2.5 JBER Surface Hydrology**

Surface water bodies on JBER include Eagle River, Ship Creek, Six Mile Creek, Otter Lake, Six Mile Lake, and several other small lakes north of the Elmendorf Moraine.

Eagle River and Ship Creek flow across JBER from the Chugach Mountains in the east to the Knik Arm of Cook Inlet to the north and west of the installation. Eagle River flows through the central portion of the installation while Ship Creek flows across the southern margin of JBER. Ship Creek is a losing stream where it flows across its alluvial fan at the foot of the mountains (because water from the stream recharges groundwater) and is a gaining stream west of the Boniface Road area, where groundwater tends to flow into the stream channel. Ship Creek serves as the main source of drinking water for JBER. Six Mile Lake and Six Mile Creek drain much of the western portion of JBER north of the Elmendorf Moraine. Flow in the creek is from east to west and discharges to Knik Arm.

## **1.3 SITE PRIORITIZATION**

This report includes a qualitative evaluation to “prioritize” sites and to give stakeholders an assessment of the overall program status. In 2007, an RPO evaluation first assessed trends in groundwater contaminant concentrations at CERCLA-regulated sites using various statistical tools (USAF, 2008b). Five of the sites presented in this report were originally prioritized in the 2007 RPO report and were updated annually between 2008 and 2011 (USAF, 2012a). In 2014, sites not previously evaluated were assigned a prioritization category.

For this report, the objective is to determine whether current conditions warrant changing the prioritization category for previously assessed sites.

The prioritization category is in each “Site Summary and Recommendations” section. Sites were assigned one of the following categories:

- **Green sites** are sites that meet or are below the defined cleanup goals in the Decision Document (DD) or ROD.
- **Yellow sites** are sites that do not meet the defined cleanup goals and/or have contaminant concentrations nearing cleanup goals.
- **Red sites** are sites that have increasing contaminant concentrations in groundwater defined by a trend analysis. These sites have the highest priority in evaluating how to meet the program objectives.

### Mann-Kendall Testing

The Mann-Kendall nonparametric test for trends (Gilbert, 1987) was used at some sites to assess groundwater contaminant concentration. The Mann-Kendall test does not require any assumptions as to the statistical distribution of the data (e.g., normal, lognormal, etc.) and can be used with data sets that include irregular sampling intervals and missing data. The Mann-Kendall test is designed for analyzing a single groundwater constituent; multiple constituents are analyzed separately.

The Mann-Kendall statistic (S) measures the trend in the data. Positive values indicate an increase in constituent concentrations over time, whereas negative values indicate a decrease in constituent concentrations over time. The confidence in the trend for the Mann-Kendall statistic is calculated using a Kendall probability table (Hollander and Wolfe, 1973). Confidence of 90 percent represents a significance level of  $\alpha = 0.1$ , and 95 percent confidence corresponds to  $\alpha = 0.05$ . The resulting confidence in the trend is applied in the Monitoring and Remediation Optimization System (MAROS) Mann-Kendall Analysis Decision Matrix (Air Force Center for Environmental Excellence [AFCEE], 2007) to determine the concentration trend, as outlined below:

**Table 1-3 MAROS Mann-Kendall Analysis Decision Matrix**

Mann-Kendall Statistic	Confidence in Trend	Concentration Trend
$S > 0$	$> 95\%$	Increasing
$S > 0$	90 - 95%	Probably Increasing
$S > 0$	$< 90\%$	No Trend
$S \leq 0$	$< 90\%$ and $COV \geq 1$	No Trend
$S \leq 0$	$< 90\%$ and $COV < 1$	Stable
$S < 0$	90 - 95%	Probably Decreasing
$S < 0$	95%	Decreasing

**Notes:**

COV = coefficient of variation, where values less than or near 1 indicate that the data form a relatively close group about the mean, and values larger than 1 indicate that the data show a greater degree of scatter about the mean.

For JBER-E, Mann-Kendall trend analysis was performed for a well if (1) a well was sampled in 2016, (2) there are four or more data points available to run the calculation, and (3) the ROD cleanup goal for contaminants of concern (COCs) have been exceeded one or more times in the past 5 years. Data sets are limited to no longer than 10 years to provide a (relatively) short-term



trend analysis for the site. For the monitoring wells/analytes that meet these criteria, a summary of the Mann-Kendall analysis results and concentration trend graphs are presented in the site-specific sections. Generally, trend graphs were omitted if all constituents in an individual monitoring well, seep or surface water location had trend test outcomes that were statistically insignificant or “no trend.” For sites where the MAROS evaluation indicated a different outcome than the Mann-Kendall trend analysis, it is indicated in the Mann-Kendall summary tables in each section.

For JBER-R, a Mann-Kendall trend analysis was selected for a well if: (1) a well was sampled in 2016, (2) there are four or more data points available to run the calculation, (3) the cleanup goal for COCs as identified in the Operable Unit (OU) B and OU E RODs (U.S. Army, 1997 and U.S. Army, 2005 [respectively]) have been exceeded one or more times in the past 5 years, and (4) the data set has less than 50 percent non-detected values. Data sets are limited to no longer than 10 years to provide a (relatively) short-term trend analysis for the site. In addition, Mann-Kendall trend analysis was also conducted for monitoring wells associated with the treatability study at CG039 and DA089 for all COCs and daughter products. The data evaluated are limited to the period from the 2013 emulsified vegetable oil injections onward. For the monitoring wells/analytes that meet these criteria, a summary of the Mann-Kendall analysis results and concentration trend graphs are presented in the site-specific sections.

Detailed output files are included in Appendices C1 (JBER-E) and C2 (JBER-R).

#### 1.4 CLEANUP GOALS

Cleanup goals are defined in the decision documents for a particular site (e.g., a ROD or a Time-Critical Removal Action), and any subsequent revision to those decision documents (e.g., an Explanation of Significant Difference [ESD] or Memorandum to the Site File). The following documents define the cleanup goals for the sites in this report:

- *OU1 ROD* (USAF, 1994a)
- *OU2 ROD* (USAF, 1995a)
- *OU3 ROD* (USAF, 1997a)
- *OU4 ROD* (USAF, 1995b) and *Errata to the 2003 Five-Year Review* (USAF, 2003b)
- *OU5 ROD* (USAF, 1995c) and *Memorandum to the Site File for Passive Operation of the Wetland Remediation System at Operable Unit 5* (USAF, 2011a)
- *OU6 and Source Area SS19 ROD* (USAF, 1997b), *LF04 Memorandum to the Site File* (USAF, 2008a) and *Memorandum to Site File: Operable Unit 6* (USAF, 2016a)
- *ESD, OU6* (USAF, 2007)
- *DP98 ROD* (USAF, 2004)
- *Memorandum to the Site File, Elmendorf Air Force Base OUs 1,2,4, and 5* (USAF, 2010b)
- *OUA and B ROD* (United States Army [U.S. Army], 1997)
- *Memorandum to the Site File for Long Term Monitoring at OUB/Poleline Road Disposal Area* (USAF, 2011b)
- *OUC ROD* (USAF, 1998a)
- *OUE ROD* (United States Army Corps of Engineers [USACE], 2005)

## 1.5 DOCUMENT ORGANIZATION

This document is organized with the following sections:

- Section 1 provides a brief introduction and presents the project purpose and scope.
- Sections 2 through 14 summarize JBER-E site-specific information including a site description, regulatory requirements, 2016 field activities and a site summary. At the beginning of Sections 2 through 14, the Performance-Based Contract (PBC) performance objectives are provided for the associated site. These performance objectives were developed by AFCEC and their contractor and were not reviewed or approved of by ADEC or EPA. Where the performance objective is “design and implement an optimized exit strategy,” the anticipated achievement date is when the final plan is due to the USAF and is usually at the end of the PBC in 2020.
- Sections 15 through 19 summarize JBER-R site-specific information including a site description, regulatory requirements, 2016 field activities and a site summary. Similar to Sections 2 through 14, the PBC performance objectives are at the beginning of each section.
- Section 20 provides references used to prepare this document.

This report includes the following three appendices:

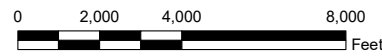
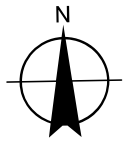
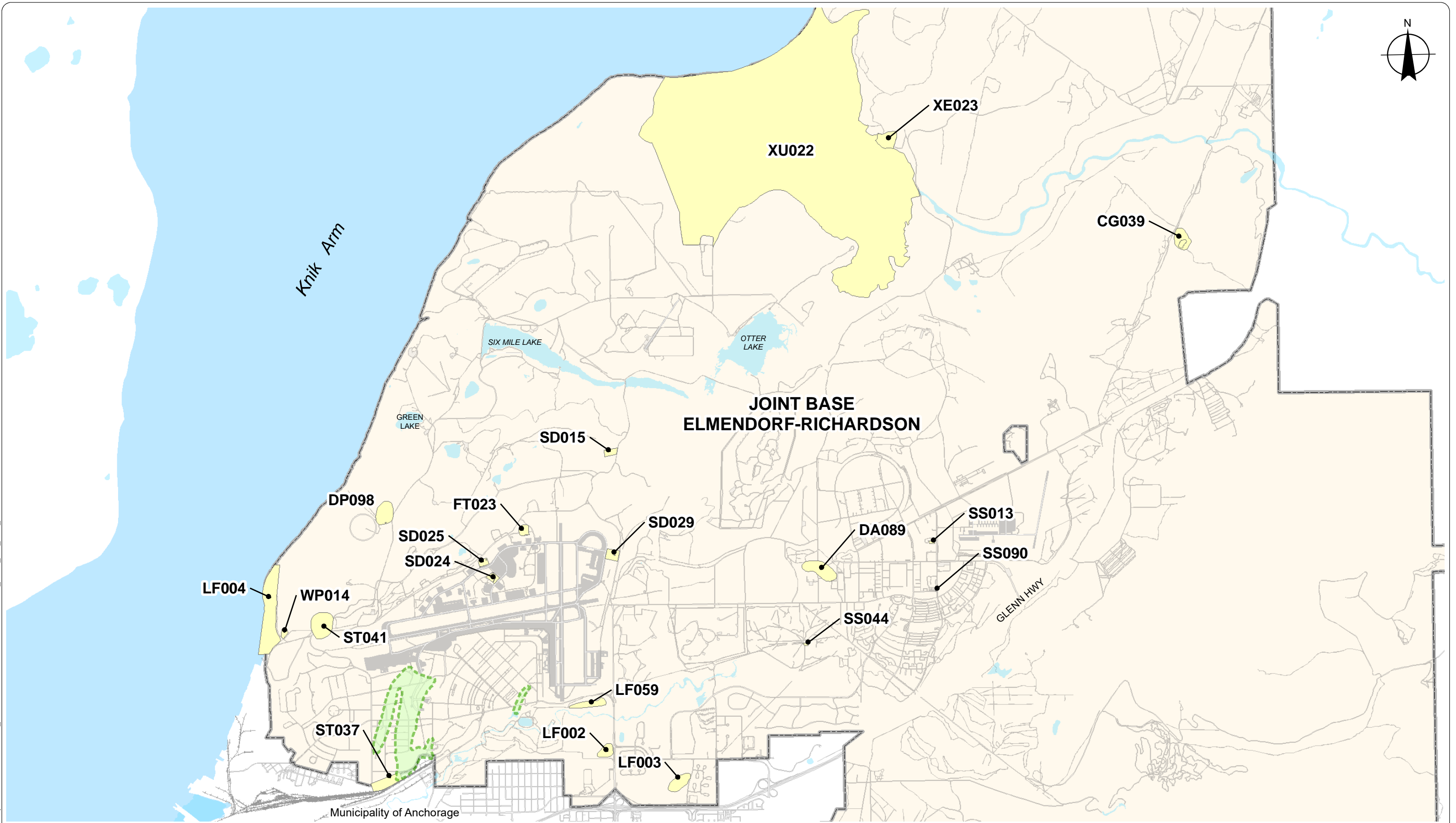
- Appendix A – Field Monitoring Records
  - A1 – JBER-Elmendorf Field Records
    - Chain of Custody Forms
    - Table of Snow-Flagged Monitoring Wells
    - Table of Monitoring Well Survey Data
    - Groundwater, Surface Water and Seep Sample Collection Sheets
    - Field Logbook Notes
    - LF04 Debris Removal Photograph Log and Debris Removal Receipt
    - OU5 Wetland Inspection Forms and Photograph Log
  - A2 – JBER-Richardson Field Records
    - Chain of Custody Forms
    - Field Logbook Notes
    - Water Level Survey
    - Well Inspections
    - Well Purge and Sampling Field Sheets
- Appendix B – LUC Inspection Forms
  - B1 – JBER Annual LUC/IC and Site Inspection Checklists – JBER-E
  - B2 – JBER Annual LUC/IC and Site Inspection Checklists – JBER-R

- Appendix C – Laboratory Analytical Data Reports, Analytical Data QA/QC Summary Reports and ADEC Laboratory Data Review Checklists, Historical Data and Mann-Kendall Summary, and Mann-Kendall Trend Test Analysis Records
  - C1 – JBER-Elmendorf
    - Analytical Laboratory Data Reports (on CD only)
    - Analytical Data Table, Excel Spreadsheets (on CD only)
    - Analytical Data QA/QC Summary Report
    - ADEC Laboratory Data Review Checklists
    - Mann-Kendall Trend Test Analysis Records
    - Historical Data and Mann-Kendall Summary
  - C2 – JBER-Richardson
    - Analytical Laboratory Data Reports (on CD only)
    - Analytical Data Table, (excel format of these tables are included on CD)
    - Analytical Data Quality Evaluation Report and ADEC Checklists
    - Historical Data and Mann-Kendall Summary



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**LEGEND**

-  CERCLA Site
-  Solvent Plume Associated with Site ST037



**2016 CERCLA SITE LOCATIONS REPRESENTED IN THIS REPORT**

2016 Annual Remedial Action – Operations and Monitoring for Select CERCLA Sites  
Joint Base Elmendorf-Richardson, Alaska

Figure  
**1-1**

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## 2.0 DP098

PBC Performance Objective: Design and Implement Optimized Exit Strategy for Site Closeout

Anticipated Achievement Date: 2020

### 2.1 SITE DESCRIPTION

DP098 is located in the northwestern portion of JBER-E on Fairchild Avenue. The site comprises 27 acres on the north side of Buildings 18220 and 18224 (Figure 2-1). It includes a former vehicle maintenance building (Building 18224), two concrete buildings (Buildings 18218 and 18220), and a fan-shaped area of undeveloped land extending north and west of the perimeter fence.

This site was previously designated and associated with Site ST423 under the SERA investigation of two USTs that served Building 18224. In 1995, petroleum-hydrocarbon contamination was discovered in the soil and groundwater during UST removal. During the 1997 SERA Phase VI investigation (USAF, 1998b), measurable concentrations of chlorinated solvents were confirmed in soil and groundwater samples, resulting in the addition of DP098 to the Environmental Restoration Program in 1999 for further investigation. In 2000, an engineering evaluation and cost analysis (USAF, 2001a) delineated the chlorinated solvent contamination and characterized the site. In 2002, a remedial investigation/feasibility study (RI/FS) (USAF, 2003c) refined the nature and extent of contamination and reviewed data from previous investigations, determining that petroleum hydrocarbons and chlorinated solvents were present in the soil, sediment, and groundwater at concentrations greater than cleanup goals.

Contamination appears to originate from Building 18224 and two USTs at the southwest corner of the building that had been used to store diesel fuel. The tanks were removed or abandoned in place in 1995 and are thought to have been the source of fuel contamination at the site. Chlorinated solvents were most likely released from Building 18224 through floor drain tiles when it was used as a vehicle maintenance facility.

In 2014, additional work at the site was conducted under the *DP098 Dense Non-aqueous Phase Liquid (DNAPL) Evaluation Work Plan and UFP-QAPP* to delineate the vertical extent of contamination (USAF, 2014b). The results and conclusions from this investigation will be in the *DP098 DNAPL Evaluation Report*, which is expected to be finalized in 2017.

#### 2.1.1 Geology and Hydrology

DP098 lies on the northwest flank of the Elmendorf Moraine on top of a low hill, at about the 200-foot elevation. The ground surface slopes gently to the northwest for a distance of about 350 feet beyond Building 18224 and then drops steeply about 20 feet into a wetland area about 400 feet from Building 18224. Soils at the site include surficial fill material in the vicinity of the buildings, possibly extending about 350 feet to the north of the buildings, underlain by up to 112 feet of glacial till composed of gravelly, sandy silts and silty, gravelly sands with scattered cobbles. The fine-grained silts and clays of the Bootlegger Cove Formation are encountered at the

120-150 foot depth, and they appear to be at least 30 feet thick in the single site boring that penetrated into the formation (USAF, 2003c).

The depth to groundwater near Building 18224 is between 5 and 10 feet bgs. To the north, just before the break in slope, which descends to the wetland, the depth to groundwater is approximately 15 feet and groundwater surfaces as intermittent seeps along the edge of the wetlands at the bottom of the slope. Downgradient from the UST site, the general groundwater gradient is to the north-northwest.

The wetland extends from the base of the slope about 500 feet to the north, where surface water is impounded in a small kettle pond that is over grown with vegetation.

## 2.2 REGULATORY REQUIREMENTS

The DP098 ROD (USAF, 2004) identified chlorinated solvents (tetrachloroethene [PCE], trichloroethene [TCE], and their degradation products cis-dichloroethene [DCE], 1,1-DCE, and vinyl chloride [VC]) as the COCs and as the basis for all DP098 COC cleanup goals. The ROD included MNA in the selected remedy.

The natural attenuation as described in the ROD (USAF, 2004) includes the following monitoring guidelines:

- Frequencies for groundwater and seep monitoring will be based on the sampling guidelines provided on Figure 12-1 (of the ROD).
- Surface water samples will be collected from the kettle pond annually as a point of compliance and sampled for the same sampling suite as the groundwater COCs.
- The analytical testing of water samples will monitor concentrations of the COCs in Table 2-1, daughter products, and other analytes, as appropriate. In addition, field-testing will monitor changes in site conditions. Analytes and field parameters will be measured to track changes in contaminant migration as well as to monitor the progress of natural attenuation.
- Due to the heterogeneity of soils, sampling for MNA parameters is unpredictable and inaccurate for use in characterization of subsurface conditions. Therefore, the intent is to collect only groundwater samples until the groundwater chemical-specific applicable or relevant and appropriate requirements (ARARs) in Table 2-1 have been achieved, and at that point, further characterization of the soil and sediment will be attempted. Chemical-specific ARARs for groundwater will be met when two consecutive sampling events indicate COCs are below Table 2-1 cleanup goals.

The ROD anticipated that, upon completion of natural attenuation of the chlorinated solvents, hydrocarbon contamination would also have naturally attenuated. In 2002, LUCs were implemented. In 2004, MNA of COCs and studies of enhanced bioremediation began. In 2005, a soil hot spot near a suspected drain tile was excavated. As of October 2008, all components of the remedy had been implemented (USAF, 2009a). The MNA component of the selected remedy is expected to continue until COC concentrations meet groundwater cleanup goals.

Table 2-1 provides a list of the current groundwater COCs and the respective cleanup goals identified in the DP098 ROD (USAF, 2004). In addition, 18 AAC 75 Table C cleanup levels (ADEC, 2017) are included in the table for informational purposes.

Current monitoring requirements at DP098 include periodic groundwater and surface water sampling and an annual LUC inspection. Groundwater sampling is required for the COCs at monitoring wells 41755WL-01 (every 5 years), 41755WL-02 (annual), 41755WL-03 (annual), 41755WL-04 (annual), 41755WL-05 (annual), 41755WL-07 (annual), 41755WL-08 (semiannual), 41755WL-09 (annual), 41755WL-12 (every 5 years), 41755WL-15 (every 2 years), 41755WL-16 (every 2 years), 41755WL-17 (every 5 years), 41755WL-23 (every 2 years), and DP98INJ-02 (annual). Annual surface water sampling is required for the COCs at DP98SW-01. LUCs are in place to prevent access and exposure to contaminated groundwater and soil at the site.

**Table 2-1 Cleanup Goals in Groundwater at DP098**

Contaminant of Concern	Cleanup Goal <sup>a</sup> (µg/L)	ADEC Cleanup Level <sup>b</sup> (µg/L)
1,1-DCE	7	280
cis-DCE	70	36
TCE	5	2.8
PCE	5	41
VC	2	0.19

**Notes:**

<sup>a</sup> Cleanup levels as cited in the DP098 ROD (USAF, 2004).

<sup>b</sup> 18 AAC 75 Table C Cleanup Levels (ADEC, 2017) are provided for informational purposes only..

µg/L = microgram(s) per liter

DCE = dichloroethene

PCE = tetrachloroethene

ROD = Record of Decision

TCE = trichloroethene

USAF = United States Air Force

VC = vinyl chloride

### 2.3 2016 FIELD ACTIVITIES AND RESULTS

During 2016, seven monitoring wells were sampled for COCs and MNA field parameter analyses. In addition, one surface water sample was collected for COC analysis. Five of the seven monitoring wells had concentrations of contaminants exceeding cleanup goals cited in the DP098 ROD. The surface water sample collected was below all cleanup goals cited in the DP098 ROD. Monitoring well 41755WL-03 was not sampled because measurable product (0.14 feet) was detected in the well for the first time in 2016. Table 2-2 presents a summary of the 2016 analytical results. Table 2-3 presents a summary of the MNA field parameters. The 2016 and truncated historical results are on Figure 2-1. Historical results and Mann-Kendall trend analysis results are in Appendix C, and a summary of the Mann-Kendall analysis results are in Table 2-4. Mann-Kendall contaminant trend graphs are on Figures 2-2 through 2-6.

A field duplicate sample was collected from the surface water location DP98SW-01. Low flow drawdown criteria was exceeded in monitoring well 41755WL-02, so three well volumes were purged before collecting a groundwater sample. Monitoring well DP98INJ-02 was purged dry and a grab sample was collected the following day using a bailer.



Mann-Kendall trend tests indicated statistically significant decreasing trends at the 95% confidence level for PCE and TCE in well 41755WL-02 and TCE in well 41755WL-04. Concentrations of cis-1,2-DCE and 1,1-DCE are decreasing in well DP98INJ-02. Statistically significant increasing trends were identified for TCE and cis-1,2-DCE in well 41755WL-08 and for VC in well DP98INJ-02.

The DP098 LUC inspection was performed on September 13, 2016 and identified one monitoring well maintenance issue. A bolt that secured the outer well casing was sheared off at 41755WL-03, but a second bolt remained and the lid to the outer casing was secured. The inner PVC casing for monitoring well 41755WL-08 was cut down and will be resurveyed 2017. A copy of the 2016 LUC inspection form for DP098 is in Appendix B.

**Table 2-2 Summary of 2016 Analytical Results at DP098**

Analyte		PCE	TCE	cis-1,2-DCE	1,1-DCE	VC
<b>Groundwater Cleanup Goal<sup>a</sup></b> (µg/L)	<b>Units</b>	<b>5</b>	<b>5</b>	<b>70</b>	<b>7</b>	<b>2</b>
DP98INJ-02 <sup>b</sup>	µg/L	<b>14.7</b>	0.66 J	<b>2,070</b>	<b>10.4</b>	<b>1,960</b>
41755WL-02	µg/L	<b>304</b>	<b>714</b>	<b>3,450</b>	<b>9.37</b>	ND [1]
41755WL-03	µg/L	0.14 feet of product in the well, not sampled				
41755WL-04	µg/L	1.92	<b>22.7</b>	<b>1,260</b>	2.95	<b>983</b>
41755WL-05	µg/L	ND [1]	0.85 J	<b>1,580</b>	1.77	<b>7.81</b>
41755WL-07	µg/L	0.71 J	ND [1]	ND [1]	ND [1]	ND [1]
41755WL-08	µg/L	1.19	<b>350</b>	<b>359</b>	0.77 J	ND [1]
41755WL-09	µg/L	0.83 J	ND [1]	ND [1]	ND [1]	ND [1]
<b>Surface Water Cleanup Goal<sup>a</sup></b>	<b>Units</b>	<b>--</b>	<b>5 µg/L</b>	<b>5 µg/L</b>	<b>--</b>	<b>--</b>
DP98SW-01	µg/L	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]
DP98SW-01 (FD)	µg/L	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]

**Notes:**

<sup>a</sup> Cleanup levels as cited in the DP098 ROD (USAF, 2004).

<sup>b</sup> Well was purged dry and sampled the following day.

-- Not available in the DP098 ROD.

[ ] = limit of detection

µg/L = microgram(s) per liter

J = the analyte was positively identified: the associated numerical value is the approximate concentration of the analyte in the sample.

**Bold** result exceeds the ROD cleanup level

DCE = dichloroethene

FD = field duplicate

ND = non-detect [limit of detection]

PCE = tetrachloroethene

TCE = trichloroethene

VC = vinyl chloride



**Table 2-3 Summary of 2016 MNA Field Parameters at DP098**

MNA Field Parameters							
Monitoring Well ID	Volume Purged (gallons)	Temp (°C)	Specific Conductance <sup>a</sup> (mS/cm)	DO (mg/L)	pH	ORP (mV)	Turbidity (NTU)
DP98INJ-02 <sup>b</sup>	Grab sample collected						
41755WL-02 <sup>c</sup>	6.6	11.69	1.508	0.48	6.25	22.4	4.14
41755WL-04	2.15	8.64	11.44	1.34	6.84	-108.8	20.26
41755WL-05	3.0	9.33	1.744	0.34	6.38	-18.4	7.69
41755WL-07	2.95	10.07	0.447	1.22	5.96	8.80	2.57
41755WL-08	1.6	10.64	0.583	2.06	6.24	97.7	7.34
41755WL-09	1.6	10.6	0.590	0.44	7.20	-45.7	5.28

**Notes:**

<sup>a</sup> Specific Conductance is a conductivity measurement that has been corrected to 25°C.

<sup>b</sup> Well purged dry, grab sample collected the following day. Water level measurement collected prior to purging and prior to sampling.

<sup>c</sup> Exceeded drawdown, and three well volumes were purged before sampling.

°C = degrees(s) Celsius

mV = millivolt(s)

DO = dissolved oxygen

mS/cm = milliSiemen(s) per centimeter

ID = identification

NTU = Nephelometric Turbidity Units

MNA = monitored natural attention

ORP = oxidation-reduction potential

mg/L = milligram(s) per liter

**Table 2-4 Summary of 2016 Mann-Kendall Concentration Trends for Select Wells at DP098**

Monitoring Well ID	PCE	TCE	cis-DCE	1,1-DCE	VC
DP98INJ-02	N/A	NE	Decreasing	Decreasing	Increasing
41755WL-02	Decreasing	Decreasing	NST <sup>a</sup>	NST <sup>a</sup>	NE
41755WL-04	NE	Decreasing	NST <sup>b</sup>	NE	NST
41755WL-05	NE	NE	NST	NE	NST <sup>a</sup>
41755WL-08	NE	Increasing	Increasing	NE	NE

**Notes:**

<sup>a</sup> Stable according to MAROS convention.

<sup>b</sup> Probably decreasing according to MAROS convention (90-95% confidence;  $S < 0$ ). DCE = dichloroethene

N/A = not applicable; not enough detected values to run Mann-Kendall analysis.

NE = no exceedance of cleanup goal in 2016

NST = no statistically significant trend

PCE = tetrachloroethene

TCE = trichloroethene

VC = vinyl chloride

**2.4 SITE SUMMARY AND RECOMMENDATIONS**

During 2016, five of the seven monitoring wells exhibited concentrations of COCs that exceeded cleanup goals cited in the DP098 ROD as shown in Table 2-2. Mann-Kendall trends are decreasing for TCE and DCE for monitoring wells located in the center of the plume (41755WL-02 and 41755WL-04). Mann-Kendall trends are increasing for TCE and DCE at the leading edge of the plume at monitoring well 41755WL-08. The Mann-Kendall trend for VC is increasing and the cis-



DCE trend is decreasing in DP98INJ-02 where an emulsified vegetable oil injection treatability study was performed in 2007. The trends at the leading edge of the plume indicate slower progress toward reaching cleanup goals. The COCs in the remaining monitoring wells (41755WL-07 and 41755WL-09) were both non-detect or below the ROD cleanup levels. The groundwater COC concentration trends for each monitoring well with COCs above cleanup goals are shown on Figures 2-2 through 2-6.

#### **2.4.1 Five-Year Review**

Contaminant concentrations at DP098 remain above cleanup goals; therefore, the site is required to have CERCLA five-year reviews conducted until the cleanup goals are achieved. The purpose of the five-year review is to evaluate the implementation and performance of the remedial actions. There have been four five-year reviews conducted at JBER-E. The fourth five-year review report recommended a vapor intrusion (VI) evaluation be performed, in accordance with EPA guidelines, for each occupied facility in proximity to the TCE Plumes (USAF, 2014c). A VI evaluation (2016-2017) and sampling for 1,4-dioxane (2016) was conducted at this site and will be reported under a separate cover.

#### **2.4.2 Recommendations**

Site DP098 is identified as a **Red** priority since the plume continues to have elevated levels of TCE, cis-DCE, and VC and an increasing trend for TCE and cis-DCE at the downgradient edge. A DNAPL evaluation was finalized in 2018. The report will provide additional information of the nature and vertical extent of the contamination at the site. The site priority may be updated in the 2017 Annual RA-O and Monitoring Report based on the report conclusion.

**NOTES:**  
 1. All groundwater results are in micrograms per liter (ug/L).  
 2. **Bold** results exceed cleanup criteria.

TCE Trichloroethene (5 ug/L\*)  
 PCE Tetrachloroethene (5 ug/L\*)  
 cis-DCE cis-1,2 Dichloroethene (70 ug/L\*)  
 1,1-DCE 1,1-Dichloroethene (7 ug/L\*)  
 VC Vinyl Chloride (2 ug/L\*)  
 ND Not Detected [brackets indicate the PQL for 2009, and the LOD for 2010 - 2016]  
 LOD Limit of Detection  
 PQL Practical Quantification Limit  
 FD Field Duplicate  
 -- Not Analyzed  
 \* Analyte Cleanup Criteria

**FLAGS:**  
 J - Analyte was positively identified, but result is estimated.  
 R - The data were rejected because certain quality control criteria were not met.

**PLUME KEY**

	cis-DCE > 70ug/L   > 1,000 ug/L
	DRO > 1,500 ug/L   > 10,000 ug/L
	PCE > 5 ug/L   > 1,000 ug/L
	TCE > 5 ug/L   > 1,000 ug/L
	VC > 2 ug/L   > 10 ug/L

41755WL-09						
Year	PCE	TCE	cis-DCE	1,1-DCE	VC	
7/2014	ND [0.5]	ND [0.5]	ND [0.5]	ND [0.5]	ND [0.5]	
9/2015	ND [0.5]	ND [0.5]	ND [0.5]	ND [0.5]	ND [0.5]	
9/2016	0.83 J	ND [1]	ND [1]	ND [1]	ND [1]	

41755WL-07						
Year	PCE	TCE	cis-DCE	1,1-DCE	VC	
7/2014	ND [0.5]	ND [0.5]	ND [0.5]	ND [0.5]	ND [0.5]	
9/2015	ND [0.5]	ND [0.5]	ND [5]	ND [5]	ND [0.5]	
9/2016	0.71 J	ND [1]	ND [1]	ND [1]	ND [1]	

41755WL-05						
Year	PCE	TCE	cis-DCE	1,1-DCE	VC	
7/2014	ND [0.5]	0.52 J	<b>4,680 J</b>	3.54	<b>7.1</b>	
9/2015	ND [5]	ND [5]	<b>2,170</b>	ND [5]	<b>9.6 J</b>	
9/2016	ND [1]	0.85 J	<b>1,580</b>	1.77	<b>7.81</b>	

**LEGEND**

- Program Monitoring Well
- Non-Program Monitoring Well
- Surface Water Sample Location
- Groundwater Elevation (feet AMSL)  
(Synoptic Water Levels Measured Sept 2014)
- Groundwater Contour Line (feet AMSL)  
(Synoptic Water Levels Measured Sept 2014)
- General Groundwater Flow Direction (Approximate)

Aero-Metric Image, Copyright © 2013

41755WL-16						
Year	PCE	TCE	cis-DCE	1,1-DCE	VC	
2009	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	
8/2013	ND [0.20]	ND [0.40]	ND [0.40]	ND [0.40]	ND [0.40]	
9/2015	ND [0.5]	ND [0.5]	ND [0.5]	ND [0.5]	ND [0.5]	

41755WL-23						
Year	PCE	TCE	cis-DCE	1,1-DCE	VC	
2009	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	
8/2013	ND [0.20]	ND [0.40]	ND [0.40]	ND [0.40]	ND [0.40]	
9/2015	ND [0.5]	ND [0.5]	ND [0.5]	ND [0.5]	ND [1.5]	

41755WL-12						
Year	PCE	TCE	cis-DCE	1,1-DCE	VC	
2010	ND [0.15]	ND [0.15]	0.28	ND [0.15]	ND [0.25]	
8/2012	ND [0.45]	ND [0.45]	ND [0.45]	ND [0.45]	ND [0.45]	

41755WL-17						
Year	PCE	TCE	cis-DCE	1,1-DCE	VC	
2010	ND [0.15]	ND [0.15]	0.38	ND [0.15]	ND [0.25]	
8/2012	ND [0.45]	ND [0.45]	0.49 J	ND [0.45]	ND [0.45]	

DP98INJ-02						
Year	PCE	TCE	cis-DCE	1,1-DCE	VC	
7/2014	ND [0.5]	1.14	<b>3,990</b>	<b>18.9</b>	<b>2,960</b>	
10/2015	ND [0.5]	0.55 J	<b>2,360</b>	<b>10.3</b>	<b>1,490</b>	
9/2016	<b>14.7</b>	0.66 J	<b>2,070</b>	<b>10.4</b>	<b>1,960</b>	

41755WL-02						
Year	PCE	TCE	cis-DCE	1,1-DCE	VC	
7/2014	<b>390</b>	<b>445</b>	<b>1,690</b>	4.18	0.510 J	
9/2015	<b>647</b>	<b>902</b>	<b>2,060</b>	4.63	0.77 J	
9/2016	<b>304</b>	<b>714</b>	<b>3,450</b>	<b>9.37</b>	ND [1]	

DP98SW-01						
Year	PCE	TCE	cis-DCE	1,1-DCE	VC	
9/2015	ND [0.5]	ND [0.5]	ND [0.5]	ND [0.5]	ND [0.5]	
9/2016	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	
9/2016 FD	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	

41755WL-15						
Year	PCE	TCE	cis-DCE	1,1-DCE	VC	
2009	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]	
8/2013	ND [0.20]	ND [0.40]	ND [0.40]	ND [0.40]	ND [0.40]	
9/2015	ND [0.5]	ND [0.5]	ND [0.5]	ND [0.5]	ND [1.5]	

DP98SW-03						
Year	PCE	TCE	cis-DCE	1,1-DCE	VC	
2010	ND [0.15]	ND [0.15]	0.18	ND [0.15]	ND [0.25]	
9/2014	ND [0.5]	ND [0.5]	1.56	ND [0.5]	ND [0.5]	

41755WL-08						
Year	PCE	TCE	cis-DCE	1,1-DCE	VC	
7/2014	ND [0.5]	<b>299</b>	<b>275</b>	0.630 J	ND [0.5]	
9/2015	ND [0.5]	<b>289</b>	<b>274</b>	0.81 J	ND [0.5]	
9/2016	1.19	<b>350</b>	<b>359</b>	0.77 J	ND [1]	

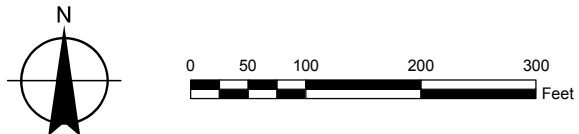
DP98SW-10						
Year	PCE	TCE	cis-DCE	1,1-DCE	VC	
2010	ND [0.15]	<b>8.9</b>	57	0.26	ND [0.25]	
9/2014	0.31 J	<b>15.3</b>	60.5	ND [0.5]	ND [0.5]	

41755WL-04						
Year	PCE	TCE	cis-DCE	1,1-DCE	VC	
7/2014	ND [0.5]	<b>6.95</b>	<b>585</b>	2.63	<b>553</b>	
9/2015	ND [5]	<b>15.4</b>	<b>936</b>	3.5	<b>741</b>	
9/2016	1.92	<b>22.7</b>	<b>1,260</b>	2.95	<b>983</b>	

41755WL-03						
Year	PCE	TCE	cis-DCE	1,1-DCE	VC	
7/2014	ND [0.5]	0.8 J	<b>499</b>	1.45	1.17	
9/2015	ND [0.5] J	1.85 J	<b>342 J</b>	1.14 J	1.5 J	
2016	0.14 feet of product in well, no sample					

41755WL-01						
Year	PCE	TCE	cis-DCE	1,1-DCE	VC	
8/2012	ND [0.45]	0.18 J	0.41 J	ND [0.45]	ND [0.45]	

Date: 24 May 2017 Drawn by: SJ K:\PROJECTS\Air\_Force\UBER\BR\TMM\XDs\2017\2017\_JBER\_DP98\_RAOM-01.mxd

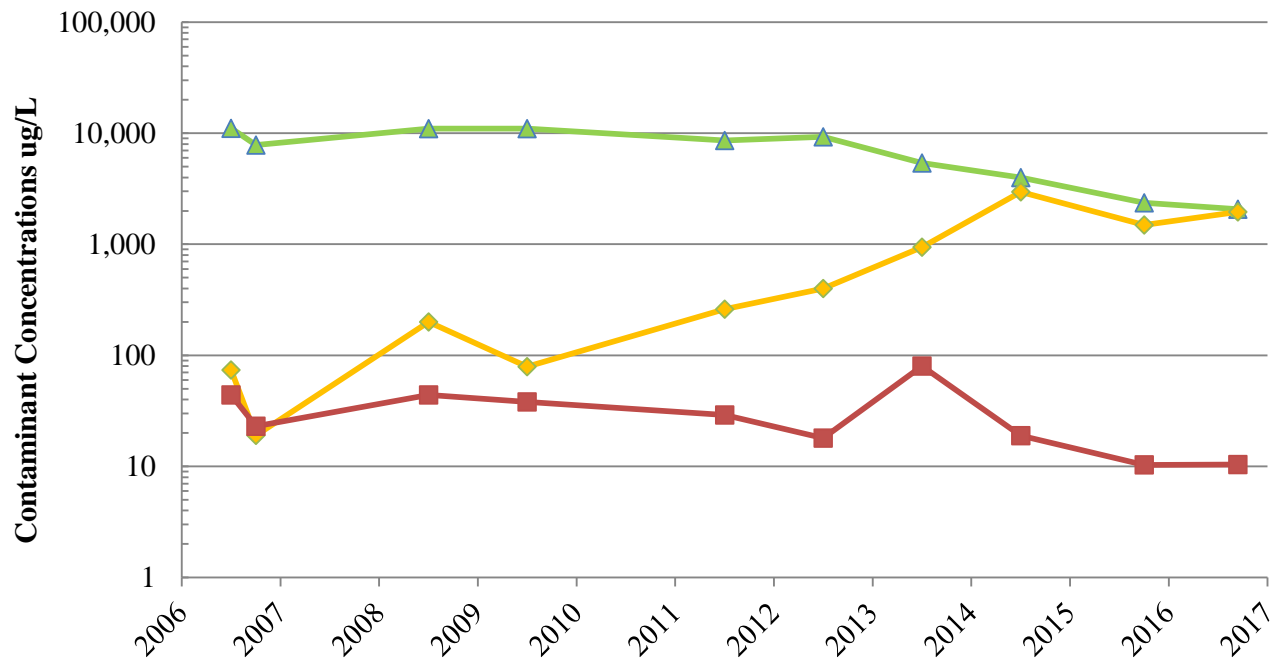


**DP098 SITE MAP WITH ANALYTICAL DATA**  
 2016 Annual Remedial Action – Operations and Monitoring for Select CERCLA Sites  
 Joint Base Elmendorf-Richardson, Alaska

Figure  
**2-1**

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Symbol	ID	M-K Concentration Trend
	cis-DCE	Decreasing Trend
	VC	Increasing Trend
	1,1-DCE	Decreasing Trend

Cleanup Levels  
 1,1-DCE = 7 µg/L  
 cis-DCE = 70 µg/L  
 VC = 2 µg/L



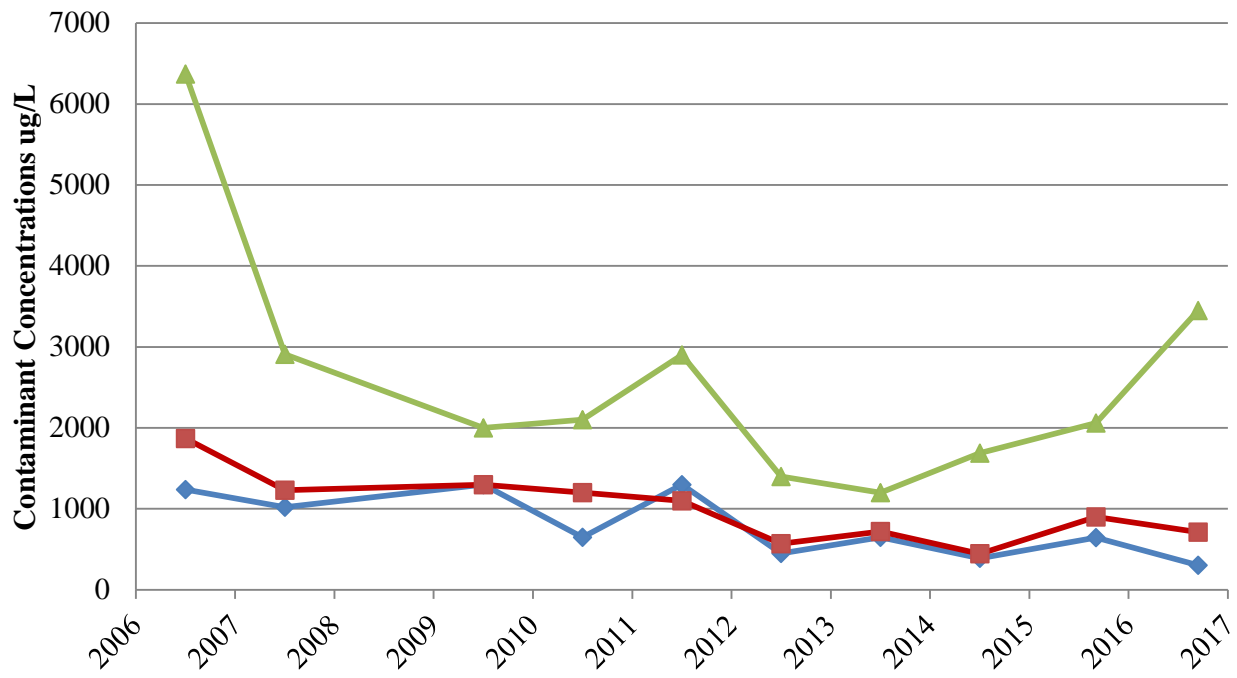
**DP098 CONTAMINANT TRENDS IN DP981NJ-02**

2016 Annual RA-O and Monitoring Report, Select CERCLA Sites  
 Joint Base Elmendorf-Richardson, Alaska

**Figure 2-2**

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Symbol	ID	M-K Concentration Trend
	PCE	Decreasing Trend
	TCE	Decreasing Trend
	cis-DCE	No Significant Trend; Stable*

\*Stable based on MAROS convention; COV < 1

Cleanup Levels  
 cis-DCE = 70 µg/L  
 TCE = 5 µg/L  
 PCE = 5 µg/L

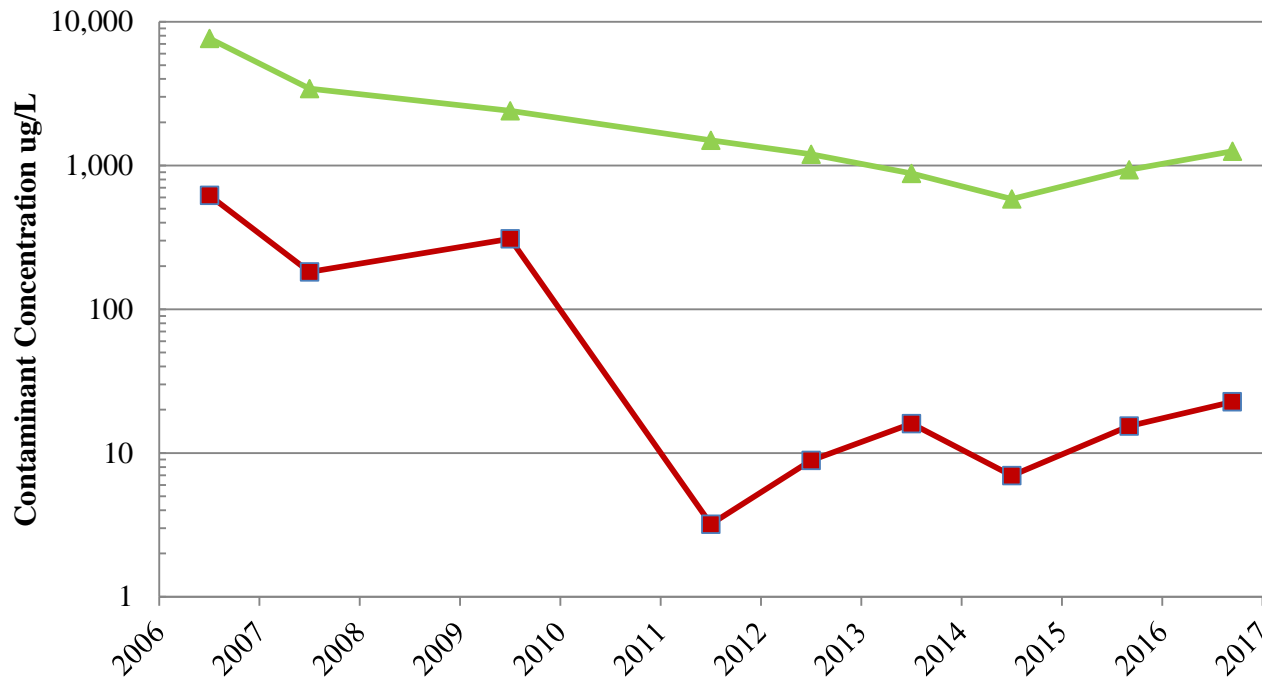


**DP098 CONTAMINANT TRENDS IN 41755WL-02**  
 2016 Annual RA-O and Monitoring Report, Select CERCLA Sites  
 Joint Base Elmendorf-Richardson, Alaska

**Figure 2-3**

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Symbol	ID	M-K Concentration Trend
	TCE	Decreasing Trend
	cis-DCE	No Significant Trend*

\*Probably decreasing based on MAROS decision matrix

Cleanup Levels  
 cis-DCE = 70 µg/L  
 TCE = 5 µg/L  
 VC = 2 µg/L



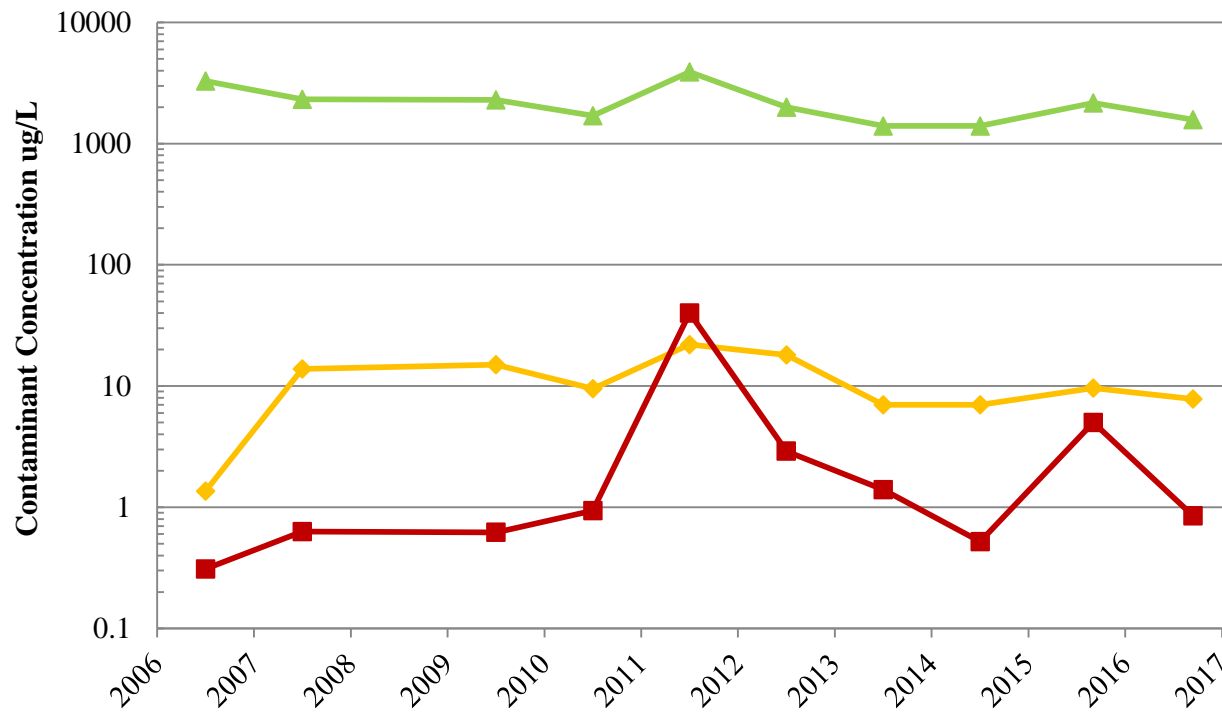
**DP098 CONTAMINANT TRENDS IN 41755WL-04**

2016 Annual RA-O and Monitoring Report, Select CERCLA Sites  
 Joint Base Elmendorf-Richardson, Alaska

**Figure 2-4**

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Symbol	ID	M-K Concentration Trend
	cis-DCE	No Significant Trend; Stable*
	VC	No Significant Trend; Stable*
	TCE	No Significant Trend

\*Stable based on MAROS convention; COV < 1

Cleanup Levels  
 cis-DCE = 70 µg/L  
 TCE = 5 µg/L  
 PCE = 5 µg/L



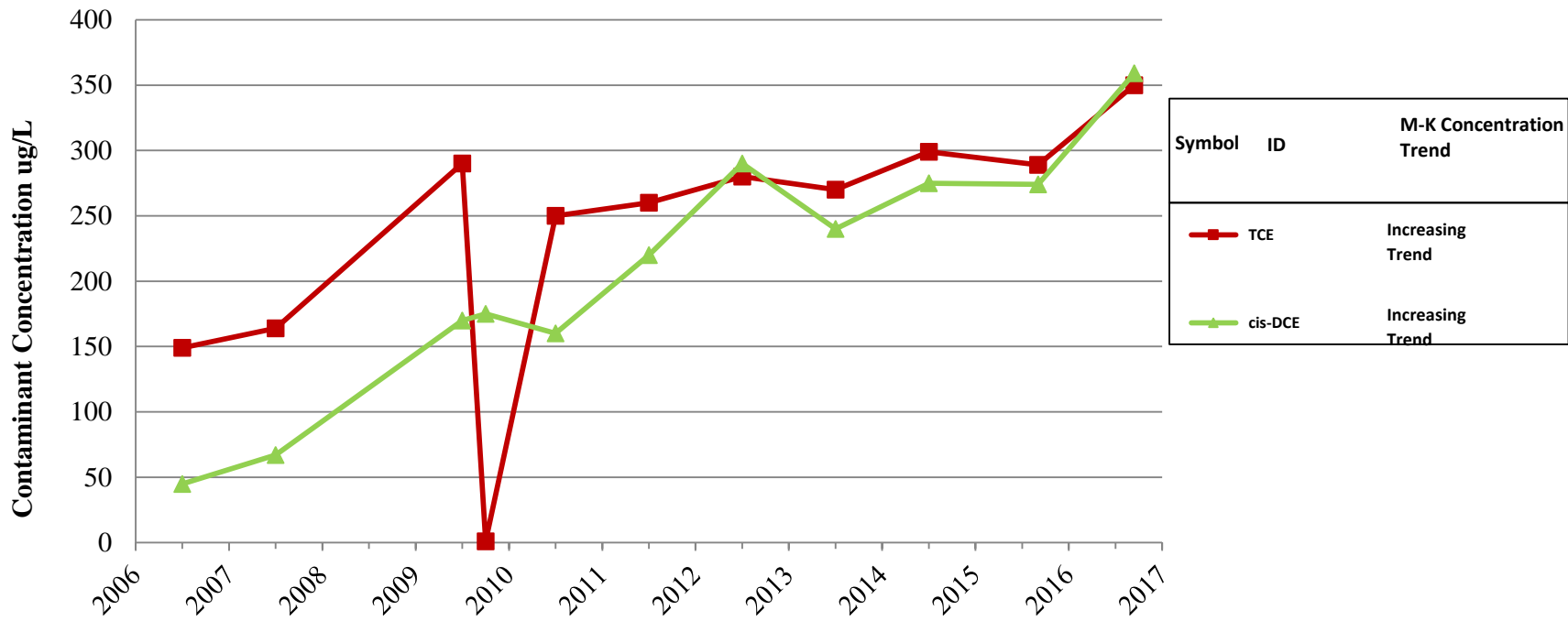
**DP098 CONTAMINANT TRENDS IN 41755WL-05**

2016 Annual RA-O and Monitoring Report, Select CERCLA Sites  
 Joint Base Elmendorf-Richardson, Alaska

**Figure 2-5**

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Cleanup Levels  
 cis-DCE = 70 µg/L  
 TCE = 5 µg/L



**DP098 CONTAMINANT TRENDS IN 41755WL-08**

2016 Annual RA-O and Monitoring Report, Select CERCLA Sites  
 Joint Base Elmendorf-Richardson, Alaska

**Figure 2-6**

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### 3.0 FT023

PBC Performance Objective: Site Closeout

Anticipated Achievement Date: 2019

#### 3.1 SITE DESCRIPTION

FT023 is located on the west side of JBER-E west of the North/South Runway between Airlifter Drive and 33<sup>rd</sup> Street and consists of two plumes (Figure 3-1). The FT023 plumes are also referred to as the Fire Training Area Plumes. Groundwater contamination at this site has been attributed to two source areas: leaking USTs and a possible upgradient unknown source area (comprising the southern plume) and a bermed burning area (comprising the northern plume). A Phase I Environmental Site Assessment record search indicated that the drum storage area was used to store as many as 100 (one hundred) 55-gallon drums of contaminated waste oils, paint thinners, waste fuel, and waste solvents from aircraft maintenance and other shop operations (USAF, 1983). The exact location of the former drum storage area is unknown. Fire training activities were conducted in the bermed area from the 1940s to 1983. From the 1940s to the 1960s, combustible wastes, including oils, fuels, and solvents were used as fuel for the training exercises. Site FT023 was included in the OU4 investigation and cleanup.

##### 3.1.1 Geology and Hydrology

FT023 is located on late Quaternary glacial outwash deposits of the Anchorage Plain in a developed area of JBER-E. Silt and peat deposits near the surface overlie the sandy and silty gravel shallow aquifer matrix. The ground surface is relatively flat, and the immediate vicinity of the site is either paved or built upon and includes limited grassy areas. Soil boring logs from FT023 and adjacent areas show that the soils consist primarily of gravelly, silty sand, with some cobbles extending to at least 60 feet bgs, which is the deepest boring on the site. Regionally, fine-grained sediment of the Bootlegger Cove Formation underlies the outwash deposits.

Groundwater levels are interpreted to vary seasonally between approximately 40 and 44 feet bgs. High water events are generally associated with spring break-up and late summer and/or autumn precipitation events. The seasonal low water level typically occurs in mid- to late winter. The groundwater flow direction at the site is toward the south-southwest. The hydraulic conductivity at FT023 is estimated to range from approximately  $10^0$  to  $10^{-3}$  centimeters per second (cm/sec), based on the soil textures and measured hydraulic conductivities in the JBER-E outwash soils.

The shallow groundwater at the site is not used as a drinking water source, with institutional controls imposed upon the area under the OU4 ROD. The nearest JBER water supply well (Well 29) is located approximately one mile west of the site and is cross-gradient of the site.

### 3.2 REGULATORY REQUIREMENTS

The OU4 ROD (USAF, 1995b) identified the chlorinated compounds 1,1,1-trichloroethane (TCA), 1,1-dichloroethene (DCA), 1,2-DCA, PCE, TCE, and cis-1,2-DCE; and the fuel hydrocarbon compound, benzene as groundwater COCs and is the basis for all FT023 COC cleanup goals. In 2010, corrections were made to some of the groundwater cleanup goals in a Memorandum to the Site File (USAF, 2010b). Groundwater cleanup goals for 1,1,1-TCA, 1,1-DCA and 1,2-DCA have been met and are no longer monitored at the site.

Table 3-1 provides a list of the current groundwater COCs and the respective cleanup goals identified in the OU4 ROD (USAF, 1996b). In addition, 18 AAC 75 Table C cleanup levels (ADEC, 2017) are included in the table for informational purposes.

The OU4 ROD included MNA in the selected remedy for groundwater. The groundwater remedy as described in the ROD (USAF, 1995b) includes the following monitoring guidelines:

- Institutional controls on land use and water use restrictions will restrict access to the contaminated groundwater throughout OU 4 until cleanup levels have been achieved.
- Groundwater will be monitored and evaluated semi-annually to assess contaminant migration and timely reduction of contaminant concentrations by intrinsic remediation. This will include five-year reviews to assess the protectiveness of the remedial action, as long as contamination remains above cleanup levels. A monitoring plan will be prepared to address the details involved in sampling.
- All groundwater is expected to be cleaned up within 13 years.

Current monitoring requirements at FT023 include periodic groundwater sampling and an annual LUC inspection. Groundwater sampling is required for COCs at monitoring wells OU4MW-11 (every 5 years), 407MW-01 (every 2 years) and GW-5A (every 2 years), which was added to the sampling program in 2015 in accordance with the Basewide Monitoring Program Well Sampling Frequency Decision Guide presented in the 2003 *Memorandum to the Site File for OU4* (USAF, 2003d). LUCs are in place to prevent access and exposure to contaminated groundwater and soil at the site.

Annual groundwater sampling occurred at the former bermed fire training pit, part of the North Fire Training Area Plume, until 2011. The northern plume was removed from annual sampling after three successive years of measuring COC concentrations below cleanup goals.

In 2014, a limited site investigation (LSI) was conducted at the site to better delineate the nature and extent of chlorinated aromatic hydrocarbon contamination in groundwater at the site. Recommendations from the *Limited Site Investigation Report FT023 (Fire Training Area)* (USAF, 2015b) are presented in Section 3.4.2.

**Table 3-1 Cleanup Goals in Groundwater at FT023**

Contaminant of Concern	Cleanup Goal <sup>a</sup> (µg/L)	ADEC Cleanup Level <sup>b</sup> (µg/L)
PCE	5	41
TCE	5	2.8
cis-1,2-DCE	70	36
Benzene	5 <sup>b</sup>	4.6

**Notes:**

<sup>a</sup> Cleanup levels as cited in the OU4 ROD (USAF, 1995b) and 2010 Final Memorandum to the Site file, Elmendorf Air Force Base, Operable Units (OUs) 1, 2, 4, and 5 (USAF, 2010b).

<sup>b</sup> 18 AAC 75 Table C Cleanup Levels (ADEC, 2017) are provided for informational purposes only.

µg/L = microgram(s) per liter

OU = Operable Unit

PCE = tetrachloroethene

DCE = dichloroethene

ROD = Record of Decision

TCE = trichloroethene

USAF = United States Air Force

### 3.3 2016 FIELD ACTIVITIES AND RESULTS

During 2016, monitoring well GW-5A was sampled for volatile organic compounds (VOCs). Concentrations of PCE and TCE in GW-5A exceeded the OU4 ROD cleanup goals. Analytical results for site COCs are in Table 3-2. The 2016 and truncated historical results are on Figure 3-1 and the MNA field parameters are in Table 3-3. Historical results and Mann-Kendall trend analysis results are in Appendix C, and a summary of the Mann-Kendall analysis results are in Table 3-4.

A Mann-Kendall trend test for TCE was conducted for monitoring well GW-5A and showed no significant trend. A trend graph was not created for this well.

A LUC inspection was performed at FT023 on October 13, 2016 and did not identify any issues except required monitoring well maintenance. A bolt was added to the outer casing of monitoring well FS-52, and the lid was secured. The outer casing cover of monitoring well 407MW-01 was replaced, but could not be secured because the bolt holes in the casing are damaged. These maintenance issues will be resolved in 2017. A copy of the 2016 LUC inspection form for Site FT023 is in Appendix B.

**Table 3-2 Summary of 2016 Analytical Results at FT023**

Analyte	Units	Cleanup Goal <sup>a</sup>	GW-5A
PCE	µg/L	5	3.43
TCE	µg/L	5	<b>35.9</b>
cis-1,2-DCE	µg/L	70	28
Benzene	µg/L	5	ND [0.4]

**Notes:**

<sup>a</sup> Cleanup levels as cited in the OU4 ROD (USAF, 1995b) and 2010 Final Memorandum to the Site file, Elmendorf Air Force Base, Operable Units (OUs) 1,2,4, and 5 (USAF, 2010b). **Bold** result exceeds the ROD cleanup level

[ ] = limit of detection

µg/L = microgram(s) per liter

DCE = dichloroethene

ND = non-detect [limit of detection]

PCE = tetrachloroethene

TCE = trichloroethene

USAF = United States Air Force

**Table 3-3 Summary of 2016 MNA Field Parameters at FT023**

MNA Field Parameters							
Monitoring Well ID	Volume Purged (gallons)	Temp (°C)	Specific Conductance <sup>a</sup> (mS/cm)	DO (mg/L)	pH	ORP (mV)	Turbidity (NTU)
GW-5A	1.6	10.6	1.39	4.52	6.99	138.1	14.57

**Notes:**

<sup>a</sup> Specific Conductance is a conductivity measurement that has been corrected to 25°C.

°C = Celsius

DO = dissolved oxygen

ID = identification

MNA = monitored natural attenuation

mg/L = milligram(s) per liter

mS/cm = milliSiemen(s) per centimeter

mV = millivolt(s)

NTU = Nephelometric Turbidity Units

ORP = oxidation-reduction potential

**Table 3-4 Summary of 2016 Mann-Kendall Concentration Trends for Select Wells at FT023**

Monitoring Well ID	PCE	TCE	cis-DCE	Benzene
GW-5A	NE	NST	NE	NE

**Notes:**

NE = no exceedance of cleanup goal in 2016

NST = no statistically significant trend

TCE = trichloroethene



### 3.4 SITE SUMMARY AND RECOMMENDATIONS

One monitoring well (GW-5A) was sampled at this site in 2016. Only TCE was detected at a concentration above the ROD cleanup level. All other target analytes were either below cleanup levels or non-detect.

#### 3.4.1 Five-Year Review

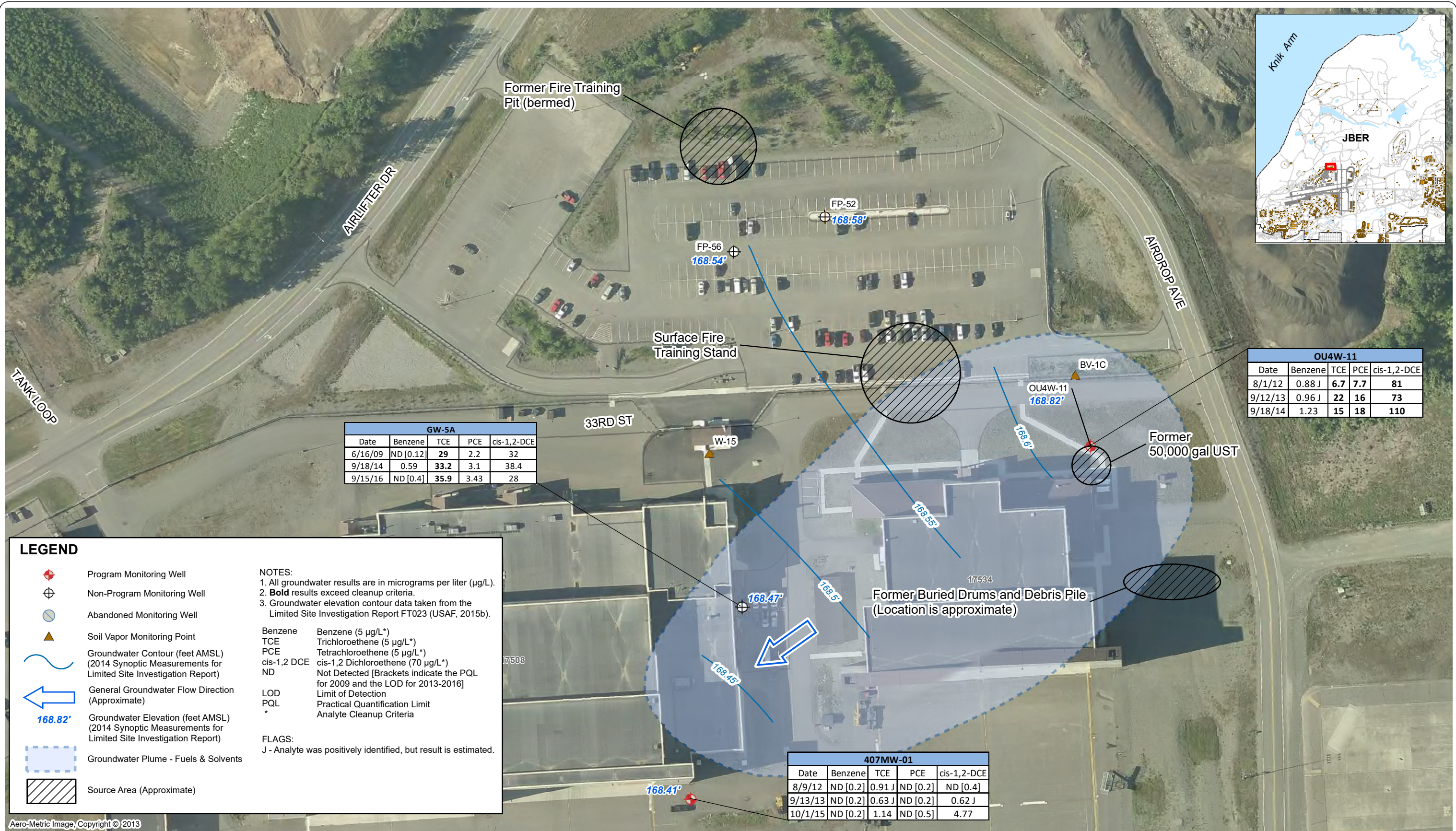
Areas in OU4 where COCs remain above cleanup goals are required to have CERCLA five-year reviews conducted until the cleanup goals are achieved. The purpose of the five-year review is to evaluate the implementation and performance of the remedial actions. There have been four five-year reviews conducted at JBER-E. The fourth five-year review report recommended that a sampling event be conducted to identify if concentrations of 1,4-dioxane exist and determine whether there is an unacceptable risk at the site. Sampling of GW-5A was also recommended, as well as conducting a VI evaluation in accordance with EPA guidelines for each occupied facility that is in proximity to a VOC groundwater plume (USAF, 2014c). In 2015, monitoring well GW-5A was added to the long term monitoring program and has a sampling frequency of every two years. A VI evaluation (2016-2017) and sampling for 1,4-dioxane (2016) was conducted at this site and will be reported under a separate cover. This site was also sampled for per- and polyfluorinated compounds (PFAS) in 2016, which and will also be reported separately.

#### 3.4.2 Recommendations

Site FT023 is identified as a **Yellow** priority since the plume continues to have concentrations of PCE, TCE, and cis-1.2-DCE. A vapor intrusion evaluation will be reported under a separate cover. The 2014 LSI recommended conducting additional work in order to better delineate the extent of the chlorinated solvent contamination by collecting soil samples, and installing a downgradient monitoring well. It is recommended to analyze soil and groundwater samples for gasoline-range organics (GRO), diesel-range organics (DRO), residual-range organics (RRO), VOCs, (including 1,4-dioxane) and perfluorinated compounds (USAF, 2015b).

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GW-5A				
Date	Benzene	TCE	PCE	cis-1,2-DCE
6/16/09	ND [0.12]	<b>29</b>	2.2	32
9/18/14	0.59	<b>33.2</b>	3.1	38.4
9/15/16	ND [0.4]	<b>35.9</b>	3.43	28

OU4W-11				
Date	Benzene	TCE	PCE	cis-1,2-DCE
8/1/12	0.88 J	<b>6.7</b>	<b>7.7</b>	<b>81</b>
9/12/13	0.96 J	<b>22</b>	<b>16</b>	<b>73</b>
9/18/14	1.23	<b>15</b>	<b>18</b>	<b>110</b>

407MW-01				
Date	Benzene	TCE	PCE	cis-1,2-DCE
8/9/12	ND [0.2]	0.91 J	ND [0.2]	ND [0.4]
9/13/13	ND [0.2]	0.63 J	ND [0.2]	0.62 J
10/1/15	ND [0.2]	1.14	ND [0.5]	4.77

**LEGEND**

- Program Monitoring Well
- Non-Program Monitoring Well
- Abandoned Monitoring Well
- Soil Vapor Monitoring Point
- Groundwater Contour (feet AMSL) (2014 Synoptic Measurements for Limited Site Investigation Report)
- General Groundwater Flow Direction (Approximate)
- Groundwater Elevation (feet AMSL) (2014 Synoptic Measurements for Limited Site Investigation Report)
- Groundwater Plume - Fuels & Solvents
- Source Area (Approximate)

**NOTES:**

- All groundwater results are in micrograms per liter (µg/L).
- Bold** results exceed cleanup criteria.
- Groundwater elevation contour data taken from the Limited Site Investigation Report FT023 (USAF, 2015b).

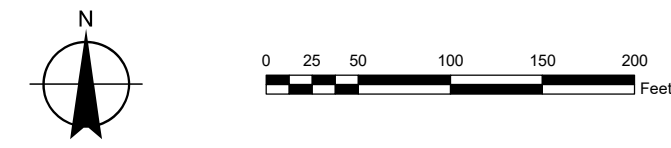
**Chemicals:**

- Benzene: Benzene (5 µg/L\*)
- TCE: Trichloroethene (5 µg/L\*)
- PCE: Tetrachloroethene (5 µg/L\*)
- cis-1,2 DCE: cis-1,2 Dichloroethene (70 µg/L\*)
- ND: Not Detected [Brackets indicate the PQL for 2009 and the LOD for 2013-2016]
- LOD: Limit of Detection
- PQL: Practical Quantification Limit
- \*: Analyte Cleanup Criteria

**FLAGS:**

- J - Analyte was positively identified, but result is estimated.

Date: 10 May 2017 Drawn by: SJ K:\PROJECTS\Air\_Force\JBER\IPBRLTMMXD\2017\2017\_JBER\_FT023\_LTM-01.mxd



**FT023 SITE MAP WITH ANALYTICAL DATA**

2016 Annual Remedial Action – Operations and Monitoring for Select CERCLA Sites  
Joint Base Elmendorf-Richardson, Alaska

Figure  
**3-1**

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## 4.0 LF002

PBC Performance Objective: Response Complete

Achievement Date: 2015

### 4.1 SITE DESCRIPTION

LF002 is an eight-acre landfill located in the southeast area of JBER-E, north of the Boniface gate, and west of Vandenberg Avenue (Figure 4-1). The landfill was reportedly active from 1940 to 1942, and aerial photographs demonstrated that activity ceased prior to 1950 (USAF, 1997b). Waste management practices of the era led to soil and groundwater contamination by metals, VOCs, and semivolatile organic compounds (SVOCs). Groundwater was also contaminated by fueling and maintenance practices at a gun battery located upgradient of the site. The gun battery was inactivated and removed prior to 1950. By the time of the OU6 ROD (USAF, 1997b), no continuing source of groundwater contamination existed at the gun battery, and all gun-battery-derived contamination had migrated to the upgradient edge of the landfill. The landfill area is currently covered with several feet of soil and vegetation in accordance with the OU6 ROD selected remedy of capping heavy metals with soil.

#### 4.1.1 Geology and Hydrology

LF002 is located on a late Quaternary glacial outwash deposits of the Anchorage Plain in an otherwise undeveloped area of JBER-E. Silt and peat deposits near the surface overlie sandy and silty gravels, which make up the matrix for a shallow aquifer. Groundwater flow through this aquifer is to the west-southwest, with a hydraulic gradient of approximately 0.008 ft/ft. Groundwater discharges into a large marsh 300 feet west of the landfill. Depth to groundwater is typically 30 feet bgs with 50 feet of saturated thickness in the shallow aquifer.

### 4.2 REGULATORY REQUIREMENTS

The OU6 ROD identified 1,1,2,2-tetrachloroethane (PCA) as the only groundwater COC for LF002 (USAF, 1997b) and as the basis for all LF002 COC cleanup goals. The PCA cleanup level of 0.43 µg/L presented in the OU6 ROD was amended by the OU6 ESD (USAF, 2007) to 4 µg/L. The OU6 ROD included MNA in the selected remedy. As of 2007, groundwater COC concentrations across the site were determined to be less than the cleanup level. The OU6 ROD states that when this condition is reached, the final round of groundwater monitoring will include analyses for all constituents that exceeded maximum contaminant levels (MCLs) during the 1994 investigation (USAF, 1996). In 2009, closure sampling was conducted at the site. All results were below cleanup goals.

Prior to determining “no further action” for groundwater, ADEC requested DRO and GRO analyses to be added for all sampling locations. Additional closure sampling was conducted in 2010, and the last round of closure sampling was conducted during 2011. In addition, ADEC requested total aromatic hydrocarbons (TAH) and total aqueous hydrocarbons (TAqH) surface water calculation for the LF002 seep. In 2010, TAH and TAqH results were below their applicable

standards in the seep sample. In 2013, TAH and TAqH were calculated once more in order to fulfill the requirements of the ROD (i.e., two consecutive clean rounds).

In 2015, an Interim Remedial Action Completion Report (I-RACR) for LF002 was approved by the EPA and ADEC and became final October 2016 (USAF, 2016b). The I-RACR identified the following:

- Soil remedies at LF002 have met the remedial action objectives;
- Groundwater COCs have been below cleanup goals since 2003 as established in the OU6 ESD, which indicated the attainment of cleanup goals;
- Monitoring wells OU6MW-49R and 53WL-05 may be decommissioned;
- The implemented remedies for soil and groundwater achieved the degree of cleanup or protection as specified in the OU6 ROD for all pathways of exposure; and
- LF002 will remain in the Five-Year Review for JBER-E because the remedy includes ICs and soil cover and does not meet the requirements of unlimited use/unrestricted exposure (UU/UE).

Thus, the site is considered “Response Complete” (RC) as presented in the I-RACR (USAF, 2016b).

### **4.3 2016 FIELD ACTIVITIES**

A LUC inspection was performed at LF002 on September 22, 2016. The site is in good condition. Monitoring well 53WL-05 needs the base secured by concrete. Hydroseeding from last year’s construction activities on the west side of the intersection of Provider Drive and Vandenberg Avenue has grown in and there are no residual signs of construction. A tree continues to grow through the open gate at the east access point to the site, but it appears that the gate is not used. A copy of the 2016 LUC inspection form for LF002 is in Appendix B. No samples were collected at LF002 in 2016.

### **4.4 SITE SUMMARY AND RECOMMENDATIONS**

The cleanup goals in the OU6 ROD and OU6 ESD have been met for LF002 and the site is considered RC. No deficiencies were observed during the LUC inspection in 2016. Annual LUC inspections will continue to be conducted in accordance with the OU6 ROD (USAF, 1997b).

#### **4.4.1 Five-Year Review**

Areas in OU6 where COCs remain above cleanup goals are required to have CERCLA five-year reviews conducted until the cleanup goals are achieved. The purpose of the five-year review is to evaluate the implementation and performance of the remedial actions. There have been four five-year reviews conducted at JBER-E. The fourth five-year review report recommended continuation of sampling the LF002 seep for TAH and TAqH parameters until the seep has been determined to

meet closure requirements, then prepare a Memorandum to the Site File documenting that groundwater and surface water meet cleanup goals and recommend a status of RC for this site (USAF, 2014c). The I-RACR prepared in 2015 identified that the site has met the cleanup goals listed in the OU6 ESD and the status of LF002 is RC (USAF, 2016b).

#### 4.4.2 Recommendations

Site LF002 is identified as a **Green** priority since the cleanup goals in the OU6 ESD have been met. It is recommended in the LF002 I-RACR to decommission monitoring wells OU6MW-49R and 53WL-05. Monitoring well 52WL-02 should be left in place for future monitoring of perfluorinated compounds or for 1,4-dioxane monitoring. The site meets RC status; however, ICs at this site remain in place, so LUCs will continue until the ICs are removed.

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NOTES:  
 1. All groundwater results are in micrograms per liter (µg/L).  
 2. **Bold** results exceed cleanup criteria.  
 3. Groundwater contours are based on the most recent Environmental Restoration Program Atlas (USAF, 2013a)

Selenium (50 µg/L\*)  
 Thallium (2 µg/L\*)

DRO Diesel Range Organics (1,500 µg/L\*)  
 GRO Gasoline Range Organics (2,200 µg/L\*)  
 BEHP bis(2-ethylhexyl)phthalate (6 µg/L\*)  
 MeCl Methylene Chloride (5 µg/L\*)  
 PCA 1,1,2,2-tetrachloroethane (4 µg/L\*)  
 TCE Trichloroethene (5 µg/L\*)  
 TAH Total Aromatic Hydrocarbon (10 µg/L\*)  
 TAqH Total Aqueous Hydrocarbon (15 µg/L\*)  
 ND Not Detected [brackets indicate the PQL for 2009, and the LOD for 2010 - 2013].  
 PQL Practical Quantification Limit  
 LOD Limit of Detection  
 --- Not Analyzed  
 \* Analyte Cleanup Criteria

FLAGS:  
 J - Analyte was positively identified, but result is estimated.  
 B - The analyte was detected in an associated blank sample, as well as in the sample at a concentration less than ten times the blank concentration.

LF02SP-01										
Year	DRO	GRO	TAH	TAqH	BEHP	PCA	TCE	Selenium	Thallium	
2009	---	---	---	---	ND [5]	ND [1]	ND [1]	0.35 J	0.27 B	
2010	100	ND [44]	1.0	1.7	ND [6]	ND [0.15]	0.16	---	---	
2011	56	17 J	---	---	---	---	---	---	---	
9/2013	---	---	1.32	1.91	---	ND [0.20]	0.17 J	---	---	

53WL-02							
Year	DRO	GRO	BEHP	PCA	TCE	Selenium	Thallium
2009-1	---	---	ND [5]	0.53 J	1.4	0.31 J	0.21 B
2010-1	ND [57]	ND [44]	---	---	---	---	---
2011-1	ND [71]	ND [25]	---	---	---	---	---

65WL-04R				
Year	DRO	GRO	PCA	TCE
2009-1	---	---	ND [1]	ND [1]
2010-1	46	ND [44]	---	---
2011-1	ND [73]	ND [25]	---	---

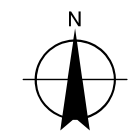
OU6MW-49R				
Year	DRO	GRO	PCA	TCE
2009-1	---	---	---	1
2010-1	ND [57]	ND [44]	---	---
2011-1	ND [72]	ND [25]	---	---

53WL-05								
Year	DRO	GRO	BEHP	MeCl	PCA	TCE	Selenium	Thallium
2009-1	---	---	ND [4.9]	ND [1]	ND [1]	ND [1]	0.3 J	0.17 B
2010-1	ND [58]	ND [44]	---	---	---	---	---	---
2011-1	ND [71] J	ND [25]	---	---	---	---	---	---

**LEGEND**

- Program Monitoring Well
- Non-Program Monitoring Well
- Abandoned Monitoring Well
- Seep Sample Location
- Groundwater Contour Line (feet AMSL)
- General Groundwater Flow Direction (Approximate)
- CERCLA Site

Aero-Metric Image, Copyright © 2013



**LF002 SITE MAP WITH ANALYTICAL DATA**

2016 Annual Remedial Action – Operations and Monitoring for Select CERCLA Sites  
 Joint Base Elmendorf-Richardson, Alaska

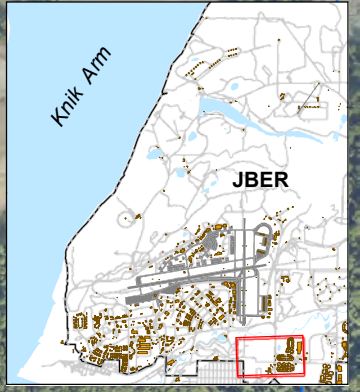


Figure  
**4-1**

Date: 09 May 2017 Drawn by: SJ K:\PROJECTS\Air\_Force\JBER\IPBRLTMMXD\2017\JBER\_LF002\_LTM-01.mxd

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## **5.0 LF003**

PBC Performance Objective: Response Complete

Achievement Date: 2014

### **5.1 SITE DESCRIPTION**

LF003 is a 15-acre landfill located on JBER-E near the southwest corner of Provider Drive and Wilkins Avenue (Figure 1-1). Between 1943 and 1957, the landfill was used for disposal of general refuse, construction rubble, spent small arms ammunition from World War II, and small quantities of shop waste. No daily cover was applied and some limited open burning occurred during the 1950s. In 1957, due to subsequent odor and nuisance complaints, the landfill was closed and covered with several feet of native soil, which now supports a substantial growth of trees and shrubs.

#### **5.1.1 Geology and Hydrology**

LF003 is located on late Quaternary glacial outwash deposits of the Anchorage Plain in an otherwise undeveloped area of JBER-E. Silt and peat deposits near the surface overlay sandy and silty gravels, which make up the matrix for a shallow aquifer. Groundwater flow through this aquifer is to the west-northwest with a hydraulic gradient of approximately 0.008 ft/ft. Depth to water is typically 30 feet bgs with 50 feet of saturated thickness in the shallow aquifer (USAF, 1997b).

### **5.2 REGULATORY REQUIREMENTS**

No COCs were identified in the OU6 ROD for LF003 and the selected remedy was identified as ICs for soil and groundwater (USAF, 1997b). The OU6 RI/FS found low levels of fuel constituents, VOCs, and metals in both soil and groundwater at LF003 (USAF, 1996). Metals results were evaluated and found to be at or near background concentrations in both soil and groundwater. Based on the concentrations of contaminants found during the RI, human health and environmental risk assessments were performed to determine whether areas should be considered for remedial action.

The OU6 ROD required no remedial action at this site and LUCs were implemented (USAF, 1997b). This ROD was modified by the OU6 ESD (USAF, 2007), which clarified the USAF's implementation of LUCs at this site.

### **5.3 2016 FIELD ACTIVITIES**

A LUC inspection was performed at LF003 on September 22, 2016, and did not identify issues. A copy of the 2016 LUC inspection form for LF003 is in Appendix B.

### **5.4 SITE SUMMARY AND RECOMMENDATIONS**

No deficiencies were observed during the LUC inspection in 2016. Annual LUC inspections will continue to be conducted in accordance with the OU6 ROD (USAF, 1997b).

#### 5.4.1 Five-Year Review

Areas in OU6 where COCs remain above cleanup goals are required to have CERCLA five-year reviews conducted until the cleanup goals are achieved. The purpose of the five-year review is to evaluate the implementation and performance of the remedial actions. There have been four five-year reviews conducted at JBER-E. As indicated above, no COCs have been identified for LF003. The most recent review, the fourth five-year review in 2014, all CERCLA sites including LF003 were recommended for review and revision of site boundaries, if needed (USAF, 2014c).

#### 5.4.2 Recommendations

Site LF003 is identified as a **Green** priority. No further remedial action is necessary; however, LUC inspections will continue for this site.

## 6.0 LF004

PBC Performance Objectives: Design and Implement an Optimized Exit Strategy for Site Closeout

Anticipated Achievement Date: 2020

### 6.1 SITE DESCRIPTION

LF004 is a landfill (also known as the Knik Bluff Landfill) located on the west side of JBER-E, west of the east-west runway. It extends approximately 3,000 feet along the Knik Arm bluff and is approximately 600 feet wide (Figure 6-1). Between 1945 and 1957, the landfill was used as a surface dump for old cars, construction rubble, 55-gallon drums, and general refuse. Much of the waste was burned in place. The surface of the landfill is covered with soil and vegetation; however, tidal action along the base of the bluff has eroded the bluff face and exposed portions of the landfill. As a result, fill and waste material has sloughed onto the beach. Expansion work at the Port of Anchorage conducted between 2006 and 2009 filled most of the beach adjacent to LF004, eliminating tidal influence and erosion along the base of the bluff for most of the length of LF004. The rate of erosion and exposure of the landfill has been significantly reduced.

In the OU6 ROD (USAF, 1997b), LF004 was divided into North/Beach and South sections. This ROD was modified by the OU6 ESD (USAF, 2007), and was followed by a Memorandum to the Site File (USAF, 2008a). The *LF04 Memorandum to the Site File* removed reference to the beach area of LF004 North in acknowledgement of the Port of Anchorage Expansion, and that no further action is required for groundwater at LF04 North. A subsurface seepage collection system and surface drainage swale were constructed at the base of the bluff.

LF004 South encompasses the area south of the LF04SP-04 dividing line (Figure 6-1). The OU6 ROD (USAF, 1997b) refers to groundwater in this area as bluff groundwater and seep groundwater. Chlorinated VOCs in the groundwater are attributed to past waste management practices. Fuel-related contaminants in the groundwater are attributed to leaking POL facilities such as PL081 and WP014. PL081 is a former 10-inch inactive pipeline that extended from the Port of Anchorage to the east end of the east/west runway that was damaged during the 1964 earthquake and abandoned in place. Site WP014 is a former fuel tank sludge disposal pit and fuel filter weathering location, which were located east of LF004 South. The general direction of groundwater flow in the vicinity of LF004 is southwesterly. Three aquifers are located in this area (USAF, 1996), complicating the site assessment and source history.

Site PL081 was not formally identified as a site until after the OU6 ROD was signed. The PL081 DD states that groundwater contamination attributable to PL081 will be managed by the OU6 ROD (USAF, 2007).

LF004 South consists of two separate benzene plumes that are monitored by monitoring wells and seeps. Additionally, the WP014 plume extends across LF004 South and a mixing zone for LF004 South COCs occurs before the WP014 plume discharges at seeps LF04SP-03 and -04. Seeps LF04SP-03 and -04 are currently monitored for both LF004 South COCs and the WP014 plume

COCs. The WP014 plume is now considered the primary influence for contamination in these seeps, and associated monitoring results are covered in Section 14.0.

Monitoring wells OU6MW-46 and OU6MW-63 and seeps LF04SP-02 and LF04SP-02DG have been previously associated with PL081. Results from these locations, except OU6MW-46, are discussed in this section with LF004 South results because they are monitored for LF004 South COCs, as stated in the OU6 ROD. The results for OU6MW-46 are discussed in Section 14.0 with the WP014 results.

### 6.1.1 Geology and Hydrology

LF004 is located on the Elmendorf End Moraine, which is a predominantly silt and clay-rich matrix containing discontinuous lenses of sand and gravel (USAF, 1997b). These lenses cause a complex hydrogeologic situation that includes a series of perched aquifers at varied depths. These are collectively called Aquifer 1, are typically 10 to 20 feet thick, and occur from 10 to 80 feet bgs. Groundwater flow in this aquifer is to the west-southwest with a gradient of approximately 0.018 ft/ft.

A deeper aquifer, Aquifer 2, is present from about 70 to 110 feet bgs between discontinuous fine grained perching layers. Aquifer 2 extends to the Knik Arm bluff and discharges as seeps along the bluff face. Aquifers 1 and 2 commingle in a mixing zone at the eastern edge of LF004 and have similar gradients. On the western side, Aquifer 2 steepens to about 0.133 ft/ft. A still deeper aquifer, Aquifer 3, is present at or near the beach level above the Bootlegger Cove Formation. Groundwater flow in this aquifer is also to the west with a gradient of about 0.10 ft/ft. There is also a mixing zone in the west formed by water from Aquifer 2 discharging as seeps on the bluff face entering Aquifer 3 through the bluff soil. The two mixing zones allow for vertical hydraulic connectivity between the three aquifers estimated at  $1.12 \times 10^{-3}$  to  $3.59 \times 10^{-5}$  centimeters per second. Aquifers 1 and 2 have been impacted at LF04. Monitoring wells OU6MW-61 and OU6MW-63 were originally thought to be screened across the water table of Aquifer 2 and OU6MW-67 is screened across the water table of Aquifer 1 (USAF, 1997b). However, recent groundwater data shows that OU6MW-61 is screened in a perched aquifer (USAF, 2012a).

## 6.2 REGULATORY REQUIREMENTS

The OU6 ROD identified benzene, ethylbenzene, toluene, 1,2-DCA, and methylene chloride as groundwater COCs for LF004 (USAF, 1997b) and is the basis for the cleanup level for all LF004 groundwater COCs. The OU6 ROD included long term monitoring in the selected remedy for groundwater. Current remedial actions at LF004 include periodic groundwater and seep sampling, an annual LUC inspection, and debris removal from the base of the bluff occurring every three years in accordance with the 2016 *Memorandum to the Site File for OU6* (USAF, 2016a).

The groundwater remedy for LF004 South described in the *Memorandum to the Site File for OU6* consists of the following:

- Access to groundwater at LF004 South will be institutionally controlled. LF004 is designated as a “restricted use area” in the Base Comprehensive Plan. This designation

provides for recreational use of the parcel (cross country skiing, etc.) and for construction of unmanned facilities such as a parking lot, storage building, or taxiway, but prohibits the construction of any sort of manned facility such as an office building or a residence. Drilling into the shallow aquifer is also restricted by the Base Comprehensive Plan. As a former landfill, LF04 will maintain this designation indefinitely.

- Groundwater will be monitored and evaluated annually to determine contaminant migration and to track the progress of contaminant degradation and dispersion, as well as to provide an early indication of unforeseen environmental or human health risk. Five-year reviews will also assess the protectiveness of the remedial action, including an evaluation of any changed site conditions, as long as contamination remains above cleanup levels.
- Recoverable quantities of free product found on top of the water table at LF04 will be regularly removed during groundwater monitoring events.
- Groundwater monitoring will be discontinued if contaminant levels are below cleanup levels during two consecutive monitoring events. In that case, no further action for groundwater will be required.
- During the final round of monitoring, samples will be collected and analyzed for all constituents that exceeded MCLs during the 1994 investigation including VOCs, SVOCs, and metals. These results will be evaluated before a final determination is made that groundwater meets all cleanup requirements.

No further action is required for the groundwater at LF004 North Beach.

Current site requirements at LF004 include sampling for COCs at monitoring wells OU6MW-61 (every 5 years), OU6MW-63 (every 5 years), and OU6MW-67 (annually). The next sampling events for monitoring wells OU6MW-61 and OU6MW-63 will be in 2020. The sampling frequency for monitoring wells OU6MW-61 and OU6MW-63 was reduced to once every 5 years in 2012 as recommended in the 2011 Zones 1, 2, and 3 Report (USAF, 2012a). These recommendations were based on the Basewide Monitoring Program Well Sampling Frequency Decision Guide presented in Attachment 1 of the OU6 Memorandum to the Site File (USAF, 2003e). Seep sampling is required for COCs at seeps LF04SP-02 (quarterly) and LF04SP-02DG (annually). The seep sampling frequency was modified for LF04 SP-02 to quarterly in 2015 because of a benzene exceedance in 2014. Quarterly sampling is based on the calendar year, which includes Q1 (Jan-March), Q2 (April-June), Q3 (July-September) and Q4 (October-December). LUCs are in place to prevent access and exposure to contaminated groundwater and soil at the site.

Table 6-1 provides a list of the current groundwater COCs and the respective cleanup goals identified in the OU6 ROD (USAF, 1997b). In addition, 18 AAC 75 Table C cleanup levels (ADEC, 2017) are included in the table for informational purposes.

**Table 6-1 Cleanup Goals in LF004 Groundwater and Seeps**

Contaminants of Concern	Cleanup Goal <sup>a</sup> (µg/L)	ADEC Cleanup Level <sup>b</sup> (µg/L)	Monitoring Location
Benzene	5	4.6	OU6MW-61, OU6MW-63, OU6MW-67, LF04SP-02, LF04SP-02DG, LF04SP-03, LF04SP-04
Ethylbenzene	700	15	LF04SP-02, LF04SP-02DG, LF04SP-03, LF04SP-04
Toluene	1,000	1,100	LF04SP-02, LF04SP-02DG, LF04SP-03, LF04SP-04
1,2-DCA	5	1.7	OU6MW-61, LF04SP-02, LF04SP-02DG, LF04SP-03, LF04SP-04
Methylene Chloride	5	110	OU6MW-61, LF04SP-02, LF04SP-02DG, LF04SP-03, LF04SP-04

**Notes:**

<sup>a</sup> Cleanup levels as cited in the OU6 ROD (USAF, 1997b).

<sup>b</sup> 18 AAC 75 Table C Cleanup Levels (ADEC, 2017) are provided for informational purposes only.

µg/L = microgram(s) per liter

DCA = dichloroethane

OU = Operable Unit

ROD = Record of Decision

USAF = United States Air Force

### 6.3 2016 FIELD ACTIVITIES AND RESULTS

In 2016, seeps LF04SP-02, LF04SP-02DG and monitoring wells OU6MW-63 and OU6MW-67 were sampled for VOCs and MNA parameters. Samples from seeps LF04SP-02 and LF04-02DG were also analyzed for polycyclic aromatic hydrocarbons (PAHs) to calculate TAH and TAqH. The debris survey was also conducted. Table 6-2 summarizes the debris removal quantities and is accompanied by a bar graph. Table 6-3 presents a summary of the 2016 analytical results and Table 6-4 presents a summary of the MNA field parameters. The 2016 and truncated historical results are on Figure 6-1. Historical results and Mann-Kendall trend analysis results are in Table 6-5. Mann-Kendall contaminant trend graphs are on Figures 6-2 through Figure 6-3.

#### 6.3.1 Erosion Survey and Debris Removal

The LF004 erosion survey and debris removal was conducted on October 19, 2016. A total of 220 pounds of material consisting of metal scrap, glass jars and bottles, burnt books and papers, vehicle parts, concrete pieces and wood and metal construction track matting were removed.

Prior to mobilization to the LF004 base of the bluff, permissions were obtained from the Port of Anchorage and JBER security forces. All personnel working on the LF004 erosion survey and debris removal attended a JBER EOD training class that consists of how to identify ordnance and how to proceed if ordnance is identified. The EOD did not inspect the base of the bluff prior to debris removal and field personnel were instructed to avoid any suspicious items and notify the EOD immediately. Potential UXO were not observed during the debris removal.

Geographic positioning system locations were recorded at the debris point of origin prior to removal and stockpiling into debris collection areas. All debris were collected and disposed of on

October 22, 2016. Debris piles were loaded into a work truck and delivered to the Municipality of Anchorage – Solid Waste Services landfill in Eagle River.

Since the Port of Anchorage expansion in 2007/2008, the quantity of debris recovered has steeply declined to levels below 0.5 ton per year and there does not appear to be any significant erosion occurring. As per the *2016 Memorandum to the Site File for OU6* (USAF, 2016a) debris removal has been modified to a frequency of once every three years, the next debris survey will be conducted in 2019. A copy of the debris removal logbook, Solid Waste Services disposal receipt, and a photograph log are included in Appendix A. Table 6-2 summarizes the debris quantities and types removed from 1997 to 2016.

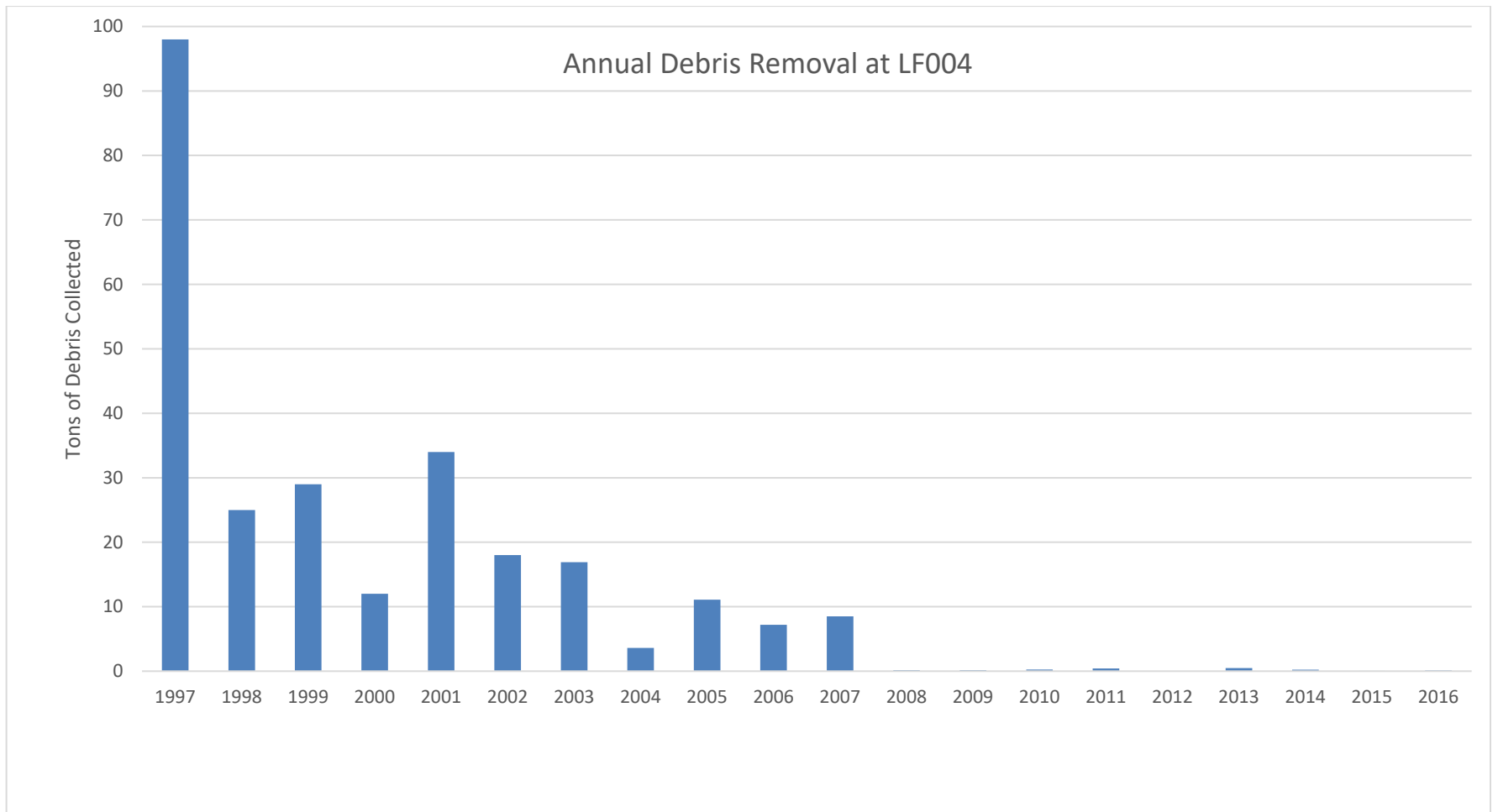
**Table 6-2 LF004 Debris Removal Summary 1997-2016**

<b>Year</b>	<b>Quantity Removed (Tons)</b>	<b>Material Classification</b>	<b>Other Material Removed</b>
1997	98	General debris, mostly metal	One roll of asbestos wrap, one large battery, two small transformers, 25 5-gallon drums and five 5- to 10-gallon drums with unknown contents
1998	25	General debris, recyclable material	No UXO or ACM identified
1999	29	General debris	No ACM identified; explosive ordnance disposal personnel removed small arms ammunition, shells, casings, and one howitzer shell casing
2000	12	Nonhazardous solid waste	No UXO or ACM identified
2001	34	Nonhazardous solid waste	No UXO or ACM identified; a cylinder with unknown contents was secured in place and left for the next field season
2002	18	Nonhazardous solid waste, mostly metal, some concrete, rubber, and vehicle parts	Forty rifle casings, one steel cylinder
2003	16.9	Nonhazardous solid waste, mostly metal, some rubber, electrical components, and wood	One .30- and one .50-caliber shell casing, 820 pounds of ACM (pipe)
2004	3.6	Nonhazardous solid waste, mostly metal, some rubber, electrical components, and wood	One previously perforated cylinder apparently containing seawater
2005	11.1	Nonhazardous solid waste, mostly metal, some rubber, electrical components, and wood	One .50-caliber shell casing, two compromised batteries, 40 pounds of asphaltic material, and 200 pounds of ACM (cementitious board and pipe)
2006	7.2	Nonhazardous solid waste, mostly metal, some rubber, electrical components, and wood	100 pounds of ACM (pipe), one light ballast PCB
2007	8.5	Nonhazardous solid waste, mostly metal, some electrical components, and wood	Pack of solder rod, a water heater, one lead battery, 120 pounds of ACM (cementitious board and pipe)
2008	0.14	Nonhazardous solid waste, mostly metal and glass	Small pieces of ceramic cookware
2009	0.15	Nonhazardous solid waste, mostly metal and glass	No UXO or ACM identified
2010	0.25	Nonhazardous solid waste, mostly metal, glass, and burned debris	No UXO or ACM identified
2011	0.42	Nonhazardous solid waste, mostly metal, glass, and burned debris	No UXO or ACM identified
2012	0.025	Nonhazardous solid waste, mostly metal scrap, household items, and a tire.	No UXO or ACM identified
2013	0.48	Nonhazardous solid waste, mostly metal scrap, glass, burned debris, household items and a porcelain sink basin.	No UXO or ACM identified
2014	0.23	Nonhazardous solid waste, mostly metal scrap, glass, burned debris, and concrete	No UXO or ACM identified
2015	< 0.05	Nonhazardous solid waste, mostly metal scrap, glass, burned debris, and concrete	No UXO or ACM identified
2016	0.11	Nonhazardous solid waste, mostly metal scrap, glass, burned debris, and concrete	No UXO or ACM identified

**Notes:**

ACM = asbestos-containing material  
 PCB = polychlorinated biphenyl(s)  
 UXO = unexploded ordnance





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### 6.3.2 Groundwater Sampling and LUC Inspection

In 2016, seeps LF04SP-02, LF04SP-02DG and monitoring wells OU6MW-63 and OU6MW-67 were sampled for VOCs. Samples from seeps LF04SP-02 and LF04SP-02DG were also analyzed for PAHs. Monitoring well OU6MW-63 was also sampled for DRO and GRO as per the fourth five-year review. Due to an exceedance in surface water quality and benzene, seep LF04SP-02 was switched to quarterly sampling in 2015. The seep was sampled in all four quarters in 2016. A field duplicate sample was collected from OU6MW-63. Seeps LF04SP-03 and LF04SP-04 were sampled for site WP014, which is discussed in Section 14.0 of this report.

All samples were analyzed for VOCs, and each of the quarterly samples collected from LF04SP-02 had concentrations of benzene (28.9, 18.3 and 15.2  $\mu\text{g/L}$ , respectively) that exceeded the cleanup level (5  $\mu\text{g/L}$ ) except for the quarter four sample. Concentrations of all other analytes were either non-detect or below the ROD cleanup level. The fourth quarter sample results for LF04SP-02 are significantly lower than the other three quarters sample results and are not consistent with previous sample results from this location. The TAH and TAqH levels exceeded the 18 AAC 70 Alaska Water Quality Standards (10 and 15  $\mu\text{g/L}$ , respectively) at seep LF04SP-02 for each of the quarterly sampling events except for quarter four. Only benzene exceeded the cleanup level at OU6MW-67 (5.73  $\mu\text{g/L}$ ). Concentrations of all ROD target analytes for monitoring well OU6MW-63 were either non-detect or below the ROD cleanup levels. However, elevated concentrations of DRO and GRO were detected in the sample.

Mann-Kendall trend tests indicated statistically significant increasing trends at the 95% confidence level for benzene, ethylbenzene and toluene in well OU6MW-67. Statistically significant decreasing trends were indicated for TAH and TAqH for LF04SP-02. The Mann-Kendall trend test for benzene in seep LF04SP-02 show no statistically significant trend. Mann-Kendall contaminant trend graphs are on Figure 6-2 and Figure 6-3.

A LUC inspection performed at LF004 on September 22, 2016. All monitoring wells were secure and no ground disturbances were noted. The information kiosk remains overgrown and blank. During the 2017 field season, the vegetation that has grown in front of the kiosk will be removed and site information will be added to the kiosk. A copy of the 2016 LUC inspection form for LF004 is in Appendix B.

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**Table 6-3 Summary of 2016 Analytical Results at LF004**

Analyte	Units	Cleanup Goal <sup>a</sup>	LF04SP-02 (Q1)	LF04SP-02 (Q2)	LF04SP-02 (Q3)	LF04SP-02 (Q4)	LF04SP-02DG	OU6MW-63	OU6MW-63 (FD)	OU6MW-67
DRO	µg/L	--	--	--	--	--	--	349 J	402 J	NA
GRO	µg/L	--	--	--	--	--	--	137	144	NA
Benzene	µg/L	5	<b>28.9</b>	<b>18.3</b>	<b>15.2</b>	0.28 J	ND [0.4]	0.15 J	0.15 J	<b>5.73</b>
Ethylbenzene	µg/L	700	166	117	90.6 J	1.77	0.47 J	ND [1]	ND [1]	2.86
Toluene	µg/L	1,000	ND [1]	ND [0.5]	ND [1]	ND [0.5]	ND [1]	ND [1]	ND [1]	0.39 J
1,2-DCA	µg/L	5	ND [0.5]	ND [0.25]	ND [0.5]	ND [0.25]	ND [0.5]	ND [0.5]	ND [0.5]	ND [0.5]
Methyl Chloride	µg/L	5	ND [5]	ND [2.5]	ND [5]	ND [2.5]	ND [5]	ND [5]	ND [5]	ND [5]
TAH <sup>b</sup>	µg/L	10	<b>474</b>	<b>300</b>	<b>214</b>	4.92	3.37	--	--	--
TAqH <sup>b</sup>	µg/L	15	<b>483</b>	<b>301</b>	<b>219</b>	5.35	4.18	--	--	--

**Notes:**

<sup>a</sup> Cleanup levels as cited in the OU6 ROD (USAF, 1997b).

<sup>b</sup> Alaska Water Quality Standards (18 AAC 70) for TAH and TAqH are 10 µg/L and 15 µg/L, respectively.

**Bold** result exceeds the ROD cleanup level

[ ] = limit of detection

J = analyte was positively identified: the associated numerical value is the approximate concentration of the analyte in the sample.

µg/L = microgram(s) per liter

ND = non-detect [limit of detection]

DCA = dichloroethane

Q = Quarter

FD = field duplicate

TAqH = total aqueous hydrocarbons

TAH = total aromatic hydrocarbons



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**Table 6-4 Summary of 2016 MNA Field Parameters at LF004**

MNA Field Parameters							
Monitoring Well ID	Volume Purged (gallons)	Temp (C)	Specific Conductance <sup>a</sup> (mS/cm)	DO (mg/L)	pH	ORP (mV)	Turbidity (NTU)
OU6MW-63	1.2	8.84	1.571	0.38	7.34	-67.1	42.79
OU6MW-67	1.5	8.09	0.829	1.57	7.54	-43.8	12.14

**Notes:**

<sup>a</sup> Specific Conductance is a conductivity measurement that has been corrected to 25°C.

µg/L = microgram(s) per liter

°C = Celsius

CaCO<sub>3</sub> = calcium carbonate

DO = dissolved oxygen

ID = identification

mg/L = milligram(s) per liter

mS/cm = milliSiemens per centimeter

mV = millivolts

NTU = Nephelometric Turbidity Units

ORP = oxidation-reduction potential

**Table 6-5 Summary of 2016 Mann-Kendall Concentration Trends for Select Wells and Seeps at LF04**

Monitoring Well or Seep ID	Benzene	Ethylbenzene	Toluene	1,2-DCA	Methyl Chloride	TAH	TAqH
LF04SP-02	NST	NE	NE	NE	NE	Decreasing	Decreasing
LF04SP-02DG	NE	NE	NE	NE	NE	NE	NE
OU6MW-63	NE	NE	NE	NE	NE	--	--
OU6MW-67	Increasing	Increasing	Increasing	NE	NE	--	--

**Notes:**

ID = identification

NE = no exceedance of cleanup goal in 2016

NST = no statistically significant trend



## 6.4 SITE SUMMARY AND RECOMMENDATIONS

Benzene concentrations at seep LF04SP-02 and monitoring well OU6MW-67 continue to exceed the ROD cleanup level (5 µg/L). Due to elevated benzene, ethylbenzene and total xylenes concentrations, the TAH and TAqH levels exceeded the 18 AAC 70 Alaska Water Quality Standards at LF04SP-02. According to the fourth five-year review, analyzing for DRO and GRO in an upgradient monitoring well from seep LF04SP-02 would help predict when the seep would meet Alaska Water Quality Standards. Monitoring well OU6MW-63 exhibited elevated concentrations of DRO and GRO, but these constituents are not used in calculating TAH and TAqH. Therefore, concentrations of DRO and GRO do not provide good information regarding the time frame for meeting Alaska Water Quality Standards.

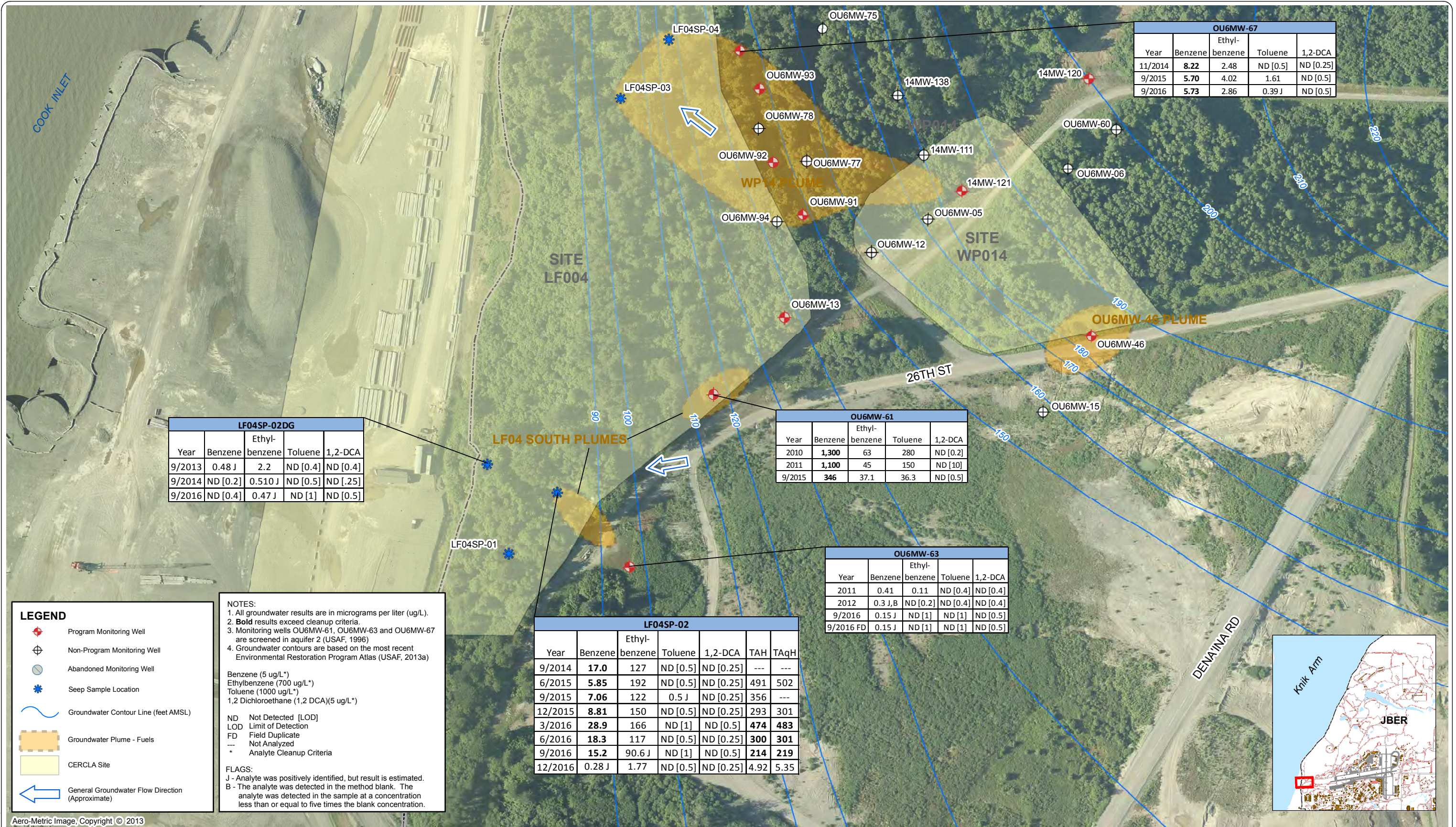
### 6.4.1 Five-Year Review

Areas in OU6 where COCs remain above cleanup goals are required to have CERCLA five-year reviews conducted until the cleanup goals are achieved. The purpose of the five-year review is to evaluate the implementation and performance of the remedial actions. There have been four five-year reviews conducted at JBER-E. The fourth five-year review report recommended performing RPO for the LF004 South site to reevaluate the cleanup time frame, as well as a sampling event to identify if concentrations of 1,4-dioxane exist at the site and, if so, present an unacceptable risk. The review also recommended following the plan to sample LF004 seeps for TAH and TAqH to assess whether the seeps were meeting Alaska Water Quality Standards. If the seeps are not meeting Alaska Water Quality Standards, fuel-related compounds DRO and GRO in upgradient wells are to be analyzed to help predict when and if the LF004 seeps might meet Alaska Water Quality Standards (USAF, 2014c). In 2014, sampling for TAH and TAqH at LF004 seeps began. The results are above Alaska Water Quality Standards. The analytes GRO and DRO were sampled for in 2016 and the results are included in this report. An evaluation of 1,4-dioxane at the site will be conducted under a separate cover. This site was sampled for PFAS in 2016, which will also be reported separately.

### 6.4.2 Recommendations

Site LF004 is identified as a **Yellow** priority. Seep LF04SP-02 does not meet surface water quality levels and continued quarterly sampling is recommended in accordance with the Basewide Monitoring Program Well Sampling Frequency Decision Guide presented in Attachment 1 of the *Memorandum to the Site File for OU6* (USAF, 2003e). It is also recommended that LUC inspections continue until the site reaches RC.

Date: 24 May 2017 Drawn by: SJ K:\PROJECTS\Air\_Force\JBER\IPBRL\TMMXD\2017\2017\_JBER\_LF004\_LTM-01.mxd



LF04SP-02DG				
Year	Benzene	Ethyl-benzene	Toluene	1,2-DCA
9/2013	0.48 J	2.2	ND [0.4]	ND [0.4]
9/2014	ND [0.2]	0.510 J	ND [0.5]	ND [.25]
9/2016	ND [0.4]	0.47 J	ND [1]	ND [0.5]

OU6MW-67				
Year	Benzene	Ethyl-benzene	Toluene	1,2-DCA
11/2014	<b>8.22</b>	2.48	ND [0.5]	ND [0.25]
9/2015	<b>5.70</b>	4.02	1.61	ND [0.5]
9/2016	<b>5.73</b>	2.86	0.39 J	ND [0.5]

OU6MW-61				
Year	Benzene	Ethyl-benzene	Toluene	1,2-DCA
2010	<b>1,300</b>	63	280	ND [0.2]
2011	<b>1,100</b>	45	150	ND [10]
9/2015	<b>346</b>	37.1	36.3	ND [0.5]

OU6MW-63				
Year	Benzene	Ethyl-benzene	Toluene	1,2-DCA
2011	0.41	0.11	ND [0.4]	ND [0.4]
2012	0.3 J,B	ND [0.2]	ND [0.4]	ND [0.4]
9/2016	0.15 J	ND [1]	ND [1]	ND [0.5]
9/2016 FD	0.15 J	ND [1]	ND [1]	ND [0.5]

LF04SP-02						
Year	Benzene	Ethyl-benzene	Toluene	1,2-DCA	TAH	TAQH
9/2014	<b>17.0</b>	127	ND [0.5]	ND [0.25]	---	---
6/2015	<b>5.85</b>	192	ND [0.5]	ND [0.25]	491	502
9/2015	<b>7.06</b>	122	0.5 J	ND [0.25]	356	---
12/2015	<b>8.81</b>	150	ND [0.5]	ND [0.25]	293	301
3/2016	<b>28.9</b>	166	ND [1]	ND [0.5]	<b>474</b>	<b>483</b>
6/2016	<b>18.3</b>	117	ND [0.5]	ND [0.25]	<b>300</b>	<b>301</b>
9/2016	<b>15.2</b>	90.6 J	ND [1]	ND [0.5]	<b>214</b>	<b>219</b>
12/2016	0.28 J	1.77	ND [0.5]	ND [0.25]	4.92	5.35

**LEGEND**

- ◆ Program Monitoring Well
- Non-Program Monitoring Well
- Abandoned Monitoring Well
- ★ Seep Sample Location
- Groundwater Contour Line (feet AMSL)
- Groundwater Plume - Fuels
- CERCLA Site
- ← General Groundwater Flow Direction (Approximate)

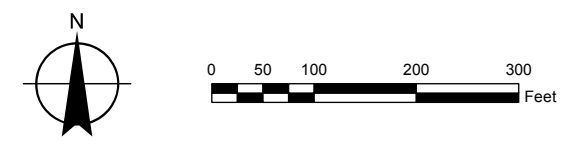
**NOTES:**

- All groundwater results are in micrograms per liter (ug/L).
- Bold** results exceed cleanup criteria.
- Monitoring wells OU6MW-61, OU6MW-63 and OU6MW-67 are screened in aquifer 2 (USAF, 1996)
- Groundwater contours are based on the most recent Environmental Restoration Program Atlas (USAF, 2013a)

Benzene (5 ug/L\*)  
Ethylbenzene (700 ug/L\*)  
Toluene (1000 ug/L\*)  
1,2 Dichloroethane (1,2 DCA)(5 ug/L\*)

ND Not Detected [LOD]  
LOD Limit of Detection  
FD Field Duplicate  
-- Not Analyzed  
\* Analyte Cleanup Criteria

**FLAGS:**  
J - Analyte was positively identified, but result is estimated.  
B - The analyte was detected in the method blank. The analyte was detected in the sample at a concentration less than or equal to five times the blank concentration.



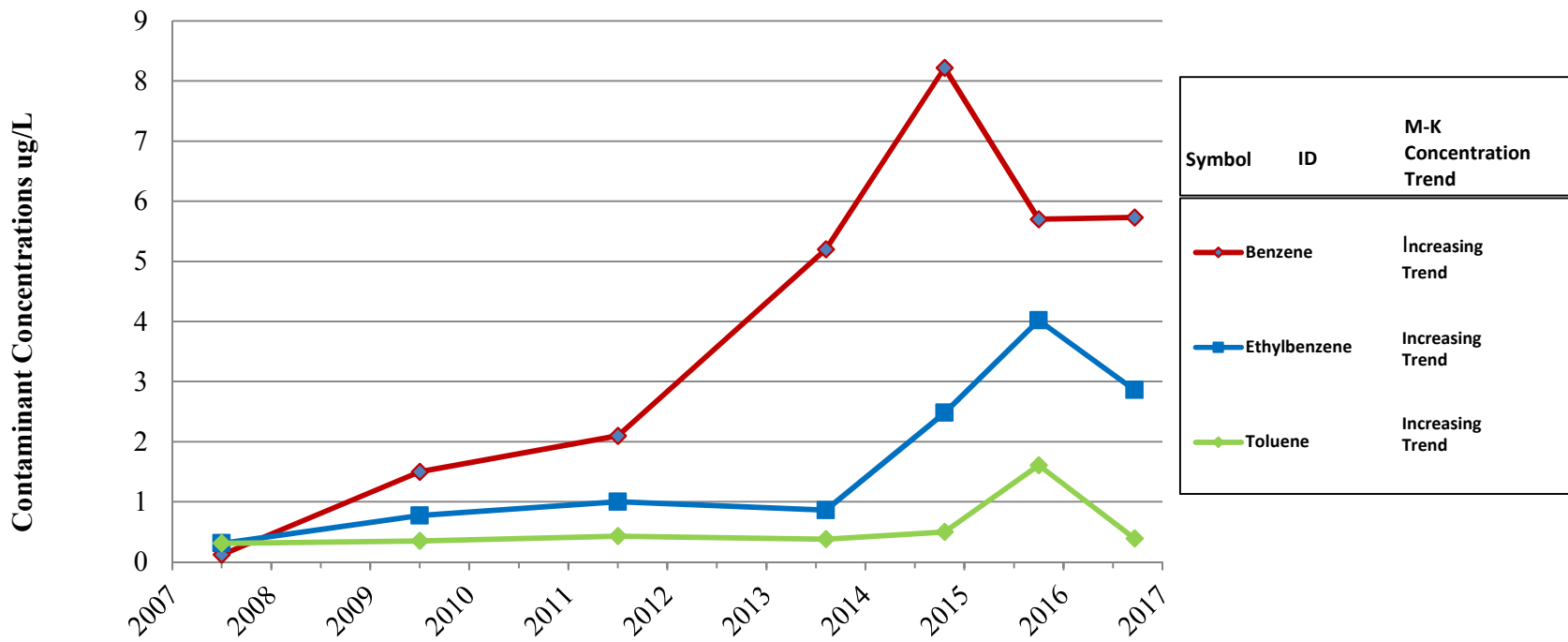
**LF004 SITE MAP WITH ANALYTICAL DATA**

2016 Annual Remedial Action – Operations and Monitoring for Select CERCLA Sites  
Joint Base Elmendorf-Richardson, Alaska

Figure  
**6-1**

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Cleanup Levels  
 Benzene = 5 µg/L  
 Ethylbenzene = 700 µg/L  
 Toluene = 1,000 µg/L



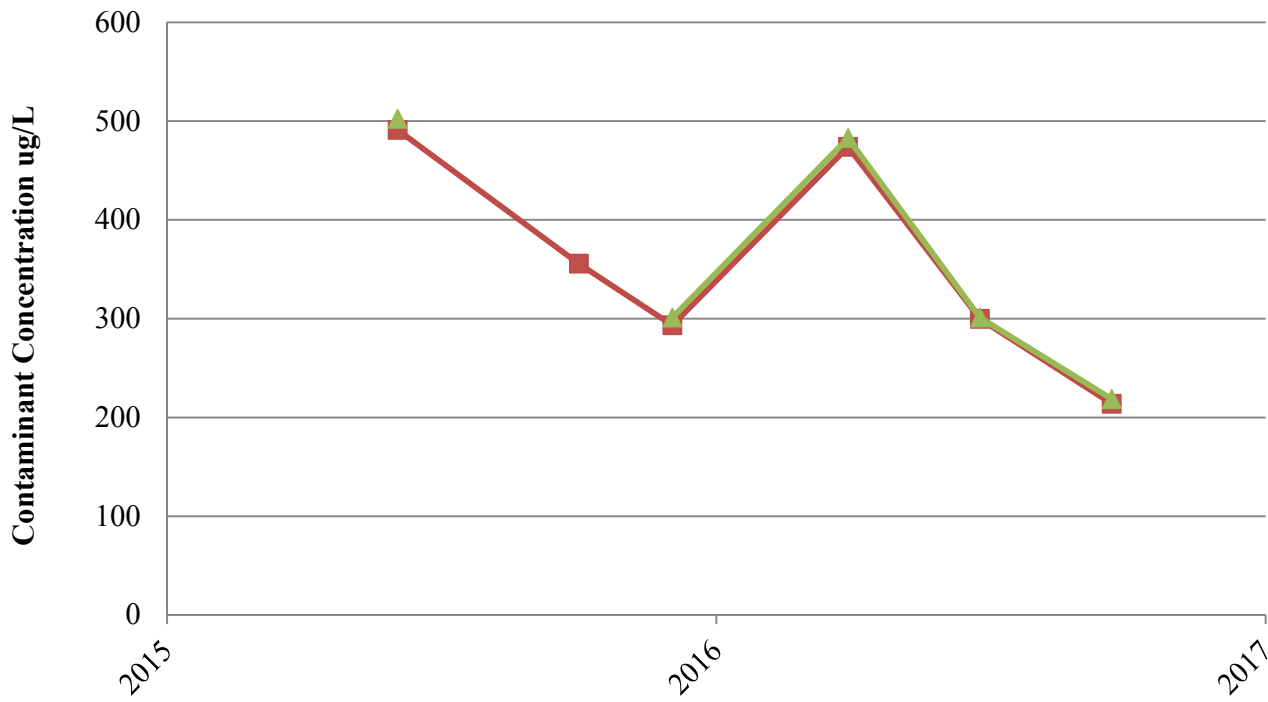
**LF004 CONTAMINANT TRENDS IN OU6MW-67**

2016 Annual RA-O and Monitoring Report, Select CERCLA Sites  
 Joint Base Elmendorf-Richardson, Alaska

Figure  
**6-2**

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Symbol	ID	M-K Concentration Trend
	TAH	No significant Trend
	TAqH	No significant Trend

Cleanup Levels  
 TAH = 10 µg/L  
 TAqH = 15 µg/L



**LF004 TAH AND TAqH TRENDS IN LF04SP-02**

2016 Annual RA-O and Monitoring Report, Select CERCLA Sites  
 Joint Base Elmendorf-Richardson, Alaska

Figure  
**6-3**

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## 7.0 LF059

PBC Performance Objectives: Response Complete

Anticipated Achievement Date: 2015

### 7.1 SITE DESCRIPTION

LF059 is a landfill on JBER-E and occupies approximately one acre near the intersection of Arctic Warrior Drive and Vandenberg Avenue (Figure 7-1). The LF059 landfill received general refuse and construction debris from 1965 until 1983 and may have housed an asphalt batch plant in the 1950s and 1960s (USAF, 1994a). During a site visit in June 1991, “fluid asphalt” was observed pooled and partially solidified on top of a hiking trail. As a result, the trail was closed. The site was excavated in 1996, and over 10,000 gallons of asphalt were recovered and recycled. This site contains one plume, referred to as the LF59MW-03 plume.

#### 7.1.1 Geology and Hydrology

Other than fill material, two lithologic units occur at the site, consisting of younger alluvial deposits adjacent to Ship Creek and older glaciofluvial deposits that underlie and extend beyond the limits of the alluvial deposits. The alluvial deposits generally consist of sand and gravel.

The glaciofluvial deposits generally consist of massive to crudely bedded, poorly sorted, sandy gravel and include relatively thin lenses of sand. Channeling is common, and the gravel occurs as lenses and channel fill. There are also occasional lenses of finer-grained material.

The alluvial and glaciofluvial deposits are underlain at depth by the Bootlegger Cove Formation, a fine-grained glacioestuarine deposit generally consisting of clay, silt, fine sandy silt, silty fine sand, and minor amounts of sand. The depth to the Bootlegger Cove Formation is approximately 100 feet bgs. This unit forms the lower limit of the shallow aquifer and is the confining layer for deeper, confined aquifer systems (USAF, 1994a).

Historical groundwater elevation data indicate that groundwater flow across the LF059 area is predominantly to the west-southwest. The average horizontal groundwater gradient is about 0.0064 ft/ft, steepening to about 0.013 ft/ft near the western boundary of Site LF059 where groundwater discharges to Ship Creek (USAF, 1994a).

### 7.2 REGULATORY REQUIREMENTS

The OU1 ROD identified manganese, 1,2-dibromoethane, TCE, and VC as COCs in groundwater at LF059 and is the basis for cleanup goals (USAF, 1994a). The OU1 ROD selected remedy included ICs for soil and groundwater and MNA for groundwater. TCE in groundwater is currently the only COC that remains above the cleanup goal (5 µg/L); however, the TCE plume at LF059 has been identified to be originating from an upgradient unknown source. The fourth five-year review recommendation for transferring the TCE plume to an unknown upgradient source, coupled with the 2014 seep sampling results which were below cleanup goals, indicate that monitoring for contaminants at LF059 can be terminated, making the site eligible for RC. The USAF has opened

a new site (CG704) associated with the upgradient unknown source for the LF059 plume and will initiate a LSI for the new site in 2017. ADEC has made CG704 an active site as of February 6, 2017.

The major components of the selected remedy for LF059 described in the OU1 ROD (USAF, 1994a) include annual groundwater sampling for TCE at monitoring wells LF59MW-02 and LF59MW-03 and an annual LUC inspection. Groundwater monitoring was discontinued in 2015 because the site is eligible for RC, but due to the delay in achieving RC at LF059, groundwater samples were collected from monitoring wells LF59MW-02 and LF50MW-03 in 2016. An annual LUC inspection is in place to prevent access and exposure to contaminated groundwater and soil at the site.

Table 7-1 provides a list of the current groundwater COCs and the respective cleanup goals identified in the OU1 ROD (USAF, 1994a). In addition, 18 AAC 75 Table C cleanup levels (ADEC, 2017) are included in the table for informational purposes.

### 7.3 2016 FIELD ACTIVITIES AND RESULTS

In 2016, monitoring wells LF59MW-02 and LF59MW-03 were sampled for VOCs. Table 7-1 presents a summary of the 2016 analytical results and Table 7-2 presents the 2016 MNA field parameters at LF059. The 2016 and truncated historical results are shown on Figure 7-1. Historical results and Mann-Kendall trend analysis results are included in Appendix C and a summary of the Mann-Kendall trend analysis is in Table 7-3.

The Mann-Kendall trend test for TCE in wells LF59MW-02 and LF59MW-03 indicated no statistically significant trends at the 95% confidence level.

A LUC inspection was performed at LF059 on September 22, 2016. All monitoring wells were in good condition and there was no evidence of ground disturbance. The information kiosk is in good condition and there is no evidence of vandalism or trespassing. A copy of the 2016 LUC inspection form for LF059 is in Appendix B.

**Table 7-1 Summary of 2016 Analytical Results at LF059**

Analyte	Units	Cleanup Goal <sup>a</sup>	ADEC Cleanup Level <sup>b</sup> (µg/L)	LF59MW-02	LF59MW-03
TCE	µg/L	5	2.8	<b>5.15</b>	<b>5.24</b>

**Notes:**

<sup>a</sup> Cleanup levels as cited in the OU1 ROD (USAF, 1994a).

<sup>b</sup> 18 AAC 75 Table C Cleanup Levels (ADEC, 2017) are provided for informational purposes only.

<sup>c</sup> The TCE concentrations at LF059 are considered to be from an upgradient source (CG704).

**Bold** result exceeds the ROD cleanup level

µg/L = microgram(s) per liter

**Table 7-2 Summary of 2016 MNA Analytical and Field Parameters at LF004**

MNA Field Parameters							
Monitoring Well ID	Volume Purged (gallons)	Temp (C)	Specific Conductance <sup>a</sup> (mS/cm)	DO (mg/L)	pH	ORP (mV)	Turbidity (NTU)
LF59MW-02	2	5.84	0.429	0.21	6.43	134.0	3.98
LF59MW-03	1	6.46	0.466	0.24	6.46	130.1	10.68

**Notes:**

<sup>a</sup> Specific Conductance is a conductivity measurement that has been corrected to 25°C.

°C = degree(s) Celsius                      mg/L = milligram(s) per liter  
 DO = dissolved oxygen                      mS/cm = milliSiemens per centimeter  
 ORP = oxidation-reduction potential    mV = millivolts  
 ID = identification                            NTU = Nephelometric Turbidity Units

**Table 7-3 Summary of 2016 Mann-Kendall Concentration Trends for Select Wells and Seeps at LF059**

Monitoring Well ID	TCE
LF59MW-02	NST <sup>a</sup>
LF59MW-03	NST

**Notes:**

<sup>a</sup> Stable according to MAROS convention  
 NST = no statistically significant trend  
 TCE = trichloroethene

**7.4 SITE SUMMARY AND RECOMMENDATIONS**

Both groundwater samples exceeded the cleanup level for TCE stated in the OU1 ROD. However, as mentioned in Section 7.2, the TCE plume at LF059 has been identified to be originating from an upgradient unknown source (CG704). Groundwater monitoring at this site has been transferred to CG704, and monitoring wells LF59MW-02 and LF59MW-03 will be sampled in association with the new site.

**7.4.1 Five-Year Review**

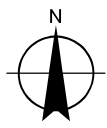
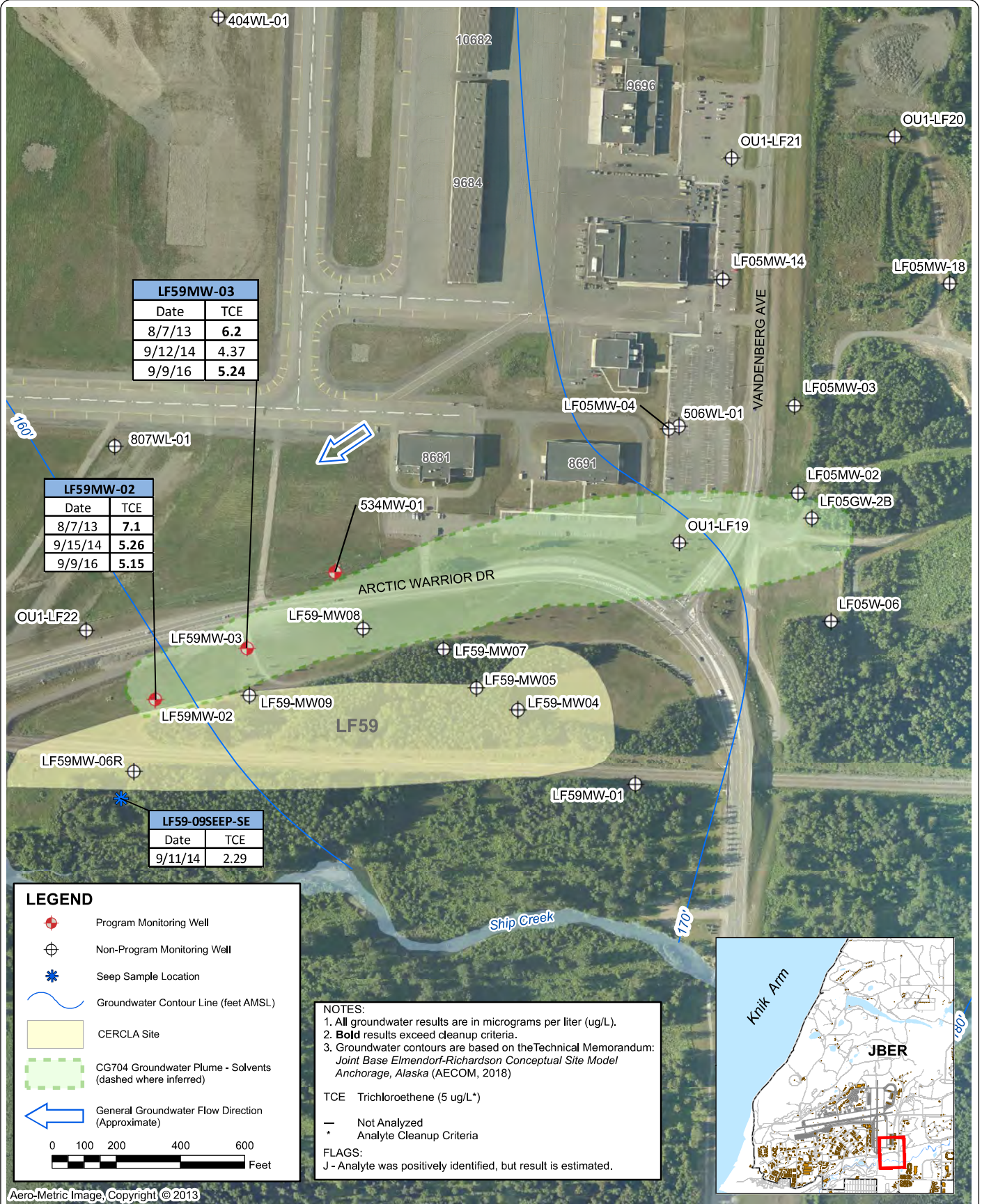
Areas in OU1 that remain above cleanup goals are required to have CERCLA five-year reviews conducted until the cleanup goals are achieved. The purpose of the five-year review is to evaluate the implementation and performance of the remedial actions. There have been four five-year reviews conducted at JBER-E. The fourth five-year review report recommended pursuing a RC status for LF059, delineation of the upgradient plume affecting LF059 that may originate from closed site LF007, pursue reopening LF007 under CERCLA and the management of the groundwater plume that is affecting part of LF059 as part of the upgradient source. The review also recommended a sampling event be conducted to identify if concentrations of 1,4-dioxane exist and whether or not there is an unacceptable risk at the site (USAF, 2014c). A VI evaluation (2016-

2017) and sampling for 1,4-dioxane (2016) was conducted at this CG704 and will be reported under a separate cover.

#### **7.4.2 Recommendations**

Site LF059 is identified as a **Green** priority. The TCE contamination at the LF059 site appears to be coming from an upgradient source. A new CERCLA site has been opened (CG704) to investigate the potential upgradient source. In pursuit of a RC for LF059, an I-RACR has been submitted and should be approved 2017. It is recommended to transfer monitoring wells at this site (LF59MW-02 and LF59MW-03) to the new site CG704 and become program wells as appropriate. It is also recommended that LUC inspections continue until the site reaches SC.

Date: 15 Mar 2018 Drawn by: SJ K:\PROJECTS\Air\_Force\JBER\BRL\TMMXD\2017\2017\_JBER\_LF059\_LTM-01.mxd



### LF59 SITE MAP WITH ANALYTICAL DATA

2016 Annual Remedial Action – Operations and Monitoring for Select CERCLA Sites  
 Joint Base Elmendorf-Richardson, Alaska

Figure  
**7-1**

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## 8.0 SD015

PBC Performance Objectives: Design and Implement an Optimized Exit Strategy for Site Closeout

Anticipated Achievement Date: 2020

### 8.1 SITE DESCRIPTION

SD015 is a former sludge disposal site located on the north side of JBER-E just west of Talley Avenue. Historically, four 4- to 6-inch thick concrete pads, each measuring approximately 30 feet by 50 feet, were located at the site. The concrete pads were used from the early 1970s until 1983 to weather fuel filters and absorbent pads, and as a disposal site for fuel tank sludge. The primary sources of contamination at this site were various spent petroleum products and solvents removed as sludge from aboveground fuel tanks, contained in filter elements, or released onto the concrete or onto the open ground surface at SD015. Two areas where concrete pads were demolished (Concrete Pads No. 2 and No. 3) are identified as contaminant source areas, shown on Figure 8-1. This remote and undeveloped area was investigated as part of the OU6 ROD (USAF, 1997b).

Per the requirements of the OU6 ROD for SD015, a soil vapor extraction (SVE) system and a high-vacuum extraction (HVE) system were designed, installed, and operated for treatment of perched groundwater at this site. An ESD, which was signed by USAF in June 2007 and accepted by the EPA and the ADEC in August 2007, transitioned the remedy for the SD015 perched groundwater plume to MNA (USAF, 2007). In 2008, the HVE and SVE systems at SD015 were decommissioned. A LSI was conducted in 2011, during which soil contamination from solvents (i.e., TCE) was discovered at depths from 40 to 45 feet bgs. Additionally, analytical results from the 2011 LSI exceeded the established cleanup goals for benzene and TCE in groundwater (USAF, 2012c). The extent of contamination within the vadose and smear zone soils was only partially defined during the 2011 LSI. Groundwater contamination is confined to the small, perched aquifer system. Currently, two monitoring wells (OU6MW-17 and OU6MW-90) are located at the site.

#### 8.1.1 Geology and Hydrology

SD015 is located on the Elmendorf Moraine and the subsurface geology at SD015 is relatively complex as would be expected in glacial moraine deposits as indicated in the OU6 RI/FS (USAF, 1995d). The predominant lithologies include silty sands, sandy and silty gravels, and sand or gravelly clays, which are interfingered both horizontally and vertically. During the 1995 RI/FS investigation, borings completed at depths of up to 140 feet bgs did not encounter the Bootlegger Cove Formation.

The 1995 RI/FS for SD015 identified a perched groundwater aquifer and a deeper unconfined aquifer at the site (believed to correlate with the unconfined shallow aquifer underlying the outwash plain in other parts of the installation). No further remediation was required for the deep aquifer at the time the ROD was signed. Dense, homogenous silt clay appears to act as an aquitard at 40 feet bgs (USAF, 2012a). The perched aquifer is approximately 10 to 20 feet thick

(USAF, 1997b). Depth to the perched groundwater ranges between approximately 35 to 45 feet bgs as measured in monitoring wells.

## 8.2 REGULATORY REQUIREMENTS

The OU6 ROD identified seven COCs in perched groundwater at Site SD015 and is the basis for cleanup goals at this site (USAF, 1997b). The COCs included in the ROD for SD015 are benzene, toluene, ethylbenzene, TCE, 1,2-DCA, 1,1,2,2-PCA, and 1,1,2-TCA. The ROD identified MNA as the selected remedy for groundwater.

The groundwater remedy described in the OU6 ROD (USAF, 1997b) consists of the following:

- Perched Aquifer at SD015:
  - ICs on land and water use to restrict access to the contaminated at SD015. Installation of wells in the contaminated plume for residential, industrial, or agricultural use will be prohibited by the Base Comprehensive Plan until cleanup levels have been achieved.
  - Groundwater in the perched aquifer at SD015 will be treated by an HVE process to remove fuel related contaminants and halogenated volatile organic compounds.
  - Recoverable quantities of free product found on top of the water table at SD015 will be removed through the HVE process.
  - Treated water will be reinjected into the subsurface beyond the boundary of the contaminated aquifer. Reinjecting water will be regularly monitored to ensure it meets cleanup and risk requirements.
  - Groundwater remaining above cleanup levels will continue to be monitored semi-annually and evaluated annually to determine contaminant migration and to track the progress of the HVE treatment, as well as to provide an early indication of unforeseen environmental or human health risk. Five-year reviews will also assess the protectiveness of the remedial action, including an evaluation of any changed site conditions, as long as contamination remains above cleanup levels.
  - When two consecutive groundwater monitoring events indicate contaminant concentrations are below cleanup levels, the HVE system will be shutoff. Semi-annual monitoring will continue for another year, and subsurface soil samples will be collected. If levels are confirmed to be below cleanup levels 1 year after the system was shut-off, no further remedial action will be required. If contamination is present in any of the samples, the system will be restarted, or another remedial option will be considered.
  - During the final round of groundwater monitoring, samples will be collected and analyzed for all constituents that exceeded MCLs during the 1994 investigation including VOCs and arsenic. These results will be evaluated before a final decision is made that groundwater meets all cleanup requirements.

In 2007, the only COCs at SD015 that did not meet cleanup goals were TCE and benzene. Therefore, groundwater cleanup goals for ethylbenzene, toluene, 1,1,2,2-PCA, 1,1,2-TCA and 1,2-DCA have been met and are no longer monitored at the site. Current monitoring requirements at

SD015 include annual groundwater monitoring and an annual LUC inspection. Annual groundwater sampling is required at monitoring well OU6MW-17 for TCE and benzene. LUCs are in place to prevent access and exposure to contaminated groundwater and soil at the site.

Table 8-1 provides a list of the current groundwater COCs and the respective cleanup goals identified in the OU6 ROD (USAF, 1997b). In addition, 18 AAC 75 Table C cleanup levels (ADEC, 2017) are included in the table for informational purposes.

**Table 8-1 Cleanup Goals in Groundwater at SD015**

Contaminant of Concern	Cleanup Goal <sup>a</sup> (µg/L)	ADEC Cleanup Level <sup>b</sup>
TCE	5	2.8
Benzene	5	4.6

**Notes:**

<sup>a</sup> Cleanup levels as cited in the OU6 ROD (USAF, 1997b).

<sup>b</sup> 18 AAC 75 Table C Cleanup Levels (ADEC, 2017) are provided for informational purposes only..

µg/L = microgram(s) per liter

OU = Operable Unit

ROD = Record of Decision

TCE = trichloroethene

USAF = United States Air Force

### 8.3 2016 FIELD ACTIVITIES AND RESULTS

During 2016, monitoring well OU6MW-17 was sampled for VOCs. Table 8-2 presents a summary of the 2016 analytical results and Table 8-3 presents the 2016 MNA field parameters at SD015. The 2016 and truncated historical results are on Figure 8-1. Historical results and Mann-Kendall trend analysis results are included in Appendix C and a summary of the Mann-Kendall trend analysis is in Table 8-4.

The Mann-Kendall trend tests for benzene and TCE in well OU6MW-17 indicated no statistically significant trends at the 95% confidence level.

A LUC inspection was performed at SD015 on September 21, 2016 and did not identify any issues. A copy of the 2016 LUC inspection form for SD015 is in Appendix B.

**Table 8-2 Summary of 2016 Analytical Results at SD015**

Analyte	Units	Cleanup Goal <sup>a</sup>	OU6MW-17
TCE	µg/L	5	<b>9.34</b>
Benzene	µg/L	5	<b>92.3</b>

**Notes:**

<sup>a</sup> Cleanup levels as cited in the OU6 ROD (USAF, 1997b).

**Bold** results exceeds cleanup level

µg/L = microgram(s) per liter

TCE = trichloroethene

**Table 8-3 Summary of 2016 MNA Field Parameters at SD015**

MNA Field Parameters							
Monitoring Well ID	Volume Purged (gallons)	Temp (°C)	Specific Conductance <sup>a</sup> (mS/cm)	DO (mg/L)	pH	ORP (mV)	Turbidity (NTU)
OU6MW-17	4.7	6.89	0.759	0.6	6.45	-150.8	28.71

**Notes:**

<sup>a</sup> Specific Conductance is a conductivity measurement that has been corrected to 25°C.

°C = degree(s) Celsius

DO = dissolved oxygen

ID = identification

mg/L = milligram(s) per liter

mS/cm = milliSiemen(s) per centimeter

mV = millivolts

NTU = Nephelometric Turbidity Units

ORP = oxidation-reduction potential

**Table 8-4 Summary of 2016 Mann-Kendall Concentration Trends for Select Wells at SD015**

Monitoring Well ID	Benzene	TCE
OU6MW-17	NST <sup>a</sup>	NST

**Notes:**

<sup>a</sup> Stable according to MAROS convention

ID = identification

NST = no statistically significant trend

TCE = trichloroethene

## 8.4 SITE SUMMARY AND RECOMMENDATIONS

Analytical laboratory results for TCE (9.34 µg/L) and benzene (92.3 µg/L) exceeded the OU6 ROD cleanup levels. TCE concentrations at the site show a decreasing trend.

### 8.4.1 Five-Year Review

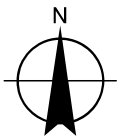
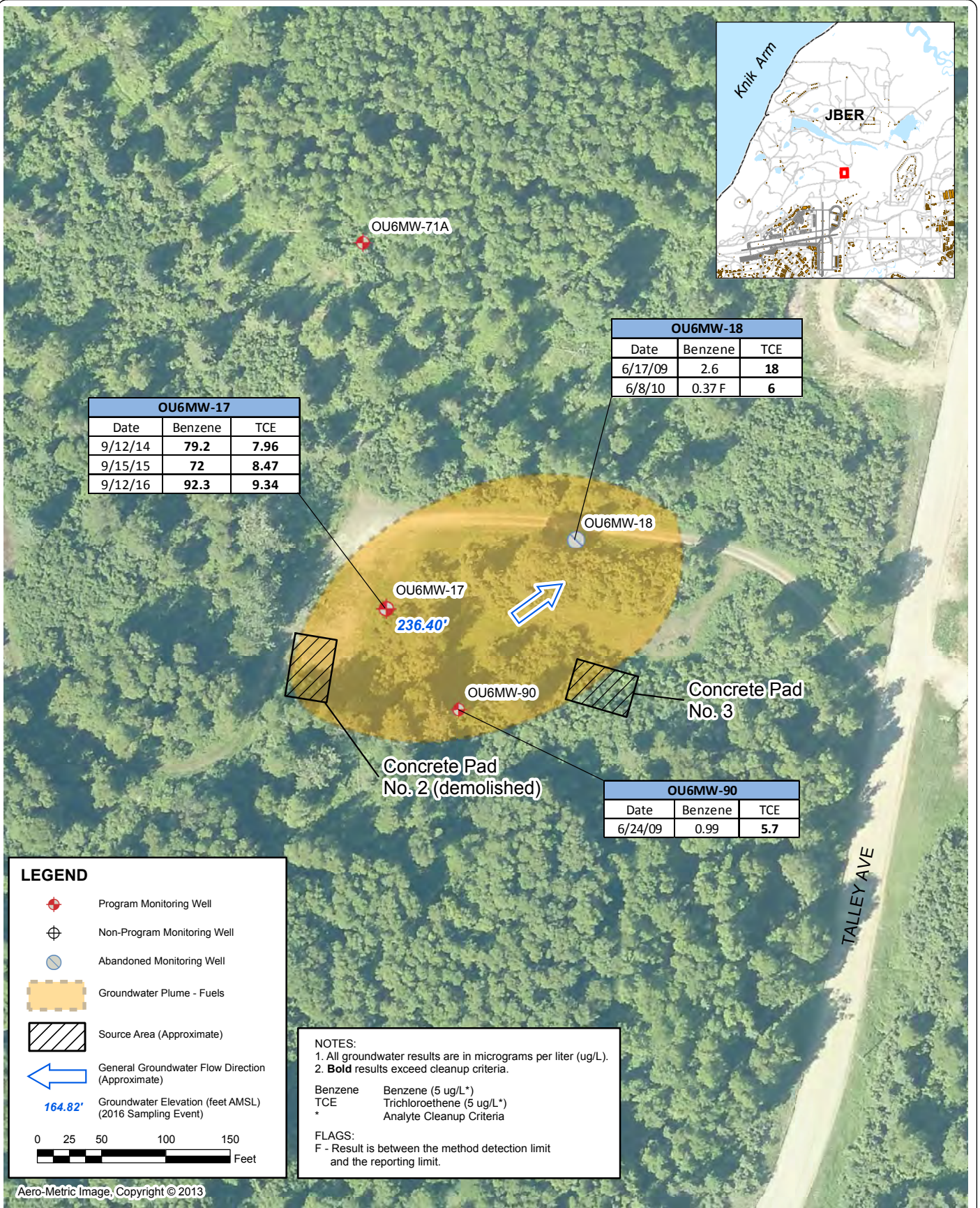
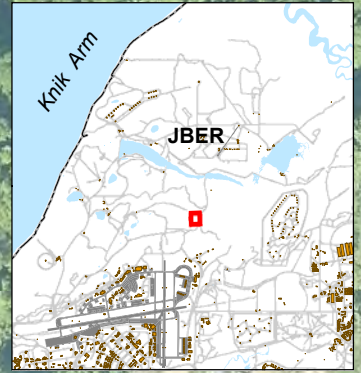
Areas in OU6 that remain above cleanup goals are required to have CERCLA five-year reviews conducted until the cleanup goals are achieved. The purpose of the five-year review is to evaluate the implementation and performance of the remedial actions. There have been four five-year reviews conducted at JBER-E. The fourth five-year review report identified a decreasing trend for TCE but not benzene and recommended installation of a downgradient monitoring well to delineate plume boundaries (USAF, 2014c).

### 8.4.2 Recommendations

Site SD015 is identified as a **Yellow** priority since contaminant concentrations continue to exceed ROD cleanup goals but show a decreasing trend for TCE. Following the recommendations of the fourth five-year review, a new monitoring well should be installed downgradient of the site to better define plume boundaries.

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**SD015 SITE MAP WITH ANALYTICAL DATA**

2016 Annual Remedial Action – Operations and Monitoring for Select CERCLA Sites  
Joint Base Elmendorf-Richardson, Alaska

Figure  
**8-1**

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## 9.0 SD024

PBC Performance Objectives: Site Closeout

Anticipated Achievement Date: 2015

### 9.1 SITE DESCRIPTION

Site SD024 is located in the central part of JBER-E, north of the East/West Runway, and consists of one groundwater plume (OU4MW-04 Plume) (Figure 9-1). The OU4MW-04 plume was formerly referred to as the Hangar 10 Plume. Hangar 10 (Building 15455) was used for fuel-loading operations. Potential sources of contamination identified in the RI/FS included a UST and pump house southwest of the Hanger 10 building and a POL system near Hangar 10. However, uncertainties regarding the local groundwater flow direction in the vicinity of site SD024 suggest that there may be a source area for this plume completely unrelated to Hangar 10.

Site SD024 was part of the OU4 investigation. A ROD was signed for OU4 in 1995 (USAF, 1995b). Currently, one monitoring well (OU4MW-04) is located at the site.

#### 9.1.1 Geology and Hydrology

SD024 is located on late Quaternary glacial outwash deposits of the Anchorage Plain in a developed area of JBER-E. Silt and peat deposits near the surface overlie sandy and silty gravels, which make up the matrix for a shallow aquifer. Sand with silt and gravel units comprise the upper 10 to 20 feet of the aquifer and are underlain by gravel and sand units approximately 10 to 50 feet thick. The saturated interval marking the top of the unconfined aquifer varies from approximately 30 feet bgs down to 60 feet bgs. The saturated interval is approximately 50 feet thick.

The shallow, unconfined aquifer in this area overlies the Bootlegger Cove Formation. The formation consists of interbedded silts and clay deposits at depths approximately 30 to 125 feet bgs. The average thickness of the formation in this area is approximately 50 feet. The structural surface of the formation is irregular. Within OU 4 West, the top of the Bootlegger Cove Formation is deepest in the vicinity of FT023 (at approximately 100 feet bgs) and near Hangar 14 (at 105 feet bgs). Further southwest, the formation becomes shallower. At Hangar 8, this formation is at 39 feet bgs (USAF, 1995b).

Groundwater flow direction is to the southwest, with a gradient of near 0.0013 ft/ft, increasing to 0.007 ft/ft toward Ship Creek. The shallow unconfined aquifer is not used for any purpose on JBER. Its future use is limited because of the higher yield of the deep, confined aquifer (USAF, 1995b).

### 9.2 REGULATORY REQUIREMENTS

The OU4 ROD identified benzene as the only groundwater COC is the basis for cleanup goals at SD024. MNA is included in the selected remedy for groundwater (as described below) (USAF, 1995b).



The groundwater remedy as described in the ROD (USAF, 1995b) includes the following monitoring guidelines:

- ICs on land use and water use restrictions will restrict access to the contaminated groundwater throughout OU 4 until cleanup levels have been achieved.
- Groundwater will be monitored and evaluated semi-annually to assess contaminant migration and timely reduction of contaminant concentrations by intrinsic remediation. This will include five-year reviews to assess the protectiveness of the remedial action, as long as contamination remains above cleanup levels. A monitoring plan will be prepared to address the details involved in sampling.
- All groundwater is expected to be cleaned up within 13 years.

Current monitoring requirements at SD024 include an annual LUC inspection. The 2012 annual sampling marked the third consecutive year in which benzene concentrations were below the cleanup level at the site monitoring well OU4MW-04, demonstrating that cleanup goals in ground water have been achieved. The site has met the remedial action objectives in the OU4 ROD and is recommended for site closure.

### **9.3 2016 FIELD ACTIVITIES AND RESULTS**

A LUC inspection was performed at SD024 on October 13, 2016 and did not identify any issues. A copy of the 2016 LUC inspection form for SD024 is in Appendix B.

### **9.4 SITE SUMMARY AND RECOMMENDATIONS**

#### **9.4.1 Five-Year Review**

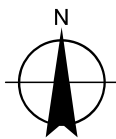
Areas in OU 4 that remain above cleanup goals are required to have CERCLA five-year reviews conducted until the cleanup goals are achieved. The purpose of the five-year review is to evaluate the implementation and performance of the remedial actions. There have been four five-year reviews conducted at JBER-E. The benzene concentrations reported in the 2010, 2011, and 2013 annual groundwater sampling events were less than the cleanup standard of 5 µg/L; therefore, the fourth five-year review report recommended no further action for Site SD024 (USAF, 2014c).

#### **9.4.2 Recommendations**

The remedial action objectives (RAO) at SD024 have been met and the site is scheduled to be closed. An I-RACR was submitted to document that remedial action at Site SD024 has been completed and the RAOs in the ROD (USAF, 1995b) have been met. The SD024 I-RACR (USAF, 2015c) documents the USAFs completion of the remedy and RAOs at SD024, signed by the EPA on August 11, 2015.

Site SD024 is identified as a **Green** priority since groundwater monitoring was discontinued in 2013 and the site has met the RAOs as described in the ROD. It is recommended to discontinue LUC inspections because the RAOs have been met.

Date: 10 May 2017 Drawn by: SJ K:\PROJECTS\Air\_Force\JBER\IPBR\LTMMXD\2016\2016\_JBER\_SD024\_RAOM-01.mxd



**SD024 SITE MAP WITH ANALYTICAL DATA**

2016 Annual Remedial Action – Operations and Monitoring for Select CERCLA Sites  
Joint Base Elmendorf-Richardson, Alaska

Figure  
**9-1**

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## 10.0 SD025

PBC Performance Objective: Site Closeout

Anticipated Achievement Date: 2017

### 10.1 SITE DESCRIPTION

Site SD025 consists of one groundwater plume (Hangar 11 Plume) located north of the East/West Runway and south of Airlifter Drive (Figure 10-1). Hangar 11 (Building 16430) is currently used for aircraft maintenance. Potential contaminant sources identified in the RI/FS included a series of USTs southwest of the hangar and valve pits west of the hangar. Site SD025 was included as part of the OU4 investigation and cleanup. A ROD was signed for OU4 in 1995 (USAF, 1995b). Between 1995 and 2003, a bioventing system was operated at the site for the treatment of contaminated soil. Confirmation sampling performed in 2002 demonstrated that soil cleanup goals had been achieved. Currently, one monitoring well (OU4MW-08R) is located at the site. Results from this well are used to track progress toward achieving groundwater cleanup goals. Monitoring well 421MW-01 is located near SD025 at an adjacent site and monitoring results from this adjacent site have been used for SD025 monitoring in the past.

#### 10.1.1 Geology and Hydrology

SD025 lies on the relatively flat outwash plain south of the Elmendorf Moraine. The site soils consist primarily of gravelly sand, with silt and cobbles and occasional thin silty layers from ground surface to at least 55 feet bgs, which was the maximum depth of the investigation. The fine-grained soils of the Bootlegger Cove Formation underlie these sandy gravel outwash soils at depth. The site is underlain by two aquifers: a shallow water table aquifer and a deeper, confined aquifer. These aquifers are separated by the Bootlegger Cove Formation, which functions as a confining layer under most of JBER-E. There is no communication between shallow and deep aquifers in the area of investigation.

Groundwater levels are interpreted to vary seasonally between approximately 28 to 34 feet bgs. High water events are generally associated with spring break-up and late summer and/or autumn precipitation events. The seasonal low water level typically occurs in mid- to late winter. Groundwater measurements collected during the November 2014 groundwater sampling event indicate a southerly groundwater gradient and estimated flow direction at the site is south-southwest. There is no current use of groundwater as a drinking water source at the site. The nearest JBER water supply well (Well 29) is located approximately 0.64 miles west of the site.

The nearest surface water, Triangle Lake, is located hydrologically upgradient approximately 0.82 miles northeast of SD025. The nearest downgradient surface water, Ship Creek, lies approximately 1.6 miles south of the site. No significant surface water runoff or sediment transport from the site has been observed.

## 10.2 REGULATORY REQUIREMENTS

The OU4 ROD identified benzene, ethylbenzene, and toluene as COCs in groundwater and is the basis for cleanup levels at SD025. The ROD includes MNA in the selected remedy for groundwater (USAF, 1995b). Current monitoring requirements at SD025 include annual groundwater monitoring and an annual LUC inspection. LUCs are in place to prevent access and exposure to contaminated groundwater and soil at the site.

The groundwater remedy described in the ROD (USAF, 1995b) includes the following monitoring guidelines:

- Institutional controls on land use and water use restrictions will restrict access to the contaminated groundwater throughout OU 4 until cleanup levels have been achieved.
- Groundwater will be monitored and evaluated semi-annually to assess contaminant migration and timely reduction of contaminant concentrations by intrinsic remediation. This will include five-year reviews to assess the protectiveness of the remedial action, as long as contamination remains above cleanup levels. A monitoring plan will be prepared to address the details involved in sampling.
- All groundwater is expected to be cleaned up within 13 years.

As described above, to assess contaminant migration and reduction of contaminant concentrations, groundwater contamination will be reviewed every 5 years to assess the protectiveness of the remedial action, as long as contamination remains above cleanup goals. Currently, benzene, ethylbenzene, and toluene levels remain above the cleanup goals. The current groundwater sampling program at SD025 includes sampling for benzene, ethylbenzene, and toluene annually at monitoring well OU4MW-08R.

Table 10-1 provides a list of the current groundwater COCs and the respective cleanup goals identified in the OU4 ROD (USAF, 1995b). In addition, 18 AAC 75 Table C cleanup levels (ADEC, 2017) are included in the table for informational purposes.

**Table 10-1 Cleanup Goals in Groundwater at SD025**

Contaminant of Concern	Cleanup Goal <sup>a</sup> (µg/L)	ADEC Cleanup Level <sup>b</sup> (µg/L)
Benzene	5	4.6
Ethylbenzene	700	15
Toluene	1,000	1,100

**Notes:**

<sup>a</sup> Cleanup levels as cited in the OU4 ROD (USAF, 1995b).

<sup>b</sup> 18 AAC 75 Table C Cleanup Levels (ADEC, 2017) are provided for informational purposes only..

µg/L = micrograms per liter

OU – Operable Unit

ROD = Record of Decision

USAF – United States Air Force



### 10.3 2016 FIELD ACTIVITIES AND RESULTS

During 2016, monitoring well OU4MW-08R was sampled for benzene, toluene, ethylbenzene, total xylenes (BTEX). The concentrations of benzene, ethylbenzene and toluene all exceeded the cleanup goals. Table 10-2 presents a summary of analytical results and Table 10-3 presents the summary of the MNA field parameters. The 2016 and truncated historical results are on Figure 10-1. Historical results and Mann Kendall trend analysis results are in Appendix C and a summary of the Mann-Kendall analysis results are in Table 10-4. The Mann-Kendall contaminant trend graph for OU4MW-08R is on Figure 10-2.

Analytical laboratory results were above cleanup goals for all COCs from 2003 through 2012 in monitoring well OU4MW-08R. During 2013, concentrations of all three COCs in this well were below OU4 ROD cleanup goals, which was inconsistent with previous rounds of sampling. In 2014, 2015 and 2016 analytical results again exceeded cleanup goals.

The Mann-Kendall trend test for benzene in OU4MW-08R indicated a statistically significant decreasing trend at the 95% confidence level. No statistically significant trends were identified for ethylbenzene or toluene in OU4MW-08R.

A LUC inspection was performed at SD025 on October 13, 2016 and did not identify any issues at the site. A copy of the 2016 LUC inspection form for SD025 is in Appendix B.

**Table 10-2 Summary of 2016 Analytical Results at SD025**

Analyte	Units	Cleanup Goal <sup>a</sup>	OU4MW-08R
Benzene	µg/L	5	<b>36.5</b>
Ethylbenzene	µg/L	700	<b>1,620</b>
Toluene	µg/L	1,000	<b>11,500</b>

**Notes:**

<sup>a</sup> Cleanup levels as cited in the OU4 ROD (USAF, 1995b).

**Bold** result exceeds the ROD cleanup level.

µg/L = micrograms per liter

**Table 10-3 Summary of 2016 MNA Field Parameters at SD025**

MNA Field Parameters							
Monitoring Well ID	Volume Purged (gallons)	Temp (°C)	Specific Conductance <sup>a</sup> (µS/cm)	DO (mg/L)	pH	ORP (mV)	Turbidity (NTU)
OU4MW-08R	2.75	8.16	18,821	0.5	6.41	-9.7	3.4

**Notes:**

<sup>a</sup> Specific Conductance is a conductivity measurement that has been corrected to 25°C.

°C = degree(s) Celsius

DO = dissolved oxygen

ID = identification

mg/L = milligram per liter

µS/cm = micro-Siemens per centimeter

mV = millivolts

NTU = Nephelometric Turbidity Units

ORP = oxidation-reduction potential



**Table 10-4 Summary of 2016 Mann-Kendall Concentration Trends for Select Wells at SD025**

Monitoring Well ID	Benzene	Ethylbenzene	Toluene
OU4MW-08R	Decreasing	NST	NST

**Notes:**

NST = no statistically significant trend

## 10.4 SITE SUMMARY AND RECOMMENDATIONS

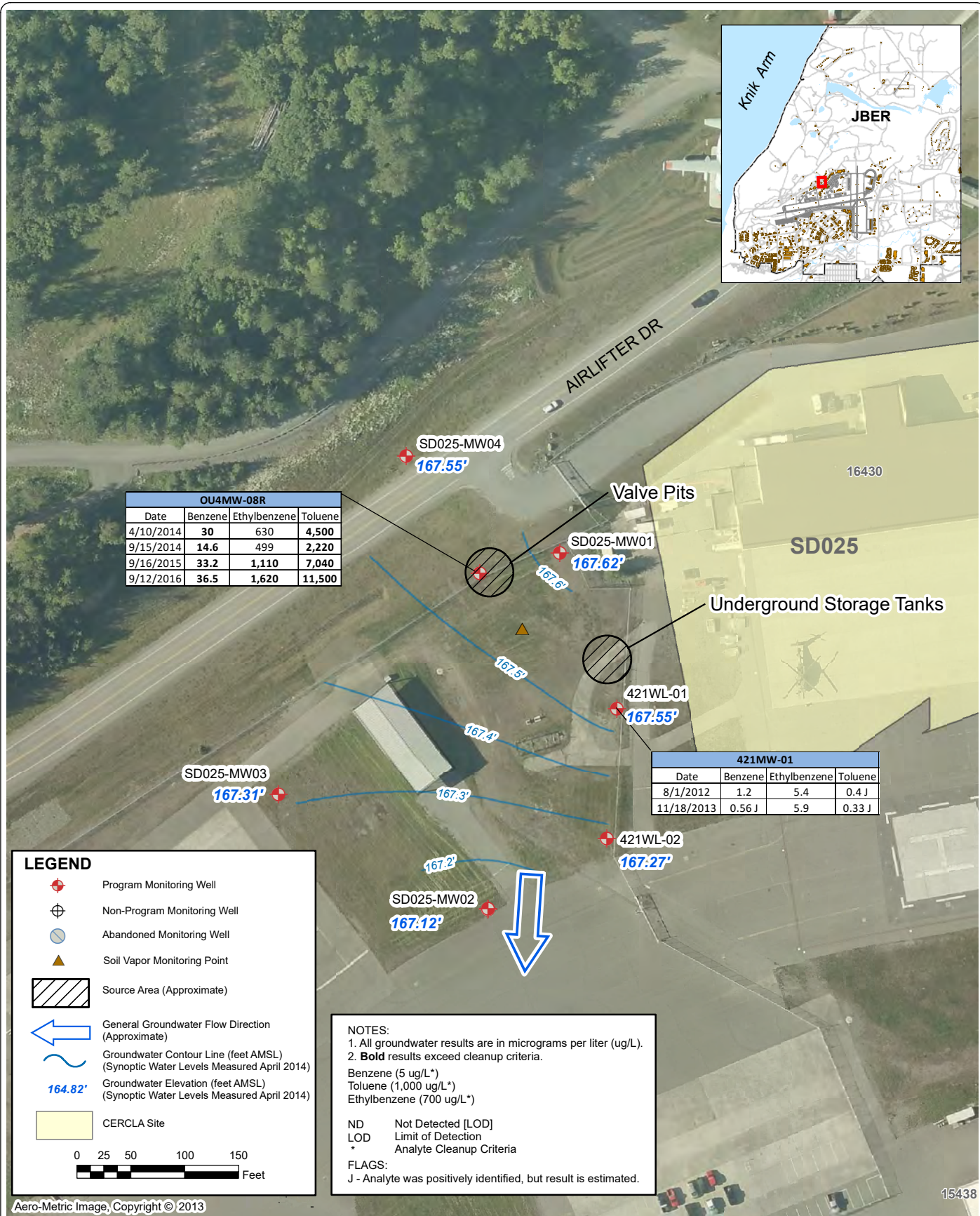
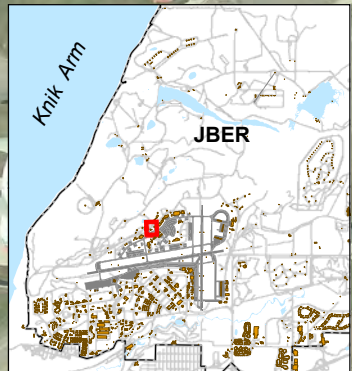
In 2013 and 2014, site characterization activities outside of annual LTM activities were conducted at SD025 to evaluate potential risks to human health and the environment in order to advance toward site closure. Results and recommendations are presented in the *SD025 – Bldg 16430 Floor Drains Site Characterization Report* finalized in April 2017 (USAF, 2017b). Additionally, an ESD has been prepared for SD025 to change the governing regulatory authority from CERCLA to state. The ESD specifically states that the site status changes from remedial action implementation to No Further Action under CERCLA, which allows future remediation to be managed under 18 AAC 78.

### 10.4.1 Five-Year Review

Areas in OU4 that remain above cleanup goals are required to have CERCLA five-year reviews conducted until the cleanup goals are achieved. The purpose of the five-year review is to evaluate the implementation and performance of the remedial actions. There have been four five-year reviews conducted at JBER-E. The fourth five-year review report recommended evaluation of alternative remedial strategies to accelerate the attainment of cleanup goals in groundwater and conduct a VI evaluation for each occupied facility that is in proximity to the plume (USAF, 2014c). A VI evaluation (2016-2017) was conducted at this site and will be reported under a separate cover.

### 10.4.2 Recommendations

Site SD025 is identified as a **Yellow** priority because site COCs are above cleanup goals. In the future, site SD025 will be regulated under Alaska regulations 18 AAC 78 once the ESD becomes final. At that time, changes to the current LTM approach for this site will be implemented under state authority.



OU4MW-08R			
Date	Benzene	Ethylbenzene	Toluene
4/10/2014	30	630	4,500
9/15/2014	14.6	499	2,220
9/16/2015	33.2	1,110	7,040
9/12/2016	36.5	1,620	11,500

421MW-01			
Date	Benzene	Ethylbenzene	Toluene
8/1/2012	1.2	5.4	0.4 J
11/18/2013	0.56 J	5.9	0.33 J

**LEGEND**

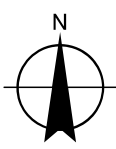
- Program Monitoring Well
- Non-Program Monitoring Well
- Abandoned Monitoring Well
- Soil Vapor Monitoring Point
- Source Area (Approximate)
- General Groundwater Flow Direction (Approximate)
- Groundwater Contour Line (feet AMSL) (Synoptic Water Levels Measured April 2014)
- Groundwater Elevation (feet AMSL) (Synoptic Water Levels Measured April 2014)
- CERCLA Site

0 25 50 100 150 Feet

**NOTES:**  
 1. All groundwater results are in micrograms per liter (ug/L).  
 2. **Bold** results exceed cleanup criteria.  
 Benzene (5 ug/L\*)  
 Toluene (1,000 ug/L\*)  
 Ethylbenzene (700 ug/L\*)

ND Not Detected [LOD]  
 LOD Limit of Detection  
 \* Analyte Cleanup Criteria

**FLAGS:**  
 J - Analyte was positively identified, but result is estimated.



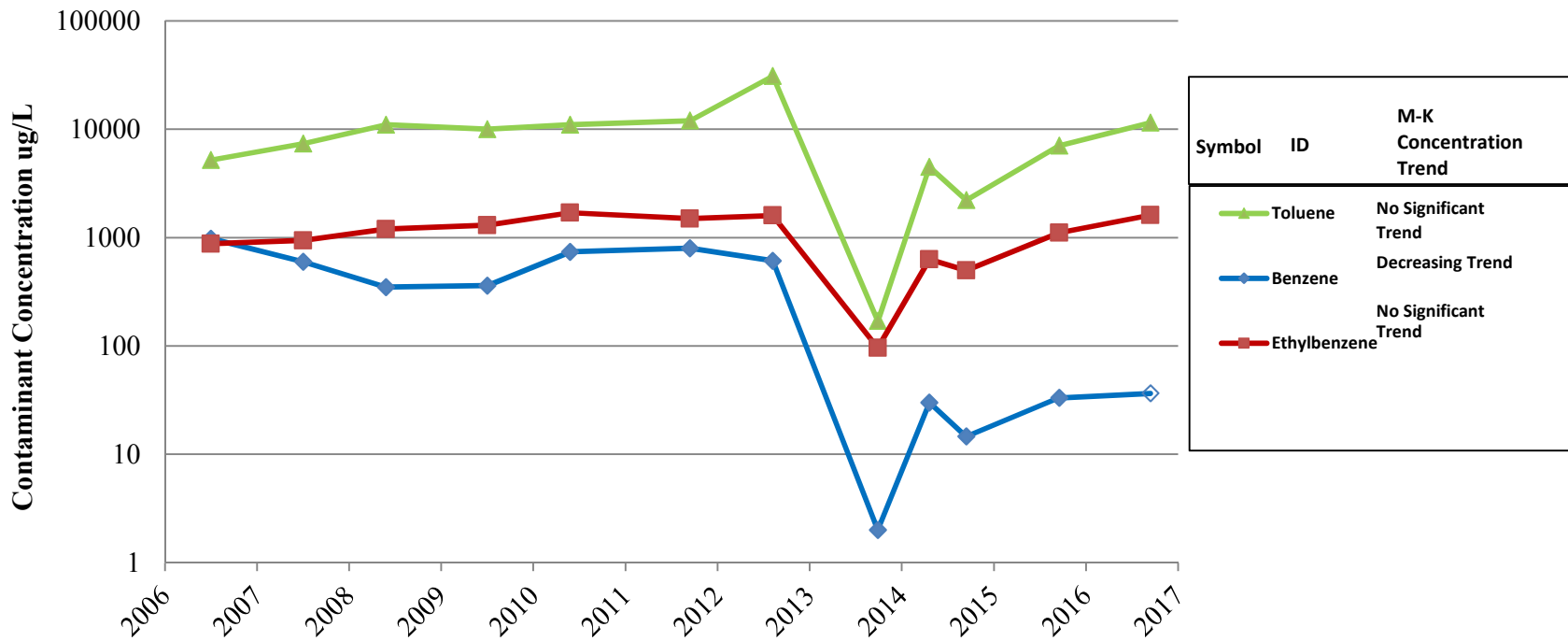
**SD025 SITE MAP WITH ANALYTICAL DATA**

2016 Annual Remedial Action – Operations and Monitoring for Select CERCLA Sites  
 Joint Base Elmendorf-Richardson, Alaska

Figure  
**10-1**

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Cleanup Levels  
 Benzene = 5 µg/L  
 Ethylbenzene = 700 µg/L  
 Toluene = 1,000 µg/L



**SD025 BENZENE TREND IN OU4MW-08R**

2016 Annual Field Activities Report, CERCLA Sites  
 Joint Base Elmendorf-Richardson, Alaska

Figure

**10-2**

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## 11.0 SD029

PBC Performance Objective: Site Closeout

Anticipated Achievement Date: 2019

### 11.1 SITE DESCRIPTION

SD029 consists of one plume (OU4 East Plume) located between Taxiway F and Talley Ave. (Figure 11-1). Hangar 15, which is located east of the plume, was used for aircraft maintenance. The plume is located approximately 500 feet southwest of the F-22 Weapons Release Shop (Building 16718) and Site SS109. Probable sources of contamination for the OU4 East Plume include a dry well, leach fields, pipelines, and valve pits east of Hangar 15. Site SD029 was investigated and a remedy implemented as part of the OU4 investigation and cleanup activities. A ROD was signed for OU4 in 1995 (USAF, 1995b).

#### 11.1.1 Site Geology and Hydrology

SD029 is located on late Quaternary glacial outwash deposits of the Anchorage Plain in a developed area of JBER-E. Silt and peat deposits near the surface overlie sandy and silty gravels, which make up the matrix for a shallow aquifer. In December of 2010, a lithological model of the subsurface soils at the site was prepared (USAF, 2011c). Consistent with the regional geology, varying mixtures of cobbles, gravels, sands, and silts constitute the subsurface soils at the F-22 Weapons Release Shop site. Generally, the lithographic units at the site were characterized as well-graded, poorly-sorted and poorly-graded, well-sorted soils. The well-graded soil layers are characterized by a variety of soil grain sizes and the poorly-graded soil layers are characterized by uniform soil grain sizes.

Groundwater data indicates flow to the southwest at the site. The depth to groundwater is approximately 55 to 58 feet bgs. Analysis suggests only a slight groundwater gradient to the southwest.

### 11.2 REGULATORY REQUIREMENTS

The OU4 ROD identified PCE and TCE as COCs and is the basis for cleanup levels at SD029. The ROD included MNA in the selected remedy for groundwater at SD029 (as described below) (USAF, 1995b). Current monitoring requirements at SD029 include annual groundwater monitoring and an annual LUC inspection. However, in 2015 the sample frequency was voluntarily increased from annually to quarterly in order to gather a large enough data set to show statistical compliance. Quarterly sampling is based on the calendar year, which includes Q1 (Jan-March), Q2 (April-June), Q3 (July-September) and Q4 (October-December). LUCs are in place to prevent access and exposure to contaminated groundwater at the site. Institutional controls on land use will restrict access to the contaminated shallow soil through OU4 until cleanup goals have been achieved. The current groundwater sampling program at SD029 includes groundwater sampling for PCE and TCE quarterly at monitoring well IS6-01. Table 11-1 provides the COCs and cleanup goals in groundwater at the site.

Table 11-1 provides a list of the current groundwater COCs and the respective cleanup goals identified in the OU4 ROD (USAF, 1995b). In addition, 18 AAC 75 Table C cleanup levels (ADEC, 2017) are included in the table for informational purposes.

The groundwater remedy as described in the ROD (USAF, 1995b) includes the following monitoring guidelines:

- Institutional controls on land use and water use restrictions will restrict access to the contaminated groundwater throughout OU 4 until cleanup levels have been achieved.
- Groundwater will be monitored and evaluated semi-annually to assess contaminant migration and timely reduction of contaminant concentrations by intrinsic remediation. This will include five-year reviews to assess the protectiveness of the remedial action, as long as contamination remains above cleanup levels. A monitoring plan will be prepared to address the details involved in sampling.
- All groundwater is expected to be cleaned up within 13 years.

**Table 11-1 Cleanup Goals in Groundwater at SD029**

Contaminant of Concern	Cleanup Goal <sup>a</sup> (µg/L)	ADEC Cleanup Level <sup>b</sup> (µg/L)
PCE	5	41
TCE	5	2.8

**Notes:**

<sup>a</sup> Cleanup levels as cited in the OU4 ROD (USAF, 1995b).

<sup>b</sup> 18 AAC 75 Table C Cleanup Levels (ADEC, 2017) are provided for informational purposes only.

µg/L = microgram(s) per liter

OU = Operable Unit

PCE = tetrachloroethene

ROD = Record of Decision

TCE = trichloroethene

USAF = United States Air Force

### 11.3 2016 FIELD ACTIVITIES AND RESULTS

During 2016, monitoring well IS6-01 was sampled for VOCs quarterly, starting with quarter one. The well was not sampled in quarter four because it could not be found due to snow, ice, and equipment in the area. Duplicate groundwater samples were collected from IS6-01 during quarters one and two. The TCE and PCE concentrations were all above the OU4 ROD cleanup goals for all sampling events. Table 11-2 presents a summary of the VOC results and Table 11-3 presents the MNA field parameters. The 2016 and truncated historical results are on Figure 11-1. Historical results and Mann-Kendall trend analysis results are in Appendix C and a summary of the Mann-Kendall analysis results are in Table 11-4.

The Mann-Kendall trend tests for PCE and TCE in well IS6-01 indicated no statistically significant trends at the 95% confidence level.

A LUC inspection was performed at SD029 on October 13, 2016. The LUC inspection identified that the parking area on the south side of Building 16716 was under construction with paving



activities and utility installation. The old parking area was demolished and the entire ground surface has been disturbed. A new bolt was placed on well IS6-01. A copy of the 2016 LUC inspection form for SD029 is in Appendix B.

**Table 11-2 Summary of 2016 Analytical Results at SD029**

Analyte	Units	Cleanup Goal <sup>a</sup>	IS6-01 (Q1)	IS6-01 (Q1) (FD)	IS6-01 (Q2)	IS6-01 (Q2) (FD)	IS6-01 (Q3)	IS6-01 (Q4)
PCE	µg/L	5	<b>6.05</b>	<b>5.87</b>	<b>5.83</b>	<b>5.79</b>	<b>5.59</b>	Not sampled
TCE	µg/L	5	<b>8.38</b>	<b>8.45</b>	<b>8.61</b>	<b>8.6</b>	<b>8.71</b>	

**Notes:**

<sup>a</sup> Cleanup levels as cited in the OU4 ROD (USAF, 1995b).

**Bold** result exceeds the ROD cleanup level

µg/L = microgram(s) per liter

FD = field duplicate

PCE = tetrachloroethene

Q = quarter

TCE = trichloroethene

**Table 11-3 Summary of 2016 MNA Field Parameters at SD029**

MNA Field Parameters							
Monitoring Well ID	Volume Purged (gallons)	Temp (°C)	Specific Conductance <sup>a</sup> (mS/cm)	DO (mg/L)	pH	ORP (mV)	Turbidity (NTU)
IS6-01 (Q1)	4.5	6.07	0.465	3.44	6.43	-33.3	1.03
IS6-01 (Q2)	4.4	7.4	0.469	3.29	6.97	157.3	4.76
IS6-01 (Q3)	1.8	9.57	0.915	2.56	7.11	147.4	33.39

**Notes:**

<sup>a</sup> Specific Conductance is a conductivity measurement that has been corrected to 25°C.

°C = degree(s) Celsius

DO = dissolved oxygen

ID = identification

mg/L = milligram(s) per liter

mV = millivolt(s)

mS/cm = milliSiemen(s) per centimeter

NTU = Nephelometric Turbidity Units

ORP = oxidation-reduction potential

Q = quarter

**Table 11-4 Summary of 2016 Mann-Kendall Concentration Trends for SD029**

Monitoring Well ID	PCE	TCE
IS6-01	NST	NST

**Notes:**

ID = identification

NST = no statistically significant trend

PCE = tetrachloroethene

TCE = trichloroethene



## 11.4 SITE SUMMARY AND RECOMMENDATIONS

The PCE concentrations at monitoring well IS6-01 had been below OU4 ROD cleanup goals in annual sampling from 2009 to 2014; however, in 2015 PCE concentrations were slightly above cleanup goals for two of the sample events. TCE was below the OU4 ROD cleanup level for the first time in 2013, but exceeded the cleanup level in 2014 and for the first three sampling events in 2015. The PCE and TCE concentrations in 2016 were above the OU4 ROD cleanup goals for all three sampling events. In 2015, sampling at IS6-01 was voluntarily increased to quarterly sampling events to obtain an adequate data set in an attempt to statistically demonstrate attainment of the cleanup level. However, the 95% upper confidence limit (UCL) for the data collected did not meet the cleanup levels for either parameter to demonstrate statistical compliance.

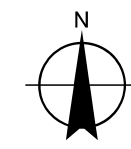
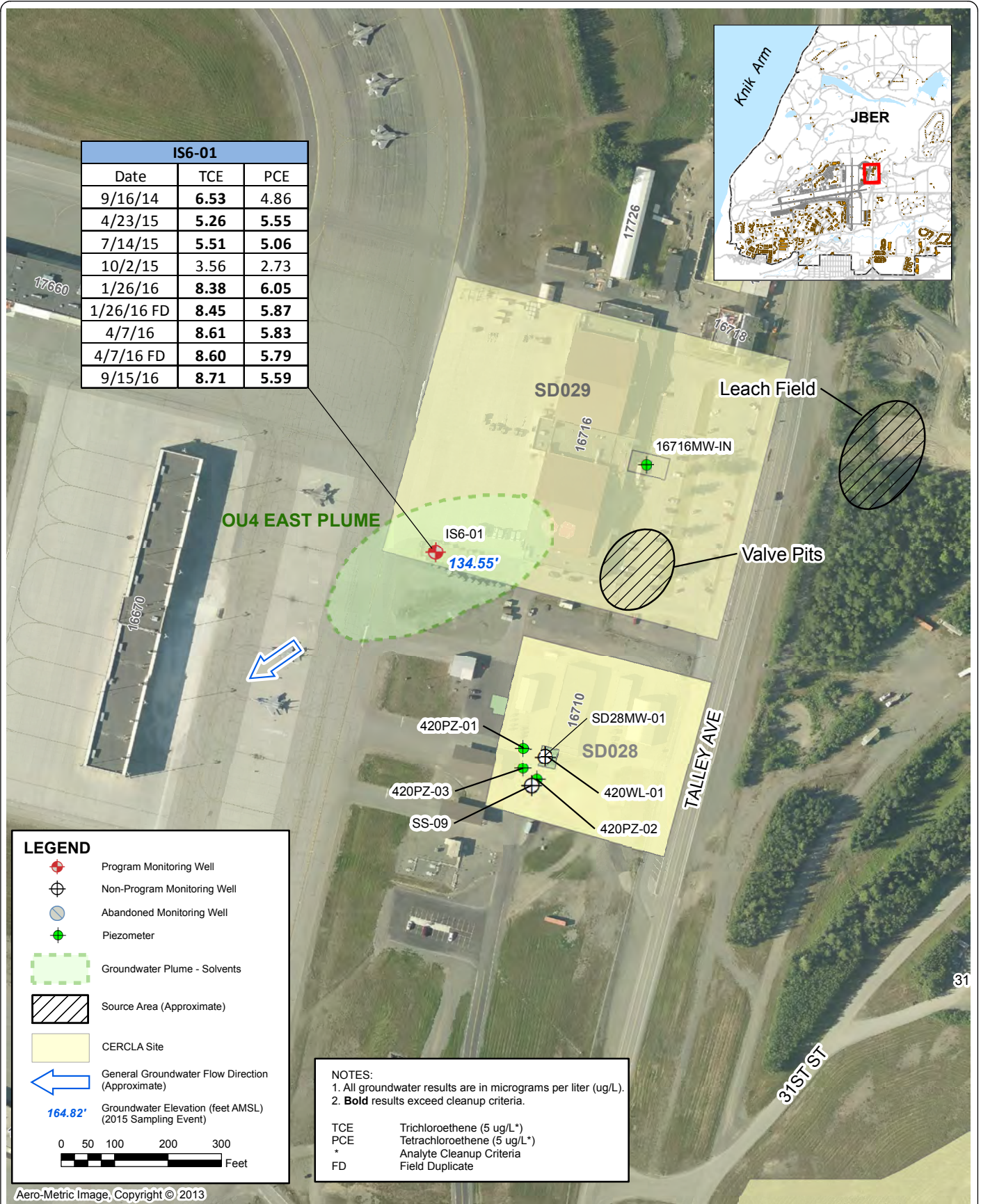
### 11.4.1 Five-Year Review

Areas in OU4 that remain above cleanup goals are required to have CERCLA five-year reviews conducted until the cleanup goals are achieved. The purpose of the five-year review is to evaluate the implementation and performance of the remedial actions. There have been four five-year reviews conducted at JBER-E. The fourth five-year review report recommended that a sampling event be conducted to identify if concentrations of 1,4-dioxane exist and determine whether or not there is an unacceptable risk at the site, as well as conducting a VI evaluation in accordance with EPA guidelines for each occupied facility that is in proximity to the plume (USAF, 2014c). A VI evaluation (2016-2017) and sampling for 1,4-dioxane (2016) was conducted at this site and will be reported under a separate cover.

### 11.4.2 Recommendations

Site SD029 is identified as a **Yellow** priority because site COCs are above cleanup. The TCE and PCE concentrations in groundwater from IS6-01 remain slightly above cleanup goals (Figure 11-1). Because the 95% UCL for the data collected during the voluntarily increased sampling frequency did not meet the cleanup levels for either COC, groundwater monitoring at IS6-01 will return to the annual groundwater sampling frequency until both COCs are measured below OU4 ROD cleanup goals. In addition, it is recommended to continue LUC inspections until the site is cleanup complete.

Date: 24 May 2017 Drawn by: SJ K:\PROJECTS\Air\_Force\JBER\BRLTMMXD\2017\2017\_JBER\_SD029\_RAQM-01.mxd



**SD029 SITE MAP WITH ANALYTICAL DATA**

2016 Annual Remedial Action – Operations and Monitoring for Select CERCLA Sites  
Joint Base Elmendorf-Richardson, Alaska

Figure  
**11-1**

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## 12.0 ST037

PBC Performance Objective: Design and Implement an Optimized Exit Strategy for Site Closeout

Anticipated Achievement Date: 2020

### 12.1 SITE DESCRIPTION

JBER-E Site ST037 was originally one of six fuel source areas investigated during the OU5 RI/FS (USAF, 1994b). These sites were grouped together into one OU (OU5) because of their proximity and similarities in the type of contamination. All groundwater in the shallow aquifer of the outwash plain on JBER-E flows towards OU5. Site ST037 is the only remaining open site within OU5 at this time. The original area identified as Site ST037 in 1990 lies at the southern perimeter of JBER-E, north of Ship Creek.

Between 1956 and 1958, a diesel fuel line broke approximately 600 feet north of Ship Creek. Fuel from the leaking pipeline reportedly seeped out of the ground near railroad tracks 200 feet south of the spill area. Thousands of gallons of fuel were recovered; however, an unknown amount remained below the ground surface.

Due to minimal soil contamination, the other sites (ST038, SD040, SS042, ST046, and SS053) were designated as no further action sites and a ROD for OU5 was signed in August 1994 (USAF, 1994b). During the RI/FS, chlorinated solvents (primarily TCE) were detected in groundwater, but no source areas were identified.

Groundwater plumes now managed under OU5 are the Slammer Avenue East and West plumes, as well as, the former Fairchild Avenue, Kenney Avenue, OU3MW-25, OU5MW-02, and SP1-02 plumes now called the Western ST037 Plume (USAF, 2011d). These plumes are contaminated with chlorinated solvents. Along with groundwater monitoring of these plumes, an early warning and sentry well network is used to determine migration of groundwater contamination and provide an alert prior to contamination reaching a downgradient environmental receptor such as Ship Creek. Additionally, seeps that daylight along the bluff near the southern boundary of JBER-E are monitored for fuels and TCE and a wetland remediation system is passively operated to treat contaminated seep water that flows directly into the wetland treatment cell.

#### 12.1.1 Geology and Hydrology

ST037 is underlain by the sands and gravels of the Anchorage glaciofluvial outwash plain as indicated in Section 1.3.1. The outwash deposits are underlain by the Bootlegger Cove Formation at depths ranging from 50 to 80 feet bgs. Along the southern margin, it is underlain by the alluvial sands and gravels of the Ship Creek flood plain. Along the southwestern margin, a steep colluvium bluff leads to a broad, flat area that ends at Ship Creek, which flows from the east to west. In the southeastern margin, a gently sloping colluvium bluff leads to a wetland area (Warhaftig, 1965) referred to as “the beaver pond area”

As indicated in Section 1.3.3 describing the general JBER-E hydrogeology, ST037 is underlain by two aquifers: a shallow water table aquifer; and a deeper, confined aquifer, separated by the

Bootlegger Cove Formation, which functions as an aquitard separating the shallow water table aquifer from the deeper, confined aquifer across the outwash plain. The deeper aquifer, below the Bootlegger Cove Formation, has a gradient estimated to be approximately 0.009 ft/ft with a general groundwater flow direction to the west. Groundwater in the shallow aquifer generally flows south to southwesterly toward Ship Creek and ST037. The shallow aquifer gradient in the Slammer and SS022 Plume area of ST037 is approximately 0.013 ft/ft with a general southwest groundwater flow direction. The shallow aquifer gradient in the Western ST037 Plume area is approximately 0.007 ft/ft with a general south-southwest groundwater flow direction. The shallow aquifer consists primarily of sand and gravel that varies in thickness between 50 and 80 feet above the bluff, depending on local topography. Depth to water above the bluff is approximately 30 feet bgs, which translates to a saturated thickness in the upper aquifer that varies between 20 and 50 feet. In the Ship Creek alluvium at the base of the bluff, the depth to water varies from about 0 to 8 feet. Groundwater from the outwash soils discharges along a line of seeps at the bluff base. The upper sand and gravel layer in this area has a total thickness as little as 10 feet thick and a saturated thickness of 5 feet.

## 12.2 REGULATORY REQUIREMENTS

The OU5 ROD identified TCE, benzene, total fuel hydrocarbons (TFH)-diesel and TFH-gas as the COCs for groundwater and is the basis for cleanup levels at ST037 (USAF, 1995c). The COCs in surface water were identified as sheen, TFH-gas and Jet Propulsion Fuel Number 4 (JP-4). There have been several revisions to the ROD. In 2003, the *OU5 Groundwater Sampling Frequency Memorandum to Site File* (USAF, 2003g) identified TAH and TAqH as the appropriate water quality standards to replace the former cleanup standards for TFH-gas and TFH diesel in groundwater and surface water, respectively.

Modifications to the ROD-specified remedy have been documented in three memorandum to the site file. The first Memorandum to the Site File adopted a sampling frequency decision guide (USAF, 2003g), while the second Memorandum to the Site File clarified how USAF intends to manage LUCs, and the most recent Memorandum to the Site File documents implementation of passive operation of the wetland remediation system for seep water treatment (USAF, 2011a). Table 12-1 provides the COCs and cleanup goals in groundwater and seep water at the site. The groundwater remedy described in the OU5 ROD (USAF, 1995c) consists of the following:

- Institutional controls on land and water use to restrict access to contaminated groundwater until cleanup goals listed in Table 3-6 of the OU5 ROD are achieved; and
- Groundwater monitoring to estimate the rate of natural attenuation, to provide an early warning of potential off-site contaminant migration and ensure protection of human health and the environment.

The seep remedy in the *Memorandum to the Site File for Passive Operation of the Wetland Remediation System at Operable Unit 5* (USAF, 2011a) includes the following:

- Seep water will continue to be extracted from areas of contamination along the western and central bluffs. Extracted seep water will either be drained directly to the constructed

wetland or treated within the seep collection area where it is extracted. Enhanced natural chemical, physical and biological processes will reduce contamination below cleanup levels. Baffles will be installed to control flow of water and maintain retention time and native vegetation will be put in place to help degrade contaminants;

- Monitoring of surface water near the exit of the constructed wetland and the Pump Station 1 seep collection area to ensure that the passive treatment systems are reducing contaminant concentrations to levels that are below the Alaska Water Quality Standards;
- Natural attenuation to treat seep and surface water in the Beaver Pond Wetland Area; and
- Monitoring of water from the seeps and Beaver Pond Wetland Areas to estimate the rate of natural attenuation and ensure that contamination does not reach Ship Creek.

Many of the seep and surface water locations at ST037 are sampled quarterly. Quarterly sampling is based on the calendar year, which includes Q1 (Jan-March), Q2 (April-June), Q3 (July-September) and Q4 (October-December). As specified in the OU5 ROD, it was expected that the remedy be implemented for 30 years or until OU5 reached the applicable cleanup levels, but the actual time frame to reach cleanup was not known. The groundwater model predicted that cleanup levels would be achieved in 10 to 15 years.

Table 12-1 provides a list of the current groundwater COCs and the respective cleanup goals identified in the OU5 ROD (USAF, 1995c). In addition, 18 AAC 75 Table C cleanup levels (ADEC, 2017) are included in the table for informational purposes.

**Table 12-1 Cleanup Goals in Groundwater, Seeps and Surface Water at ST037**

Contaminant of Concern	Medium	Cleanup Goal (µg/L)	ADEC Cleanup Level <sup>c</sup> (µg/L)
TCE	Groundwater	5 <sup>a</sup>	2.8
TCE	Surface Water	5 <sup>a</sup>	--
Benzene		5 <sup>a</sup>	--
TAH		--	10 <sup>b</sup>
TAqH		--	15 <sup>b</sup>

**Notes:**

- <sup>a</sup> Cleanup levels as cited in the OU5 ROD (USAF, 1995c).
- <sup>b</sup> Memorandum to the Site File for Passive Operation of the Wetland Remediation System at Operable Unit 5 (USAF, 2011a).
- <sup>c</sup> 18 AAC 75 Table C Cleanup Levels (ADEC, 2017) are provided for informational purposes only
- µg/L = microgram(s) per liter
- OU = Operable Unit
- ROD = Record of Decision
- TAH = total aromatic hydrocarbons
- TAqH = total aqueous hydrocarbons
- TCE = trichloroethene
- USAF = United States Air Force

**12.2.1 Land Use Control Inspection**

A LUC inspection performed at ST037 on September 22, 2016, identified some areas of construction that included ground disturbances. Ground disturbance was noted around an electrical box near the intersection of Jerstad Avenue and Arctic Warrior Drive, construction activities



related to utility installation at the intersection Sijan Avenue and Arctic Warrior Drive, and a section of asphalt was cut near monitoring well 61WL-04 along Sijan Avenue. Dig permits were issued for the areas of construction and none of these areas were located in known areas of soil contamination. Dig permits were also issued for vapor intrusion investigations in the area.

The inner PVC casing was cut down at monitoring wells OU5MW-31, NS3-2 and OU5MW-15. Monitoring well OU5MW-34 is a stick-up wells that was repaired by replacing the top portion of the PVC casing that was above the ground. All monitoring wells that were repaired were resurveyed on February 16 and February 17, 2017 and the survey data is included in Appendix A. A copy of the 2016 LUC inspection form for ST037 is in Appendix B.

### **12.3 WESTERN ST037 PLUME**

The Western ST037 plume includes the former Fairchild Avenue Plume, Kenney Avenue Plume, OU3MW-25 Plume, OU5MW-02 Plume, and SP1-02 Plume (Figure 12-1). In 2010, a source area investigation was conducted and these plumes were consolidated and mapped as a single plume with multiple lobes. The data, conclusions, and recommendations from this 2010 investigation are presented in the *ST37 TCE Plume and Source Area Investigation Report* (USAF, 2011c). The western lobe of the Western ST037 Plume generally matches the extent of the former Fairchild Avenue Plume. The downgradient (southern) extent of the western lobe is defined by TCE concentrations less than the method detection limit at the groundwater sampling location FA06, as presented in the *ST37 TCE Plume and Source Area Investigation Report* and by results of samples collected from monitoring wells OU5MW-37, OU5MW-40, and OU5MW-43 (shown on Figure 12-1).

The central lobe of the Western ST037 Plume encompasses the footprints of the former OU3MW-25, OU5MW-02, and SP1-02 Plumes and appears to originate at least partially from site SO552 as indicated in the *Site Characterization and Risk Evaluation Report SO552* (USAF, 2016c) and the *ST37 TCE Plume and Source Area Investigation Report* (USAF, 2011d).

The eastern lobe of the Western ST037 Plume corresponds to the former Kenney Avenue Plume (USAF, 2011d). According to the *ST37 TCE Plume and Source Area Investigation Report*, the source area of the former Kenney Avenue Plume is west of Kenney Avenue and south of Building 5326. During the 2010 investigation, further delineation of this area (eastern lobe) was conducted with direct push sample points (FA01-2010, KA03 and KA05). At the time of the investigation, the western extent of the eastern lobe could not be differentiated from the central lobe, probably due to an unidentified source of TCE in the area (USAF, 2011d).

#### **12.3.1 2016 Field Activities and Results**

During 2016, nine monitoring wells (403WL-01, SP1-02, OU3MW-02, OU3MW-11, OU5MW-15, OU5MW-34, OU5MW-38, OU5MW-44 and OU5MW-45), and four seeps (OU5SP-09, OU5SP-10, OU5SP-11, and OU5SP-15) were sampled for TCE. Seeps OU5SP-10 and OU5SP-11 were sampled quarterly and seeps OU5SP-09 and OU5SP-15 were sampled annually to monitor the OU5 Wetland Remediation System (Section 12.5). Additionally, field duplicate samples were

collected from monitoring wells OU5MW-34 and OU5MW-38, and seep OU5SP-11 in quarters two and three. The TCE concentrations in all wells (except OU5MW-15 and OU5MW-45) and all seeps (except OU5SP-09 and OU5SP-15) within the Western ST037 Plume continue to exceed the OU5 ROD cleanup goals.

Table 12-2 presents a summary of the 2016 analytical results and Table 12-3 presents a summary of the MNA field parameters. The 2016 and truncated historical results are on Figure 12-1. Historical results and Mann Kendall trend analysis results are in Appendix C and a summary of the Mann-Kendall analysis results are in Table 12-4. The Mann-Kendall contaminant trend graphs are on Figure 12-2 and Figure 12-3.

The Mann-Kendall trend tests for TCE in wells 403WL-01, OU3MW-02, OU3MW-11, OU5MW-44 and SP1-02 indicated statistically significant decreasing trends at the 95% confidence level. No statistically significant trends were identified for TCE in well OU5MW-38 and the seep OU5SP-10 at the 95% confidence level. TCE concentrations in seep OU5SP-11 are increasing.

**Table 12-2 Summary of 2016 Analytical Results at Western ST037 Plumes**

Monitoring Well or Seep ID	TCE Result (µg/L)
<b>Cleanup Goal<sup>a</sup></b>	<b>5 (µg/L)</b>
<b>Monitoring Wells</b>	
403WL-01	<b>20.6</b>
SP1-02	<b>7.03</b>
OU3MW-02	<b>11.6</b>
OU3MW-11	<b>44</b>
OU5MW-15	ND [1]
OU5MW-34	<b>46.6</b>
OU5MW-34 (FD)	<b>47.6</b>
OU5MW-38	<b>14</b>
OU5MW-38 (FD)	<b>13.9</b>
OU5MW-44	<b>25.6</b>
OU5MW-45 (7/7/16)	ND [0.5]
OU5MW-45 (10/17/16)	ND [0.5]
<b>Seeps</b>	
OU5SP-09	1.67
OU5SP-10 Q1 (3/29/16)	<b>6.37</b>
OU5SP-10 Q2 (6/22/16)	<b>8.39</b>
OU5SP-10 Q3 (9/14/16)	<b>10.2</b>
OU5SP-10 Q4	Frozen, not sampled
OU5SP-11 Q1 (3/29/16)	<b>12</b>
OU5SP-11 Q2 (6/22/16)	<b>10.3</b>
OU5SP-11 Q2 (6/22/16) (FD)	<b>10</b>
OU5SP-11 Q3 (9/14/16)	<b>12</b>
OU5SP-11 Q3 (9/14/16) (FD)	<b>11.3</b>
OU5SP-11 Q4 (12/8/16)	<b>8.74</b>
OU5SP-15	ND [1]

**Notes:**

<sup>a</sup> Cleanup levels as cited in the OU5 ROD (USAF, 1995c).

[ ] = limit of detection

**Bold** result exceeds cleanup level

µg/L = microgram(s) per liter

FD = field duplicate

ID = identification

ND = non-detect [limit of detection]

Q = quarter

TCE = trichloroethene



**Table 12-3 Summary of 2016 MNA Field Parameters at Western ST037 Plume**

MNA Field Parameters							
Monitoring Well ID	Volume Purged (gallons)	Temp (°C)	Specific Conductance <sup>a</sup> (mS/cm)	DO (mg/L)	pH	ORP (mV)	Turbidity (NTU)
OU3MW-02	3.9	8.7	0.801	0.58	6.47	151.8	4.91
OU3MW-11	2.4	9.31	0.799	0.59	6.88	115.9	0.92
OU5MW-15	2.0	11.09	0.601	0.09	6.85	7.1	2.24
OU5MW-38	4.8	10.18	0.662	3.17	6.83	106.8	44.41
OU5MW-43	3.0	9.49	0.563	0.700	6.63	142.7	8.51
OU5MW-44	5.0	10.34	0.349	4.06	6.48	111.7	19.5
403WL-01	1.5	9.85	0.679	0.57	6.77	24.4	2.04
SP1-02	2.2	7.04	0.886	0.41	7.05	137.4	0.00

**Notes:**

<sup>a</sup> Specific Conductance is a conductivity measurement that has been corrected to 25°C.  
 °C = degree(s) Celsius  
 mS/cm = milliSiemen(s) per centimeter  
 DO = dissolved oxygen  
 ID = identification  
 mV = millivolts  
 mg/L = milligram(s) per liter  
 NTU = Nephelometric Turbidity Units  
 ORP = oxidation-reduction potential

**Table 12-4 Summary of 2016 Mann-Kendall Concentration Trends for Select Wells and Seeps at Western ST037 Plume**

Monitoring Well ID or Seep ID	TCE
Monitoring Wells	
403WL-01	Decreasing
OU3MW-02	Decreasing
OU3MW-11	Decreasing
OU5MW-34	NST
OU5MW-38	NST
OU5MW-44	Decreasing
SP1-02	Decreasing
Seeps	
OU5SP-10	NST <sup>a</sup>
OU5SP-11	Increasing

**Notes:**

<sup>a</sup> Stable according to MAROS convention.  
 ID = identification  
 NST = no statistically significant trend  
 TCE = trichloroethene

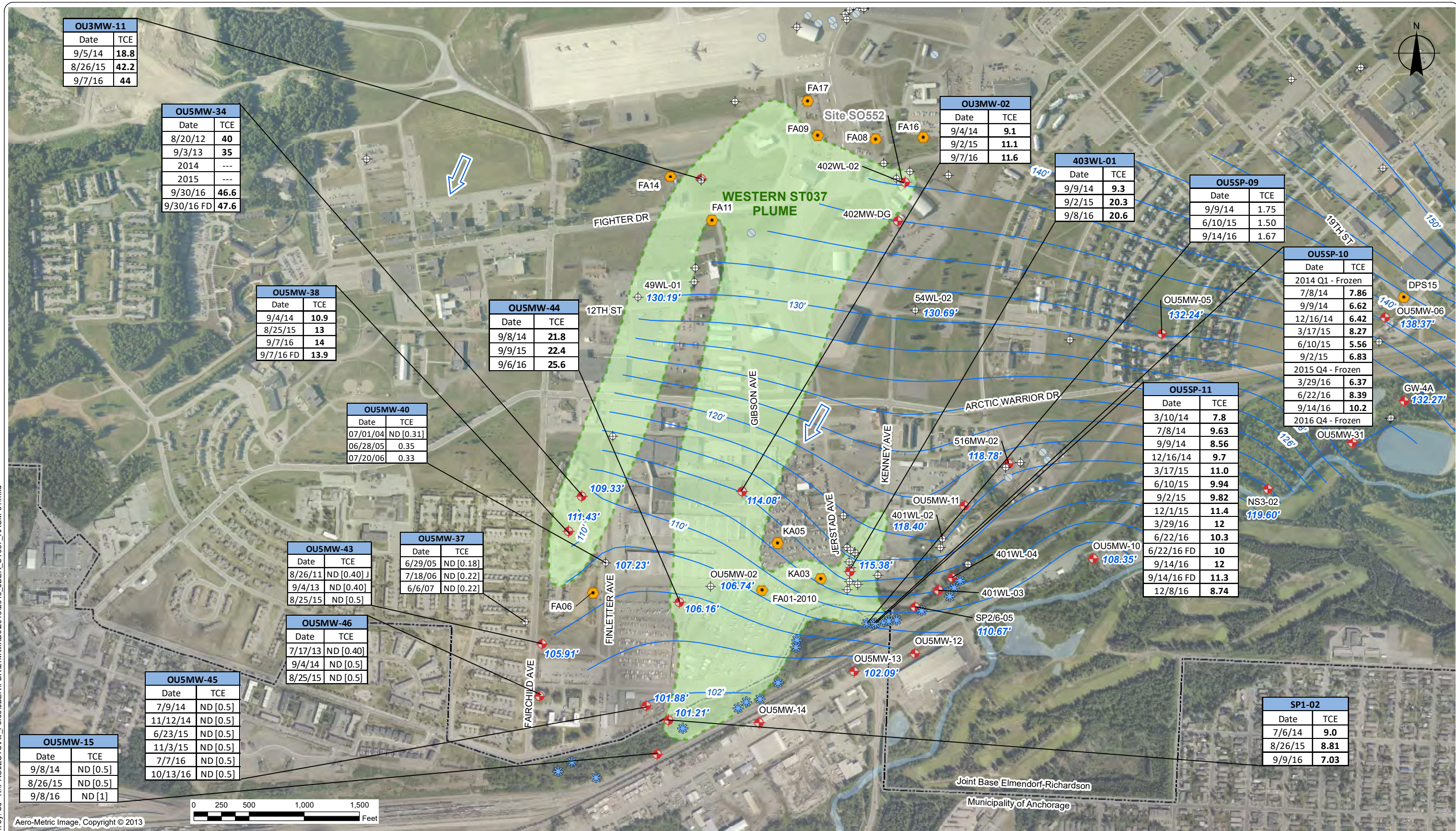


### 12.3.2 Site Summary and Recommendations

The Western ST037 Plume is identified as a **Yellow** priority because site COCs are above cleanup goals. Recommendations in this section are based on the results of the findings in the *Site Characterization and Risk Evaluation Report SO552* (USAF, 2016c) and the *ST37 TCE Plume and Source Area Investigation Report* (USAF, 2011d) and subsequent LTM data collected, the following recommendations are made for the Western ST037 Plume:

- For the eastern lobe of the Western ST037 Plume (formerly the Kenney Avenue Plume), a new monitoring well is needed to evaluate trends in a previously unknown source area. The location and screen interval for this new source area monitoring well may be selected by the collection of additional discrete groundwater samples between previous discrete sample locations FA01-2010, KA03, and KA05 (Figure 12-1).
- For the central lobe of the Western ST037 Plume, the installation of one new monitoring well is recommended north of Fighter Drive to monitor source area(s). The location and screen interval for the new well may be selected by the collection of additional discrete groundwater samples between existing monitoring wells and the discrete groundwater sample points (FA08, FA09, FA 11, FA14, FA16 and FA17) installed in 2010 (Figure 12-1).
- The chlorinated volatile organic compound contamination at SO552 has been transferred to CERCLA regulation for groundwater monitoring and future site investigation. In accordance with the *Remedial Action-Operations Monitoring Letter Work Plan and Basewide Uniform Federal Policy-Quality Assurance Project Plan (UFP-QAPP) Addendum* (USAF, 2017a), sampling of monitoring well 402WL-02 has been added to the annual long term monitoring program as part of the Western ST037 Plume monitoring.

Date: 12 Mar 2018 Drawn by: SJ K:\PROJECTS\Air\_Force\JBER\IPBRLTMMXD\2016\2016\_JBER\_ST037\_RA\OM-01.mxd



OU3MW-11	
Date	TCE
9/5/14	18.8
8/26/15	42.2
9/7/16	44

OU5MW-34	
Date	TCE
8/20/12	40
9/3/13	35
2014	---
2015	---
9/30/16	46.6
9/30/16 FD	47.6

OU5MW-38	
Date	TCE
9/4/14	10.9
8/25/15	13
9/7/16	14
9/7/16 FD	13.9

OU5MW-40	
Date	TCE
07/01/04	ND [0.31]
06/28/05	0.35
07/20/06	0.33

OU5MW-44	
Date	TCE
9/8/14	21.8
9/9/15	22.4
9/6/16	25.6

OU5MW-43	
Date	TCE
8/26/11	ND [0.40] J
9/4/13	ND [0.40]
8/25/15	ND [0.5]

OU5MW-37	
Date	TCE
6/29/05	ND [0.18]
7/18/06	ND [0.22]
6/6/07	ND [0.22]

OU5MW-46	
Date	TCE
7/17/13	ND [0.40]
9/4/14	ND [0.5]
8/25/15	ND [0.5]

OU5MW-45	
Date	TCE
7/9/14	ND [0.5]
11/12/14	ND [0.5]
6/23/15	ND [0.5]
11/3/15	ND [0.5]
7/7/16	ND [0.5]
10/13/16	ND [0.5]

OU5MW-15	
Date	TCE
9/8/14	ND [0.5]
8/26/15	ND [0.5]
9/8/16	ND [1]

OU3MW-02	
Date	TCE
9/4/14	9.1
9/2/15	11.1
9/7/16	11.6

403WL-01	
Date	TCE
9/9/14	9.3
9/2/15	20.3
9/8/16	20.6

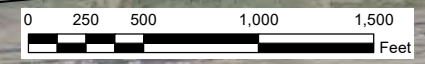
OU5SP-09	
Date	TCE
9/9/14	1.75
6/10/15	1.50
9/14/16	1.67

OU5SP-10	
Date	TCE
2014 Q1 - Frozen	
7/8/14	7.86
9/9/14	6.62
12/16/14	6.42
3/17/15	8.27
6/10/15	5.56
9/2/15	6.83
2015 Q4 - Frozen	
3/29/16	6.37
6/22/16	8.39
9/14/16	10.2
2016 Q4 - Frozen	

OU5SP-11	
Date	TCE
3/10/14	7.8
7/8/14	9.63
9/9/14	8.56
12/16/14	9.7
3/17/15	11.0
6/10/15	9.94
9/2/15	9.82
12/1/15	11.4
3/29/16	12
6/22/16	10.3
6/22/16 FD	10
9/14/16	12
9/14/16 FD	11.3
12/8/16	8.74

SP1-02	
Date	TCE
7/6/14	9.0
8/26/15	8.81
9/9/16	7.03

Aero-Metric Image, Copyright © 2013



**NOTES:**  
 1. All groundwater results are in micrograms per liter (ug/L).  
 2. **Bold** results exceed cleanup criteria.

**FLAGS:**  
 J - Analyte was positively identified, but the result is estimated.

**TCE** Trichloroethene (5 ug/L\*)  
**ND** Not Detected [brackets indicate the MDL for 2007 and earlier, and the LOD for 2011-2016]  
**LOD** Limit of Detection  
**PQL** Practical Quantification Limit  
**FD** Field Duplicate  
**MDL** Method Detection Limit  
**Q** Quarter (Yearly)  
 --- Not Analyzed  
 \* Analyte Cleanup Criteria

**LEGEND**

- Program Monitoring Well
- Non-Program Monitoring Well
- Abandoned Monitoring Well
- \* Seep Sample Location
- Direct Push Sample Location

Groundwater Contour Line (feet AMSL) (Synoptic Water Levels Measured June 2015)  
 Groundwater Elevation (feet AMSL) (Synoptic Water Levels Measured June 2015)  
 General Groundwater Flow Direction (Approximate)  
 Groundwater Plume - Solvents



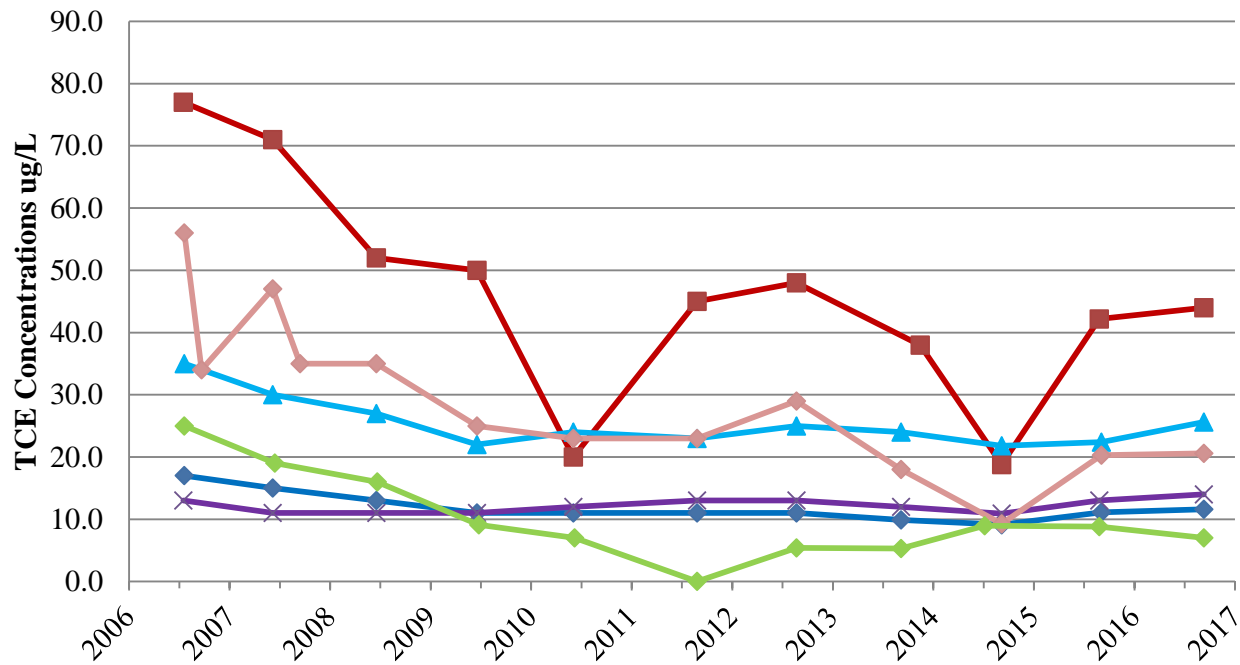
2016 Annual Remedial Action – Operations and Monitoring for Select CERCLA Sites  
 Joint Base Elmendorf-Richardson, Alaska

## WESTERN ST037 PLUME SITE MAP WITH ANALYTICAL DATA

Figure 12-1

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Symbol	Well ID	M-K Concentration Trend
■	OU3MW-11	Decreasing Trend
◆	OU3MW-02	Decreasing Trend
▲	OU5MW-44	Decreasing Trend
×	OU5MW-38	No Significant Trend
◇	403WL-01	Decreasing Trend
◇	SP1-02	Decreasing Trend

Cleanup Level  
TCE = 5 µg/L



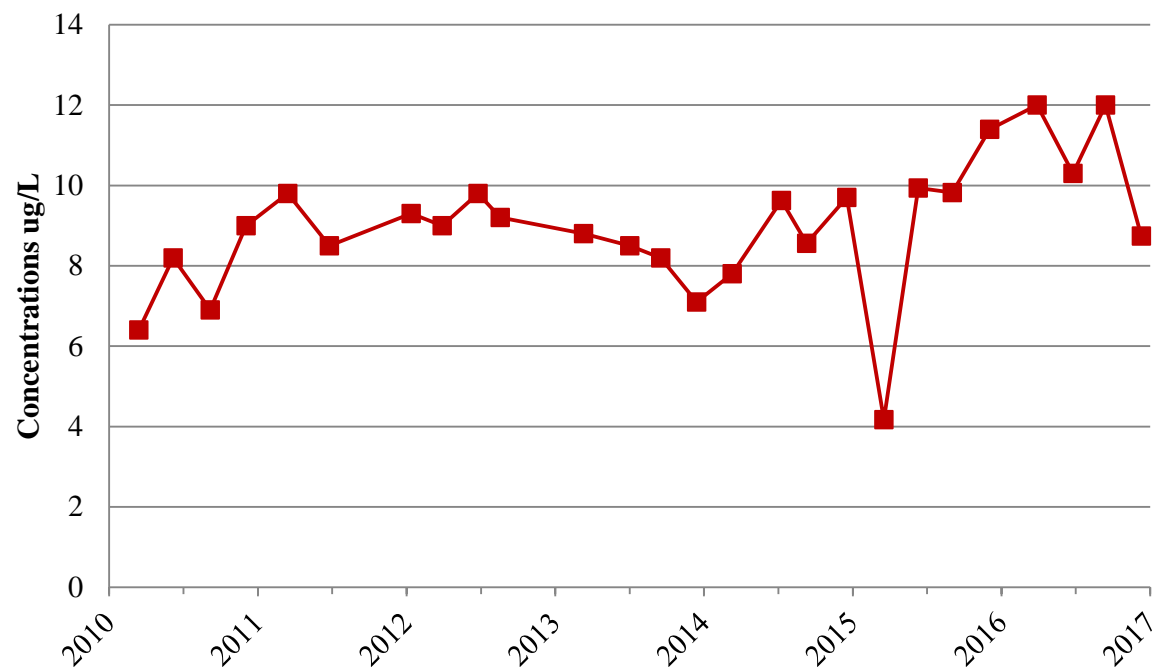
**ST037 TCE TRENDS IN MONITORING WELLS**  
2016 Annual Field Activities Report, CERCLA Sites  
Joint Base Elmendorf-Richardson, Alaska

Figure  
**12-2**

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OU5SP-11 TCE



Symbol	Well ID	M-K Concentration Trend
	OU5SP-11 TCE	Increasing Trend

Cleanup Level  
TCE = 5 µg/L



**WESTERN ST037 TCE TRENDS IN SEEPS**

2016 Annual Field Activities Report, CERCLA Sites  
Joint Base Elmendorf-Richardson, Alaska

Figure  
**12-3**

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## 12.4 SLAMMER AVENUE PLUMES

The Slammer Avenue Plumes are located near Slammer Avenue and Arctic Warrior Drive (Figure 12-4). The TCE concentrations in groundwater prior to 2007 indicated a single, diffuse plume approximately 200 feet to 600 feet wide and 1,500 feet long. The TCE data collected in September 2007 suggested two separate chlorinated VOC plumes exist at this site, an eastern and a western plume. Currently, the eastern plume is being identified as the downgradient extension of the SS022 Plume, a recently discovered TCE plume (USAF, 2011d). Similarly, the western plume is located hydrogeologically downgradient of Site TU091, which has TCE contamination present in soil and groundwater (USAF, 2016b). Given the presence and known persistence of TCE in the subsurface soils and groundwater and the groundwater gradient to the southwest, it is likely that contamination from TU091 contributes to the western Slammer Avenue TCE Plume.

The Slammer Avenue Plumes may be contributing to TCE detected in groundwater seeps and the drainage ditch that flows into the Beaver Pond Area. The point of compliance for the Slammer Avenue plumes (BPSW-01) is at the outlet of the Beaver Pond Area (Figure 12-5), which is located on a tributary to Ship Creek. Additional discussion of COC results for groundwater seeps and surface water is in Section 12.5. The only remaining COC for the Slammer Avenue Plumes is TCE.

### 12.4.1 2016 Field Activities and Results

During 2016, monitoring wells GW-4A, OU5MW-06, OU5MW-07, and OU5MW-08 were sampled for VOCs. Additionally, a field duplicate sample was collected from well OU5MW-06. The TCE concentration in wells GW-4A (5.56 µg/L), OU5MW-06 (12.3 µg/L), and OU5MW-07 (17.4 µg/L) exceeded the groundwater cleanup level of 5 µg/L. Table 12-5 presents a summary of the 2016 analytical results and Table 12-6 presents a summary of the MNA field parameters. The 2016 and truncated historical results are presented on Figure 12-4 and Figure 12-5. Historical results and Mann Kendall trend analysis results are in Appendix C and a summary of the Mann-Kendall analysis results are in Table 12-7. The Mann-Kendall contaminant trend graph is on Figure 12-6.

The Mann-Kendall trend tests for TCE in well, OU5MW-06 indicated a statistically significant decreasing trends at the 95% confidence level. A statistically significant increasing trend in the TCE concentration was indicated for well GW-4A. No statistically significant trends were identified for TCE in wells OU5MW-07 and OU5MW-08.

**Table 12-5 Summary of 2016 Analytical Results at Slammer Avenue Plume**

Analyte	Units	Cleanup Goal <sup>a</sup>	GW-4A	OU5MW-06	OU5MW-06 (FD)	OU5MW-07	OU5MW-08
TCE	µg/L	5	<b>5.56</b>	<b>11.8</b>	<b>12.3</b>	<b>17.4</b>	3.87

**Notes:**

<sup>a</sup> Cleanup levels cited in the OU5 ROD (USAF, 1995c).

**Bold** result exceeds the ROD cleanup level

µg/L = microgram(s) per liter

FD = field duplicate sample

TCE = trichloroethene

**Table 12-6 Summary of 2016 MNA Field Parameters at Slammer Avenue**

MNA Field Parameters							
Monitoring Well ID	Volume Purged (gallons)	Temp (°C)	Specific Conductance <sup>a</sup> (mS/cm)	DO (mg/L)	pH	ORP (mV)	Turbidity (NTU)
GW-4A	1.4	8.73	0.35	0.230	6.66	15.9	2.94
OU5MW-06	2.6	8.64	0.417	0.820	6.76	85.6	4.56
OU5MW-07	2.75	7.17	0.605	1.38	6.64	122.2	11.9
OU5MW-08	1.7	9.33	0.329	3.03	6.37	94.5	1.16

**Notes:**

<sup>a</sup> Specific Conductance is a conductivity measurement that has been corrected to 25°C.

°C = degree(s) Celsius

DO = dissolved oxygen

ID = identification

mg/L = milligram(s) per liter

mS/cm = milliSiemen(s) per centimeter

mV = millivolt(s)

NTU = Nephelometric Turbidity Units

ORP = oxidation-reduction potential



**Table 12-7 Summary of 2016 Mann-Kendall Concentration Trends for Select Wells  
 Slammer Avenue Plumes**

Monitoring Well ID	TCE
GW-4A	Increasing
OU5MW-06	Decreasing
OU5MW-07	NST <sup>a</sup>
OU5MW-08	NST <sup>a</sup>

**Notes:**

a Stable according to MAROS convention

ID = identification

NST = no statistically significant trend

TCE = trichloroethene

**12.4.2 Site Summary and Recommendations**

The Slammer Avenue Plumes are identified as a **Yellow** priority because site COCs are above cleanup goals. The TCE concentrations measured in the eastern Slammer Avenue Plume at monitoring wells OU5MW-06 and OU5MW-07 continue to exceed the OU5 ROD cleanup goal. Concentrations measured at these wells have been similar from 2007 through 2016. The eastern Slammer Avenue Plume cross-gradient monitoring well (OU5MW-08) does not have a TCE concentration above the OU5 ROD cleanup goal, but the monitoring well located at the leading edge of the plume (GW-4A) exceeded the TCE cleanup goal in both 2015 and 2016. This eastern plume has been identified as the leading edge of the SS022 Plume. Contamination from Site TU091 may be the source of the western Slammer Avenue Plume.

Monitoring well GW-4A is downgradient of the drainage ditch with 2015 and 2016 TCE results exceeding the ROD cleanup level. To help determine the extent of the TCE plume, the collection of samples for TCE and PCE analyses from the next downgradient monitoring well (SS37MW07), which is screened over the same approximate depth will take place in 2017. Monitoring well SS37MW07 would be the most representative as it completed to 16.0 feet below top of casing and GW-4A was completed to 12.3 feet.

It is also recommended to continue quarterly surface water monitoring at the existing Beaver Pond Area surface water monitoring points to demonstrate compliance with Alaska Water Quality Standards.

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NOTES:  
 1. All groundwater results are in micrograms per liter (ug/L).  
 2. **Bold** results exceed cleanup criteria.

TCE Trichloroethene (5 ug/L\*)  
 FD Field Duplicate  
 --- Not Analyzed  
 \* Analyte Cleanup Criteria

FLAGS:  
 J - Analyte was positively identified, but result is estimated.

Projected Path of TCE Contamination from TU091

OU5MW-06	
Date	TCE
9/8/14	<b>8.61</b>
9/9/15	<b>11.5</b>
9/8/16	<b>11.8</b>
9/8/16 FD	<b>12.3</b>

OU5MW-07	
Date	TCE
9/8/14	<b>15.8</b>
9/9/15	<b>15.6</b>
9/9/16	<b>17.4</b>

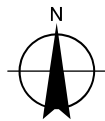
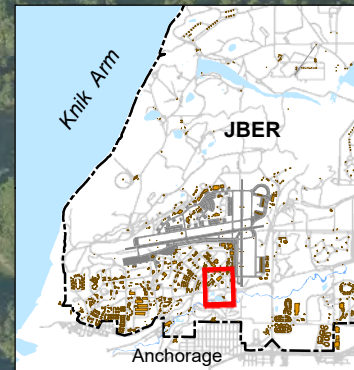
GW-4A	
Date	TCE
9/5/14	4.08
9/2/15	<b>6.2</b>
9/8/16	5.56

OU5MW-08	
Date	TCE
9/8/14	2.46 J
9/1/15	3.88
9/9/16	3.87

**LEGEND**

- Program Monitoring Well
  - Non-Program Monitoring Well
  - Abandoned Monitoring Well
  - Groundwater Plume - Solvents (dashed where inferred)
  - Groundwater Contour (feet AMSL) (Synoptic Water Levels Measured June 2015)
  - General Groundwater Flow Direction (Approximate)
  - Groundwater Elevation (feet AMSL) (Synoptic Water Levels Measured June 2015)
- 0 100 200 400 600  
 Feet

Aero-Metric Image, Copyright © 2013



**SLAMMER AVENUE PLUME SITE MAP WITH ANALYTICAL DATA**

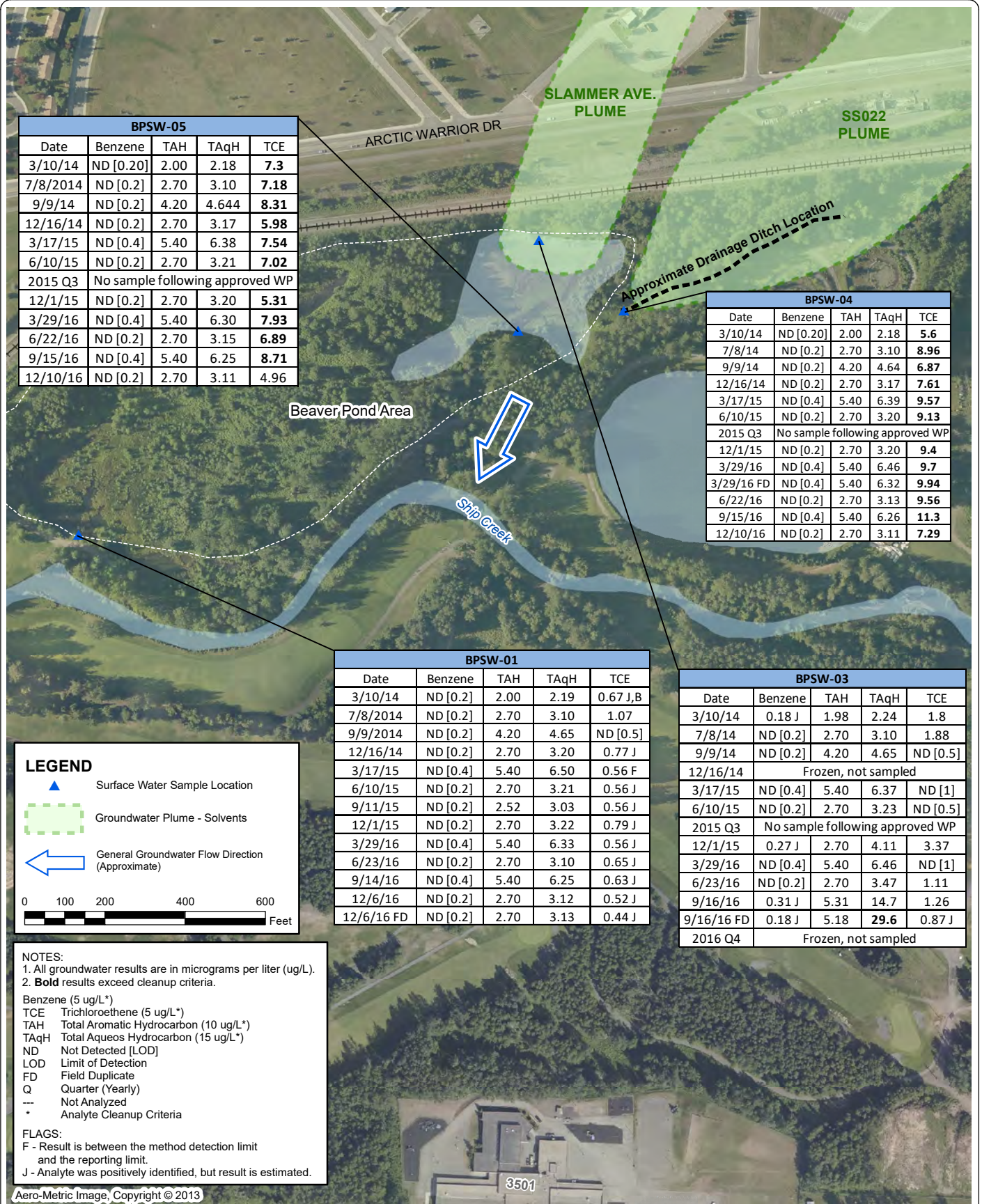
2016 Annual Remedial Action – Operations and Monitoring for Select CERCLA Sites  
 Joint Base Elmendorf-Richardson, Alaska

Figure  
**12-4**

Date: 08 May 2017 Drawn by: SJ K:\PROJECTS\Air\_Force\JBER\IPBR\LTMMXD\2017\2017\_-\_JBER\_Slammer\_RAOM-01.mxd

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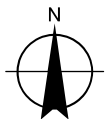


BPSW-05				
Date	Benzene	TAH	TAqH	TCE
3/10/14	ND [0.20]	2.00	2.18	<b>7.3</b>
7/8/2014	ND [0.2]	2.70	3.10	<b>7.18</b>
9/9/14	ND [0.2]	4.20	4.644	<b>8.31</b>
12/16/14	ND [0.2]	2.70	3.17	<b>5.98</b>
3/17/15	ND [0.4]	5.40	6.38	<b>7.54</b>
6/10/15	ND [0.2]	2.70	3.21	<b>7.02</b>
2015 Q3	No sample following approved WP			
12/1/15	ND [0.2]	2.70	3.20	<b>5.31</b>
3/29/16	ND [0.4]	5.40	6.30	<b>7.93</b>
6/22/16	ND [0.2]	2.70	3.15	<b>6.89</b>
9/15/16	ND [0.4]	5.40	6.25	<b>8.71</b>
12/10/16	ND [0.2]	2.70	3.11	4.96

BPSW-04				
Date	Benzene	TAH	TAqH	TCE
3/10/14	ND [0.20]	2.00	2.18	5.6
7/8/14	ND [0.2]	2.70	3.10	<b>8.96</b>
9/9/14	ND [0.2]	4.20	4.64	<b>6.87</b>
12/16/14	ND [0.2]	2.70	3.17	<b>7.61</b>
3/17/15	ND [0.4]	5.40	6.39	<b>9.57</b>
6/10/15	ND [0.2]	2.70	3.20	<b>9.13</b>
2015 Q3	No sample following approved WP			
12/1/15	ND [0.2]	2.70	3.20	<b>9.4</b>
3/29/16	ND [0.4]	5.40	6.46	<b>9.7</b>
3/29/16 FD	ND [0.4]	5.40	6.32	<b>9.94</b>
6/22/16	ND [0.2]	2.70	3.13	<b>9.56</b>
9/15/16	ND [0.4]	5.40	6.26	<b>11.3</b>
12/10/16	ND [0.2]	2.70	3.11	<b>7.29</b>

BPSW-01				
Date	Benzene	TAH	TAqH	TCE
3/10/14	ND [0.2]	2.00	2.19	0.67 J,B
7/8/2014	ND [0.2]	2.70	3.10	1.07
9/9/2014	ND [0.2]	4.20	4.65	ND [0.5]
12/16/14	ND [0.2]	2.70	3.20	0.77 J
3/17/15	ND [0.4]	5.40	6.50	0.56 F
6/10/15	ND [0.2]	2.70	3.21	0.56 J
9/11/15	ND [0.2]	2.52	3.03	0.56 J
12/1/15	ND [0.2]	2.70	3.22	0.79 J
3/29/16	ND [0.4]	5.40	6.33	0.56 J
6/23/16	ND [0.2]	2.70	3.10	0.65 J
9/14/16	ND [0.4]	5.40	6.25	0.63 J
12/6/16	ND [0.2]	2.70	3.12	0.52 J
12/6/16 FD	ND [0.2]	2.70	3.13	0.44 J

BPSW-03				
Date	Benzene	TAH	TAqH	TCE
3/10/14	0.18 J	1.98	2.24	1.8
7/8/14	ND [0.2]	2.70	3.10	1.88
9/9/14	ND [0.2]	4.20	4.65	ND [0.5]
12/16/14	Frozen, not sampled			
3/17/15	ND [0.4]	5.40	6.37	ND [1]
6/10/15	ND [0.2]	2.70	3.23	ND [0.5]
2015 Q3	No sample following approved WP			
12/1/15	0.27 J	2.70	4.11	3.37
3/29/16	ND [0.4]	5.40	6.46	ND [1]
6/23/16	ND [0.2]	2.70	3.47	1.11
9/16/16	0.31 J	5.31	14.7	1.26
9/16/16 FD	0.18 J	5.18	<b>29.6</b>	0.87 J
2016 Q4	Frozen, not sampled			



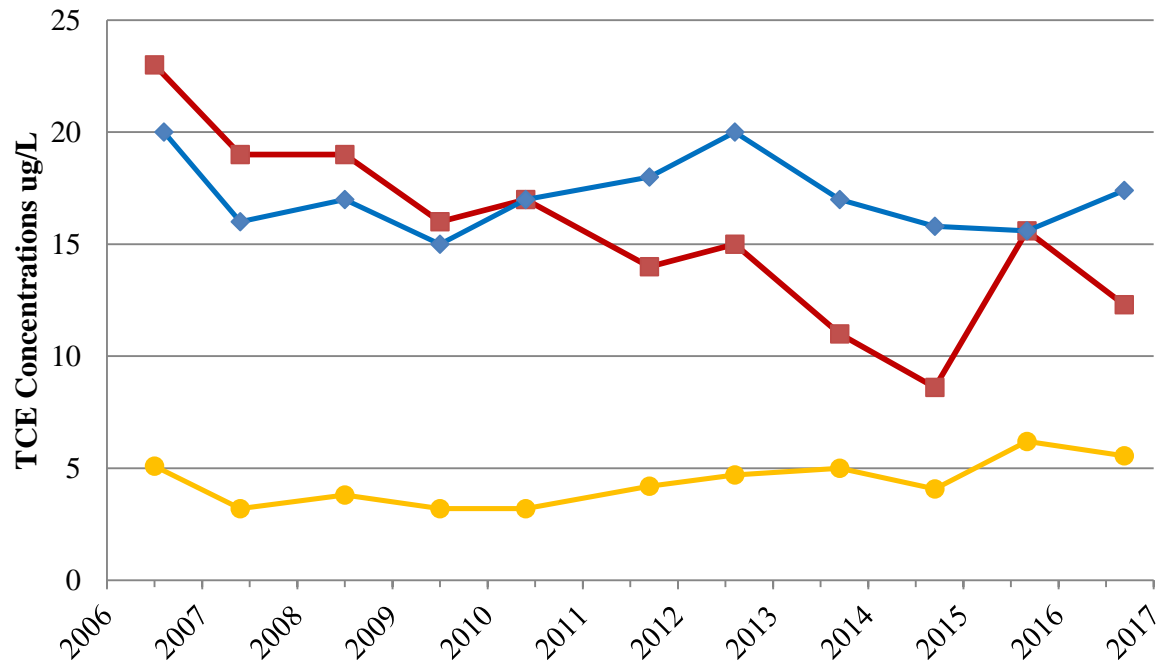
## ST037 BEAVER POND SURFACE WATER SAMPLE LOCATIONS WITH ANALYTICAL DATA

2016 Annual Remedial Action – Operations and Monitoring for Select CERCLA Sites  
 Joint Base Elmendorf-Richardson, Alaska

Figure  
**12-5**

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Symbol	Well ID	M-K Concentration Trend
■	OU5MW-06	Decreasing Trend
◆	OU5MW-07	No Significant Trend; Stable*
●	GW-4A	Increasing Trend

Cleanup Level  
TCE = 5 µg/L



**SLAMMER AVE PLUME TCE TRENDS IN MONITORING WELLS**

2016 Annual Field Activities Report, CERCLA Sites  
Joint Base Elmendorf-Richardson, Alaska

Figure  
**12-6**

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## 12.5 SEEPS, SURFACE WATER, AND WETLAND REMEDIATION SYSTEMS

Along the southern boundary of JBER-E, seeps, surface water features, and the Wetland Remediation System make up a system of discharge points, monitoring locations, and treatment systems associated with Site ST037 (Figure 12-7).

### 12.5.1 Wetland Remediation System

The Wetland Remediation System was constructed in 1996 to treat contaminated groundwater emerging from several seeps along the southern bluff of JBER-E. The purpose of the system was to remediate petroleum hydrocarbon contamination in seeps OU5SP-01 through OU5SP-04. In 2005, seeps OU5SP-09, OU5SP-10, OU5SP-11 were added to the Wetland Remediation System (USAF, 2005a). The Wetland Remediation System was designed to treat contaminants through a combination of passive and active system components. Components that originally contributed to treatment were as follows:

- Gravel-lined collection areas for seeps OU5SP-01 through OU5SP-04 and OU5SP-09 through OU5SP-11
- Pump Stations #1, #2, and #3
- Overland Flow Cell for water collected from seeps OU5SP-01 through OU5SP-04
- Wetland Treatment Cell for effluent from the Overland Flow Cell and seeps OU5SP-09, OU5SP-10, OU5SP-11, OU5SP-17, and OU5SP-18

The primary treatment process in the seep collection areas are believed to be biodegradation, achieved by a biofilm that has developed as a coating on the saturated gravel. Prior to 2007, water from the seep collection areas was transported via the three pump stations to the Overland Flow Cell, which removed hydrocarbon contamination through a combination of volatilization and aerobic biodegradation that was enhanced by increasing DO concentrations in the water. Treated water from the Overland Flow Cell was gravity fed into the Wetland Treatment Cell, except during the coldest winter months; when the Overland Flow Cell was reduced to fewer cells, which allowed for a higher volume of water to flow through fewer cells. The treatment processes active in the Wetland Treatment Cell include volatilization, sorption, phytoremediation, and biodegradation. Retention time in the Wetland Treatment Cell is maintained by raising or lowering the V-notch weir gate. Effluent from the Wetland Treatment Cell, at the V-notch weir, is monitored to ensure that discharged water is below cleanup levels. Effluent from the Wetland Treatment Cell discharges to Ship Creek via underground culverts and ditches.

Over the past 5 years, components of the remediation system have been shut down based on analytical data which indicated that they were no longer needed or as part of an ongoing Wetland Remediation System Optimization Study (Optimization Study) described in the *2009 Zone 2 and Zone 3 Management Areas Work Plan* (USAF, 2009b) and performed during 2009 and 2010. The purpose of the Optimization Study was to evaluate, in three phases, whether the Wetland Remediation System could achieve treatment objectives established by the OU5 ROD when

operated without pump station operation. The results of Phases I and II of the Optimization Study are described in a report published in March 2010 (USAF, 2010c).

In 2007, Pump Station #3 was shut down because concentrations of COCs in the associated seep (OU5SP-04) were below cleanup goals. The results of Phases I and II of the Optimization Study indicated that COC degradation within the two seep collection areas serviced by Pump Stations #1 and #2 was sufficient to achieve applicable cleanup standards within these areas prior to discharge from those areas.

The results of Phase III, described in an addendum to the Optimization Study report (USAF, 2010d), were generally consistent with the results of Phases I and II, with one exception. Modifications to the configuration of the Pump Station #1 seep collection area might be necessary to (1) increase the retention time of COCs from seep OU5SP-02 in the collection area, and (2) maintain the water level within the collection area at an elevation below ground level.

The USAF, EPA, and ADEC have agreed and signed the OU5 Memorandum to the Site File (USAF, 2011a) for a non-significant change to the OU5 ROD formally changing the OU5 Wetland Remediation System treatment approach from an active (i.e., pumping) to a passive system.

#### ***12.5.2 Seep and Surface Water Sampling System***

Twenty seeps have been identified south of 2nd Street and downgradient of Western ST037 Plume. Historical sample results for these seeps were reported under the Fairchild Avenue Plume, OU5MW-02 Plume, and Kenney Avenue Plume.

Historically, some of these seeps have been contaminated with benzene, TAH, TAqH, and/or TCE at concentrations that exceeded cleanup goals. Six seeps (OU5SP-09, OU5SP-10, OU5SP-11, OU5SP-17, and OU5SP-18) are configured to discharge directly into the Wetland Treatment Cell. In 2015, a new seep (OU5SP-11A) emerged 5 feet east of OU5SP-11, outside of the Wetland Treatment Cell. The new seep was sampled twice in 2015 for VOCs. The results (10.7 µg/L and 11.7 µg/L) were above the TCE cleanup goal so the collection area for seeps OU5SP-10 and OU5SP-11 was expanded laterally to the east 20 feet to incorporate the discharge from OU5SP-11A. This collection area flows into the Wetland Treatment Cell. Seep OU5SP-11A was not added to the sampling program because of proximity to the adjacent seep OU5SP-11, which is representative of the groundwater seeping in that area.

Concentrations of contaminants of concern in water are currently monitored within the Wetland Treatment Cell at three locations (WCSW-02, WCSW-03, and WCSW-04) and two locations at the Pump Station #1 seep collection area (OU5CP-01 and OU5CP-02) to gauge the effectiveness of the passive operations of the Wetland Remediation System (Figure 12-7). Concentrations of contaminants of concern were also historically measured at a fourth location (WCSW-01), which was the discharge point for water entering the Wetland Treatment Cell from three pump stations. Samples have not been collected at WCSW-01 since 2011 because the pump stations have not

been operated since 2009 in an effort to passively operate the wetland remediation system (See Section 12.5.1 for a discussion of the Wetlands Remediation System).

TCE concentrations have consistently been detected in surface water samples collected from the Beaver Pond Area (Figure 12-5). The probable sources of TCE contamination in the Beaver Pond Area are the Slammer Avenue Plume and SS022 Plume, with recent site data suggesting that groundwater discharge into the drainage ditch flowing into the Beaver Pond Area is a significant source of the contaminants detected in surface water. The COCs entering the Beaver Pond Area naturally attenuate in the pond before surface water flows into Ship Creek. This process is monitored at four locations (BPSW-01, BPSW-03, BPSW-04, and BPSW-05). Discharge from the Beaver Pond Area is monitored at sample point BPSW-01 which is the compliance point.

All seeps and surface water ultimately discharge to Ship Creek. Surface water in Ship Creek is monitored at two locations (SC-01B and SC-08) to evaluate water quality of this receptor (Figure 12-8).

### **12.5.3 2016 Field Activities and Results**

In 2016, ten seeps (OU5SP-01 to OU5SP-03, OU5SP-07, OU5SP-09 to OU5SP-11, OU5SP-15, OU5SP-17 and OU5SP-18), nine surface water locations (BPSW-01, BPSW-03 to BPSW-05, WCSW-02 to WCSW-04, SC-08 and SC-1B), two control points (OU5CP-01 and OU5CP-02), and one sediment location (WCD-09) were sampled at varying frequencies. Field duplicate samples were collected from BPSW-01, BPSW-03, BPSW-04, OU5CP-01, OU5SP-03, OU5SP-07 and OU5SP-11. Samples from all locations were analyzed for VOCs and PAHs. Surface water was sampled at two locations in Ship Creek, three locations at the Wetland Treatment Cell, and four locations in the Beaver Pond Area. Sediment was also sampled at one point (WCD-09) in the Wetland Treatment Cell in the vicinity of the outfall of discharge points for seeps OU5SP-09, OU5SP-10, and OU5SP-11. Samples were not collected at BPSW-03, OU5CP-01, OU5SP-02 and OU5SP-10 during quarter four because they were frozen.

Tables 12-8 and 12-9 present a summary of the 2016 analytical results and the 2016 and truncated historical results are on Figure 12-5, Figure 12-7, and Figure 12-8. Historical results and Mann Kendall trend analysis results are presented in Appendix C and a summary of the Mann-Kendall analysis results are in Table 12-10. Mann-Kendall contaminant trend graphs are on Figure 12-9 through Figure 12-11.

The TCE concentrations measured at seeps OU5SP-07, OU5SP-10, and OU5SP-11 exceeded the cleanup level (5 µg/L) in each quarterly sample collected in 2016, which is consistent with previous results. The TAH and TAqH concentrations for seeps OU5SP-01 and OU5SP-02 exceeded the Alaska Water Quality Standards (10 µg/L and 15 µg/L, respectively) in each quarterly sample collected. Benzene concentrations measured at seep OU5SP-02 exceeded the cleanup level (5 µg/L) during all three sampling events in 2016, which is consistent with previous results. The two control points are at the exit point of the seep collection area, which is

downgradient of seep sample points OU5SP-01 and OU5SP-02. The area between the seeps and the control points is functioning as a natural wetland and is remediating the contaminants.

Sample control point OU5CP-01 is located near the former inlet of Pump Station #1 and OU5CP-02 is located about 10 feet away at the designed overflow point in the berm at the lower edge of the seep area. Both sample points are located at low points in the seep area, where the water exits the area. All constituent concentrations measured at control points OU5CP-01 and OU5CP-02 were below the OU5 ROD cleanup goals during any of the sample events. The TAH and TAqH concentrations in the surface water samples collected from control points OU5CP-01 and OU5CP-02 did not exceed the OU5 ROD cleanup level for TAqH, but they did exceed the cleanup level for TAH. Although there was no exceedance for TAqH in OU5CP-01 or OU5CP-02, a Mann-Kendall trend tests was conducted.

The Mann-Kendall trend tests for benzene in seeps OU5SP-01 and OU5SP-02 and TCE in seep OU5SP-07 indicated no statistically significant trends at the 95% confidence level. The OU5SP-07 TCE concentrations are probably decreasing under the MAROS decision matrix. No statistically significant trend was identified for TAH and TAqH in seep OU5SP-01 and TAH in OU5CP-01.

No statistically significant trend was identified for TCE in seep OU5SP-10 TCE concentrations in OU5SP-11 are increasing. The Mann-Kendall trend tests for TAqH concentrations in OU5CP-01 and OU5CP-02 and TAH and TAqH concentrations in seep OU5CP-02 indicated statistically significant increasing trends at the 95% confidence level. Inspections at the OU5 Wetland Remediation System occurred monthly from January through May and October through December. Weekly wetland inspections occurred during the summer months, from June through September. Routine monthly and weekly monitoring occurred for 2016 with no damage to the wetland cell or significant beaver activity noted.

Samples were collected from three surface water locations (WCSW-02, WCSW-03, and WCSW-04) and one sediment location (WCSD-09) at the Wetland Treatment Cell. All results for VOCs, TAH, and TAqH were below cleanup goals in surface water samples collected from WCSW-02, WCSW-03, and WCSW-04 during 2016. All TCE and benzene (both methanol-preserved and low-level methods) results for the sediment sample collected at WCSD-09 were non-detect.

Samples were collected from four surface water locations (BPSW-01, BPSW-03, BPSW-04, and BPSW-05) at the Beaver Pond Area. The TCE concentrations measured in the Beaver Pond Area surface water samples from locations BPSW-04 and BPSW-05 exceeded the TCE cleanup level (5 µg/L) during all 2016 quarterly sample events, except for quarter four. The TCE concentration in quarter four for BPSW-05 was below the cleanup level. Additionally, BPSW-03 exceeded the TAqH cleanup goal in the third quarter. The TCE concentrations for BPSW-04 and BPSW-05 were above the cleanup level for TCE but were below the TAH and TAqH criteria. Benzene, TCE, TAH, and TAqH concentrations were below cleanup goals at surface water sample point BPSW-

01, which is located at the Beaver Pond Area discharge point. Surface water sample location BPSW-03 exceeded the TAqH criterion in quarter three only.

The Mann-Kendall trend tests for TAH and TAqH surface water concentrations at BPSW-03 indicated statistically significant increasing trends at the 95% confidence level. The Mann-Kendall trend tests for TCE surface water concentrations at BPSW-04 and BPSW-05 indicated statistically significant increasing trends at the 95% confidence level.

The benzene, TCE, TAH, and TAqH concentrations were below cleanup goals in sample locations collected from Ship Creek (SC-01B and SC-08), OU5SP-03, OU5SP-15, OU5SP-17, and OU5SP-18 in 2016.

#### ***12.5.4 Seeps, Surface Water, and Wetland Remediation Systems Site Summary and Recommendations***

The Slammer Avenue Plumes are identified as a **Yellow** priority because site COCs are above cleanup goals at seeps BPSW-04 and BPSW-05. Even though TCE is above ROD cleanup goals at BPSW-04 and BPSW-05, they are upgradient of the point of compliance (BPSW-01), where COC concentrations are below the ROD cleanup goals and the Alaska Surface Water criteria. In the 2016 Q2 sampling event, the TAH concentration in surface water at OU5CP-02 exceeded the cleanup level. The TAH concentration at OU5CP-02 has never historically exceeded the TAH cleanup level. This control point should be closely monitored and if surface water at this location continues to exceed Alaska Water Quality Standards a new approach to reducing the potential risk exposed at this control point should be evaluated in the next five-year review.

The results of visual inspection and assessment of analytical data continue to demonstrate that pumping is not required for the Wetland Remediation System to reduce influent COC concentrations in seeps to concentrations that are below applicable cleanup goals. Quarterly sample results at the effluent discharge point (V-notch) have consistently been below all applicable cleanup levels since 2011. Continued operation of the Wetland Remediation System in a passive configuration is recommended. Additionally, in accordance with the *OU5 Wetland Remediation System Optimization Memorandum to the Site File* (USAF, 2011a) it is recommended to discontinue sediment sampling WCD-09.

It is recommended to keep the surface water sampling frequency the same (quarterly) at the wetland treatment cell because the Mann-Kendall trend results show an unstable plume.

The Western ST037 Plume is also identified as a **Yellow** priority because site COCs are above cleanup goals. A new monitoring well should be installed to evaluate trends in a previously unknown source area of the eastern lobe. The location and screen interval for this new source area monitoring well may be selected by the collection of additional discrete groundwater samples north of the previous discrete sample locations FA01-2010, KA03, and KA05 (Figure 12-1). Further delineation in this area should help address the increasing TCE concentrations in seep OU5SP-11.

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**Table 12-8 2016 Summary of Analytical Results of Seeps, Surface Water and Wetlands Remediation System**

Analyte	Units	Cleanup Goal <sup>a</sup>	BPSW-01 (Q1)	BPSW-01 (Q2)	BPSW-01 (Q3)	BPSW-01 (Q4)	BPSW-01 (Q4)(FD)	BPSW-03 (Q1)	BPSW-03 (Q2)	BPSW-03 (Q3)	BPSW-03 (Q3)(FD)	BPSW-03 (Q4)	BPSW-04 (Q1)
Benzene	µg/L	5	ND [0.4]	ND [0.2]	ND [0.4]	ND [0.2]	ND [0.2]	ND [0.4]	ND [0.2]	0.31 J	0.18 J	Frozen, not sampled	ND [0.4]
TAH <sup>c</sup>	µg/L	10	5.40	2.70	5.40	2.70	2.70	5.40	2.70	5.31	5.18		5.40
TAqH <sup>c</sup>	µg/L	15	6.33	3.10	6.25	3.12	3.13	6.46	3.47	14.7	<b>29.6</b>		6.46
TCE	µg/L	5	0.56 J	0.65 J	0.63 J	0.52 J	0.44 J	ND [1]	1.11	1.26	0.87 J		<b>9.7</b>
Analyte	Units	Cleanup Goal <sup>a</sup>	BPSW-04 (Q1)(FD)	BPSW-04 (Q2)	BPSW-04 (Q3)	BPSW-04 (Q4)	BPSW-05 (Q1)	BPSW-05 (Q2)	BPSW-05 (Q3)	BPSW-05 (Q4)	OU5CP-01 (Q1)	OU5CP-01 (Q2)	OU5CP-01 (Q2)(FD)
Benzene	µg/L	5	ND [0.4]	ND [0.2]	ND [0.4]	ND [0.2]	ND [0.4]	ND [0.2]	ND [0.4]	ND [0.2]	ND [0.4]	0.32 J	0.31 J
TAH <sup>c</sup>	µg/L	10	5.40	2.70	5.40	2.70	5.40	2.70	5.40	2.70	5.40	<b>11.2</b>	<b>10.9</b>
TAqH <sup>c</sup>	µg/L	15	6.32	3.13	6.26	3.11	6.30	3.15	6.25	3.11	6.36	11.9	11.7
TCE	µg/L	5	<b>9.94</b>	<b>9.56</b>	<b>11.3</b>	<b>7.29</b>	<b>7.93</b>	<b>6.89</b>	<b>8.71</b>	4.96	ND [1]	ND [0.5]	ND [0.5]
Analyte	Units	Cleanup Goal <sup>a</sup>	OU5CP-01 (Q3)	OU5CP-01 (Q4)	OU5CP-02 (Q1)	OU5CP-02 (Q2)	OU5CP-02 (Q3)	OU5CP-02 (Q4)	WCSW-02 (Q1)	WCSW-02 (Q2)	WCSW-02 (Q3)	WCSW-02 (Q4)	WCSW-03 (Q1)
Benzene	µg/L	5	ND [0.4]	Frozen, not sampled	0.35 J	0.19 J	0.3 J	0.8	ND [0.4]	ND [0.2]	ND [0.4]	ND [0.2]	ND [0.4]
TAH <sup>c</sup>	µg/L	10	3.90		5.38	<b>12.1</b>	4.97	8.31	5.40	2.70	5.40	2.70	5.40
TAqH <sup>c</sup>	µg/L	15	4.80		7.25	13.0	6.13	9.50	6.35	3.13	6.24	3.11	6.32
TCE	µg/L	5	ND [1]		ND [1]	ND [0.5]	ND [1]	ND [0.5]	1.18	ND [0.4]	0.34 J	1.08	4.8
Analyte	Units	Cleanup Goal <sup>a</sup>	WCSW-03 (Q2)	WCSW-03 (Q3)	WCSW-03 (Q4)	WCSW-04 (Q1)	WCSW-04 (Q2)	WCSW-04 (Q3)	WCSW-04 (Q4)	OU5SP-01 (Q1)	OU5SP-01 (Q2)	OU5SP-01 (Q3)	OU5SP-01 (Q4)
Benzene	µg/L	5	ND [0.2]	ND [0.4]	ND [0.2]	ND [0.4]	ND [0.2]	ND [0.4]	ND [0.2]	3.5	4.06	3.73	Frozen, not sampled
TAH <sup>c</sup>	µg/L	10	2.60	5.40	2.70	5.40	2.70	5.40	2.70	<b>97.1</b>	<b>160</b>	<b>109</b>	
TAqH <sup>c</sup>	µg/L	15	3.03	6.22	3.13	6.35	3.13	6.23	3.17	<b>119</b>	<b>163</b>	<b>111</b>	
TCE	µg/L	5	3.45	4.88	4.3	ND [1]	ND [0.5]	ND [1]	ND [0.5]	ND [1]	ND [0.5]	ND [1]	



**Table 12-8 2016 Summary of Analytical Results of Seeps, Surface Water and Wetlands Remediation System (Continued)**

Analyte	Units	Cleanup Goal <sup>a</sup>	OU5SP-02 (Q1)	OU5SP-02 (Q2)	OU5SP-02 (Q3)	OU5SP-02 (Q4)	OU5SP-03	OU5SP-03 (FD)	OU5SP-07 (Q1)	OU5SP-07 (Q1)(FD)	OU5SP-07 (Q2)	OU5SP-07 (Q3)	OU5SP-07 (Q4)
Benzene	µg/L	5	<b>20.1</b>	<b>16.5</b>	<b>18.9</b>	Frozen, not sampled	0.45	0.46	ND [0.4]	ND [0.4]	ND [0.2]	ND [0.4]	ND [0.2]
TAH <sup>b</sup>	µg/L	10	<b>111</b>	<b>96.7</b>	<b>92.7</b>		5.45	5.46	5.40	5.40	2.70	5.40	2.70
TAqH <sup>b</sup>	µg/L	15	<b>126</b>	<b>107</b>	<b>107</b>		6.27	6.21	6.38	6.36	3.13	6.24	3.11
TCE	µg/L	5	ND [1]	ND [0.5]	ND [1]		2.08	2.12	3.26	3.95	<b>5.63</b>	2.83	<b>5.44</b>
Analyte	Units	Cleanup Goal <sup>a</sup>	OU5SP-09	OU5SP-10 (Q1)	OU5SP-10 (Q2)	OU5SP-10 (Q3)	OU5SP-10 (Q4)	OU5SP-11 (Q1)	OU5SP-11 (Q2)	OU5SP-11 (Q2)(FD)	OU5SP-11 (Q3)	OU5SP-11 (Q3)(FD)	OU5SP-11 (Q4)
Benzene	µg/L	5	0.21 J	ND [0.4]	ND [0.2]	ND [0.4]	Frozen, not sampled	ND [0.4]	ND [0.2]	ND [0.2]	ND [0.4]	ND [0.4]	ND [0.2]
TAH <sup>b</sup>	µg/L	10	5.21	5.40	2.70	5.40		5.40	2.70	2.86	5.40	5.40	2.70
TAqH <sup>b</sup>	µg/L	15	6.04	6.36	3.14	6.25		6.30	3.13	3.29	6.21	6.27	3.13
TCE	µg/L	5	1.67	<b>6.37</b>	<b>8.39</b>	<b>10.2</b>		<b>12</b>	<b>10.3</b>	<b>10</b>	<b>12</b>	<b>11.3</b>	<b>8.74</b>
Analyte	Units	Cleanup Goal <sup>a</sup>	OU5SP-15	OU5SP-17	OU5SP-18	SC-01B	SC-08						
Benzene	µg/L	5	ND [0.4]	0.4 U	0.4 U	ND [0.4]	ND [0.4]						
TAH <sup>b</sup>	µg/L	10	5.40	5.40	5.40	5.40	5.40						
TAqH <sup>b</sup>	µg/L	15	6.19	6.23	5.99	6.20	6.24						
TCE	µg/L	5	ND [1]	ND [1]	0.54 J	ND [1]	ND [1]						

**Notes:**

<sup>a</sup> Cleanup levels as cited in the OU5 ROD (USAF, 1995c).

<sup>b</sup> Alaska Water Quality Standards (18 AAC 70) for total aromatic hydrocarbons (TAH) and total aqueous hydrocarbons (TAqH) are 10 µg/L and 15 µg/L, respectively.

J = analyte was positively identified: the associated numerical value is the approximate concentration of the analyte in the sample.

[ ] = limit of detection

**Bold** result exceeds cleanup level

µg/L = microgram(s) per liter

FD = field duplicate

ND = non-detect [limit of detection]

Q = quarter

TAH = total aromatic hydrocarbons

TAqH = total aqueous hydrocarbons

TCE = trichloroethene



**Table 12-9 2016 Summary of Analytical Results of Sediment at the Wetlands Remediation System**

Analyte	Units	WCSD-09 <sup>a</sup>	WCSD-09 <sup>a</sup> (FD)	WCSD-09 <sup>b</sup>	WCSD-09 <sup>b</sup> (FD)
Benzene	µg/kg	ND [0.044]	ND [0.095]	ND [0.0064]	ND [0.01]
TCE	µg/kg	ND [0.044]	ND [0.095]	ND [0.0064]	ND [0.01]

**Notes:**

<sup>a</sup> Sample analyzed using SW8260 Medium-level method (methanol preserved)

<sup>b</sup> Sample analyzed using SW8260 Low-level method

[ ] = limit of detection

µg/kg = microgram(s) per kilogram

FD = field duplicate

ND = non-detect [limit of detection]

TCE = trichloroethene

**Table 12-10 Summary of 2016 Mann-Kendall Concentration Trends for Select Seeps and Surface Water at Seeps, Surface Waters and Wetlands Remediation System**

Monitoring Well ID	TCE	Benzene	TAH	TAqH
OU5CP-01	NE	NE	NST	Increasing
OU5CP-02	NE	NE	Increasing	Increasing
OU5SP-01	NE	NE	NST	NST
OU5SP-02	NE	NST <sup>a</sup>	Decreasing	Decreasing
OU5SP-07	NST <sup>b</sup>	NE	NE	NE
OU5SP-10	NST <sup>a</sup>	NE	NE	NE
OU5SP-11	Increasing	NE	NE	NE
BPSW-03	NE	NE	Increasing	Increasing
BPSW-04	Increasing	NE	NE	NE
BPSW-05	Increasing	NE	NE	NE

**Notes:**

<sup>a</sup> Stable according to MAROS convention.

<sup>b</sup> Probably decreasing according to MAROS convention (90-95% confidence; S < 0).

ID = identification

NE = no exceedance of cleanup goal in 2015

NST = no significant trend

TAH = total aromatic hydrocarbons

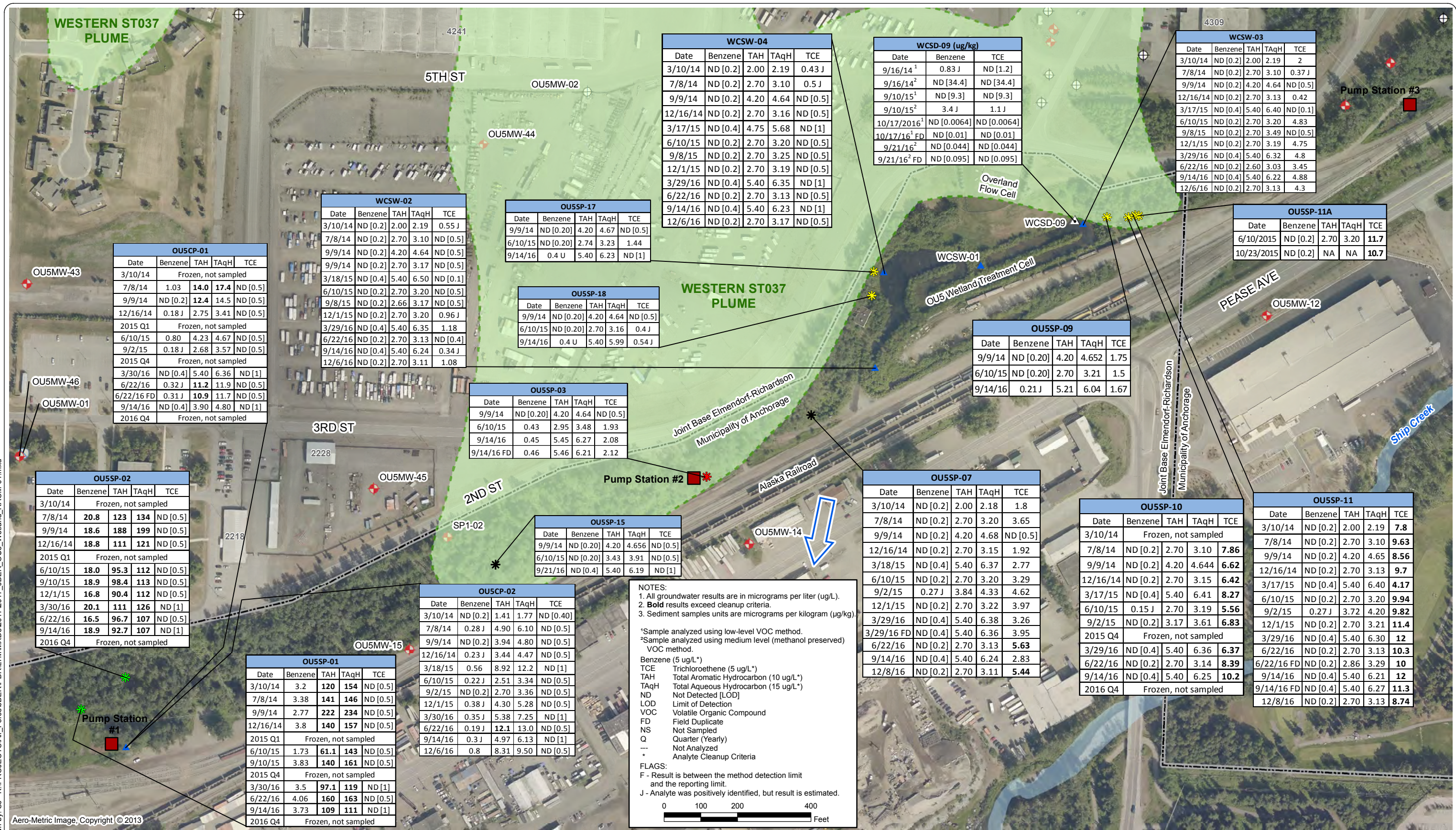
TAqH = total aqueous hydrocarbons

TCE = trichloroethene



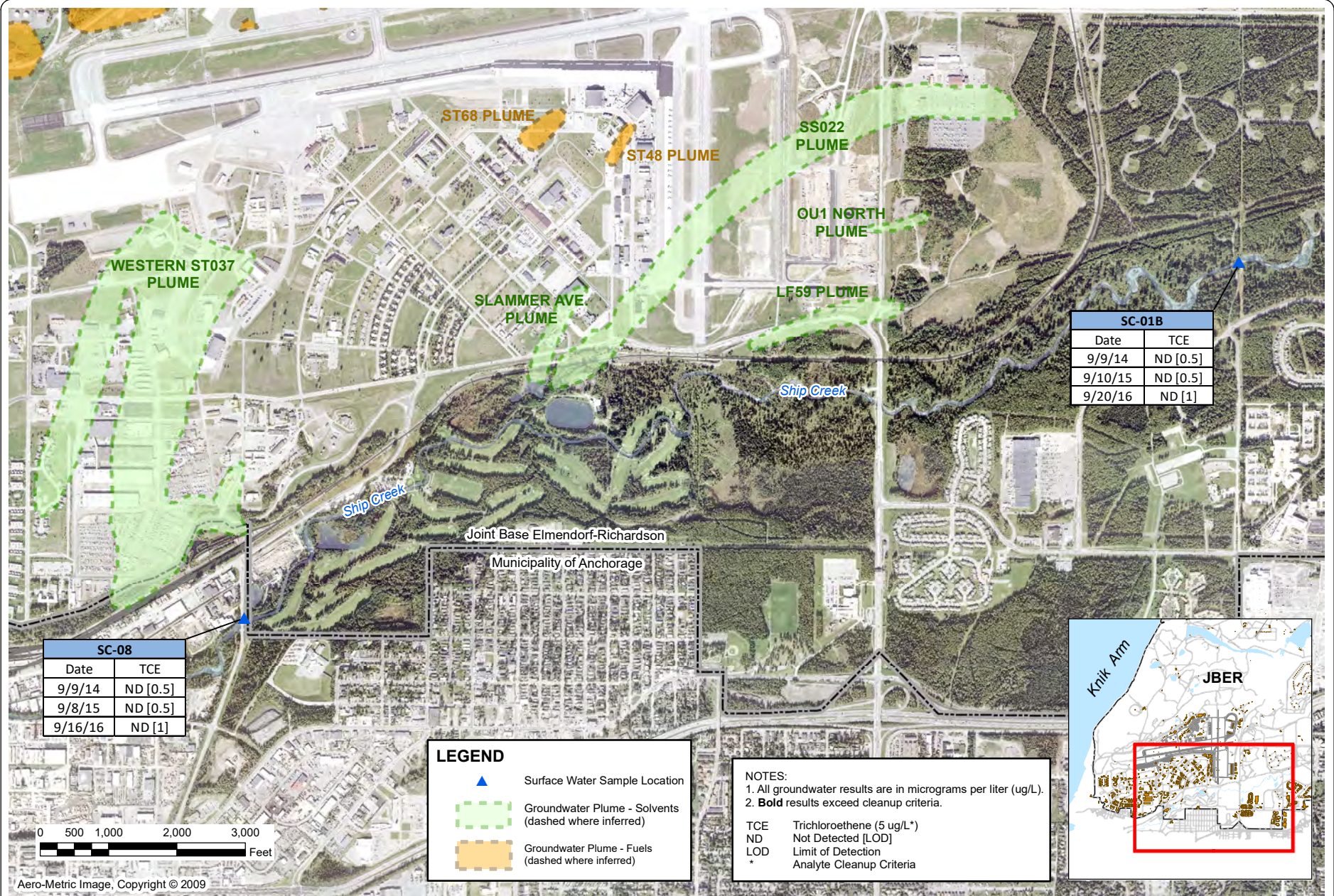
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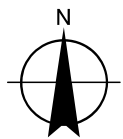


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Aero-Metric Image, Copyright © 2009



### SHIP CREEK SITE MAP WITH ANALYTICAL DATA

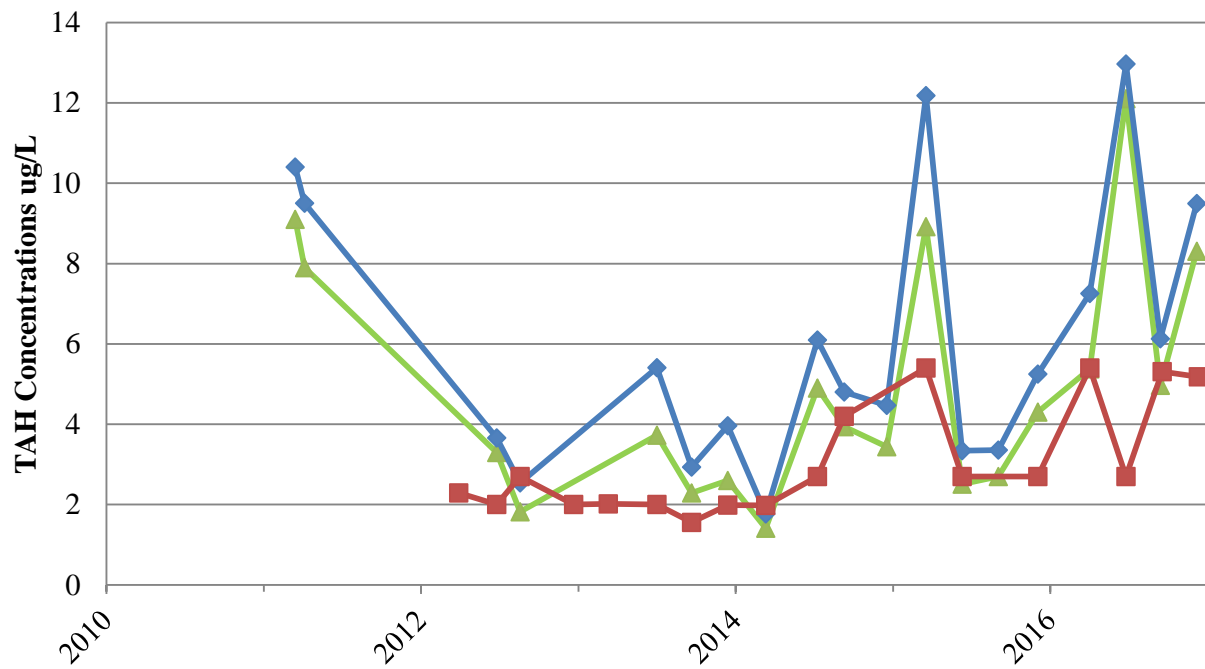
2016 Annual Remedial Action – Operations and Monitoring for Select CERCLA Sites  
 Joint Base Elmendorf-Richardson, Alaska

Figure

**12-8**

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Symbol	Well ID	M-K Concentration Trend
▲	OU5CP-02 TAH	Increasing Trend
◆	OU5CP-02 TAqH	Increasing Trend
■	BPSW-03 TAH	Increasing Trend

Cleanup Level  
 TAH = 10 µg/L  
 TAqH = 15 µg/L



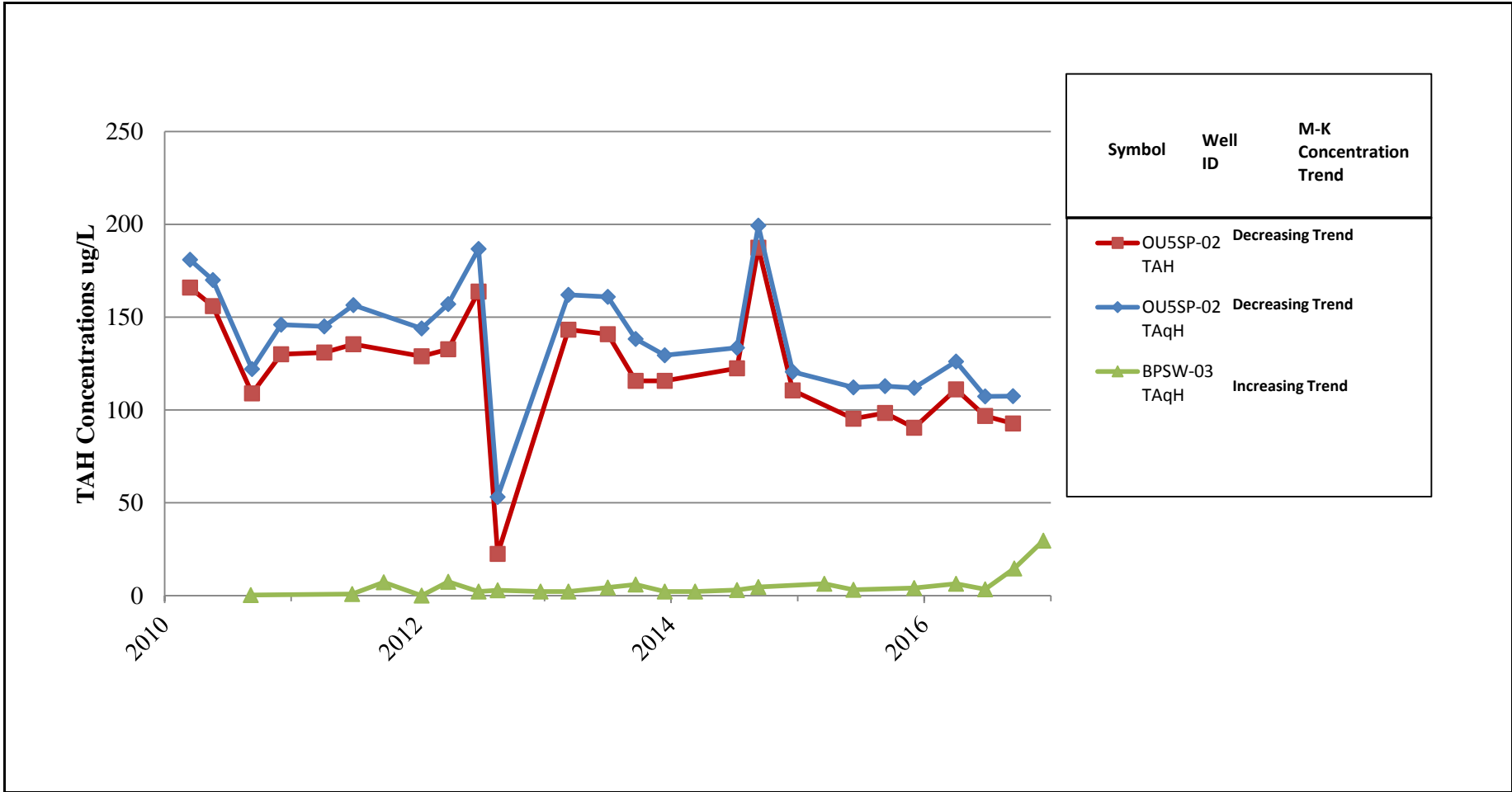
**OU5 TAH AND TAqH TRENDS IN SEEPS AND SURFACE WATER**

2016 Annual Field Activities Report, CERCLA Sites  
 Joint Base Elmendorf-Richardson, Alaska

Figure  
**12-9**

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Cleanup Level  
 TAH = 10 µg/L  
 TAqH = 15 µg/L



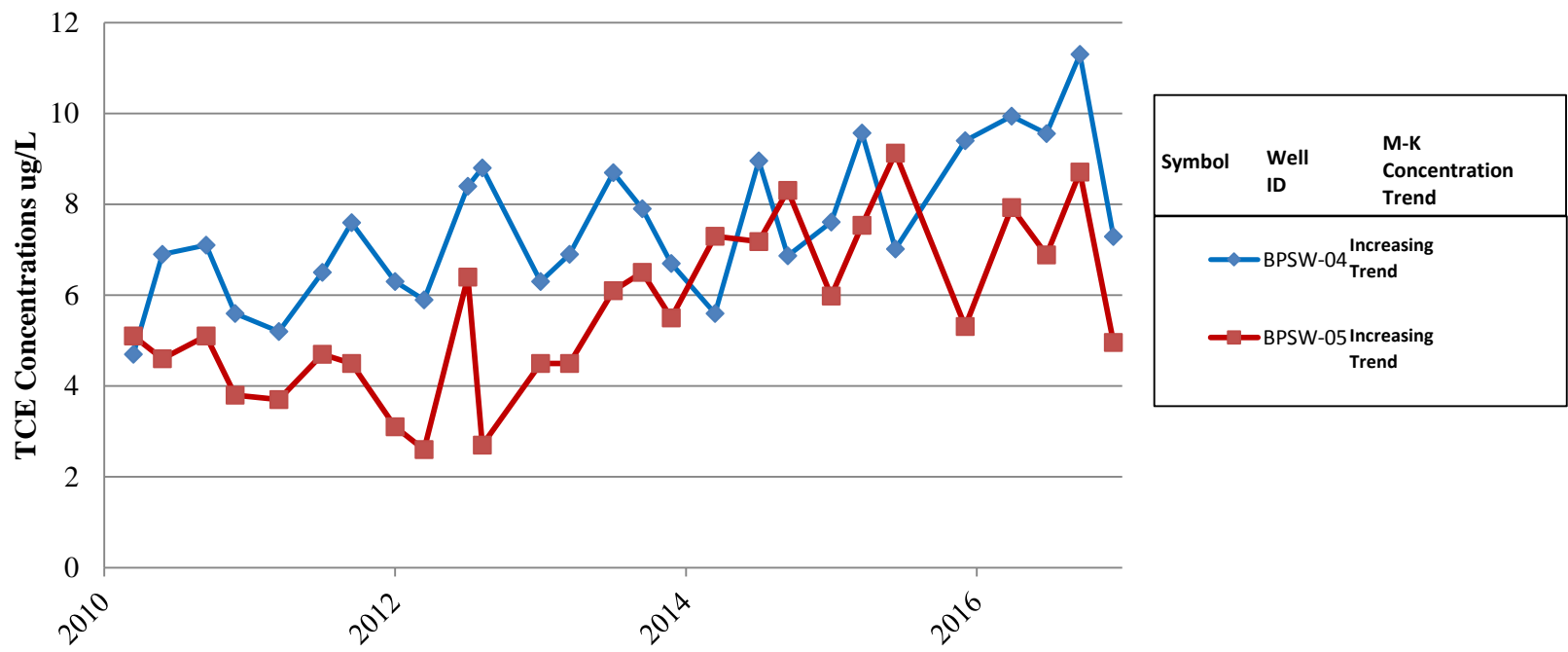
**OU5 TAH AND TAqH TRENDS IN OU5SP-02 and BPSW-03**

2016 Annual Field Activities Report, CERCLA Sites  
 Joint Base Elmendorf-Richardson, Alaska

Figure  
**12-10**

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Cleanup Level  
TCE = 5 µg/L



**BEAVER POND TCE TRENDS IN SURFACE WATER**

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Figure  
**12-11**

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## 12.6 EARLY WARNING AND SENTRY MONITORING WELL NETWORK

An Early Warning Monitoring Well network at OU5 was established in 2001 to provide early detection of contaminant plumes that may impact Ship Creek or other downgradient environmental receptors. This network was established based on contaminant migration time and the area hydrology to provide early warning of potential future downgradient impacts and to allow time for implementation of additional parameters to reduce the likelihood of contamination reaching the Sentry Wells. The Sentry Well network consists of 11 monitoring wells located downgradient of the Early Warning Monitoring Well network and OU5 plumes (Figure 12-12). Specifically, the Early Warning and Sentry Monitoring Well networks include the following:

- Early Warning Monitoring Wells: 516MW-02 (replacement of abandoned well 76WL-01), SP4/11-03, OU5MW-46, OU5MW-05, OU5MW-11, and OU5MW-45. Damaged well 76WL-01 was replaced in 2011 with well 516MW-02. In 2015, monitoring well OU5MW-46 replaced OU5MW-01 as an Early Warning well, which was decommissioned due to an obstruction in the monitoring well (USAF, 2015a).
- Sentry Monitoring Wells: 401WL-03, 401WL-04, NS3-02, SP2/6-05, OU5MW-09, OU5MW-10, OU5MW-12, OU5-MW13, OU5-MW14, OU5MW-31, and OU5MW-33.

The early warning and sentry well network is used to track chlorinated VOC concentrations in groundwater and detect TCE above the cleanup level (5 µg/L). Groundwater sampling occurs in order to identify if contaminant concentrations increase to levels that would potentially impact environmental receptors, such as Ship Creek.

### 12.6.1 2016 Field Activities and Results

For the first semiannual sampling event, a Passive Diffusion Bag Sampler (PDB) was placed in each Early Warning and Sentry monitoring well on June 20 and 21, 2016, and sampled on July 7, 2016. For the second semiannual sampling event, PDBs were placed on September 30, 2016 and October 3, 2016, and sampled on October 17, 2016. The PDBs were deployed for 16-17 days during the first sampling event and deployed for 14-17 days during the second sampling event. Each PDB was placed in the well in the middle of the screened water column. All groundwater samples collected from these wells were submitted to an analytical laboratory for analysis of VOCs.

In 2016, TCE concentrations at the Early Warning and Sentry Monitoring Wells were all below the OU5 ROD TCE groundwater cleanup level of 5 µg/L. Current and historical results are in Table 12-11 and on Figure 12-12.

**Table 12-11 Summary of 2016 Analytical Results for The Early Warning and Sentry Well Network**

Monitoring Well	TCE Result (µg/L)	TCE Result (FD) (µg/L)	TCE Result (µg/L)	TCE Result (FD) (µg/L)
	Deployed on June 20 and 21, 2016		Deployed on September 30, 2016 and October 3, 2016	
	Sampled on 7 July 2016		Sampled on 17 October 2016	
Cleanup Goal <sup>a</sup> (µg/L)	5 (µg/L)	5 (µg/L)	5 (µg/L)	5 (µg/L)
401WL-03	ND [0.5]	--	ND [0.5]	ND [0.5]
401WL-04	ND [0.5]	--	ND [0.5]	ND [0.5]
516MW-02	ND [0.5]	--	ND [0.5]	--
OU5MW-05	ND [0.5]	--	ND [0.5]	--
OU5MW-09	ND [0.5]	--	ND [0.5]	--
OU5MW-10	ND [0.5]	--	ND [0.5]	--
OU5MW-11	ND [0.5]	--	ND [0.5]	--
OU5MW-12	ND [0.5]	--	ND [0.5]	--
OU5MW-13	ND [0.5]	ND [0.5]	0.41 J	--
OU5MW-14	0.51 J	--	0.81 J	--
OU5MW-31	ND [0.5]	--	1.39	--
OU5MW-33	0.6 J	--	0.87 J	--
OU5MW-45	ND [0.5]	--	ND [0.5]	--
OU5MW-46	ND [0.5]	--	ND [0.5]	--
SP4/11-03	ND [0.5]	ND [0.5]	0.42 J	--
SP2/6-05	ND [0.5]	--	ND [0.5]	--
NS3-02	2.61	--	2.29	--

**Notes:**

<sup>a</sup> Cleanup levels as cited in the OU5 ROD (USAF, 1995c).

[ ] = limit of detection

µg/L = microgram(s) per liter

J = analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

FD = field duplicate

ND = non-detect [limit of detection]

TCE = trichloroethene



### **12.6.2 Early Warning and Sentry Wells Site Summary and Recommendations**

Analytical samples collected from Early Warning and Sentry Monitoring Wells in 2016 were all below the OU5 ROD groundwater cleanup level for TCE. Monitoring well OU5MW-01 was decommissioned in 2015 and monitoring well OU5MW-46 has become part of the Early Warning and Sentry Well network (USAF, 2017a). Sentry Well NS3-02 continues to show concentrations of TCE that may be attributed to the upgradient Slammer Avenue Plume and SS022 Plume.

## **12.7 ST037 SITE SUMMARY AND RECOMMENDATIONS**

The rate of TCE degradation at the site is slow. The attainment of cleanup goals at this site will likely occur primarily as a result of other natural attenuation mechanisms including dispersion, adsorption, and dilution. Recommendations from the 2010 investigation include, use of in situ treatment of contaminated groundwater by injection of chemicals that degrade TCE and excavation of shallow vadose zone source areas (if identified). Also recommended was soil vapor treatment for deeper vadose zone source areas, which may be appropriate to reduce the remediation time frame for source areas where current or future TCE concentration data indicate that remediation goals will not achieve cleanup goals within an acceptable time frame.

### **12.7.1 Five-Year Review**

Areas in OU5 that remain above cleanup goals are required to have CERCLA five-year reviews conducted until the cleanup goals are achieved. The purpose of the five-year review is to evaluate the implementation and performance of the remedial actions. There have been four five-year reviews conducted at JBER-E. The fourth five-year review recommended optimization of the early warning and sentry monitoring well network and optimization of the groundwater monitoring network as recommended by the *ST37 TCE Plume and Source Area Investigation Report* (USAF, 2011d). The review also recommended that OU5 seep locations be verified and clearly marked to ensure appropriate sampling in the future (USAF, 2014c). In 2014, seep locations at OU5 were resurveyed and marked. A VI evaluation (2016-2017) and sampling for 1,4-dioxane (2016) was conducted at this site and will be reported under a separate cover. This site was sampled for PFAS in 2016, which will also be reported separately.

### **12.7.2 Recommendations**

Based on the results of the 2010 investigation, five-year reviews and 2016 program sampling, the following recommendations are made for the ST037 site:

- Optimize the groundwater and surface water monitoring network at OU5 as recommended in Sections 12.3.2, 12.4.2, 12.5.4, and 12.6.2.
- Begin sampling 402WL-02 (formerly part of site SO552) for TCE as part of the ST037 long term monitoring sampling program.
- To help determine the extent of the Slammer Avenue and SS022 TCE Plumes, sample monitoring well SS37MW07 for TCE and PCE during the 2017 field season.
- Sample frequency to remain quarterly at the Beaver Pond Area for all surface water locations.

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## 13.0 ST041

PBC Performance Objective: Design and Implement an Optimized Exit Strategy for Site Closeout

Anticipated Achievement Date: 2020

### 13.1 SITE DESCRIPTION

JBER-E Site ST041 (known as Four-Million Gallon Hill) is an approximately 20-acre site located at the top of a ridge, east of the Knik Arm and north of Fairchild Avenue (Figure 13-1). In 1942, four one-million gallon USTs were installed and used to store aviation fuel for flight line operations. In 1991, these tanks were taken out of service. During the mid-1960s, an estimated 60,000 gallons of aviation gasoline spilled and in 1974, a UST was overfilled spilling 33,000 gallons of JP-4. No fuel was recovered from the gasoline spill, but 16,000 gallons of fuel were recovered from the JP-4 spill; the remainder infiltrated into the ground northwest of the tanks. Presently, two groundwater plumes (ST041 North and ST041 South) are tracked at the site (Figure 13-1).

#### 13.1.1 Geology and Hydrology

ST041 lies on the southern edge of the Elmendorf Moraine, which is 210 to 280 feet above mean sea level along the northeast-southwest trending ridgeline. Ground surface rises abruptly to the east and west of the tank locations to the top of small knolls. The grade to the north is approximately 10 percent and to the south is approximately 20 percent (USAF, 1998d).

The Elmendorf Moraine consists of laterally and vertically discontinuous, unconsolidated glacial till with poorly sorted boulders, gravel, sand, silt, and clay (USAF, 1993). In the ST041 area, the moraine material is approximately 10 to 20 feet bgs, and is not present on the flanks of the hill (USAF, 1998d) where a cover material consisting of silty sand to sandy silt is present (USAF, 1995a). The Bootlegger Cove Formation, generally consists of low permeability silts and clays, underlies the moraine and functions as an aquitard layer separating a shallow, unconfined aquifer from the deep, confined aquifer (USAF, 1995a). The Bootlegger Cove Formation is between 8 and 22.5 feet bgs and is up to 60 feet thick in the ST041 area (USAF, 1995a).

The glacial till material at the site includes layers of fine grained material and sand and gravel lenses that can create local confining layers or perched zones of groundwater (USAF, 1995a). A groundwater flow divide is present at the top of the hill, where groundwater flows northwest on the north side of the hill and south on the south side of the hill (USAF, 2001b). Groundwater levels range from approximately 35 feet bgs on the hilltop to 1 to 2 feet bgs on the north and south sides (USAF, 2001b). The average depth to groundwater is 15 feet bgs and the saturated interval averages 13 feet (USAF, 2001b). The north side of the hill, where groundwater discharges, is a marshy wetland area approximately 1 acre in size (USAF, 1998d). The south side of the hill drains to a drainage ditch (USAF, 1998d). In general, surface water drains south and west on the south side of the divide (USAF, 1993).

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## 13.2 REGULATORY REQUIREMENTS

The OU2 ROD identified BTEX as the groundwater COC for ST041 and is the basis for cleanup levels at the site. The ROD selected remedy included groundwater treatment system for groundwater and surface water and MNA (as described below) (USAF, 1995a). Free-product collection systems operated in the ST041 North plume from 1993 to 1999, after which collection activities ceased because recovery rates had diminished to negligible levels.

The selected remedy for ST041 groundwater includes the following major components:

- Monitoring the groundwater beneath and adjacent to the site to evaluate contaminant migration and timely reduction of contaminant concentrations by natural attenuation within twenty-one years. This will include five-year reviews to assess the protectiveness of the remedial action as long as contamination remains above unacceptable levels.
- Maintaining ICs that restrict access to groundwater and groundwater development at the site as long as hazardous substances remain on the site at levels that preclude unrestricted use.

The OU2 ROD identified BTEX as the groundwater monitoring COC at ST041, but by 1998 toluene and xylene were below cleanup levels, leaving benzene and ethylbenzene as the only two COCs that remain above cleanup levels. However, in the South Plume, toluene is still present above cleanup goals. The OU2 ROD identified only benzene, toluene, and ethylbenzene as the surface water monitoring COCs. The sum of benzene, toluene, and ethylbenzene results must also be below the surface water cleanup level (10 µg/L) to meet Alaska Water Quality Standards for TAH (USAF, 1995a).

Table 13-1 provides a list of the current groundwater COCs and the respective cleanup goals identified in the OU2 ROD (USAF, 1995ab). In addition, 18 AAC 75 Table C cleanup levels (ADEC, 2017) are included in the table for informational purposes.

Current monitoring requirements at ST041 include groundwater, seep, and surface water sampling and an annual LUC inspection. Groundwater sampling is required for the above COCs at monitoring wells ST41-16 (annually), ST41-25 (annually), ST41-28 (annually), ST41-10R (every two years), ST41-20 (every five years), ST41-30 (every five years), and ST41-34 (every five years). Seep ST41SP-01 is required to be sampled for site COCs every five years and surface water location ST41SW-13 annually for site COCs. LUCs are in place to prevent access and exposure to contaminated groundwater and soil at the site.

**Table 13-1 Cleanup Goals in Groundwater and Surface Water at ST041**

Contaminant of Concern	Medium	Cleanup Goal (µg/L)	ADEC Cleanup Level <sup>c</sup> (µg/L)
Benzene	Groundwater	5 <sup>a</sup>	4.6
Ethylbenzene		700 <sup>a</sup>	15
Toluene		1,000 <sup>a</sup>	1,100
Xylenes		10,000 <sup>a</sup>	190
TAH	Surface Water	10 <sup>b</sup>	--

**Notes:**

<sup>a</sup> Cleanup levels as cited in the OU2 ROD (USAF, 1995a).

<sup>b</sup> The sum of benzene, ethylbenzene, and toluene concentrations must also be below surface water criteria for TAH (10 µg/L) in accordance with Section 10.2.2 of the OU2 ROD (USAF, 1995a).

<sup>c</sup> 18 AAC 75 Table C Cleanup Levels (ADEC, 2017) are provided for informational purposes only..

µg/L = microgram(s) per liter

OU = Operable Unit

ROD = Record of Decision

TAH = total aromatic hydrocarbons

### 13.3 2016 FIELD ACTIVITIES AND RESULTS

During 2016, two monitoring wells from the South Plume (ST41-16 and ST41-25) and one well (ST41-10R) from the North Plume were sampled for BTEX compounds and MNA field parameters. One surface water sample was collected at the point of compliance downgradient of the North Plume (ST41SW-13) and was analyzed for BTEX. Monitoring well ST41-28 had free product measuring 0.29 feet so a sample was not collected and the product was bailed out.

Concentrations of benzene exceeded the cleanup level (5 µg/L) in monitoring wells ST41-16 (6,300 µg/L), ST41-25 (28.6 µg/L) and ST41-10R (32.4 µg/L). In the South Plume monitoring well ST41-16, concentrations of ethylbenzene (1,840 µg/L) and toluene (5,780 µg/L) exceeded OU2 ROD cleanup goals. Contaminants of concern did not exceed the cleanup level at the surface water point of compliance (ST41SW-13). Table 13-2 presents a summary of the 2016 analytical results and Table 13-3 presents a summary of the MNA field parameters. The 2016 and truncated historical results are on Figure 13-1. Historical results and Mann Kendall trend analysis results are in Appendix C and a summary of the Mann-Kendall analysis results are in Table 13-4. Mann-Kendall contaminant trend graphs are on Figure 13-2 through Figure 13-4.

The Mann-Kendall trend tests for toluene in well ST41-16 indicated statistically significant decreasing trends at the 95% confidence level.

A LUC inspection was performed for ST041 on September 21, 2016. During the inspection, the inner PVC casing of well ST41-10R was cut down so that the lid to the outer casing could be secured. Monitoring well ST41-30 remains unfound due to marshy area and overgrown groundcover. All other monitoring wells were secured and in good condition. The information kiosk is intact and accessible, but still needs some repairs and the information needs to be replaced because most of the photographs and text on the kiosk are faded and illegible. A copy of the 2016 LUC inspection form for ST041 is in Appendix B.

**Table 13-2 Summary of 2016 Analytical Results at ST041**

Analyte	Units	Cleanup Goal <sup>a</sup>	ST41-10R	ST41-16	ST41-25	ST41SW-13
Benzene	µg/L	5	<b>32.4</b>	<b>6,300</b>	<b>28.6</b>	ND [0.4]
Ethylbenzene	µg/L	700	129	<b>1,840</b>	47.6	ND [1]
Toluene	µg/L	1,000	2.16	<b>5,780</b>	4.11	ND [1]
Xylenes	µg/L	10,000	637	8,240	10.46	ND [3]
TAH	µg/L	10	--	--	--	5.4

**Notes:**

<sup>a</sup> Cleanup levels as cited in OU2 ROD (USAF, 1995a).

**Bold** result exceeds the ROD cleanup level

µg/L = microgram(s) per liter

[ ] = limit of detection

ND = non-detect [limit of detection]

TAH = total aromatic hydrocarbons

**Table 13-3 Summary of 2016 MNA Field Parameters at ST041**

MNA Field Parameters							
Monitoring Well ID	Volume Purged (gallons)	Temp (°C)	Specific Conductance <sup>a</sup> (mS/cm)	DO (mg/L)	pH	ORP (mV)	Turbidity (NTU)
ST41-10R	2.3	9.27	0.741	1.96	6.35	-16.7	6.8
ST41-16	2.5	10.58	1.62	0.41	6.39	-120.5	5.21
ST41-25	2.5	11.05	0.977	0.53	6.49	-97.9	7.73

**Notes:**

<sup>a</sup> Specific Conductance is a conductivity measurement that has been corrected to 25°C.

°C = degree(s) Celsius

DO = dissolved oxygen

ID = identification

mg/L = milligram(s) per liter

mS/cm = milliSiemen(s) per centimeter

mV = millivolt(s)

NTU = Nephelometric Turbidity Units

ORP = oxidation-reduction potential

**Table 13-4 Summary of 2016 Mann-Kendall Concentration Trends for Select Wells at ST041**

Monitoring Well ID	Benzene	Ethylbenzene	Toluene	Total Xylenes
ST41-10R	NST <sup>a</sup>	NE	NE	NE
ST41-16	NST <sup>b</sup>	NST <sup>a</sup>	Decreasing	NE
ST41-25	NST <sup>a</sup>	NE	NE	NE

**Notes:**

<sup>a</sup> Stable according to MAROS convention

<sup>b</sup> Probably decreasing according to MAROS convention (90-95% confidence; S < 0)

ID = identification

NE = no exceedance of cleanup goal in 2016



## 13.4 SITE SUMMARY AND RECOMMENDATIONS

During 2016, the three monitoring wells sampled had concentrations of contaminants that exceeded cleanup goals. The Mann-Kendall trend tests for all analytes in all monitoring wells sampled indicated statistically significant decreasing trends at the 95 percent confidence level.

### 13.4.1 Five-Year Review

Areas in OU2 that remain above cleanup goals are required to have CERCLA five-year reviews conducted until the cleanup goals are achieved. The purpose of the five-year review is to evaluate the implementation and performance of the remedial actions. There have been four five-year reviews conducted at JBER-E. The fourth five-year review report recommended that maintenance be performed on monitoring well ST41-25, which showed signs of frost heaving during site inspection activities and reevaluate the sampling frequency for monitoring well ST41-10R based on the decision guide for monitoring well sampling frequency at OU2 provided in the *2011 Memorandum to the Site File: Operable Unit 2* (USAF, 2014c).

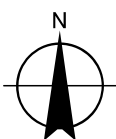
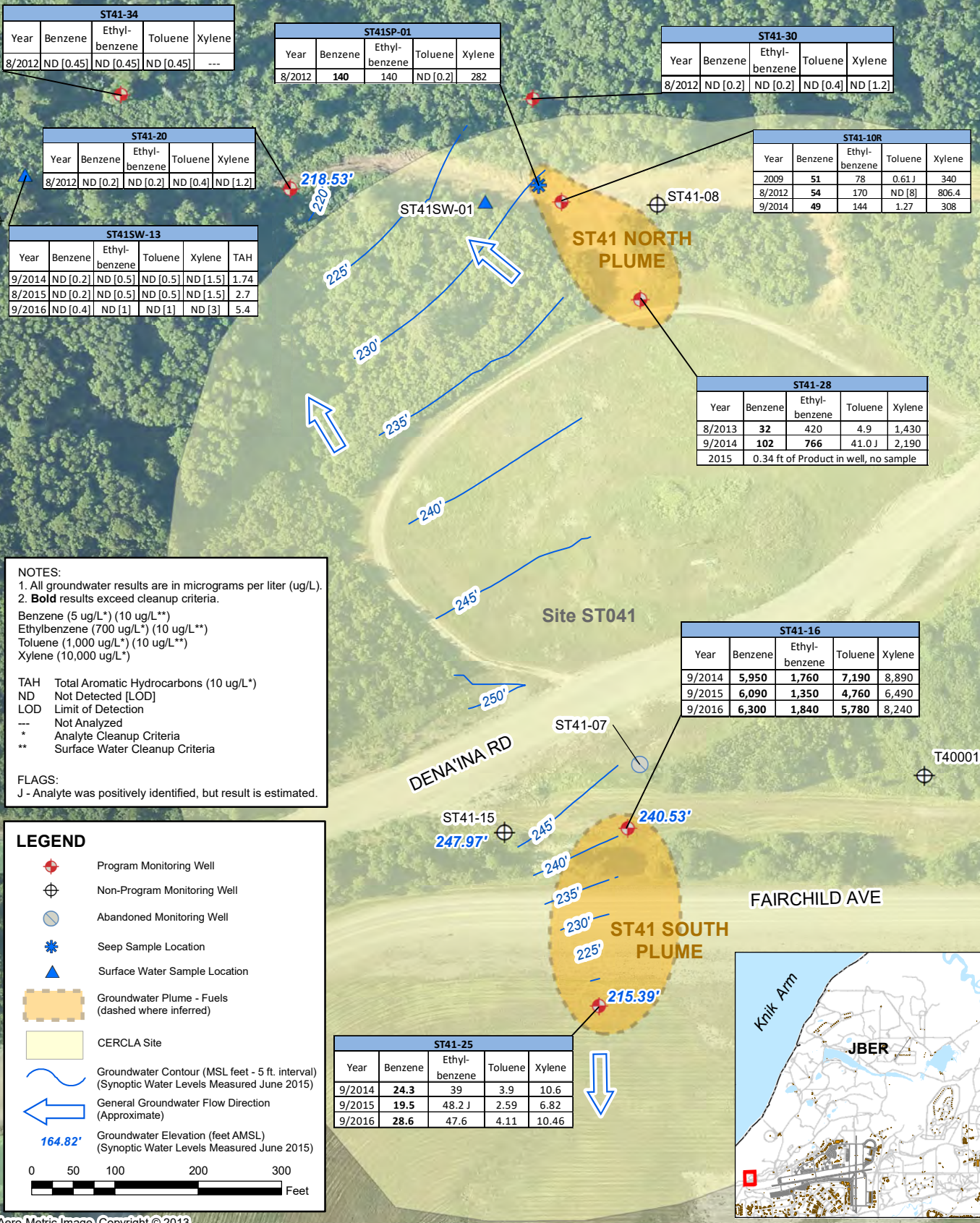
### 13.4.2 Recommendations

Site ST041 is identified as a **Yellow** priority because contaminant concentrations continue to exceed ROD cleanup goals but do not show an increasing trend. It is recommended to keep sample frequency consistent for 2017 and continue LUC inspections. It is also recommended that the information and the Plexiglas of the kiosk be replaced. A work plan has been submitted to conduct a treatability study to assess the effectiveness of in situ treatment for reducing benzene, toluene, and ethylbenzene concentrations in the South Plume and using an oxygen-releasing compound to enhance natural attenuation. Additionally, the treatability study will evaluate injection hydraulics and radius of influence of the injections for use in designing a full-scale treatment design, if needed.

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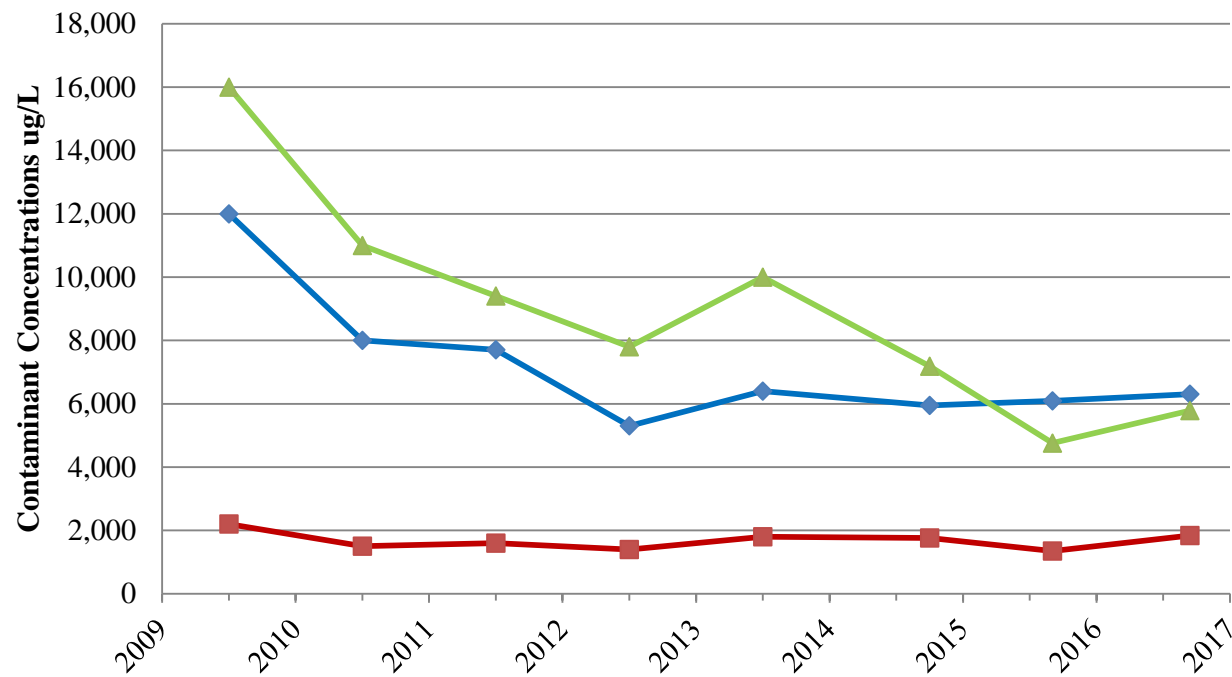
### ST041 SITE MAP WITH ANALYTICAL DATA

2016 Annual Remedial Action - Operations and Monitoring for Select CERCLA Sites  
 Joint Base Elmendorf-Richardson, Alaska

Figure  
**13-1**

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Symbol	ID	M-K Concentration Trend
	Benzene	No Significant Trend*
	Ethylbenzene	No Significant Trend; Stable**
	Toluene	Decreasing Trend

\*Probably decreasing based on MAROS decision matrix

\*\*Stable based on MAROS convention; COV < 1

Cleanup Levels  
 Benzene = 5 µg/L  
 Ethylbenzene = 700 µg/L  
 Toluene = 1,000 µg/L  
 Xylenes = 10,000 µg/L



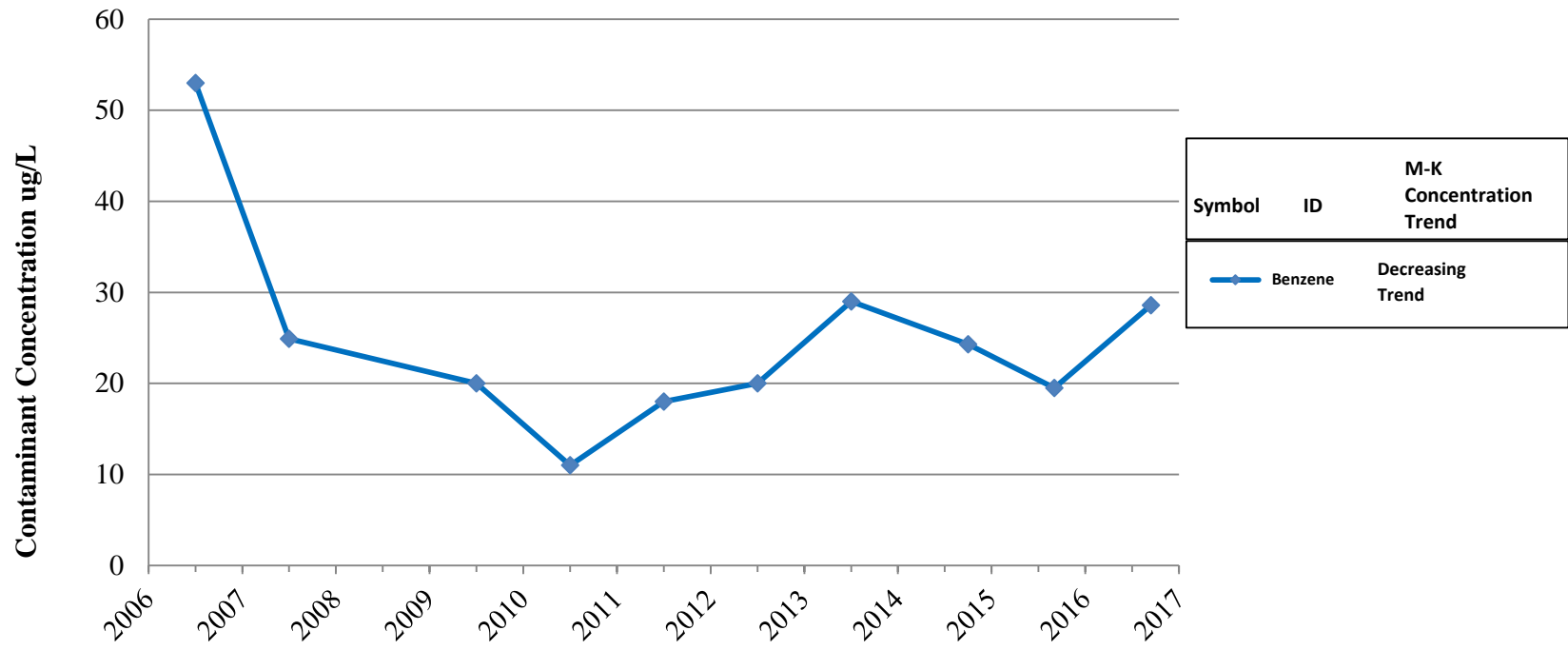
**ST041 CONTAMINANT TRENDS IN ST41-16**

2016 Annual RA-O and Monitoring Report, Select CERCLA Sites  
 Joint Base Elmendorf-Richardson, Alaska

Figure  
**13-2**

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Cleanup Levels  
Benzene = 5 µg/L



**ST041 BENZENE TREND IN ST41-25**

2016 Annual RA-O and Monitoring Report, Select CERCLA Sites  
Joint Base Elmendorf-Richardson, Alaska

Figure  
**13-3**

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## 14.0 WP014

PBC Performance Objective: Design and Implement an Optimized Exit Strategy for Site Closeout

Anticipated Achievement Date: 2020

### 14.1 SITE DESCRIPTION

WP014 is a 400-foot by 300-foot area located a few hundred feet east of LF004 South (Figure 14-1). Petroleum hydrocarbon contamination at this site originated between 1964 and 1968 when the area was used for fuel tank sludge disposal generated from POL tank cleaning operations. Fuel filters and pads were also weathered on the ground surface in a broad area of vegetated soil. Local soil was reportedly used to cover the site after disposal operations ceased. Soil and groundwater contamination may also be associated with the former PL81 Valve Pit 11, which was approximately 100 feet northeast of WP014 and west-southwest of 14MW-120. In 2005, petroleum contaminated vadose-zone soils were excavated from the former location of PL81 Valve Pit 11, as outlined in the PL81 DD (USAF, 2005b).

Two plumes (WP014 and OU6MW-46) are managed within WP014 (Figure 14-1). The WP014 plume encompasses groundwater contamination derived from WP014 and PL081. The plume migrates westerly toward LF004 and discharges at two seeps overlooking Knik Arm, a distance of approximately 1,000 feet from the WP014 and PL081 source areas. The PL081 DD states that all groundwater contamination attributable to PL081 will be managed by the OU6 ROD. Therefore, groundwater contamination associated with PL081 is monitored as part of the LF004 South and WP014 groundwater monitoring program. The second WP014 plume (OU6MW-46 plume) is a smaller plume cross-gradient from the WP014 source area and is monitored with one monitoring well (OU6MW-46) in a perched groundwater aquifer. In 2011, an attempt was made to install a downgradient monitoring well to define the extent of the OU6MW-46 plume. During drilling activities, the same groundwater unit was not found and there was insufficient groundwater volume to install a monitoring well. It was determined that the OU6MW-46 plume is likely located within a perched aquifer and is not connected to the WP014 plume (USAF, 2011e).

#### 14.1.1 Geology and Hydrology

WP014 is located on the Elmendorf End Moraine. Soils at WP014 generally consist of poorly sorted silty sands and gravels with discontinuous clay layers. A denser silty sand and gravelly clay was documented at deeper intervals starting at 55 feet bgs in OU6MW-78 (USAF, 1996). To the southeast, dense silty clay and clay intervals have been documented at shallower depths of 15 feet down to 30 feet bgs (USAF, 1996) and become more predominant at shallow depths surrounding the OU6MW-46 Plume (USAF, 2011e). The far northern portion of the site is dominated by sand and silty sand. Clay layers were reported at OU6MW-75 between 30 and 65 feet bgs. Overall, the central portion of the plume is dominated by sand and silty sand with discontinuous silty clay layers documented at approximately 30 feet bgs, while to the southeast, discontinuous silty clay

layers are documented at a shallower depth. The subsurface materials observed are consistent with the description of glacial moraine deposits.

Depth to water in the upper aquifer ranges from a 12.2 feet bgs at the eastern portion of the site in OU6MW-60 and deepens westward to a maximum depth measured in OU6MW-93 of 56.04 feet bgs. The eastern portion of the site has a southwest groundwater gradient of 0.087 ft/ft, which decreases to 0.077 ft/ft westward toward the bluff. The southern portion of the site has a shallower overall gradient, which is 0.051 ft/ft in the area surrounding 14MW-121.

As shown on Figure 14-1, the shallow groundwater gradient changes direction from a southwest to a westerly gradient toward the bluff, which is located approximately 75 feet west of OU6MW-67. During the June 2015 sampling event, the water table elevation was measured at a greater elevation than the top of screen interval in OU6MW-67. This monitoring well appears to be screened in a semi-confined aquifer as suggested by the boring and well log. Two prominent seeps (LF04SP-03 and LF04-04) exist at lower elevations on the bluff. No higher elevation groundwater discharge points on the bluff have been located, suggesting that the two aquifers converge before discharging at the seep locations.

Both the upper and lower aquifers are underlain by the Bootlegger Cove Formation, which functions as a confining layer for an even deeper aquifer (and extends under most of JBER-E). The Bootlegger Cove Formation has not been definitively encountered under WP014. There is no communication between shallow and deep aquifer below the Bootlegger Cove Formation in the area of investigation.

## 14.2 REGULATORY REQUIREMENTS

The groundwater COCs at WP014 were identified as benzene, ethylbenzene, and toluene in the OU6 ROD, which is the basis for cleanup levels at the site. The ROD included long-term monitoring in the selected remedy for groundwater (USAF, 1997b). In 2003, the OU6 Memorandum to the Site File modified the sampling frequency at WP014 (USAF, 2003e).

Table 14-1 provides a list of the current groundwater COCs and the respective cleanup goals identified in the OU5 ROD (USAF, 1997b). In addition, 18 AAC 75 Table C cleanup levels (ADEC, 2017) are included in the table for informational purposes.

The groundwater remedy described in the OU6 ROD (USAF, 1997b) consists of the following:

- Institutional controls on land and water use to restrict access to contaminated groundwater throughout WP014.
- Groundwater will be monitored semi-annually and evaluated annually to determine contaminant migration and to track the progress of contaminant degradation and dispersion, as well as to provide an early indication of unforeseen environmental or human health risk. Five-year reviews will also assess the protectiveness of the remedial action, including an evaluation of any changed site conditions. Recoverable quantities of free

product found on top of the water table at WP014 will be regularly removed during groundwater monitoring events.

- Groundwater monitoring will be discontinued if contaminant levels are below cleanup levels for two consecutive groundwater monitoring events.
- During the final round of monitoring, samples will be collected and analyzed for all constituents that exceeded maximum contaminant levels during the original 1994 investigation.

Current groundwater sampling is required for the site COCs at monitoring wells OU6MW-46 (every 2 years), 14MW-120 (every 5 years), 14MW-121 (every 5 years), OU6MW-13 (every 5 years), OU6MW-91 (every 2 years), OU6MW-92 (annually), and OU6MW-93 (annually). Quarterly seep sampling is required for the above COCs at seeps LF04SP-03 and LF04SP-04. LUCs are in place to prevent access and exposure to contaminated groundwater and no further action is required for soil at the site. Table 14-1 provides the COCs and cleanup goals in groundwater at the site.

**Table 14-1 Cleanup Goals in Groundwater at WP014**

Contaminant of Concern	Cleanup Goal <sup>a</sup> (µg/L)	ADEC Cleanup Level <sup>b</sup> (µg/L)
Benzene	5	4.6
Ethylbenzene	700	15
Toluene	1,000	1,100

**Notes:**

<sup>a</sup> Cleanup levels as cited in the OU6 ROD (USAF, 1997b).

<sup>b</sup> 18 AAC 75 Table C Cleanup Levels (ADEC, 2017) are provided for informational purposes only.

µg/L = microgram(s) per liter

OU = Operable Unit

ROD = Record of Decision

### 14.3 2016 FIELD ACTIVITIES AND RESULTS

During 2016, monitoring wells OU6MW-46, OU6MW-92, OU6MW-93, and OU6MW-94 were sampled for VOCs and MNA field parameters. Monitoring wells OU6MW-12, OU6MW-13, OU6MW-92, OU6MW-93, and OU6MW-94 were also sampled for 2-methylnaphthalene. Monitoring well OU6MW-91 was not sampled because 0.02 feet of free product was present in the well and monitoring well OU6MW-94 was sampled as a replacement well. The product levels for monitoring well OU6MW-77 were measured at 0.01 feet thick. Free product was not removed from either well because it was impractical to remove such small amounts. Seeps LF04SP-03 and LF04SP-04 were sampled quarterly for VOCs and one field duplicate sample was collected from LF04SP-04 in the fourth quarter. These seeps were also analyzed for PAHs in the third and fourth quarters to calculate TAH and TAqH.

Monitoring wells OU6MW-12 and OU6MW-92 were pumped dry and grab samples were collected the following day using a bailer. Field parameters were not measured when the grab samples were collected due to limited volume. Because these wells are screened across the

saturated zone in low permeability formations and that they were bailed dry during purging, groundwater recharge to the well will tend to occur throughout the saturated zone of the formation. Recharge could be expected to cascade down the filter pack as a thin film and would result in a potential low bias for VOCs. These wells would be a good candidate for PDB sampling.

Monitoring wells OU6MW-12, OU6MW-13, OU6MW-92, OU6MW-93, and OU6MW-94 were also sampled for 2-methylnaphthalene to determine if current concentrations present an unacceptable risk as per the fourth five-year review (USAF, 2014c). All concentrations of 2-methylnaphthalene (4.66 µg/L to 24.2 µg/L) detected in groundwater were below the ADEC 18 AAC 75 Table C cleanup level (36 µg/L) and do not pose a risk to human health or the environment.

Concentrations of benzene exceeded the cleanup goal in monitoring wells OU6MW-46 (137 µg/L) and OU6MW-92 (82.3 µg/L). Concentrations of benzene also exceeded the cleanup goal in seep LF04SP-03 during the third quarter and seep LF04SP-04 in the first, second and third quarters. Table 14-2 presents a summary of the 2016 analytical results and Table 14-3 presents a summary of the MNA field parameters. The 2016 and truncated historical results are on Figure 14-1. Historical results and Mann Kendall trend analysis results are in Appendix C and a summary of the Mann-Kendall analysis results are in Table 14-4. Mann-Kendall contaminant trend graphs are on Figure 14-2 and Figure 14-3.

The Mann-Kendall trend tests for benzene and ethylbenzene in well OU6MW-92 indicated no statistically significant trend at the 95% confidence level and ethylbenzene concentrations are considered stable under the MAROS decision matrix. A statistically significant decreasing trend was identified for benzene in seep LF04SP-03. No statistically significant trend for benzene was identified in the seep LF04SP-04 and monitoring well OU6MW-46.

A LUC inspection was performed for WP014 on September 21, 2016. During the inspection, the inner PVC casing of well OU6MW-46 was cut down so that the lid to the outer casing could be secured. All other wells were secure and in good condition except for previously noted well OU6MW-05, which is bent over. A copy of the 2016 LUC inspection form for WP014 is in Appendix B.

**Table 14-2 Summary of 2016 Analytical Results at WP014**

Analyte	Units	Cleanup Goal <sup>a</sup>	LF04SP-03 (Q1)	LF04SP-03 (Q2)	LF04SP-03 (Q3)	LF04SP-03 (Q4)	LF04SP-04 (Q1)	LF04SP-04 (Q2)	LF04SP-04 (Q3)	LF04SP-04 (Q4)
Benzene	µg/L	5	0.19 J	2.63	<b>5.08</b>	0.66	<b>5.18</b>	<b>5.29</b>	<b>5.01</b>	4.28
Ethylbenzene	µg/L	700	ND [1]	ND [0.5]	ND [1]	ND [0.5]	16.4	21.2 J	20.4	16.3
Toluene	µg/L	1,000	ND [1]	ND [0.5]	ND [1]	ND [0.5]	0.66 J	0.89 J	0.76 J	0.69 J
TAH <sup>b</sup>	µg/L	10	5.19	5.13	<b>10.1</b>	3.16	<b>78.5</b>	<b>105</b>	<b>96.9</b>	<b>80.7</b>
TAqH <sup>b</sup>	µg/L	15	--	--	11.0	3.60	--	--	<b>111</b>	<b>84.7</b>
2-Methylnaphthalene	µg/L	36 <sup>c</sup>	--	--	ND [0.0581 J]	ND [0.0274]	--	--	9.24	4.66
Analyte	Units	Cleanup Goal <sup>a</sup>	LF04SP-04 (Q4)(FD)	OU6MW-12 <sup>c</sup>	OU6MW-13	OU6MW-46	OU6MW-92 <sup>c</sup>	OU6MW-93	OU6MW-94	
Benzene	µg/L	5	4.85	--	--	<b>137</b>	<b>82.3</b>	ND [0.4 J]	2.33	
Ethylbenzene	µg/L	700	18.7	--	--	440	481	1.16 J	618	
Toluene	µg/L	1,000	0.72 J	--	--	15.6	26.1	ND [1 J]	15.7	
TAH <sup>b</sup>	µg/L	10	<b>91.5</b>	--	--	--	--	--	--	
TAqH <sup>b</sup>	µg/L	15	<b>96.2</b>	--	--	--	--	--	--	
2-Methylnaphthalene	µg/L	36 <sup>c</sup>	5.8	8.68	ND [0.0556]	--	7.44 J	ND [0.0515]	24.2	

**Notes:**

<sup>a</sup> Cleanup levels as cited in the OU6 ROD (USAF, 1997b).

<sup>b</sup> Alaska Water Quality Standards (18 AAC 70) for TAH and TAqH are 10 µg/L and 15 µg/L, respectively.

<sup>c</sup> Well is very slow to recharge and was pumped dry. A groundwater sample was collected the following day using a bailer.

**Bold** result exceeds cleanup level

[ ] = limit of detection

J = analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

µg/L = microgram(s) per liter

FD = field duplicate

ND = non-detect [limit of detection]

Q = quarter



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**Table 14-3 Summary of 2016 MNA Field Parameters at WP014**

MNA Field Parameters							
Monitoring Well ID	Volume Purged (gallons)	Temp (°C)	Specific Conductance <sup>b</sup> (mS/cm)	DO (mg/L)	pH	ORP (mV)	Turbidity (NTU)
OU6MW-12 <sup>a</sup>	Grab Sample Collected						
OU6MW-46	1.8	9.1	0.958	8.2	7.54	-70.4	240
OU6MW-92 <sup>a</sup>	Grab Sample Collected						
OU6MW-93	2.3	8.11	1.035	1.44	7.54	11.3	67.39
OU6MW-94	1.1	7.7	0.562	0.59	6.5	21.7	6.44

**Notes:**

<sup>a</sup> Well is very slow to recharge and was pumped dry. A groundwater sample was collected the following day using a bailer.

<sup>b</sup> Specific Conductance is a conductivity measurement that has been corrected to 25°C.

°C = degree(s) Celsius

DO = dissolved oxygen

ID = identification

mg/L = milligram(s) per liter

mS/cm = milliSiemen(s) per centimeter

mV = millivolt(s)

NTU = Nephelometric Turbidity Units

ORP = oxidation-reduction potential

**Table 14-4 Summary of 2016 Mann-Kendall Concentration Trends for Select Wells at WP014**

Monitoring Well ID	Benzene	Ethylbenzene
LF04SP-03	Decreasing	NE
LF04SP-04	NST	NE
OU6MW-46	NST <sup>b</sup>	NST
OU6MW-92	NST <sup>a</sup>	NST <sup>a</sup>

**Notes:**

<sup>a</sup> Stable according to MAROS convention

<sup>b</sup> Probably decreasing according to MAROS convention (90-95% confidence;  $S < 0$ )

ID = identification

NE = no exceedance of cleanup goal in 2015

NST = no significant trend



## 14.4 SITE SUMMARY AND RECOMMENDATIONS

The 2016 results are consistent with the plume in the shallow aquifer extending from the WP014 site to discharge at seeps LF04SP-03 and LF04SP-04 on the bluff overlooking Knik Arm. Dissolved benzene concentrations are likely maintained by ongoing dissolution of residual product in the smear zone and will continue to be present until the residual product attenuates.

Downgradient of the WP014 Plume, COCs in seep LF04SP-03 show variability over time. The benzene level was above the cleanup goals during only one of four quarterly sampling events in 2016. Seep LF04SP-04 has been sampled quarterly since 2013 as the benzene concentrations continue to exceed the OU6 ROD cleanup goal of 5µg/L. In 2016, benzene concentrations continued to exceed the cleanup level in the first, second and third quarters. The seeps are expected to continue to exhibit variability in benzene concentrations while the core of the WP014 plume attenuates and possibly migrates westward. The TAH levels exceeded the 18 AAC 70 Alaska Water Quality Standard (10 µg/L) at seep LF04SP-04 for each of the quarterly sampling event and TAqH levels exceeded the Alaska Water Quality Standard (15 µg/L) in the third and fourth quarters. The TAH and TAqH levels in seep LF04SP-03 did not exceed either standard during any sampling event.

Concentrations of benzene in seep LF04SP-03 show seasonal variability with higher concentrations occurring during Q2 (summer) and Q3 (fall) and lower concentrations Q1 (spring) and Q4 (winter). This may be attributed to more water moving through the formation during Q2 and Q3 than during Q1 and Q4. Seep LF04SP-04 does not show appreciable fluctuation in benzene concentrations between quarterly sampling events.

Upgradient of the WP014 plume, the sources have been removed and no additional upgradient sources are anticipated. The remaining contaminants appear to have moved past monitoring well 14MW-120 in 2007, suggesting it is on the upgradient edge of the plume. Current observations are consistent with the hypothesis that product remains in the contaminated smear zone at residual saturation and is now generally immobile, degrading, and dissolving in place (USAF, 2008b). Contaminant fluctuations in the in-plume monitoring wells will continue as varying water levels control the degree of interaction with the contaminated smear zone, and minor mobility of residual product can lead to the accumulation of free product in monitoring wells as shown by the recent measurement of free product in OU6MW-91 and in OU6 MW-77.

### 14.4.1 Five-Year Review

Areas in OU6 that remain above cleanup goals are required to have CERCLA five-year reviews conducted until the cleanup goals are achieved. The purpose of the five-year review is to evaluate the implementation and performance of the remedial actions. There have been four five-year reviews conducted at JBER-E. The fourth five-year review recommended groundwater sampling for 2-methylnaphthalene to determine whether current concentrations present an unacceptable risk (USAF, 2014c).

#### 14.4.2 Recommendations

Site WP014 is identified as a **Yellow** priority since contaminant concentrations continue to exceed ROD cleanup goals. Two seeps and five monitoring wells were sampled for 2-methylnaphthalene and all concentrations were either non-detect or below the ADEC cleanup level. Therefore, 2-methylnaphthalene does not show unacceptable risk at the site and sampling for that constituent should be discontinued. Monitoring wells OU6MW-12 and OU6MW-92 are located in low permeability formations and are bailed dry every year during well purging activities. Since recharge is slow and could be expected to cascade down the filter pack as a thin film, resulting in a potential low bias for VOCs, these wells could be sampled by PDB samplers. It is also recommended that the damaged monitoring well OU6MW-05 decommissioned.

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LF04SP-04				
Year	Benzene	Ethyl-benzene	Toluene	
3/2014	2.7	6.9	0.41	J
7/2014	0.380	J	0.870	J
9/2014	<b>5.12</b>	16.2	ND	[0.8]
12/2014	<b>5.03</b>	ND	[0.5]	0.71
3/2015	4.31	11.9	0.61	F
6/2015	<b>5.09</b>	18.1	ND	[0.5]
9/2015	4.71	18.6	0.85	J
12/2015	<b>5.28</b>	17.0	0.77	J
3/2016	<b>5.18</b>	16.4	0.66	J
6/2016	<b>5.29</b>	21.2	0.89	J
9/2016	<b>5.01</b>	20.4	0.76	J
12/2016	4.28	16.3	0.69	J
12/2016 FD	4.85	18.7	0.72	J

LF04SP-03						
Year	Benzene	Ethyl-benzene	Toluene			
3/2014	4.3	ND	[0.20]	ND	[0.50]	
7/2014	<b>14.8</b>	ND	[0.5]	ND	[0.5]	
9/2014	0.340	J	ND	[0.5]	ND	[0.5]
12/2014	3.29	ND	[0.5]	ND	[0.5]	
3/2015	4.51	ND	[1]	ND	[1]	
6/2015	<b>17.6</b>	ND	[0.5]	ND	[0.5]	
9/2015	<b>12.4</b>	ND	[0.5]	ND	[0.5]	
12/2015	ND	[0.2]	ND	[0.5]	ND	[0.5]
3/2016	0.19	J	ND	[1]	ND	[1]
6/2016	2.63	ND	[0.5]	ND	[0.5]	
9/2016	<b>5.08</b>	ND	[1]	ND	[1]	
12/2016	0.66	ND	[0.5]	ND	[0.5]	

OU6MW-93						
Year	Benzene	Ethyl-benzene	Toluene			
11/2014	0.22	ND	[0.5]	ND	[0.5]	
6/2015	ND	[0.4]	ND	[1]	0.59	J
9/2016	0.4	UJ	1.16	J	1	UJ

14MW-121				
Year	Benzene	Ethyl-benzene	Toluene	
8/2012	1	73	55	
6/2015	4.89	50.9	85.8	

14MW-120				
Year	Benzene	Ethyl-benzene	Toluene	
8/2012	3.6	20	24	
6/2015	3.66	55.3	50.2	

OU6MW-46				
Year	Benzene	Ethyl-benzene	Toluene	
2011	<b>520</b>	<b>1,100</b>	70	
8/2013	<b>160</b>	<b>910</b>	45	J
9/2016	<b>137</b>	<b>440</b>	<b>15.6</b>	

OU6MW-91				
Year	Benzene	Ethyl-benzene	Toluene	
8/2013	2.1	490	50	
2015	0.28 feet of product, no sample			
2016	0.02 feet of product, no sample			

OU6MW-13						
Year	Benzene	Ethyl-benzene	Toluene			
8/2012	ND	[0.2]	ND	[0.4]		
6/2015	ND	[0.4]	ND	[1]	0.56	J

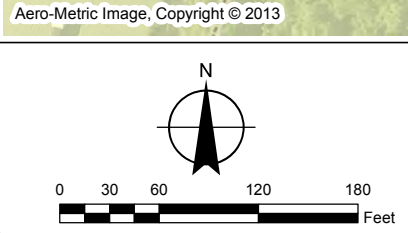
OU6MW-94				
Year	Benzene	Ethyl-benzene	Toluene	
9/2016	<b>2.33</b>	<b>618</b>	<b>15.7</b>	

OU6MW-92				
Year	Benzene	Ethyl-benzene	Toluene	
11/2014	<b>46.3</b>	518	6.72	
6/2015	<b>66.8</b>	340	24.6	
9/2016	<b>82.3</b>	<b>481</b>	<b>26.1</b>	

**NOTES:**  
 1. All groundwater results are in micrograms per liter (ug/L).  
 2. **Bold** results exceed cleanup criteria.  
 Benzene (5 ug/L\*)  
 Ethylbenzene (700 ug/L\*)  
 Toluene (1,000 ug/L\*)

ND Not Detected [brackets indicate the MDL for 2008 and earlier, the PQL for 2009, and the LOD for 2010 and 2016].  
 LOD Limit of Detection  
 PQL Practical Quantification Limit  
 FD Field Duplicate  
 \* Analyte Cleanup Criteria

**FLAGS:**  
 J - Analyte was positively identified, but the result is estimated.



**LEGEND**

- Program Monitoring Well
- Non-Program Monitoring Well
- Abandoned Monitoring Well
- Seep Sample Location
- Groundwater Plume - Fuels (dashed where inferred)
- CERCLA Site
- State Site
- General Groundwater Flow Direction (Approximate)
- Groundwater Elevation (feet AMSL) (Synoptic Water Levels Measured June 2015)
- Groundwater Contour Line (feet AMSL) (Synoptic Water Levels Measured June 2015)



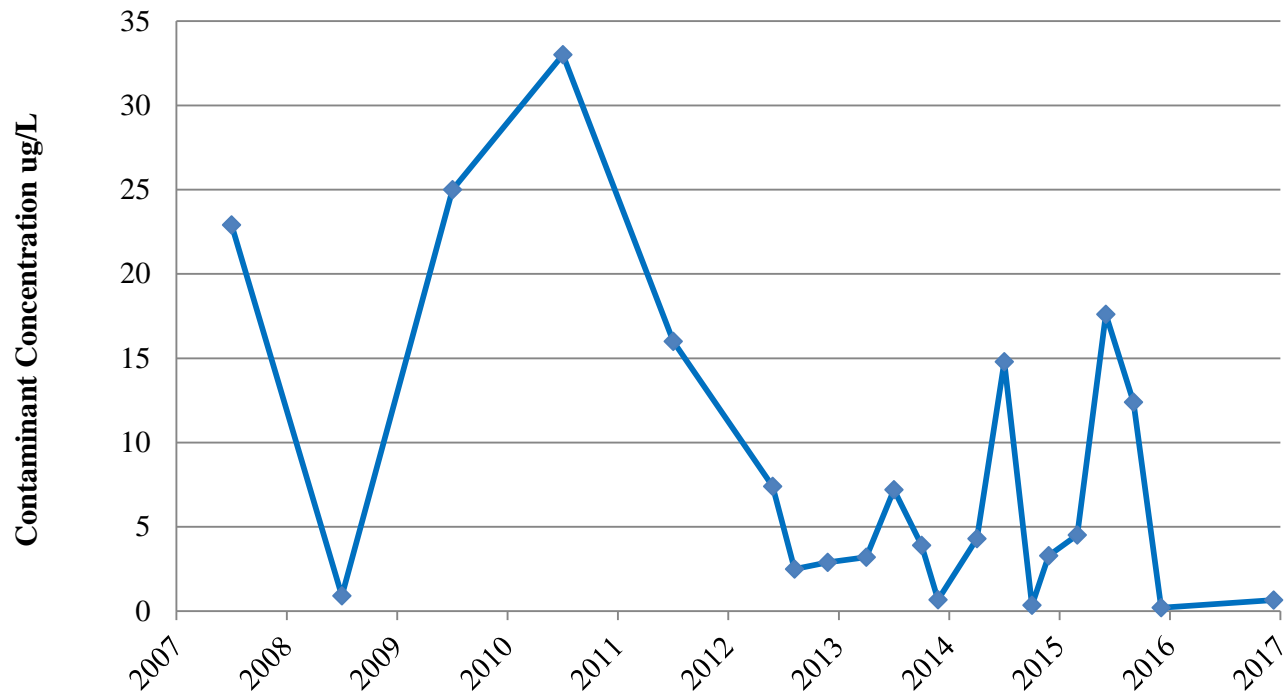
2016 Annual Remedial Action - Operations and Monitoring for Select CERCLA Sites  
 Joint Base Elmendorf-Richardson, Alaska

**WP014 SITE MAP WITH ANALYTICAL DATA**

Figure 14-1

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Symbol	ID	M-K Concentration Trend
—◆—	Benzene	Decreasing Trend

Cleanup Levels  
Benzene = 5 µg/L



**WP014 BENZENE TREND IN LF04SP-03**

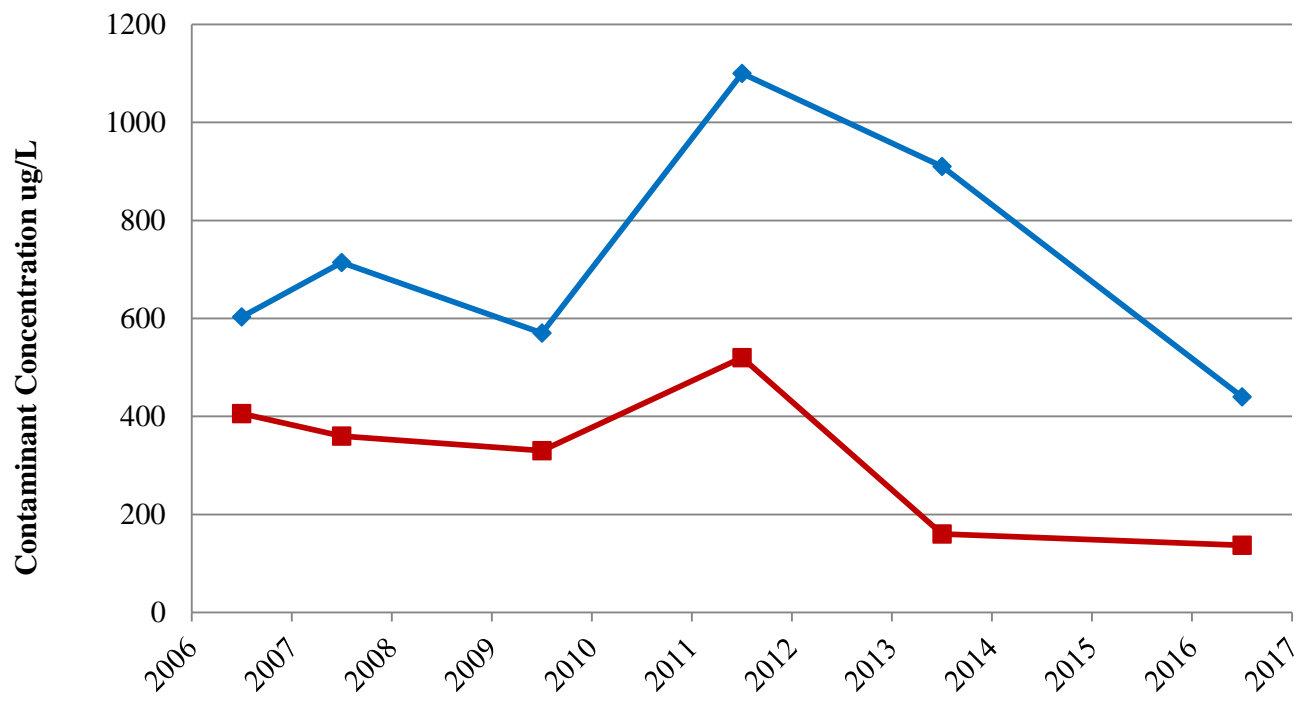
2016 Annual RA-O and Monitoring Report, Select CERCLA Sites  
Joint Base Elmendorf-Richardson, Alaska

Figure

**14-2**

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Symbol	ID	M-K Concentration Trend
	Benzene	No Significant Trend*
	Ethylbenzene	No Significant Trend

\*Probably decreasing based on MAROS decision matrix

Cleanup Levels  
 Benzene = 5 µg/L  
 Ethylbenzene = 700 µg/L



**WP014 CONTAMINANT TRENDS IN OU6MW-46**

2016 Annual RA-O and Monitoring Report, Select CERCLA Sites  
 Joint Base Elmendorf-Richardson, Alaska

Figure  
**14-3**

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## 15.0 CG039 (POLELINE ROAD DISPOSAL AREA)

PBC Performance Objective: Design and Implement an Optimized Exit Strategy for Site Closeout

Anticipated Achievement Date: 2020

### 15.1 SITE DESCRIPTION

CG039 – Poleline Road Disposal Area (formerly known as FTRS-39) is located approximately 1.2 miles south of Eagle River (see Figure 1-1). The land is a restricted access site, currently used for training activities and recreational purposes. Groundwater and soil contamination at the site resulted from the historical activities associated with four chemical disposal areas that were used from 1950 to 1972. During this time, chemical agent identification sets (CAISs) and other military debris were burned and disposed of in trenches. Chlorinated solvents were used to neutralize the chemical agents in the CAIS. A Rapid Response Removal Action within two of the four areas (A-3 and A-4) occurred from 1993 to 1994, during which time buried debris and soil were excavated to a maximum depth of 14 feet. The remaining two areas (A-1 and A-2) have not been excavated because they are suspected to contain buried munitions ([U.S. Army] Directorate of Public Works [DPW], 1996). For additional site information, including previous investigations, see the Environmental Restoration Program *2011 Groundwater Monitoring and Borehole Sampling, Three-Party Agreement Sites: OUB Poleline Road Disposal Area and OUE Armored Vehicle Maintenance Area* (USAF, 2012b).

#### 15.1.1 Site Geology

CG039 is located within a lowland area with complex geology resulting from periods of repeated glaciation. Glacial sediments and glacial tills make up the aquifer material beneath the site, which consists of a range of material from clay to boulders (Woodward-Clyde, 1998). The unconsolidated material at the site was reworked by prehistoric glacial-melt-water rivers, resulting in the complex distribution of laterally and vertically discontinuous layers and lenses observed at the site (USACE Cold Regions Research and Engineering Laboratory [CRREL], 2003). Bedrock was encountered at a depth of approximately 70 feet bgs in borings in the southern portions of the site and at approximately 190 feet bgs in borings north of the site.

#### 15.1.2 Site Hydrology

The nearest surface water is an unnamed wetland area located upgradient of CG039 approximately 255 feet to the southwest. The nearest downgradient surface water, Eagle River, is located approximately 1.2 miles north of the site. No significant surface water runoff or sediment transport from the site was observed.

#### 15.1.3 Site Hydrogeology

Groundwater flowing in and adjacent to the main disposal area has been the ongoing subject of study and is fairly well documented in both the shallow and deep groundwater aquifers (USACE CRREL, 2000; USACE CRREL, 2003; and USACE CRREL, 2011). The groundwater hydraulics

at the site are driven primarily by recharge from the wetland area and secondarily from surface infiltration across the site. Water infiltrating from the wetland area recharges both the shallow and deep saturated intervals because of the leaky nature of the aquitard in the area of the wetlands. Although the unconsolidated material over the bedrock is considered quite heterogeneous, several hydrostratigraphic units have been identified (Figure 15-1).

There is no current use of groundwater as a drinking water source at the site. The nearest JBER water supply well is a standby drinking water well located approximately 5.6 miles southwest of the site.

#### **15.1.3.1 Shallow Aquifer**

The upper, shallow aquifer is present from ground surface to a depth of approximately 40 feet bgs (Figure 15-1). This interval consists primarily of silty sands and gravels with frequent, discontinuous silt and clay lenses. The silt and clay lenses act as barriers to vertical flow, creating zones of perched groundwater. The shallow aquifer is normally saturated from approximately 20 to 40 feet bgs. Groundwater flow in the shallow aquifer is primarily to the northeast.

Previous investigations have shown that the shallow aquifer is not present downgradient of shallow aquifer monitoring well AP-3747 (Figures 15-1 and 15-2). This interpretation is based on the confirmed absence of a shallow aquifer at the locations of deep monitoring wells AP-4345, AP-5246, and AP-3748 (Figures 15-1 and 15-2), which are located north and northeast of monitoring well AP-3747 (CRREL, 2008; CH2M, 2007; USAF, 2016c). Additionally, there is evidence that the shallow aquifer is not present to the northwest of monitoring well AP-3747 at shallow monitoring well AP-4352. A shallow monitoring well was installed into a shallow, thin, perched aquifer at location AP-4352 (Figure 15-2). However, this well has subsequently gone dry, and it is therefore interpreted that the shallow, thin, perched aquifer it was installed in is not hydraulically connected to the main shallow aquifer at CG039 (USAF, 2016c). The intermediate aquitard that perches the shallow aquifer (Figure 15-1) is interpreted to pinch out north of monitoring well AP-3747, where the shallow aquifer likely merges with the regional aquifer. Because the shallow aquifer doesn't exist past AP-3747, it is currently the farthest downgradient well within the shallow aquifer, and only the deep regional aquifer is monitored downgradient of that location (Figures 15-1, 15-2, 15-3).

#### **15.1.3.2 Intermediate Aquitard**

The intermediate aquitard (Figure 15-1) consists of poorly sorted and silt-rich sand and gravel (USACE CRREL, 2003). The material has been previously described as a basal till (Woodward-Clyde, 1998) and diamicton (USACE CRREL, 2003). The intermediate interval is lithologically similar to the shallow aquifer but considerably denser (Woodward-Clyde, 1998). Although the intermediate interval serves as somewhat of a barrier, hydraulic gradients suggest that downward flow is occurring through the intermediate interval from the shallow aquifer to the deep perched aquifer. Perched water zones have been encountered during drilling through the intermediate zone.

### 15.1.3.3 Deep Perched Aquifer

The deep perched aquifer is located at the base of the till aquitard that locally perches groundwater extending from approximately 95 to 126 feet bgs (Figure 15-1). This till is referred to as an aquifer because it has enough water to sample in some places; however, the area is more characteristic of an aquitard (USACE CRREL, 2011). It is most closely associated with the previously described intermediate aquitard. The deep perched aquifer is located above a layer of laminated glacial silt (termed the “basal silt”) or directly on the bedrock surface. The deep perched aquifer produces only small volumes of water and has little seasonal water-level variation, suggesting that this aquifer is not directly hydraulically connected to the shallow or regional aquifers. Groundwater and contaminants seep slowly through the till until they reach the bedrock or basal silt layer where a thin layer of perched groundwater is present. It is not known whether there is a pathway between the deep perched aquifer and the regional aquifer, although based on the lack of groundwater variation, it is presumed that the mechanism of this connection would be a slow diffusive process through the low-permeability till (USACE CRREL, 2011). Groundwater flow within the deep perched aquifer follows the topography of the bedrock in a northeasterly direction until it merges with the regional aquifer.

### 15.1.3.4 Regional Aquifer

The regional aquifer is the primary aquifer across the Anchorage Bowl where groundwater migrates from the base of the Chugach Mountains toward Knik Arm. At CG039, the regional aquifer underlies the shallow aquifer and deep perched aquifer at depths of approximately 140 to 190 feet bgs. The flow direction in the regional aquifer is northwest according to groundwater elevation data at Poleline Road. Groundwater elevations within this aquifer fluctuate annually, with the highest levels in the fall or early winter months. This aquifer contains the most groundwater of the three aquifers discussed here and likely has the greatest flow velocities. Although the groundwater velocity of the regional aquifer has not been measured at Poleline Road, groundwater velocities from regional aquifer wells nearby on the JBER-R Main Cantonment area average 1.6 to 2.5 feet per day, according to data collected from USACE CRREL groundwater flow systems installed in regional aquifer monitoring wells (USACE CRREL, 2000). Average bulk hydraulic conductivities at Poleline Road were estimated by Woodward-Clyde (1998) to range from 0.03 to 284 feet per day, and were estimated by USACE CRREL (2003) to range from 0.6 to 121 feet per day.

## 15.2 REGULATORY REQUIREMENTS

CG039 was included in the Operable Units A and B ROD (U.S. Army, 1997). COCs for soil and groundwater and their respective cleanup goals are presented in Table 15-1. In the ROD, risk-based concentrations (RBCs) were adopted as cleanup goals for 1,1,2,2-PCA in groundwater and soil and for PCE in soil at CG039 because neither federal nor state cleanup goals were available. Chemical-specific toxicity factors for these compounds have been revised since the ROD was signed in August 1997. In 2013, the Third CERCLA Five-Year Review Report for JBER-R (USAF, 2013a) recommended updating the cleanup goals to provide future protectiveness of

human health because chemical-specific toxicity factors have been revised, and cleanup goals were risk-based at the time of the ROD. In addition, ADEC promulgated cleanup levels (18 AAC 75) for 1,1,2,2-PCA in groundwater and soil and for PCE in soil after the Operable Units A and B ROD was signed (see Table 15-1). A technical memorandum has been completed and added to the site file that documents the updated RBCs. ADEC completed a revision to 18 AAC 75 (November 6, 2016) which includes updates to the Table B1 and C cleanup levels (ADEC, 2017). A comparison of the OU B ROD Cleanup goals, MCLs, and the revised 18 AAC 75 cleanup levels is provided in Table 15-1. In addition, Table 15-1 contains a comparison of MCLs and the revised 18 AAC 75 cleanup levels for contaminants that were not identified as COCs in the OU B ROD. However, these compounds are of interest as they pertain to the treatability study that is ongoing at the site.

HVE/air stripping of groundwater within the source area (historical hot spot with 1,1,2,2-PCA-contaminated soil concentrations greater than 1,000 µg/kg [micrograms per kilogram] and/or free-phase solvents), ICs, natural attenuation of groundwater outside of the hot spot, and LTM of groundwater was the selected remedy for CG039 in the ROD (U.S. Army, 1997). An estimated 95 to 99 percent of the soil contamination has been removed from the source area during system operations, therefore reducing the source of groundwater contamination at the site (U.S. Army DPW, 2008). Groundwater monitoring of natural attenuation has continued over the last 15 years. The 2011 *Memorandum to the Site File for Long Term Monitoring at the Poleline Road Disposal Area, Operable Unit B* established a revised monitoring schedule that defines the monitoring well network and the sampling frequency of those wells and corrects an error in the cleanup goal for 1,1,2,2-PCA in groundwater (USAF, 2011b).

**Table 15-1 Cleanup Goals for Site CG039**

COCs in OU B ROD			
COC in Soil	OU B ROD Cleanup Goal <sup>a</sup> (mg/kg)		ADEC Cleanup Level <sup>b</sup> (mg/kg)
PCE	4 <sup>c</sup>		0.017
1,1,2,2-PCA	0.1 <sup>c</sup>		0.024
COC in Groundwater	OU B ROD Cleanup Goal <sup>c</sup> (µg/L)	MCL (µg/L)	ADEC Cleanup Level <sup>b</sup> (µg/L)
Benzene	5	5	4.6
Carbon tetrachloride	5	5	4.6
cis-1,2-DCE	70	70	36
trans-1,2-DCE	100	100	360
PCE	5	5	41
TCE	5	5	2.8
1,1,2,2-PCA	5.3 <sup>d</sup>	--	0.76
Other Chemicals of Interest in Groundwater Related to Ongoing Treatability Study <sup>e</sup>			
Chemical	MCL (µg/L)		ADEC Cleanup Level <sup>b</sup> (µg/L)
1,1,2-TCA	5		0.41
1,1-DCE	7		280
Vinyl chloride	2		0.19

**Notes:**

<sup>a</sup> RBCs were adopted as cleanup goals for 1,1,2,2-PCA and PCE in soil because neither federal nor state cleanup goals were available at the time of the signing of the ROD (U.S. Army, 1997.)

<sup>b</sup> 18 AAC 75 Table B1 and C Cleanup Levels (ADEC, 2017)

<sup>c</sup> OU B ROD cleanup goals were based on state and federal MCLs at the signing of the ROD (with the exception of PCE and 1,1,2,2-PCA in soil, which were based on RBCs) (U.S. Army, 1997).

<sup>d</sup> The RBC is the cleanup level specified for 1,1,2,2-PCA in the Memo to Site File (USAF, 2011b), which corrects an error to the RBC presented in the ROD (U.S. Army, 1997).

<sup>e</sup> Includes monitoring wells AP-3744, AP-3747, AP-3983R, AP-3989, AP-4525, AP-4550, and AP-4551.

-- = not applicable; same concentration as the Cleanup Goal

µg/L = microgram(s) per liter

ADEC = Alaska Department of Environmental Conservation

COC = contaminant of concern

DCE = dichloroethene

MCL = maximum contaminant level

mg/kg = milligram(s) per kilogram

OU = operable unit

PCA = tetrachloroethane

PCE = tetrachloroethene

RBC = risk-based concentration

ROD = Record of Decision

TCA = trichloroethane

TCE = trichloroethene



Historical groundwater data (Figures 15-2 and 15-3) indicate that both the shallow and deep groundwater plumes are well defined and stable. While concentrations of VOCs are generally decreasing in both the shallow and deep aquifers (see Section 15.6 for the results of Mann-Kendall trend analysis), current concentrations of some compounds remain above their respective Cleanup Goals (TCE, cis-1,2-DCE, and 1,1,2,2 PCA) or federal MCLs for drinking water (1,1-DCE and vinyl chloride) (see Table 15-4 and Figures 15-2 and 15-3).

The Third CERCLA Five-Year Review for JBER-R (USAF, 2013a) recommended additional delineation of the downgradient boundary of the shallow plume. A soil boring (CG039-NMW) was drilled near existing deep monitoring well AP-3748 (Figure 15-1 and 15-2) in September 2015. This boring confirmed that the shallow aquifer pinches out north of shallow monitoring well AP-3747 (Figures 15-1 and 15-2). Since the shallow aquifer does not exist north of shallow monitoring well AP-3747, the shallow groundwater plume is considered to be delineated downgradient of shallow monitoring well AP 3747, and the recommendation in the 2013 Five Year Review is considered addressed (USAF, 2016c).

An in situ bioremediation treatability study was implemented at the site in 2013 and is ongoing (Section 15.5).

### 15.3 FIELD ACTIVITIES

In September 2016, groundwater samples were collected from 16 wells at CG039. Wells were sampled under the LTM program and to support continued monitoring of the ongoing enhanced reductive dechlorination (ERD) treatability study. Six of these monitoring wells were sampled to support the Five-Year Review process. Data from these wells will be used during the 2018 Five-Year Review to evaluate the effectiveness of the remedy. A summary of the sampling and analysis performed at each well is presented in Table 15-2. Results for wells sampled as part of the LTM Program are presented in Section 15.4. Results for wells sampled as part of the on-going treatability study (including wells which function as both LTM and the on-going treatability study) are presented in Section 15.5. Field forms are included in Appendix A2. LUC inspections and site inspections were also conducted; inspection forms are included in Appendix B2. Sampling of groundwater for 1,4-dioxane was conducted in 2016 under a separate workplan and will be reported separately.

Following the 2016 annual groundwater monitoring event, the bioaugmentation of the six injection wells associated with target treatment zones AP-3983R, AP-4550, and AP-4551 was conducted in accordance with the *Uniform Federal Policy-Quality Assurance Project Plan – Addendum CG039 – Poleline Road Disposal Area Treatability Study Work Plan – Bioaugmentation* (USAF, 2016d). The bioaugmentation was conducted to assess if the introduction of a microbial consortium known to be capable of completely degrading cis-1,2-DCE and vinyl chloride to nontoxic ethene would be effective at reducing cis-1,2-DCE concentrations at CG039.

SiREM KB-1 Plus microbial culture was injected at the three target treatment zones (AP-3983R, AP-4550, and AP-4551) in September 2016. Bioaugmentation specifications are presented in Table 15-3. Field forms are documentation for the bioaugmentation activities, and are included in field notes in Appendix A2.

**Table 15-2 2016 CG039 Sampling and Analysis Summary**

Monitoring Well ID	VOCs (SW8260B)	TOC (9060)	VFA (300.0M)	Sulfide (376.2)	Alkalinity (310.1)	Natural Attenuation Parameters <sup>a</sup>	Ferrous Iron Field Test
<b>LTM Program</b>							
<i>Shallow, Unconfined Aquifer Wells</i>							
AP-3745 <sup>b</sup>	x					x	
AP-3981 <sup>b</sup>	x					x	
AP-3982 <sup>b</sup>	x					x	
AP-4353	x					x	
<i>Deep, Semi-Confined Aquifer Wells</i>							
AP-3748	x					x	
AP-4344	x					x	
AP-4350	x					x	
AP-5246	x					x	
AP-5683	x					x	
<b>Treatability Study Program Wells</b>							
<i>Shallow, Unconfined Aquifer Wells</i>							
AP-3983R	x	x	x	x	x	x	x
AP-3989 <sup>b</sup>	x	x	x	x	x	x	x
<i>Deep, Semi-Confined Aquifer Wells</i>							
AP-4525	x	x	x	x	x	x	x
AP-4551	x	x	x	x	x	x	x
<b>LTM and Treatability Study Program Wells</b>							
<i>Shallow, Unconfined Aquifer Wells</i>							
AP-3744 <sup>b</sup>	x	x	x	x	x	x	x
AP-4550	x	x	x	x	x	x	x

**Notes:**

<sup>a</sup>Natural attenuation parameters include chloride/sulfate (E300.0); nitrite/nitrate (E323.3); methane, ethane, ethene (RSK 175); dissolved iron and manganese (SW6020).

<sup>b</sup>These wells are designated as “sentinel” wells to be sampled once every 5 years under the LTM program (USAF, 2011b) to support the Five-Year Review process.

“x” = was sampled and analyzed for

ID = identification

LTM = long-term management

TOC = total organic carbon

VFA = volatile fatty acid

VOC = volatile organic compound



**Table 15-3 Bioaugmentation Specifications**

Target Treatment Zone	Injection Well	Volume of Microbial Culture (liters)	Volume of Anaerobic Chase Water (gallons)
AP-3983R	IW-01-3983	4	50
AP-3983R	IW-02-3983	4	50
AP-4550	IW-01-4550	4	50
AP-4550	IW-02-4550	4	50
AP-4551	IW-01-4551	2	30
AP-4551	IW-02-4551	2.4	35

## 15.4 LTM PROGRAM RESULTS

### 15.4.1 Groundwater Elevation Measurements

On August 31, 2016, depth to groundwater was measured at 22 monitoring wells throughout the site. Depth to groundwater measurements are summarized in Table 15-4 along with the groundwater elevations calculated from those measurements. In addition, depth to groundwater measurements are recorded on the Water Level Survey Forms in Appendix A2, and groundwater elevations are shown on Figures 15-2 and 15-3.

**Table 15-4 2016 Groundwater Elevations at CG039**

Monitoring Well ID	Top of Casing Elevation <sup>a</sup> (feet AMSL)	Total Depth of Well (feet FTOC)	Depth to Groundwater <sup>b</sup> (feet FTOC)	Groundwater Elevation (feet AMSL)
<i>Shallow, Unconfined Aquifer</i>				
AP-3744	307.11	37.60	28.82	278.29
AP-3745	303.46	29.80	22.44	281.02
AP-3747	303.07	32.20	26.64	276.43
AP-3749	311.97	24.60	22.03	289.94
AP-3981	306.12	40.70	23.65	282.47
AP-3982	305.74	32.00	27.58	278.16
AP-3983R	307.40	45.00	27.00	280.40
AP-3989	307.99	36.30	29.23	278.76
AP-4352	312.52	33.00	30.90	281.62
AP-4353	305.27	69.40	32.65	272.62
AP-4354	305.37	14.00	11.74	293.63
AP-4518	306.98	46.80	26.07	280.91
AP-4519	307.30	47.10	25.45	281.85
AP-4550	307.56	43.00	25.93	281.63
<i>Deep, Semi-Confined Aquifer</i>				
AP-3748	300.24	171.60	134.85	165.39
AP-4344	313.52	163.50	151.11	162.41
AP-4345	321.46	186.50	157.17	164.29
AP-4350	309.11	188.60	149.37	159.74
AP-4525	306.29	127.20	126.55	179.74
AP-4551	307.20	98.00	95.32	211.88
AP-5246	313.65	161.00	151.55	162.10
AP-5683	303.10	150.70	138.70	164.40

**Notes:**

<sup>a</sup> Top of casing elevations reference June 2003 and August 2004 surveys, except for AP-5246 and AP-5683, which were installed and surveyed in 2007 and 2011, respectively.

<sup>b</sup> Depth to Groundwater measurements from August 31, 2016 Water Level Survey located in Appendix A2

AMSL = above mean sea level

FTOC = from top of casing



### 15.4.2 Groundwater Sample Analytical Results

Groundwater samples were collected from nine monitoring wells as part of the LTM program and Five-Year Review at CG039 and were analyzed for the compounds listed in Table 15-2. Analytical results for CG039 COCs are summarized in Table 15-5 and shown on Figures 15-2 and 15-3. Complete analytical results are included in Appendix C2.

In the shallow aquifer, TCE and 1,1,2,2-PCA exceeded their respective cleanup goals in one or more wells. In the deep aquifer, TCE exceeded the cleanup goal in only one monitoring well: AP-4344. No other compounds exceeded OU B ROD cleanup goals. Carbon tetrachloride, PCE, cis-1,2-DCE, and trans-1,2-DCE were detected in groundwater but at concentrations below their respective cleanup levels.

In regard to non-COCs, acetone, chloroform, 1,1,2-TCA, 1,1-DCE, and vinyl chloride were detected in groundwater. When compared to the lowest of EPA MCLs and 18 AAC 75 ADEC Method Two groundwater cleanup levels (Table C), acetone and chloroform were detected below their respective groundwater cleanup levels. 1,1,2-TCA was detected above the ADEC Table C cleanup level of 0.41 µg/L at eight locations (with a maximum concentration of 8.94 [estimated] at AP-3983R), and 1,1-DCE was detected at eight locations and was above the EPA MCL of 7 µg/L at two of these locations (with a maximum concentration of 13.6 µg/L in AP-4551). Vinyl chloride was detected above the ADEC Table C cleanup level of 0.19 µg/L at four locations (with a maximum concentration of 37.3 at AP-3983R).

**Table 15-5 Summary of Select 2016 LTM Analytical Results at CG039**

Analyte	OU B ROD Cleanup Goal (µg/L)	MCL (µg/L)	Shallow, Unconfined Aquifer				Deep, Semi-Confined Aquifer				
			AP-3745 <sup>a</sup>	AP-3981 <sup>a</sup>	AP-3982 <sup>a</sup>	AP-4353	AP-3748	AP-4344	AP-4350 <sup>a</sup>	AP-5246	AP-5683 <sup>b</sup>
Benzene	5 <sup>c</sup>	5	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.3)
PCE	5 <sup>c</sup>	5	1.6	ND (0.3)	ND (0.3)	2.3	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.3)
TCE	5 <sup>c</sup>	5	<b>346</b>	0.35B	ND (0.3)	<b>169</b>	ND (0.3)	<b>12</b>	ND (0.3)	ND (0.3)	ND (0.3)
cis-1,2-DCE	70 <sup>c</sup>	70	68.4	ND (0.3)	ND (0.3)	30.7	ND (0.3)	0.36J	ND (0.3)	ND (0.3)	ND (0.3)
trans-1,2-DCE	100 <sup>c</sup>	100	17.1	ND (0.3)	ND (0.3)	10.6	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.3)
1,1,2,2-PCA	5.3 <sup>d</sup>	--	<b>81.7</b>	ND (0.3)	ND (0.3)	<b>24.5</b>	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.3)
Carbon tetrachloride	5 <sup>c</sup>	5	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.3)	0.36J	ND (0.3)	ND (0.3)	ND (0.3)

**Notes:**

<sup>a</sup> These wells are designated as “sentinel” wells to be sampled once every 5 years under the LTM program (USAF, 2011b) to support the Five-Year Review process.

<sup>b</sup> AP-5683 is a replacement well for AP-4019.

<sup>c</sup> OU B ROD cleanup goals were based on state and federal MCLs at the signing of the ROD (with the exception of 1,1,2,2-PCA) (U.S. Army, 1997.)

<sup>d</sup> The RBC is the cleanup level specified for 1,1,2,2-PCA in the Memo to Site File (USAF, 2011b), which corrects an error to the RBC presented in the ROD (U.S. Army, 1997).

All units are µg/L

MCL based cleanup level established in the Operable Units A and B ROD (U.S. Army, 1997), unless otherwise noted.

**Bold** = result exceeded cleanup criteria

µg/L= microgram(s) per liter

B = The analyte was detected in the associated method and/or calibration blank.

DCA = dichloroethane

DCE = dichloroethene

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

MCL = United States Environmental Protection Agency Maximum Contaminant Level (unless otherwise noted)

ND = analyte was not detected

PCA = tetrachloroethane

PCE = tetrachloroethene

RBC = risk-based concentration

TCE = trichloroethene



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### 15.4.3 Natural Attenuation Assessment

Geochemical results (including laboratory and field measured parameters) were evaluated to assess natural attenuation processes at CG039. Laboratory measured parameters included sulfate, nitrate/nitrite, dissolved iron and manganese, methane, ethane, and ethene. Field measured parameters (using a YSI 556) include pH, conductivity, turbidity, DO, temperature, and ORP. Laboratory and field measured natural attenuation parameter results are presented in Tables 15-6 and 15-7, respectively.

**Table 15-6 Summary of 2016 Laboratory Measured Natural Attenuation Parameters at CG039 LTM Monitoring Wells**

Monitoring Well ID	Total Nitrate/Nitrite (mg/L)	Dissolved Iron (mg/L)	Dissolved Manganese (mg/L)	Sulfate (mg/L)	Chloride (mg/L)	Ethane (µg/L)	Ethene (µg/L)	Methane (µg/L)
<i>Shallow, Unconfined Aquifer</i>								
AP-3745 <sup>a</sup>	0.0128 J	0.0125 J	0.0386	6.41	1.1	ND (0.201)	ND (0.212)	204 J
AP-3981 <sup>a</sup>	0.091	18.4	0.952	2.34	1.26	ND (0.145)	ND (0.16)	792
AP-3982 <sup>a</sup>	0.332	0.341	0.0174	8.65	1.64	ND (0.165)	ND (0.178)	0.0631 B
AP-4353	0.0643	14.9	0.995	0.669	1.32	0.223	0.171 J	606
<i>Deep, Semi-Confined Aquifer</i>								
AP-3748	0.837	ND (0.02)	0.00307 J	16.6	153	ND (0.173)	ND (0.185)	0.185 B
AP-4344	0.379	0.0522 J	0.00354 B	11.8	21.6	ND (0.161)	ND (0.175)	0.251
AP-4350 <sup>a</sup>	0.822	ND (0.02)	0.00243 J	24.6	52.2	ND (0.161)	ND (0.175)	ND (0.0848)
AP-5246	0.825	ND (0.02)	ND (0.02)	23.1	58.2	ND (0.162)	ND (0.175)	0.0816 B
AP-5683	0.31	ND (0.02)	0.00112 J	12.8	11.9	ND (0.149)	ND (0.163)	0.0513 B

**Notes:**

<sup>a</sup> These wells are designated as “sentinel” wells to be sampled once every 5 years under the LTM program (USAF, 2011b) to support the Five-Year Review process.

J = Analyte was present but the reported value may not be precise or accurate (estimated).

B = The analyte was detected in the associated method and/or calibration blank.

µg/L= microgram(s) per liter

mg/L = milligram(s) per liter

ND = analyte was not detected



**Table 15-7 Summary of 2016 Field Measured Natural Attenuation Parameters at CG039 LTM Monitoring Wells**

Monitoring Well ID	Date	Time	Volume Purged (gallons)	pH	Conductivity (mS/cm)	Turbidity (NTU)	DO (mg/L)	Temp (°C)	ORP (mV)
<i>Shallow, Unconfined Aquifer</i>									
AP-3745 <sup>a</sup>	9/7/2016	1810	2.8	6.76	0.384	5.54	0.9 <sup>b</sup>	3.98	160.5
AP-3981 <sup>a</sup>	9/10/2016	1650	5	7.05	0.466	9.2	14.07 <sup>c</sup>	5.09	-25.6
AP-3982 <sup>a</sup>	9/7/2016	1345	7.5	7.49	0.27	65.7	5.85	3.98	20.2
AP-4353	9/10/2016	1435	1.5	6.83	0.432	0.33	1.66	5.41	-15.5
<i>Deep, Semi-Confined Aquifer</i>									
AP-3748	9/9/2016	1150	1.1	7.53	0.812	3.39	4.61	5.03	129.3
AP-4344	9/2/2016	1145	2	7.89	0.311	26.7	15.07 <sup>c</sup>	5.28	198
AP-4350 <sup>a</sup>	9/6/2016	1730	0.9	7.7	0.549	2.76	17.19 <sup>c</sup>	5.42	208.5
AP-5246	9/2/2016	1410	1	7.88	0.431	5.46	16.42 <sup>c</sup>	7.91	156.8
AP-5683	9/9/2016	1500	1.1	7.56	0.343	1.57	2.86 <sup>b</sup>	7.08	137.3

**Notes:**

<sup>a</sup> These wells are designated as “sentinel” wells to be sampled once every 5 years under the LTM program (USAF, 2011b) to support the Five-Year Review process.

<sup>b</sup> DO reading likely biased low. DO sensor suspect.

<sup>c</sup> DO reading likely biased high. 100 percent saturation for site temperature and conductivity ranges is approximately 12 to 13 mg/L. DO sensor suspect

°C = degree(s) Celsius

DO = dissolved oxygen

mg/L = milligram(s) per liter

mS/cm = milliSiemen(s) per centimeter

mV = millivolt(s)

NTU = nephelometric turbidity unit(s)

Natural attenuation parameter results indicate the following:

- In the shallow aquifer, anaerobic/reducing conditions are observed in monitoring well AP-4353. At AP-4353, which is screened deeper in the shallow aquifer (Figure 15-1), geochemical conditions have historically been consistently somewhat anaerobic/reducing.
- Results from the deep aquifer wells demonstrate that geochemical conditions in the deep aquifer are predominantly aerobic.

Additional evaluation of the natural attenuation data has been performed in association with the ongoing treatability study, which is discussed in Section 15.5.

### 15.5 TREATABILITY STUDY MONITORING RESULTS

Beginning in 2013, an ERD treatability study was conducted at CG039 that evaluated whether the injection of an emulsified vegetable oil (EVO) substrate, with and without ferrous sulfate, into a TCE-contaminated aquifer is able to enhance the natural degradation of TCE, speed up the cleanup process, and reduce overall life-cycle costs. Additionally, the treatability study tested how easily EVO can be injected into the ground and how far it was distributed. Three target treatment zones were evaluated: monitoring well AP-4550 located in the shallow aquifer was injected with an EVO substrate, and monitoring well AP-3983R (shallow aquifer) and monitoring well AP-4551 (deep

aquifer) were injected with EVO and ferrous sulfate substrate (Figures 15-2 and 15-3). The results of the initial EVO injections and four quarters of groundwater monitoring following the EVO injections are documented in the *Treatability Study Implementation Report CG039 – Poleline Road Disposal Area Joint Base Elmendorf-Richardson, Alaska* (USAF, 2014d) and the *Treatability Study Report CG039 – Poleline Road Disposal Area Joint Base Elmendorf-Richardson, Alaska* (USAF, 2015d). The treatability study has demonstrated that the 2013 injection of EVO into three TCE-contaminated target treatment zones (near AP-3983R and AP-4550 in the shallow aquifer and AP-4551 in the deep perched aquifer) was able to enhance the natural degradation of TCE.

As part of the ongoing monitoring of the ERD treatability study at CG039, outlined in the *Treatability Study Report CG039 – Poleline Road Disposal Area* (USAF, 2015d) and the 2015 Remedial Action-Operations and Monitoring Letter Work Plan Addendum (USAF, 2015a), groundwater samples were collected from three treatability study target treatment zone monitoring wells (shallow aquifer monitoring wells AP-3983R and AP-4550, and deep aquifer monitoring well AP-4551) and three monitoring wells downgradient of the treatability study target treatment zones (shallow aquifer wells AP-3744, AP-3747 and AP-3989) (Figures 15-2 and 15-3). Due to the limited volume of groundwater in monitoring well AP-4525, no sample could be collected at that location. The objective of the continued groundwater monitoring is to assess potential rebound of TCE concentrations, degradation of TCE daughter products, persistence of reducing groundwater conditions, and the influence of the EVO injections downgradient of the anticipated target treatment zones.

Groundwater samples were analyzed for VOCs, total organic carbon (TOC), dissolved iron, dissolved manganese, dissolved gases, sulfide, nitrate+nitrite, alkalinity, chloride, sulfate, and volatile fatty acids (VFAs). Field forms are included in Appendix A2. The complete analytical results and DQE and laboratory analytical report is included as Appendix C2.

### **15.5.1 Target Treatment Zone Monitoring Wells**

Within each target treatment zone, downgradient from the injection wells, is a monitoring well specifically used to monitor the progress of ERD treatment within that target treatment zone. An evaluation of the data for each target treatment zone is presented in the following sections.

#### **15.5.1.1 AP-3983R Groundwater Results (EVO and Ferrous Sulfate in Shallow Aquifer)**

Analyte concentration trends are summarized in the following subsections. Chlorinated aliphatic hydrocarbon (CAH) results for AP-3983R and an updated representation of the shallow TCE plume are presented on Figure 15-2. Graphs presenting AP-3983R CAH concentrations, geochemical parameters, and total CAH molar concentration trends are presented on Figure 15-4.

##### **15.5.1.1.1 AP-3983R – Chlorinated Aliphatic Hydrocarbons**

Concentrations of TCE in groundwater at AP-3983R have decreased to below the MCL since the injection of EVO and ferrous sulfate in September 2013. In turn, concentrations of TCE daughter

products, particularly cis-1,2-DCE and vinyl chloride, have increased substantially compared to pre-injection concentrations. Additionally, it appears that the ERD treatment has degraded 1,1,2,2-PCA as evidenced by the decreasing concentrations of 1,1,2,2-PCA and the increase and subsequent decrease in the concentration of 1,1,2-TCA (Chen et al., 1996). A summary of the concentration trends observed for the CAHs at AP-3983R is provided in Table 15-8.

**Table 15-8 AP-3983R Chlorinated Aliphatic Hydrocarbon Results**

Analyte (µg/L)	Clean up Level	August 2013 (baseline)	Oct 2013	Jan 2014	April 2014	Sept 2014	Sept 2015	Sept 2016	Comments
PCE	5 <sup>a</sup>	<b>30.5</b>	<b>20.9</b>	<b>27.8</b>	3.44 J	0.79	1.5 U	3 UJ	PCE is non-detect and has been completely degraded.
TCE	5 <sup>a</sup>	<b>1,880</b>	<b>1,820</b>	<b>1,190</b>	<b>118</b>	<b>12.4</b>	3.6	3.4 J	TCE has been degraded to below the MCL.
cis-1,2-DCE	70 <sup>a</sup>	<b>180</b>	<b>207</b>	<b>1,470</b>	<b>2,260</b>	<b>4,070</b>	<b>3,480</b>	<b>3,510 J</b>	TCE to cis-1,2-DCE is the primary dechlorination pathway. Slight increase from 2015 to 2016 indicates that this pathway continues to be active.
trans-1,2-DCE	100 <sup>a</sup>	62	71.4	<b>113</b>	99.9	98.8	84.9	83 J	Low concentrations indicate that TCE to trans-1,2-DCE is not a primary dechlorination pathway.
1,1-DCE	7 <sup>b</sup>	3.88	3.62	6.71	6.74	<b>8.12</b>	<b>7.8</b>	<b>7.41 J</b>	Low concentrations indicate that TCE to 1,1-DCE is not a primary dechlorination pathway.
Vinyl chloride	0.19 <sup>c</sup>	0.25 U	<b>0.32 J</b>	<b>14.1</b>	<b>16.5</b>	<b>43.7</b>	<b>42.1</b>	<b>37.3 J</b>	Increase in vinyl chloride indicates that DCE is being dechlorinated.
Ethene	NA	0.0682	0.252 J	0.253 J	0.501	2.36	1.09 U	1.62 U	Increase indicates that complete dechlorination is occurring.
1,1,2,2-PCA	5.3 <sup>d</sup>	<b>407</b>	<b>472</b>	<b>521</b>	<b>301</b>	<b>332</b>	<b>279</b>	<b>224 J</b>	1,1,2,2-PCA has been degraded, likely as a result of ERD treatment.
1,1,2-TCA	0.41 <sup>c</sup>	<b>10.5</b>	<b>12.4</b>	<b>65.5</b>	<b>71.6</b>	<b>24.4</b>	<b>10.9</b>	<b>8.94 J</b>	Increase and subsequent decrease in 1,1,2-TCA likely the result of ERD treatment.

**Notes:**

- <sup>a</sup> The MCL is the cleanup level selected in the OU B ROD (U.S. Army, 1997); therefore, it is used for comparison.
- <sup>b</sup> The MCL is less than the 18 AAC 75 Table C Groundwater Cleanup Level (ADEC, 2017), therefore it is used for comparison.
- <sup>c</sup> The 18 AAC 75 Table C Groundwater Cleanup Level (ADEC, 2017) is less than the MCL; therefore it is used for comparison.
- <sup>d</sup> The RBC is the cleanup level specified in the Memo to Site File (USAF, 2011b); therefore it is used for comparison.

**Bold** values indicate the result exceeded the MCL

µg/L= microgram(s) per liter

DCE = dichloroethene

ERD = enhanced reductive dechlorination

J = The analyte was positively identified: the associated value is the approximate concentration of the analyte in the sample.

MCL = maximum contaminant level

NA = Not available

PCA = tetrachloroethane

PCE = tetrachloroethene

RBC = risk-based concentration

TCA = trichloroethane

TCE = trichloroethene

U = The analyte was analyzed for, but was not detected above the reported sample quantitation limit.

To estimate the quantity of TCE that has been degraded by reductive dechlorination, the concentrations of TCE and each of the daughter products were converted to molar concentrations (measured in micromoles per liter [µmol/L]). In molar concentrations, the quantities of TCE and



daughter products can be related on a one-to-one basis, where 1  $\mu\text{mol/L}$  of daughter product represents the reduction of 1  $\mu\text{mol/L}$  of TCE. In this manner, a conservative estimate can be obtained for the quantity of TCE that has been degraded. This is a conservative estimate because (1) the daughter products do not include the final reductive dechlorination end members of ethene, ethane, and carbon dioxide, which are difficult to quantify and are therefore left out of the evaluation, and (2) degradation mechanisms other than reductive dechlorination are not considered.

The success of ERD is dependent on the existence of a viable population of Dehalococcoides bacteria (DHC), which is necessary for the complete and timely degradation of cis-1,2-DCE and vinyl chloride under reducing conditions. Slow degradation rates for cis-1,2-DCE and vinyl chloride can be associated with a poor or unviable population of DHC within the subsurface.

Figure 15-4 shows a graphical representation of the relative molar concentrations of all the detected CAHs (including TCE, 1,1,2,2-PCA, and daughter products) at AP-3983R through time. The following observations can be made from total CAH molar concentration trends:

- Practically all of the TCE has been degraded to cis-1,2-DCE; other daughter products such as trans-1,2-DCE and vinyl chloride make up very little of the total CAH molar mass.
- Cis-1,2,DCE now constitutes 92 percent of the CAHs at AP-3983R.
- The latest molar concentration of cis-1,2-DCE (36.2  $\mu\text{mol/L}$ ) is greater than the baseline molar concentration of TCE and 1,1,2,2-PCA (which can degrade to 1,1,2-TCA or cis-1,2-DCE [Chen et al., 1996]) combined (16.7  $\mu\text{mol/L}$ ).
- The total CAH molar concentration at AP-3983R has increased from 19.4 to 39.2  $\mu\text{mol/L}$  since the beginning of the treatability study.

Based on these observations, the following conclusions can be drawn:

- While there is evidence that cis-1,2-DCE is being degraded to vinyl chloride and then to ethene, the degradation of cis-1,2-DCE is occurring at a rate much slower than TCE is being degraded. The slow degradation of cis-1,2-DCE is likely evidence that a sufficient population of DHC was not naturally present within the target treatment zone.
- As TCE (and to some extent 1,1,2,2-PCA) is degraded, it is expected that the total molar concentration of daughter products should be equal to (if daughter products are not degraded) or less than (if daughter products are being degraded) the baseline molar concentrations of TCE. However, the data from AP-3983R show an increase in the molar concentrations of daughter products (primarily cis-1,2-DCE) relative to TCE. This increase in cis-1,2-DCE molar concentration could be explained by any combination of the following:
  - An influx of either TCE at a concentration greater than the baseline concentration (which was then degraded to cis-1,2-DCE) or cis-1,2-DCE from the upgradient target treatment zone AP-4550,

- Back-diffusion of sorbed CAHs from the surrounding fine-grained soils into the dissolved phase,
- 1,1,2,2-PCA being degraded to cis-1,2-DCE,
- 1,1,2,2-PCA being abiotically degraded to TCE and then the TCE being degraded to cis-1,2-DCE,
- Variability of CAHs within the subsurface.

#### **15.5.1.1.2 AP-3983R – Geochemical Parameters**

The geochemical parameters measured in groundwater at AP-3983R indicate that the groundwater environment has been and remains sufficiently anaerobic for reductive dechlorination to occur. A summary of the trends observed for the geochemical parameters at AP-3983R is provided in Table 15-9.

**Table 15-9 AP-3983R Geochemical Parameter Results**

Analyte	Aug 2013 (baseline)	Oct 2013	Jan 2014	Apr 2014	Sep 2014	Sep 2015	Sep 2016	Comments
ORP (mV)	52	60.1	-79	-112	-94.2	-38.8	-118.2	Negative value indicates reduced conditions, favorable for dechlorination.
DO (mg/L)	4.89	6.37	4.56	0.0	1.2	0.31	0.14	DO values below 1 mg/L indicate conditions are favorable for dechlorination.
TOC (mg/L)	3.47	3.96	61.6	93.2	138	229 B	245	Greater than 20 mg/L is considered a sufficient carbon and energy source to drive dechlorination.
VFAs* – acetic acid (µg/L)	60 U	15,700	148,000	152,000	179,000	447,000	491,000	VFAs are a degradation product of EVO, and concentrations of VFAs greater than 10,000 to 20,000 µg/L are a good indicator of sufficient EVO distribution at a given location.
Methane (µg/L)	9.84	15.8	11.8	29.9	720	4,200	7,400	Levels greater than 1,000 µg/L are an indicator of highly reducing conditions, and are desirable for dechlorination to occur.
Manganese (mg/L)	0.416	5.11	4.24	4.31	2.73	2.04	2.6	An increase in manganese concentrations can indicate that groundwater is sufficiently reducing for anaerobic dechlorination to occur.
Dissolved Iron (mg/L)	3.03	64.7	27.5	60.9	50.9	42.6	56.1	An increase in ferrous iron concentrations can indicate that groundwater is sufficiently reducing for anaerobic dechlorination to occur. Although dissolved iron reported from laboratory analysis did not speciate between ferric and ferrous iron, ferrous iron was measured using a field test kit (Appendix A). The ferrous iron result from the field test kit was 3.3 mg/L, which indicates that most of the dissolved iron concentration is likely to be in the ferric form of iron.
Sulfate (mg/L)	25.3	369	84.5	3.01	0.557	3.63	0.737	Depleted concentrations of sulfate relative to background indicate that the groundwater is sufficiently reducing for anaerobic dechlorination to occur. Abundant sulfate and iron can promote FeS formation and abiotic reduction of TCE.
Sulfide (mg/L)	0.0647	0.705	0.264	5.16	2.05	0.827 J	0.0825	Increase in sulfide corresponds to a decrease in sulfate. Subsequent decrease in sulfide is likely due to reaction with ferrous iron to form FeS minerals.



**Table 15-9 AP-3983R Geochemical Parameter Results (Continued)**

Analyte	Aug 2013 (baseline)	Oct 2013	Jan 2014	Apr 2014	Sep 2014	Sep 2015	Sep 2016	Comments
Nitrate (mg/L)	0.0611	0.191	0.0847	0.155	0.173	0.152	0.13	A nitrate level of <1.0 mg/L is desirable for dechlorination.
pH	5.78	6.36	6.73	6.79	7.05	6.32	6.78	pH value is within the ideal range (6 to 8) for reductive dechlorination.

**Notes:**

\*Acetic acid is the most prevalent VFA at AP-3983R; see data table in Appendix C2.

µg/L = microgram(s) per liter

B = The analyte was detected in the associated method and/or calibration blank.

DO = dissolved oxygen

EVO = emulsified vegetable oil

J = The analyte was positively identified: the associated value is the approximate concentration of the analyte in the sample.

mg/L = milligram(s) per liter

mV = millivolt(s)

ORP = oxidation-reduction potential

TCE = trichloroethene

TOC = total organic carbon

U = The analyte was analyzed for, but was not detected above the reported sample quantitation limit.

VFA = volatile fatty acid



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### 15.5.1.2 AP-4550 Groundwater Results (EVO in Shallow Aquifer)

Analyte concentration trends are summarized in the following subsections. CAH results for AP-4550 and an updated representation of the shallow TCE plume are presented on Figure 15-2. Graphs presenting CAH concentration, geochemical parameter, and total CAH molar concentration trends are presented on Figure 15-5.

#### 15.5.1.2.1 AP-4550 – Chlorinated Aliphatic Hydrocarbons

Concentrations of TCE in groundwater at AP-4550 have decreased to below the MCL since the injection of EVO in September 2013. In turn, concentrations of TCE daughter products, particularly cis-1,2-DCE and vinyl chloride, have increased substantially compared to pre-injection concentrations. A summary of the concentration trends observed for the CAHs at AP-4550 is provided in Table 15-10.

Figure 15-5 shows a graphical representation of the relative molar concentrations of all the detected CAHs (including TCE, 1,1,2,2-PCA, and daughter products) at AP-4550 through time. The following observations can be made from total CAH molar concentration trends:

- Practically all of the TCE has been degraded to cis-1,2-DCE; other daughter products such as trans-1,2-DCE and vinyl chloride make up very little of the total CAH molar mass.
- Cis-1,2,DCE now constitutes 92 percent of the CAHs at AP-4550.
- The latest molar concentration of cis-1,2-DCE (22.2  $\mu\text{mol/L}$ ) is greater than the baseline molar concentration of TCE and 1,1,2,2-PCA combined (14.4  $\mu\text{mol/L}$ ).
- The total CAH molar concentration at AP-4550 has increased from 16.8 to 23.9  $\mu\text{mol/L}$  (and as high as 24.9  $\mu\text{mol/L}$ ) since the beginning of the treatability study.

Based on these observations, the following conclusions can be drawn:

- While there is evidence that cis-1,2-DCE is being degraded to vinyl chloride and then to ethene, the degradation of cis-1,2-DCE is occurring at a rate much slower than TCE is being degraded. The slow degradation of cis-1,2-DCE is likely evidence that a sufficient population of DHC was not naturally present within the target treatment zone.
- As TCE is degraded, it is expected that the total molar concentration of daughter products should be equal to or less than the baseline molar concentrations of TCE. However, the data from AP-4550 show an increase in the molar concentrations of daughter products (primarily cis-1,2-DCE) relative to TCE. This increase in cis-1,2-DCE molar concentration could be explained by any combination of the following:
  - An influx of CAH mass from upgradient of the AP-4550 target treatment zone
  - Back-diffusion of sorbed CAHs from the surrounding fine-grained soils into the dissolved phase
  - 1,1,2,2-PCA being degraded to cis-1,2-DCE
  - 1,1,2,2-PCA being abiotically degraded to TCE and then the TCE being degraded to cis-1,2-DCE
  - Variability of CAHs within the subsurface.

**Table 15-10 AP-4550 Chlorinated Aliphatic Hydrocarbon Results**

Analyte (µg/L)	Cleanup Level	Aug 2013 (baseline)	Oct 2013	Jan 2014	Apr 2014	Sep 2014	Sep 2015	Sep 2016	Comments
PCE	5 <sup>a</sup>	<b>29.3</b>	<b>8.76</b>	1.68	1.5	0.52	0.3 J	3 U	PCE has been dechlorinated to below the MCL.
TCE	5 <sup>a</sup>	<b>1,500</b>	<b>822</b>	<b>34.9</b>	<b>6.89</b>	<b>10.6</b>	4.19	2.18 J	TCE has been dechlorinated to below the MCL.
cis-1,2-DCE	70 <sup>a</sup>	<b>160</b>	<b>115</b>	<b>2,040</b>	<b>1,130</b>	<b>924</b>	<b>1,630</b>	<b>2,150</b>	TCE to cis-1,2-DCE is the primary dechlorination pathway.
trans-1,2-DCE	100 <sup>a</sup>	58.4	38.6	62.2	37.5	31.8	55.2	62	Low concentrations indicate that TCE to trans-1,2-DCE is not a primary dechlorination pathway.
1,1-DCE	7 <sup>b</sup>	4.05	1.94 J	<b>7.94</b>	3.94	3.14	4.78	6.12	Low concentrations indicate that TCE to 1,1-DCE is not a primary dechlorination pathway.
Vinyl chloride	0.19 <sup>c</sup>	0.28 U	1.25 U	<b>40.3</b>	<b>11.1</b>	<b>5.25</b>	<b>18.5</b>	<b>24.5</b>	Increase in vinyl chloride indicates that DCE is being dechlorinated.
Ethene	NA	0.0407	0.537	1.29	0.261 J	0.303 J	2.33 UJ	8.09	Detections of ethene indicate that complete dechlorination is occurring.
1,1,2,2-PCA	5.3 <sup>d</sup>	<b>501</b>	<b>164</b>	<b>362</b>	<b>150</b>	<b>97.2 J</b>	<b>94.4</b>	<b>89.3 J</b>	1,1,2,2-PCA has been degraded, likely as a result of ERD treatment.
1,1,2-TCA	0.41 <sup>c</sup>	<b>11</b>	<b>6.33</b>	<b>13.6</b>	<b>6.18</b>	<b>3.39</b>	<b>4.13</b>	<b>3.71 J</b>	Lack of increase in 1,1,2-TCA could indicate that 1,1,2,2-PCA is being degraded to cis-1,2-DCE. Decrease in 1,1,2-TCA likely the result of ERD treatment.

**Notes:**

<sup>a</sup> The MCL is the cleanup level selected in the OU B ROD (U.S. Army, 1997); therefore, it is used for comparison.

<sup>b</sup> The MCL is less than the 18 AAC 75 Table C Groundwater Cleanup Level (ADEC, 2017); therefore it is used for comparison.

<sup>c</sup> The 18 AAC 75 Table C Groundwater Cleanup Level (ADEC, 2017) is less than the MCL; therefore it is used for comparison.

<sup>d</sup> The RBC is the cleanup level specified in the Memo to Site File (USAF, 2011b); therefore it is used for comparison.

**Bold** values indicate the result exceeded the MCL.

µg/L = microgram(s) per liter

DCE = dichloroethene

ERD = enhanced reductive dechlorination

J = The analyte was positively identified: the associated value is the approximate concentration of the analyte in the sample.

MCL = maximum contaminant level

NA = Not available

PCA = tetrachloroethane

PCE = tetrachloroethene

TCA = trichloroethane

TCE = trichloroethene

U = The analyte was analyzed for, but was not detected above the reported sample quantitation limit.

UJ = The analyte was below the reported sample quantitation limit. However, the reported value is approximate.



### 15.5.1.2.2 AP-4550 – Geochemical Parameters

The geochemical parameters measured in groundwater at AP-4550 indicate that the groundwater environment has been and remains sufficiently anaerobic for reductive dechlorination to occur. A summary of the trends observed for the geochemical parameters at AP-4550 is provided in Table 15-11.

**Table 15-11 AP-4550 Geochemical Parameter Results**

Analyte	Aug 2013 (baseline)	Oct 2013	Jan 2014	Apr 2014	Sep 2014	Sep 2015	Sep 2016	Comments
ORP (mV)	40.5	40.7	-50.5	-71.8	-96.2	5.5	-63.3	Negative value indicates reduced conditions, favorable for dechlorination.
DO (mg/L)	0.35	5.01	4.21	0.18	0.90	0.32	0.17	DO values below 1 mg/L indicate conditions are favorable for dechlorination.
TOC (mg/L)	3.53	NA	134	41.3	51.9	371 B	288	Greater than 20 mg/L is considered a sufficient carbon and energy source to drive dechlorination.
VFAs* – acetic acid (µg/L)	60 U	NA	129,000	52,900	98,100	625,000 J	560,000	VFAs are a degradation product of EVO, and concentrations of VFAs greater than 10,000 to 20,000 µg/L are a good indicator of sufficient EVO distribution at a given location.
Methane (µg/L)	53.3	44.2	220	1,060	5,860	13,500 J	10,600	Levels greater than 1,000 µg/L are an indicator of highly reducing conditions and are desirable for dechlorination to occur. The elevated level of methane could be an indication that methanogenic bacteria are outcompeting DHC bacteria, which could explain the slow degradation of cis-1,2-DCE.
Manganese (mg/L)	0.775	1.19	1.75	1.07	0.983	3.13	3.47	An increase in manganese concentrations can indicate that groundwater is sufficiently reducing for anaerobic dechlorination to occur.
Dissolved Iron (mg/L)	8.36	14.7	35.9	27.3	25.6	78.9 J	68.5	An increase in ferrous iron concentrations can indicate that groundwater is sufficiently reducing for anaerobic dechlorination to occur. Although dissolved iron reported from laboratory analysis did not speciate between ferric and ferrous iron, ferrous iron was measured using a field test kit (Appendix A). The ferrous iron result from the field test kit was 3.21 mg/L, which indicates that most of the dissolved iron concentration is likely to be in the ferric form of iron.
Sulfate (mg/L)	30.3	115	0.222	0.353	0.1 U	0.532 B	0.394 B	Depleted concentrations of sulfate relative to background indicate that the groundwater is sufficiently reducing for anaerobic dechlorination to occur.
Sulfide (mg/L)	0.0456	NA	0.141	0.148	0.0839	0.0388 J	0.0558	Low concentrations could indicate that FeS minerals have been formed.
Nitrate (mg/L)	0.0661	0.15	0.114	0.154	0.156	0.208 J	0.118 J	A nitrate level of <1.0 mg/L is desirable for dechlorination.
pH	6.11	6.54	6.27	6.69	6.76	5.84	6.36	pH value is within the ideal range (6 to 8) for reductive dechlorination.

**Notes:**

\*Acetic acid is the most prevalent VFA at AP-4550; see data table in Appendix C2

B = The analyte was detected in the associated method and/or calibration blank.

J = The analyte was positively identified: the associated value is the approximate concentration of the analyte in the sample.

U = The analyte was analyzed for, but was not detected above the reported sample quantitation limit.

µg/L = microgram(s) per liter

DO = dissolved oxygen

EVO = emulsified vegetable oil

mg/L = milligram(s) per liter

mV = millivolt(s)

NA = not analyzed

ORP = oxidation-reduction potential

TOC = total organic carbon

VFA = volatile fatty acid



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### 15.5.1.3 AP-4551 Groundwater Results (EVO and Ferrous Sulfate in Deep Perched Aquifer)

Analyte concentration trends are summarized in the following subsections. CAH results for AP-4551 and an updated representation of the deep TCE plume are presented on Figure 15-3. Graphs presenting CAH concentration, geochemical parameter, and total CAH molar concentration trends are presented on Figure 15-6.

#### 15.5.1.3.1 AP-4551 – Chlorinated Aliphatic Hydrocarbons

Concentrations of TCE in groundwater at AP-4551 have decreased substantially since the injection of EVO and ferrous sulfate in September 2013. In turn, concentrations of TCE daughter products, particularly cis-1,2-DCE, have increased substantially compared to pre-injection concentrations; and concentrations of vinyl chloride have increased to detectable levels. A summary of the concentration trends observed for the CAHs at AP-4551 is provided in Table 15-12.

Figure 15-6 shows a graphical representation of the relative molar concentrations of all the detected CAHs (including TCE, 1,1,2,2-PCA, and daughter products) at AP-4551 though time. The following observations can be made from total CAH molar concentration trends:

- Practically all of the TCE has been degraded to cis-1,2-DCE; other daughter products such as trans-1,2-DCE and vinyl chloride make up very little of the total CAH molar mass
- Cis-1,2,DCE now constitutes the 96 percent of the CAHs at AP-4551
- The latest molar concentration of cis-1,2-DCE (22.1  $\mu\text{mol/L}$ ) is greater than the baseline molar concentration of TCE and 1,1,2,2-PCA combined (18.1  $\mu\text{mol/L}$ )
- The total CAH molar concentration at AP-4551 has increased from 19.5 to 23.1  $\mu\text{mol/L}$  (and as high as 27.4  $\mu\text{mol/L}$ ) since the beginning of the treatability study.

Based on these observations the following conclusions can be drawn.

- While there is evidence that cis-1,2-DCE is being degraded to vinyl chloride and then to ethene, the degradation of cis-1,2-DCE is occurring at a rate much slower than TCE is being degraded. The slow degradation of cis-1,2-DCE is likely evidence that a sufficient population of DHC was not naturally present within the target treatment zone.
- As TCE is degraded, it is expected that the total molar concentration of daughter products should be equal to or less than the baseline molar concentrations of TCE. However, the data from AP-4551 show a slight increase in the molar concentrations of daughter products (primarily cis-1,2-DCE) relative to TCE. This increase in cis-1,2-DCE molar concentration could be explained by any combination of the following:
  - An influx of CAH mass from upgradient of the AP-4551 target treatment zone
  - Back-diffusion of sorbed CAHs from the surrounding fine-grained soils into the dissolved phase
  - 1,1,2,2-PCA being degraded to cis-1,2-DCE

- 1,1,2,2-PCA being abiotically degraded to TCE and then the TCE being degraded to cis-1,2-DCE
- Variability of CAHs within the subsurface.

**Table 15-12 AP-4551 Chlorinated Aliphatic Hydrocarbon Results**

Analyte (µg/L)	Cleanup Level	Aug 2013 (baseline)	Oct 2013	Jan 2014	Apr 2014	Sep 2014	Sep 2015	Sep 2016	Comments
PCE	5 <sup>a</sup>	5	0.64	2.42	0.3 U	0.3 U	1.5 U	3 U	PCE has been dechlorinated to below the MCL.
TCE	5 <sup>a</sup>	<b>2,300</b>	<b>698</b>	<b>1,190</b>	<b>14.7</b>	<b>8.43</b>	<b>9.36</b>	<b>14.9</b>	TCE has been dechlorinated to near the MCL.
cis-1,2-DCE	70 <sup>a</sup>	<b>113</b>	<b>82.7</b>	<b>730</b>	<b>2,370</b>	<b>2,520</b>	<b>1,870</b>	<b>2,140</b>	TCE to cis-1,2-DCE is the primary dechlorination pathway.
trans-1,2-DCE	100 <sup>a</sup>	9.59	8.92	14.2	24.1	28.2	28.3	28.1	Low concentrations indicate that TCE to trans-1,2-DCE is not a primary dechlorination pathway.
1,1-DCE	7 <sup>b</sup>	<b>10.4</b>	2.11	4.76	<b>15.2</b>	<b>16.7</b>	<b>15.8</b>	<b>13.6</b>	Low concentrations indicate that TCE to 1,1-DCE is not a primary dechlorination pathway.
Vinyl chloride	0.19 <sup>c</sup>	0.25 U	0.25 U	<b>2.43</b>	<b>7.87</b>	<b>5.55</b>	<b>2.3 J</b>	3 U	Lack of vinyl chloride could indicate that DCE is not being dechlorinated.
Ethene	NA	0.123	0.293 J	0.0858 J	0.115 J	0.219 J	0.0702 J	0.172 U	Lack of ethene could indicate that complete dechlorination is not occurring.
1,1,2,2-PCA	5.3 <sup>d</sup>	<b>106</b>	<b>51.6</b>	<b>121</b>	<b>108</b>	<b>119</b>	<b>78.8</b>	<b>62.6</b>	Little indication that ERD treatment is increasing degradation of 1,1,2,2-PCA.
1,1,2-TCA	0.41 <sup>c</sup>	<b>6.91</b>	<b>5.09</b>	<b>7.85</b>	<b>15.3</b>	<b>12.9</b>	<b>9.04</b>	<b>8.45</b>	Little indication that ERD treatment is increasing degradation of 1,1,2-PCA.

**Notes:**

<sup>a</sup> The MCL is the cleanup level selected in the OU B ROD (U.S. Army, 1997); therefore, it is used for comparison.

<sup>b</sup> The MCL is less than the 18 AAC 75 Table C Groundwater Cleanup Level (ADEC, 2017); therefore it is used for comparison

<sup>c</sup> The 18 AAC 75 Table C Groundwater Cleanup Level (ADEC, 2017) is less than the MCL; therefore it is used for comparison.

<sup>d</sup> The RBC is the cleanup level specified in the Memo to Site File (USAF, 2011b); therefore it is used for comparison.

**Bold** values indicate the result exceeded the MCL.

µg/L = microgram(s) per liter

DCE = dichloroethene

ERD = enhanced reductive dechlorination

J = The analyte was positively identified: the associated value is the approximate concentration of the analyte in the sample.

MCL = maximum contaminant level

NA = Not available

PCA = tetrachloroethane

PCE = tetrachloroethene

TCA = trichloroethane

TCE = trichloroethene

U = The analyte was analyzed for, but was not detected above the reported sample quantitation limit.

### 15.5.1.3.2 AP-4551 – Geochemical Parameters

The geochemical parameters measured in groundwater at AP-4551 indicate that the groundwater environment was sufficiently anaerobic for reductive dechlorination to occur; however, there are some indications that those conditions may not be persistent. A summary of the trends observed for the geochemical parameters at AP-4551 is provided in Table 15-13.

**Table 15-13 AP-4551 Geochemical Parameter Results**

Analyte	Aug 2013 (baseline)	Oct 2013	Jan 2014	Apr 2014	Sep 2014	Sep 2015	Sep 2016	Comments
ORP (mV)	45.1	48.6	-102	-68.8	-41.3	12.6	-95.6	A negative value indicates reduced conditions, favorable for dechlorination.
DO (mg/L)	12.73	11.98	4.21	0.58	1.02	1.21	0.49	DO values below 1 mg/L indicate conditions are favorable for dechlorination.
TOC (mg/L)	4.25	4.13	38	28.1	24.1	31.4 B	17.8	Greater than 20 mg/L is considered a sufficient carbon and energy source to drive dechlorination.
VFAs* – acetic acid (µg/L)	60 U	60 U	16,100	27,300	400 U	50,500	26,000	VFAs are a degradation product of EVO, and concentrations of VFAs greater than 10,000 to 20,000 µg/L are a good indicator of sufficient EVO distribution at a given location.
VFAs* – lactic acid (µg/L)	60 U	60 U	60 U	100 U	31,800	250	200 U	
Methane (µg/L)	0.463	0.364 B	0.849	119	849	1,090	345 J	Levels greater than 1,000 µg/L are an indicator of highly reducing conditions and are desirable for dechlorination to occur.
Manganese (mg/L)	0.00552	19.3	19.2	12.5	10.5	7.93	5.7	An increase in manganese concentrations can indicate that groundwater is sufficiently reducing for anaerobic dechlorination to occur.
Dissolved Iron (mg/L)	0.0312	0.13	21.9	7.27	5.46	5.4	4.4	An increase in ferrous iron concentrations can indicate that groundwater is sufficiently reducing for anaerobic dechlorination to occur. Although dissolved iron reported from laboratory analysis did not speciate between ferric and ferrous iron, ferrous iron was measured using a field test kit (Appendix A). The ferrous iron result from the field test kit was 1.94 mg/L.
Sulfate (mg/L)	9.53	117	12	0.289	1.11	1.05 B	0.502 B	Depleted concentrations of sulfate relative to background indicate that the groundwater is sufficiently reducing for anaerobic dechlorination to occur.
Sulfide (mg/L)	0.0142	0.112	0.0197 J	0.258	0.032	0.0328	0.0808	Low concentrations could indicate that FeS minerals have been formed.
Nitrate (mg/L)	0.0357	0.0302 B	0.0976	0.0656	0.0416	0.0365	0.0255	A nitrate level of <1.0 mg/L is desirable for dechlorination.
pH	6.58	7.11	6.79	6.97	7.07	6.80	6.78	pH value is within the ideal range (6 to 8) for reductive dechlorination.

**Notes:**

\*Acetic acid and lactic acid are the most prevalent VFAs at AP-4551; see data tables in Appendix C2.

µg/L = microgram(s) per liter

B = The analyte was detected in the associated method and/or calibration blank.

DO = dissolved oxygen

EVO = emulsified vegetable oil

mg/L = milligram(s) per liter

mV = millivolt(s)

ORP = oxidation-reduction potential

TOC = total organic carbon

U = The analyte was analyzed for, but was not detected above the reported sample quantitation limit.

VFA = volatile fatty acid

### 15.5.2 Downgradient Monitoring Wells

Beginning in September 2014, annual monitoring of select wells downgradient of the three target treatment zones was started to assess the effects of ERD treatment downgradient of the target treatment zones. This sampling was initiated due to the greater than expected distribution of EVO during the September 2013 injections. Since monitoring of these downgradient wells was not originally intended as part of the treatability study, an August 2013 baseline sample was not

collected. Therefore, post-injection data are compared to the most recent pre-injection data. Additionally, less post-injection data are available for these downgradient locations as compared to the target treatment zone locations. As a result, concentration trends are not as robust and therefore fewer concentration graphs are presented for these wells. An evaluation of the data for each downgradient monitoring well is presented in the following sections.

### 15.5.2.1 AP-3744 – Shallow Downgradient Monitoring Well

Analyte concentration trends are summarized in the following subsections. CAH results for AP-3744 and an updated representation of the shallow TCE plume are presented on Figure 15-2. Graphs presenting CAH concentration, geochemical parameter, and total molar concentration trends are presented on Figure 15-7.

#### 15.5.2.1.1 AP-3744 – Chlorinated Aliphatic Hydrocarbons

AP-3744 is approximately 220 feet downgradient of the closest shallow aquifer target treatment zone, AP-3983. TCE concentrations in groundwater have decreased slightly and concentrations of cis-1,2-DCE increased compared to pre-injection concentrations. A summary of the concentration trends observed for the CAHs at AP-3744 is provided in Table 15-14.

Figure 15-7 shows a graphical representation of the relative molar concentrations of all the detected CAHs (including TCE, 1,1,2,2-PCA, and daughter products) at AP-3744 through time. The following observations can be made from total CAH molar concentration trends:

- TCE concentrations remain largely unchanged while cis-1,2-DCE has increased substantially.
- Cis-1,2,DCE now constitutes 85 percent of the CAHs at AP-3744
- The latest molar concentration of cis-1,2-DCE (3.3  $\mu\text{mol/L}$ ) is substantially greater than the total baseline molar concentration (0.4  $\mu\text{mol/L}$ )
- The total CAH molar concentration at AP-3744 has increased from 0.4 to 3.9  $\mu\text{mol/L}$  since the beginning of the treatability study.

Based on these observations the following conclusions can be drawn.

- It is unlikely that reductive dechlorination is occurring at AP-3744
- These results indicate that lower TCE concentrations and daughter products of upgradient reductive dechlorination are arriving at AP-3744.
- As TCE is degraded, it is expected that the total molar concentration of daughter products should be equal to or less than the baseline molar concentrations of TCE. However, the data from AP-3744 show a substantial increase in the molar concentrations of cis-1,2-DCE without a corresponding decrease in TCE. This increase in cis-1,2-DCE molar concentration is indicative of an influx of CAH mass from upgradient of AP-3744.

**Table 15-14 AP-3744 Chlorinated Aliphatic Hydrocarbon Results**

Analyte (µg/L)	Cleanup Level	September 2012	September 2014	September 2015	September 2016	Comments
PCE	5 <sup>a</sup>	0.4 U	0.33 J	0.3 U	0.17 J	Concentrations are below the MCL of 5 µg/L.
TCE	5 <sup>a</sup>	<b>42</b>	<b>47.2</b>	<b>22.1</b>	<b>33.2</b>	Concentration has decreased and could indicate that groundwater with lower TCE concentrations as a result of upgradient dechlorination are arriving at this well.
cis-1,2-DCE	70 <sup>a</sup>	1.5	13.7	41.6	<b>324</b>	Increase in concentration could indicate that daughter products from upgradient dechlorination of TCE are arriving at this well.
trans-1,2-DCE	100 <sup>a</sup>	0.38 J	0.82	0.38 J	5.07	Increase in concentration could indicate that daughter products from upgradient dechlorination of TCE are arriving at this well.
1,1-DCE	7 <sup>b</sup>	0.2 U	0.3 U	0.2 J	1.09	Increase in concentration could indicate that daughter products from upgradient dechlorination of TCE are arriving at this well.
Vinyl chloride	0.19 <sup>c</sup>	0.8 U	0.3 U	0.3 U	<b>0.52</b>	Increase in concentration could indicate that daughter products from upgradient dechlorination of TCE are arriving at this well.
Ethene	NA	0.64 U	0.118 U	0.167 U	0.206 U	Ethene is not present.
1,1,2,2-PCA	5.3 <sup>d</sup>	<b>5.2</b>	<b>9.3</b>	<b>11.3</b>	<b>41.8</b>	No indication that ERD treatment is degrading 1,1,2,2-PCA.
1,1,2-TCA	0.41 <sup>c</sup>	0.4 U	0.29 J	0.58	<b>2.07</b>	Increase in concentration could indicate degradation of 1,1,2,2-PCA.

**Notes:**

- <sup>a</sup> The MCL is the cleanup level selected in the OU B ROD (U.S. Army, 1997); therefore, it is used for comparison.
- <sup>b</sup> The MCL is less than the 18 AAC 75 Table C Groundwater Cleanup Level (ADEC, 2017); therefore it is used for comparison.
- <sup>c</sup> The 18 AAC 75 Table C Groundwater Cleanup Level (ADEC, 2017) is less than the MCL; therefore it is used for comparison.
- <sup>d</sup> The RBC is the cleanup level specified in the Memo to Site File (USAF, 2011b); therefore it is used for comparison.

**Bold** values indicate the result exceeded the MCL.

µg/L = microgram(s) per liter

DCE = dichloroethene

ERD = enhanced reductive dechlorination

J = The analyte was positively identified: the associated value is the approximate concentration of the analyte in the sample.

MCL = maximum contaminant level

NA = Not available

PCA = tetrachloroethane

PCE = tetrachloroethene

TCA = trichloroethane

U = The analyte was analyzed for, but was not detected above the reported sample quantitation limit.

TCE = trichloroethene

### 15.5.2.1.2 AP-3744 – Geochemical Parameters

The geochemical parameters measured at AP-3744 indicate that the groundwater environment is not sufficiently anaerobic to promote reductive dechlorination. The following results were observed for the geochemical parameters at AP-3744. A summary of the results observed for the geochemical parameters at AP-3744 is provided in Table 15-15.



**Table 15-15 AP-3744 Geochemical Parameter Results**

Analyte	September 2014	September 2015	September 2016	Comments
ORP (mV)	6.4	135	135.7	Positive value indicates that conditions are not reduced enough for dechlorination to occur.
DO (mg/L)	6.94	10.25	0.63 <sup>a</sup>	DO values below 1 mg/L indicate that conditions are favorable for dechlorination to occur.
TOC (mg/L)	1.01 B	1.6 B	2.28	Insufficient carbon and energy source to drive dechlorination (>20 mg/L is considered sufficient).
VFAs <sup>b</sup> - lactic acid (µg/L)	40 U – 80 U	72.1 J	100 U	Indicates that EVO distribution did not reach AP-3744. VFAs are a degradation product of EVO, and concentrations of VFAs greater than 10,000 to 20,000 µg/L are a good indicator of sufficient EVO distribution at a given location.
Methane (µg/L)	1.04 B	3.64	91.8	Levels greater than 1,000 µg/L are an indicator of highly reducing conditions, and are desirable for dechlorination to occur.
Dissolved Iron (mg/L)	0.02 U	0.0586 B	0.0121 J	Ferrous iron was measured at 0.0 mg/L using a field test kit, indicating that conditions are not sufficiently reduced.
Sulfate (mg/L)	13.1	9.49	2.72	The presence of sulfate indicates that the groundwater is insufficiently reduced for anaerobic dechlorination to occur.
Sulfide (mg/L)	0.0193 U	0.02 U	0.02 U	Lack of sulfide is consistent with the presence of sulfate.
Nitrate (mg/L)	0.394	0.21	0.006 U	A nitrate level of <1.0 mg/L is desirable for dechlorination.
pH	7.08	6.68	7.05	pH value is within the acceptable range (6 to 8) for reductive dechlorination.

**Notes:**

<sup>a</sup> Based on the ORP readings, DO value is probably biased low.

<sup>b</sup> Lactic acid was the only VFA historically detected at AP-3744; see data tables in Appendix C2.

B = The analyte was detected in the associated method and/or calibration blank.

J = The analyte was positively identified: the associated value is the approximate concentration of the analyte in the sample.

U = The analyte was analyzed for, but was not detected above the reported sample quantitation limit.

µg/L = microgram(s) per liter

DO = dissolved oxygen

EVO = emulsified vegetable oil

mV = millivolt(s)

mg/L = milligram(s) per liter

ORP = oxidation-reduction potential

VFA = volatile fatty acid

### 15.5.2.2 AP-3747 – Shallow Downgradient Monitoring Well

Analyte concentration trends are summarized in the following subsections. CAH results for AP-3747 and an updated representation of the shallow TCE plume are presented on Figure 15-2. Graphs presenting CAH concentration, geochemical parameter, and total molar concentration trends are presented on Figure 15-8.

#### 15.5.2.2.1 AP-3747 – Chlorinated Aliphatic Hydrocarbons

AP-3747 is approximately 375 feet downgradient of the closest shallow aquifer target treatment zone, AP-3983. TCE concentrations in groundwater have increased since September 2012. All other CAH concentrations have remained stable, with the exception of cis-1,2-DCE, which has slightly increased. A summary of the concentration trends observed for the CAHs at AP-3747 is provided in Table 15-16.

**Table 15-16 AP-3747 Chlorinated Aliphatic Hydrocarbon Results**

Analyte (µg/L)	Cleanup Level	September 2012	September 2014	September 2015	September 2016	Comments
PCE	5 <sup>a</sup>	0.87 J	1.96	3.96	3.51	Concentrations are below the MCL of 5 µg/L.
TCE	5 <sup>a</sup>	<b>88</b>	<b>209</b>	<b>391</b>	<b>397</b>	Concentration has increased from 2012 value, but the 2012 value is relatively low compared to 2010 and 2011 sample results.
cis-1,2-DCE	70 <sup>a</sup>	5.1	13.4	29	24.9	Likely related to increase in TCE concentration.
trans-1,2-DCE	100 <sup>a</sup>	1.7	3.17	6.51	6.73	Slight increase over time.
1,1-DCE	7 <sup>b</sup>	0.33 J	0.79	1.37	1.17	Slight increase over time.
Vinyl chloride	0.19 <sup>c</sup>	0.8 U	0.3 U	0.3 U	0.3 U	Vinyl chloride is not present.
Ethene	NA	0.64 U	0.119 U	0.215 U	0.145 U	Ethene is not present.
1,1,2,2-PCA	5.3 <sup>d</sup>	0.81 J	<b>27.8</b>	<b>18.6</b>	<b>8.17</b>	Concentration has increased from 2012 value, but the 2012 value is suspiciously low compared to 2009 sample results. Some indication that ERD treatment is degrading 1,1,2,2-PCA.
1,1,2-TCA	0.41 <sup>c</sup>	0.52 J	1.57	1.9	1.88	Slight increase over time.

**Notes:**

- <sup>a</sup> The MCL is the cleanup level selected in the OU B ROD (U.S. Army, 1997); therefore, it is used for comparison.
- <sup>b</sup> The MCL is less than the 18 AAC 75 Table C Groundwater Cleanup Level (ADEC, 2017); therefore it is used for comparison.
- <sup>c</sup> The 18 AAC 75 Table C Groundwater Cleanup Level (ADEC, 2017) is less than the MCL; therefore it is used for comparison.
- <sup>d</sup> The RBC is the cleanup level specified in the Memo to Site File (USAF, 2011b); therefore it is used for comparison.

**Bold** values indicate the result exceeded the MCL.

µg/L = microgram(s) per liter

DCE = dichloroethene

ERD = enhanced reductive dechlorination

J = The analyte was positively identified: the associated value is the approximate concentration of the analyte in the sample.

MCL = maximum contaminant level

NA = Not available

PCA = tetrachloroethane

PCE = tetrachloroethene

TCA = trichloroethane

TCE = trichloroethene

U = The analyte was analyzed for, but was not detected above the reported sample quantitation limit.

Figure 15-9 shows a graphical representation of the relative molar concentrations of all the detected CAHs (including TCE, 1,1,2,2-PCA, and daughter products) at AP-3747 through time. The following observations can be made from total CAH molar concentration trends:

- TCE constitutes 88 percent of the CAHs at AP-3747
- The latest molar concentration of TCE (3.0 µmol/L) is substantially greater than the total baseline molar concentration (0.7 µmol/L)
- The total CAH molar concentration at AP-4551 has increased from 0.7 to 3.4 µmol/L (and as high as 3.5 µmol/L) since the beginning of the treatability study.

Based on these observations the following conclusions can be drawn.

- These results indicate that reductive dechlorination resulting from upgradient injections is not occurring at AP-3747.
- When compared with only the 2012 result (88 µg/L), it appears as if the TCE concentration (397 µg/L in 2016) is increasing at AP-3747. However, the TCE concentrations from 2010 and 2011 were 680 and 600 µg/L, respectively. Therefore, it is likely that the results from 2012 represent an anomalously low result, and it does not seem likely that the TCE plume is expanding.

#### **15.5.2.2.2 AP-3747 – Geochemical Parameters**

The geochemical parameters measured at AP-3747 indicate that the groundwater environment is not sufficiently anaerobic to promote reductive dechlorination. The following results were observed for the geochemical parameters at AP-3747. A summary of the results observed for the geochemical parameters at AP-3747 is provided in Table 15-17.

**Table 15-17 AP-3747 Geochemical Parameter Results**

Analyte	September 2014	September 2015	September 2016	Comments
ORP (mV)	250.3	130	140.3	Positive value indicates that conditions are not reducing enough for dechlorination to occur.
DO (mg/L)	1.81 <sup>a</sup>	11.59 <sup>b</sup>	15.51 <sup>b</sup>	DO values greater than 1 mg/L indicate that conditions are not reduced enough for dechlorination to occur.
TOC (mg/L)	0.859 B	0.935 B	0.907	Insufficient carbon and energy source to drive dechlorination (>20 mg/L is considered sufficient).
VFAs <sup>c</sup> (µg/L)	40 U – 80 U	100 U – 180 U	100 U	Indicates that EVO distribution did not reach AP-3747. VFAs are a degradation product of EVO, and concentrations of VFAs greater than 10,000 to 20,000 µg/L are a good indicator of sufficient EVO distribution at a given location.
Methane (µg/L)	0.0961 B	0.412 B	2.02 J	Levels greater than 1,000 µg/L are an indicator of highly reducing conditions, and are desirable for dechlorination to occur.
Dissolved Iron (mg/L)	0.02 U	0.142	0.02 U	Ferrous iron was measured at 0.13 mg/L using a field test kit, indicating that conditions are not sufficiently reduced.
Sulfate (mg/L)	11.4	10.9	8.94	The presence of sulfate indicates that the groundwater is insufficiently reduced for anaerobic dechlorination to occur.
Sulfide (mg/L)	0.0193 U	0.02 U	0.0112 J	Lack of sulfide is consistent with the presence of sulfate.
Nitrate (mg/L)	0.334	0.3	0.246	A nitrate level of <1.0 mg/L is desirable for dechlorination.
pH	7.60	6.90	7.84	pH value is within the acceptable range (6 to 8) for reductive dechlorination.

**Notes:**

<sup>a</sup> Based on the ORP readings, DO value is probably biased low.

<sup>b</sup> Erroneous DO measurement. Based on temperature at time of 2016 readings, (3.5 degrees Celsius), value represents approximately 117 percent saturation.

<sup>c</sup> VFAs include acetic acid, butyric acid, formic acid, lactic acid, propionic acid, and pyruvic acid.

µg/L = microgram(s) per liter

B = The analyte was detected in the associated method and/or calibration blank.

DO = dissolved oxygen

EVO = emulsified vegetable oil

mg/L = milligram(s) per liter

mV = millivolt(s)

ORP = oxidation-reduction potential

U = The analyte was analyzed for, but was not detected above the reported sample quantitation limit.

VFA = volatile fatty acid

### 15.5.2.3 AP-3989 – Shallow Downgradient Monitoring Well

Analyte concentration trends are summarized in the following subsections. CAH results for AP-3989 and an updated representation of the shallow TCE plume are presented on Figure 15-2. Graphs presenting CAH concentration, geochemical parameter, and total molar concentration trends are presented on Figure 15-9.

#### 15.5.2.3.1 AP-3989 – Chlorinated Aliphatic Hydrocarbons

AP-3989 is approximately 100 feet downgradient of the closest shallow aquifer target treatment zone, AP-3983. Current groundwater results indicate that reductive dechlorination is occurring at

AP-3989. Concentrations of TCE in groundwater at AP-3989 have decreased substantially since the injection of EVO in September 2013. In turn, concentrations of TCE daughter products, particularly cis-1,2-DCE, have increased substantially compared to pre-injection concentrations; and concentrations of vinyl chloride have increased to detectable levels. A summary of the concentration trends observed for the CAHs at AP-3989 is provided in Table 15-18.

Figure 15-9 shows a graphical representation of the relative molar concentrations of all the detected CAHs (including TCE, 1,1,2,2-PCA, and daughter products) at AP-3989 through time. The following observations can be made from total CAH molar concentration trends:

- Practically all of the TCE has been degraded to cis-1,2-DCE; other daughter products like trans-1,2-DCE and vinyl chloride make up very little of the total CAH molar mass
- cis-1,2-DCE now constitutes 93 percent of the CAHs at AP-3989
- The latest molar concentration of cis-1,2-DCE (13.7  $\mu\text{mol/L}$ ) is substantially greater than the total baseline molar concentration (6.8  $\mu\text{mol/L}$ )
- The total CAH molar concentration at AP-4551 has increased from 6.8 to 14.7  $\mu\text{mol/L}$  (and as high as 17.0  $\mu\text{mol/L}$ ) since the beginning of the treatability study.

Based on these observations the following conclusions can be drawn:

- While there is evidence that cis-1,2-DCE is being degraded to vinyl chloride and then to ethene, the degradation of cis-1,2-DCE is occurring at a rate much slower than TCE is being degraded. The slow degradation of cis-1,2-DCE is likely evidence that a sufficient population of DHC was not present within the target treatment zone.
- As TCE is degraded, it is expected that the total molar concentration of daughter products should be equal to or less than the baseline molar concentrations of TCE. However, the data from AP-3989 show a substantial increase in the molar concentrations of daughter products (primarily cis-1,2-DCE) relative to TCE. This increase in cis-1,2-DCE molar concentration could be explained by any combination of the following:
  - An influx of CAH mass from upgradient of AP-3989
  - Back-diffusion of sorbed CAHs from the surrounding fine-grained soils into the dissolved phase
  - 1,1,2,2-PCA being degraded to cis-1,2-DCE
  - 1,1,2,2-PCA being abiotically degraded to TCE and then the TCE being degraded to cis-1,2-DCE
  - Variability of CAHs within the subsurface

**Table 15-18 AP-3989 Chlorinated Aliphatic Hydrocarbon Results**

Analyte (µg/L)	Cleanup Level	September 2012	September 2014	September 2015	September 2016	Comments
PCE	5 <sup>a</sup>	4.1	0.3 U	1.5 U	1.5 U	Decrease indicates that PCE is being dechlorinated.
TCE	5 <sup>a</sup>	<b>610</b>	2.47	1.64 J	1.99 J	Decrease indicates that TCE is being dechlorinated.
cis-1,2-DCE	70 <sup>a</sup>	83	<b>1,250</b>	<b>1,540</b>	<b>1,330</b>	Increase indicates that TCE is being dechlorinated.
trans-1,2-DCE	100 <sup>a</sup>	26	39.9	45.6	43.3	Increase indicates that TCE is being dechlorinated.
1,1-DCE	7 <sup>b</sup>	1.7 J	3.2	4.72	4.53	Not a primary dechlorination pathway.
Vinyl chloride	0.19 <sup>c</sup>	1.6 U	<b>8.71</b>	<b>11</b>	<b>7.25</b>	Increase indicates that DCE is also being dechlorinated.
Ethene	NA	0.64 U	0.368 J	1.19 U	0.161 J	Detection indicates that complete dechlorination is occurring.
1,1,2,2-PCA	5.3 <sup>d</sup>	<b>150</b>	<b>97.4</b>	<b>58.2</b>	<b>52.6</b>	Concentration of 1,1,2,2-PCA is decreasing, could indicate degradation via ERD.
1,1,2-TCA	0.41 <sup>c</sup>	<b>6.6</b>	<b>3.73</b>	<b>2.92</b>	<b>2.55</b>	Concentration is stable.

**Notes:**

<sup>a</sup> The MCL is the cleanup level selected in the OU B ROD (U.S. Army, 1997); therefore, it is used for comparison.

<sup>b</sup> The MCL is less than the 18 AAC 75 Table C Groundwater Cleanup Level (ADEC, 2017); therefore it is used for comparison.

<sup>c</sup> The 18 AAC 75 Table C Groundwater Cleanup Level (ADEC, 2017) is less than the MCL; therefore it is used for comparison.

<sup>d</sup> The RBC is the cleanup level specified in the Memo to Site File (USAF, 2011b); therefore it is used for comparison.

**Bold** values indicate the result exceeded the MCL.

µg/L = microgram(s) per liter

DCE = dichloroethene

ERD = enhanced reductive dechlorination

J = The analyte was positively identified: the associated value is the approximate concentration of the analyte in the sample.

MCL = maximum contaminant level

NA = Not available

PCA = tetrachloroethane

PCE = tetrachloroethene

TCA = trichloroethane

TCE = trichloroethene

U = The analyte was analyzed for, but was not detected above the reported sample quantitation limit.

### 15.5.2.3.2 AP-3989 – Geochemical Parameters

The geochemical parameters measured in groundwater at AP-3989 indicate that the groundwater environment is sufficiently anaerobic for reductive dechlorination to occur. However, the DO reading from September 2016 appears anomalous. A summary of the results observed for the geochemical parameters at AP-3989 is provided in Table 15-19.



**Table 15-19 AP-3989 Geochemical Parameter Results**

Analyte	September 2014	September 2015	September 2016	Comments
ORP (mV)	-119	-45.1	-52.7	Negative value indicates reducing conditions, favorable for dechlorination.
DO (mg/L)	1.03	0.51	13.68 <sup>a</sup>	DO values less than 1 mg/L indicate that conditions are favorable for dechlorination.
TOC (mg/L)	63.3	176 B	82.7	Sufficient carbon and energy source to drive dechlorination (>20 mg/L is considered sufficient).
VFAs <sup>b</sup> – acetic acid (µg/L)	116,000	404,000	170,000	VFAs are a degradation product of EVO, and concentrations of VFAs greater than 10,000 to 20,000 µg/L are a good indicator of sufficient EVO distribution at a given location.
Methane (µg/L)	1,700	5,830	1,370	Levels greater than 1,000 µg/L are an indicator of highly reducing conditions and are desirable for dechlorination to occur.
Dissolved Iron (mg/L)	32.5	39.9	30.6	An increase in ferrous iron concentrations can indicate that groundwater is sufficiently reducing for anaerobic dechlorination to occur. Although dissolved iron reported from laboratory analysis did not speciate between ferric and ferrous iron, ferrous iron was measured using a field test kit (Appendix A). The ferrous iron result from the field test kit was 1.80 mg/L, and the other geochemical parameters indicate groundwater is sufficiently reducing for anaerobic dechlorination to occur.
Sulfate (mg/L)	0.1 U	3.12 J	0.351 B	Low sulfate indicates that the groundwater is sufficiently reduced for dechlorination to occur.
Sulfide (mg/L)	0.0304	0.0107 J	0.02 U	Low concentrations could indicate that FeS minerals have been formed.
Nitrate (mg/L)	0.228	0.143	0.0869	A nitrate level of <1.0 mg/L is desirable for dechlorination.
pH	7.43	6.59	7.19	pH value is within the acceptable range (6 to 8) for reductive dechlorination.

**Notes:**

<sup>a</sup> Erroneous DO measurement. Based on temperature at time of 2016 readings, (5.5 degrees Celsius), value represents approximately 109 percent saturation.

<sup>b</sup> Acetic acid is the most prevalent VFA at AP-3989; see data tables in Appendix C2.

µg/L = microgram(s) per liter

B = The analyte was detected in the associated method and/or calibration blank.

DO = dissolved oxygen

EVO = emulsified vegetable oil

mg/L = milligram(s) per liter

mV = millivolt(s)

ORP = oxidation-reduction potential

U = The analyte was analyzed for, but was not detected above the reported sample quantitation limit.

VFA = volatile fatty acid

#### 15.5.2.4 AP-4525 – Deep Downgradient Monitoring Well

AP-4525 is approximately 200 feet downgradient of the closest deep aquifer target treatment zone, AP-4551. Due to the limited volume of water in monitoring well AP-4525, no sample was obtained. Therefore, there are no data to assess the current geochemical conditions at AP-4525.



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## 15.6 MANN-KENDALL TREND ANALYSIS

A Mann-Kendall trend analysis was performed for a CG039 monitoring well if: (1) the well was sampled in 2016, (2) there are four or more data points available to run the calculation, (3) the cleanup goal for COCs as identified in the OU B ROD have been exceeded one or more times in the past 5 years, and (4) the data set has less than 50 percent non-detected values. Data sets are limited to no longer than 10 years for all LTM wells to provide a (relatively) short-term trend analysis for the site. In addition, Mann-Kendall trend analysis was also conducted for monitoring wells located within and downgradient of the treatability study target treatment zones at CG039 (AP-3744, AP-3747, AP-3983R, AP-3983, AP-4550, and AP-4551) for all COCs and daughter products. The data evaluated are limited to the period from the 2013 emulsified vegetable oil injections onward.

A Mann-Kendall trend analysis was performed for six monitoring wells (AP-3744, AP-3747, AP-3983R, AP-3989, AP-4353, and AP-4550) located within the shallow aquifer plume and two monitoring wells (AP-4344 and AP-4551) located within the deep aquifer plume. A summary of Mann-Kendall concentration trends is provided in Table 15-20 and on Figures 15-4 through 15-11. Historical data used to calculate the Mann-Kendall concentrations trends are provided in Appendix C2.

Trend results indicate that statistically significant (95 percent confidence level or greater) decreasing trends are present for the following constituents and locations:

- TCE in monitoring wells AP-3983R and AP-4550
- PCE in monitoring wells AP-3983R and AP-4550
- 1,1,2,2-PCA in monitoring wells AP-AP-3983R, AP-3989, AP-4353, and AP-4550
- 1,1,2-TCA in monitoring wells AP-3989, AP-4353, and AP-4550

Increasing trends are present for the following constituents and locations:

- TCE at monitoring well AP-3747
- cis-1,2-DCE at monitoring wells AP-3744 and AP-3983R
- 1,1,2,2-PCA in monitoring well AP-3744
- 1,1,2-TCA in monitoring well AP-3744
- 1,1-DCE in monitoring well AP-3983R
- Vinyl chloride at AP-3983R

A probable (between 90 and 95 percent confidence levels) increasing trend is present for the following constituents:

- 1,1-DCE at monitoring well AP-4551
- cis-1,2-DCE at monitoring wells AP-4550 and AP-4551
- Vinyl chloride at monitoring well AP-4550

A probable (between 90 and 95 percent confidence levels) decreasing trend is present for TCE at monitoring well AP-4551.

There are no statistically significant trends present for benzene, carbon tetrachloride, or trans-1,2-DCE.

**Table 15-20 Summary of 2016 Mann-Kendall Concentration Trends for Select Wells at CG039**

Well	Aquifer	PCE <sup>a</sup>	TCE <sup>a</sup>	cis-1,2-DCE <sup>a</sup>	trans-1,2-DCE <sup>a</sup>	1,1-DCE	1,1,2,2-PCA <sup>a</sup>	1,1,2-TCA	Vinyl Chloride	Carbon Tetrachloride <sup>a</sup>	Benzene
<i>Treatability Study Wells – Target Treatment Zone<sup>b</sup></i>											
AP-3983R <sup>b</sup>	Shallow	Decreasing (99.7)	Decreasing (100.0)	Increasing (99.9)	NST	Increasing (98.5)	Decreasing (98.5)	NST	Increasing (95.8)	ID	ID
AP-4550 <sup>b,c</sup>	Shallow	Decreasing (99.0)	Decreasing (99.9)	Probably Increasing (93.2)	NST	NST	Decreasing (99.9)	Decreasing (98.5)	Probably Increasing (93.2)	ID	ID
AP-4551 <sup>b</sup>	Deep	ID	Probably Decreasing (93.2)	Probably Increasing (93.2)	ID	Probably Increasing (93.2)	NST	NST	NST	ID	ID
<i>Treatability Study Wells – Downgradient</i>											
AP-3744	Shallow	ID	NST	Increasing (95.8)	ID	ID	Increasing (95.8)	Increasing (95.8)	ID	ID	ID
AP-3747 <sup>c</sup>	Shallow	ID	Increasing (95.8)	ID	ID	ID	NST	NST	ID	ID	ID
AP-3989	Shallow	ID	ID	NST	ID	ID	Decreasing (95.8)	Decreasing (95.8)	NST	ID	ID
<i>LTM Only Program Wells</i>											
AP-4344	Deep	ID	NST	ID	ID	ID	ID	ID	ID	ID	ID
AP-4353	Shallow	ID	NST	ID	ID	ID	Decreasing (99.9)	Decreasing (99.0)	ID	ID	ID

**Notes:**

<sup>a</sup> COCs

<sup>b</sup> Data points included in the Mann-Kendall trend calculation for wells in the treatability study target treatment zone (AP-3983R, AP-4550, and AP-4551) have been limited to August 2013 (pre-injection baseline) forward. Results for all COCs and daughter products are presented in this table.

<sup>c</sup> LTM and Treatability Study Well

Decreasing (96.2) = Decreasing concentration trend with 96.2 percent confidence.

Trends are considered significant at greater than 95 percent confidence. Trends are considered probably significant between 90 and 95 percent confidence.

Wells included in the 2016 Mann-Kendall Trend analysis (1) were sampled during the 2016 monitoring event, (2) have four or more data points available to run the calculation, (3) show that cleanup levels for COCs have been exceeded one or more times in the past 5 years, and (4) have data sets that have been limited to less than 10 years to provide a (relatively) short-term trend. The remaining wells are either free of contamination, have not had exceedances in the past 5 years, or do not have any significant trends and were therefore not evaluated. The remaining wells are either free of contamination, have not had exceedances in the past 5 years, or do not have any significant trends.

COC = contaminant of concern

DCE = dichloroethene

ID = insufficient data to run Mann-Kendall trend analysis. Data set either contains greater than 50 percent non-detect values or has less than four data points

LTM = long-term management

NST = No significant trend.

PCA = tetrachloroethane

PCE = tetrachloroethene

TCA = trichloroethane

TCE = trichloroethene



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## 15.7 SITE SUMMARY AND RECOMMENDATIONS

The current ADEC site status for CG039 is “Active.”

An Optimized Exit Strategy (OES) Performance Plan for CG039 was finalized in February 2013 under the current PBR contract. The OES at CG039 includes performing an enhanced reductive dechlorination treatability study and continuing long-term monitoring as outlined in the 2011 *Memorandum to the Site File for Long Term Monitoring at OUB/Poleline Road Disposal Area* (USAF, 2011b).

### 15.7.1 Treatability Study Summary

Implementation of the treatability study occurred in 2013, when injection wells were installed and a combination of EVO and ferrous sulfate were injected into two areas in the shallow aquifer and one area in the deep aquifer. Monitoring of the treatability study is ongoing. The objective of the additional treatability study groundwater monitoring is to assess potential rebound of TCE concentrations, degradation of TCE daughter products, and persistence of reducing groundwater conditions.

Conclusions for the treatability study wells (AP-3983, AP-4550, and AP-4551) are as follows:

- Geochemical parameters indicate that anaerobic conditions necessary for reductive dechlorination have persisted in the shallow and deep aquifers.
- Concentrations of TCE in groundwater within the shallow and deep aquifer target treatment zones remain steady near the MCL, and represent a reduction of over 99 percent when compared to the 2013 baseline TCE concentrations.
- High concentrations of TCE daughter products, primarily cis-1,2-DCE and vinyl chloride, remain within the shallow and deep aquifer target treatment zones. While there is evidence that cis-1,2-DCE is being degraded to vinyl chloride and then to ethene, the degradation of cis-1,2-DCE is occurring much slower than the rate at which TCE is being degraded. The slow rate cis-1,2-DCE degradation suggests that the native populations of DHC within the target treatment zones are insufficient to completely degrade cis-1,2-DCE to vinyl chloride and then to ethene. Bioaugmentation was conducted following the 2016 sampling round to assess if the introduction of a microbial consortium known to be capable of completely degrading cis-1,2-DCE and vinyl chloride to nontoxic ethene would be effective at reducing cis-1,2-DCE concentrations at CG039.

Conclusions for the downgradient monitoring wells AP-3744, AP-3747, AP-3989, and AP-4525 are as follows:

- As a result of greater-than-expected downgradient distribution of the substrate, concentrations of TCE in groundwater at shallow monitoring well AP-3989, approximately 100 feet downgradient of the AP-3983 injections, remain steady near the MCL and represent a reduction of over 99 percent. Correspondingly, relatively high concentrations of the TCE daughter product (cis-1,2-DCE), as well as low concentrations of vinyl chloride, have been generated.

- Shallow aquifer monitoring wells AP-3744 and AP-3747, which are located further downgradient of the EVO distribution area, have shown little indication of reducing conditions being generated and no reduction in TCE concentrations.
- Due to the limited volume of water in monitoring well AP-4525, located approximately 200 feet downgradient of the closest deep aquifer target treatment zone AP-4551, no groundwater sample could be obtained. Therefore, there are no data to evaluate whether reductive dechlorination is occurring at AP-4525.

### 15.7.2 Five-Year Review

CG039 is required to have CERCLA five-year reviews conducted until such time as the cleanup goals are achieved. The purpose of the five-year review is to evaluate the implementation and performance of the remedial actions. To date, three CERCLA five-year reviews (in 2003, 2008, and 2013) have been performed for JBER-R (which includes CG039). Groundwater sampling was completed during the 2016 field effort to ensure results were available for the Fourth CERCLA Five-Year Review Report for JBER-R (to be completed in 2018).

The 2016 sampling event included six wells (AP-3744, AP-3745, AP-3981, AP-3982, AP-3989, and AP-4350) that are sampled only during events prior to the Five-Year Review; these wells are considered “sentinel wells” because of their locations and consistent historical results. Significant changes in concentrations of contaminants in sentinel wells can be indicative of changes in plume size or shape (USAF, 2011b).

Results from the six “sentinel wells” sampled during 2016 indicate that the TCE plume is stable, but the core of the TCE may have shifted slightly as a result of the treatability study:

- **AP-3744 and AP-3745 (Shallow):** The carbon substrate injections in the core of the shallow plume may have pushed groundwater with relatively higher TCE concentrations laterally towards monitoring well AP-3745 (which increased from 55 µg/L in 2012 to 346 µg/L in 2016). Similarly, the increase in 1,1,2,2-PCA concentrations to AP-3744 are potentially a result of the injection.
- **AP-3981 and AP-3982 (Shallow):** COCs and other chemicals of interest were not detected at these locations.
- **AP-3989 (Shallow):** COC concentrations at this location have been significantly impacted by the treatability study. See Section 15.5.2.3. for details.
- **AP-4530 (Deep):** COCs and other chemicals of interest were not detected at this location.

### 15.7.3 Recommendations

CG039 has been identified as a **Red** priority because the treatability study has substantially reduced contaminant concentrations in the target treatment zones; however, concentrations of TCE daughter products, primarily cis-1,2-DCE, have increased substantially. Annual monitoring will

continue to assess plume-wide and treatability target treatment zone concentration trends, as described below.

Specific recommendations for ongoing groundwater monitoring are as follows:

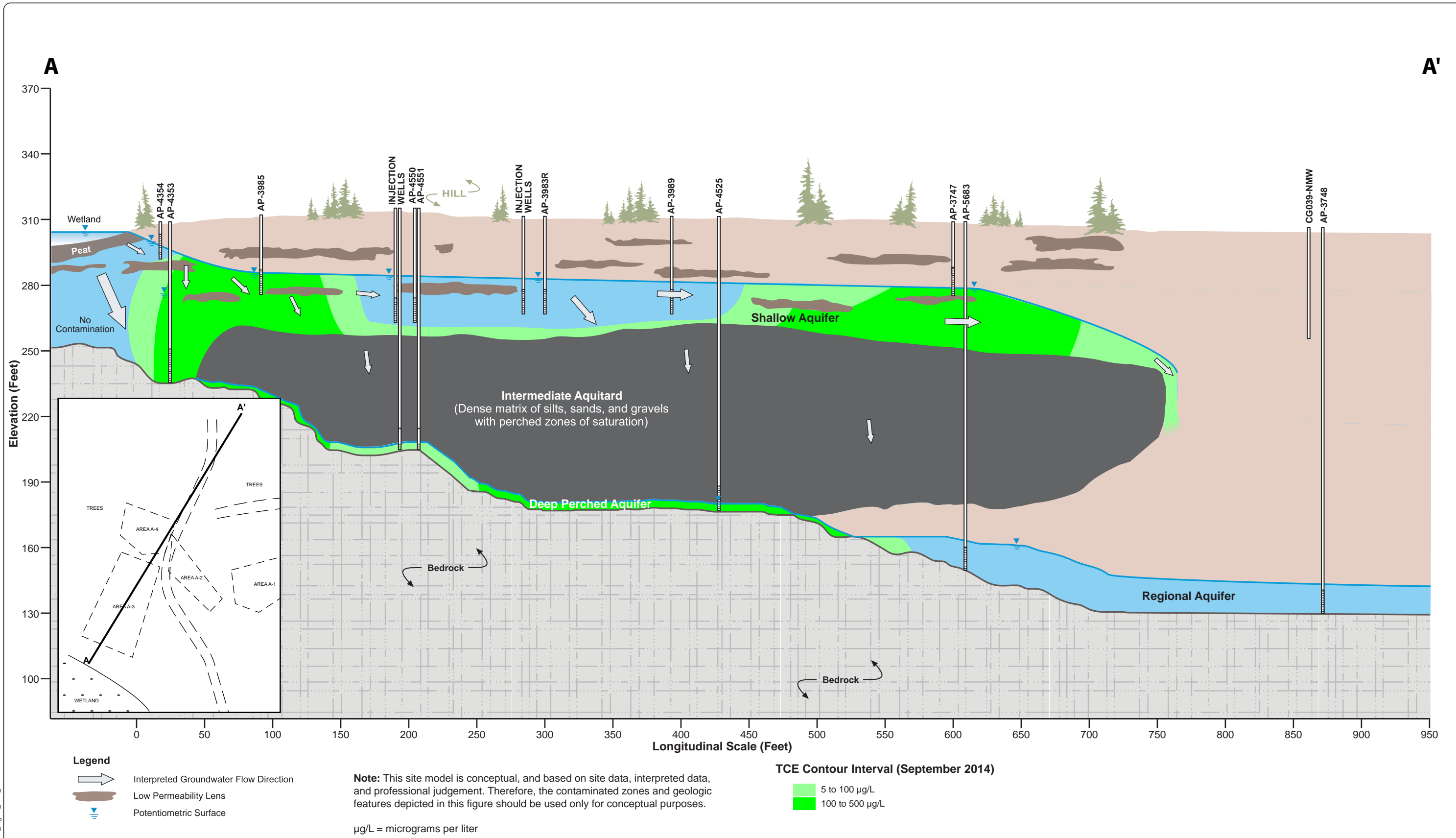
- Annual groundwater monitoring will continue in accordance with the 2011 *Memorandum to the Site File for Long Term Monitoring at OUB/Poleline Road Disposal Area*(2011 Memo to Site File) (USAF, 2011b).
- Continue with annual groundwater monitoring of the treatability study wells (AP-3744, AP-3747, AP-3983R, AP-3989, AP-4550, and AP-4551) in accordance with the *Remedial Action – Operations and Monitoring Letter Work Plan and Basewide Uniform Federal Policy-Quality Assurance Project Plan Addendum* (USAF, 2017a) to assess potential rebound of TCE concentrations, degradation of TCE daughter products (following the 2016 bioaugmentation), and persistence of reducing groundwater conditions.
- Suspend monitoring of treatability study well AP-4525 due to inadequate volume of groundwater. During the past three monitoring events, the limited volume prevented the use of a submersible bladder pump, and only one partial sample has been collected (by bailer in 2015). The inability to produce enough volume for analysis of planned methods, and a bailer not being the preferred sampling method for VOCs, are the reasons that AP-4525 is unable to provide viable groundwater samples for the treatability study.
- The monitoring results from the six treatability study wells will be reported in the 2017 annual groundwater monitoring report.

Based on the results of the additional treatability study groundwater monitoring, the following actions are recommended:

- Continue with annual groundwater monitoring as outlined in *Treatability Study Report CG039 – Poleline Road Disposal Area Joint Base Elmendorf-Richardson, Alaska* (USAF, 2015d).
- Continue the treatability study to evaluate whether bioaugmentation (completed in 2016) can degrade cis-1,2-DCE and possibly 1,1,2,2-PCA to accelerate the remedial time frame at the site.

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**CONCEPTUAL SITE MODEL**  
 CG039 - Poleline Road Disposal Area  
 2016 Annual Remedial Action Operations and  
 Monitoring Report for Select CERCLA Sites  
 Joint Base Elmendorf-Richardson, Alaska

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**NOTES:**

- Monitoring well AP-4353 was not included in the the groundwater elevation contour assessment because it is screened in a transition zone between the shallow and deep aquifer.
- Coordinate System: UTM Zone 6, WGS84, meters.
- All results in micrograms per liter (µg/L).
- Bold** font indicates concentration exceeds relevant cleanup level.
- Approximate groundwater flow direction was based on 2016 Long-Term Monitoring groundwater elevation data.
- Depth to groundwater measurements are included in the "Water Level Survey Form" provided in Appendix A2. The groundwater elevation data presented on this figure are calculated from those measurements and are summarized in Table 15-4.
- Data shown represents the most recent three annual monitoring events, with the exception of older data the helps define the known extent of TCE.
- Flags:
  - J The analyte was positively identified: the associated numerical value is the approximate concentration of the analyte in the sample.
  - Not measured or not sampled.
  - ND(0.4) Indicates non-detect (MDL) or non-detect (PQL).
- Abbreviations:
  - 1,1-DCE 1,1-Dichloroethene
  - 1,1,2-TCA 1,1,2-Trichloroethane
  - 1,1,2,2-PCA 1,1,2,2-Tetrachloroethane
  - ADEC Alaska Department of Environmental Conservation.
  - AMSL above mean sea level
  - cis-1,2-DCE cis-1,2-Dichloroethene
  - MDL method detection limit
  - OU B ROD Operable Unit B Record of Decision
  - PCE tetrachloroethene
  - PQL practical quantitation limit
  - TCE trichloroethane
  - trans-1,2-DCE trans-1,2-Dichloroethene

AP-4550											
Date	Benzene	Carbon Tetrachloride	cis-1,2-DCE	trans-1,2-DCE	PCE	TCE	1,1,2,2-PCA	Ethene	Vinyl Chloride	1,1-DCE	1,1,2-TCA
9/9/2014	ND(1.5)	ND(1.5)	<b>924</b>	31.8	0.52	<b>10.6</b>	<b>97.2</b>	0.303 J	<b>5.25</b>	3.14	<b>6.18</b>
9/18/2015	0.49 J	ND(0.3)	<b>1630</b>	55.2	0.3 J	4.19	<b>94.4</b>	ND(2.33) J	<b>18.5</b>	4.78	<b>4.13</b>
9/1/2016	ND(3)	ND(3)	<b>2150</b>	62	ND(3)	2.18 J	<b>89.3 J</b>	8.09	<b>24.5</b>	6.12	<b>3.71 J</b>

AP-3983R											
Date	Benzene	Carbon Tetrachloride	cis-1,2-DCE	trans-1,2-DCE	PCE	TCE	1,1,2,2-PCA	Ethene	Vinyl Chloride	1,1-DCE	1,1,2-TCA
9/9/2014	0.9	ND(0.3)	<b>4070</b>	98.8	0.79	<b>12.4</b>	<b>332</b>	2.36	<b>43.7</b>	8.12	<b>24.4</b>
9/22/2015	0.77 J	ND(1.5)	<b>3480</b>	84.9	ND(1.5)	3.6	<b>279</b>	ND(1.09)	<b>42.1</b>	7.8	<b>10.9</b>
9/1/2016	ND(3) J	ND(3) J	<b>3510 J</b>	83 J	ND(3) J	3.4 J	<b>224 J</b>	ND(1.62)	<b>37.3 J</b>	7.41 J	<b>8.94 J</b>

AP-3747											
Date	Benzene	Carbon Tetrachloride	cis-1,2-DCE	trans-1,2-DCE	PCE	TCE	1,1,2,2-PCA	Ethene	Vinyl Chloride	1,1-DCE	1,1,2-TCA
9/5/2014	ND(0.3)	1.85	13.4	3.17	1.96	<b>209</b>	<b>27.8</b>	ND(0.119)	ND(0.3)	0.79	<b>1.57</b>
9/17/2015	ND(0.3)	2.21	29	6.51	3.96	<b>391</b>	<b>18.6</b>	ND(0.215)	ND(0.3)	1.37	<b>1.9</b>
9/10/2016	ND(0.3)	1.35	24.9	6.73	3.51	<b>397</b>	<b>8.17</b>	ND(0.145)	ND(0.3)	1.17	<b>1.88</b>

AP-3989											
Date	Benzene	Carbon Tetrachloride	cis-1,2-DCE	trans-1,2-DCE	PCE	TCE	1,1,2,2-PCA	Ethene	Vinyl Chloride	1,1-DCE	1,1,2-TCA
9/9/2014	1.03	ND(0.3)	<b>1250</b>	39.9	ND(0.3)	2.47	<b>97.4</b>	ND(0.368)	<b>8.71</b>	3.2	<b>3.73</b>
9/22/2015	1.44 J	ND(1.5)	<b>1540</b>	45.6	ND(1.5)	1.64 J	<b>58.2</b>	ND(1.19)	<b>11</b>	4.72	<b>2.92</b>
9/10/2016	1.22 J	ND(1.5)	<b>1330</b>	43.3	ND(1.5)	1.99 J	<b>52.6</b>	0.161 J	<b>7.25</b>	4.53	<b>2.55</b>

AP-3744											
Date	Benzene	Carbon Tetrachloride	cis-1,2-DCE	trans-1,2-DCE	PCE	TCE	1,1,2,2-PCA	Ethene	Vinyl Chloride	1,1-DCE	1,1,2-TCA
9/9/2014	ND(0.3)	0.51	13.7	0.82	0.33 J	<b>47.2</b>	<b>9.3</b>	ND(0.118)	ND(0.3)	ND(0.3)	0.29 J
9/22/2015	ND(0.3)	0.22 J	41.6	0.38 J	ND(0.3)	<b>22.1</b>	<b>11.3</b>	ND(0.167)	ND(0.3)	0.2 J	<b>0.58</b>
9/7/2016	0.27 J	0.24 J	<b>324</b>	5.07	0.17 J	<b>33.2</b>	<b>41.8</b>	ND(0.206)	<b>0.52</b>	1.09	<b>2.07</b>

AP-3982						
Date	Benzene	Carbon Tetrachloride	cis-1,2-DCE	trans-1,2-DCE	PCE	TCE
9/7/2016	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.3)

AP-3745						
Date	Benzene	Carbon Tetrachloride	cis-1,2-DCE	trans-1,2-DCE	PCE	TCE
9/7/2016	ND(0.3)	ND(0.3)	68.4	17.1	1.6	<b>346</b>

AP-4347	
Date	TCE
11/1/2010	ND(0.62)

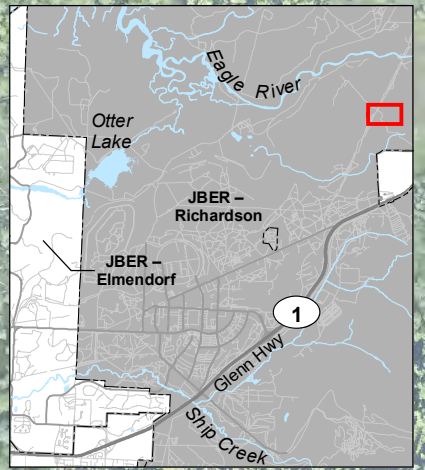
AP-3981							
Date	Benzene	Carbon Tetrachloride	cis-1,2-DCE	trans-1,2-DCE	PCE	TCE	1,1,2,2-PCA
9/10/2016	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.3)	0.35 B	ND(0.3)

AP-4353							
Date	Benzene	Carbon Tetrachloride	cis-1,2-DCE	trans-1,2-DCE	PCE	TCE	1,1,2,2-PCA
9/5/2014	ND(0.3)	ND(0.3)	43.9	12	3.02	<b>196</b>	<b>40.6</b>
9/17/2015	ND(0.3)	ND(0.3)	33.5	12.1	2.44	<b>180</b>	<b>26.9</b>
9/10/2016	ND(0.3)	ND(0.3)	30.7	10.6	2.3	<b>169</b>	<b>24.5</b>

COC in Groundwater	OU B ROD Cleanup Goal <sup>a</sup> (µg/L)	MCL (µg/L)	ADEC Cleanup Level <sup>b</sup> (µg/L)
Benzene	5	5	4.6
Carbon tetrachloride	5	5	4.6
cis-1,2-DCE	70	70	36
trans-1,2-DCE	100	100	360
PCE	5	5	41
TCE	5	5	2.8
1,1,2,2-PCA	5.3 <sup>c</sup>	--	0.76

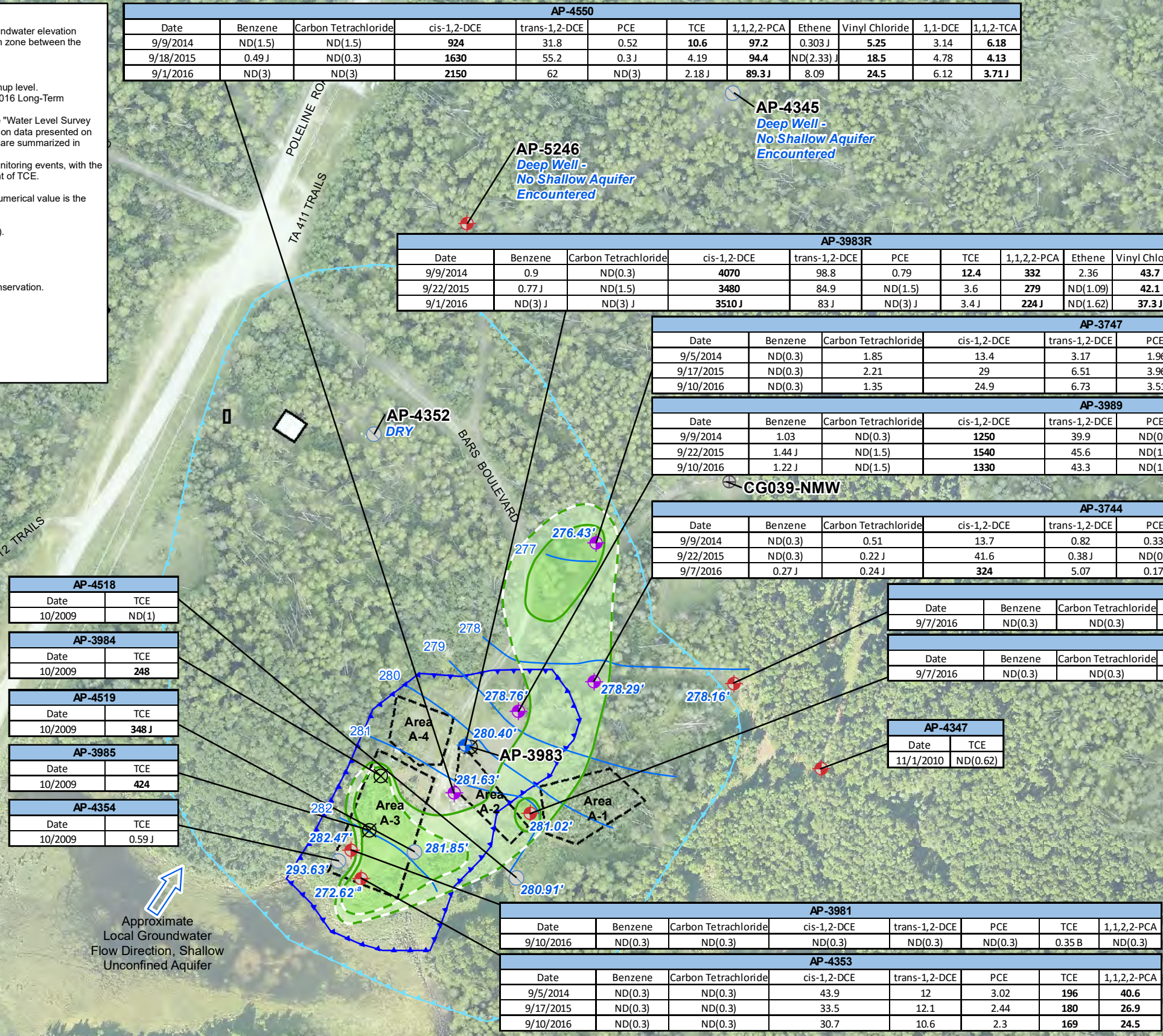
Other Chemicals of Interest in Groundwater Related to Ongoing Treatability Study <sup>a</sup>		
Chemical	MCL (µg/L)	ADEC Cleanup Level <sup>b</sup> (µg/L)
1,1,2-TCA	5	0.41
1,1-DCE	7	280
Vinyl chloride	2	0.19

<sup>a</sup> U.S. Army, 1997  
<sup>b</sup> 18 AAC 75 Table B1 and C Cleanup Levels (November 6, 2016)  
<sup>c</sup> RBCs were adopted as cleanup goals for PCA in groundwater because neither federal nor state cleanup goals were available prior to the signing of the ROD.  
<sup>d</sup> Includes shallow aquifer monitoring wells AP-3744, AP-3747, AP-3983R, AP-3989, and AP-4550



**LEGEND**

- Program Monitoring Well
- Treatability Study Monitoring Well
- Program and Treatability Study Monitoring Well
- Non-Program Monitoring Well
- Non-program Monitoring Well (Abandoned)
- Soil Boring - No Shallow Aquifer Encountered
- Disposal Area
- Building (Facility ID)
- Land Use Control Boundary Groundwater
- Land Use Control Boundary Soil
- TCE Contour Interval (dashed where inferred)
- 5 to 100 µg/L
- 100 to 500 µg/L
- Groundwater Contour Line (feet AMSL) (October 2016)
- General Groundwater Flow Direction (Approximate)
- Groundwater Elevation (feet AMSL) (2016 Sampling Event)



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**CG039 SITE MAP WITH ANALYTICAL DATA FOR THE SHALLOW, UNCONFINED AQUIFER**

2016 Annual Remedial Action - Operations and Monitoring Report for Select CERCLA Sites  
 Joint Base Elmendorf-Richardson, Alaska

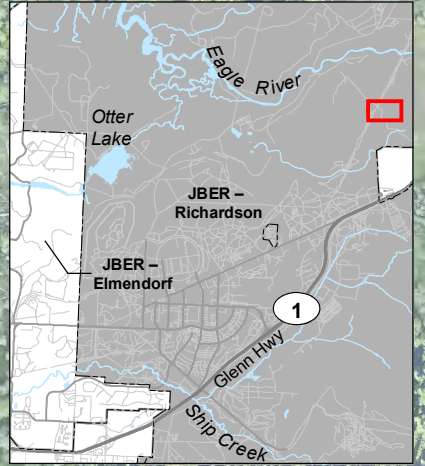
Figure 15-2



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NOTES:  
<sup>a</sup> Monitoring well AP-4525 had very little water and the bailer became stuck, no sample was collected for 2016.  
 1. Coordinate System: UTM Zone 6, WGS84, meters.  
 2. All results in micrograms per liter (µg/L).  
 3. **Bold font** indicates concentration exceeds relevant cleanup level.  
 4. Approximate groundwater flow direction was based on 2015 Long-Term Monitoring groundwater elevation data.  
 5. Depth to groundwater measurements are included in the "Water Level Survey Form" provided in Appendix A2. The groundwater elevation data presented on this figure are calculated from those measurements and are summarized in Table 15-1.  
 6. Data shown represents the most recent three annual monitoring events, with the exception of older data the helps define the known extent of TCE.  
 7. Flags:  
 J The analyte was positively identified: the associated numerical value is the approximate concentration of the analyte in the sample.  
 - Not measured or not sampled.  
 ND(0.4) Indicates non-detect (MDL) or non-detect (PQL).  
 8. Abbreviations:  
 1,1-DCE 1,1-Dichloroethene  
 1,1,2-TCA 1,1,2-Trichloroethane  
 1,1,2,2-PCA 1,1,2,2-Tetrachloroethane  
 ADEC Alaska Department of Environmental Conservation.  
 AMSL above mean sea level  
 cis-1,2-DCE cis-1,2-Dichloroethene  
 MDL method detection limit  
 OU B ROD Operable Unit B Record of Decision  
 PCE tetrachloroethene  
 PQL practical quantitation limit  
 TCE trichloroethane  
 trans-1,2-DCE trans-1,2-Dichloroethene



AP-4350							
Date	Benzene	Carbon Tetrachloride	cis-1,2-DCE	trans-1,2-DCE	PCE	TCE	1,1,2,2-PCA
9/6/2016	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.3)

AP-5246							
Date	Benzene	Carbon Tetrachloride	cis-1,2-DCE	trans-1,2-DCE	PCE	TCE	1,1,2,2-PCA
9/4/2014	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.3)
9/17/2015	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.3)
9/2/2016	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.3)

AP-5683							
Date	Benzene	Carbon Tetrachloride	cis-1,2-DCE	trans-1,2-DCE	PCE	TCE	1,1,2,2-PCA
9/4/2014	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.3)
9/16/2015	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.3)
9/9/2016	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.3)

AP-4525 <sup>a</sup>											
Date	Benzene	Carbon Tetrachloride	cis-1,2-DCE	trans-1,2-DCE	PCE	TCE	1,1,2,2-PCA	Ethene	Vinyl Chloride	1,1-DCE	1,1,2-TCA
10/1/2009	0.24J	ND(20)	<b>199</b>	36.5	ND(20)	<b>2,270</b>	<b>108</b>	-	-	4.86	<b>15.6</b>
9/22/2015	ND(12)	ND(12)	<b>216</b>	ND(12)	ND(12)	<b>361</b>	<b>38</b>	-	ND(12)	ND(12)	<b>8.89J</b>

AP-4344							
Date	Benzene	Carbon Tetrachloride	cis-1,2-DCE	trans-1,2-DCE	PCE	TCE	1,1,2,2-PCA
9/5/2014	ND(0.3)	0.2J	0.45J	ND(0.3)	ND(0.3)	<b>16.6</b>	ND(0.3)
9/16/2015	ND(0.3)	0.25J	0.24J	ND(0.3)	ND(0.3)	<b>8.16</b>	ND(0.3)
9/2/2016	ND(0.3)	0.36J	0.36J	ND(0.3)	ND(0.3)	<b>12</b>	ND(0.3)

AP-3748							
Date	Benzene	Carbon Tetrachloride	cis-1,2-DCE	trans-1,2-DCE	PCE	TCE	1,1,2,2-PCA
9/5/2014	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.3)
9/16/2015	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.3)
9/9/2016	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.3)	ND(0.3)

AP-4551											
Date	Benzene	Carbon Tetrachloride	cis-1,2-DCE	trans-1,2-DCE	PCE	TCE	1,1,2,2-PCA	Ethene	Vinyl Chloride	1,1-DCE	1,1,2-TCA
9/10/2014	0.70	ND(0.3)	<b>2525</b>	28.2	ND(0.3)	<b>8.43</b>	<b>119</b>	0.219J	<b>5.55</b>	<b>16.7</b>	<b>12.9</b>
9/21/2015	ND(1.5)	ND(1.5)	<b>1870</b>	28.3	ND(1.5)	<b>9.36</b>	<b>78.8</b>	0.0702J	<b>2.3J</b>	<b>15.8</b>	<b>9.04</b>
9/1/2016	ND(3)	ND(3)	<b>2140</b>	28.1	ND(3)	<b>14.9</b>	<b>62.6</b>	ND(0.172)	ND(3)	<b>13.6</b>	<b>3.71J</b>

AP-4011	
Date	TCE
10/2009	<b>15.5</b>

AP-4017	
Date	TCE
10/2009	<b>884</b>

AP-4349	
Date	TCE
11/1/2010	0.39J

COC in Groundwater	OU B ROD Cleanup Goal <sup>a</sup> (µg/L)	MCL (µg/L)	ADEC Cleanup Level <sup>b</sup> (µg/L)
Benzene	5	5	4.6
Carbon tetrachloride	5	5	4.6
cis-1,2-DCE	70	70	36
trans-1,2-DCE	100	100	360
PCE	5	5	41
TCE	5	5	2.8
1,1,2,2-PCA	5.3 <sup>c</sup>	--	0.76

Other Chemicals of Interest in Groundwater Related to Ongoing Treatability Study <sup>d</sup>		
Chemical	MCL (µg/L)	ADEC Cleanup Level <sup>b</sup> (µg/L)
1,1,2-TCA	5	0.41
1,1-DCE	7	280
Vinyl chloride	2	0.19

<sup>a</sup> U.S. Army, 1997  
<sup>b</sup> 18 AAC 75 Table B1 and C Cleanup Levels (November 6, 2016)  
<sup>c</sup> RBCs were adopted as cleanup goals for PCA in groundwater because neither federal nor state cleanup goals were available prior to the signing of the ROD.  
<sup>d</sup> Includes deep aquifer monitoring wells AP-4525 and AP-4550

**LEGEND**

- Program Monitoring Well
- Treatability Study Monitoring Well
- Non-Program Monitoring Well
- Non-program Monitoring Well (Abandoned)
- Disposal Area
- Building (Facility ID)
- Land Use Control Boundary Groundwater
- Land Use Control Boundary Soil
- TCE Contour Interval (dashed where inferred)
- 5 to 100 µg/L
- > 100 µg/L
- Groundwater Contour Line (feet AMSL) (October 2016)
- General Groundwater Flow Direction (Approximate)
- Groundwater Elevation (feet AMSL) (2016 Sampling Event)

Approximate Local Groundwater Flow Direction, Deep, Semi-confined Aquifer

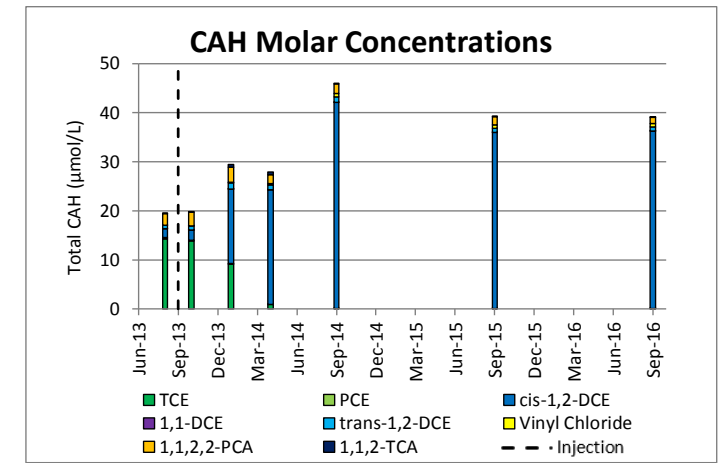
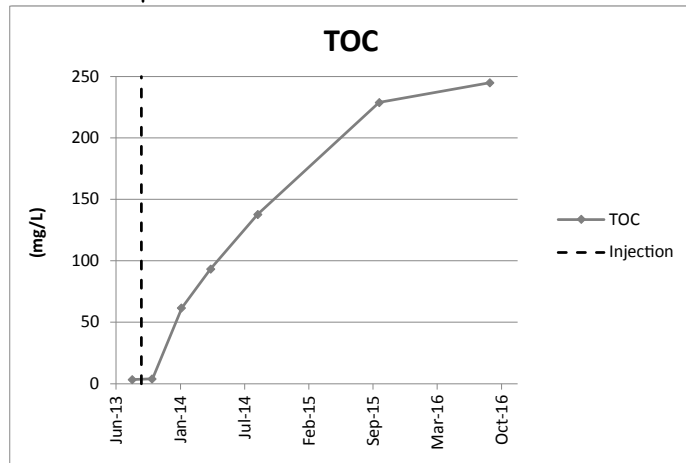
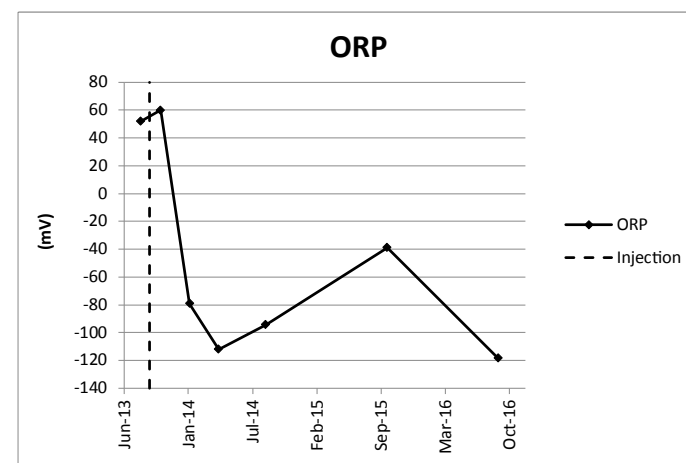
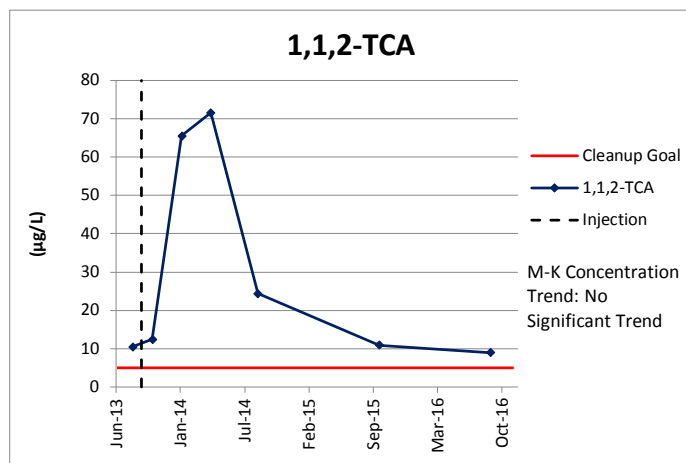
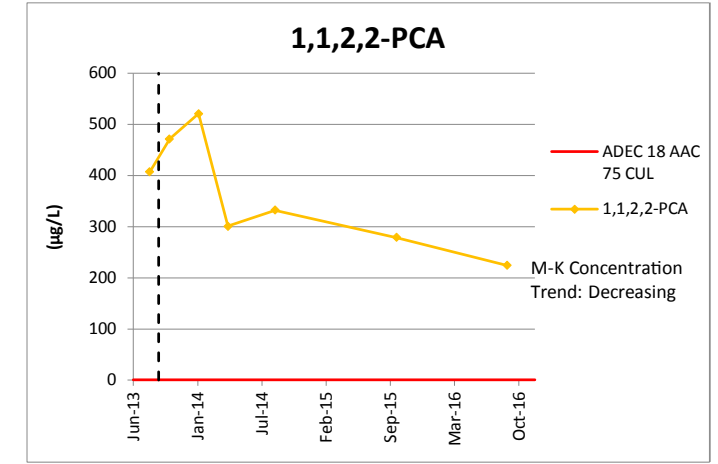
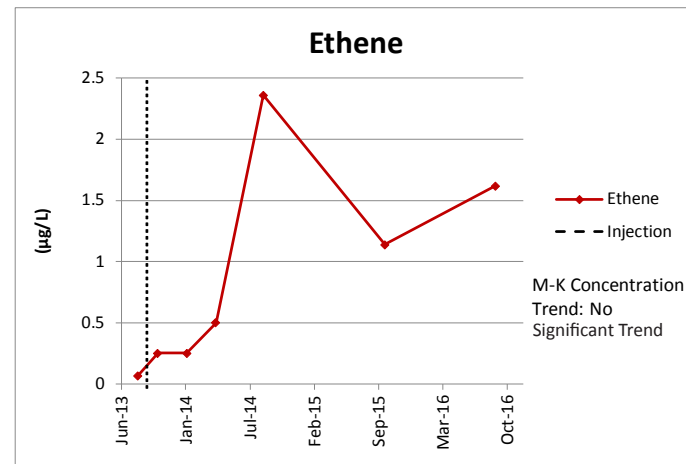
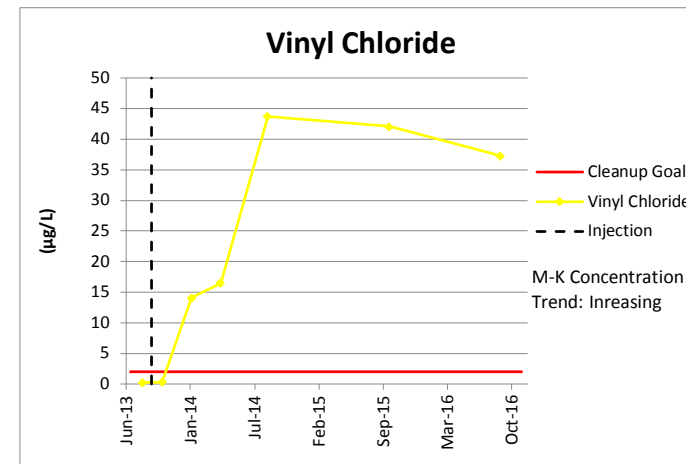
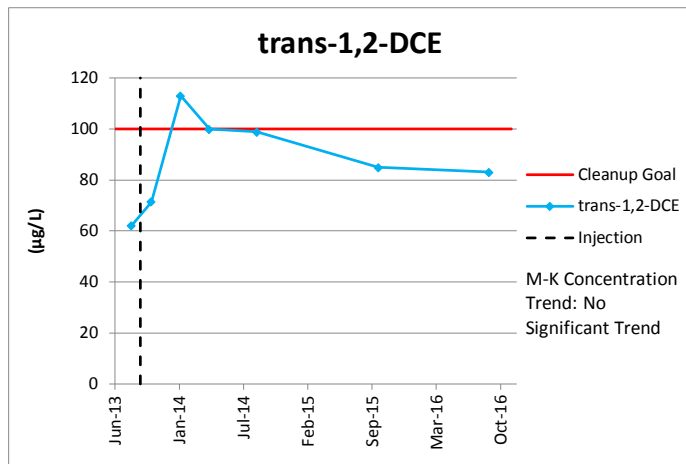
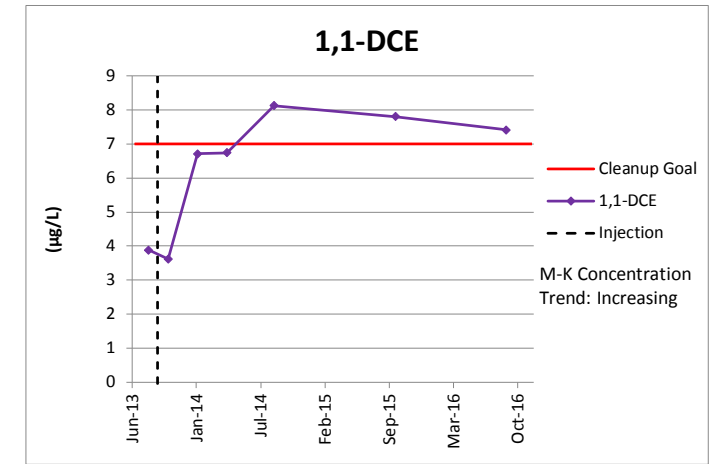
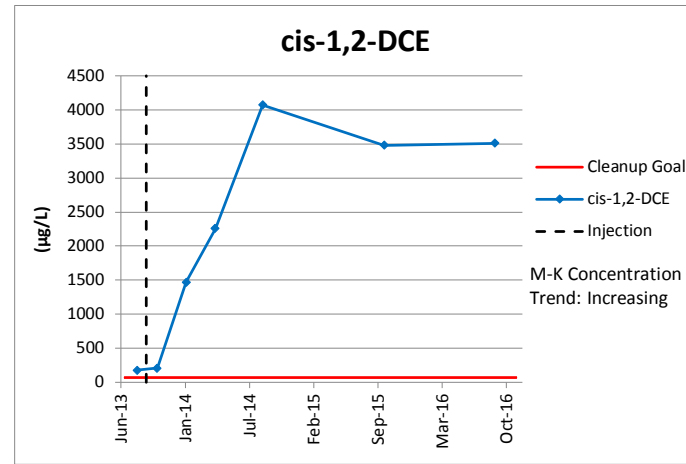
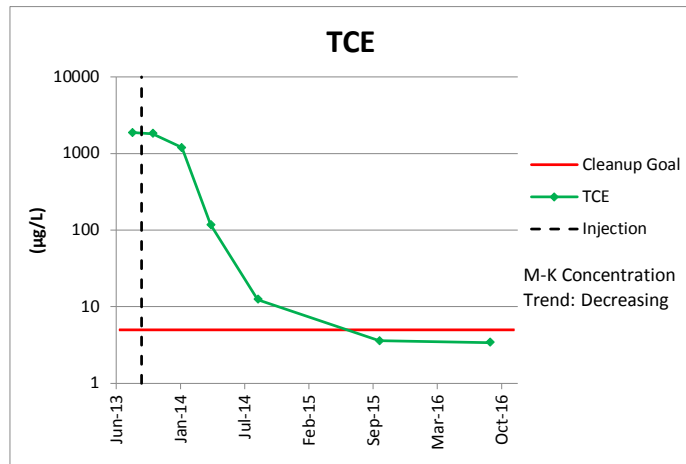
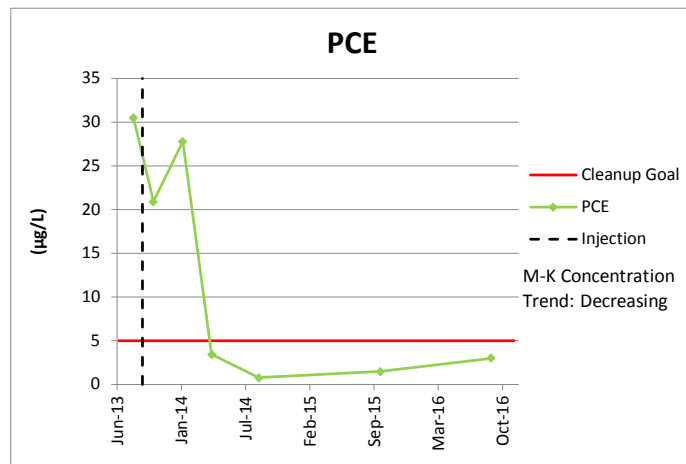
Aero-Metric Image, Copyright © 2012



**CG039 SITE MAP WITH ANALYTICAL DATA FOR THE DEEP, SEMI-CONFINED AQUIFER** Figure 15-3  
 2016 Annual Remedial Action - Operations and Monitoring Report for Select CERCLA Sites  
 Joint Base Elmendorf-Richardson, Alaska

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**NOTES:**

µg/L	microgram(s) per liter	mg/L	milligram(s) per liter
1,1,2,2-PCA	1,1,2,2-Tetrachloroethane	mV	millivolt(s)
1,1,2-TCA	1,1,2-Trichloroethane	ORP	oxygen reduction potential
1,1-DCE	1,1-Dichloroethane	PCE	Tetrachloroethene
ADEC 18 AAC 75 CUL	2008 Alaska Department of Environmental Conservation 18 AAC Chapter 75.345 Table C ground water clean up level	TCE	Trichloroethene
CAH	Chlorinated Aliphatic Hydrocarbon	TOC	total organic carbon
cis-1,2-DCE	cis-1,2-Dichloroethene	trans-1,2-DCE	trans-1,2-Dichloroethene

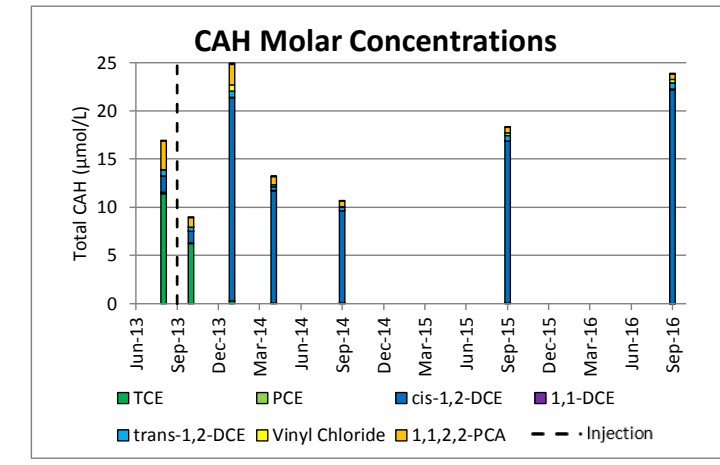
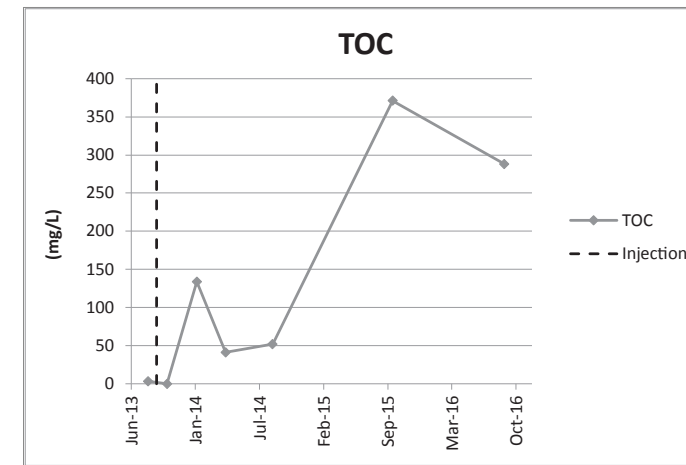
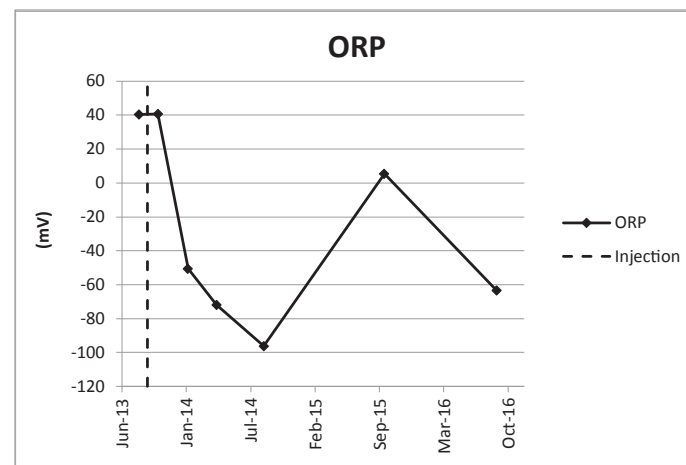
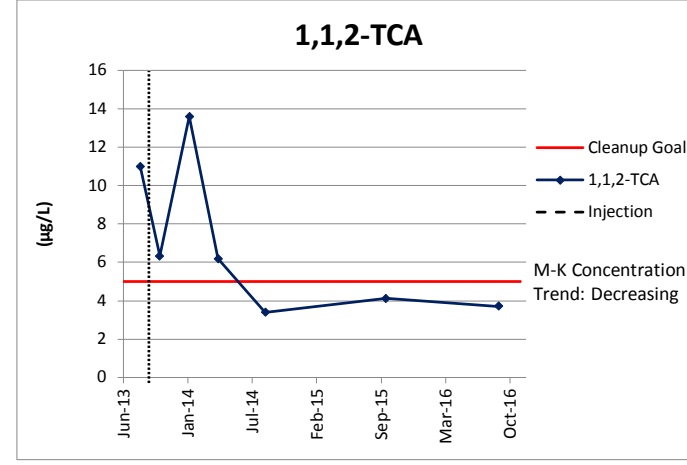
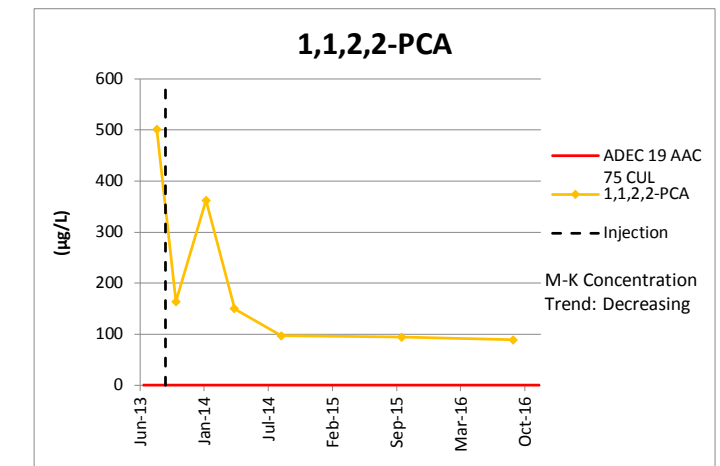
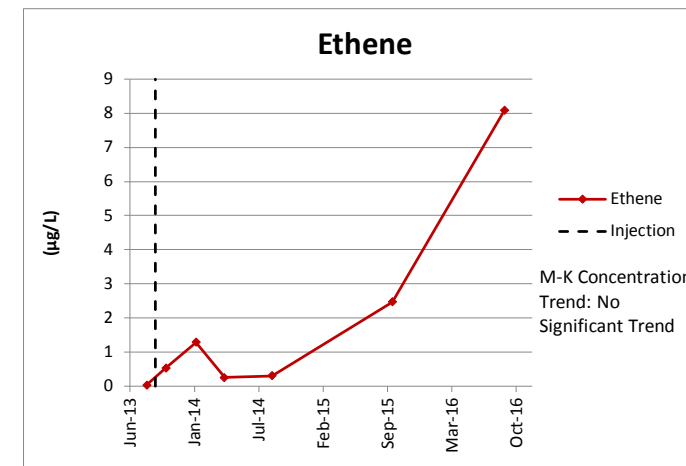
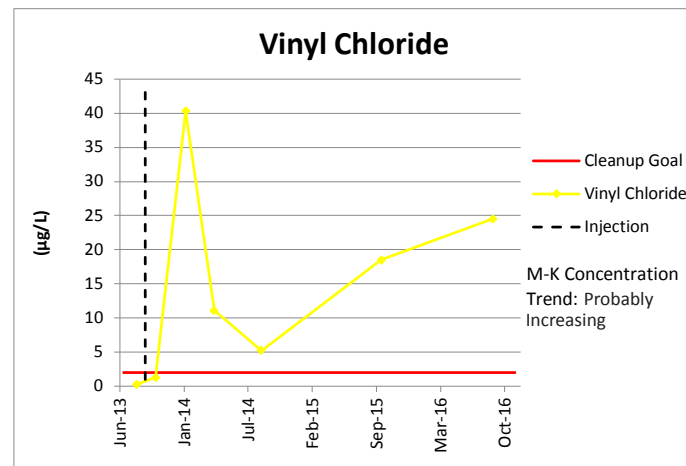
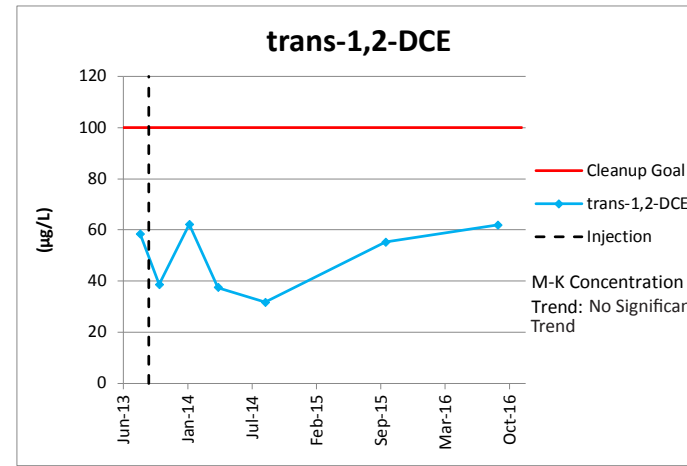
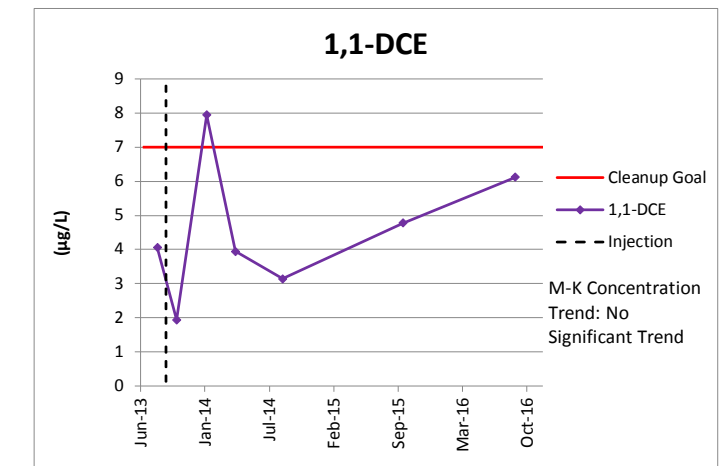
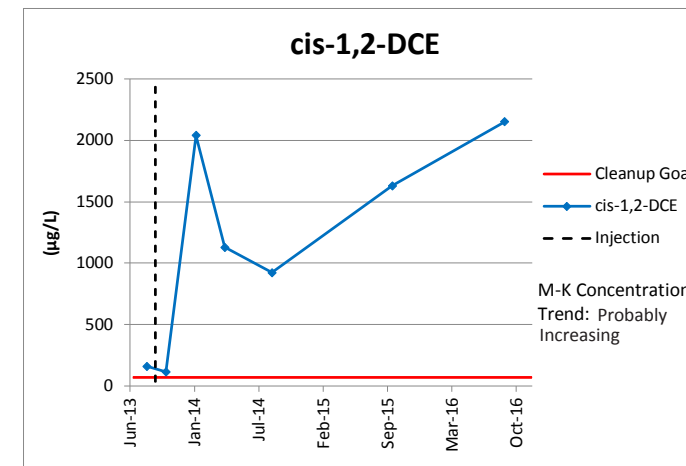
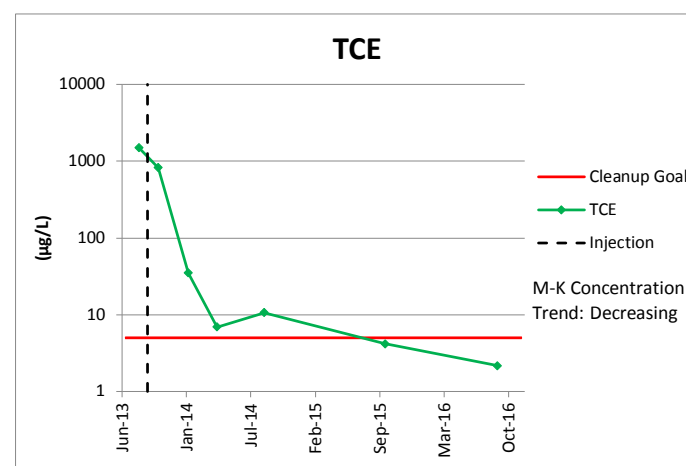
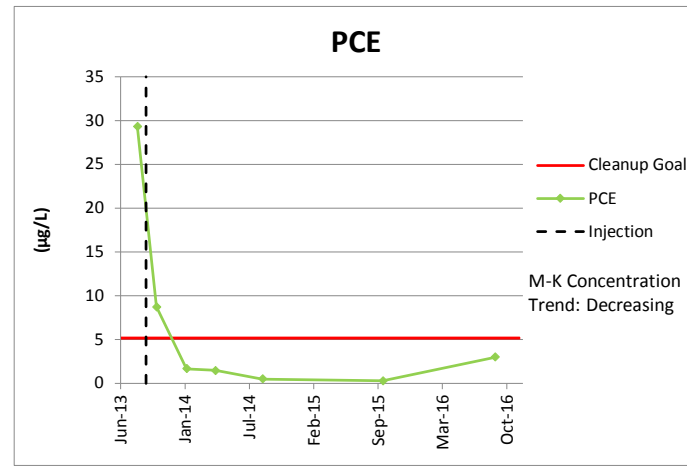


**CONCENTRATION TRENDS FOR SELECT ANALYTES AT MONITORING WELL AP-3983R**  
 2016 Annual Remedial Action - Operations and Monitoring Report for Select CERCLA Sites  
 Joint Base Elmendorf-Richardson, Alaska

Figure 15-4

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NOTES:

µg/L	microgram(s) per liter	mg/L	milligram(s) per liter
1,1,2,2-PCA	1,1,2,2-Tetrachloroethane	mV	millivolt(s)
1,1,2-TCA	1,1,2-Trichloroethane	ORP	oxidation-reduction potential
1,1-DCE	1,1-Dichloroethene	PCE	Tetrachloroethene
ADEC 18 AAC 75 CUL	2008 Alaska Department of Environmental Conservation 18 AAC Chapter 75.345 Table C Groundwater Clean Up Level	TCE	Trichloroethene
CAH	chlorinated aliphatic hydrocarbon	TOC	total organic carbon
cis-1,2-DCE	cis-1,2-Dichloroethene	trans-1,2-DCE	trans-1,2-Dichloroethene

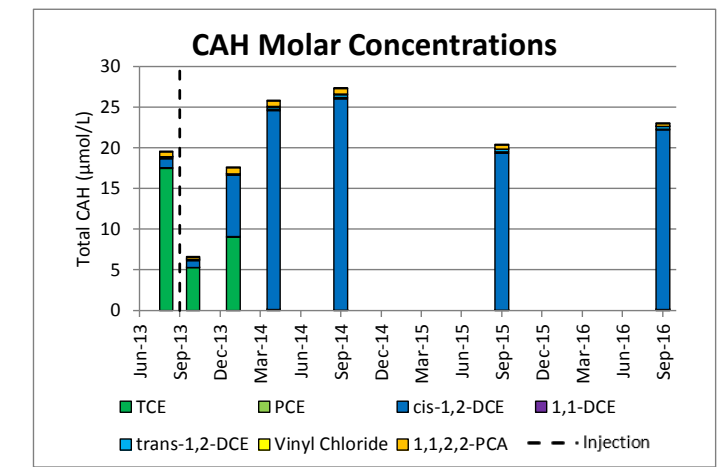
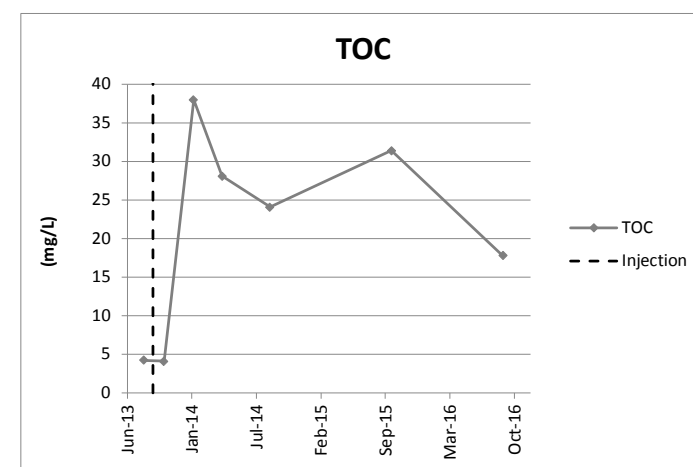
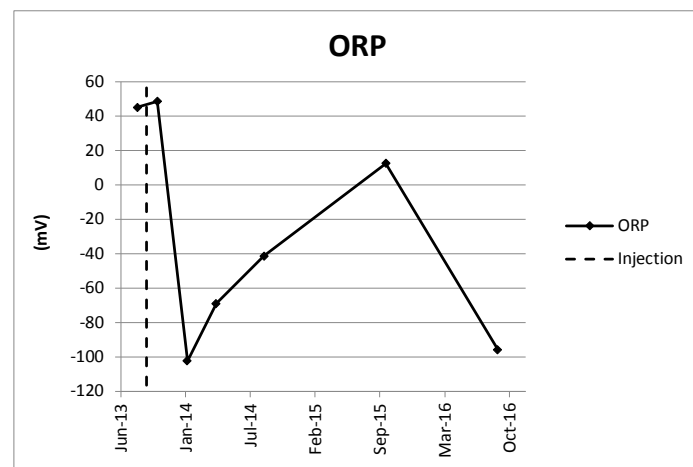
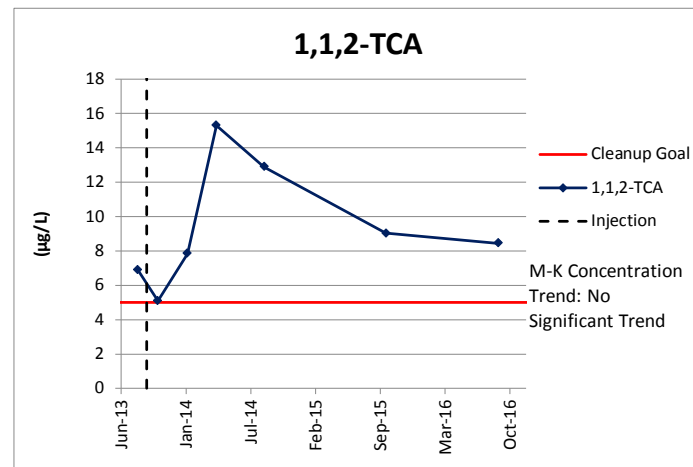
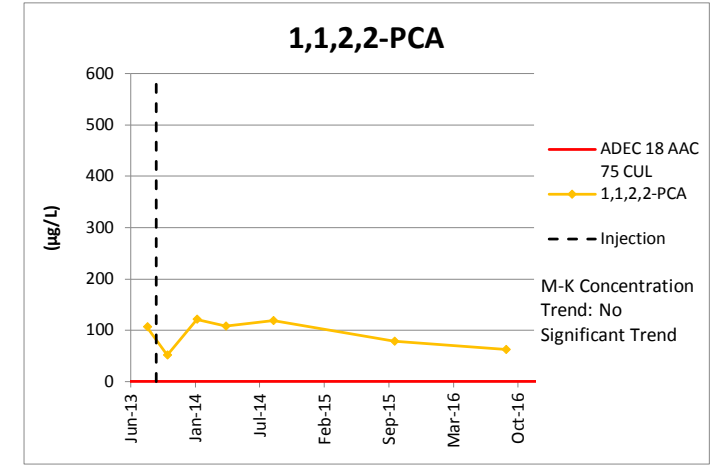
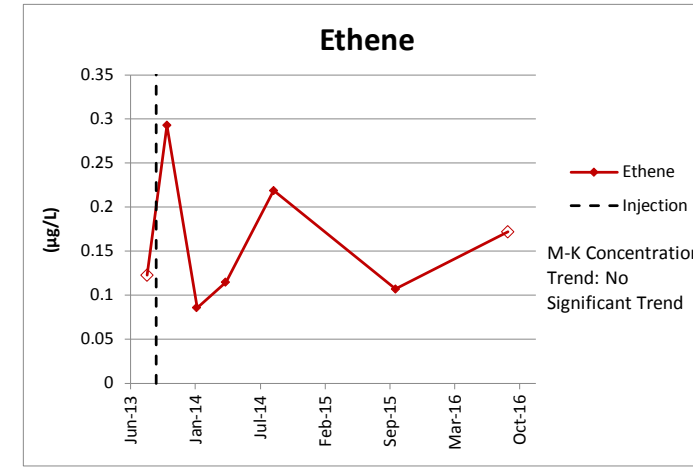
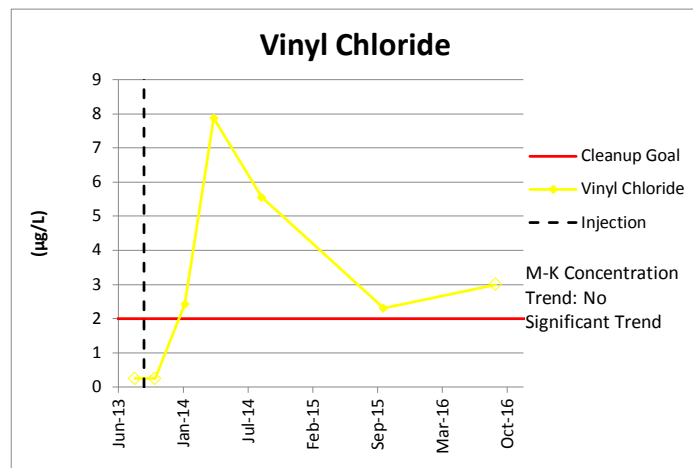
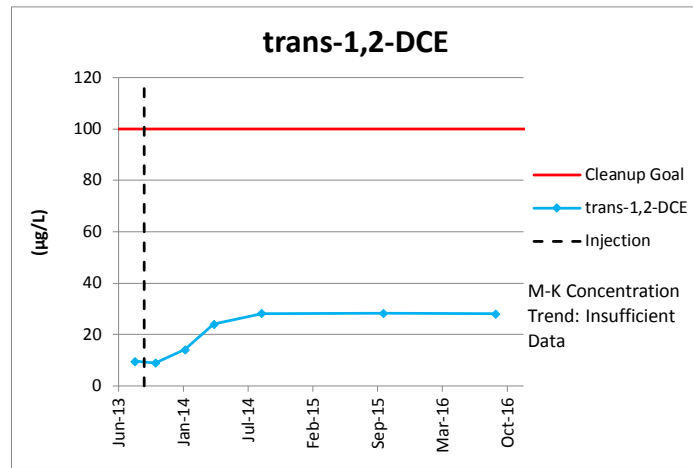
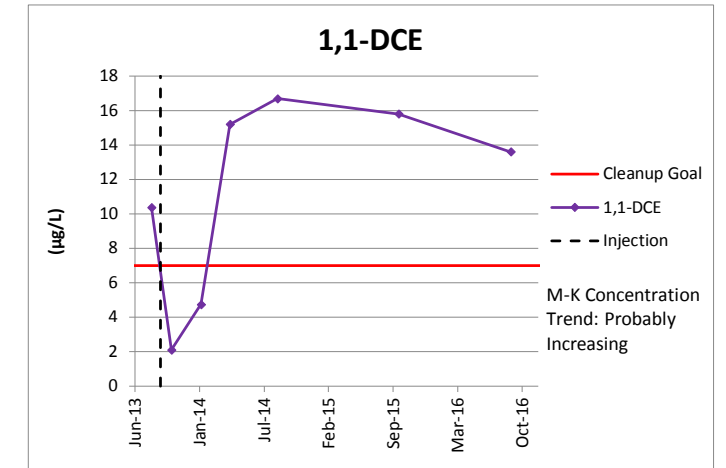
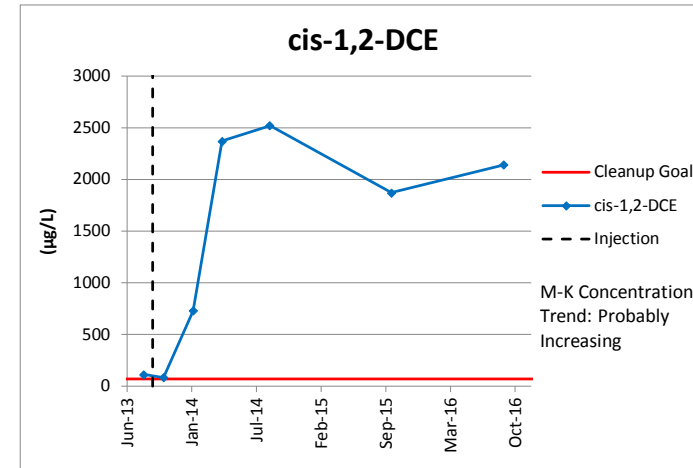
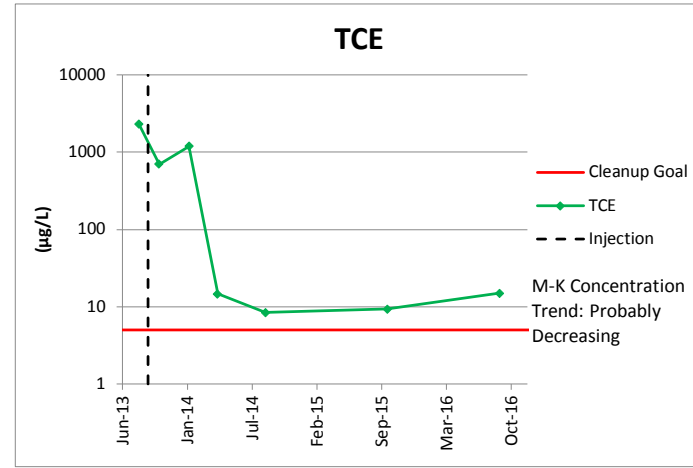
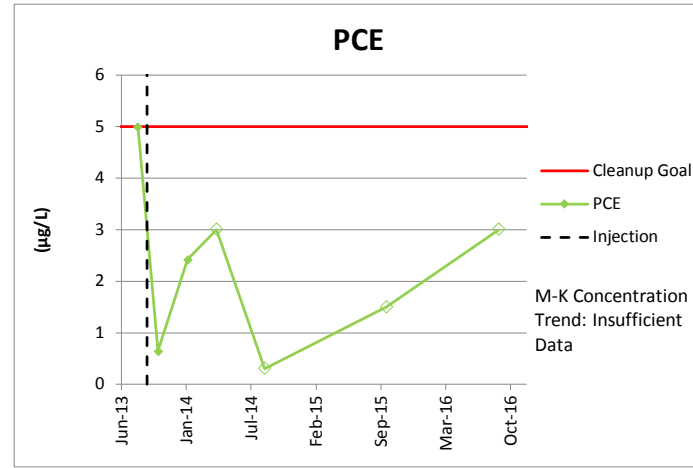


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 Figure 15-5

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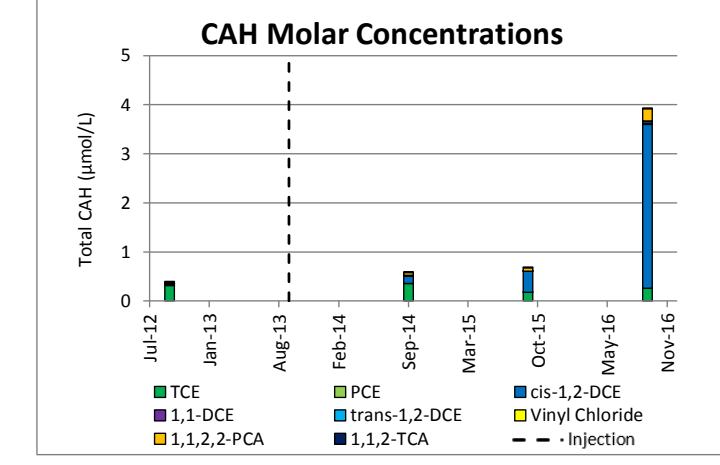
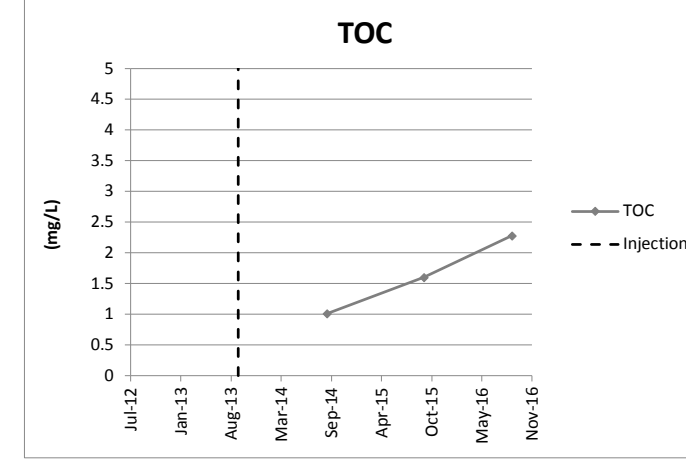
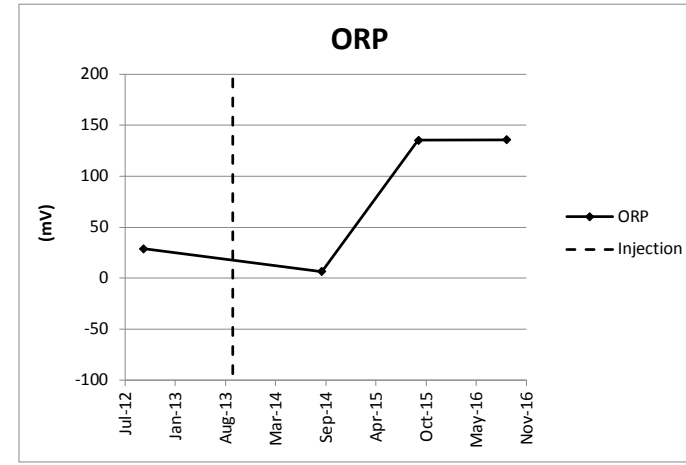
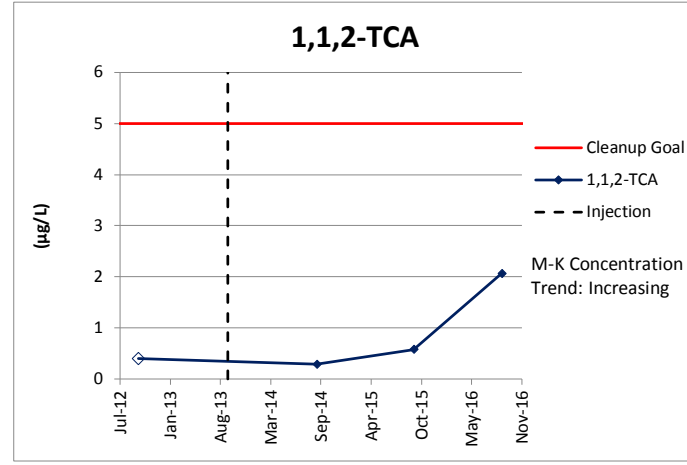
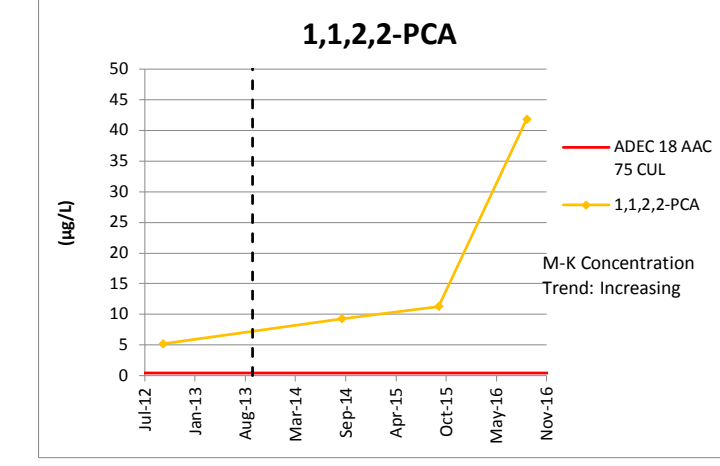
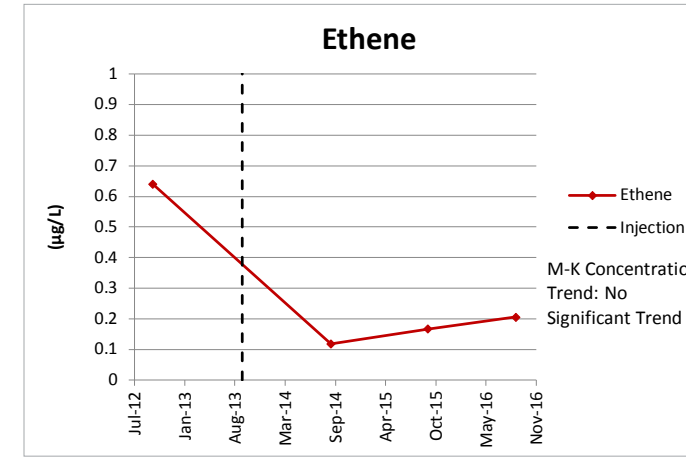
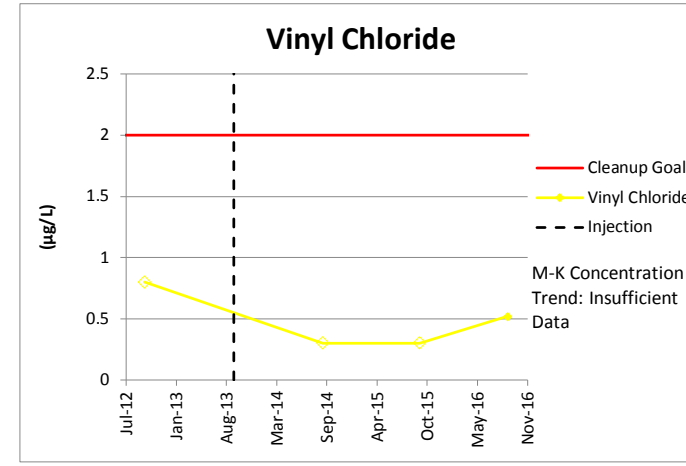
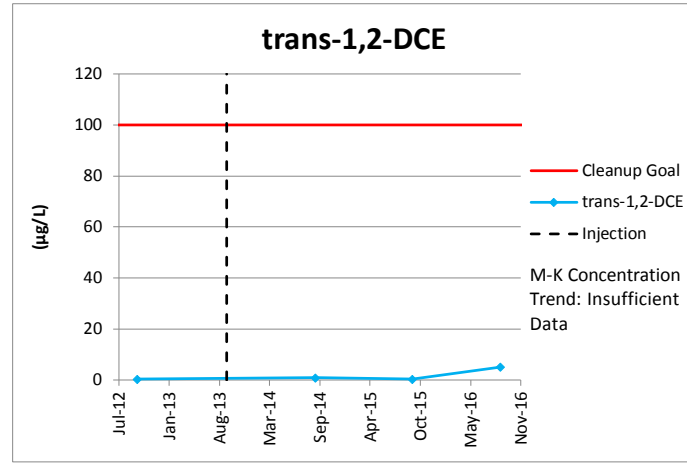
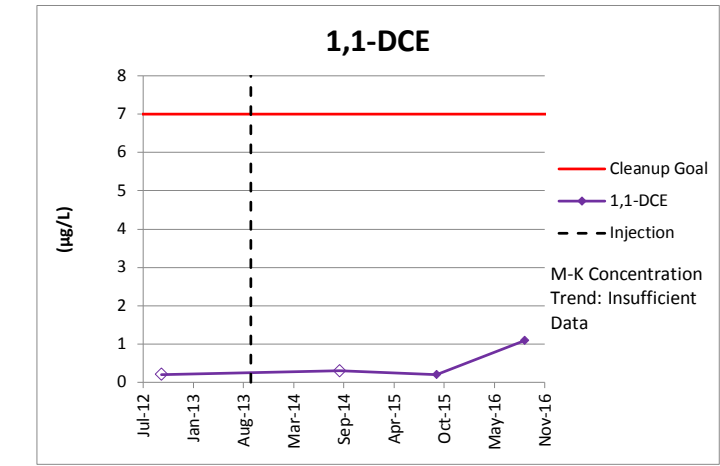
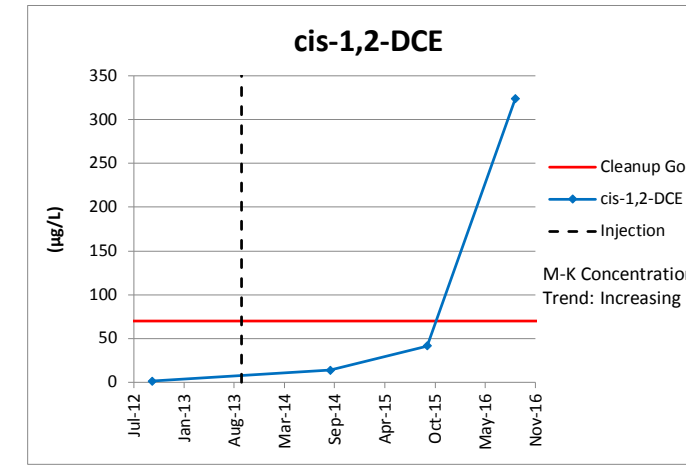
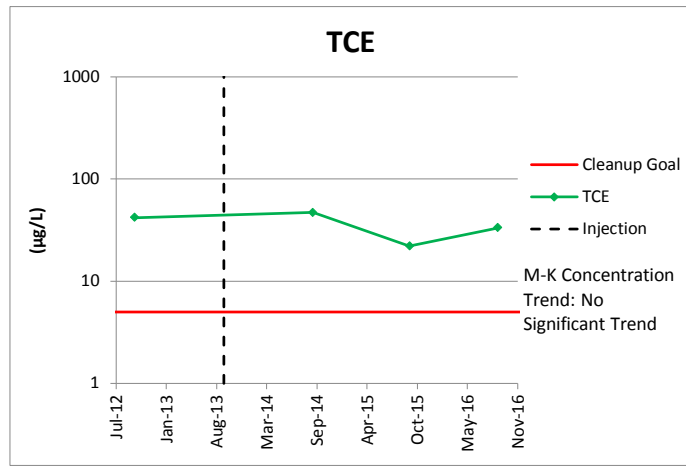
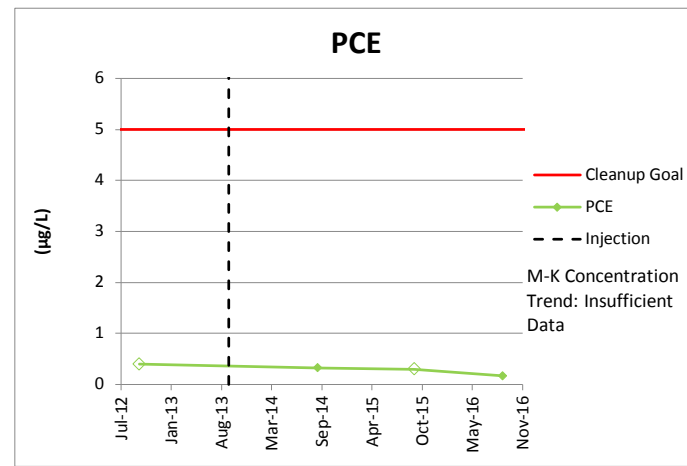
µg/L	microgram(s) per liter	mg/L	milligram(s) per liter
1,1,2,2-PCA	1,1,2,2-Tetrachloroethane	mV	millivolt(s)
1,1,2-TCA	1,1,2-Trichloroethane	ORP	oxidation-reduction potential
1,1-DCE	1,1-Dichloroethene	PCE	Tetrachloroethene
ADEC 18 AAC 75 CUL	2008 Alaska Department of Environmental Conservation 18 AAC Chapter 75.345 Table C Groundwater Clean Up Level	TCE	Trichloroethene
CAH	chlorinated aliphatic hydrocarbon	TOC	total organic carbon
cis-1,2-DCE	cis-1,2-Dichloroethene	trans-1,2-DCE	trans-1,2-Dichloroethene



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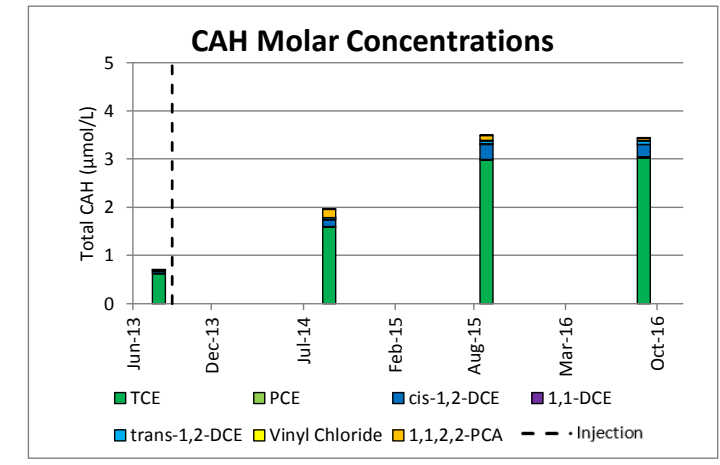
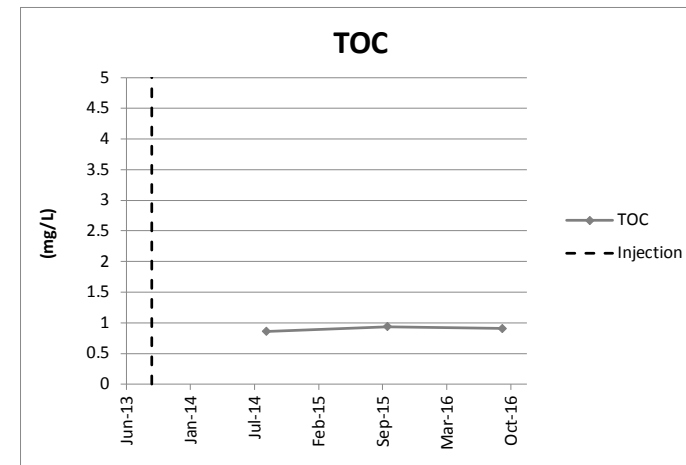
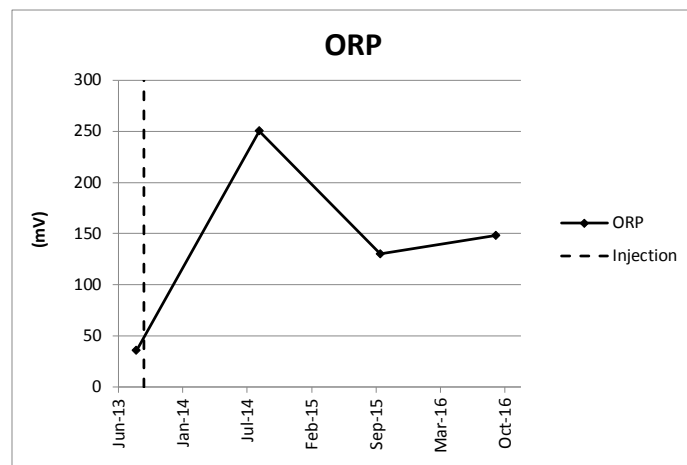
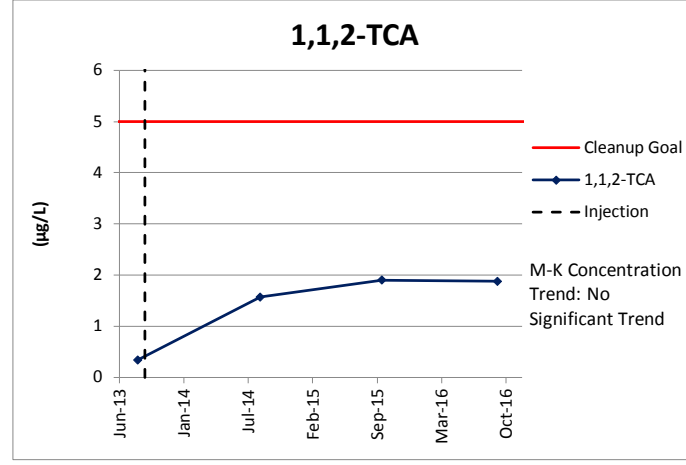
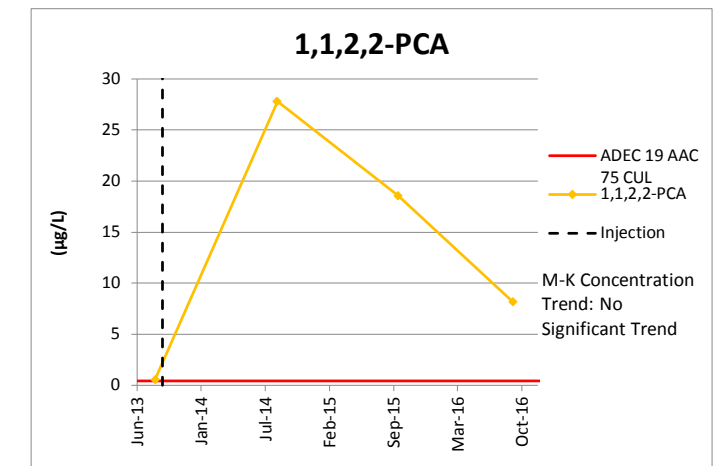
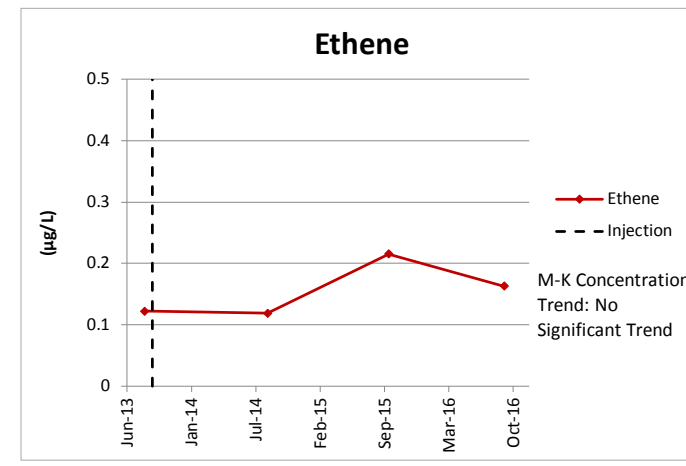
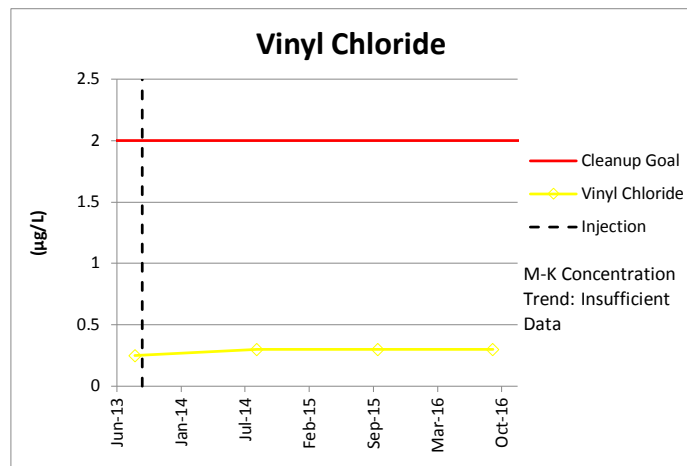
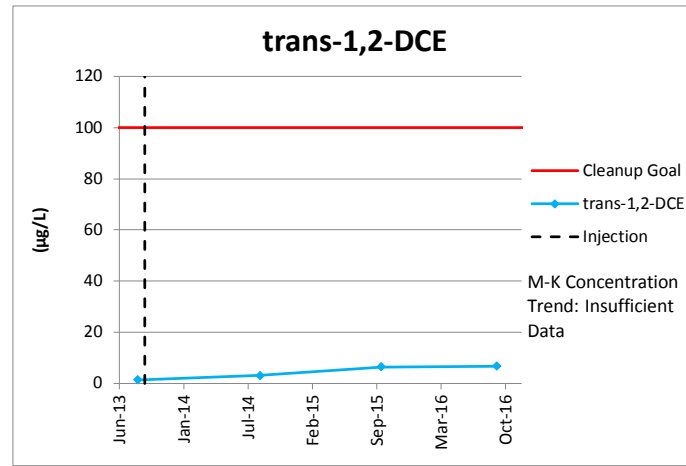
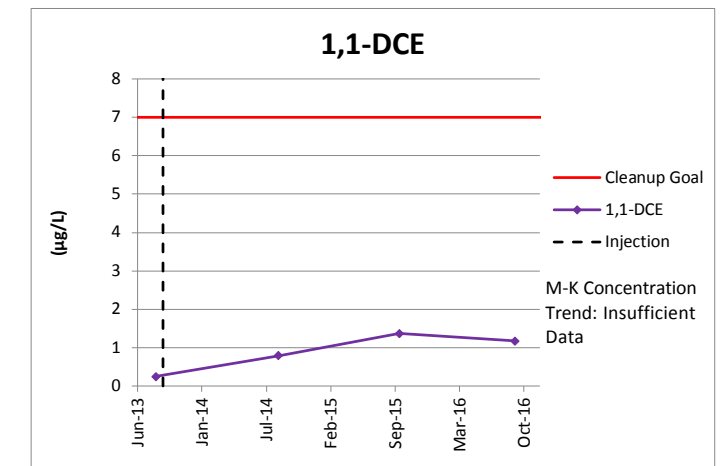
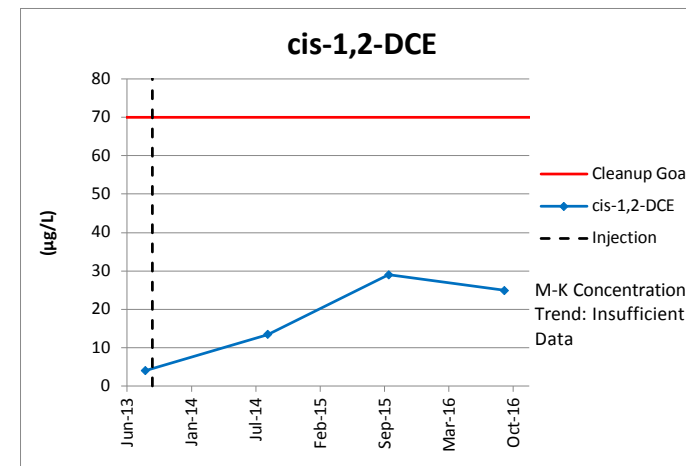
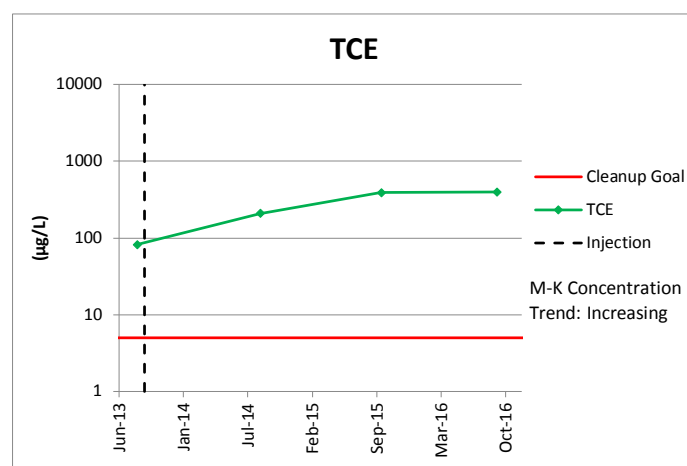
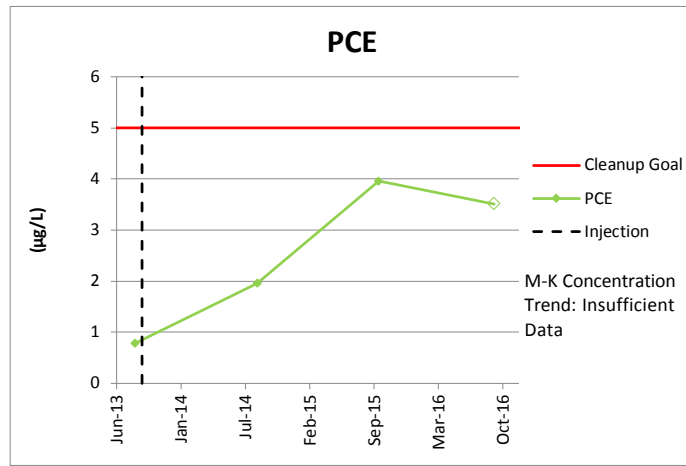
µg/L	microgram(s) per liter	mg/L	milligram(s) per liter
1,1,2,2-PCA	1,1,2,2-Tetrachloroethane	mV	millivolt(s)
1,1,2-TCA	1,1,2-Trichloroethane	ORP	oxidation-reduction potential
1,1-DCE	1,1-Dichloroethene	PCE	Tetrachloroethene
ADEC 18 AAC 75 CUL	2008 Alaska Department of Environmental Conservation 18 AAC Chapter 75.345 Table C Groundwater Clean Up Level	TCE	Trichloroethene
CAH	chlorinated aliphatic hydrocarbon	TOC	total organic carbon
cis-1,2-DCE	cis-1,2-Dichloroethene	trans-1,2-DCE	trans-1,2-Dichloroethene



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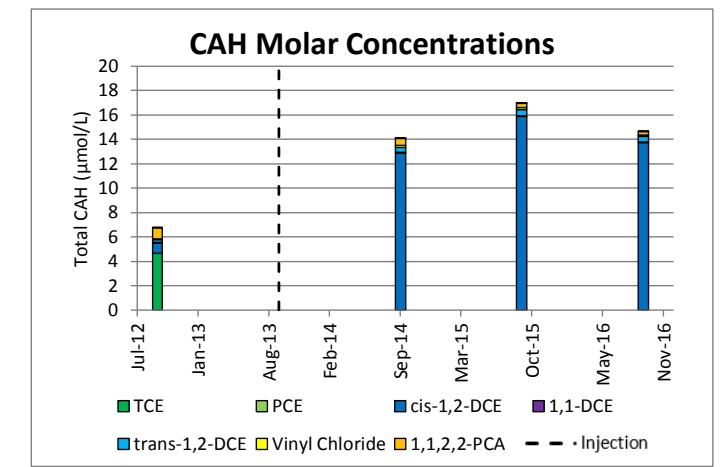
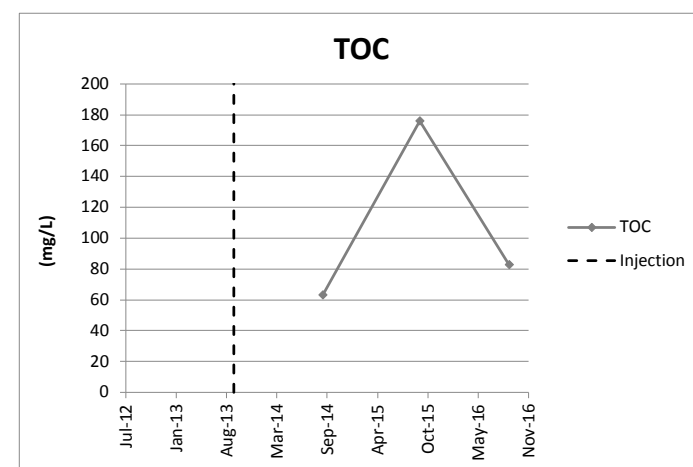
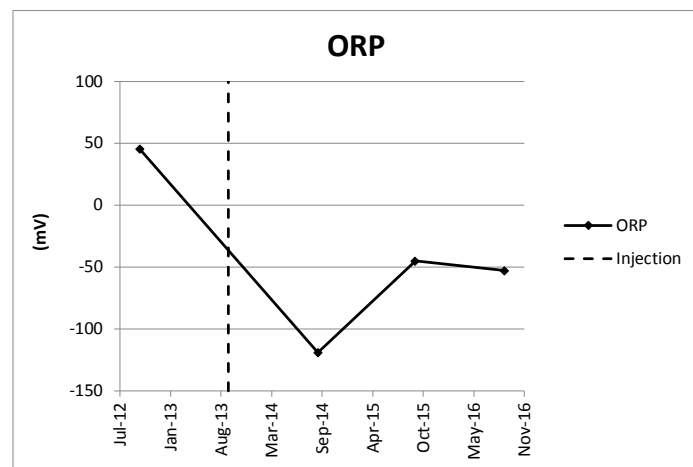
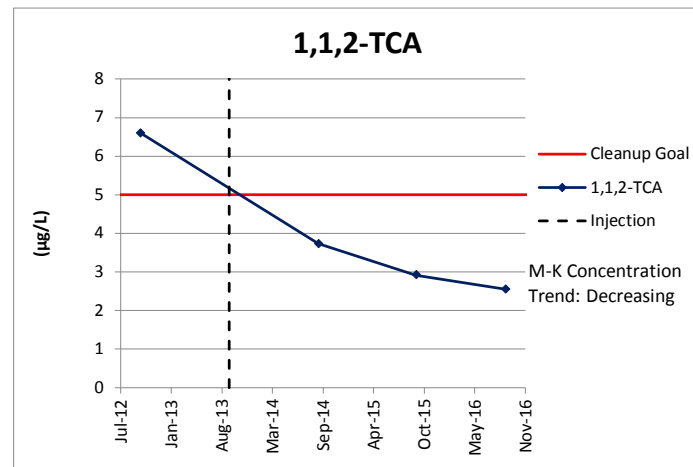
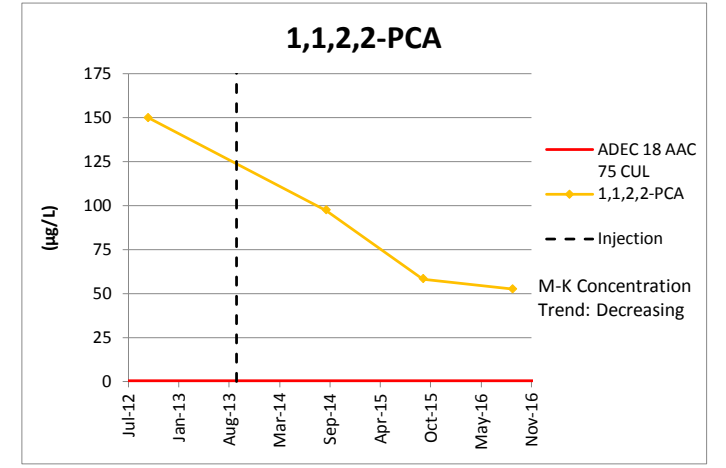
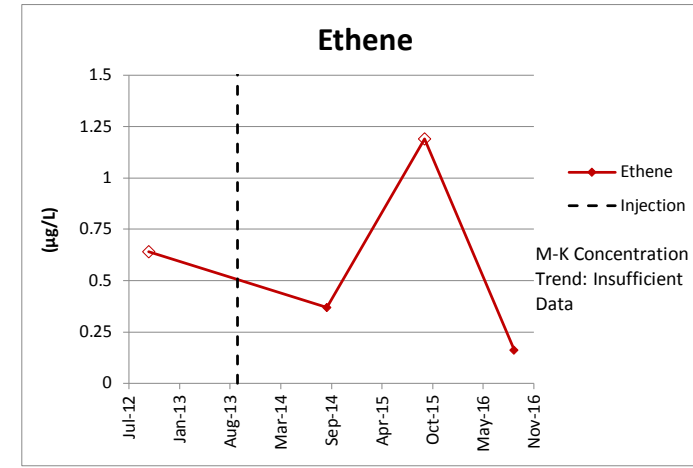
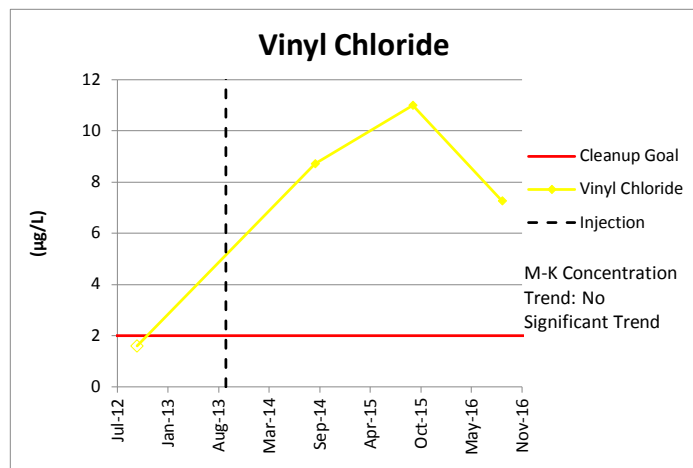
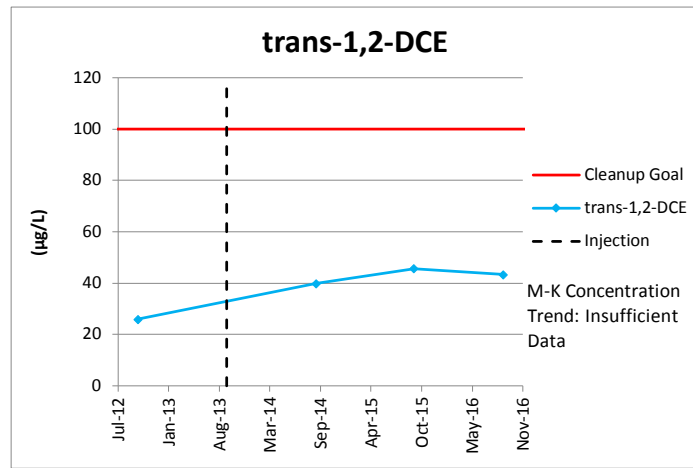
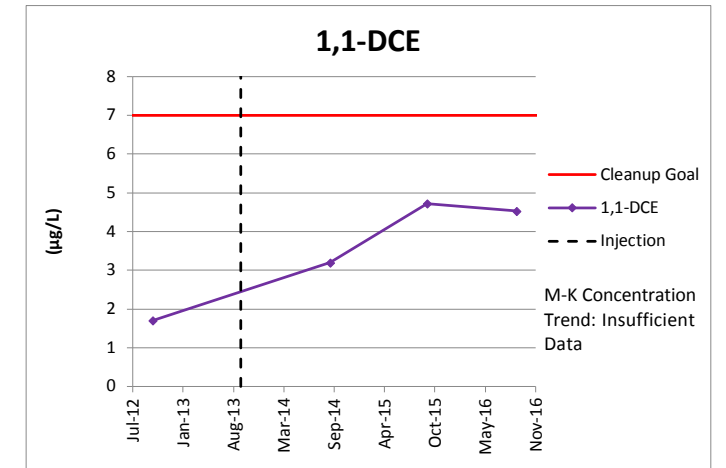
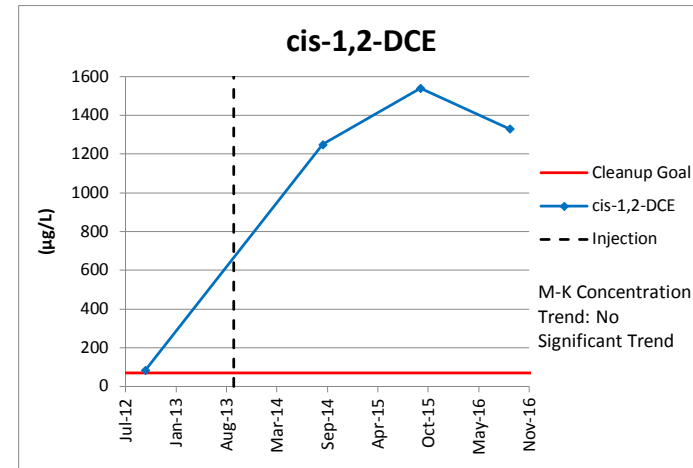
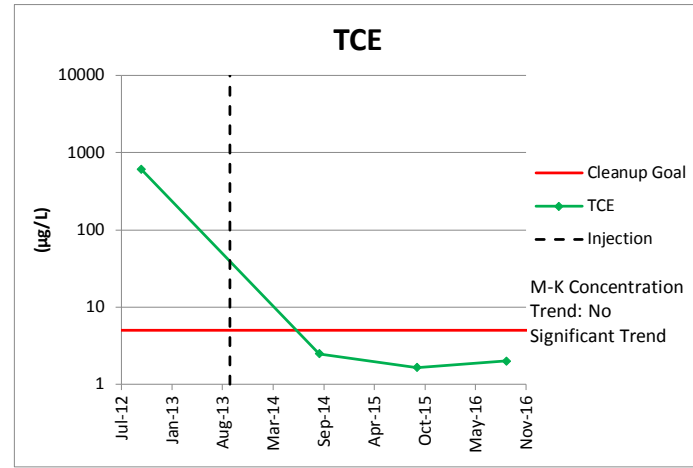
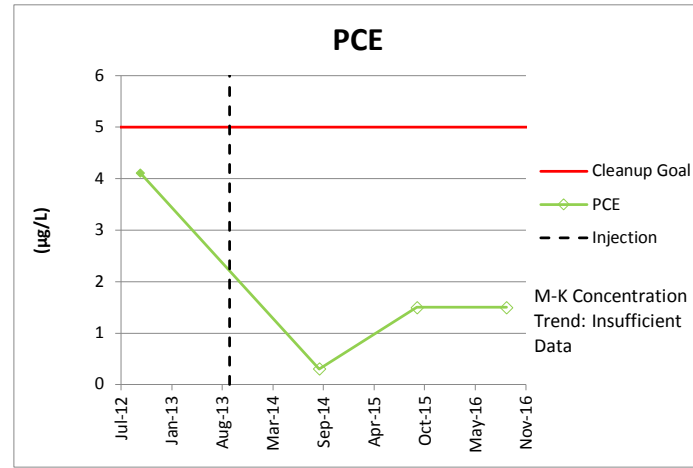
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1,1,2,2-PCA	1,1,2,2-Tetrachloroethane	mV	millivolt(s)
1,1,2-TCA	1,1,2-Trichloroethane	ORP	oxidation-reduction potential
1,1-DCE	1,1-Dichloroethene	PCE	Tetrachloroethene
ADEC 18 AAC 75 CUL	2008 Alaska Department of Environmental Conservation 18 AAC Chapter 75.345 Table C Groundwater Clean Up Level	TCE	Trichloroethene
CAH	chlorinated aliphatic hydrocarbon	TOC	total organic carbon
cis-1,2-DCE	cis-1,2-Dichloroethene	trans-1,2-DCE	trans-1,2-Dichloroethene



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**NOTES:**

µg/L	microgram(s) per liter	mg/L	milligram(s) per liter
1,1,2,2-PCA	1,1,2,2-Tetrachloroethane	mV	millivolt(s)
1,1,2-TCA	1,1,2-Trichloroethane	ORP	oxidation-reduction potential
1,1-DCE	1,1-Dichloroethene	PCE	Tetrachloroethene
ADEC 18 AAC 75 CUL	2008 Alaska Department of Environmental Conservation 18 AAC Chapter 75.345 Table C Groundwater Clean Up Level	TCE	Trichloroethene
CAH	chlorinated aliphatic hydrocarbon	TOC	total organic carbon
cis-1,2-DCE	cis-1,2-Dichloroethene	trans-1,2-DCE	trans-1,2-Dichloroethene

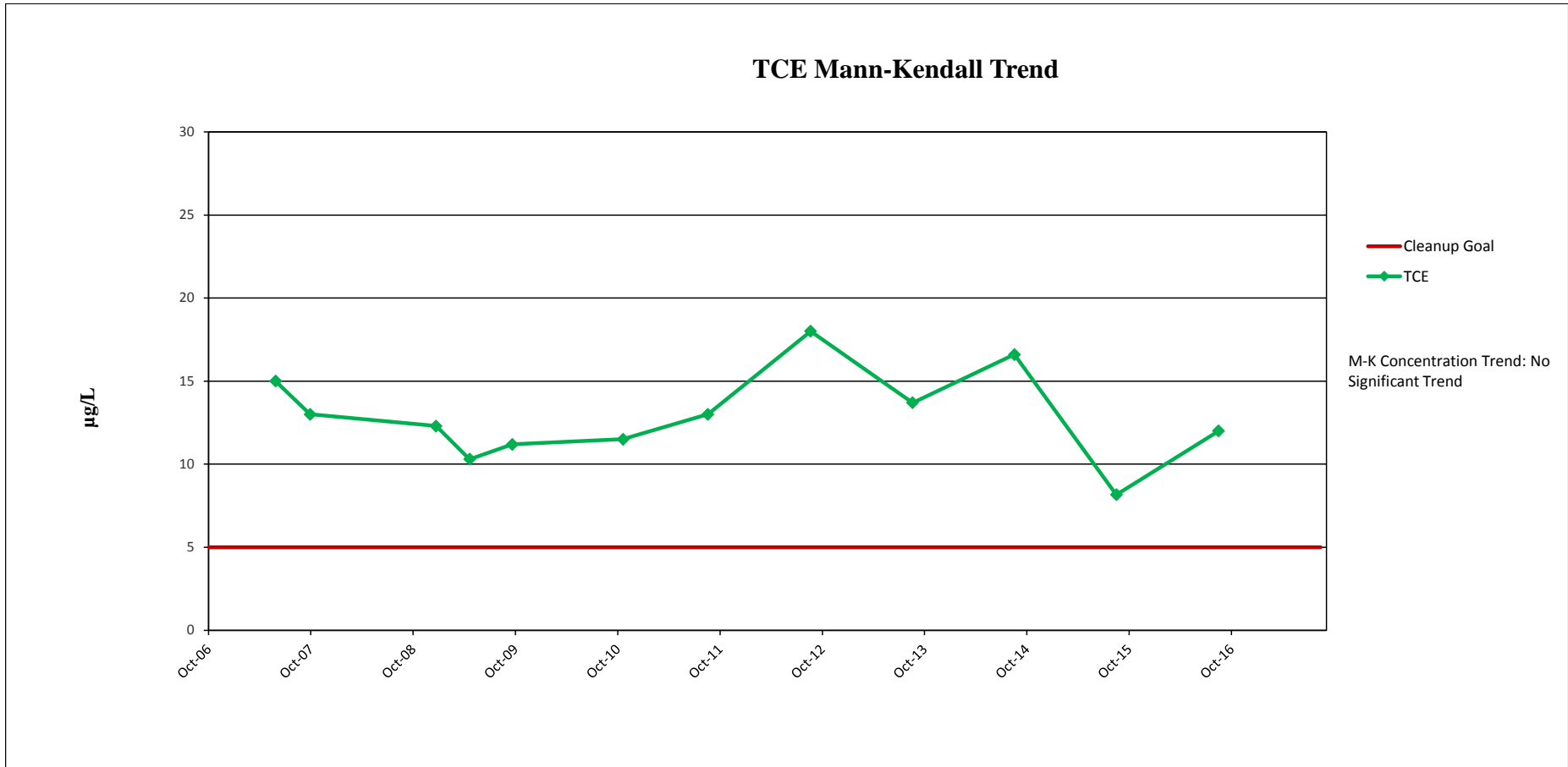


**CONCENTRATION TRENDS FOR SELECT ANALYTES AT MONITORING WELL AP-3989**  
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### TCE Mann-Kendall Trend



NOTES:  
 µg/L micrograms per liter  
 Cleanup goals are presented in Table 15-1  
 TCE Trichloroethene

### CONCENTRATION TRENDS FOR SELECT ANALYTES AT MONITORING WELL AP-4344

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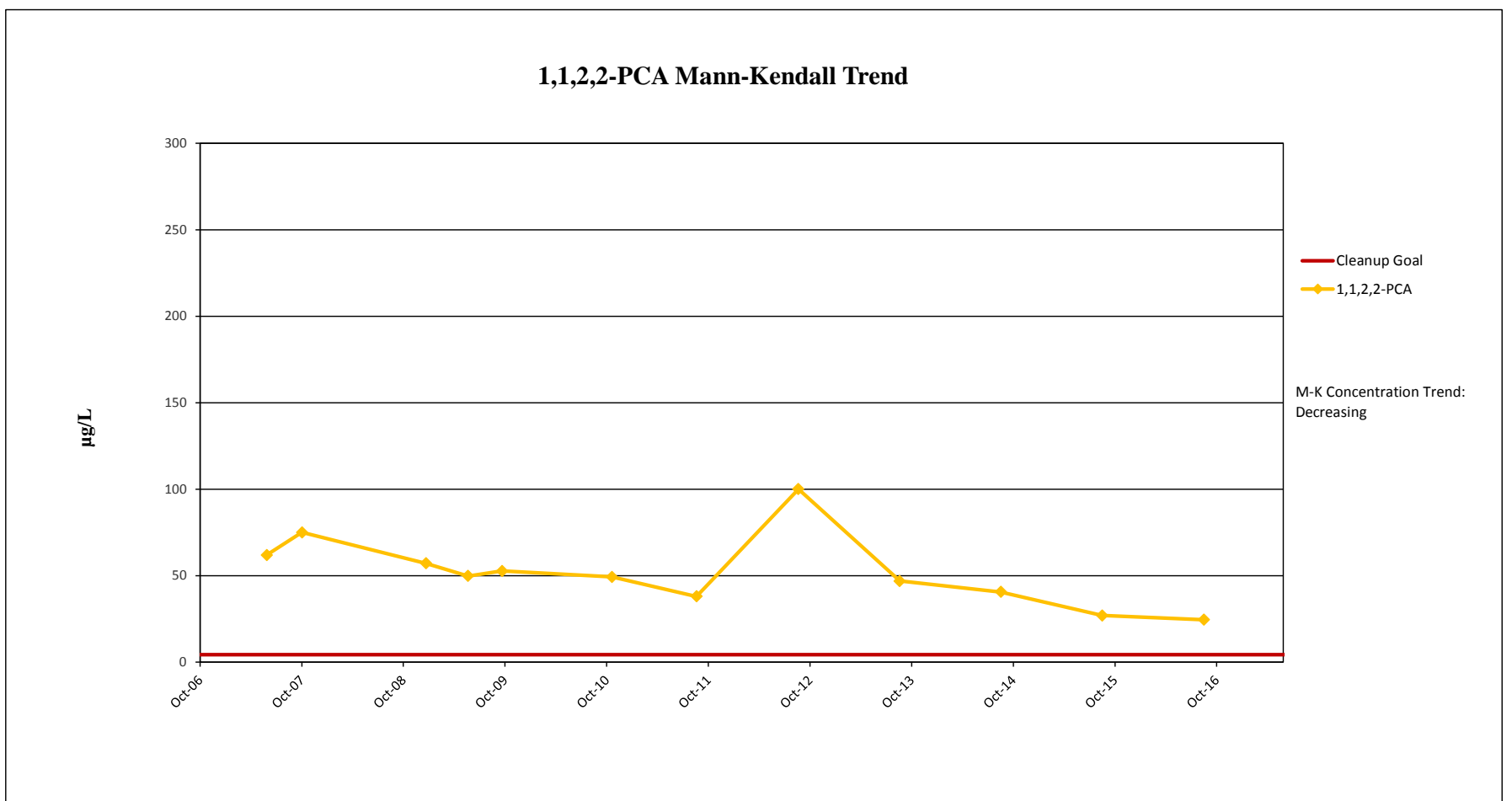
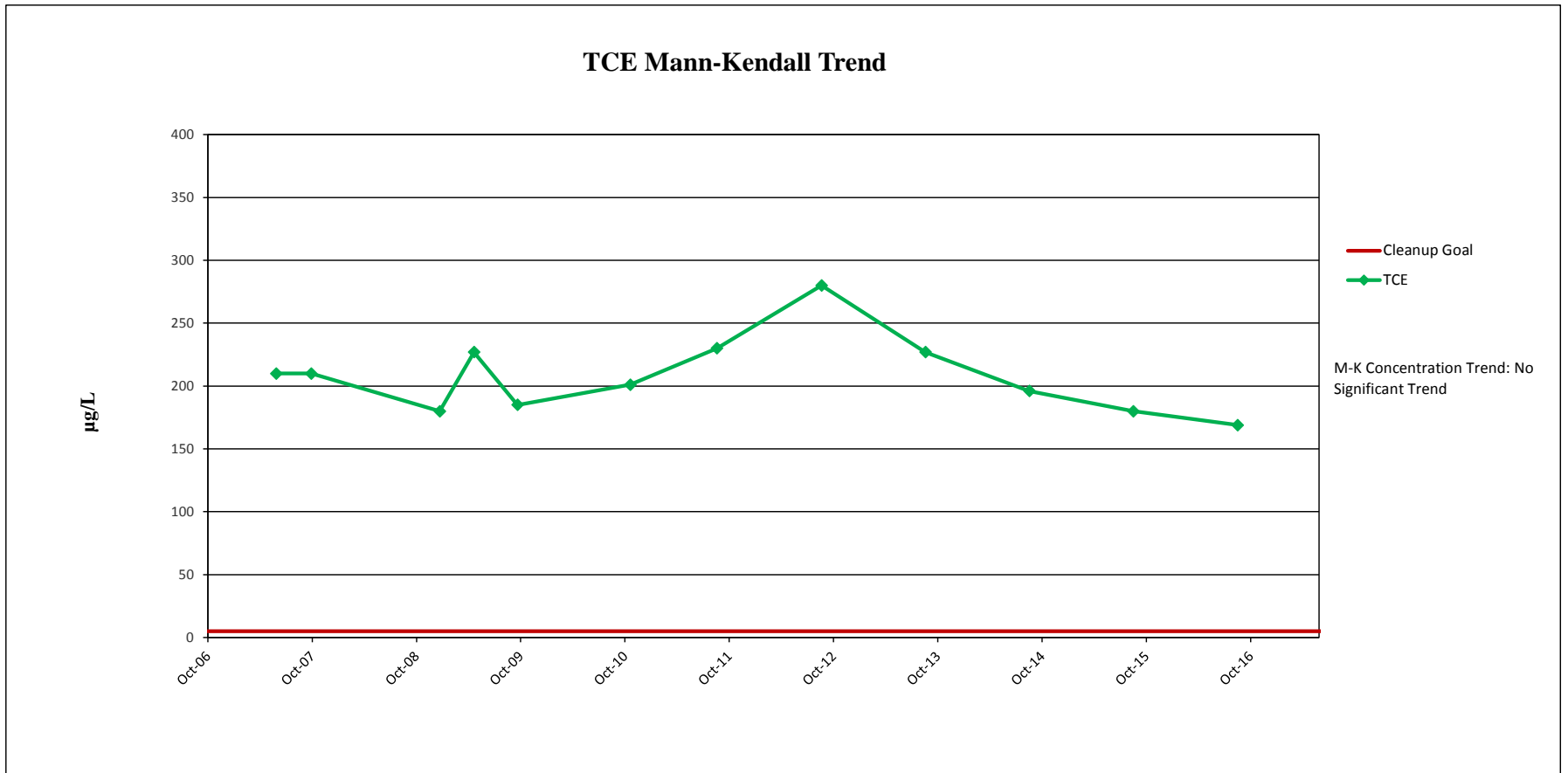
Figure

**15-10**



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NOTES:  
 µg/L                      micrograms per liter  
 1,1,2,2-PCA            1,1,2,2-Tetrachloroethane  
 ADEC 18 AAC 75 CUL    2008 Alaska Department of Environmental Conservation 18 AAC Chapter 75.345 Table C groundwater clean up level  
 Cleanup goals are presented in Table 15-1  
 TCE                        Trichloroethene

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Figure  
**15-11**



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## 16.0 DA089 (ARMORED VEHICLE MAINTENANCE AREA)

PBC Performance Objective: Design and Implement Optimized Exit Strategy for Site Closeout

Anticipated Achievement Date: 2019

### 16.1 SITE DESCRIPTION

DA089 (formerly DA085 and FTRS-89) – Armored Vehicle Maintenance Area (AVMA) is located southeast of the intersection of Otter Lake Road and D Street (Figure 1-1). DA089 consists of a PCE groundwater plume that was investigated as a part of the OUE RI in 2004 (CH2M HILL, 2004). The dissolved-phase PCE contamination in groundwater originated in the area immediately downgradient from Building 726. Dry cleaning solvents (PCE and/or Stoddard solvent) were stored in USTs at the site, and tank bottoms were disposed of in a dumpster at the site. Low levels of PCE contamination were detected in soils at the Building 726 site, indicating that PCE had been used at the facility (U.S. Army DPW, 2008). For additional site information, including previous investigations, see the Environmental Restoration Program 2011 *Groundwater Monitoring and Borehole Sampling, Three-Party Agreement Sites: OUB Poleline Road Disposal Area and OUE Armored Vehicle Maintenance Area* (USAF, 2012b).

#### 16.1.1 Site Geology

DA089 lies on an alluvial plain, often referred to as the Anchorage Lowland. The underlying geology at DA089 is complex and highly variable. The Mountain View Fan is approximately 40 to 60 feet thick under most of the site, and consists of mostly sands and gravels with localized deposits of silt and clay. The Elmendorf Moraine can be found approximately 0.5 mile north of the site.

#### 16.1.2 Site Hydrology

There are no wetlands or surface water features located on the site. The nearest surface water is Ship Creek, located crossgradient of DA089 approximately 1 mile to the southwest.

#### 16.1.3 Site Hydrogeology

Groundwater directly underlying the site is encountered in both a shallow perched aquifer and a deeper confined aquifer separated by a low-permeability silt layer. The thickness of the silt layer varies across the site and pinches out toward the northern edge of the site. The perching layer was found to extend north to the Davis Highway, northwest of Building 732.

In areas where the silt layer is present, a shallow perched aquifer is encountered at approximately 60 feet bgs, and a deeper confined aquifer is present below the silt layer at approximately 100 feet bgs. The aquifers merge where the silt layer pinches out, just north of Davis Highway, forming a thick unconfined aquifer. Groundwater flow is toward the northwest in all components of the aquifer system at the site.

## 16.2 REGULATORY REQUIREMENTS

The only COC for DA089 identified in the OUE ROD (U.S. Army, 2005) is PCE in groundwater (Table 16-1). No COCs are identified for soil. Although previous site investigations conducted at the site did not identify a source for the PCE in groundwater, anecdotal evidence suggests that a localized source must have existed near the northwestern side of Building 726 as a result of vehicle maintenance and laundry operations conducted at Buildings 732 and 726, respectively (U.S. Army DPW, 2008). Regulatory concurrence for no further action under CERCLA for soils at Building 726 (Site SS045) was obtained under the OU D ROD (U.S. Army, 2000).

ADEC completed a revision to 18 AAC 75 (November 6, 2016), which includes updates to the Table B1 and C cleanup levels (ADEC, 2017). A comparison of the OUE ROD Cleanup goals, MCLs, and the revised 18 AAC 75 cleanup levels is provided in Table 16-1. In addition, Table 16-1 contains a comparison of MCLs and the revised 18 AAC 75 cleanup levels for contaminants that were not identified as COCs in the OUE ROD. However, these compounds are of interest as they pertain to the treatability study that is ongoing at the site.

**Table 16-1 Cleanup Goals for Site DA089**

COCs in OU E ROD			
COC in Groundwater	OU E ROD Cleanup Goal <sup>a</sup> (µg/L)	MCL (µg/L)	ADEC Cleanup Level <sup>b</sup> (µg/L)
PCE	5	5	41
Other Chemicals of Interest in Groundwater Related to Ongoing Treatability Study			
Chemical	MCL (µg/L)	ADEC Cleanup Level <sup>b</sup> (µg/L)	
cis-1,2-DCE	70	36	
TCE	5	2.8	
Vinyl chloride	2	0.19	

**Notes:**

<sup>a</sup> OU E ROD cleanup goals were based on state and federal cleanup levels at the signing of the ROD (U.S. Army, 2005).

<sup>b</sup> 18 AAC 75 Table C Cleanup Levels (November 6, 2016).

µg/L = microgram(s) per liter

DCE = dichloroethene

PCE = tetrachloroethene

ROD = Record of Decision

TCE = trichloroethene

The selected remedy in the OUE ROD consists of ICs for groundwater use, natural attenuation of PCE in groundwater, and long-term groundwater monitoring (U.S. Army, 2005). Long-term groundwater monitoring began in 2004 (U.S. Army DPW, 2008). Current monitoring requirements include annual groundwater sampling at ten wells: six wells within the plume, three downgradient wells, and one crossgradient well. According to the OUE ROD, it is expected that the selected remedy (natural attenuation) will reduce PCE concentrations in groundwater to less than the MCL within 30 years (i.e., by 2034).

As stated in the OUE ROD, if the monitoring results for any two consecutive sampling events indicate that contaminant concentrations are increasing, then EPA, ADEC, and the Air Force will reevaluate the remedy. As such, statistical analyses are performed following each annual monitoring round to assess concentration trends across the site (see Section 16.3).

An in situ bioremediation treatability study was implemented at the site in 2013 and is ongoing (Section 16.5).

The PCE groundwater plume extends approximately 1,300 feet northwest from this apparent Building 726 source. PCE contamination is present in the shallow perched aquifer south of Davis Highway and the deeper unconfined aquifer north of Davis Highway (i.e., where the shallow perched and deeper confined aquifers merge [Section 16.1.3]). PCE contamination is not observed in deep confined aquifer.

The boundaries of the plume are not expanding – sentinel wells AP-3774, AP-3870, and AP-3871 have shown no indication of increasing PCE concentrations. Although there is a “probably increasing” trend for PCE at upgradient well AP-4341, downgradient wells AP-3468, AP-4411, and AP-4413 show statistically decreasing PCE trends, indicating that the plume is stable (see Section 16.3 and CH2M HILL, 2012). As stated in Section 16.2, the probable increasing trend at AP-4341 is in large part driven by two anomalously low results in October 2002 (1.8 µg/L) and December 2008 (non-detect). Additional data should be collected to confirm the trend before any decisions are made based on the trend analysis.

Outside of the treatability study treatment zone, dilution appears to be the primary mechanism for natural attenuation at the site (CH2M HILL, 2012). The presence of aerobic groundwater, the stability of natural attenuation geochemical parameters (Appendix A2), and the lack of PCE daughter products suggest that biodegradation plays a limited role in PCE attenuation.

### **16.3 2016 FIELD ACTIVITIES**

In October 2016, groundwater samples were collected at DA089 as part of the LTM program and an ongoing ERD treatability study. Field forms are included in Appendix A2. LUC inspections and site inspections were also conducted; inspection forms are included in Appendix B2. Sampling of groundwater for 1,4-dioxane and vapor intrusion sampling were conducted in 2016 under separate workplans and will be reported separately.

### **16.4 LONG-TERM MANAGEMENT PROGRAM RESULTS**

#### ***16.4.1 Groundwater Elevation Measurements***

On October 11, 2016, depth to groundwater was measured at 10 monitoring wells at the site. Depth to groundwater measurements are summarized in Table 16-2 along with the groundwater elevations calculated from those measurements. In addition, depth to groundwater measurements are recorded on the Water Level Survey Forms in Appendix A2, and groundwater elevations are shown on Figure 16-1.

**Table 16-2 2016 Groundwater Elevations at DA089**

Monitoring Well ID	Top of Casing Elevation <sup>a</sup> (feet AMSL)	Total Depth of Well (feet FTOC)	Depth to Groundwater <sup>b</sup> (feet FTOC)	Groundwater Elevation (feet AMSL)
AP-3468	293.38	114.7	109.54	183.84
AP-3534	293.05	138.4	109.42	183.63
AP-3774	289.46	116.4	105.88	183.58
AP-3870	281.92	109.9	99.05	182.87
AP-3871	293.46	120.2	110.31	183.15
AP-3893	307.49	124.1	87.75	219.74
AP-4341	294.23	68.1	63.95	230.28
AP-4342	293.36	100.8	96.95	196.41
AP-4411	292.82	72.8	67.89	224.93
AP-4413	291.57	75.4	71.87	219.70

**Notes:**

<sup>a</sup> Top of casing elevations measured during June 2003 and August 2004 surveys, except for AP-4413, which was resurveyed in 2013

<sup>b</sup> Depth to Groundwater measurements from October 11, 2016 Water Level Survey located in Appendix A2

AMSL = above mean sea level

ft = feet

FTOC = from top of casing

### 16.4.2 Groundwater Sample Analytical Results

Groundwater samples were collected from 10 groundwater monitoring wells. Analytical results for PCE and other select compounds are summarized in Table 16-3 and shown on Figure 16-1. The complete analytical results and DQE and laboratory analytical report is included as Appendix C2.

PCE was detected in seven of the 10 monitoring wells sampled. However only five of the 10 locations had concentrations detected above the cleanup goal of 5 µg/L (with a maximum concentration of 28.2 µg/L at monitoring well AP-4342).

In regard to non-COCs, carbon tetrachloride, chloroform, and cis-1,2-DCE were detected in groundwater at multiple monitoring wells. DRO was detected in the one well sampled for that compound (AP-4341). 2-butanone, 2-hexanone, acetone, TCE, and vinyl chloride were detected at one well only (AP-4413), which is associated with the ongoing treatability study at the site (Section 16.5).

When compared to the lowest of EPA MCLs and 18 AAC 75 Method Two groundwater cleanup levels (Table C), 2-butanone, 2-hexanone, acetone, carbon tetrachloride, DRO, and TCE were detected below their respective groundwater cleanup levels. Chloroform was detected above the ADEC Table C cleanup level of 2.2 µg/L at one location (2.76 µg/L at AP-3871). Cis-1,2-DCE and vinyl chloride were detected (47.8 and 1 µg/L, respectively) at one location (AP-4413) above their respective ADEC Table C cleanup levels of 36 and 0.19 µg/L, respectively.

**Table 16-3 Summary of Select 2016 Analytical Results at DA089**

Analyte	Cleanup Level	AP-3468	AP-3534	AP-3774	AP-3870	AP-3871	AP-3893	AP-4341	AP-4342	AP-4411	AP-4413 <sup>a</sup>
PCE	5 <sup>b</sup>	<b>24.8</b>	<b>15</b>	0.38J	ND (0.3)	ND (0.3)	ND (0.3)	<b>23.3</b>	<b>28.2</b>	<b>12.5</b>	3.31
TCE	2.8 <sup>c</sup>	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.3)	0.8
cis-1,2-DCE	36 <sup>c</sup>	ND (0.3) J	ND (0.3) J	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.3) J	<b>47.8</b>
Vinyl chloride	0.19 <sup>c</sup>	ND (0.3) J	ND (0.3) J	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.3) J	<b>1</b>
DRO	1,500 <sup>c</sup>	--	--	--	--	--	--	25.2 J	--	--	--
GRO	2,200 <sup>c</sup>	--	--	--	--	--	--	ND (75)	--	--	--

**Notes:**

<sup>a</sup> Analytical results have been affected by the ongoing treatability study which began in Fall 2013

<sup>b</sup> Cleanup goal established in the OU E ROD

<sup>c</sup> The 18 AAC 75 Table C Groundwater Cleanup Level (ADEC, 2017) is less than the MCL; therefore it is used for comparison.

All units are µg/L

**Bold** = Result exceeded cleanup criteria

-- = not analyzed

B = The analyte was detected in the associated method and/or calibration blank

DCE = dichloroethene

DRO = diesel-range organics

GRO = gasoline-range organics

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample

ND = analyte was not detected

PCE = tetrachloroethene

TCE = trichloroethene



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### 16.4.3 Natural Attenuation Assessment

Geochemical results (including laboratory and field measured parameters) were evaluated to assess natural attenuation processes at DA089. Laboratory measured parameters include sulfate, nitrate/nitrite, dissolved iron and manganese, methane, ethane, and ethene. Field-measured parameters (using an YSI 556) include pH, conductivity, turbidity, DO, temperature, and ORP. Laboratory and field-measured natural attenuation parameter results are presented in Tables 16-4 and 16-5, respectively.

**Table 16-4 Summary of 2016 Field Measured Natural Attenuation Parameters at DA089**

Monitoring Well ID	Date	Time	Volume Purged (gallons)	pH	Conductivity (mS/cm)	Turbidity (NTU)	DO (mg/L)	Temp (°C)	ORP (mV)
<i>Shallow/Perched Wells Within PCE Plume</i>									
AP-3468 <sup>a</sup>	10/24/2016	1045	1.9	7.69	0.645	25.7	16.88 <sup>c</sup>	1.56	88.3
AP-3534 <sup>a</sup>	10/21/2016	1005	1.4	7.63	0.413	0.79	6.07	3.3	108.2
AP-4341 <sup>a</sup>	10/20/2016	1325	0.6	7.52	0.609	71.6	0.69	3.87	111.2
AP-4342 <sup>a</sup>	10/21/2016	1258	1.7	7.8	0.492	63.1	14.01 <sup>c</sup>	3.57	106.2
AP-4411 <sup>a</sup>	10/20/2016	1015	1	7.52	0.547	37.6	5.23	4.71	121.7
AP-4413 <sup>b</sup>	10/24/2016	1308	0.5	6.79	1.173	8.75	14.79 <sup>c</sup>	0.58	12
<i>Downgradient Wells</i>									
AP-3774 <sup>a</sup>	10/19/2016	1215	2	7.17	0.509	1.88	8.56	3.27	109
AP-3871 <sup>a</sup>	10/19/2016	1035	0.9	7.38	0.474	3.68	11.53 <sup>c</sup>	2.25	105.8

**Notes:**

<sup>a</sup> Long-Term Monitoring program well

<sup>b</sup> Long-Term Monitoring program and Treatability Study well

<sup>c</sup> DO reading likely biased high. 100 percent saturation for site temperature and conductivity ranges is approximately 12 to 13 mg/L. DO sensor suspect.

°C = degree(s) Celsius

ID = identification

mg/L = milligram(s) per liter

mS/cm = milliSiemen(s) per centimeter

mV = millivolt(s)

NTU = nephelometric turbidity unit(s)

ORP = oxidation-reduction potential



**Table 16-5 Summary of 2016 Laboratory Measured Natural Attenuation Parameters at DA089**

Monitoring Well ID	Total Nitrate/Nitrite (mg/L)	Dissolved Iron (mg/L)	Dissolved Manganese (mg/L)	Sulfate (mg/L)	Chloride (mg/L)	Ethane (µg/L)	Ethene (µg/L)	Methane (µg/L)
<i>Shallow/Perched Wells Within PCE Plume</i>								
AP-3468 <sup>a</sup>	1.76	0.17	0.025	16.5	---	0.187 U	0.199 U	0.055 B
AP-3534 <sup>a</sup>	1.15	0.02 U	0.002 U	19.2	---	0.15 U	0.164 U	0.0789 U
AP-4341 <sup>a</sup>	1.95	0.139 J	0.00409 B	15.8	---	0.164 U	0.178 U	0.0434 B
AP-4342 <sup>a</sup>	1.66	0.0541 J	0.00181 B	14.3	---	0.179 U	0.191 U	0.0661 B
AP-4411 <sup>a</sup>	1.87	0.433	0.0115	11.3	---	0.16 U	0.174 U	0.0843 U
AP-4413 <sup>b</sup>	0.10	20.4	14.3	3.46 J	12.5	0.2 U	0.0933 J	256 J
<i>Downgradient Wells</i>								
AP-3774 <sup>a</sup>	0.82	0.02 U	0.002 U	22.4	---	0.155 U	0.169 U	0.049 B
AP-3871 <sup>a</sup>	1.46	0.02 U	0.000921 B	23.1	---	0.157 U	0.171 U	0.0827 U

**Notes:**

- <sup>a</sup> Long-Term Monitoring program well
- <sup>b</sup> Long-Term Monitoring program and Treatability Study well
- µg/L = microgram(s) per liter
- B = The analyte was detected in the associated method and/or calibration blank
- ID = identification
- J = Analyte was present but the reported value may not be precise or accurate (estimated)
- mg/L = milligram(s) per liter
- ND = analyte was not detected
- PCE = tetrachloroethene

Natural attenuation parameters collected from monitoring wells throughout the plume indicate the aquifer is largely aerobic which suggests that dilution is the primary mechanism of natural attenuation at DA089. Supporting evidence for an aerobic aquifer includes the following:

- Relatively high DO and positive ORP results.
- Relatively high concentrations of nitrate and sulfate.
- Low concentrations of dissolved iron, dissolved manganese, and dissolved methane.

Conversely, natural attenuation parameters collected near AP-4413, which is within the target treatment zone of the ERD treatability study, indicate that conditions are favorable for reductive dechlorination processes. Supporting evidence includes the following:

- Relatively low ORP result in comparison with the other DA089 wells.
- A higher concentration of methane in the sample from AP-4413 than from other sampled DA089 wells (although not indicative of highly reducing conditions, which is generally indicated by greater than 1,000 µg/L methane; the concentration at AP-4413 is four orders of magnitude greater than results from most other DA089 wells).
- A higher dissolved manganese concentration in the sample from AP-4413 (an increase in manganese concentrations can indicate conditions favorable for reductive dechlorination).

- A higher dissolved iron concentration in the sample from AP-4413 than other DA089 wells (an increase in iron concentrations can indicate conditions favorable for reductive dechlorination).

Depleted concentrations of sulfate in the sample from AP-4413 (one order of magnitude less) in comparison with other DA089 wells (indicate conditions are favorable for reductive dechlorination).

## 16.5 TREATABILITY STUDY RESULTS

Following the initial EVO injection in September 2013, four rounds of groundwater monitoring (October 2013, January 2014, April 2014, and September 2014) were conducted at the performance monitoring well AP-4413. Following the initial four rounds of quarterly groundwater monitoring, results showed that, although geochemically reducing conditions were evolving, PCE concentrations were not decreasing as anticipated. Based on these results, the USAF decided to implement Contingency 1, a second EVO injection, as outlined in the *Uniform Federal Policy-Quality Assurance Project Plan, DA089 – Armored Vehicle Maintenance Area Treatability Study Work Plan, Joint Base Elmendorf-Richardson, Alaska* (USAF, 2013b).

The second EVO injection was performed at DA089 in October 2014. Following the second EVO injection, four subsequent rounds of groundwater monitoring (March 2015, June 2015, September 2015, and December 2015) were conducted.

Geochemical parameters indicate that the injections of EVO have been effective at generating anaerobic conditions necessary for reductive dechlorination. Concentrations of PCE in groundwater at AP-4413 decreased substantially after the second injection of EVO in October 2014, increased slightly, and have now decreased substantially again.

### 16.5.1 Target Treatment Zone Monitoring Well AP-4413

The target treatment zone is hydrologically upgradient from the designated performance monitoring well AP-4413, which is used to evaluate the effectiveness of the EVO treatment. The four injection wells were installed within the perched aquifer, which is approximately 65 feet bgs and is located on top of a silt confining layer.

#### 16.5.1.1 AP-4413 Groundwater Results

A baseline sample from AP-4413 prior to EVO injection was collected in August 2013 and was presented in the Implementation Report (USAF, 2014e). Four groundwater samples were collected from AP-4413 from October 2013 to September 2014 following the initial EVO injection. Another four groundwater samples were collected from March 2015 to December 2015 following the second EVO injection in October 2014. In October 2016, additional monitoring was conducted in conjunction with the LTM program. Analyte concentration trends are summarized in the following sections. CAH results for AP-4413 and an updated representation of the PCE plume are presented on Figure 16-1. Graphs presenting CAH, geochemical parameter, and total molar concentration trends are presented on Figure 16-2.

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#### 16.5.1.1.1 AP-4413 – Chlorinated Aliphatic Hydrocarbons

Figure 16-2 shows a graphical representation of the relative molar concentrations of all the detected CAHs (including PCE and daughter products) at AP-4413 through time. Following the first EVO injection, concentrations of PCE in groundwater at AP-4413 increased from 78.8 µg/L to 171 µg/L before decreasing to 52.8 µg/L approximately 1 year following the first EVO injection. Based on those results, a second EVO injection was performed and, following that injection, PCE concentrations then decreased substantially immediately following the second injection, increased slightly in 2015, and decreased again in 2016. In turn, concentrations of PCE daughter products, TCE, cis-1,2-DCE and vinyl chloride, have increased compared to pre-injection concentrations. Concentrations of TCE, cis-1,2-DCE and vinyl chloride have begun to decrease, indicating that those compounds are also being dechlorinated. A summary of the concentrations observed for the CAHs at AP-4413 is provided in Table 16-6.

The following observations can be made from total CAH molar concentration trends shown on Figure 16-2:

- Most of the PCE has been degraded to cis-1,2-DCE; other daughter products like TCE and vinyl chloride make up very little of the total CAH molar mass.
- Cis-1,2-DCE now constitutes 91 percent of the CAHs at AP-4413.
- The latest molar concentration of cis-1,2-DCE (0.49 µmol/L) is similar to the baseline molar concentration of PCE and TCE combined (0.48 µmol/L)
- The total CAH molar concentration at AP-4413 has increased from 0.49 to 0.54 µmol/L (and as high as 1.09 µmol/L) since the beginning of the treatability study.

Based on these observations, the following conclusions can be drawn:

- As PCE is degraded, it is expected that the total molar concentration of daughter products should be equal to (if daughter products are not degraded) or less than (if daughter products are being degraded) the baseline molar concentrations of PCE. The observed cis-1,2-DCE molar concentration is similar to the baseline PCE and TCE molar concentration at AP-4413, which could indicate that cis-1,2-DCE is not being degraded. However, concentration data indicate that cis-1,2-DCE is being degraded to vinyl chloride and ethene (which should result in the cis-1,2-DCE molar concentration being less than the baseline PCE and TCE molar concentration).
- The similarity of the current cis-1,2-DCE molar concentration to the baseline PCE molar concentration and previous increase in molar concentrations could be explained by any combination of the following:
  - An influx of dissolved PCE from the area of the plume immediately upgradient of the target treatment zone, some of which is being degraded to cis-1,2-DCE,
  - Back-diffusion of sorbed CAHs from the surrounding fine-grained soils into the dissolved phase,
  - Variability of CAHs within the subsurface.

#### 16.5.1.1.2 AP-4413 Geochemical Parameters

The geochemical parameters measured in groundwater at AP-4413 indicate that the groundwater environment has been and likely remains sufficiently anaerobic for reductive dechlorination to occur. Following the second EVO injection, the TOC concentration increased to 875 mg/L and still remains well above the 20 mg/L threshold condition for reductive dechlorination to occur. ORP decreased to negative values (-53.2 millivolts [mV]) following the initial EVO injection and has since increased to slightly positive values (12.0 mV in October 2016). This increase in ORP could be indicative of geochemical conditions becoming less reducing; however, the other geochemical parameters indicate that conditions are still favorable for reductive dechlorination. A summary of the geochemical parameters measured at AP-4413 is provided in Table 16-7.

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**Table 16-6 AP-4413 Chlorinated Aliphatic Hydrocarbon Results**

Analyte (µg/L)	Cleanup Level	August 2013 (pre-injections)	Initial Injection – September 2013				Second Injection – October 2014				March 2015	June 2015	Sept 2015	Dec 2015	Oct 2016	Comments
			Oct 2013	Jan 2014	April 2014	Sept 2014	March 2015	June 2015	Sept 2015	Dec 2015	Oct 2016					
PCE	5 <sup>a</sup>	78.8	135	130	171	52.8	5.56	7.13	14.9	23.7	3.31					Decrease indicates that PCE is being dechlorinated.
TCE	2.8 <sup>b</sup>	0.25 U	0.25 U	0.32	0.31	4.24	1.68	2.14	4.26	4.86	0.8					Decrease indicates that PCE is mostly dechlorinated.
cis-1,2-DCE	36 <sup>b</sup>	0.25 U	0.25 U	0.63	0.3 U	46.1	45.9	76.4	88.4	45.1 J	47.8					Increase indicates that TCE is being dechlorinated. Subsequent decrease indicates that cis-1,2-DCE is being dechlorinated.
trans-1,2-DCE	100 <sup>c</sup>	0.25 U	0.25 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U					Non-detect concentrations indicate that trans-1,2-DCE is not a primary dechlorination pathway.
1,1-DCE	7 <sup>c</sup>	0.25 U	0.25 U	0.3 U	0.3 U	0.3 U	0.3 U	0.16 J	0.3 U	0.3 U	0.3 U					Non-detect concentrations indicate that 1,1-DCE is not a primary dechlorination pathway.
Vinyl chloride	0.19 <sup>b</sup>	0.25 U	0.25 U	0.3 U	0.3 U	0.3 U	0.54	2.42	3.31	0.85	1.0					Increase indicates that DCE is being dechlorinated. Subsequent decrease indicates that vinyl chloride is being dechlorinated.
Ethene	NA	0.27 U	0.12 U	0.123 U	0.0735 J	0.188 J	0.552 J	0.169 J	0.141 J	0.985	0.0933 J					Increase indicates that complete dechlorination is occurring.

**Notes:**  
<sup>a</sup>The MCL is the cleanup level selected in the OU E ROD (U.S. Army, 2005); therefore, it is used for comparison.  
<sup>b</sup>The 18 AAC 75 Table C Groundwater Cleanup Level (ADEC, 2017) is less than the MCL; therefore it is used for comparison.  
<sup>c</sup>The MCL is less than the 18 AAC 75 Table C Groundwater Cleanup Level (ADEC, 2017); therefore it is used for comparison.  
**Bold** values indicate that the result exceeded the MCL.  
 µg/L = microgram(s) per liter  
 J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.  
 MCL = maximum contaminant level  
 U = The analyte was analyzed for, but was not detected above limit of detection.

**Table 16-7 AP-4413 Geochemical Parameter Results**

Analyte	August 2013 (baseline)	Initial Injection – September 2013				Second Injection – October 2014				March 2015	June 2015	Sept 2015	Dec 2015	Oct 2016	Comments
		Oct 2013	Jan 2014	April 2014	Sept 2014	March 2015	June 2015	Sept 2015	Dec 2015	Oct 2016					
ORP (millivolts)	47.9	51.8	16.6	-39.7	-53.2	25.3	28.4	44.7	10.1	12.0					A negative value indicates reduced conditions, favorable for dechlorination. Slightly positive current result could indicate that conditions are becoming more aerobic; however, other geochemical parameters are indicative of highly reduced conditions.
DO (mg/L)	8.82	0.49	10.3	2.14	4.56	0.86	2.33	1.82	0.12	14.79 <sup>a</sup>					DO values below 1 mg/L indicate that conditions are favorable for dechlorination.
TOC (mg/L)	0.482 B	1.34 B	74.6	40.2	50.9	875	518	350	277 B	314					Greater than 20 mg/L is considered a sufficient carbon and energy source to drive dechlorination.
VFAs <sup>b</sup> - acetic acid (µg/L)	60 U	NA	16,500	37,500	46,800	176,000	229,000	227,000 J	110,000	277,000					VFAs are a degradation product of EVO, and concentrations of VFAs greater than 10,000 to 20,000 µg/L are a good indicator of sufficient EVO distribution at a given location.
VFAs <sup>b</sup> - propionic acid (µg/L)	60 U	NA	113,000	12,900	4,690	202,000	48,800	39,600 J	27,400 J	36,500					
Methane (µg/L)	1.184 B	0.0436 B	0.109 J	0.218 B	78.4	102	271 J	397	367	256 J					Levels greater than 1,000 µg/L are an indicator of highly reducing conditions, which are desirable for dechlorination to occur.
Manganese (mg/L)	0.000601 B	0.543 B	12.6	10.4	10.1	34.2	25.5	22	11.2	14.3					An increase in manganese concentrations can indicate that groundwater conditions are sufficiently reducing for anaerobic dechlorination to occur.
Dissolved Iron (mg/L)	0.0173 J	0.029 J	1.6	3.33	4.27	51.3	32.9	25.8	9.44	20.4					An increase in ferrous iron concentrations can indicate that groundwater is sufficiently reducing for anaerobic dechlorination to occur. Although dissolved iron reported from laboratory analysis did not speciate between ferric and ferrous iron, ferrous iron was measured using a field test kit (Appendix A2). The ferrous iron result from the field test kit was 1.60 mg/L.
Sulfate (mg/L)	24.1	21.8 B	0.449	0.29	2.72	1.94	2.2	1.18 B	1.13	1.75 J					Depleted concentrations of sulfate compared to baseline indicate that groundwater conditions are sufficiently reducing for anaerobic dechlorination to occur.
Sulfide (mg/L)	0.017 J	0.241 B	0.0187 J	0.0193 U	0.0134 J	0.0926	0.0531	0.0557	0.0342	0.192 J					Low concentrations could indicate that iron sulfide minerals are being formed.
Nitrate (mg/L)	3.6	0.0223 B	0.018	0.0349	0.0386 B	0.0799	0.0921	0.109 B	0.0482	0.099					A nitrate level of <1.0 mg/L is desirable for dechlorination.
pH	6.74	7.28	7.13	6.93	7.31	6.19	6.39	6.36	6.61	6.79					pH values are within the acceptable range (6 to 8) for reductive dechlorination.

**Notes:**  
<sup>a</sup>Erroneous DO measurement. Value is outside of range of typical values for groundwater (0 to 10 mg/L).  
<sup>b</sup>Acetic acid and propionic acid are the most prevalent VFAs detected at AP-4413. See Appendix B2.  
 B = The analyte was detected in the associated method or calibration blank.  
 DO = dissolved oxygen  
 J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.  
 NA = not analyzed  
 U = The analyte was analyzed for, but was not detected above the limit of detection.



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## 16.6 MANN-KENDALL TREND ANALYSIS

A Mann-Kendall trend analysis was performed for a DA089 monitoring well if: (1) the well was sampled in 2016, (2) there are four or more data points available to run the calculation, (3) the cleanup goal for COCs as identified in the OUE ROD have been exceeded one or more times in the past 5 years, and (4) the data set has less than 50 percent non-detected values. Data sets are limited to no longer than 10 years for all LTM wells to provide a (relatively) short-term trend analysis for the site. In addition, Mann-Kendall trend analysis was also conducted for monitoring well AP-4413, which is located within the treatability study target treatment zones at DA089 (USAF 2014e). The data evaluated are limited to the period from the 2013 emulsified vegetable oil injections onward.

A Mann-Kendall trend analysis was performed for six monitoring wells (AP-3468, AP-3534, AP-4341, AP-4342, AP-4411, and AP-4413). A summary of Mann-Kendall concentration trends is provided in Table 16-8 and on Figures 16-2 and 16-3. Historical data used to calculate the Mann-Kendall concentrations trends are provided in Appendix C2.

Trend results indicate that statistically significant (95 percent confidence level or greater) decreasing trends are present for the following constituents and locations:

- PCE in monitoring wells AP-3468, AP-4342, and AP-4413

Statistically significant increasing trends (greater than 95 percent confidence) are present for the following constituents:

- TCE in monitoring well AP-4413
- cis-1,2-DCE in monitoring well AP-4413

A probable (between 90 and 95 percent confidence levels) increasing trend is present for the PCE in monitoring well AP-4341. However, it is important to note that (1) this trend is not “statistically significant” at this time, and (2) the probable increasing trend is in large part driven by two anomalously low results in October 2002 (1.8 µg/L) and December 2008 (non-detect). Additional data should be collected to confirm the trend before any decisions are made based on the trend analysis.

No other wells show a statistically significant trend in the PCE-affected area.

**Table 16-8 Summary of 2016 Mann-Kendall Statistical Analysis at DA089**

Well	PCE <sup>a</sup>	TCE	cis-1,2-DCE	Vinyl Chloride
<i>Treatability Study Wells – Target Treatment Zone</i>				
AP-4413 <sup>b</sup>	Decreasing (97.7)	Increasing (99.4)	Increasing (99.4)	ID
<i>LTM Only Program Wells</i>				
AP-3468	Decreasing (98.4)	ID	ID	ID
AP-3534	NST	ID	ID	ID
AP-4341	Probably Increasing (92.4)	ID	ID	ID
AP-4342	Decreasing (98.4)	ID	ID	ID
AP-4411	NST	ID	ID	ID

**Notes:**

<sup>a</sup> COC

<sup>b</sup> Data points included in the Mann-Kendall trend calculation for well AP-4413 located in the treatability study target treatment zone have been limited to August 2013 (pre-injection baseline) forward. Results for the site COC and daughter products meeting the criteria identified in Section 1.4 are presented in this table.

Decreasing (96.2) = Decreasing concentration trend with 96.2 percent confidence.

Trends are considered significant at greater than 95 percent confidence. Trends are considered probably significant between 90 and 95 percent confidence.

Wells included in the 2016 Mann-Kendall Trend analysis (1) were sampled during the 2016 monitoring event, (2) have four or more data points available to run the calculation, (3) show that cleanup levels for COCs have been exceeded one or more times in the past 5 years, and (4) have data sets that have been limited to less than 10 years to provide a (relatively) short-term trend. The remaining wells are either free of contamination, have not had exceedances in the past 5 years, or do not have any significant trends and were therefore not evaluated.

COC = contaminant of concern

ID = insufficient data to run Mann-Kendall trend analysis; data set either contains greater than 50 percent non-detect values or has less than four data points

LTM = long-term management

NST = no statistically significant trend.

PCE = tetrachloroethene

TCE = trichloroethene

## 16.7 SITE SUMMARY AND RECOMMENDATIONS

The current ADEC site status for DA089 is “Active.”

An OES Performance Plan for DA089 was finalized in February 2013 under the current PBR contract. The OES at DA089 includes performing an in situ bioremediation treatability study and continuing long-term monitoring as outlined in the OUE ROD.

### 16.7.1 Treatability Study Summary

The treatability study was implemented in September 2013, when injection wells were installed and an EVO substrate was injected into the shallow perched aquifer near AP-4413. Following the four quarters of groundwater monitoring, results showed that, although geochemically reducing conditions were evolving, PCE concentrations were not decreasing. Therefore, a second EVO injection was performed in October 2014. An additional four quarters of groundwater monitoring was completed in December 2015. Based on the recommendations of the *Treatability Study Report DA089 – Armored Vehicle Maintenance Area*, additional monitoring was conducted in conjunction with the LTM program (USAF, 2017c).

Conclusions for the treatability study following the latest round of monitoring are as follows:

- Geochemical parameters indicate that anaerobic conditions necessary for reductive dechlorination have persisted in the target treatment zone.
- The concentration of PCE in groundwater within the target treatment zone has decreased to below the MCL, and represents a reduction of over 95 percent when compared to the 2013 baseline PCE concentrations.
- The concentration of cis-1,2-DCE, a PCE daughter product, remains above the cleanup goal within the target treatment zone. However, there is evidence that cis-1,2-DCE is being degraded to vinyl chloride and then to ethene, but the degradation of cis-1,2-DCE is occurring at a slower rate than PCE was being degraded.

### 16.7.2 Recommendations

Site DA089 has been identified as a **Yellow** priority because of the potentially significant increasing PCE concentration at monitoring well AP-4341. Additional data should be collected to confirm the trend before any decisions are made based on the trend analysis.

Based on the results of this report and the *Treatability Study Report* (USAF, 2017c), the following actions are recommended:

- Continue annual groundwater monitoring at the remaining wells within the monitoring program in accordance with the 2016 LTM work plan addendum.
- Continue annual groundwater monitoring at AP-4413 to assess potential rebound of PCE concentrations, continued degradation of PCE daughter products, and persistence of reducing groundwater conditions. Treatability study monitoring results from AP-4413 will continue to be reported in a distinct section of the annual groundwater monitoring report.

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NOTES:

1. Coordinate System: UTM Zone 6, WGS84, meters.
2. All results in micrograms per liter (µg/L).
3. **Bold** results exceed cleanup criteria.  
PCE (5 µg/L\*)  
\* Groundwater Cleanup Goal Operable Unit E ROD (U.S. Army, 2005)
4. Depth to groundwater measurements are included in the "Water Level Survey Form" provided in Appendix A2. The groundwater elevation data presented on this figure are calculated from those measurements and are summarized in Table 16-2.
5. Groundwater elevations are presented in in feet above mean sea level (msl).
6. Abbreviations:  
ADEC Alaska Department of Environmental Conservation.  
PCE tetrachloroethene
7. Flags:  
J The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.  
J+ Analyte is present, but value may not be accurate or precise (estimated high).  
J- Analyte is present, but value may not be accurate or precise (estimated low).  
- Not measured or not sampled.  
ND(0.4) Indicates non-detect (MDL) or non-detect (PQL).

AP-3870		AP-3774		AP-3871	
Date	PCE	Date	PCE	Date	PCE
9/8/2014	ND(0.3)	9/11/2014	0.39J	9/8/2014	ND(0.3)
9/23/2015	ND(0.3)	9/24/2015	0.63	9/24/2015	ND(0.3)
		10/19/2016	0.38J	10/19/2016	ND(0.3)

AP-3534	
Date	PCE
9/11/2014	32.5
9/25/2015	13.8J
10/21/2016	15

AP-3468	
Date	PCE
9/11/2014	32.3
9/25/2015	31.2J
10/24/2016	24.8

AP-3893	
Date	PCE
9/12/2014	ND(0.3)
9/23/2015	ND(0.3)

AP-4411	
Date	PCE
9/12/2014	9.53
9/25/2015	11.1
10/20/2016	12.5

AP-4342	
Date	PCE
9/15/2014	51.9
9/28/2015	34.1
10/21/2016	28.2

AP-4413	
Date	PCE
9/15/2014	52.8
9/28/2015	14.9
10/24/2016	3.31

AP-4341	
Date	PCE
9/12/2014	21.2
9/24/2015	13.2
10/20/2016	23.3



**LEGEND**

- Program Monitoring Well
- Non-Program Monitoring Well
- Non-Program Monitoring Well (Abandoned)
- Injection Well Location
- Fence
- Railroad
- Building (Facility ID)
- Demolished Structure
- Land Use Control Boundary Groundwater
- Land Use Control Boundary Soil
- Treatability Study Area
- Historic PCE Contour Interval (dashed where inferred)
- 5 to 50 µg/L PCE
- Groundwater Contour Line (feet AMSL) (APR 2014)
- General Groundwater Flow Direction (Approximate)
- 164.82' Groundwater Elevation (feet AMSL) (2016 Sampling Event)

R:\ENBG00\_Proj\AAI\Forecast\FCEE\_JBER\_20001102\MapFiles\CERCLA\_Sites\2017\DA089\_Figure\_16-1\_Site\_Map.mxd 3/14/2018 AESPEJJO

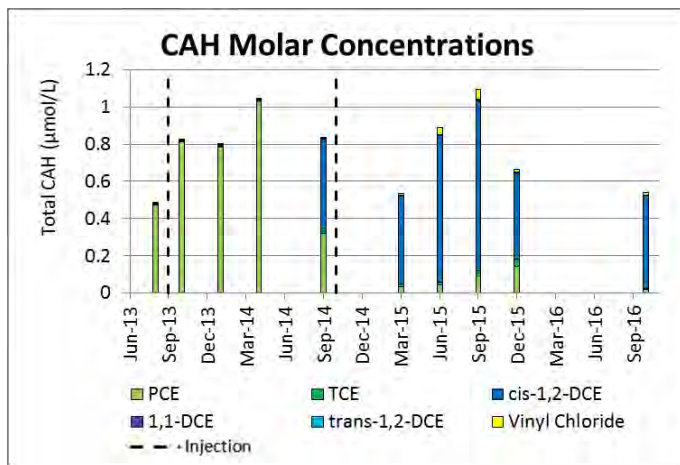
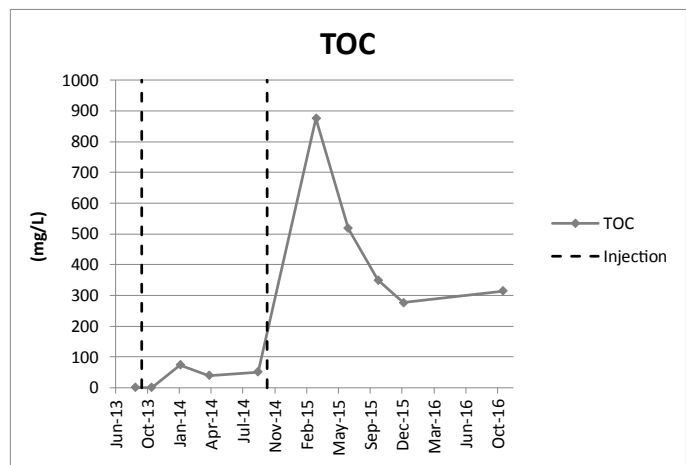
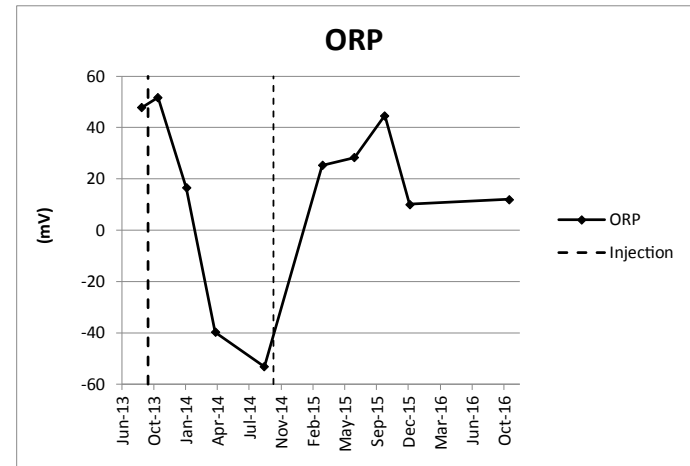
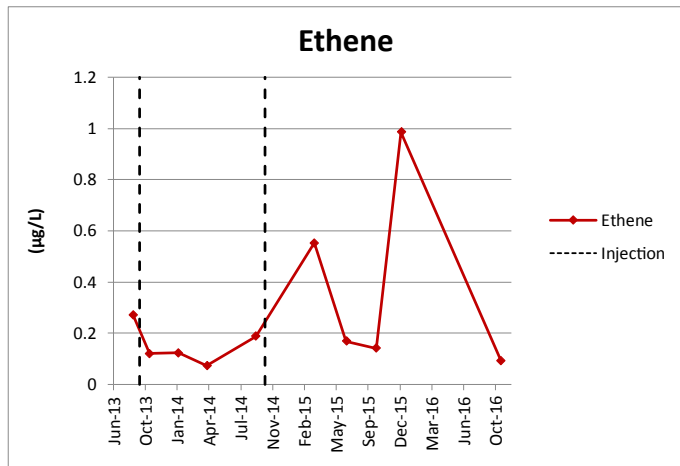
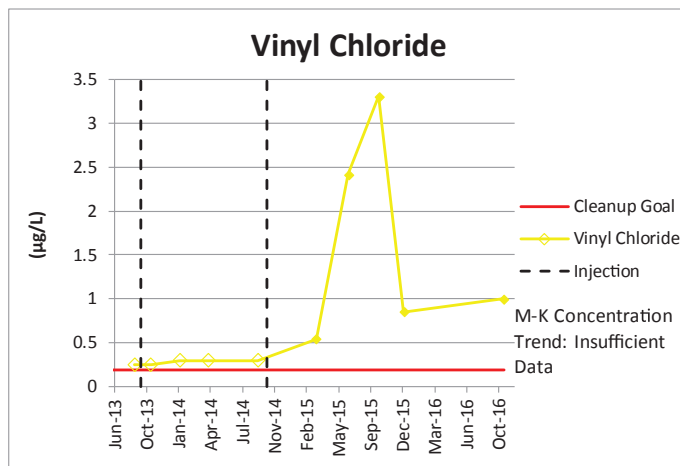
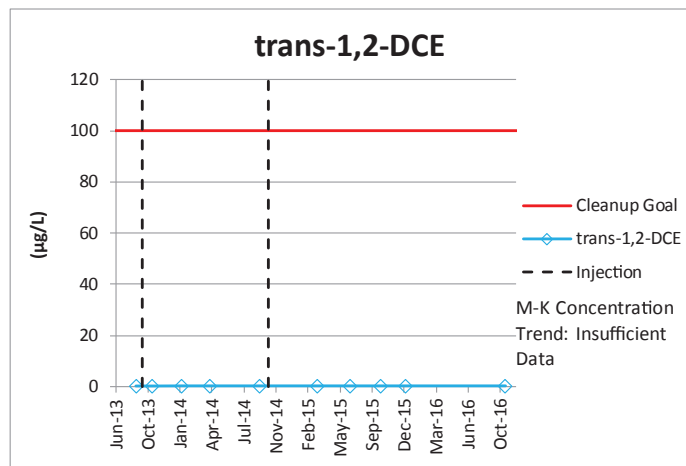
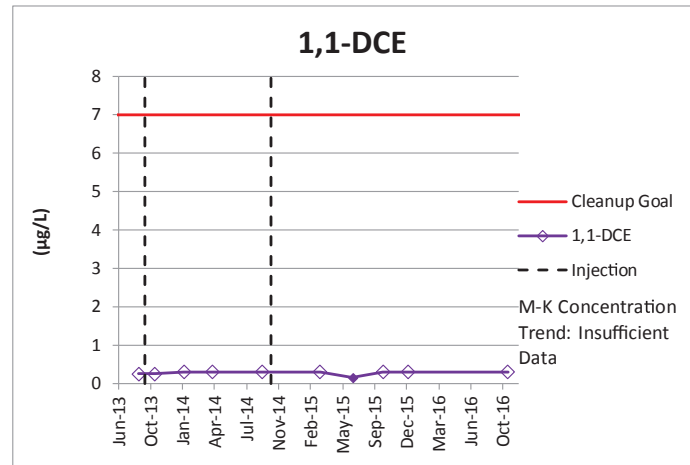
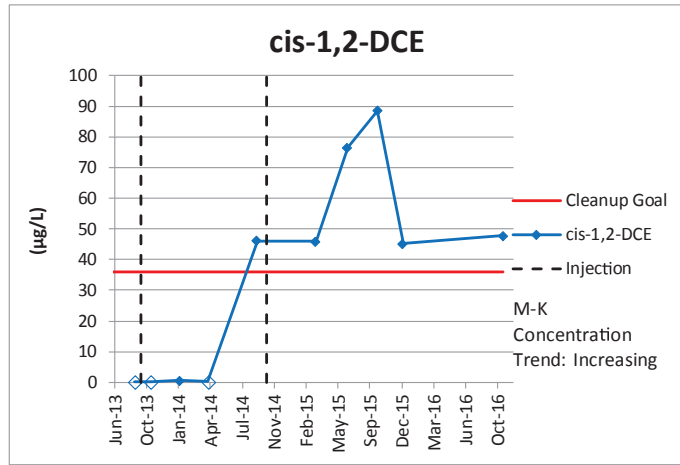
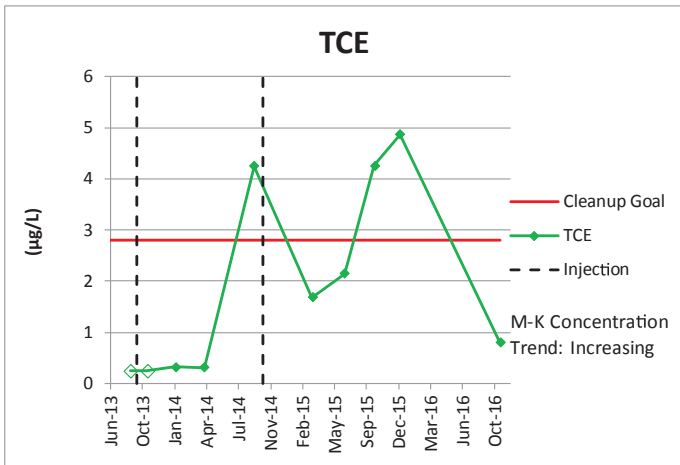
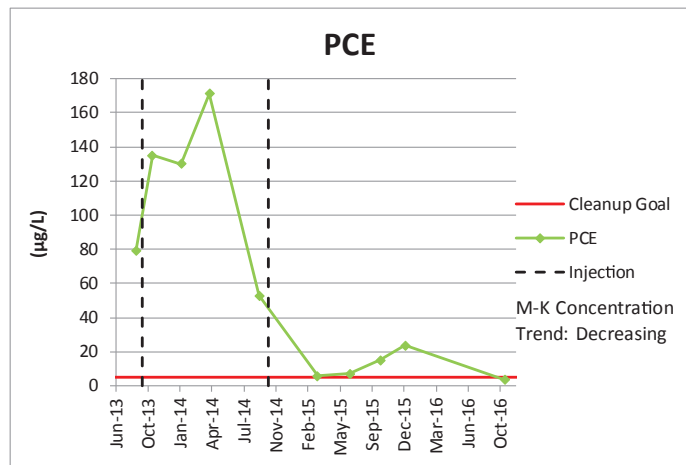


**DA089 SITE MAP WITH ANALYTICAL DATA**

2016 Annual Remedial Action - Operations and Monitoring Report for Select CERCLA Sites  
Joint Base Elmendorf-Richardson, Alaska

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NOTES:

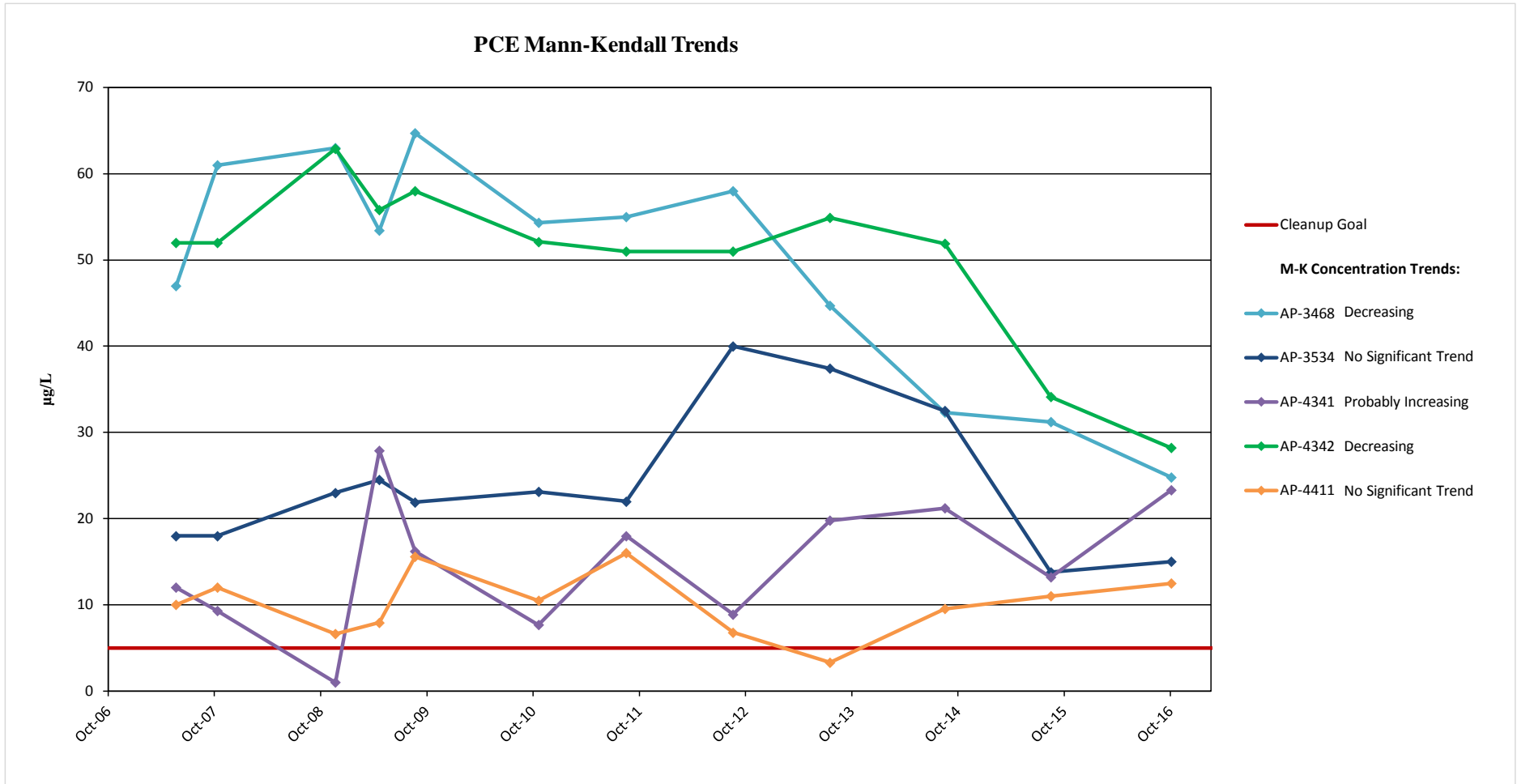
µg/L	microgram(s) per liter	PCE	Tetrachloroethene
1,1-DCE	1,1-Dichloroethene	TCE	Trichloroethene
CAH	Chlorinated Aliphatic Hydrocarbon	TOC	total organic carbon
cis-1,2-DCE	cis-1,2-Dichloroethene	trans-1,2-DCE	trans-1,2-Dichloroethene
mg/L	milligram(s) per liter		
mV	millivolt(s)		
ORP	oxygen reduction potential		



**CONCENTRATION TRENDS FOR SELECT ANALYTES AT MONITORING WELL AP-4413**  
 2016 Annual Remedial Action - Operations and Monitoring Report for Select CERCLA Sites  
 Joint Base Elmendorf-Richardson, Alaska

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## CONCENTRATION TRENDS FOR SELECT ANALYTES FOR LONG-TERM MONITORING WELLS AT DA089

2016 Annual Remedial Action - Operations and  
Monitoring Report for Select CERCLA Sites  
Joint Base Elmendorf-Richardson, Alaska

Figure



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## 17.0 SS044 (BUILDING 35-752 PCB SITE)

PBC Performance Objectives: Design and Implement Optimized Exit Strategy for Site Closeout

Anticipated Achievement Date: 2019

### 17.1 SITE DESCRIPTION

SS044, part of OUE at JBER-R, is located approximately one-third mile south of the Davis Highway, in a relatively undeveloped part of JBER-R (see Figure 1-1). Groundwater and soil contamination resulted from the historic activities associated with the operation and maintenance of USTs and electrical power generation equipment (generators and transformers) used from 1953 to 1987. The generators were housed inside Building 35-752, and were used to power a high-frequency transmitter array and control center located in the adjacent Building 35-750. Fuel for the generators was stored in seven 5,000-gallon USTs. Cooling ponds stored water to cool the generators. Four large transformers (750 kilovolt) were located at the site during operation of the power generation facility. The transformers were located on the northeastern side of Building 35-750. Sometime around 1982, these transformers were replaced and removed from the site (U.S. Army DPW, 2008). The generators were removed in 1987, and the building was used for general storage for several years afterward. In 1990, the seven 5,000-gallon USTs were excavated and removed from the southern side of Building 35-752. The building was boarded up and secured with a locked fence in 1995.

SS044 was initially investigated as part of an RI conducted from 1996 to 1998 for OUD (ENSR, 1998). The primary source areas at the site include a transformer mounting pad, a pit where waste oil was burned, a peripheral road where contaminated soil was used as a base, and a stockpile area for polychlorinated biphenyl (PCB)-contaminated soil.

In 1997, approximately 1,500 cubic yards of soil were excavated from the site during construction of a parking lot and roadway (U.S. Army, 2005). The soil was determined to be contaminated with PCBs, and was stockpiled at the site until being transported to a Toxic Substances Control Act (TSCA)-regulated landfill in 2001.

While the OUD ROD (U.S. Army, 2000) was being developed, new information indicated that PCB-containing transformer oil may have been burned at the site. Additional potential hazardous source areas were identified at the site related to releases from a transformer mounting pad, a burn pit for waste oil, use of PCB-contaminated soil as a base for the peripheral road, and an area where soil containing PCBs had been stockpiled. As a result of the new information obtained after issuing the Proposed Plan, the U.S. Army, EPA, and ADEC determined that SS044 had not been adequately characterized, and further investigation was recommended as part of the OUE RI.

The OUE RI was conducted in 2002 and 2003 to address the nature and extent of PCBs in soil and VOCs in groundwater (CH2M HILL, 2004). The highest level of PCBs detected (99.9 milligrams per kilogram [mg/kg]) was confined to a small area less than 1 square meter in size next to the transformer mounting pad. During the OUE RI, only two compounds were detected in groundwater

that exceeded MCLs: benzene and TCE. Benzene was detected at a concentration of 8.2 µg/L in 2002 at location AP-2983. However, in 2003, benzene was detected at a concentration of 1.6 µg/L, which was less than the MCL of 5 µg/L.

In 2003, a limited excavation of PCBs in surface soil around the transformer mounting pad was completed under the TSCA self-implementing procedure for cleanup and disposal of PCB remediation waste (40 Code of Federal Regulations 761.61(a)(4)(v)). Approximately 50 cubic yards of PCB-contaminated surface soil in the vicinity of the transformer pad were excavated from the site and disposed of at a TSCA-regulated landfill. Post-excavation samples contained PCBs less than the TSCA cleanup level for low-occupancy areas (25 mg/kg). The highest post-removal sample result was 14.1 mg/kg located at 1 foot bgs. Geotextile fabric was placed over the excavation, and was then covered with clean backfill.

PCBs remain in soil at concentrations above the levels for high-occupancy areas (1 mg/kg unrestricted), but below the TSCA Cleanup Level for low-occupancy areas (25 mg/kg). SS044 is currently considered a low-occupancy area. USAF-internal administrative controls were put in place at the site because of the remaining PCB contamination above 1 mg/kg.

Historically, TCE was detected in shallow groundwater beneath Building 35-752 at only monitoring well AP-3231 (11 µg/L in 1996 and 8.60 µg/L in 2002 [CH2M HILL, 2004]) at concentrations above the MCL of 5 µg/L. TCE concentrations at AP-3231 decreased from 5 µg/L in 2008 to as low as 0.77 µg/L in 2013 (USAF, 2014f).

### **17.1.1 Geology and Hydrology**

The subsurface geology associated with SS044 consists of sandy gravel, with a shallow unconfined aquifer approximately 13 to 38 feet bgs (USAF, 2014g). Groundwater beneath SS044 is not used for household, recreational, or industrial uses at the site. The nearest surface water to the site is Ship Creek, which is approximately 0.3 mile south of the site. Ship Creek serves as the main source of drinking water for JBER; the drinking water intake is located over 3.5 miles upstream (upgradient) of the point where SS044 is closest to Ship Creek.

## **17.2 REGULATORY REQUIREMENTS**

The remedy selected for SS044 in the OUE ROD is No Further Action (NFA) (U.S. Army, 2005). To ensure the protectiveness of the NFA decision, the OUE ROD also required monitoring of groundwater and site conditions during five-year reviews. Relevant cleanup levels for chemicals of interest in groundwater at SS044 are presented in Table 17-1.

The groundwater LUC was removed in accordance with the *Summary of 2013 Groundwater Monitoring Results SS044 – Building 35-752 PCB Site* dated March 2014 (Figure 17-1). An Air Force administrative control manages PCBs remaining in soil above the levels for high-occupancy areas.

**Table 17-1 Cleanup Levels for Chemicals of Interest in Groundwater at SS044**

Chemicals of Interest in Groundwater		
Chemical	MCL (µg/L)	ADEC Cleanup Level <sup>a</sup> (µg/L)
Benzene	5	4.6
TCE	5	2.8
PCBs <sup>b</sup>	0.5	0.5

**Notes:**

<sup>a</sup> 18 AAC 75 Table B1 and C Cleanup Levels (ADEC, 2017)

<sup>b</sup> There are no established cleanup levels for individual Aroclor compounds. However, the PCB cleanup levels can be compared to the sum of the Aroclor compound concentrations (using 1/2 of the non-detect values, when necessary).

### 17.3 2016 FIELD ACTIVITIES

In September 2016, groundwater samples were collected from well AP-3231 at SS044 so that groundwater data from the site is available for the 2018 Five-Year Review. Field forms are included in Appendix A2. A site inspection was also conducted. The inspection form is included in Appendix B2. Sampling for a PFAS site inspection and sampling of groundwater for 1,4-dioxane were conducted in 2016 under separate workplans and will be reported separately.

### 17.4 GROUNDWATER MONITORING RESULTS

#### 17.4.1 Groundwater Elevation Measurements

On September 12, 2016, depth to groundwater was measured at monitoring well AP-3231. The depth to groundwater measurement is summarized in Table 17-2 along with the groundwater elevation calculated from that measurement. In addition, the depth to groundwater measurement is recorded on the Water Level Survey Form in Appendix A2, and the groundwater elevation is shown on Figure 17-1.

**Table 17-2 2016 Groundwater Elevation at SS044**

Monitoring Well ID	Top of Casing Elevation (feet AMSL)	Total Depth of Well (feet FTOC)	Depth to Groundwater <sup>a</sup> (feet FTOC)	Groundwater Elevation (feet AMSL)
AP-3231	263.00	22.0	16.14	246.86

**Notes:**

<sup>a</sup> Depth to Groundwater measurement from September 12, 2016 Water Level Survey located in Appendix A2

AMSL = above mean sea level

FTOC = from top of casing

#### 17.4.2 Groundwater Sample Analytical Results

A groundwater sample was collected from groundwater monitoring well AP-3231. Analytical results for PCBs, benzene, and TCE are summarized in Table 17-3 and shown on Figure 17-1. Complete analytical results are included in Appendix C2.



Some metals, chloroform, and TCE were detected in groundwater but at concentrations below cleanup levels. No other compounds were detected at the site. Stabilized field-measured natural attenuation parameters are summarized in Table 17-4.

**Table 17-3 Summary of Select 2016 Analytical Results at SS044**

Analyte	Cleanup Level	AP-3231
Aroclor 1016	0.5 <sup>a</sup>	ND (0.038)
Aroclor 1221	0.5 <sup>a</sup>	ND (0.0475)
Aroclor 1232	0.5 <sup>a</sup>	ND (0.0475)
Aroclor 1242	0.5 <sup>a</sup>	ND (0.0475)
Aroclor 1248	0.5 <sup>a</sup>	ND (0.0475)
Aroclor 1254	0.5 <sup>a</sup>	ND (0.0475)
Aroclor 1260	0.5 <sup>a</sup>	ND (0.038)
Benzene	4.6 <sup>b</sup>	ND (0.3)
TCE	2.8 <sup>b</sup>	1.84

**Notes:**

<sup>a</sup> There are no established cleanup levels for individual Aroclor compounds. However, PCB cleanup levels (see Table 17-1) can be compared to the sum of the Aroclor compound concentrations (using 1/2 of the non-detect values, when necessary).

<sup>b</sup> The 18 AAC 75 Table C Groundwater Cleanup Level (ADEC, 2017) is less than the MCL; therefore it is used for comparison.

All units are µg/L

ND = analyte was not detected

TCE = trichloroethene

**Table 17-4 Field Measured Natural Attenuation Parameters for SS044**

Monitoring Well ID	Date	Time	Volume Purged (gallons)	pH	Conductivity (mS/cm)	Turbidity (NTU)	DO (mg/L)	Temp (°C)	ORP (mV)
<i>Shallow Wells Inside Hot Spot</i>									
AP-3231*	9/12/2016	1500	2.85	6.1	0.163	8.6	7.92	6.5	196.2

**Notes:**

\*Sampled every 5 years

°C = degree(s) Celsius

ID = identification

mg/L = milligram(s) per liter

mS/cm = milliSiemen(s) per centimeter

mV = millivolt(s)

NTU = nephelometric turbidity unit(s)

## 17.5 LUC INSPECTION RESULTS

The well cap for AP-3231 was noted as needing to be replaced during the inspection in 2016. Inspections will continue to be conducted annually in accordance with the OUE ROD (U.S. Army, 2005).



## 17.6 SITE SUMMARY AND RECOMMENDATIONS

### 17.6.1 Five-Year Review

Consistent with the National Contingency Plan (NCP), five-year reviews are required because the remedial action resulted in hazardous substances, pollutants, or contaminants remaining onsite above levels that allow for UU/UE. PCBs remain in soil at concentrations that do not allow for UU/UE. To date, three CERCLA five-year reviews (2003, 2008, and 2013) have been performed for JBER-R, which includes SS044.

No recommendations specific to SS044 were made in the *Third CERCLA Five-Year Review Report for JBER-R, Alaska* (USAF, 2013a).

Groundwater sampling at monitoring well AP-3231 was performed in 2016 so that results can be incorporated in the Fourth Five-Year Review in 2018.

### 17.6.2 Recommendations

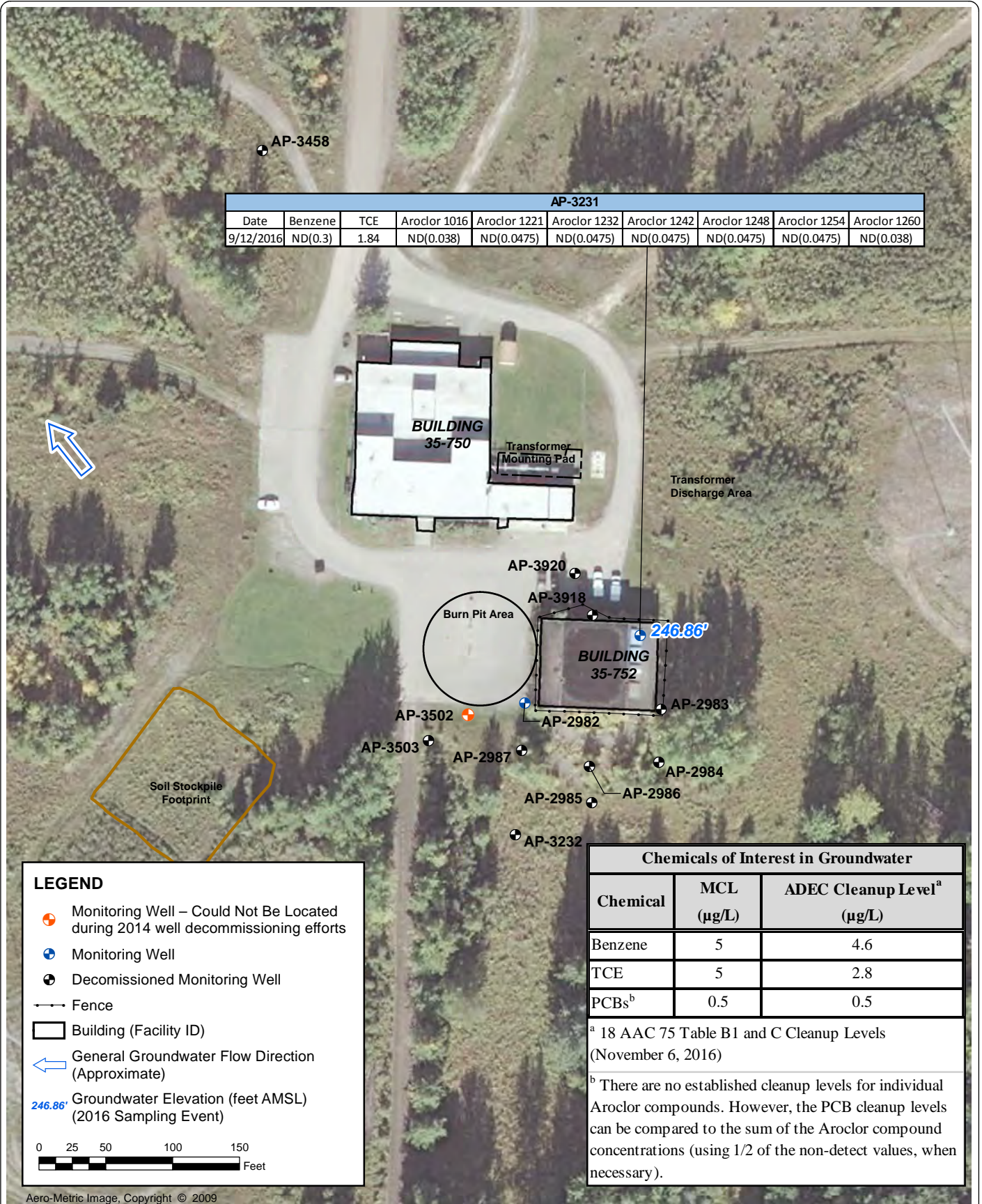
Site SS044 is identified as a **Green** priority. No chemicals in groundwater exceed relevant cleanup levels. Continuation of internal administrative controls and associated inspections are recommended for this site. This site was sampled for PFAS in 2016, which will be reported separately.

The well cap for AP-3231 should be replaced during the next site visit.

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AP-3231									
Date	Benzene	TCE	Aroclor 1016	Aroclor 1221	Aroclor 1232	Aroclor 1242	Aroclor 1248	Aroclor 1254	Aroclor 1260
9/12/2016	ND(0.3)	1.84	ND(0.038)	ND(0.0475)	ND(0.0475)	ND(0.0475)	ND(0.0475)	ND(0.0475)	ND(0.038)

**LEGEND**

- Monitoring Well – Could Not Be Located during 2014 well decommissioning efforts
- Monitoring Well
- Decommissioned Monitoring Well
- Fence
- Building (Facility ID)
- General Groundwater Flow Direction (Approximate)
- Groundwater Elevation (feet AMSL) (2016 Sampling Event)

0 25 50 100 150 Feet

Chemicals of Interest in Groundwater		
Chemical	MCL (µg/L)	ADEC Cleanup Level <sup>a</sup> (µg/L)
Benzene	5	4.6
TCE	5	2.8
PCBs <sup>b</sup>	0.5	0.5

<sup>a</sup> 18 AAC 75 Table B1 and C Cleanup Levels (November 6, 2016)

<sup>b</sup> There are no established cleanup levels for individual Aroclor compounds. However, the PCB cleanup levels can be compared to the sum of the Aroclor compound concentrations (using 1/2 of the non-detect values, when necessary).

Aero-Metric Image, Copyright © 2009



**SS044 SITE MAP WITH ANALYTICAL DATA**

Figure

**17-1**

SS044 - Building 35-752 PCB Site  
 2016 Annual Remedial Action  
 - Operations and Monitoring Report for Select CERCLA Sites  
 Joint Base Elmendorf-Richardson, Alaska

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## 18.0 XE023 (EOD AREA [2 EA] [OB/OD PAD])

PBC Performance Objectives: Design and Implement Optimized Exit Strategy for Site Closeout

Anticipated Achievement Date: 2019

### 18.1 SITE DESCRIPTION

XE023 is a former 10-acre gravel Open Burn/Open Detonation (OB/OD) Pad that is physically located within the eastern boundary of an active military munitions impact area, Eagle River Flats (ERF) firing range (Figure 1-1). The site is regulated as part of OUC. The site was used from 1956 to 1988 to dispose of expired or unwanted explosive materials and ammunition (CH2M HILL, 1997). Some of the explosive materials included fuses, 105- and 40-millimeter (mm) high-explosive projectiles, smoke pots, mortar rounds, star clusters, flares, booby traps, blasting caps, detonation cord, mines, rocket motors, claymore C4, 40-pound shape charges, mine AP M16, pentaerythritol tetranitrate detonation cord, smoke grenades, hand grenades, incendiary box liners for safes, thermite, and propellant bags. On at least one occasion, military police requested destruction of a small quantity of potassium and sodium chlorate. Materials from non-military sources occasionally destroyed on the OB/OD Pad included dynamite (supplied by the Alaska State Troopers), explosives (supplied by an oil service company in Kenai), 105-mm projectiles (supplied by Alyeska Ski Resort), and various flammable solids, including sodium, red phosphorus, and yellow phosphorus (supplied by ADEC). Ordnance disposal by detonation would tend to spread shrapnel and explosives over adjacent areas of the pad surface. Existing records indicate that no liquids were disposed at the XE023 OB/OD Pad. During the 1960s, smaller pieces of ordnance were ignited on the ground surface or in pits using diesel fuel (EMCON Alaska, Inc. [EMCON], 1993).

In recent years, XE023 has been used primarily for the storage of nonhazardous equipment related to the studies and cleanup efforts conducted at the adjacent XU022. A road, access-controlled by a gate located 0.25 mile from the pad, enters at the southeastern corner of the pad and provides the primary vehicular access to the site. XE023 is currently an inactive site (CH2M HILL, 1999).

COPCs in soil at the site consist primarily of un-combusted components of explosives and residues from the use of explosives including 2,4-dinitrotoluene and metals. Research Department Explosive (cyclotrimethylenetrinitramine) and High-velocity Military Explosive (cyclotetramethylene-tetranitramine) were detected in groundwater along with metals; however, all detected concentrations were below applicable EPA MCLs or ADEC groundwater cleanup levels in effect during the 1997 Remedial Investigation. Metals (including arsenic, barium, chromium, lead, mercury, and zinc) have been detected in samples from all monitoring wells, and were within the range of background concentrations (U.S. Army, 1998).

#### 18.1.1 Geology and Hydrology

Soil associated with XE023 consists of sandy gravel and gravelly sand. Based on groundwater monitoring data collected during the OUC RI, depth-to-groundwater beneath the XE023 ranges

from 19 to 36 feet bgs, and the water table appears to be generally flat with a slight hydraulic gradient of 0.0004 ft/ft to the southwest (CH2M HILL, 1997). It is believed that the groundwater movement patterns are strongly influenced by the tides and Eagle River. The coarse-grained material suggests that precipitation infiltrates freely through the pad surface to the water table.

## 18.2 REGULATORY REQUIREMENTS

XE023 is regulated under CERCLA as part of OUC, and is also a solid waste management unit as defined by the Resource Conservation and Recovery Act (RCRA). EPA, ADEC, and the Army decided to combine XE023 response actions under RCRA and CERCLA for the following reasons:

- XE023 is administratively subject to RCRA closure authority.
- XE023 is in the same physical location as the rest of OU C, which is subject to CERCLA authority.
- Similar, but not identical, historical actions took place at XE023 (destruction of explosives) in comparison to the rest of OU C (use as a firing range with residuals of explosives remaining).
- Applying CERCLA authority concurrently with RCRA closure and corrective action requirements will minimize response costs as much as possible while remaining fully protective.

In accordance with the regulatory framework of XE023, closure will be implemented under RCRA following final clearance and closure of the adjacent active Eagle River Flats firing range. As stated in the OU C ROD (U.S. Army, 1998), because XE023 is located within an active range, pursuing site closeout at this time would have little, if any, demonstrable benefit. Therefore, the ROD approved the delay of closure until the Eagle River Flats range is no longer operating or until the base is closed, or for any other reason determined by the Army. This delay in closure has been approved by EPA in accordance with 40 CFR 261.113(b)(1)(i). Continuing appropriateness of the delay is evaluated no less often than during CERCLA 5-year reviews, and a closure plan was submitted in 2013 and is pending approval under RCRA. Eventual closure-related activities will be conducted according to the RCRA closure plan (which also satisfies requirements under the CERCLA ROD).

The selected remedy for the site is NFA. ICs to monitor and control site access due to concerns about potential human exposure to unexploded ordnance are also in place (U.S. Army, 1998) (Figure 18-1).

## 18.3 2016 FIELD ACTIVITIES

A LUC inspection was performed at XE023 on September 22, 2016. No issues were identified during the inspection. A copy of the 2016 LUC inspection form is provided in Appendix B2. Monitoring wells are present, but long-term monitoring and LUCs for groundwater are not part of the selected remedy. LUC inspections will continue to be conducted annually in accordance with the OUC ROD (U.S. Army, 1998).

## 18.4 SITE SUMMARY AND RECOMMENDATIONS

### 18.4.1 Five-Year Review

XE023 is required to have CERCLA five-year reviews conducted until the cleanup goals are achieved. The purpose of the five-year review is to evaluate the implementation and performance of the remedial actions. To date, three CERCLA five-year reviews (2003, 2008, and 2013) have been performed for JBER-R, which includes XE023.

No recommendations specific to XE023 were made in the *Third CERCLA Five-Year Review Report for JBER-R, Alaska* (USAF, 2013a).

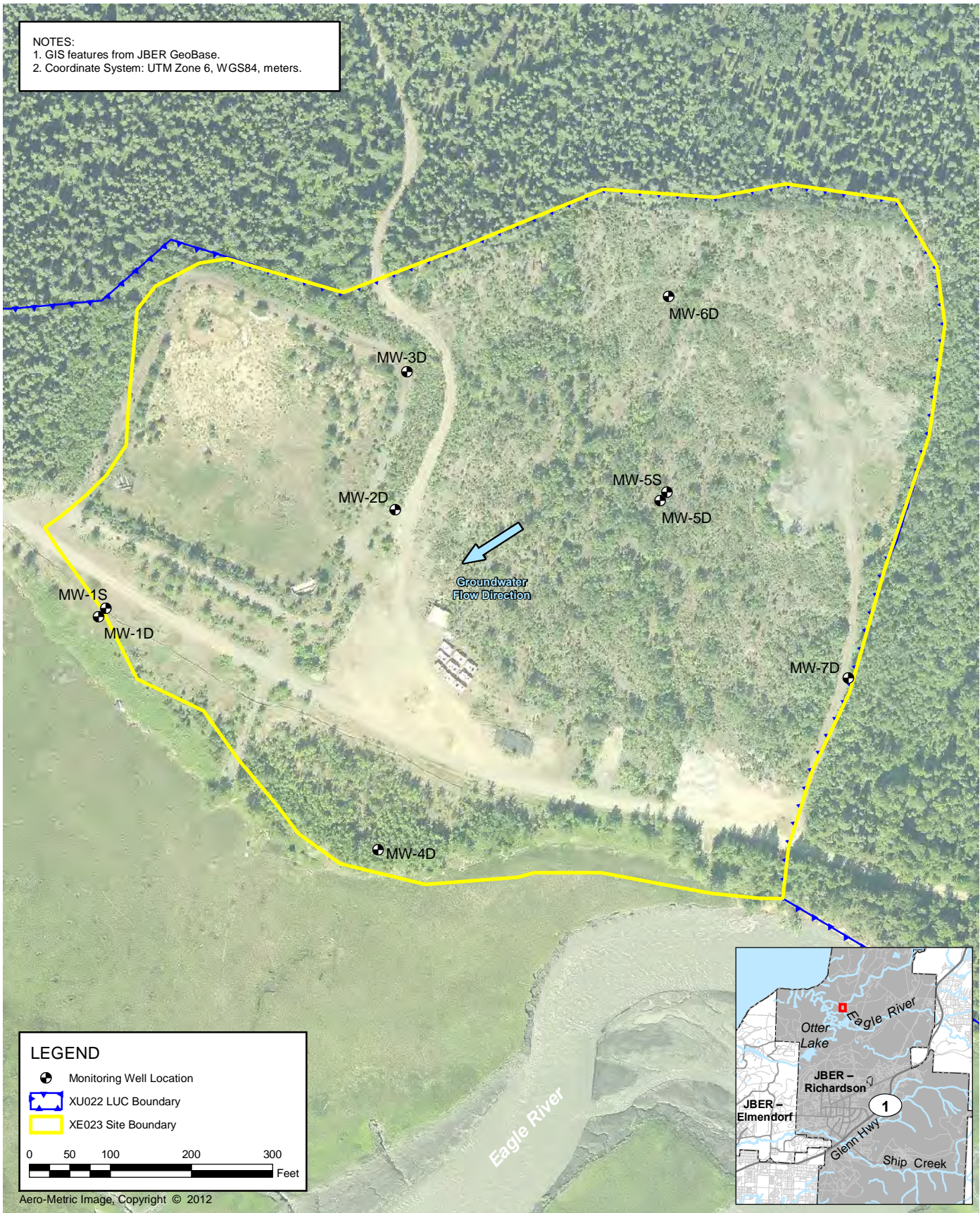
### 18.4.2 Recommendations

Site XE023 is identified as a **Green** priority. No further remedial action is necessary and continuation of LUC inspections is recommended for this site.

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NOTES:  
 1. GIS features from JBER GeoBase.  
 2. Coordinate System: UTM Zone 6, WGS84, meters.



Date: 08 Mar 2018 Drawn by: AESPEJO R:\ENBGG00\_Proj\AAirForce\AFCEE\_JBER\_20001102\MapFiles\CERCLA\_Sites\2017\Figure\_18-1\_XE023\_SiteMap.mxd

**LEGEND**

- Monitoring Well Location
- XU022 LUC Boundary
- XE023 Site Boundary

0 50 100 200 300 Feet

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**XE023 SITE MAP**  
 XE023 - EOD Area (OB/OD pad)  
 2016 Annual Remedial Action -  
 Operations and Monitoring Report for Select CERCLA Sites  
 Joint Base Elmendorf-Richardson, Alaska

Figure  
**18-1**

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## 19.0 XU022 (OU C/IMPACT AREA EAGLE RIVER FLATS)

PBC Performance Objectives: Design and Implement Optimized Exit Strategy for Site Closeout

Anticipated Achievement Date: 2019

### 19.1 SITE DESCRIPTION

XU022 is an estuarine salt marsh at the mouth of the Eagle River (Figure 1-1). It is surrounded by forested uplands on the west, south, and east, and is bounded by the Knik Arm on the north. The Eagle River flows through the site from southeast to northwest, ultimately discharging into Knik Arm. Clunie and Otter Creeks also drain into ERF. XU022 serves as an important staging ground for waterfowl during spring and fall migrations because of its wetlands and small, interconnected ponds. In addition, the site supports local populations of fish, birds, mammals, and macro-invertebrates (primarily insects, snails, and crustaceans), as well as a population of wood frogs.

XU022 has been used for artillery and munitions training since the 1940s. Site access is restricted to personnel with appropriate site-specific training (on UXO, range procedures, and white phosphorus [WP]). Site access is controlled by a locked gate.

XU022 contains numerous targets, as well as craters created by detonation of munitions in the wetlands and associated mud flats. During the 1980s, an unusually high number of waterfowl carcasses was discovered in the ERF marshes. Subsequent investigation revealed that WP particles were being ingested by the birds, causing their deaths. WP particles had been dispersed into the impact area during detonation of specific smoke munitions. WP is a smoke and incendiary agent that burns (oxidizes) and degrades readily in air. However, when WP particles are disbursed from munitions and come into contact with water, they are extinguished (without oxidizing) and settle out as seed-sized particles. Dabbling waterfowl, such as green-winged teal, northern pintails, and mallards that feed mainly on seeds and insects in shallow pond bottom sediments, consume WP particles while foraging for food, which results in waterfowl mortality. This discovery resulted in a nationwide U.S. Army ban on the use of WP in wetland impact areas.

Studies at XU022 have since indicated that concentrations of WP in sediment associated with a spent WP round ranged from thousands of micrograms per gram ( $\mu\text{g/g}$ ) for sediment collected from within the spent rounds to hundreds of  $\mu\text{g/g}$  for sediment co-located (immediately surrounding) with the spent rounds, and to less than 10  $\mu\text{g/g}$  in sediment within a few meters of the spent rounds. Sediment with a concentration over 1  $\mu\text{g/g}$  is likely to contain WP particles large enough to poison ducks.

#### 19.1.1 Geology and Hydrology

Site XU022 is an estuarine salt marsh that was formed by the erosional force of Eagle River through the glacial alluvial deposits of the Anchorage lowland to create a deep valley that subsequently filled with sediment. The area has relative low relief with elevations ranging from 3 to 18 feet AMSL, and is subject to tidal flooding. Eagle River bisects the site with an average

flow rate of 530 cubic feet per second, draining approximately 1,300 square miles of mountains and lowlands into the Knik Arm. Numerous channels and ponds also cut across XU022. Otter Creek, Clunie Creek, and several small lakes also enter into the site (U.S. Army, 1998), in addition to Eagle River.

## 19.2 REGULATORY REQUIREMENTS

The ROD for OUC was signed by the U.S. Army, EPA, and ADEC on September 30, 1998. The selected remedy outlined in the ROD was to reduce WP contamination by draining ponds and other water bodies with pumps in an effort to dry out the contaminated sediments causing the WP to sublimate and oxidize.

Two temporal RAOs were established for OUC as follows:

1. Within 5 years of the ROD being signed (in 1998), reduce the dabbling duck mortality rate attributable to WP to 50 percent of the 1996 mortality rate attributable to WP (achieved in 1999). Based on radio telemetry data at the time, the number of allowable duck deaths from WP was estimated to be approximately 500 (the short-term RAO did not specify that adjustments for total population would be incorporated.)
2. Within 20 years of the ROD being signed, reduce the mortality rate attributable to WP to no more than 1 percent of the total annual fall population of dabbling ducks at XU022 (achieved starting in 2006, 8 years after the ROD was signed).

The mortality rate of dabbling ducks at XU022 indicates that both RAOs have been achieved. Refinement of the mortality model in 2005 reduced the calculated 1996 mortality rate from 1,000 to 655 ducks (Bigl and Collins, 2007). Therefore, to meet the short-term RAO, the allowable number of duck deaths attributable to WP needed to be less than 327 by 2003. Duck mortality rates since 1999 have been less than the target number (the most recent event occurred in the fall of 2016). Based on the mortality data, the short-term RAO has been successfully met. The calculated mortality rate has been below 1 percent since 2006, and the upper bound of the conservative estimated range was also below 1 percent in 2008, 2010, and 2011. Overall, waterfowl mortality resulting from WP poisoning has decreased substantially in ERF since remedial activities have begun (Section 19.3).

Remedial action (active pond pumping/draining) began in 1999. Although treated pond acreage is not a specific RAO for this project, it is a good indicator that WP residual matter is being remediated. The ROD identified 57 acres as contaminated or potentially contaminated at ERF. Monitoring activities performed since 1999 have indicated that some areas previously thought to be contaminated were not, whereas other areas thought to be uncontaminated actually were contaminated. The current revised estimate of the total area that had been contaminated by WP (before treatment) is approximately 47 acres. Pumping and draining remediation activities have successfully treated most of the contaminated area. Smaller hot spots with WP concentrations above the target of 1 µg/g in areas that could not be drained or pumped consisted of less than 0.5 acre; these areas have been remediated through capping.

The Air Force maintains a geographic information system (GIS) database with information on all of the contaminated sites on JBER. LUCs are in place restricting site access, construction, and road maintenance, as well as requiring training for personnel who work at OUC source areas, as long as site conditions do not allow for UU/UE (Figure 19-1). USAF is responsible for ensuring that ICs are maintained. Evidence of trespassing by unauthorized individuals was not observed in 2016. ICs will remain in place as long as hazardous substances remain onsite at levels that preclude unrestricted use.

### **19.3 2016 FIELD ACTIVITIES**

A LUC inspection was performed at XU022 on September 22, 2016. No issues were identified during the inspection. A copy of the 2016 LUC inspection form is provided in Appendix B2.

Long-term management activities were conducted in September and October of 2016, during the fall waterfowl migration period. Activities included waterfowl mortality studies (aerial surveys and ground based transect monitoring), and sediment sampling. Waterfowl monitoring results indicated that the mortality rate at XU022 continues to remain below the long-term RAO of 1 percent. The mortality studies and sediment sampling results did not identify any areas of white phosphorus contamination available to dabbling waterfowl; as a result, no additional remedial actions (capping of contaminated areas) were required following the monitoring event. A more detailed summary of the 2016 LTM results is provided in the *2016 Remedial Action Long-Term Management Report, XU022 – Eagle River Flats, Operable Unit C* (USAF, 2017d).

### **19.4 SITE SUMMARY AND RECOMMENDATIONS**

No deficiencies were observed during the LUC inspection in 2016. LUC inspections will continue to be conducted annually in accordance with the OUC ROD (U.S. Army, 1998).

Remedial actions at XU022 have been successful in reducing and maintaining a mortality rate of less than the long-term RAO of one percent of waterfowl since 2006. Based on the early achievement of the long-term RAO, the frequency of LTM activities has been reduced to a frequency of once every five years (prior to Five-Year Reviews). In addition, the implementation of some of the specific monitoring and remedial action components of the remedy have been updated. Upcoming remedial action management events are scheduled to precede five-year reviews for the site in order for the results to be incorporated in the reviews. The changes to the ROD schedule and implementation of remedy components have been documented in Memos to the Site file (USAF, 2011e; USAF, 2017e). The next LTM event for XU022 is scheduled for the fall of 2021.

#### **19.4.1 Five-Year Review**

XU022 is required to have CERCLA five-year reviews conducted as long as hazardous substances remain onsite at levels that preclude unrestricted use. The purpose of the five-year review is to evaluate the implementation and performance of the remedial actions. To date, three CERCLA

five-year reviews (2003, 2008, and 2013) have been performed for JBER-R, which includes XU022.

The Third CERCLA Five-Year Review Report for JBER-R, Alaska (USAF, 2013a) for XU022 noted that waterfowl populations during surveys may be biased slightly low due to unintentional hazing during field activities and recommended that the USAF readdress waterfowl populations upon completion of seasonal field activities and compare population numbers with previous surveys to evaluate for any potential bias.

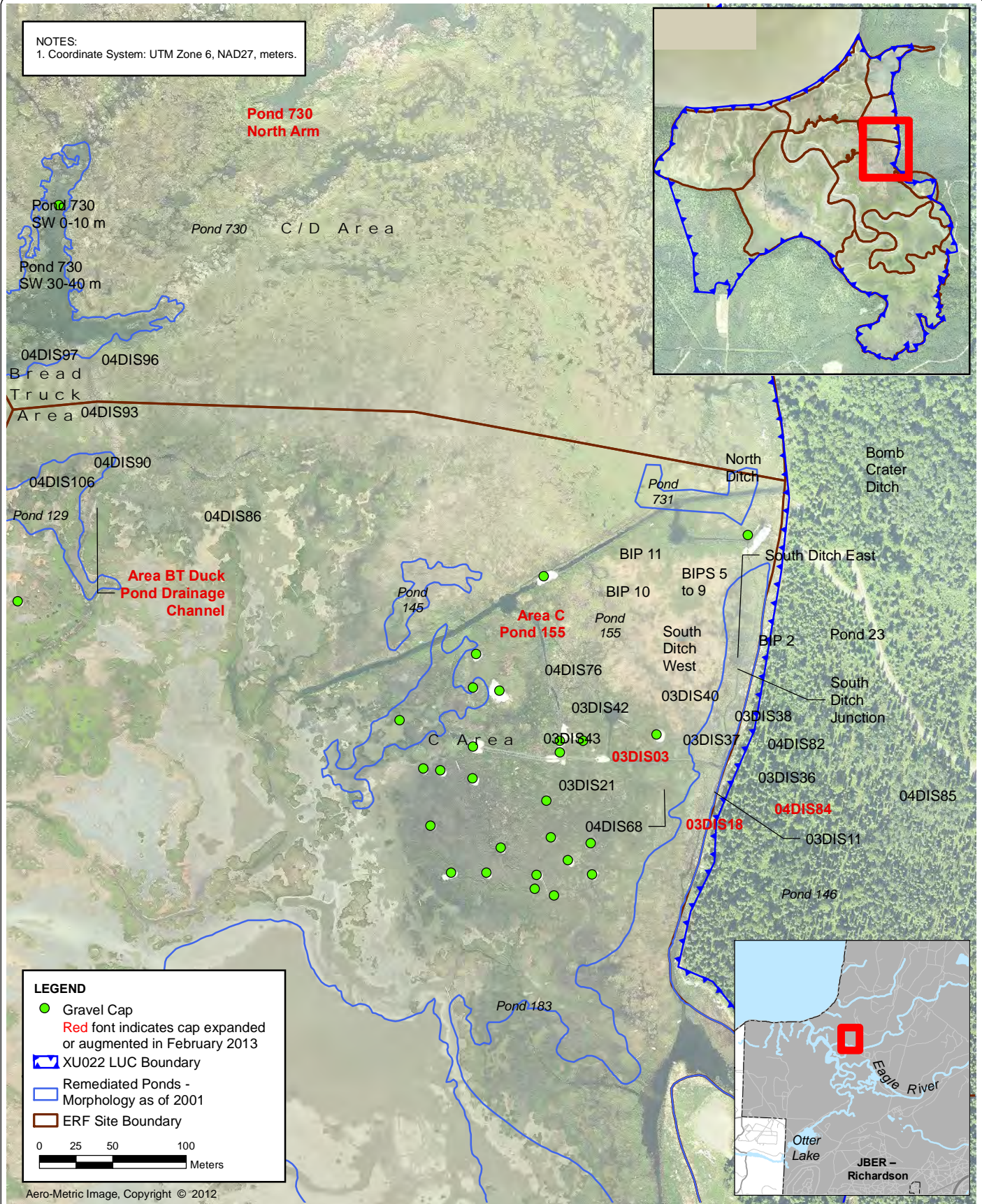
Observations during 2016 and previous events indicated waterfowl typically do not leave the area and generally move to a nearby pond. This could result in no change to the count or waterfowl being counted more than once (which would bias the day's population estimate high), or it could result in missed waterfowl (which would bias the day's population estimate low). It is unlikely that any unintentional hazing significantly skews aerial counts in one direction or another to significantly bias the overall estimates. In addition, early telemetry studies identified uncertainty based on observed turnover; as a result, actual daily counts are divided by 0.83 to help account for uncertainty in estimating mortality rates (USAF, 2017b).

#### ***19.4.2 Recommendations***

Site XU022 is identified as a **Green** priority. LTM and continuation of LUC inspections are recommended for this site.

NOTES:  
1. Coordinate System: UTM Zone 6, NAD27, meters.

Date: 14 Jun 2017 Drawn by: jcar3 \brooks\GIS\_SHARE\ENBG\00\_Proj\A\AirForce\AFCEE\_JBER\_20001102\MapFiles\CERCLA\_Sites\2016\XU022\_SiteMap\_Figure\_19-1.mxd



**XU022 SITE MAP**

XU022 - OUC/Impact Area Eagle River Flats  
2016 Annual Remedial Action -  
Operations and Monitoring Report for Select CERCLA Sites  
Joint Base Elmendorf-Richardson, Alaska

Figure  
**19-1**

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## 20.0 REFERENCES

- Air Force Center for Environmental Excellence (AFCEE), 2007. *AFCEE Monitoring and Remediation Optimization System Software*, Version 2.2. February.
- Alaska Department of Environmental Conservation (ADEC), 2017. *Title 18 Alaska Administrative Code Chapter 75. Oil and Other Hazardous Substances Pollution Control*. As amended through October 1.
- Astley, B.N., C.F. Snyder, D.E. Lawson, C.R. Williams, T. Hall, A. Staples, and J. Denner, 2000. *Groundwater Data from Fort Richardson, Alaska for the Period April 1997 to March 2000*.
- Bigl, S.R., and C.M. Collins, 2007. *Remediating and Monitoring White Phosphorus Contamination at Eagle River Flats (Operable Unit C), Fort Richardson, Alaska – FY06 Data Report*. Cold Regions Research and Engineering Laboratory, ERDC/CRREL. May.
- CH2M HILL Constructors, Inc. (CH2M HILL), 2012. *2011 Groundwater Monitoring and Borehole Sampling, Three-party Agreement Sites: OUB Poleline Road Disposal Area and OUE Armored Vehicle Maintenance Area*. July.
- CH2M HILL, 2004. *Remedial Investigation Report Operable Unit E Fort Richardson, Alaska*. June.
- CH2M HILL, 1999. *Draft Operable Unit C OB/OD Pad, Interim Closure Plan, Fort Richardson, Alaska*. Prepared for Department of the Army U.S. Army Engineering District, Alaska, March.
- CH2M HILL, 1997. *Final Remedial Investigation Report Operable Unit C, Fort Richardson Alaska*. Prepared for Department of the Army, Engineer District, Alaska. May.
- Chen, Chun, Puhakka, J.A., and Ferguson, J.F., 1996. *Transformations of 1,1,2,2-tetrachloroethane under methanogenic conditions*. Environmental Science and Technology, v. 30, no. 2, p. 542-547.
- EMCON Alaska, Inc. (EMCON), 1993. *Demolition Area Number One Closure Guidelines, Fort Richardson, Alaska*. Prepared for Department of the Army, Engineer District, Alaska. December.
- ENSR, 1998. *Remedial Investigation/Feasibility Study, Operable Unit D, Fort Richardson, Alaska, Vol. I, Remedial Investigation*. November.
- Freethy, G.M., 1976. *Preliminary Report on Water Availability in the Lower Ship Creek Basin, Anchorage, Alaska*. U.S. Geological Survey Water Resources Investigations 48-75.
- Gilbert, R.O., 1987. *Statistical Method for Environmental Pollution Monitoring*, Chapter 16.4 Mann-Kendall Test, pp 208-217, and Appendix A, Table A.18 Probabilities for Mann-Kendall Non-Parametric Test for Trend, p. 272. John Wiley & Sons, Inc., New York, NY.

- Hollander, M. and D.A. Wolfe, 1973. *Nonparametric Statistical Methods*, Wiley, New York, NY.
- Hunter, L.E., D.E. Lawson, S.R. Bigl, B.N. Astley, C. Snyder, and F. Perron, 1999. *Subsurface Geologic Investigations of the Fort Richardson Cantonment Area, Alaska Interim Report*. Prepared for U.S. Army Directorate of Public Works, Fort Richardson.
- United States Air Force (USAF), 2017a. *Remedial Action-Operations Monitoring Letter Work Plan and Basewide Uniform Federal Policy-Quality Assurance Project Plan (UFP-QAPP) Addendum*. February.
- USAF, 2017b. *SD025 – Building 16430 Floor Drains Site Characterization Report*. April.
- USAF, 2017c. *Treatability Study Report DA089 – Armored Vehicle Maintenance Area*. Final. August.
- USAF, 2017d. 2016 Remedial Action Long-Term Management Report, XU022 – Eagle River Flats, Operable Unit C. Draft. June.
- USAF, 2017e. *Memorandum to the Site File Updated Schedule for XU022 – Eagle River Flats Impact Area, Operable Unit C, Joint Base Elmendorf-Richardson, Alaska*. Preliminary Draft. March.
- USAF, 2016a. *Memorandum to the Site File: Operable Unit 6*. Final. November.
- USAF, 2016b. *Interim Remedial Action Completion Report LF002*. Final. October.
- USAF, 2016c. *Site Characterization and Risk Evaluation Report SO552 (ST402)*. Final. January.
- USAF, 2016d. *Uniform Federal Policy-Quality Assurance Project Plan – Addendum CG039 – Poleline Road Disposal Area Treatability Study Work Plan – Bioaugmentation*.
- USAF, 2015a. *Remedial Action-Operations and Monitoring Letter Work Plan Addendum*. Final. August.
- USAF, 2015b. *Limited Site Investigation Report FT023 (Fire Training Area)*. Final. June.
- USAF, 2015c. *Interim Remedial Action Completion Report Site SD024*. Final August. USAF,
- USAF, 2015d. *Treatability Study Report CG039 – Poleline Road Disposal Area CG039 – Poleline Road Disposal Area Treatability Study Report*.
- USAF, 2014a. *Basewide Uniform Federal Policy-Quality Assurance Project Plan (UFP-QAPP), Revision 1*. Joint Base Elmendorf-Richardson, Alaska. Final. August.
- USAF, 2014b. *DP098 DNAPL Evaluation Work Plan and UFP-QAPP*. Final. February.
- USAF, 2014c. *Fourth Five-Year Review for Elmendorf AFB*. March.

- USAF, 2014d. *Treatability Study Implementation Report CG039 – Poleline Road Disposal Area Joint Base Elmendorf-Richardson, Alaska.*
- USAF, 2014e. *DA089 – Armored Vehicle Maintenance Area Treatability Study Implementation Report.* September.
- USAF, 2014f. *Summary of 2013 Groundwater Monitoring Results, SS044 – Building 35-752 PCB Site.* March.
- USAF, 2014g. *Decommissioning of Monitoring Wells at SS044.* Final. February.
- USAF, 2013a. *Third CERCLA Five-Year Review Report; JBER-Richardson, Alaska.* Final. February.
- USAF, 2013b. *Uniform Federal Policy-Quality Assurance Project Plan, DA089 – Armored Vehicle Maintenance Area Treatability Study Work Plan, Joint Base Elmendorf-Richardson, Alaska.* Final. September.
- USAF, 2013d. *Environmental Restoration Program Atlas.* Final. July
- USAF, 2012a. *2011 Zones 1, 2, and 3 Annual Report.* JBER, Alaska. June.
- USAF, 2012b. *2011 Groundwater Monitoring and Borehole Sampling, Three-Party Agreement Sites: OUB Poleline Road Disposal Area and OUE Armored Vehicle Maintenance Area.*
- USAF, 2012c. *Summary of SD15 Limited Site Assessment.* January.
- USAF, 2011a. *Memorandum to the Site File for Passive Operation of the Wetland Remediation System at Operable Unit 5.* Elmendorf Air Force Base, Alaska. June
- USAF, 2011b. *Memorandum to the Site File for Long Term Monitoring at the Poleline Road Disposal Area, Operable Unit B.* March.
- USAF, 2011c. *Engineering Evaluation and Cost Analysis, F-22 Weapons Release Shop.*
- USAF, 2011d. *ST37 TCE Plume and Source Area Investigation Report.* Draft Final. October.
- USAF, 2011e. *2011 Drilling in the WP14 OU6MW-46 Plume (Final), Joint Base Elmendorf-Richardson.*
- USAF, 2010a. *Source LF04 Operations and Management Plan, Elmendorf Air Force Base, Alaska.* July
- USAF, 2010b. *Memorandum to the Site File, Elmendorf Air Force Base Operable Units (OUs) 1,2,4, and 5.* January.
- USAF, 2010c. *2009 Zone 3 Management Area Wetland Remediation System Optimization Study.* Elmendorf Air Force Base, Alaska. March.

- USAF, 2010d. *2009 Zone 3 Management Area Wetland Remediation System Optimization Study Addendum*. Elmendorf Air Force Base, Alaska. July.
- USAF, 2009a. *DP98 Remedial Action Report*. Elmendorf Air Force Base, Alaska. September.
- USAF, 2009b. *2009 Zone 2 and Zone 3 Management Areas Work Plan*. Elmendorf Air Force Base, Alaska. June.
- USAF, 2008a. *Memorandum to Site File, Site LF04, Operable Unit 6*. Elmendorf Air Force Base, Alaska. March.
- USAF, 2008b. *2007 Zone 1 Remedial Process Optimization Report*. Elmendorf Air Force Base, Alaska. June.
- USAF, 2008c. *Third Five-Year Review for Elmendorf Air Force Base*. December.
- USAF, 2007. *Explanation of Significant Difference, Operable Unit 6*, Elmendorf Air Force Base, Alaska. March.
- USAF, 2005a. *Monitoring and System Optimization Modification Report for Seeps 9, 10, and 11, Operable Unit 5, Engineered Wetland Remediation System*, Elmendorf AFB, Alaska, January.
- USAF, 2005b. *Decision Document, PL81 Valve Pit 11 Soil Cleanup*, Elmendorf Air Force Base, Alaska USAF, 2003a. *Final Land Use Controls Management Plan*; Elmendorf Air Force Base, Alaska.
- USAF, 2004. *DP98 Record of Decision*. Elmendorf Air Force Base, Alaska. May.
- USAF, 2003a. *Final Land Use Controls Management Plan*; Elmendorf Air Force Base, Alaska.
- USAF, 2003b. *Second Five-Year Review for Elmendorf AFB*. November.
- USAF, 2003c. *Remedial Investigation/Feasibility Study for Site DP98*. Elmendorf Air Force Base, Alaska. June.
- USAF, 2003d. *Memorandum to Site File. Operable Unit 4*. Elmendorf Air Force Base, Alaska. September.
- USAF, 2003e. *Operable Unit 6 Memorandum to Site File*. Elmendorf Air Force Base, Alaska. September.
- USAF, 2003f. *Operable Unit 4 2002 Annual Report*.
- USAF, 2003g. *Memorandum to Site File, Operable Unit 5*. Elmendorf Air Force Base, Alaska. September. (Subject: Sampling Frequency Decision Guide).
- USAF, 2001a. *Engineering Evaluation/Cost Analysis for Site DP-98*. Elmendorf Air Force Base, Alaska. September.

- USAF, 2001b. *Groundwater Modeling Report Operable Unit 2, Site ST041*, Elmendorf Air Force Base, Alaska. April.
- USAF, 1998a. *Record of Decision for Operable Unit C*, Fort Richardson, Anchorage, Alaska. September.
- USAF, 1998b. *1997 SERA Phase VI Investigation*. Elmendorf Air Force Base, Alaska.
- USAF, 1998c. *Five-Year Review for Elmendorf Air Force Base*. November
- USAF, 1998d. *Operable Unit 2 Remedial Action Report*, Elmendorf Air Force Base, Alaska. September.
- USAF, 1997a. *Record of Decision, Operable Unit 3, Environmental Restoration Program*. Elmendorf Air Force Base, Alaska. January.
- USAF, 1997b. *Operable Unit 6 and Source Area SS19 Record of Decision*. Elmendorf Air Force Base, Alaska. January.
- USAF, 1996. *Remedial Investigation/Feasibility Study Report: Operable Unit 6*. Elmendorf Air Force Base, Alaska. January.
- USAF, 1995a. *Record of Decision, Operable Unit 2*, Environmental Restoration Program. Elmendorf Air Force Base, Alaska. March.
- USAF, 1995b. *Record of Decision, Operable Unit 4*, Environmental Restoration Program. Elmendorf Air Force Base, Alaska. September.
- USAF, 1995c. *Record of Decision, Operable Unit 5, Environmental Restoration Program*. Elmendorf Air Force Base, Alaska. February.
- USAF, 1995d. *OU6 Remedial Investigation/Feasibility Study Report, Final*. Elmendorf Air Force Base, Alaska.
- USAF, 1994a. *Record of Decision: Operable Unit 1*, Environmental Restoration Program. Elmendorf Air Force Base, Alaska. September.
- USAF, 1994b. *Operable Unit 5 Remedial Investigation/Feasibility Study Report, Final*. Elmendorf Air Force Base, Alaska. September.
- USAF, 1993. *Basewide Background Sampling Report, Volume 1*, Elmendorf Air Force Base, Alaska. January.
- USAF, 1983. *Installation Restoration Program Phase I- Records Search*. Elmendorf Air Force Base, Alaska. September.
- United States Army (U.S. Army), 2005. *Record of Decision Operable Unit E Fort Richardson*, Anchorage, Alaska. CERCLIS ID: AK6214522157. September.

- U.S. Army, 2000. *Record of Decision, Operable Unit D*. Fort Richardson, Alaska. June.
- U.S. Army, 1998. *Record of Decision for Operable Unit C, Fort Richardson, Anchorage, Alaska*. September.
- U.S. Army, 1997. *Record of Decision for Operable Units A and B*, Fort Richardson, Anchorage, Alaska. Final. August.
- U.S. Army Corps of Engineers (USACE), 2005. *Record of Decision Operable Unit E Fort Richardson, Anchorage, Alaska*. CERCLIS ID: AK6214522157. September.
- U.S. Army Corps of Engineers (USACE), Cold Regions Research and Engineering Laboratory (CRREL), 2011. *Poleline Road Disposal Area Hydrologic Analysis and Modeling Summary Report*. December.
- USACE CRREL, 2003. *Hydrogeology of the Poleline Road Disposal Area, Operable Unit B*, Fort Richardson, Alaska.
- USACE CRREL, 2000. *Groundwater data from Fort Richardson, Alaska, for the period April 1997 to March 2000*. Draft.
- U.S. Army Directorate of Public Works (U.S. Army DPW), 2008. *Five-Year Review Report, Second Five-Year Review for Fort Richardson, Alaska*. February.
- U.S. Army DPW, 1996. *Remedial Investigation Report Operable Unit B Poleline Road Disposal Area*. Fort Richardson, Alaska. September.
- Warhaftig, C., 1965. *Physiographic Divisions of Alaska*. United States Geological Survey Professional Paper 482. United States Government Printing Office, Washington, D.C.
- Woodward-Clyde, 1998. *Long-Term Groundwater Monitoring Workplan, Operable Unit B, Poleline Road Disposal Area, Fort Richardson, Alaska*. April.