UNITED STATES AIR FORCE
JOINT BASE ELMENDORF-RICHARDSON
ALASKA

ENVIRONMENTAL RESTORATION PROGRAM

2015 ANNUAL REMEDIAL ACTION-OPERATIONS AND MONITORING REPORT FOR SELECT CERCLA SITES

FINAL

SEPTEMBER 2017

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2015 ANNUAL REMEDIAL ACTION-OPERATIONS AND MONITORING REPORT FOR SELECT CERCLA SITES

JOINT BASE ELMENDORF-RICHARDSON, ALASKA

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LIST OF ACRONYMS

°C	degree(s) Celsius
µg/g	micrograms 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
ARRC	Alaska Railroad Corporation
AVMA	Armored Vehicle Maintenance Area
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, total xylenes
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
ERP	Environmental Restoration Program
ERPIMS	Environmental Restoration Program Information Management Systems

LIST OF ACRONYMS (CONTINUED)

ESD	Explanation of Significant Difference
EVO	emulsified vegetable oil
FD	field duplicate
FFA	Federal Facility Agreement
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
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
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 significant trend
NTU	Nephelometric Turbidity Units
OB/OD	Open Burn/Open Detonation
ORP	oxidation-reduction potential
OU	Operable Unit
PAH	polycyclic aromatic hydrocarbon
PBC	Performance-Based Contract
PBR	Performance Based Remediation
PCA	tetrachloroethane
PCB	polychlorinated biphenyl

LIST OF ACRONYMS (CONTINUED)

PCE	tetrachloroethene
PDB	Passive Diffusion Bag Sampler
POL	petroleum, oil, and lubricants
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
S	statistic
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
UFP-QAPP	Uniform Federal Policy-Quality Assurance Project Plan
USACE	U.S. Army Corps of Engineers
USAF	United States Air Force
USDA	United States Department of Agriculture
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 2015 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) 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 (FFA) 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 regulation 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 an FFA 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 2014 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 2014 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 2015 including sampling, analysis, debris removal, and land use control (LUC) inspections. Fieldwork conducted in 2015 followed the ADEC and EPA-approved *2015 Remedial Action-Operations and Monitoring Letter Work Plan Addendum* (USAF, 2015a). The letter work plan referenced the procedures for performing fieldwork in the *Final Basewide Uniform Federal Policy-Quality Assurance Project Plan (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.

1.2 2015 FIELD ACTIVITIES OVERVIEW

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

1.2.1 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 log books and field forms and are included in Appendix A of this report. Digital data capture devices (hand-held tablet) were used at JBER-E sites in conjunction with field forms for recording water quality parameters.

Electronic data was exported from the tablet or hand entered into Environmental Restoration Program Information Management Systems (ERPIMS).

Field parameters measured at the time of groundwater sample collection from monitoring wells include biogeochemical monitored natural attenuation (MNA) parameters pH, conductivity, dissolved oxygen (DO), oxidation-reduction potential (ORP), temperature, turbidity and alkalinity. At JBER-E, alkalinity was measured in the field using a field test kit (Hach Alkalinity Test Kit, Model AL-DT). Additional analytical MNA parameters were collected and included Anions (chloride and sulfide) Total Nitrite and Nitrate, dissolved iron and manganese and dissolved gases (methane, ethane and ethene). These 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 began 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 (Aug 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 geochemical conditions at each site. JBER-E will collect laboratory MNA parameters once every 5 years. MNA parameters were collected in 2015. EPA requested this to be revised so the laboratory MNA sample timing coincided with the 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.

1.2.2 Monitoring Well Maintenance

The following maintenance was performed based on the observed condition of monitoring wells: relabeling due to fading; and replacement of caps, locks or bolts. 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 2015 is included in the individual Field Activities and Results sections for each site. Monitoring well survey data are in Appendix A.

1.2.3 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 2015. 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 2015 to ensure they were in good condition. A list of flagged monitoring wells is included in Appendix A.

1.2.4 LF04 Erosion Survey and Debris Removal

In accordance with the most recent *Source LF04 Operations and Management Plan* (USAF, 2010a) and *LF04 Memorandum to the Site File* (USAF, 2008a), exposed debris at the base of the LF04 bluff was surveyed, removed (where possible) and appropriately disposed of in late summer during the 2015 field season. In accordance with recommendations made in the 2013 Five-Year Review, a Memorandum to the Site File will be prepared documenting a reduction in the Erosion Survey and Debris Removal frequency from annually to once every 3 years.

Access to the LF04 bluff area was coordinated with the Port of Anchorage before entering the secured site. Prior to LF04 site work, field personnel attended Explosive Ordnance Disposal (EOD) training. After clearance, the survey classified and photographed all debris, established its geodetic location, and managed any potentially hazardous findings. 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.

1.2.5 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 June to September 2015 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. The repairs will be addressed during the 2016 field season. The 2015 LUC Inspection Checklist forms and photograph logs for each site are in Appendix B.

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
JBER-Elmendorf			
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
JBER-Richardson			
CG039	Yes	Yes	RA-O / Active
DA089	Yes	Yes	RC / Active
SS044[a]	Yes	Yes	RC / Cleanup Complete - ICs
XE023	No	Yes	RC / Active
XU022	No	Yes	RC / Active

Notes:

[a] 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
JBER-Elmendorf		
FT023	FS-52	Requires a new bolt for casing lid
FT023	407MW-01	Requires outer monitoring well casing lid to be secured
ST037	OU5MW-15	Requires PVC casing to be cut down and resurveyed
SD029	IS6-01	Requires a new bolt for casing lid
ST037	OU5MW-34	Check well PVC casing for possible repair; the upper PVC casing is dented
JBER -Richardson		
CG039	AP-3747	Replace 4” cap (currently missing).
CG039	AP-3749	Replace lock. Add fill to annular space.
CG039	AP-3981	Add fill to annular space.
CG039	AP-3981	Add fill to annular space.
CG039	AP-4352	Outer casing loose, may need surface seal repairs. Add fill to annular space.
CG039	AP-4350	Replace lock.
CG039	AP-4352	Outer casing loose, may need surface seal repairs. Add fill to annular space.
CG039	AP-4354	Add fill to annular space.

Notes:
ADEC = Alaska Department of Environmental Conservation
AFID = Air Force Identification
PVC = polyvinyl chloride

1.3 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.

1.3.1 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 glacio-fluvial outwash plain. The Elmendorf Moraine (a glacial end moraine) crosses JBER-E from the southwest to the northeast, and ground moraine and glacio-fluvial 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 glacio-fluvial 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 glacio-fluvial 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.

1.3.2 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).

1.3.3 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 glacio-fluvial 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).

1.3.4 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 feet (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.

1.3.5 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.

1.4 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 ≥ 1	No Trend
$S \leq 0$	< 90% and COV < 1	Stable
$S < 0$	90 - 95%	Probably Decreasing
$S < 0$	95%	Decreasing

Note:
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 tests were performed on constituents that currently exceeded cleanup levels and for wells that were sampled in 2015. Trend graphs were omitted if all constituents in an individual monitoring well trend test had 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 on the plot and 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 2015, (2) there are four or more data points available to run the calculation, and (3) the cleanup goal for contaminants of concern (COCs) or daughter products have been exceeded one or more times in the past 5 years. In addition, Mann-Kendall trend analysis was conducted for monitoring wells associated with the treatability study at CG039 for all COCs and daughter products. For the monitoring wells/analytes that meet these criteria, a summary of the Mann-Kendall analysis results and concentration trend graphs are in the site-specific sections.

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

1.5 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:

- *Operable Unit (OU) 1 ROD* (USAF, 1994a)
- *OU2 ROD* (USAF, 1995a)
- *OU3 ROD* (USAF, 1997a)
- *OU4 ROD* (USAF, 1995b) and *Errata to the 2003 Five-Year Review* (USAF, 2003d)
- *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)
- *ESD, OU6* (USAF, 2007)
- *DP98 ROD* (USAF, 2004)
- *OUA and B ROD* (United States Army [U.S. Army], 1997)
- *Memorandum to the Site File for OUB/Poleline Road Disposal Area* (USAF, 2011b)
- *OUC ROD (*USAF, 1998a)
- *OUE ROD* (United Stated Army Corps of Engineers [USACE], 2005)

1.6 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, 2015 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, 2015 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-Elmendorf Annual LUC/IC and Site Inspection Checklists – JBER-E
  - B2 – JBER-Richardson 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, 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 Quality Assurance 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 Spreadsheets (on CD only)

    Analytical Data Quality Evaluation Report

    ADEC Laboratory Data Review Checklists

    Historical Data and Mann-Kendall Summary

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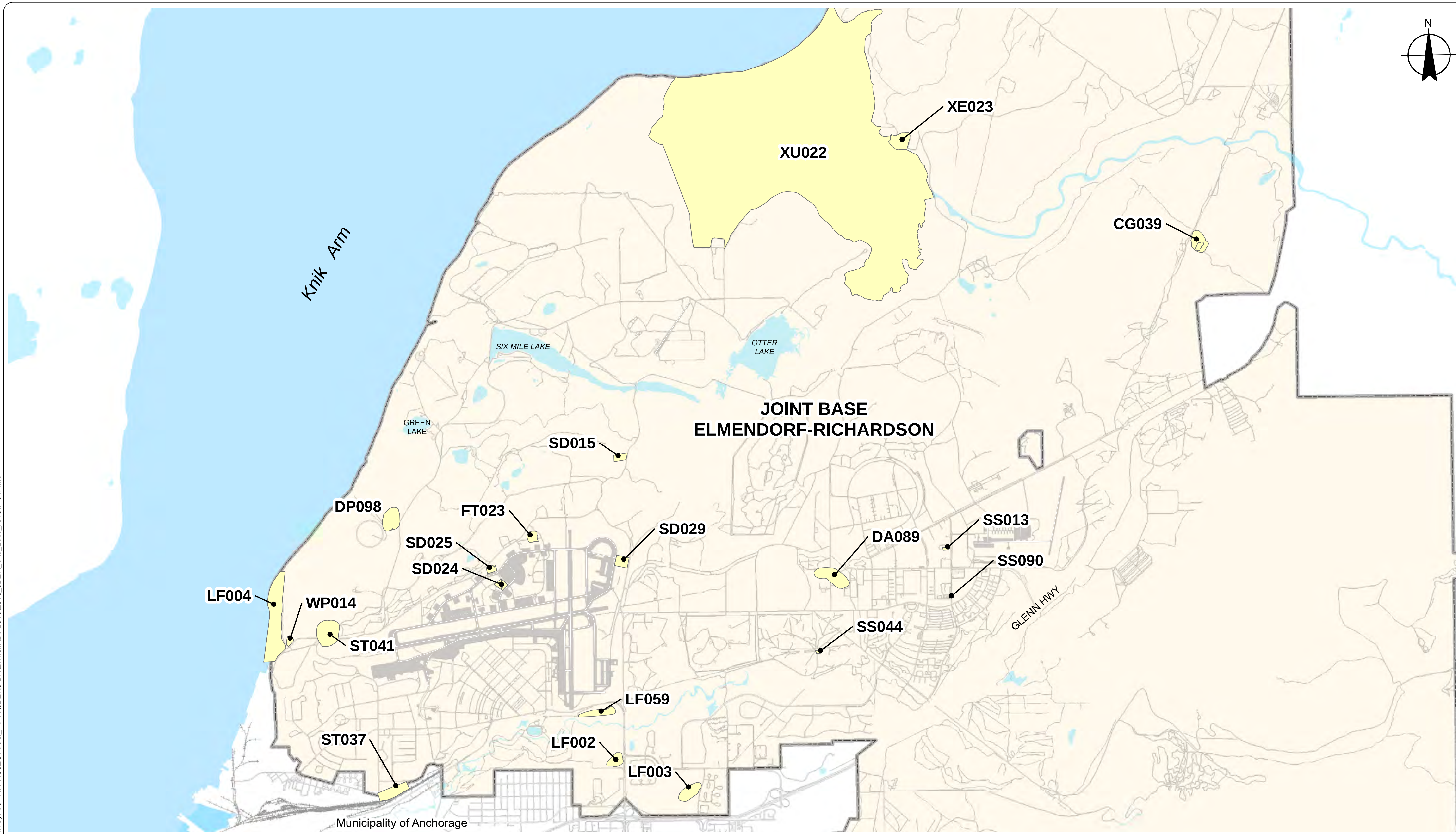

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LEGEND

CERCLA Site

2015 CERCLA SITE LOCATIONS REPRESENTED IN THIS REPORT

2015 Annual Remedial Action – Operations and Monitoring for Select CERCLA Sites
Joint Base Elmendorf-Richardson, Alaska

Figure 1-1

Date: 10 May 2017 Drawn by: SJ K:\PROJECTS\Air_Force\JBER\PBR\LTM\MXDs\2016\2016_JBER_Site_Locs_RAOM-01.mxd

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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 on the northwestern side 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 (ERP) 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, 2003b) 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* to be prepared and 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, 2003b).

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 in the vicinity of 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 the current COCs and cleanup goals in groundwater at the site.

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 (µg/L)	Basis for Cleanup Goal
1,1-DCE	7	DP98 ROD (USAF, 2004)
cis-DCE	70	
TCE	5	
PCE	5	
VC	2	

Notes:

µg/L = microgram(s) per liter
DCE = dichloroethene
OU = Operable Unit
PCE = tetrachloroethene
ROD = Record of Decision
TCE = trichloroethene
USAF = United States Air Force
VC = vinyl chloride

2.3 2015 FIELD ACTIVITIES

During 2015, samples from eleven monitoring wells were collected for COC and MNA parameter analyses. In addition, one surface water sample was collected for COC analysis. Based on exceedances in 2014, surface water location DP98SW-10 was scheduled to be sampled but the point was dry so a sample was not collected. Six of the eleven monitoring wells sampled had concentrations of contaminants exceeding cleanup goals cited in the DP098 ROD. Table 2-2 presents a summary of the 2015 analytical results. Table 2-3 presents a summary of the MNA analytical data and field parameters. The 2015 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 2-7.

A field duplicate sample was collected from monitoring wells 41755WL-04 and 41755WL-08. Low flow drawdown criteria was exceeded in monitoring wells 41755WL-04, 41755WL-05, 41755WL-07 and 41755WL-15, so three well volumes were purged before collecting a sample. Monitoring well DP98INJ-02 was purged dry and a sample was collected the following day.

Under anaerobic conditions, reductive dechlorination will occur. In general, reductive dechlorination occurs by sequential dechlorination from PCE to TCE to DCE to VC to ethene. Reductive dechlorination of chlorinated solvent compounds is associated with the accumulation of daughter products and an increase in the concentration of chloride. Methanogenesis is occurring within the in-plume monitoring wells indicating reducing conditions with the greatest methane concentration reported from DP98INJ-02 at 4,700 micrograms per liter (µg/L). Reducing conditions are expected to be present where DO measurements are less than 0.5 mg/L and also where ORP measurements are negative. DO measurements indicate reducing conditions in 41755WL-02, -04, -05, -09, -15, -23, and DP98INJ-02. ORP measurements indicate reducing conditions in 41755WL-03, -04, -05, and DP98INJ-02. DO and ORP measurements indicating reducing conditions are in alignment at 41755WL-04, -05, and DP98INJ-02. The presence of reducing conditions are not supported by both DO and ORP measurements at 41755WL-02 and 41755WL-03. The unusually high DO measurements at 41755WL-03 may have been associated with the reported sporadic pumping and subsequent bailing of the well, which could introduce oxygen into the monitored water. It is unclear why the other wells did not show consistent responses between the two parameters.

Mann-Kendall trend tests indicate statistically significant decreasing trends at the 95 percent confidence level for PCE, TCE, and cis-1,2-DCE in monitoring well 41755WL-02; TCE and cis-1,2-DCE in monitoring wells 41755WL-03 and 41755WL-04; and cis-1,2-DCE in monitoring well 41755WL-05. Statistically significant increasing trends were identified for TCE and cis-1,2-DCE in well 41755WL-08 and for VC in monitoring well DP98INJ-02. Based on the MAROS decision matrix, concentrations of cis-1,2-DCE are probably decreasing in monitoring well DP98INJ-02.

The DP098 LUC inspection was performed on October 10, 2015, and only identified monitoring well maintenance issues. Well maintenance was performed at six monitoring wells. One bolt that secured the outer well casing was sheared off at 41755WL-01, but a second bolt was still secure and the lid was relabeled. The monitoring well cap was replaced on the inner casing, and the outer casing seal was cleaned. The outer well casing for monitoring well 41755WL-02 received one new bolt and was relabeled. The inner PVC casing for monitoring well 41755WL-03 was cut down and resurveyed. In addition, the bolts were replaced on the outer casing and it was relabeled. The inner PVC casings for monitoring wells 41755WL-06, 41755WL-12, and 41755WL-19 were cut down and resurveyed. Survey data is in Appendix A. In 2014, the inner PVC casing for monitoring well 41755WL-08 was cut down below the top of the outer casing. Upon return to the well in 2015, it was noted that the PVC casing had pushed back up above the top of the outer casing. The inner PVC casing was not cut down in 2015. A copy of the 2015 LUC inspection form for DP098 is in Appendix B.

Table 2-2 Summary of 2015 Analytical Results at DP098

Analyte		PCE	TCE	cis-1,2-DCE	1,1-DCE	VC
Groundwater Cleanup Goal *	**Units**	**5 µg/L**	**5 µg/L**	**70 µg/L**	**7 µg/L**	**2 µg/L**
DP98INJ-02	µg/L	ND [0.5]	0.55 J	**2,360**	**10.3**	**1,490**
41755WL-02	µg/L	**647**	**902**	**2,060**	4.63	0.77 J
41755WL-03	µg/L	ND [0.5] J	1.85 J	**342 J**	1.14 J	1.5 J
41755WL-04	µg/L	ND [5]	**13.9**	**876**	ND [0.5]	**545**
41755WL-04 FD	µg/L	ND [0.5]	**15.4**	**936**	3.5	**741**
41755WL-05	µg/L	ND [5]	ND [5]	**2,170**	ND [5]	**9.6 J**
41755WL-07	µg/L	ND [0.5]	ND [0.5]	ND [5]	ND [5]	ND [0.5]
41755WL-08	µg/L	ND [0.5]	**254**	**274**	0.81 J	ND [0.5]
41755WL-08 FD	µg/L	ND [0.5]	**289**	**252**	ND [0.5]	ND [0.5]
41755WL-09	µg/L	ND [0.5]	ND [0.5]	ND [0.5]	ND [0.5]	ND [0.5]
41755WL-15	µg/L	ND [0.5]	ND [0.5]	ND [0.5]	ND [0.5]	ND [1.5]
41755WL-16	µg/L	ND [0.5]	ND [0.5]	ND [0.5]	ND [0.5]	ND [0.5]
41755WL-23	µg/L	ND [0.5]	ND [0.5]	ND [0.5]	ND [0.5]	ND [1.5]
Surface Water Cleanup Goal[a]	**Units**	**--**	**5 µg/L**	**5 µg/L**	**--**	**--**
DP98SW-01	µg/L	ND [0.5]	ND [0.5]	ND [0.5]	ND [0.5]	ND [0.5]

Notes:

[a] Cleanup levels as cited in the DP098 ROD (USAF, 2004)
-- Not available in the DP098 ROD
[ ] = limit of detection (LOD)
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 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 2015 MNA Analytical Results and Field Parameters at DP098

MNA Analytical Parameters

Monitoring Well ID	Chloride (mg/L)	Sulfate (mg/L)	Ethane (µg/L)	Ethene (µg/L)	Methane (µg/L)	Total Nitrate/Nitrite (mg/L)	Dissolved Iron (µg/L)	Dissolved Manganese (µg/L)
41755WL-02	81.4	6.18	ND [0.24]	ND [0.22]	110	ND [0.05]	1,160	2,780
41755WL-03	156	0.41 J	ND [0.24]	ND [0.22]	4,500	ND [0.05]	7,890	17,800
41755WL-04	102	1.01	2.4	59	1,400	ND [0.05]	12,400	7,390
41755WL-04 FD	108	1	3.3	82	1,900	ND [0.05]	12,700	7,310
41755WL-05	131 J	0.102 J	ND [0.24]	0.16 J	2,800	0.226	142,000	33,500
41755WL-07	138 J	4.0 J	ND [0.24]	ND [0.22]	51	ND [0.05]	1,130.0	7,540
41755WL-08	37.9	16.0	ND [0.24]	0.18 J	0.63 U	3.67	ND [250]	1.54 J
41755WL-08 FD	37.9	16.1	ND [0.24]	0.17 J	0.63 U	3.73	ND [250]	1.68 J
41755WL-09	49.4	12.4 J	ND [0.24]	ND [0.22]	33	ND [0.05]	ND [250]	501
41755WL-15	32.1	4.69	ND [0.24]	0.11 J	6.4	0.805	ND [250]	52.2
41755WL-16	14.0	0.128	ND [0.24]	0.35 J	550	ND [0.05]	11,400	903
41755WL-23	24.1	8.71	0.27 J	2.1	15	ND [0.05]	182 J	37.8
DP98INJ-02[d]	44.2	0.644	ND [0.24]	66	4,700	0.18	66,300	5,740

MNA Field Parameters

Monitoring Well ID	Volume Purged (gallons)	Temp (ºC)	Specific Conductance[e] (mS/cm)	DO (mg/L)	pH	ORP (mV)	Turbidity (NTU)	Alkalinity (mg/L of $CaCO_3$)
41755WL-02	4.6	10.10	0.573	0.43	5.78	75.9	[a]	180
41755WL-03[b]	2.0	10.11	1.056	11.77	6.40	-28.70	[a]	340
41755WL-04[c]	5.9	6.26	1.139	0.41	5.98	-13.7	11.84	580
41755WL-05[c]	3.4	6.72	1.245	0.35	6.00	-4.20	171.7	560
41755WL-07[c]	4.3	5.89	1.372	2.57	4.94	159.5	5.20	620
41755WL-08	3.9	5.42	1.020	0.72	4.71	168.2	4.04	240
41755WL-09	2.3	5.59	0.700	0.43	5.79	142.4	3.69	300
41755WL-15[c]	9.75	5.08	1.011	0.28	6.96	95.7	16.45	280
41755WL-16	3.5	5.69	0.521	1.00	5.31	85.9	63.03	160
41755WL-23	12	5.35	0.332	0.17	7.99	109.8	37.60	140
DP98INJ-02[d]	4.2	7.64	2.850	0.35	6.26	-30.7	28.24	500

Notes:

[a] Turbidity meter had a malfunction, and a turbidity reading was unable to be measured.
[b] Pump was acting sporadic. Bailed three well volumes and sampled.
[c] Exceeded drawdown, and three well volumes were purged before sampling.
[d] Well purged dry, grab sample collected the following day. Water level measurement collected prior to purging and prior to sampling.
[e] Specific Conductance is a conductivity measurement that has been corrected to 25°C.
[ ] = 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.
ºC = Celsius
$CaCO_3$ = calcium carbonate
DO = dissolved oxygen
FD = field duplicate
ID = identification
mg/L = milligram(s) per liter
mV = millivolt(s)
mS/cm = milli-Siemen(s) per centimeter
NA = not analyzed
ND = non-detect [limit of detection]
NTU = Nephelometric Turbidity Units
ORP = oxidation-reduction potential

Table 2-4 Summary of 2015 Mann-Kendall Concentration Trends for Select Wells at DP098

Monitoring Well ID	PCE	TCE	cis-DCE	1,1-DCE	VC
41755WL-02	Decreasing	Decreasing	Decreasing	NE	NE
41755WL-03	NE	Decreasing	Decreasing	NE	NE
41755WL-04	NE	Decreasing	Decreasing	NE	NST
41755WL-05	NE	NST	Decreasing	NE	NST
41755WL-08	NE	Increasing	Increasing	NE	NE
DP98INJ-02	NE	NST	NS[a]	NST	Increasing

Notes:
DCE = dichloroethene
NE = no exceedance of cleanup goal in 2015
NS[a] = no statistically significant trend identified at α=0.05; probably decreasing trend using MAROS matrix
NST = no significant trend
PCE = tetrachloroethene
TCE = trichloroethene
VC = vinyl chloride

2.4 SITE SUMMARY AND RECOMMENDATIONS

During 2015, six of the eleven monitoring wells exhibited concentrations of COCs that exceeded cleanup goals cited in the DP098 ROD as shown in Table 2-2. Mann-Kendall analysis of results from the leading edge of the plume (monitoring well 41755WL-08) shows an overall increasing concentration trend for TCE and cis-DCE, but these concentrations have been relatively stable since 2009. These trends indicate that under the existing conditions the cleanup timeframe could be extensive without additional remedial action. Cis-DCE and VC degradation appears to have stalled, particularly in DP98INJ-02, 41755WL-02, and 41755WL-05. The COCs in the downgradient monitoring wells (41755WL-07, 41755WL-09, 41755WL-15, 41755WL-16, and 41755WL-23) were all non-detect. The groundwater COC concentration trends for each monitoring well with COCs above cleanup goals are shown on Figures 2-2 through 2-7.

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. By 2008, the major components of the ROD had been implemented and the site was included in the third JBER-Elmendorf five-year review (USAF, 2008c). Preparation of a remedial action report was recommended and completed. The fourth five-year review 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 vapor intrusion evaluation will be conducted 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 the downgradient edge. A DNAPL evaluation is projected to be finalized in 2017. 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 2016 Annual RA-O and Monitoring Report based on the report conclusion.

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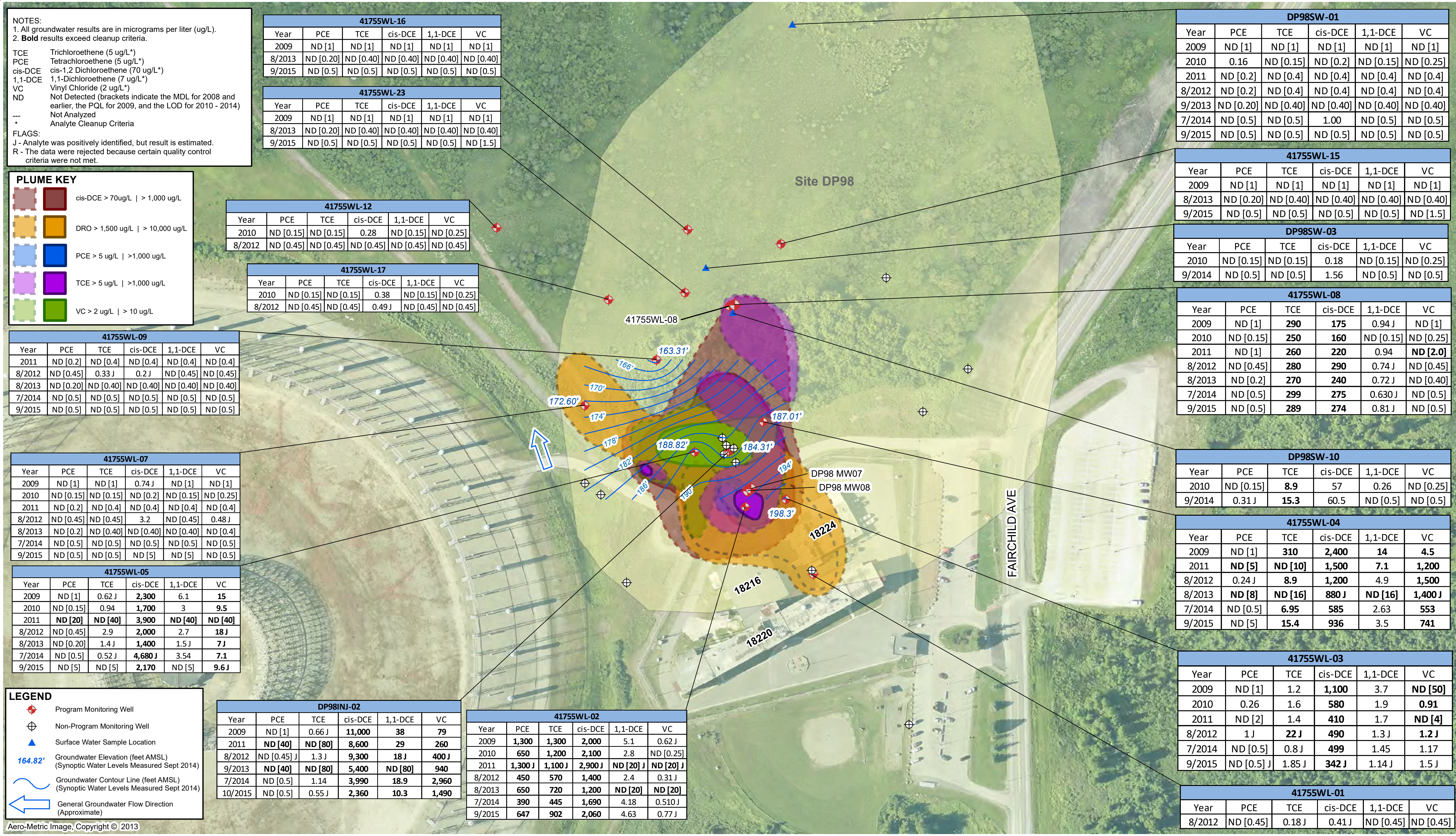
NOTES:
1. All groundwater results are in micrograms per liter (ug/L).
2. **Bold** results exceed cleanup criteria.

TCE	Trichloroethene (5 ug/L*)
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 MDL for 2008 and earlier, the PQL for 2009, and the LOD for 2010 - 2014)
---	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-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]

41755WL-09

Year	PCE	TCE	cis-DCE	1,1-DCE	VC
2011	ND [0.2]	ND [0.4]	ND [0.4]	ND [0.4]	ND [0.4]
8/2012	ND [0.45]	0.33 J	0.2 J	ND [0.45]	ND [0.45]
8/2013	ND [0.20]	ND [0.40]	ND [0.40]	ND [0.40]	ND [0.40]
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]

41755WL-07

Year	PCE	TCE	cis-DCE	1,1-DCE	VC
2009	ND [1]	ND [1]	0.74 J	ND [1]	ND [1]
2010	ND [0.15]	ND [0.15]	ND [0.2]	ND [0.15]	ND [0.25]
2011	ND [0.2]	ND [0.4]	ND [0.4]	ND [0.4]	ND [0.4]
8/2012	ND [0.45]	ND [0.45]	3.2	ND [0.45]	0.48 J
8/2013	ND [0.2]	ND [0.40]	ND [0.40]	ND [0.40]	ND [0.4]
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]

41755WL-05

Year	PCE	TCE	cis-DCE	1,1-DCE	VC
2009	ND [1]	0.62 J	**2,300**	6.1	**15**
2010	ND [0.15]	0.94	**1,700**	3	**9.5**
2011	**ND [20]**	**ND [40]**	**3,900**	**ND [40]**	**ND [40]**
8/2012	ND [0.45]	2.9	**2,000**	2.7	**18 J**
8/2013	ND [0.20]	1.4 J	**1,400**	1.5 J	**7 J**
7/2014	ND [0.5]	0.52 J	**4,680 J**	3.54	**7.1**
9/2015	ND [5]	ND [5]	**2,170**	ND [5]	**9.6 J**

DP98INJ-02

Year	PCE	TCE	cis-DCE	1,1-DCE	VC
2009	ND [1]	0.66 J	**11,000**	**38**	**79**
2011	**ND [40]**	**ND [80]**	**8,600**	**29**	**260**
8/2012	ND [0.45] J	1.3 J	**9,300**	**18 J**	**400 J**
9/2013	**ND [40]**	**ND [80]**	**5,400**	**ND [80]**	**940**
7/2014	ND [0.5]	1.14	**3,990**	**18.9**	**2,960**
10/2015	ND [0.5]	0.55 J	**2,360**	**10.3**	**1,490**

41755WL-02

Year	PCE	TCE	cis-DCE	1,1-DCE	VC
2009	**1,300**	**1,300**	**2,000**	5.1	0.62 J
2010	**650**	**1,200**	**2,100**	2.8	ND [0.25]
2011	**1,300 J**	**1,100 J**	**2,900 J**	**ND [20] J**	**ND [20] J**
8/2012	**450**	**570**	**1,400**	2.4	0.31 J
8/2013	**650**	**720**	**1,200**	**ND [20]**	**ND [20]**
7/2014	**390**	**445**	**1,690**	4.18	0.510 J
9/2015	**647**	**902**	**2,060**	4.63	0.77 J

DP98SW-01

Year	PCE	TCE	cis-DCE	1,1-DCE	VC
2009	ND [1]	ND [1]	ND [1]	ND [1]	ND [1]
2010	0.16	ND [0.15]	ND [0.2]	ND [0.15]	ND [0.25]
2011	ND [0.2]	ND [0.4]	ND [0.4]	ND [0.4]	ND [0.4]
8/2012	ND [0.2]	ND [0.4]	ND [0.4]	ND [0.4]	ND [0.4]
9/2013	ND [0.20]	ND [0.40]	ND [0.40]	ND [0.40]	ND [0.40]
7/2014	ND [0.5]	ND [0.5]	1.00	ND [0.5]	ND [0.5]
9/2015	ND [0.5]	ND [0.5]	ND [0.5]	ND [0.5]	ND [0.5]

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
2009	ND [1]	**290**	**175**	0.94 J	ND [1]
2010	ND [0.15]	**250**	**160**	ND [0.15]	ND [0.25]
2011	ND [1]	**260**	**220**	0.94	**ND [2.0]**
8/2012	ND [0.45]	**280**	**290**	0.74 J	ND [0.45]
8/2013	ND [0.2]	**270**	**240**	0.72 J	ND [0.40]
7/2014	ND [0.5]	**299**	**275**	0.630 J	ND [0.5]
9/2015	ND [0.5]	**289**	**274**	0.81 J	ND [0.5]

DP98SW-10

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

41755WL-04

Year	PCE	TCE	cis-DCE	1,1-DCE	VC
2009	ND [1]	**310**	**2,400**	**14**	**4.5**
2011	**ND [5]**	**ND [10]**	**1,500**	**7.1**	**1,200**
8/2012	0.24 J	**8.9**	**1,200**	4.9	**1,500**
8/2013	**ND [8]**	**ND [16]**	**880 J**	**ND [16]**	**1,400 J**
7/2014	ND [0.5]	**6.95**	**585**	2.63	**553**
9/2015	ND [5]	**15.4**	**936**	3.5	**741**

41755WL-03

Year	PCE	TCE	cis-DCE	1,1-DCE	VC
2009	ND [1]	1.2	**1,100**	3.7	**ND [50]**
2010	0.26	1.6	**580**	1.9	**0.91**
2011	ND [2]	1.4	**410**	1.7	**ND [4]**
8/2012	1 J	**22 J**	**490**	1.3 J	**1.2 J**
7/2014	ND [0.5]	0.8 J	**499**	1.45	1.17
9/2015	ND [0.5] J	1.85 J	**342 J**	1.14 J	1.5 J

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]

LEGEND

Program Monitoring Well
Non-Program Monitoring Well
Surface Water Sample Location
164.82' 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)

N

0 50 100 200 300 Feet

DP098 SITE MAP WITH ANALYTICAL DATA

2015 Annual Remedial Action – Operations and Monitoring for Select CERCLA Sites
Joint Base Elmendorf-Richardson, Alaska

Figure **2-1**

Date: 03 May 2017 Drawn by: SJ K:\PROJECTS\Air_Force\JBER\PBRLTM\MXDs\2016\2016_JBER_DP98_RAOM-01.mxd

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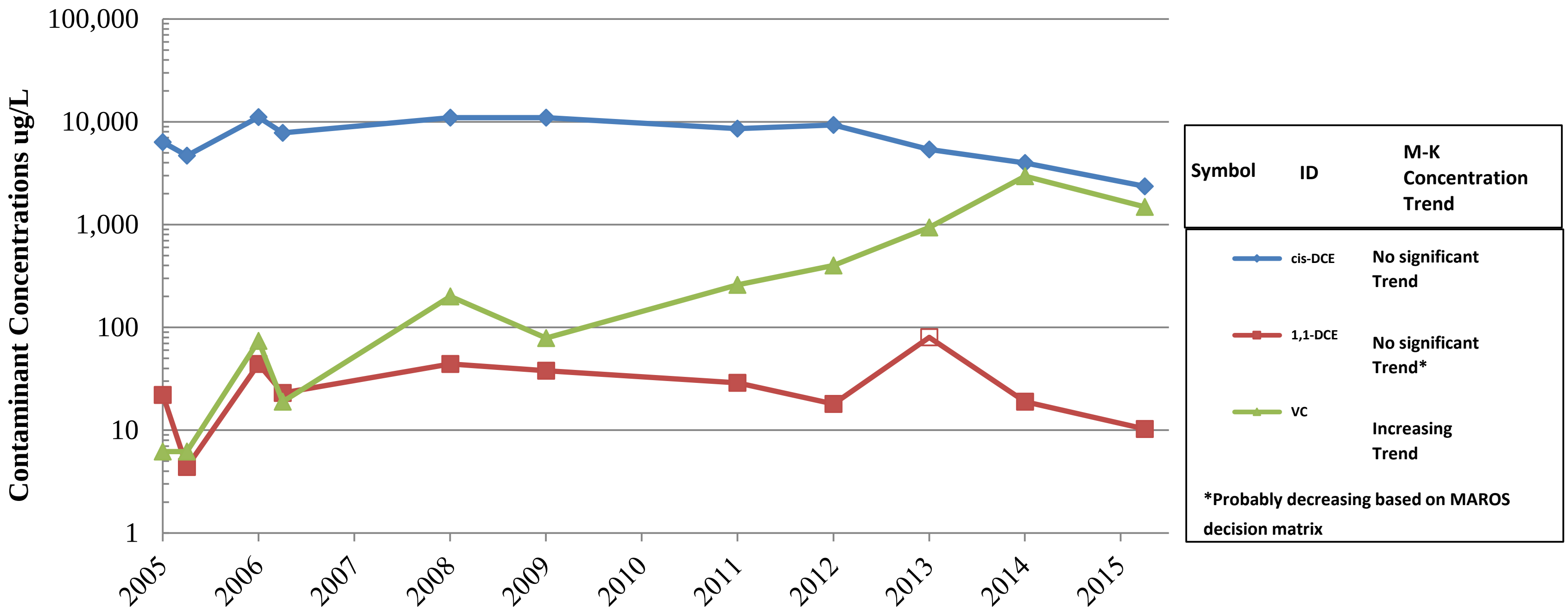

Cleanup Levels
1,1-DCE = 7 µg/L
cis-DCE = 70 µg/L
VC = 2 µg/L

DP098 CONTAMINANT TRENDS IN DP98INJ-02

2015 Annual RA-O and Monitorig Report, Select CERCLA Sites
Joint Base Elmendorf-Richardson, Alaska

Figure
2-2

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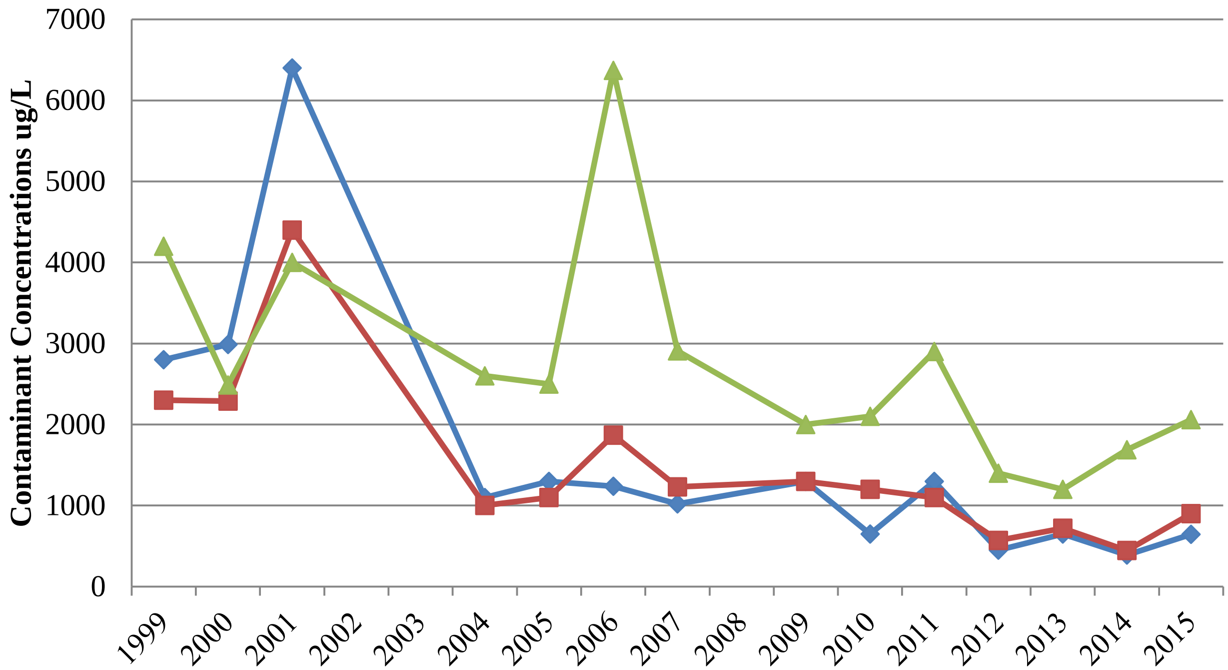

Symbol	ID	M-K Concentration Trend
	PCE	Decreasing Trend
	TCE	Decreasing Trend
	cis-DCE	Decreasing Trend

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

DP098 CONTAMINANT TRENDS IN 41755WL-02

2015 Annul RA-O and Monitoring Report, Select CERCLA Sites
Joint Base Elmendorf-Richardson, Alaska

Figure **2-3**

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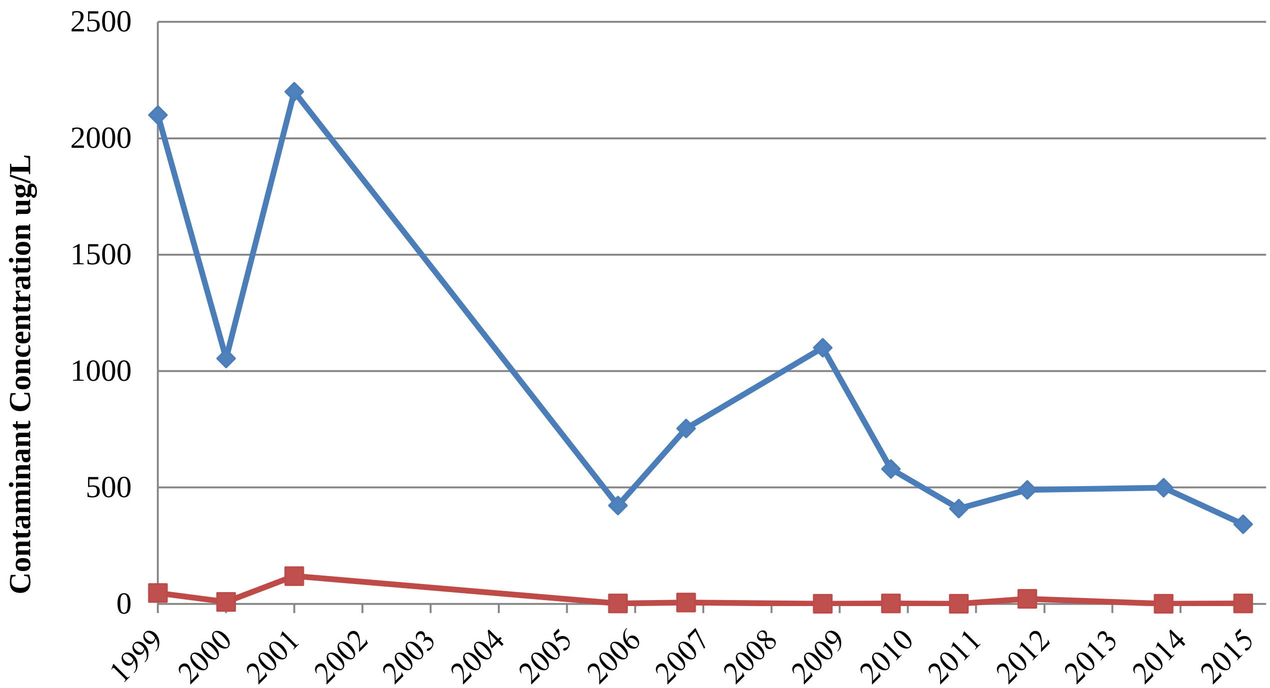

Symbol	ID	M-K Concentration Trend
	cis-DCE	Decreasing Trend
	TCE	Decreasing Trend

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

DP098 CONTAMINANT TRENDs IN 41755WL-03

2015 Annul RA-O and Monitoring Report, Select CERCLA Sites
Joint Base Elmendorf-Richardson, Alaska

Figure
2-4

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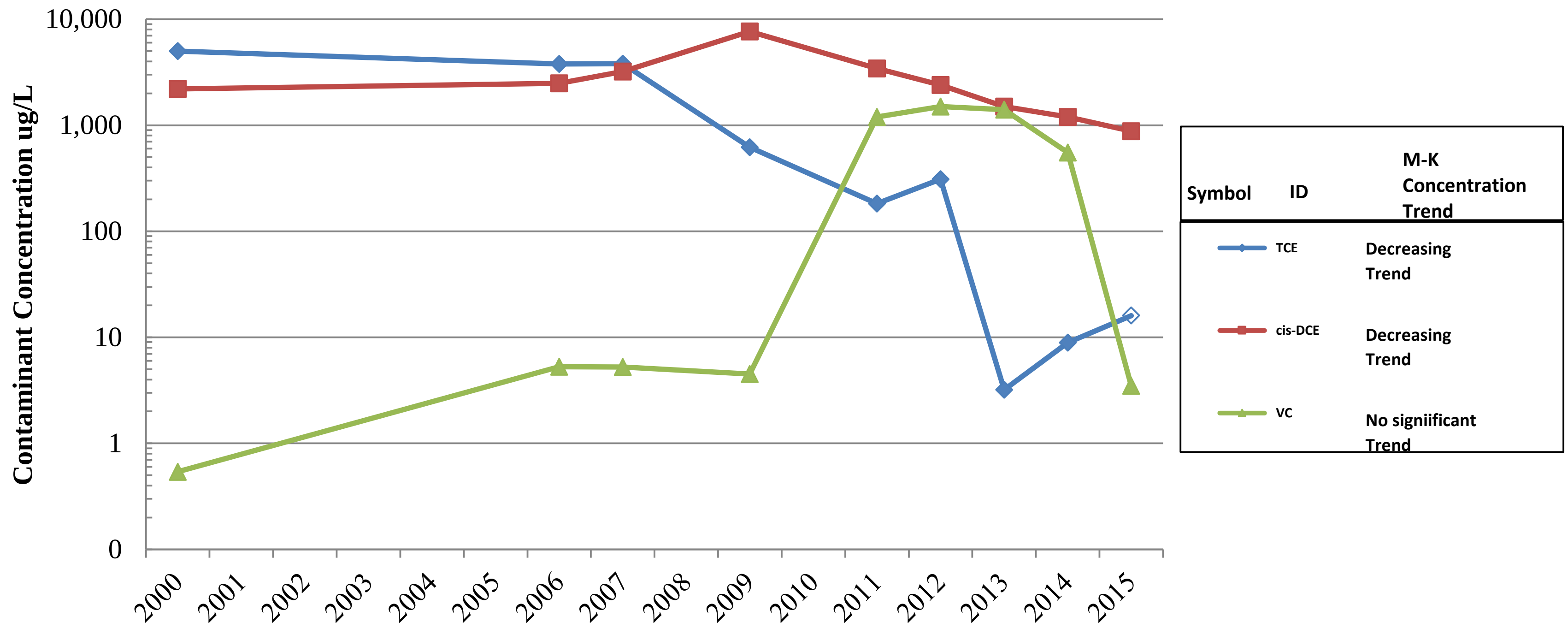

Cleanup Levels
cis-DCE = 70 µg/L
TCE = 5 µg/L
VC = 2 µg/L

DP098 CONTAMINANT TRENDS IN 41755WL-04

2015 Annul RA-O and Monitoring Report, Select CERCLA Sites
Joint Base Elmendorf-Richardson, Alaska

Figure
2-5

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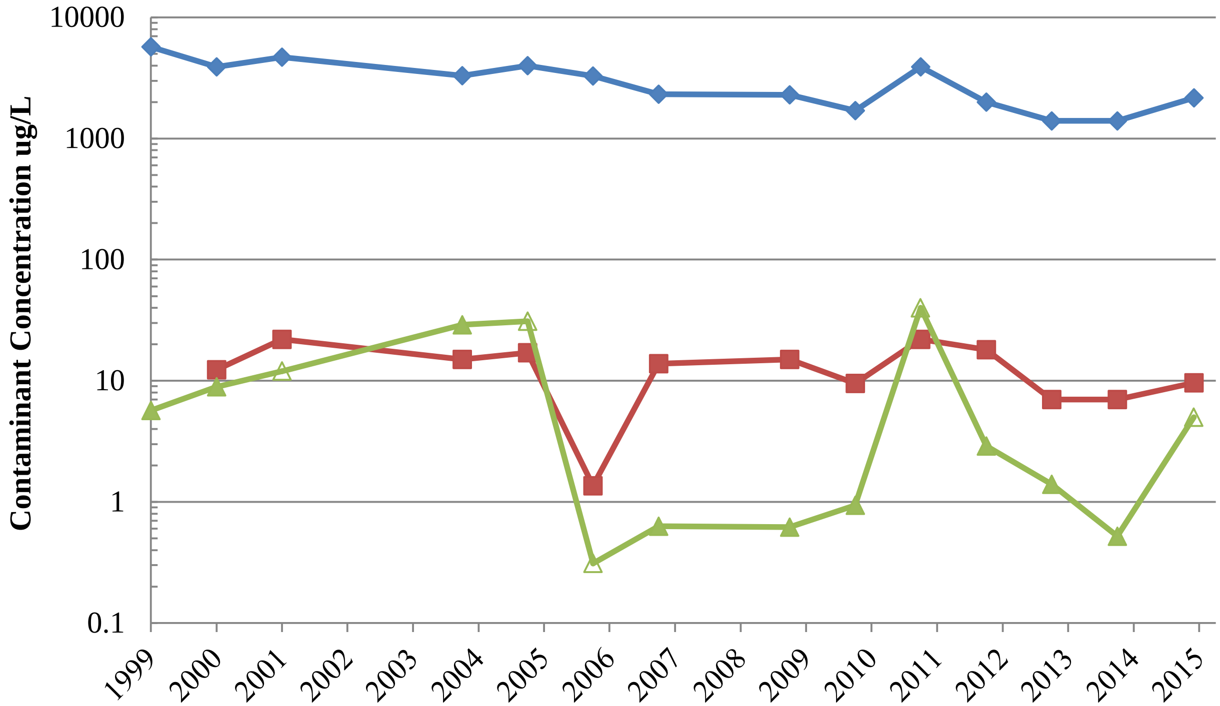

Symbol	ID	M-K Concentration Trend
	cis-DCE	Decreasing Trend
	VC	No significant Trend
	TCE	No significant Trend

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

DP098 CONTAMINANT TRENDS IN 41755WL-05

2015 Annul RA-O and Monitoring Report, Select CERCLA Sites
Joint Base Elmendorf-Richardson, Alaska

Figure
2-6

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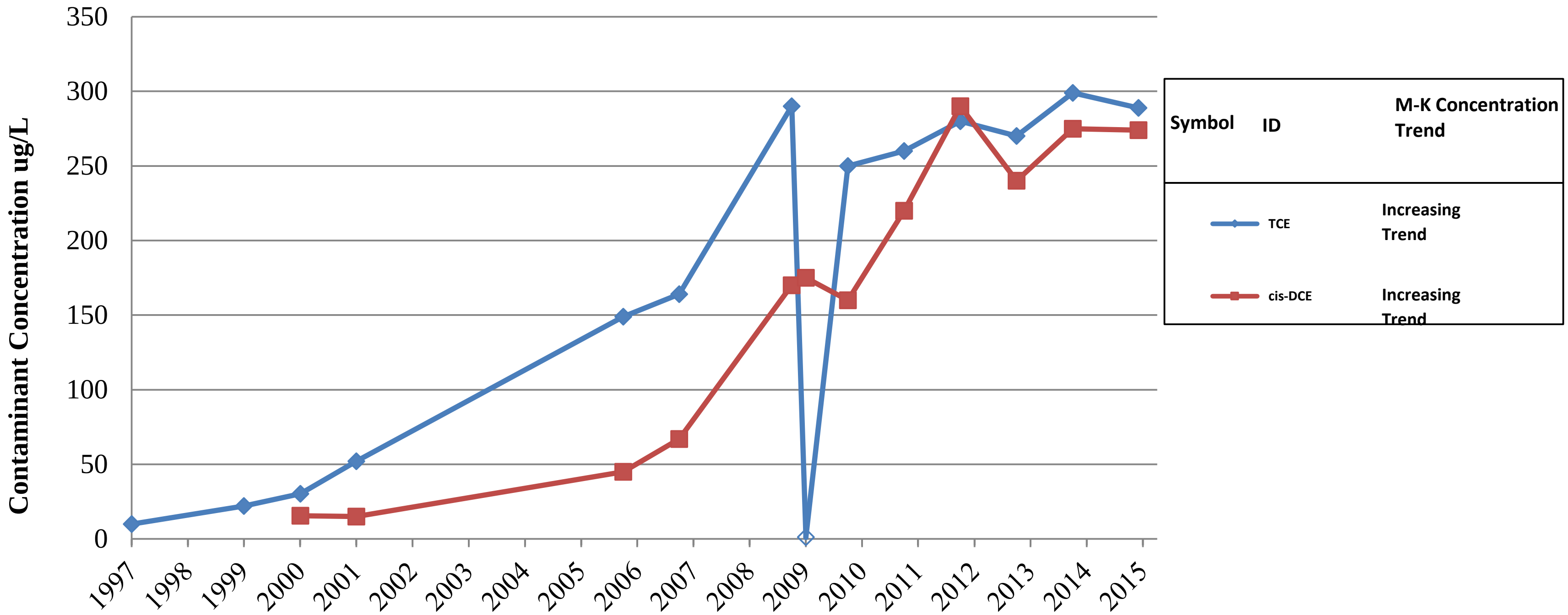

Cleanup Levels
cis-DCE = 70 µg/L
TCE = 5 µg/L

DP098 CONTAMINANT TRENDS IN 41755WL-08

2015 Annul RA-O and Monitoring Report, Select CERCLA Sites
Joint Base Elmendorf-Richardson, Alaska

Figure **2-7**

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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 33rd 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 crossgradient of the site.

3.2 REGULATORY REQUIREMENTS

The OU4 ROD (USAF, 1995b) identified the chlorinated compounds 1,1,1-trichloroethane (TCA), 1,1-dichloroethane (DCA), 1,2-DCA, PCE, TCE, and cis-1,2-DCE; and the fuel hydrocarbon compound, benzene as 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). Diesel-range organics (DRO) and gasoline-range organics (GRO) were identified as soil COCs at FT023 in the ROD. The ROD cleanup goals for DRO and GRO are 2,000 and 1,000 milligrams per kilogram (mg/kg), respectively. 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 cleanup goals for the site. 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), and 407MW-01 (every 2 years). Monitoring well OU4MW-11 will be sampled again in 2018 prior to the next Five-Year Review and 407MW-01 will be sampled in 2017. Groundwater sampling at monitoring well GW-5A was included in the LTM sample program in 2015, the well is sampled every 2 years in accordance with the Basewide Monitoring Program Well Sampling Frequency Decision Guide presented in the 2003 Memorandum to the Site File for OU4 (USAF, 2003c). The next groundwater sample collected from well GW-4A will occur in 2017. 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.

Table 3-1 Cleanup Goals in Groundwater at FT023

Contaminant of Concern	Cleanup Goal (µg/L)	Basis for Cleanup Goal
PCE	5	OU4 ROD (USAF,1995b)
TCE	5	
cis-1,2-DCE	70	
Benzene	5	Errata to Second Five-year Review (USAF, 2003d)

Notes:
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 2015 FIELD ACTIVITIES

During 2015, monitoring well 407MW-01 was sampled for volatile organic compounds (VOCs) and analytical MNA parameters. Analytical laboratory results did not exceed the OU4 ROD cleanup goals for any COC. Analytical results for site COCs are in Table 3-2. The 2015 and truncated historical results are on Figure 3-1. The MNA analytical and field parameters are in Table 3-3. Historical results are in Appendix C. Recommendations of the Limited Site Investigation (LSI) are in the *Limited Site Investigation Report FT023 (Fire Training Area)* (USAF, 2015b).

Evaluation of MNA parameters in monitoring well 407MW-01 does not indicate a strong reducing, anaerobic environment. This well appears to be outside of the 5µg/L TCE plume boundary, but the COC results do show that upgradient of the site, reductive dechlorination is occurring, indicating that upgradient of the site, anaerobic conditions exist.

A Mann-Kendall trend test was not conducted because results for groundwater monitoring well 407MW-01 were either non-detect or did not exceed the OU4 ROD cleanup goals.

A LUC inspection was performed at FT023 on September 16, 2015, and did not identify any issues except required monitoring well maintenance. Monitoring well FS-52 is missing a bolt for the outer casing. 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 2016. A copy of the 2015 LUC inspection form for Site FT023 is in Appendix B.

Table 3-2 Summary of 2015 Analytical Results at FT023

Analyte	Units	Cleanup Goal[a]	407MW-01
PCE	µg/L	5	ND [0.5]
TCE	µg/L	5	1.14
cis-1,2-DCE	µg/L	70	4.77
Benzene	µg/L	5	ND [0.2]

Notes:

[a] 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).
[ ] = 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 2015 MNA Analytical Results and Field Parameters at FT023

MNA Analytical Parameters								
Monitoring Well ID	**Chloride (mg/L)**	**Sulfate (mg/L)**	**Ethane (µg/L)**	**Ethene (µg/L)**	**Methane (µg/L)**	**Total Nitrate/Nitrite (mg/L)**	**Dissolved Iron (µg/L)**	**Dissolved Manganese (µg/L)**
407MW-01	25	27.2	ND [0.24]	ND [0.22]	ND [0.63]	0.984	932	92.4
MNA Field Parameters								
Monitoring Well ID	**Volume Purged (gallons)**	**Temp (°C)**	**Specific Conductance[a] (mS/cm)**	**DO (mg/L)**	**pH**	**ORP (mV)**	**Turbidity (NTU)**	**Alkalinity (mg/L of $CaCO_3$)**
407MW-01	0.45	9.23	0.746	1.25	6.77	59.5	95.38	360

Notes:

[a] Specific Conductance is a conductivity measurement that has been corrected to 25°C.
[ ] = limit of detection
µg/L = microgram(s) per liter
°C = Celsius
$CaCO_3$ = calcium carbonate
DO = dissolved oxygen
ID = identification
mg/L = milligram(s) per liter
MNA = monitored natural attenuation
mS/cm = milli-Siemen(s) per centimeter
mV = millivolt(s)
NA = not analyzed
ND = non-detect [limit of detection]
NTU = Nephelometric Turbidity Units
ORP = oxidation-reduction potential

3.4 SITE SUMMARY AND RECOMMENDATIONS

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. No recommendations for FT023 were documented in the first and second five-year review periods (USAF, 1998c; USAF, 2003d). The third five-year review report recommended updating 1,2-dichloroethane, PCE, and TCE groundwater cleanup goals to be consistent with the referenced standards (USAF, 2008c). 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. 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). Note: as part of the 2014 LSI, GW-5A was sampled and found to have COC concentrations exceeding ROD cleanup goals.

3.4.2 Recommendations

Site FT023 is identified as a **Yellow** priority since the plume continues to have concentrations of TCE, and cis-1.2-DCE. A vapor intrusion evaluation will be conducted 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 GRO, DRO, residual-range organics (RRO), VOCs, (including 1,4-dioxane) and perfluorinated compounds (USAF, 2015b).

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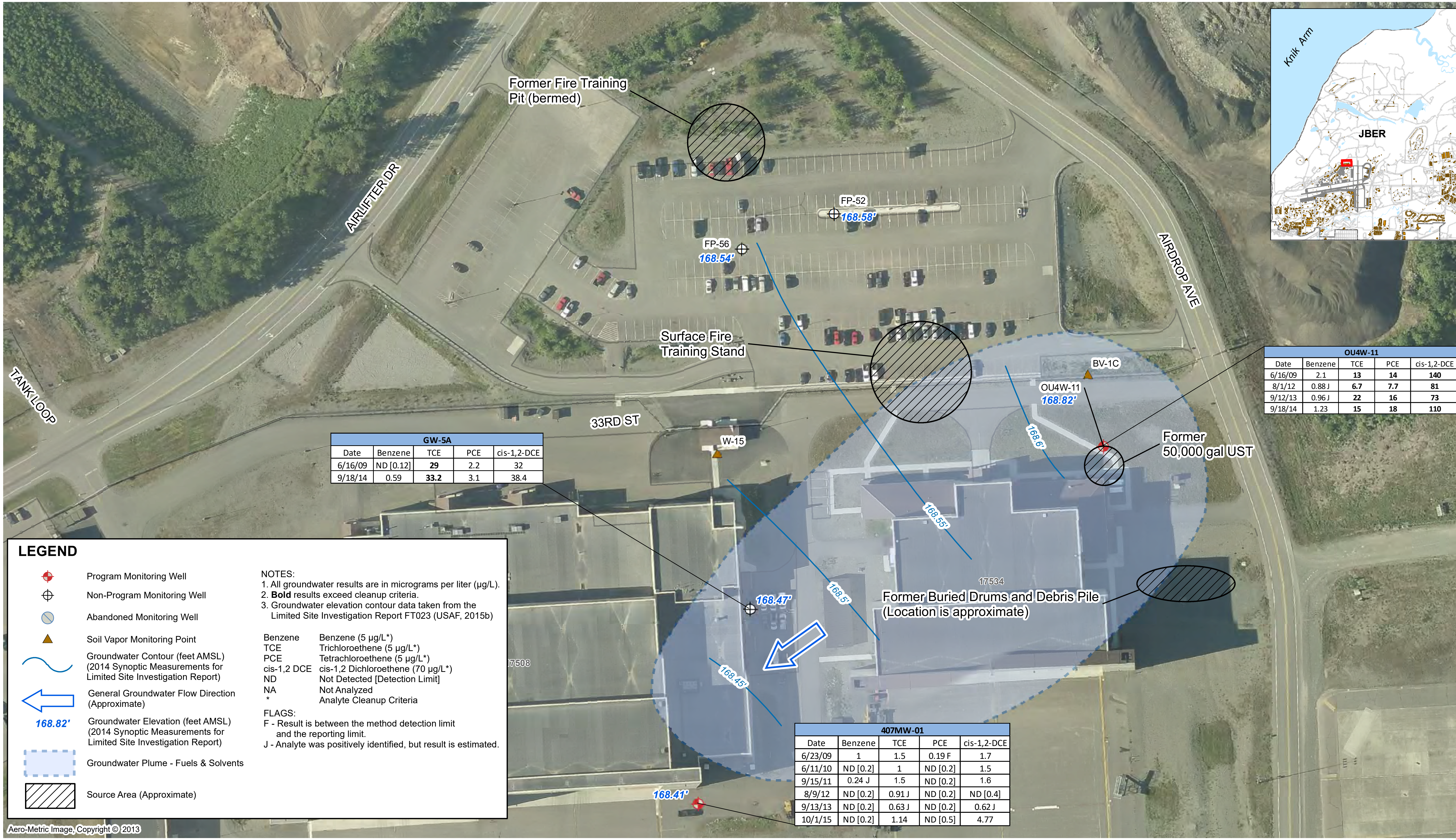

OU4W-11				
Date	Benzene	TCE	PCE	cis-1,2-DCE
6/16/09	2.1	**13**	**14**	**140**
8/1/12	0.88 J	**6.7**	**7.7**	**81**
9/12/13	0.96 J	**22**	**16**	**73**
9/18/14	1.23	**15**	**18**	**110**

GW-5A				
Date	Benzene	TCE	PCE	cis-1,2-DCE
6/16/09	ND [0.12]	**29**	2.2	32
9/18/14	0.59	**33.2**	3.1	38.4

407MW-01				
Date	Benzene	TCE	PCE	cis-1,2-DCE
6/23/09	1	1.5	0.19 F	1.7
6/11/10	ND [0.2]	1	ND [0.2]	1.5
9/15/11	0.24 J	1.5	ND [0.2]	1.6
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)
- 168.82' Groundwater Elevation (feet AMSL) (2014 Synoptic Measurements for Limited Site Investigation Report)
- Groundwater Plume - Fuels & Solvents
- Source Area (Approximate)

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

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 [Detection Limit]
NA	Not Analyzed
*	Analyte Cleanup Criteria

FLAGS:
F - Result is between the method detection limit and the reporting limit.
J - Analyte was positively identified, but result is estimated.

N

0 25 50 100 150 200 Feet

Date: 03 May 2017 Drawn by: SJ K:\PROJECTS\Air_Force\JBER\PBR\LTM\MXDs\2017\2017_JBER_FT023_LTM-01.mxd

FT023 SITE MAP WITH ANALYTICAL DATA

2015 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 LF02 (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. 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 as presented in the I-RACR.

4.3 2015 FIELD ACTIVITIES

A LUC inspection was performed at LF002 on June 6, 2015. During the inspection, it was noted that the inner PVC casing of monitoring well 53WL-05 was frost-jacked and was cut down to fit inside the outer protective casing. A new lock was installed on the outer casing and the well was resurveyed. New construction occurred on the east side of the site, near the Boniface Gate Road. Monitoring well 65WL-04R was decommissioned on 3 September 2015. A copy of the 2015 LUC inspection form for LF002 is in Appendix B. No samples were collected at LF002 in 2015.

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 “Response Complete” (RC). No deficiencies were observed during the LUC inspection in 2015. 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 were no recommendations for LF002 documented during the first and second five-year review period (USAF, 1998c; USAF, 2003d). The third five-year review report recommended one round of groundwater sampling for all contaminants of potential concern (COPCs) and preparation of a site closure report to document RC for LF002 if groundwater met all cleanup goals (USAF, 2008c).

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.

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 will 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 ug/L*)
Thallium (2 ug/L*)

DRO Diesel Range Organics (1,500 ug/L*)
GRO Gasoline Range Organics (2,200 ug/L*)
BEHP bis(2-ehthylexyl)phthlate (6 ug/L*)
MeCl Methylene Chloride (5 ug/L*)
PCA 1,1,2,2-tetrachloroethane (4 ug/L*)
TCE Trichloroethene (5 ug/L*)
TAH Total Aromatic Hydrocarbon (10 ug/L*)
TAqH Total Aqueous Hydrocarbon (15 ug/L*)
ND Not Detected [brackets indicate the MDL for 2008 and earlier, the PQL for 2009, and the LOD for 2010 - 2013].
--- 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 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

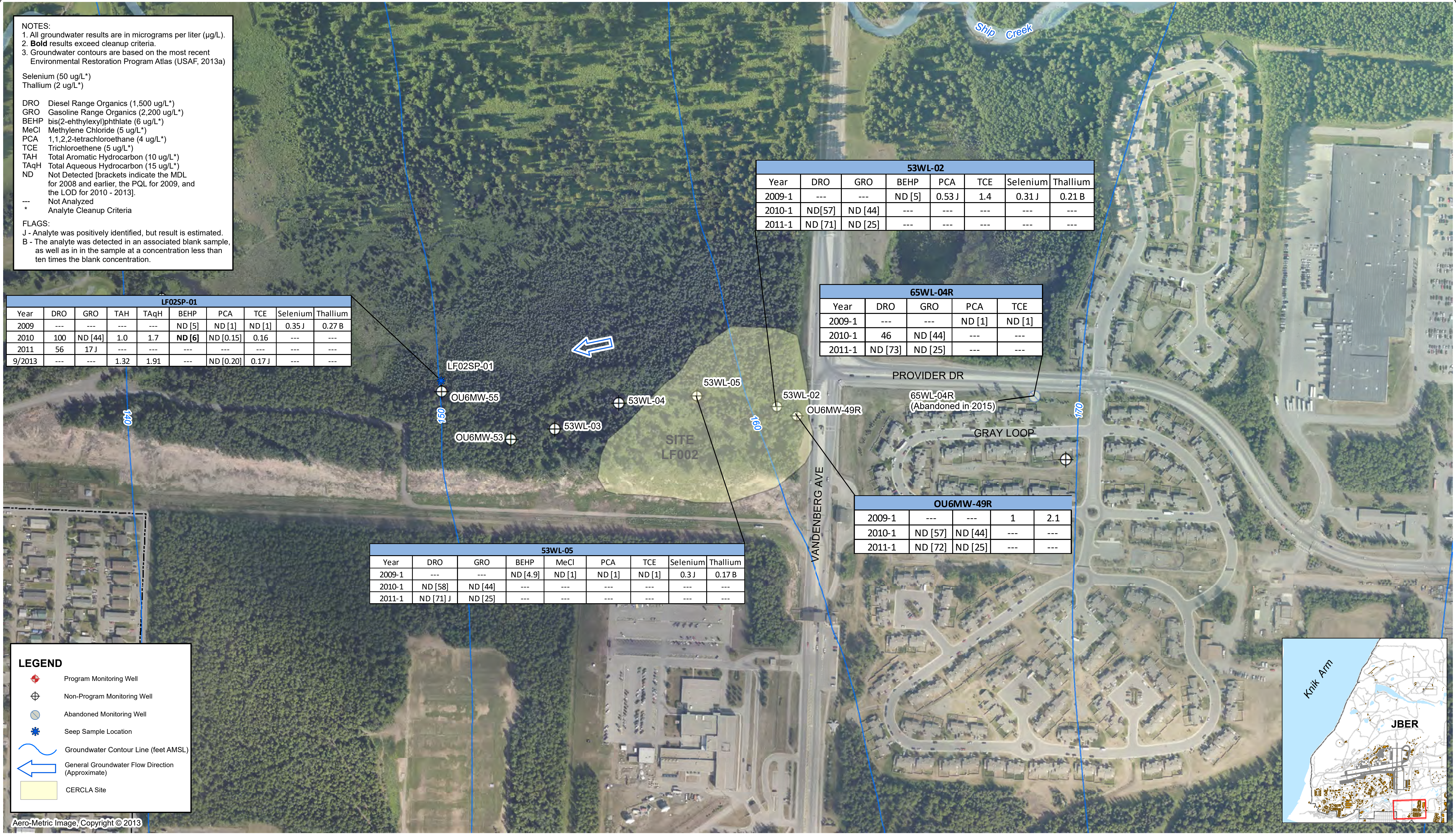
Year	DRO	GRO	PCA	TCE
2009-1	---	---	ND [1]	ND [1]
2010-1	46	ND [44]	---	---
2011-1	ND [73]	ND [25]	---	---

OU6MW-49R

2009-1	---	---	1	2.1
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

N

0 100 200 400 600 Feet

Date: 24 Apr 2017 Drawn by: SJ K:\PROJECTS\Air_Force\JBER\PBR\LTM\MXDs\2017\2017_JBER_LF002_LTM-01.mxd

LF002 SITE MAP WITH ANALYTICAL DATA

2015 Annual Remedial Action – Operations and Monitoring for Select CERCLA Sites
Joint Base Elmendorf-Richardson, Alaska

Figure **4-1**

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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 2015 FIELD ACTIVITIES

A LUC inspection was performed at LF003 on June 15, 2015, and did not identify issues. A copy of the 2015 LUC inspection form for LF003 is in Appendix B.

5.4 SITE SUMMARY AND RECOMMENDATIONS

No deficiencies were observed during the LUC inspection in 2015. 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. As indicated above, no COCs have been identified for LF003. There were no recommendations for LF003 documented during the first five-year review period in 1998, the second five-year review in 2003, or for the third five-year review in 2008 (USAF, 1998c; USAF, 2003d; USAF, 2008c). For 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 is 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. A subsurface seepage collection system and surface drainage swale were constructed at the base of the bluff.

The OU6 ESD defines the boundary between LF004 North/Beach and LF004 South as an east-west line through seep LF04SP-04. 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, and 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 to be 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 report with LF004 South results because they are monitored for LF004 South COCs, as stated in the OU6 ROD.

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, which includes a series of perched aquifers at varied depths. These are collectively called Aquifer 1 and 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 1.12×10^{-3} to 3.59×10^{-5} centimeters per second. Aquifers 1 and 2 have been impacted by contamination 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 COCs. The OU6 ROD included MNA in the selected remedy for groundwater. Current remedial actions at LF004 include periodic groundwater and seep sampling, 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-63 and OU6MW-67 will be in 2016. Monitoring well OU6MW-61 will be sampled next 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 LF04SP-02 to quarterly in 2015 because of a benzene exceedance in 2014. LUCs are in place to prevent access and exposure to contaminated groundwater and soil at the site. Table 6-1 provides the COCs and cleanup goals in groundwater at the site.

Table 6-1 Cleanup Goals in LF004 Groundwater and Seeps

Contaminants of Concern	Cleanup Goal (µg/L)	Monitoring Location	Basis for Cleanup Goal
Benzene	5	OU6MW-61, OU6MW-63, OU6MW-67, LF04SP-02, LF04SP-02DG, LF04SP-03, LF04SP-04	OU6 ROD (USAF, 1997b)
Ethylbenzene	700	LF04SP-02, LF04SP-02DG, LF04SP-03, LF04SP-04	
Toluene	1,000	LF04SP-02, LF04SP-02DG, LF04SP-03, LF04SP-04	
1,2-DCA	5	OU6MW-61, LF04SP-02, LF04SP-02DG, LF04SP-03, LF04SP-04	
Methylene Chloride	5	OU6MW-61, LF04SP-02, LF04SP-02DG, LF04SP-03, LF04SP-04	

Notes:
µg/L = microgram(s) per liter
DCA = dichloroethane
OU = Operable Unit
ROD = Record of Decision
USAF = United States Air Force

6.3 2015 FIELD ACTIVITIES AND RESULTS

In 2015, seep LF04SP-02 and monitoring wells OU6MW-61 and OU6MW-67 were sampled for VOCs and MNA parameters. Samples from seep LF04SP-02 were also analyzed for polycyclic aromatic hydrocarbons (PAHs). The annual debris survey was also conducted. Table 6-2 summarizes the debris removal quantities and is also accompanied by a bar graph. Table 6-3 presents a summary of the 2015 analytical results and Table 6-4 presents a summary of the MNA analytical data and field parameters. The 2015 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 Figure 6-2 and Figure 6-3.

6.3.1 Debris Removal

The annual LF004 debris removal was conducted on August 27, 2015. Less than 100 pounds of material consisting of metal scrap, glass jars and bottles, burnt books and papers, an inner tube, vehicle parts, concrete pieces and wood and particle board were removed. Due to the limited volume of debris, the scale at the landfill could not measure the weight.

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 annual debris removal attend a JBER EOD training class, consisting of identification 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. No potential unexploded ordnance (UXO) was 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 on August 27, 2015. On August 28, 2015, a second beach walk was performed and the debris piles were loaded into a work truck and delivered to the Municipality of Anchorage – Solid Waste Services landfill in Eagle River.

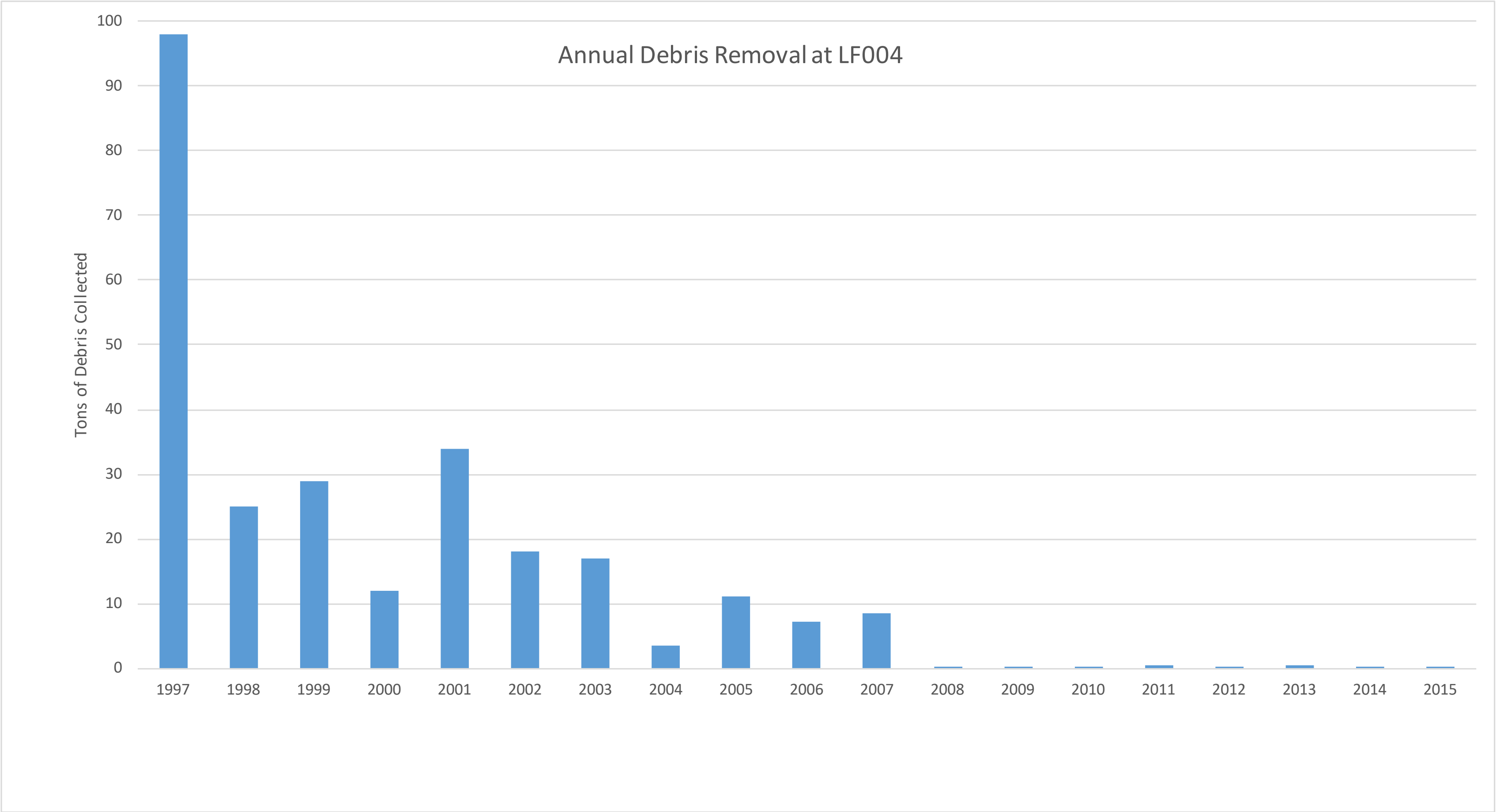
Since the Port of Anchorage expansion in 2007/2008, the quantity of debris recovered has steeply declined to levels below 0.5 ton per year. A debris survey was conducted in 2016. Due to the October 2016 approval of the *2016 Memorandum to the Site File for OU6* modifying the debris survey frequency to once every three years, the next debris survey will be conducted in 2019.. A copy of the debris removal field 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 2015.

Table 6-2 LF004 Debris Removal Summary 1997-2015

Year	Quantity Removed (Tons)	Material Classification	Other Material Removed
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

Notes:

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


Annual Debris Removal at LF004
Tons of Debris Collected
100
90
80
70
60
50
40
30
20
10
0
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015

6.3.2 Groundwater Sampling and LUC Inspection

In 2015, seep LF04SP-02 and monitoring wells OU6MW-61 and OU6MW-67 were sampled for VOCs and MNA parameters. Samples from seep LF04SP-02 were also analyzed for PAHs. Following recommendations from the fourth five-year review, the upgradient monitoring well OU6MW-61 was sampled in 2015. Sampling OU6MW-67 in 2015 is recommended to determine whether benzene concentrations persist above the cleanup level and if a concentration trend is present. Seep LF04SP-02DG, located at the base of the LF004 bluff and downgradient of seep LF04SP-02, was not sampled in 2015 due to an oversight. The realization that LF04SP-02DG was not sampled occurred in 2016 after the 2015 sampling year had ended. Historic results for annual BTEX sampling show these compounds below cleanup levels at LF04SP-02DG. Seep LF04SP-02 was sampled quarterly starting with the second quarter in June, due to an exceedance in the surface water quality and benzene. A field duplicate sample was collected from OU6MW-67 and from Seep LF04SP-02 during the second quarter sampling event. Seeps LF04SP-03 and LF04SP-04 are sampled for site WP014, which is discussed in Section 14.0 of this report.

All samples were analyzed for VOCs, and benzene exceeded the cleanup level (5 µg/L) for each of the quarterly sampling events at LF04SP-02 (5.9, 7.1, and 8.81 µg/L). In addition, benzene exceeded the cleanup level at OU6MW-61 (346 µg/L) and monitoring well OU6MW-67 (5.7 µg/L). The TAH and TAqH levels exceeded the 18 AAC 70 water quality standards (10 and 15 µg/L, respectively) at seep LF04SP-02 for each of the quarterly sampling events.

The evaluation of MNA parameters in monitoring wells OU6MW-61 and OU6MW-67 does not indicate a strong reducing, anaerobic environment. Mann-Kendall trend tests indicated statistically significant decreasing trends at the 95 percent confidence level for ethylbenzene and toluene in monitoring well OU6MW-67. The Mann-Kendall trend tests for benzene in OU6MW-67 and LF04SP-02 show no statistically significant trends. Mann-Kendall Trends are on Figures 6-2 and 6-3.

A LUC inspection performed at LF004 on June 15, 2015, identified two issues: a fence is leaning against OU6MW-46, and an information kiosk is overgrown and blank. It is recommended to clear the vegetation that has grown in front of the kiosk and update the information it contained. It is recommended that the fence be moved away from the monitoring well. A copy of the 2015 LUC inspection form for LF004 is in Appendix B.

Table 6-3 Summary of 2015 Analytical Results at LF004

Analyte	Units	Cleanup Goal[a]	LF04SP-02 (Q2)	LF04SP-02 (Q2)(FD)	LF04SP-02 (Q3)	LF04SP-02 (Q4)	OU6MW-61	OU6MW-67	OU6MW-67 (FD)
Benzene	µg/L	5	**5.81**	**5.85**	**7.06**	**8.81**	**346**	**5.18**	**5.7**
Ethylbenzene	µg/L	700	164	192	122	150	37.1	4.00	4.02
Toluene	µg/L	1,000	ND [0.5]	ND [0.5]	0.5 J	ND [0.5]	36.3	1.61	1.47
1,2-DCA	µg/L	5	ND [0.25]	ND [0.25]	ND [0.25]	ND [0.25]	ND [0.5]	ND [0.5]	ND [0.5]
Methylene Chloride	µg/L	5	ND [2.5]	ND [2.5]	ND [2.5]	ND [2.5]	ND [2.5]	ND [2.5]	ND [2.5]
TAH[b]	µg/L	10	**429**	**491**	**356**	**293**	--	--	--
TAqH[b]	µg/L	15	**442**	**502**	--[c]	**301**	--	--	--

Notes:

[a] Cleanup levels as cited in the OU6 ROD (USAF, 1997b).
[b] Water quality standards (18 AAC 75) for TAH and TAqH are 10 µg/L and 15 µg/L, respectively.
[c] TAqH calculations were not conducted because PAHs were not collected.
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
ND = non-detect [limit of detection]
DCA = dichloroethane
PAH = polycyclic aromatic hydrocarbons
FD = field duplicate
Q = Quarter
TAH = total aromatic hydrocarbons
TAqH = total aqueous hydrocarbons

Table 6-4 Summary of 2015 MNA Analytical and Field Parameters at LF004

MNA Analytical Parameters								
Monitoring Well ID	Chloride (mg/L)	Sulfate (mg/L)	Ethane (µg/L)	Ethene (µg/L)	Methane (µg/L)	Total Nitrate/Nitrite (mg/L)	Dissolved Iron (µg/L)	Dissolved Manganese (µg/L)
OU6MW-61	6.47 J	9.95	ND [0.24]	1.6	0.55 J	ND [0.05]	7,560	3,650
OU6MW-67	9.96 J	0.096 J	ND [0.24]	1.5	220	ND [0.05]	13,100	6,810
OU6MW-67 FD	10 J	0.1 J	0.50 J	3.7	370	ND [0.05]	12,200	6,840
MNA Field Parameters								
Monitoring Well ID	Volume Purged (gallons)	Temp (°C)	Specific Conductance[b] (mS/cm)	DO (mg/L)	pH	ORP (mV)	Turbidity (NTU)	Alkalinity (mg/L of $CaCO_3$)
OU6MW-61[a]	4.5	6.70	0.984	4.33	6.65	-22.1	83.44	560
OU6MW-67	4.0	7.25	0.722	3.99	6.03	18.4	4.05	260

Notes:

[a] Well purged dry, grab sample collected the following day; water level measurement collected prior to purging.
[b] Specific Conductance is a conductivity measurement that has been corrected to 25°C.
[ ] = 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
°C = Celsius
mV = millivolts
$CaCO_3$ = calcium carbonate
ND = non-detect [limit of detection]
DO = dissolved oxygen
NTU = Nephelometric Turbidity Units
FD = field duplicate
ORP = oxidation-reduction potential
ID = identification
mg/L = milligram(s) per liter
mS/cm = milli-Siemens per centimeter

Table 6-5 Summary of 2015 Mann-Kendall Concentration Trends for Select Wells and Seeps at LF04

Monitoring Well or Seep ID	Benzene	Ethylbenzene	Toluene	TAH	TAqH
LF04SP-02	NST	NE	NE	NST	NST
OU6MW-67	NST	Decreasing	Decreasing	--	--

Notes:
ID = identification
NE = no exceedance of cleanup goal in 2015
NST = no significant trend

6.4 SITE SUMMARY AND RECOMMENDATIONS

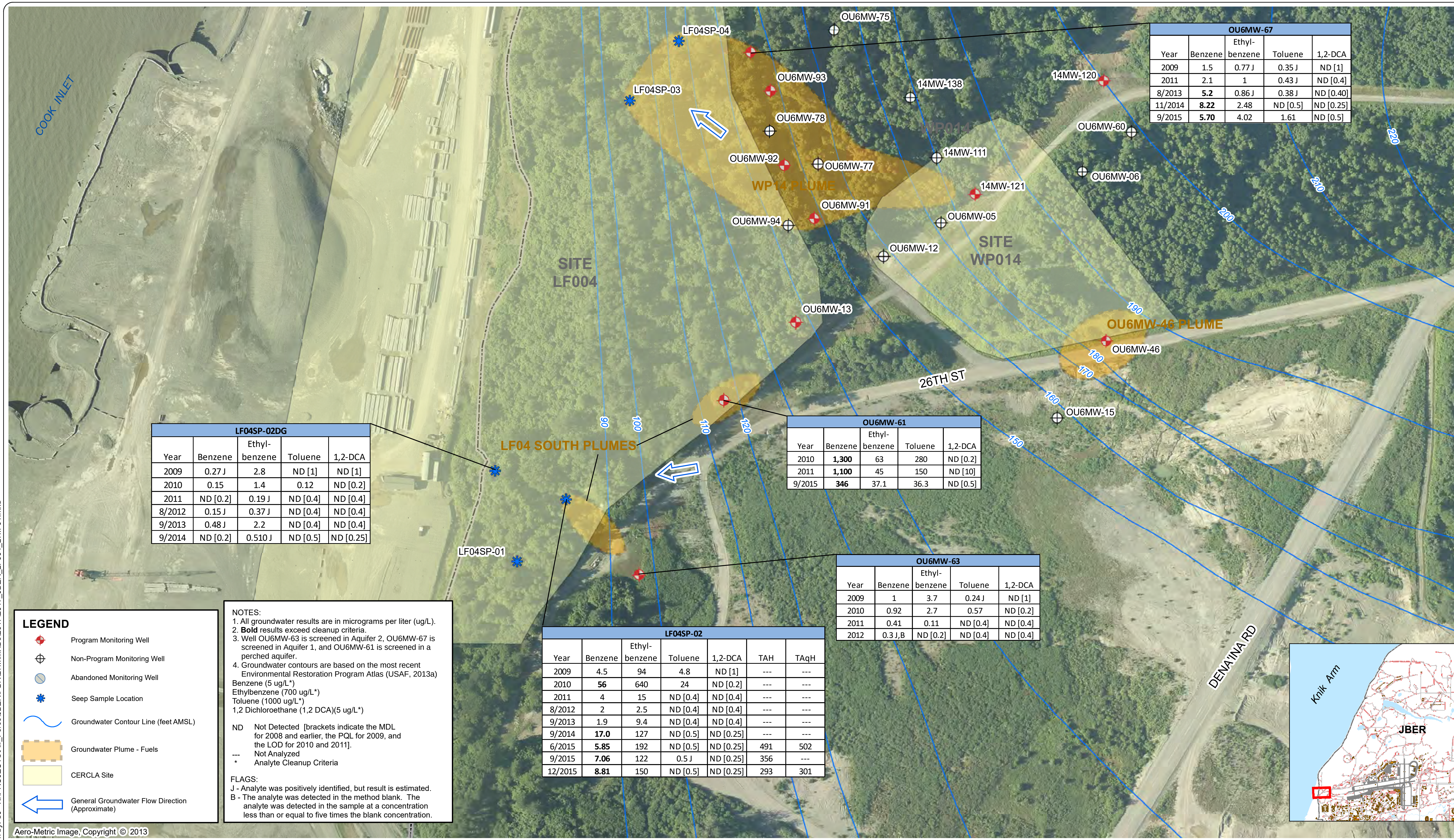
Benzene concentrations at seep LF04SP-02 and monitoring wells OU6MW-67 and OU6MW-61 continue to exceed the 5 µg/L cleanup level. Due to elevated benzene and ethylbenzene concentrations, the TAH and TAqH levels exceeded the 18 AAC 70 water quality standards at LF04SP-02.

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 were no recommendations for LF004 documented during the first five-year review period in 1998, or for the second five-year review in 2003 (USAF, 1998c; USAF, 2003d). The third five-year review report recommended continuation of groundwater monitoring and evaluation of LF004 South in accordance with the OU6 ROD, and sampling of OU6MW-61 to determine whether LF004 South groundwater met cleanup goals for chlorinated solvent COCs (USAF, 2008c). The fourth five-year review report recommended performing remedial process optimization 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 surface water quality standards. If the seeps are not meeting water quality standards, fuel-related compounds DRO and GRO in upgradient wells are to be analyzed to predict when and if the LF004 seeps will meet surface water quality standards (USAF, 2014c).

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). Following recommendations from the fourth five-year review, sampling of both OU6-MW61 and OU6MW-63 for GRO and DRO is recommended. It is also recommended that LUC inspections continue until the site reaches RC.



OU6MW-67				
Year	Benzene	Ethyl-benzene	Toluene	1,2-DCA
2009	1.5	0.77 J	0.35 J	ND [1]
2011	2.1	1	0.43 J	ND [0.4]
8/2013	**5.2**	0.86 J	0.38 J	ND [0.40]
11/2014	**8.22**	2.48	ND [0.5]	ND [0.25]
9/2015	**5.70**	4.02	1.61	ND [0.5]

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

LF04SP-02DG				
Year	Benzene	Ethyl-benzene	Toluene	1,2-DCA
2009	0.27 J	2.8	ND [1]	ND [1]
2010	0.15	1.4	0.12	ND [0.2]
2011	ND [0.2]	0.19 J	ND [0.4]	ND [0.4]
8/2012	0.15 J	0.37 J	ND [0.4]	ND [0.4]
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 [0.25]

OU6MW-63				
Year	Benzene	Ethyl-benzene	Toluene	1,2-DCA
2009	1	3.7	0.24 J	ND [1]
2010	0.92	2.7	0.57	ND [0.2]
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]

LF04SP-02						
Year	Benzene	Ethyl-benzene	Toluene	1,2-DCA	TAH	TAqH
2009	4.5	94	4.8	ND [1]	---	---
2010	**56**	640	24	ND [0.2]	---	---
2011	4	15	ND [0.4]	ND [0.4]	---	---
8/2012	2	2.5	ND [0.4]	ND [0.4]	---	---
9/2013	1.9	9.4	ND [0.4]	ND [0.4]	---	---
9/2014	**17.0**	127	ND [0.5]	ND [0.25]	---	---
6/2015	**5.85**	192	ND [0.5]	ND [0.25]	491	502
9/2015	**7.06**	122	0.5 J	ND [0.25]	356	---
12/2015	**8.81**	150	ND [0.5]	ND [0.25]	293	301

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:
1. All groundwater results are in micrograms per liter (ug/L).
2. **Bold** results exceed cleanup criteria.
3. Well OU6MW-63 is screened in Aquifer 2, OU6MW-67 is screened in Aquifer 1, and OU6MW-61 is screened in a perched aquifer.
4. 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 [brackets indicate the MDL for 2008 and earlier, the PQL for 2009, and the LOD for 2010 and 2011].
--- 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.

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N

0 50 100 200 300 Feet

673d AIR BASE WING

AIR FORCE CIVIL ENGINEER CENTER

LF004 SITE MAP WITH ANALYTICAL DATA

2015 Annual Remedial Action – Operations and Monitoring for Select CERCLA Sites
Joint Base Elmendorf-Richardson, Alaska

Figure 6-1

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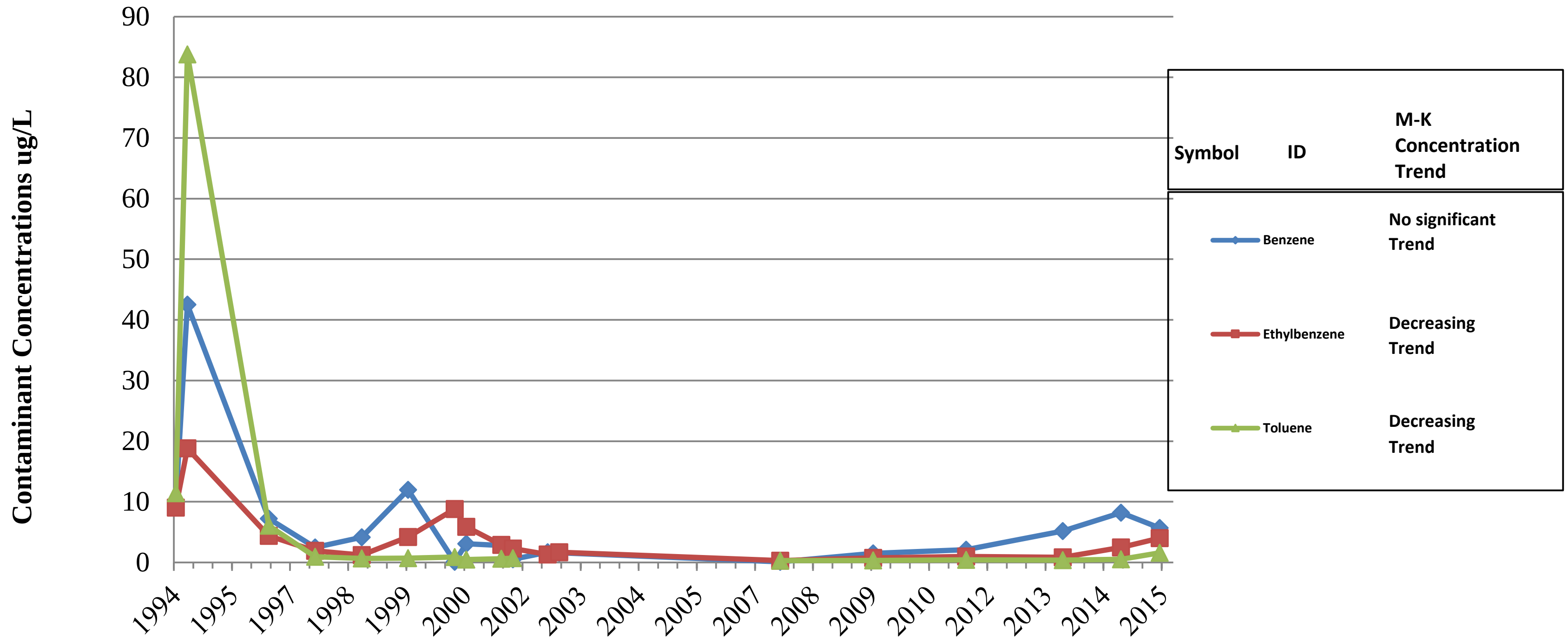

Cleanup Levels
Benzene = 5 µg/L
Ethylbenzene = 700 µg/L
Toluene = 1,000 µg/L

LF004 CONTAMINANT TRENDS IN OU6MW-67

2015 Annul RA-O and Monitoring Report, Select CERCLA Sites
Joint Base Elmendorf-Richardson, Alaska

Figure
6-2

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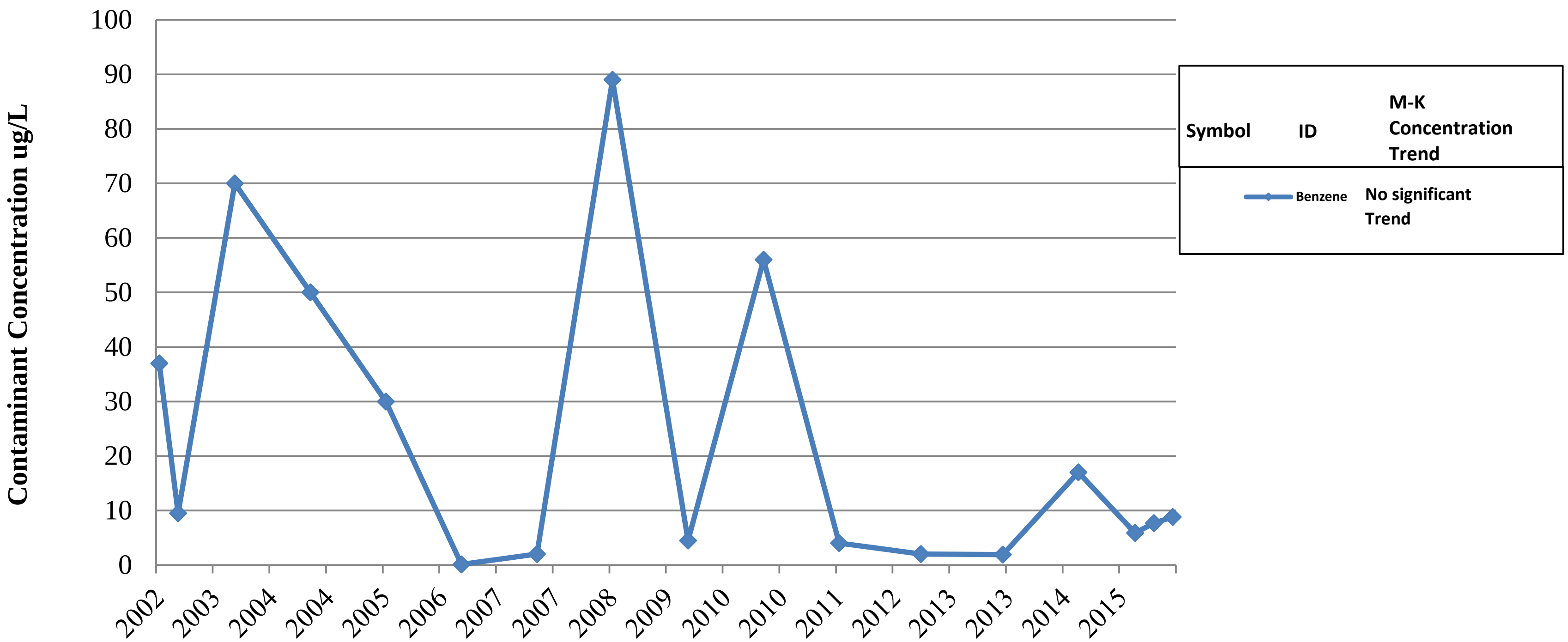

Cleanup Level
Benzene = 5 µg/L

LF004 BENZENE TREND IN LF04SP-02

2015 Annul 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 1st Street 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 2016.

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. An annual LUC inspection is in place to prevent access and exposure to contaminated groundwater and soil at the site.

7.3 2015 FIELD ACTIVITIES AND RESULTS

A LUC inspection was performed at LF059 on September 15, 2015. During the inspection the outer casing lid that was found to be missing, was found and secured on LF59MW-04, the monitoring well is in proper condition. In addition, LF59MW-07 and LF59MW-08 were relabeled. Monitoring well LF59MW-05 was identified as needing re-labeling by the 2014 inspection, but the well was actually properly labeled. A copy of the 2015 LUC inspection form for LF059 is in Appendix B. Historical results are in Appendix C.

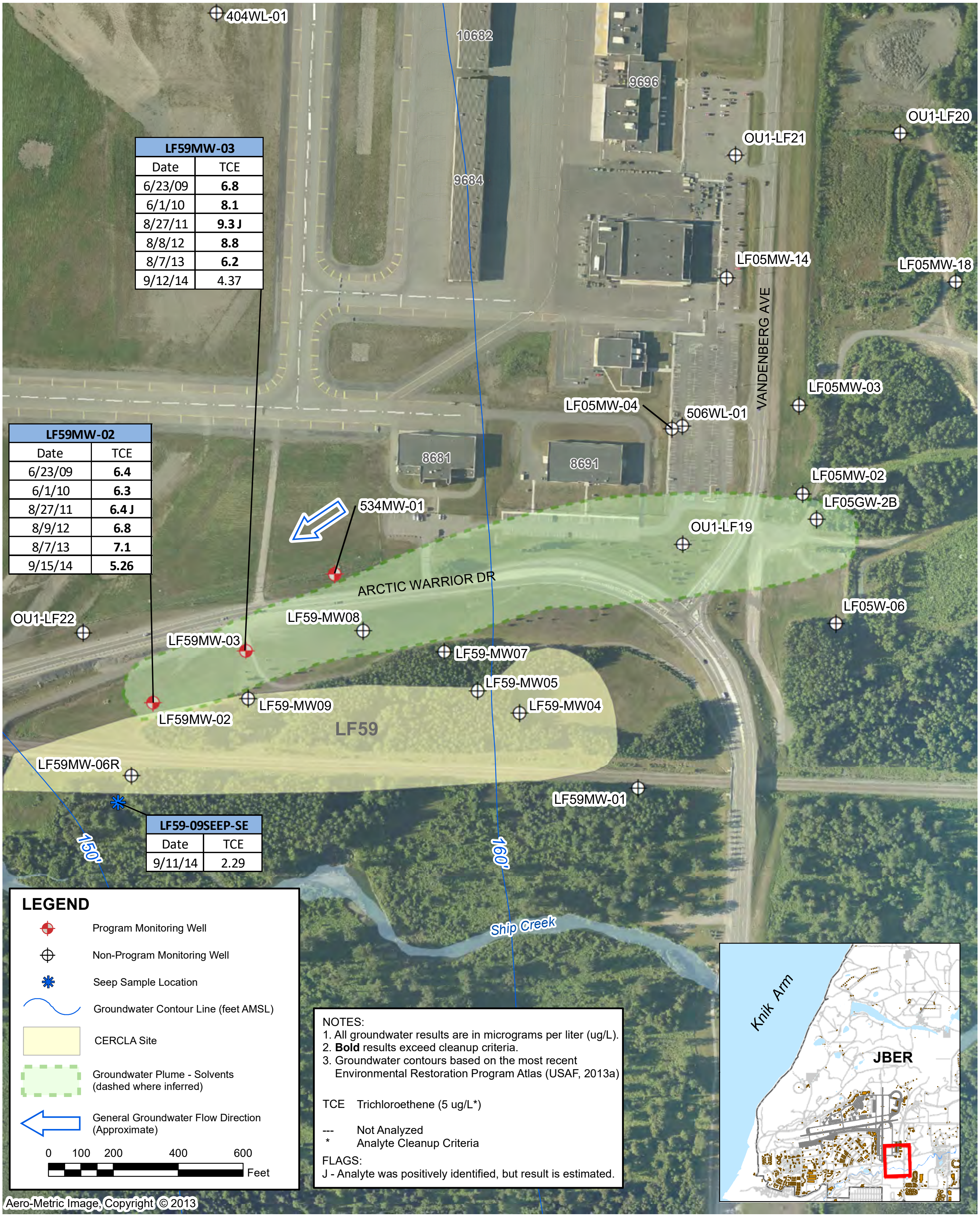
7.4 SITE SUMMARY AND RECOMMENDATIONS

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 were no recommendations for LF059 documented during the first five-year review period in 1998, or for the second five-year review in 2003 (USAF, 1998c; USAF, 2003d). The third five-year review report recommended incorporating data from upgradient monitoring wells LF05GW-2B and OU1LF-19 into the evaluation of natural attenuation and analysis of contaminant trends, and updating the conceptual site model for the TCE plume (USAF, 2008c). 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).

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. Pursuit of a RC for LF059 is recommended. An I-RACR is in the process of being prepared, and should be submitted in 2016. It is recommended to transfer monitoring wells at this site (LF59MW-02 and LF59MW-03) to the new site and become program wells as appropriate.



LF59MW-03

Date	TCE
6/23/09	**6.8**
6/1/10	**8.1**
8/27/11	**9.3 J**
8/8/12	**8.8**
8/7/13	**6.2**
9/12/14	4.37

LF59MW-02

Date	TCE
6/23/09	**6.4**
6/1/10	**6.3**
8/27/11	**6.4 J**
8/9/12	**6.8**
8/7/13	**7.1**
9/15/14	**5.26**

LF59-09SEEP-SE

Date	TCE
9/11/14	2.29

N

LF059 SITE MAP WITH ANALYTICAL DATA

2015 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 current 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. Reinjected 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 the COCs and cleanup goals in groundwater at the site.

Table 8-1 Cleanup Goals in Groundwater at SD015

Contaminant of Concern	Cleanup Goal (µg/L)	Basis for Cleanup Goal
TCE	5	OU6 ROD (USAF, 1997b)
Benzene	5	

Notes:
µg/L = microgram(s) per liter
OU = Operable Unit
ROD = Record of Decision
TCE = trichloroethene
USAF = United States Air Force

8.3 2015 FIELD ACTIVITIES AND RESULTS

During 2015, monitoring well OU6MW-17 was sampled for VOCs and MNA parameters. Analytical laboratory results for TCE (8.74 µg/L) and benzene (72 µg/L) exceeded the cleanup levels. Table 8-2 presents a summary of the 2015 analytical results and Table 8-3 presents the 2015 MNA analytical data and field parameters at SD015. The 2015 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 contaminant trend graph for OU6MW-17 is on Figure 8-2.

A groundwater level measurement was collected at SD015 from monitoring well OU6MW-17 (46.00 feet below top of casing) during the time of sampling. Due to an oversight, a groundwater elevation was not collected from monitoring well OU6MW-90.

Biogeochemical indicator parameters measured in the field indicate a mildly aerobic (oxidizing) environment at well OU6MW-17. These are typical at a POL plume undergoing biodegradation as aerobic bacteria degrade the POL contaminants and consume the available oxygen. The rate of petroleum hydrocarbon degradation under aerobic conditions is faster than the rate observed in an anaerobic environment. The biogeochemical environment at monitoring well OU6MW-17 is relatively conducive to aerobic of benzene, and it may be occurring a low rates.

In contrast to the indication of an aerobic environment and the low potential for reductive dechlorination for TCE, the Mann-Kendall trend test for TCE in monitoring well OU6MW-17 indicated a statistically significant decreasing trend at the 95 percent confidence level. No statistically significant trend was identified for benzene in well OU6MW-17. Figure 8-2 presents Mann-Kendall Trend test for well OU6MW-17.

A LUC inspection was performed at SD015 on 15 June 2015 and did not identify any issues. A copy of the 2015 LUC inspection form for SD015 is in Appendix B.

Table 8-2 Summary of 2015 Analytical Results at SD015

Analyte	Units	Cleanup Goal[a]	OU6MW-17
TCE	µg/L	5	**8.47**
Benzene	µg/L	5	**72**

Notes:
[a] 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 2015 MNA Analytical and Field Parameters at SD015

MNA Analytical Parameters								
Monitoring Well ID	Chloride (mg/L)	Sulfate (mg/L)	Ethane (µg/L)	Ethene (µg/L)	Methane (µg/L)	Total Nitrate/Nitrite (mg/L)	Dissolved Iron (µg/L)	Dissolved Manganese (µg/L)
OU6MW-17	3.41	8.44	ND [0.24]	0.63 J	4.6	ND [0.05]	13,600	5,080
MNA Field Parameters								
Monitoring Well ID	Volume Purged (gallons)	Temp (°C)	Specific Conductance[a] (mS/cm)	DO (mg/L)	pH	ORP (mV)	Turbidity (NTU)	Alkalinity (mg/L of $CaCO_3$)
OU6MW-17	3.4	5.78	0.776	1.53	6.02	16.1	61.75	460

Notes:
[a] Specific Conductance is a conductivity measurement that has been corrected to 25°C.
[ ] = limit of detection
µg/L = microgram(s) per liter
°C = Celsius
$CaCO_3$ = calcium carbonate
DO = dissolved oxygen
ID = identification
mg/L = milligram(s) per liter
mV = millivolts
mS/cm = milli-Siemen(s) per centimeter
NA = not analyzed
ND = non-detect [limit of detection]
NTU = Nephelometric Turbidity Units
ORP = oxidation-reduction potential

Table 8-4 Summary of 2015 Mann-Kendall Concentration Trends for Select Wells at SD015

Monitoring Well ID	Benzene	TCE
OU6MW-17	NST	Decreasing

Notes:
ID = identification
NST = no significant trend
TCE = trichloroethene

8.4 SITE SUMMARY AND RECOMMENDATIONS

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 were no recommendations for SD015 documented during the first five-year review period (USAF, 1998c). The second five-year review report recommended modification to the existing HVE system configuration to include SVE in shallow soils, minimize vacuum to deep soils, and increase groundwater extraction and HVE wells that exceed remediation goals (USAF, 2003d). Consistent with the 2007 ESD, the third five-year review report recommended an MNA remedy for the perched aquifer and use of trend analysis in order to evaluate the remedy and revise estimated dates for achieving cleanup goals (USAF, 2008c). 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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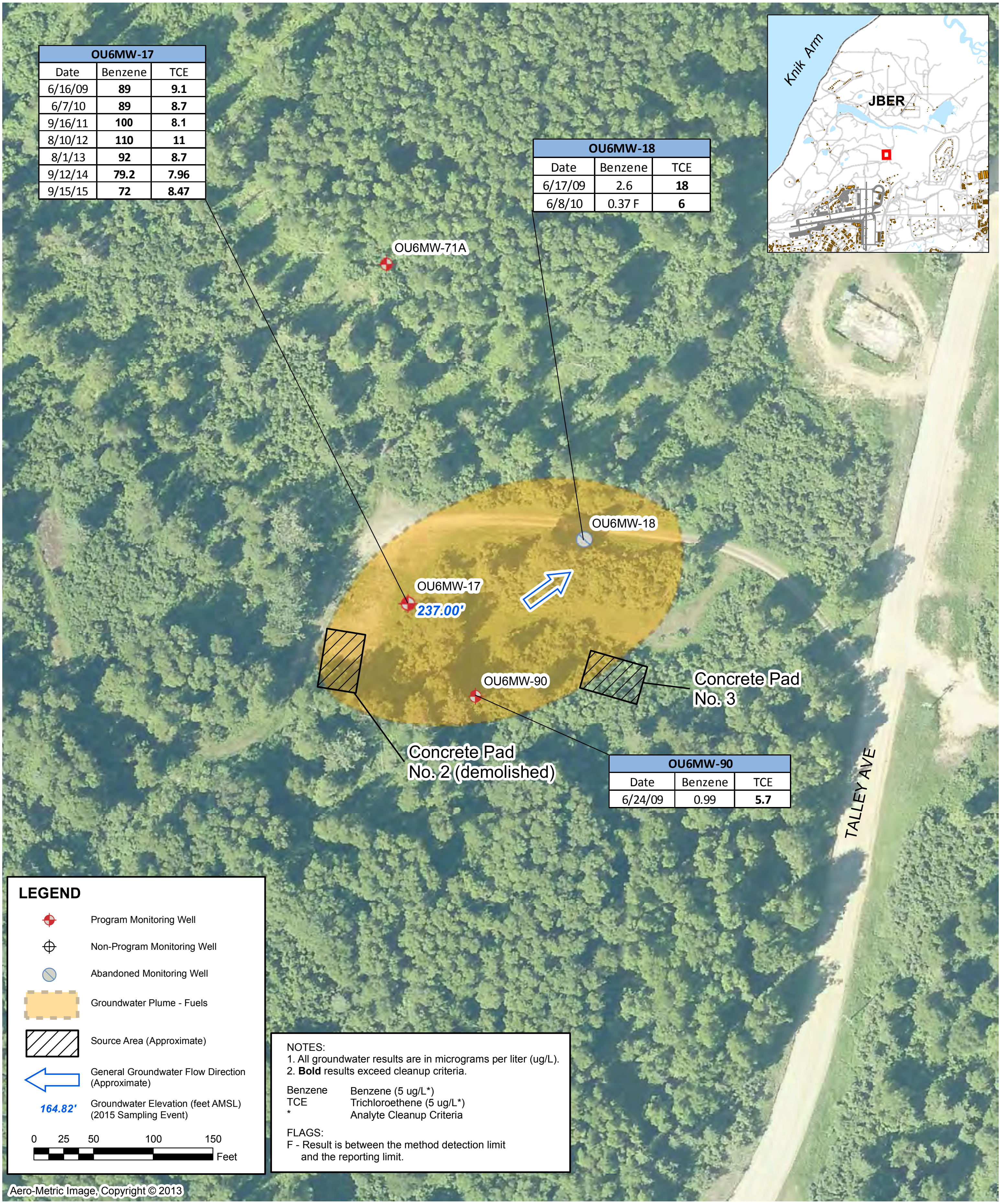

OU6MW-17		
Date	Benzene	TCE
6/16/09	**89**	**9.1**
6/7/10	**89**	**8.7**
9/16/11	**100**	**8.1**
8/10/12	**110**	**11**
8/1/13	**92**	**8.7**
9/12/14	**79.2**	**7.96**
9/15/15	**72**	**8.47**

OU6MW-18		
Date	Benzene	TCE
6/17/09	2.6	**18**
6/8/10	0.37 F	**6**

OU6MW-90		
Date	Benzene	TCE
6/24/09	0.99	**5.7**

LEGEND

- Program Monitoring Well
- Non-Program Monitoring Well
- Abandoned Monitoring Well
- Groundwater Plume - Fuels
- Source Area (Approximate)
- General Groundwater Flow Direction (Approximate)
- *164.82'* Groundwater Elevation (feet AMSL) (2015 Sampling Event)

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	Benzene (5 ug/L*)
TCE	Trichloroethene (5 ug/L*)
*	Analyte Cleanup Criteria

FLAGS:
F - Result is between the method detection limit and the reporting limit.

Date: 29 Aug 2016 Drawn by: SJ K:\PROJECTS\Air_Force\JBER\PBR\LTM\MXDs\2016\2016_JBER_SD015_RAOM-01.mxd

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SD015 SITE MAP WITH ANALYTICAL DATA

2015 Annual Remedial Action – Operations and Monitoring for Select CERCLA Sites
Joint Base Elmendorf-Richardson, Alaska

Figure 8-1

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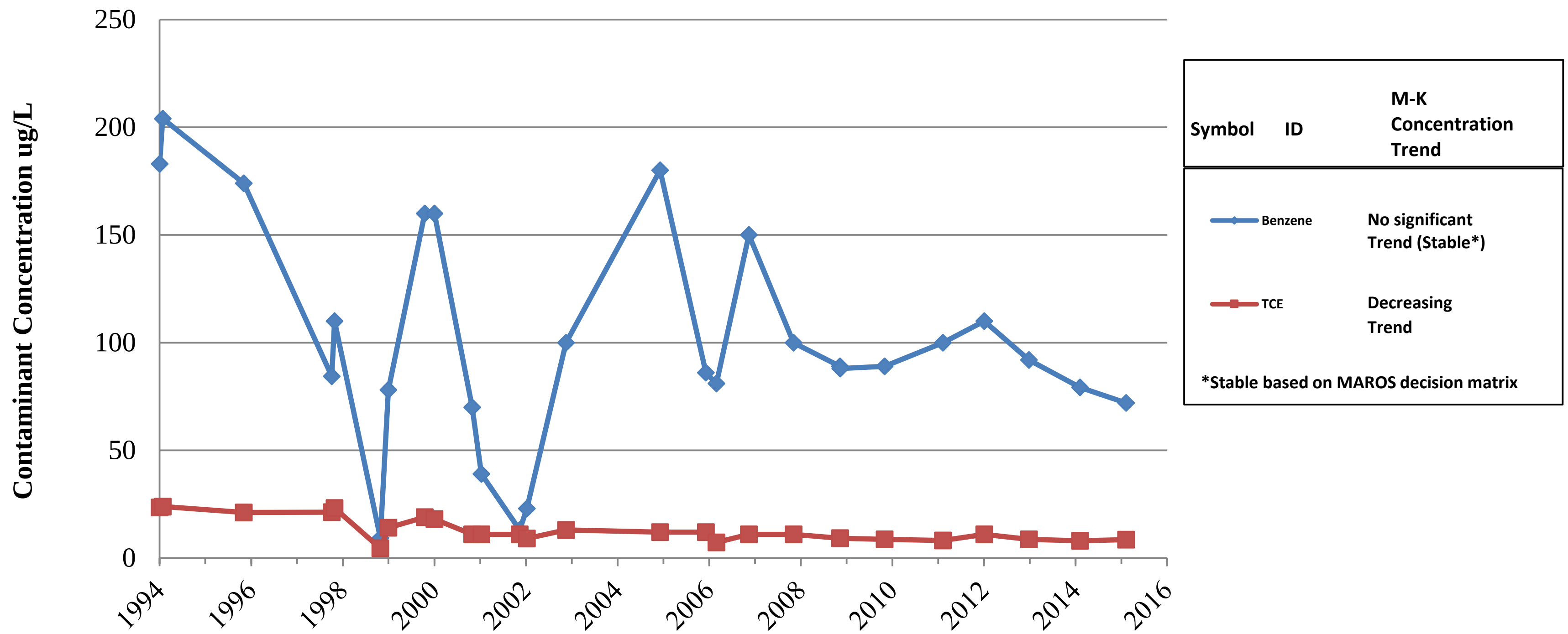

Cleanup Levels
Benzene = 5 µg/L
TCE = 5 µg/L

SD015 CONTAMINANT TRENDS IN OU6MW-17

2015 Annul RA-O and Monitoring Report, Select CERCLA Sites
Joint Base Elmendorf-Richardson, Alaska

Figure
8-2

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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 toward the southwest, the formation becomes shallower. At Hangar 8, this unit 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 2015 FIELD ACTIVITIES AND RESULTS

A LUC inspection was performed at SD024 on August 12, 2015, and did not identify any issues. A copy of the 2015 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 were no recommendations for SD024 documented during the first five-year review period (USAF, 1998c). Site SD024 groundwater results for benzene indicated intrinsic remediation was occurring. Consistent with the 2002 Annual Report (USAF, 2003f) and OU4 Memorandum to the Site File (USAF, 2003c), the second five-year review report recommended decreasing the frequency of sampling at the in-plume monitoring well OU4MW-04 to once every 5 years (USAF, 2003d). The third five-year review report recommended increasing the frequency of sampling at monitoring well OU4MW-04 at SD024 to document attainment of cleanup goals (USAF, 2008c). 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 (RAOs) 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.

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OU4MW-04	
Date	Benzene
6/17/09	**6.2 J**
6/11/10	4.2
9/22/11	1.4
8/14/12	3.3

LEGEND

- Program Monitoring Well
- Non-Program Monitoring Well
- Source Area (Approximate)
- CERCLA Site
- General Groundwater Flow Direction (Approximate)

0 50 100 200 300 Feet

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

Benzene — Benzene (5 ug/L*)
* — Analyte Cleanup Criteria

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

N

SD024 SITE MAP WITH ANALYTICAL DATA

2015 Annual Remedial Action – Operations and Monitoring for Select CERCLA Sites
Joint Base Elmendorf-Richardson, Alaska

Figure **9-1**

Date: 14 Dec 2016 Drawn by: SJ K:\PROJECTS\Air_Force\JBER\PBRLTMMXDs\2016\2016_JBER_SD024_RAOM-01.mxd

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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 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 is 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 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 was 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 the COCs and cleanup goals in groundwater at the site.

Table 10-1 Cleanup Goals in Groundwater at SD025

Contaminant of Concern	Cleanup Goal (μg/L)	Basis for Cleanup Goal
Benzene	5	OU4 ROD (USAF,1995b)
Ethylbenzene	700	
Toluene	1,000	

Notes:
μg/L = micrograms per liter
OU – Operable Unit
ROD = Record of Decision
USAF – United States Air Force

10.3 2015 FIELD ACTIVITIES AND RESULTS

During 2015, monitoring well OU4MW-08R was sampled for benzene, toluene, ethylbenzene, total xylenes (BTEX) and MNA parameters. The concentration of benzene, ethylbenzene and toluene exceeded the cleanup goals. Table 10-2 presents a summary of analytical results and Table 10-3 presents the summary of the MNA analytical and field parameters. The 2015 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 10-4. The Mann-Kendall contaminant trend graph for OU4MW-08R is on Figure 10-2.

The results of biogeochemical indicator parameters measured from OU4MW-08R indicate an anaerobic, reducing environment. The rate of petroleum hydrocarbon degradation under anaerobic conditions is slower than the rate typically observed in an aerobic environment. Degradation rates for benzene and other petroleum hydrocarbon constituents are often significant in aerobic environments.

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 the well were below OU4 ROD cleanup goals, which was inconsistent with previous rounds of sampling. In 2014 and 2015, analytical results again exceeded cleanup goals.

The Mann-Kendall trend test for benzene in well OU4MW-08R indicated a statistically significant decreasing trend at the 95 percent confidence level. No statistically significant trends were identified for ethylbenzene or toluene in monitoring well OU4MW-08R.The 2013 groundwater results were excluded from the Mann-Kendall analysis because the data are considered anomalous and do not represent site conditions.

A LUC inspection was performed at SD025 on 12 August 2015 and did not identify any issues at the site. A copy of the 2015 LUC inspection form for SD025 is in Appendix B.

Table 10-2 Summary of 2015 Analytical Results at SD025

Analyte	Units	Cleanup Goal[a]	OU4MW-08R
Benzene	µg/L	5	**33.2**
Ethylbenzene	µg/L	700	**1,110**
Toluene	µg/L	1,000	**7,040**

Notes:

[a] Cleanup levels as cited in the OU4 ROD (USAF, 1995b).
Bold result exceeds cleanup level.
µg/L = micrograms per liter

Table 10-3 Summary of 2015 MNA Analytical and Field Parameters at SD025

MNA Analytical Parameters								
Monitoring Well ID	**Chloride (mg/L)**	**Sulfate (mg/L)**	**Ethane (μg/L)**	**Ethene (μg/L)**	**Methane (μg/L)**	**Total Nitrate/Nitrite (mg/L)**	**Dissolved Iron (μg/L)**	**Dissolved Manganese (μg/L)**
OU4MW-08R	31.7 J	0.2 J	ND [0.24]	0.26 J	220	ND [0.05]	52,000	8,030
MNA Field Parameters								
Monitoring Well ID	**Volume Purged (gallons)**	**Temp (C)**	**Specific Conductance[a] (mS/cm)**	**DO (mg/L)**	**pH**	**ORP (mV)**	**Turbidity (NTU)**	**Alkalinity (mg/L of $CaCO_3$)**
OU4MW-08R	3.8	7.71	1.102	0.80	5.98	7.5	6.25	360

Notes:
[a] Specific Conductance is a conductivity measurement that has been corrected to 25°C.
[ ] = limit of detection (LOD)
μg/L = microgram(s) per liter
C = Celsius
$CaCO_3$ = calcium carbonate
DO = dissolved oxygen
ID = identification
mg/L = milligram per liter
mV = millivolts
mS/cm = milli-Siemens per centimeter
NA = not analyzed
ND = non-detect [limit of detection]
NTU = Nephelometric Turbidity Units
ORP = oxidation-reduction potential

Table 10-4 Summary of 2015 Mann-Kendall Concentration Trends for Select Wells at SD025

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

Notes:
NST = no significant trend

10.4 SITE SUMMARY AND RECOMMENDATIONS

In 2013 and 2014, site characterization activities outside of annual LTM activities were conducted at the SD025 site to evaluate potential risks to human health and the environment in order to advance toward site closure. Results and recommendations will be presented in the *SD025 – Bldg 16430 Floor Drains Site Characterization Report* to be finalized in 2017.

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 were no recommendations for SD025 documented during the first five-year review period (USAF, 1998c). The second five-year report recommended decommissioning and closure of the bioventing system at the site because residential soil cleanup goals had been reached (USAF, 2003d). The third five-year review report recommended updating DRO and GRO soil cleanup goals in the OU4 ROD to be consistent with the referenced standards and use of trend analysis in order to evaluate the remedy and revise estimated dates for achieving cleanup goals (USAF, 2008c). 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). JBER is currently conducting a vapor intrusion investigation, in which SD025 is included; results will be presented under a separate cover.

10.4.2 Recommendations

Site SD025 is identified as a **Yellow** priority because site COCs are above cleanup goals. There are no recommended changes to the current LTM approach for this site. The site priority and recommendations will be updated once the *SD025 – Bldg 16430 Floor Drains Site Characterization Report* is final.

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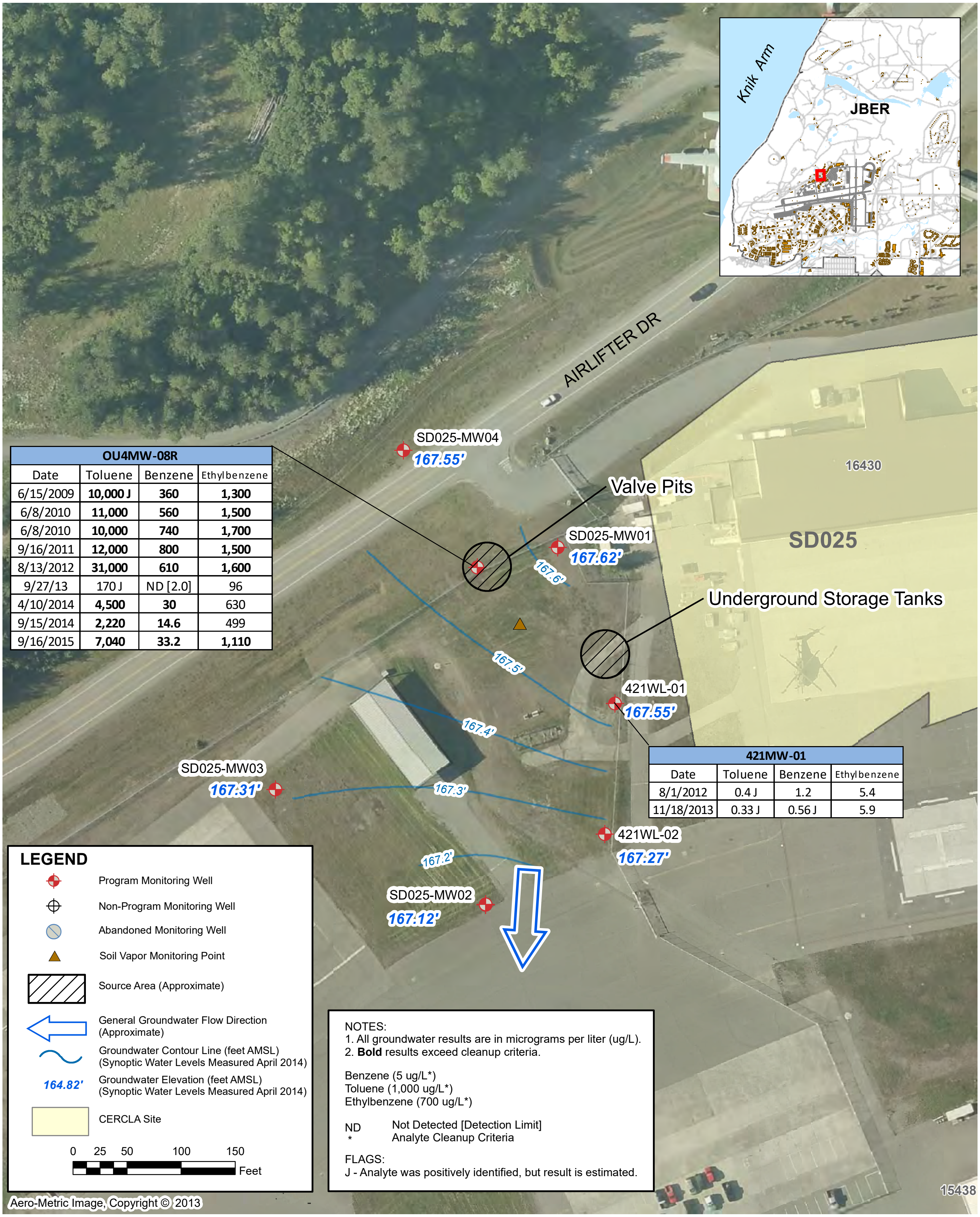

OU4MW-08R			
Date	Toluene	Benzene	Ethylbenzene
6/15/2009	**10,000 J**	**360**	**1,300**
6/8/2010	**11,000**	**560**	**1,500**
6/8/2010	**10,000**	**740**	**1,700**
9/16/2011	**12,000**	**800**	**1,500**
8/13/2012	**31,000**	**610**	**1,600**
9/27/13	170 J	ND [2.0]	96
4/10/2014	**4,500**	**30**	630
9/15/2014	**2,220**	**14.6**	499
9/16/2015	**7,040**	**33.2**	**1,110**

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

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)
- 164.82' 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 [Detection Limit]
* Analyte Cleanup Criteria

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

Date: 04 May 2017 Drawn by: SJ K:\PROJECTS\Air_Force\JBER\PBRLTM\MXDs\2016\2016_JBER_SD025_RAOM-01.mxd

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SD025 SITE MAP WITH ANALYTICAL DATA

2015 Annual Remedial Action – Operations and Monitoring for Select CERCLA Sites
Joint Base Elmendorf-Richardson, Alaska

Figure
10-1

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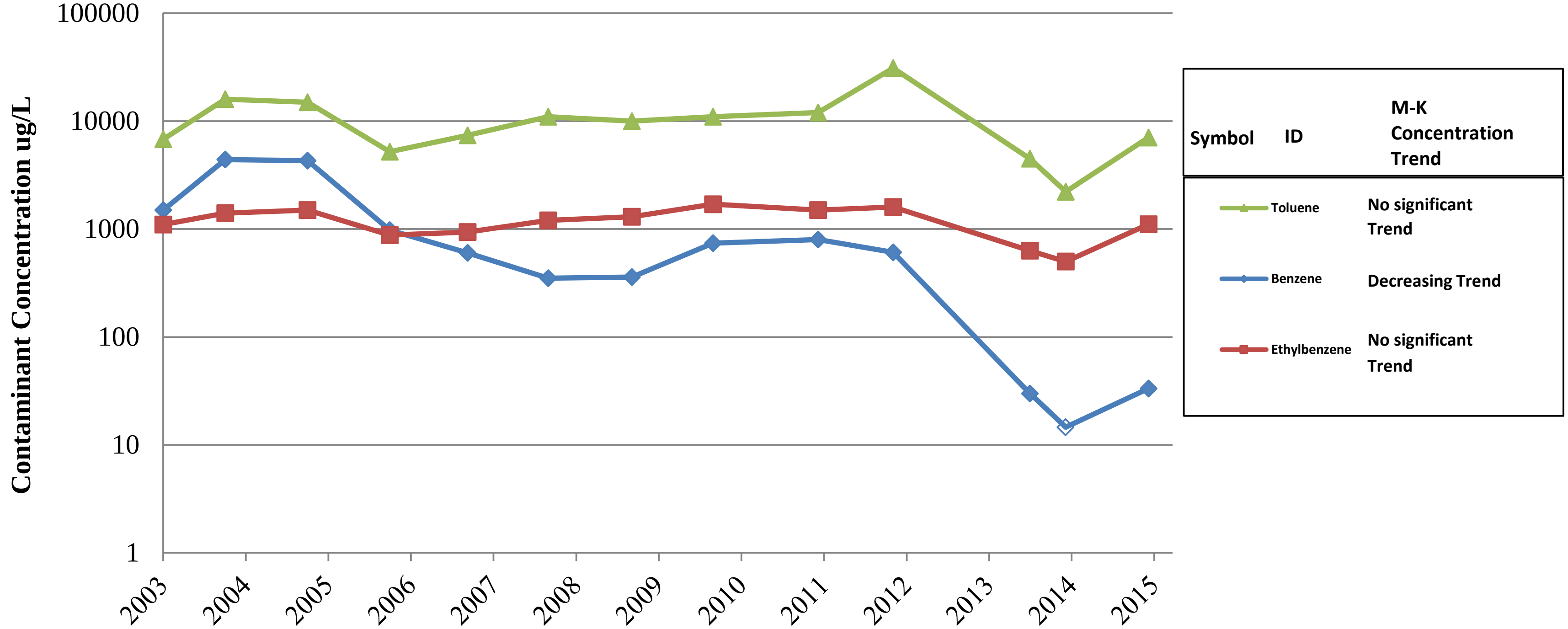

Cleanup Levels
Benzene = 5 µg/L
Ethylbenzene = 700 µg/L
Toluene = 1,000 µg/L

SD025 BENZENE TREND IN OU4MW-08R

2015 Annul RA-O and Monitoring Report, Select 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, 2011b). 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. 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.

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 (µg/L)	Basis for Cleanup Goal
PCE	5	OU4 ROD (USAF,1995b)
TCE	5	

Notes:
µg/L = microgram(s) per liter
OU = Operable Unit
PCE = tetrachloroethene
ROD = Record of Decision
TCE = trichloroethene
USAF = United States Air Force

11.3 2015 FIELD ACTIVITIES AND RESULTS

During 2015, monitoring well IS6-01 was sampled for VOCs quarterly, starting with quarter two. The sample frequency changed from annually to quarterly in order to gather a large enough data set to show statistical compliance. It was sampled once in quarter three for analytical MNA parameters. The PCE and TCE concentrations exceeded the cleanup level (5 µg/L) in the first three quarters in 2015, and were below the ROD cleanup level in quarter four. Table 11-2 presents a summary of the VOC results and Table 11-3 presents the MNA analytical and field parameters. The 2015 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 contaminant trend graph for IS6-01 is on Figure 11-2.

Biogeochemical indicator parameters measured from IS6-01 indicate an aerobic environment. PCE and TCE will degrade under anaerobic conditions. However, the site historically is aerobic, which means that attainment of cleanup goals at this site may have occurred due to other natural attenuation mechanisms including dispersion, adsorption, and dilution.

The Mann-Kendall trend tests for PCE and TCE in monitoring well IS6-01 indicated statistically significant decreasing trends at the 95 percent confidence level.

A LUC inspection was performed at SD029 on August 12, 2015, and identified one issue: a bolt was missing from the lid of the outer casing. This will be replaced in 2016. A copy of the 2015 LUC inspection form for SD029 is in Appendix B.

Table 11-2 Summary of 2015 Analytical Results at SD029

Analyte	Units	Cleanup Goal[a]	IS6-01 (Q2)	IS6-01 (Q2) (FD)	IS6-01 (Q3)	IS6-01 (Q3) (FD)	IS6-01 (Q4)
PCE	µg/L	5	**5.30**	**5.55**	4.86	**5.06**	2.73
TCE	µg/L	5	**5.06**	**5.26**	**5.36**	**5.51**	3.56

Notes:
[a] Cleanup levels as cited in the OU4 ROD (USAF, 1995b).
Bold result exceeds cleanup level
µg/L = microgram(s) per liter
FD = field duplicate
PCE = tetrachloroethene
Q = quarter
TCE = trichloroethene

Table 11-3 Summary of 2015 MNA Analytical and Field Parameters at SD029

MNA Analytical Parameters								
Monitoring Well ID	**Chloride (mg/L)**	**Sulfate (mg/L)**	**Ethane (µg/L)**	**Ethene (µg/L)**	**Methane (µg/L)**	**Total Nitrate/Nitrite (mg/L)**	**Dissolved Iron (µg/L)**	**Dissolved Manganese (µg/L)**
IS6-01 (Q2)	2.13	9.63	ND [0.24]	ND [0.22]	ND [0.63]	0.315	ND [250]	15.4
MNA Field Parameters								
Monitoring Well ID	**Volume Purged (gallons)**	**Temp (°C)**	**Specific Conductance[a] (mS/cm)**	**DO (mg/L)**	**pH**	**ORP (mV)**	**Turbidity (NTU)**	**Alkalinity (mg/L of $CaCO_3$)**
IS6-01 (Q2)	3.5	6.34	0.565	4.62	7.14	81.8	8.98	NA
IS6-01 (Q3)	2.9	9.02	0.362	4.06	7.15	130.2	17.54	NA
IS6-01 (Q4)	5.1	6.90	0.274	3.76	5.79	134.5	20.37	180

Notes:
[a] Specific Conductance is a conductivity measurement that has been corrected to 25°C.
[ ] = limit of detection
µg/L = microgram(s) per liter
°C = Celsius
$CaCO_3$ = calcium carbonate
DO = dissolved oxygen
ID = identification
mg/L = milligram(s) per liter
mV = millivolt(s)
mS/cm = milli-Siemen(s) per centimeter
NA = not analyzed
ND = non-detect [limit of detection]
NTU = Nephelometric Turbidity Units
ORP = oxidation-reduction potential
Q = quarter

Table 11-4 Summary of 2015 Mann-Kendall Concentration Trends for SD029

Monitoring Well ID	PCE	TCE
IS6-01	Decreasing	Decreasing

Notes:
ID = identification
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. The TCE concentration 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. Continued quarterly groundwater monitoring through at least 2017 is proposed at monitoring well IS6-01 to closely monitor COCs for comparison against OU4 ROD cleanup goals.

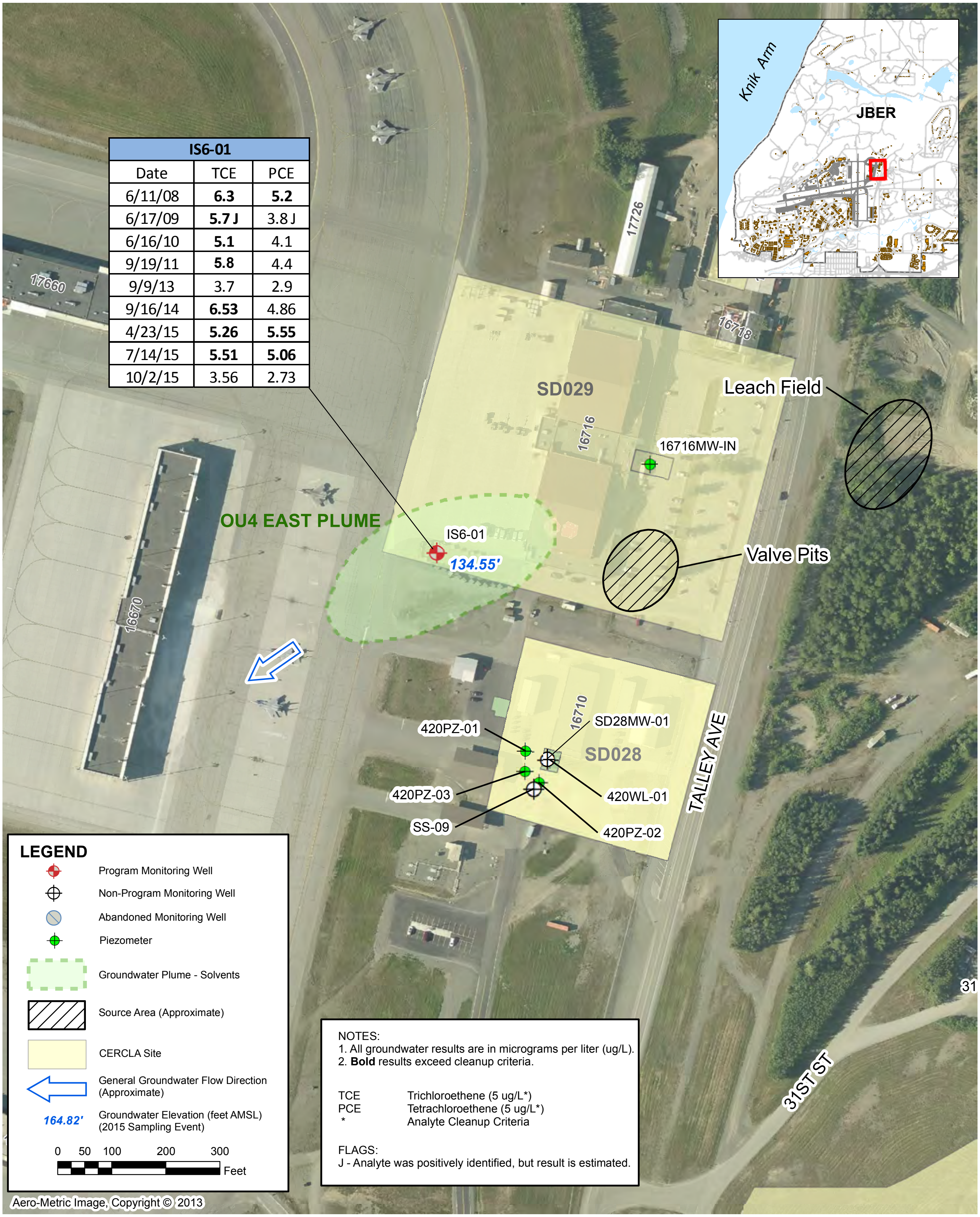
11.4.1 Five-Year Review

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 were no recommendations for SD029 documented during the first or second five-year review period (USAF, 1998c; USAF, 2003d). The third five-year review report recommended increasing the monitoring of well IS6-01 to annually to document the attainment of cleanup goals. 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).

11.4.2 Recommendations

Site SD029 is identified as a **Yellow** priority because site COCs are above cleanup goals. The TCE and PCE concentrations in groundwater from IS6-01 remain slightly above cleanup goals (Figure 11-1). TCE concentrations exhibit an overall decreasing trend with a relatively high R^2 value (0.96).

It is recommended to continue groundwater monitoring at IS6-01 for this site 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.



IS6-01		
Date	TCE	PCE
6/11/08	**6.3**	**5.2**
6/17/09	**5.7 J**	3.8 J
6/16/10	**5.1**	4.1
9/19/11	**5.8**	4.4
9/9/13	3.7	2.9
9/16/14	**6.53**	4.86
4/23/15	**5.26**	**5.55**
7/14/15	**5.51**	**5.06**
10/2/15	3.56	2.73

LEGEND

- Program Monitoring Well
- Non-Program Monitoring Well
- Abandoned Monitoring Well
- Piezometer
- Groundwater Plume - Solvents
- Source Area (Approximate)
- CERCLA Site
- General Groundwater Flow Direction (Approximate)
- *164.82'* Groundwater Elevation (feet AMSL) (2015 Sampling Event)

0 50 100 200 300 Feet

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*)
*	Analyte Cleanup Criteria

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

Date: 29 Aug 2016 Drawn by: SJ K:\PROJECTS\Air_Force\JBER\PBR\LTMMXDs\2016\2016_JBER_SD029_RAOM-01.mxd

N

SD029 SITE MAP WITH ANALYTICAL DATA

2015 Annual Remedial Action – Operations and Monitoring for Select CERCLA Sites
Joint Base Elmendorf-Richardson, Alaska

Figure **11-1**

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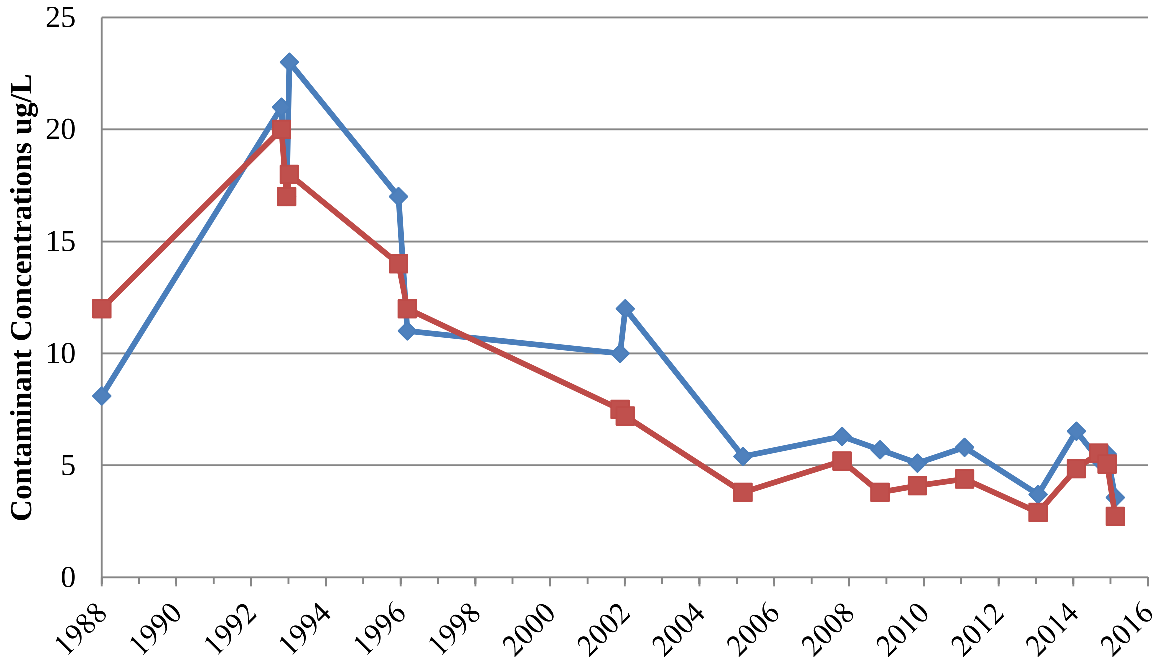

Symbol	ID	M-K Concentration Trend
	TCE	Decreasing Trend
	PCE	Decreasing Trend

Cleanup Levels
TCE = 5 µg/L
PCE = 5 µg/L

SD029 CONTAMINANT TRENDS IN IS6-01

2015 Annul RA-O and Monitoring Report, Select CERCLA Sites
Joint Base Elmendorf-Richardson, Alaska

Figure
11-2

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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 contamination 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, 2011c). 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 of 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 glacio-fluvial 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 referred to as "the beaver pond area" (Warhaftig, 1965).

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 gradient is 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 Files. 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 (USAF, 2011d), and the most recent Memorandum to the Site File documents implementation of passive operation of the wetland remediation system for seep water treatment. 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 or 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.

As specified in the OU5 ROD, it was expected to implement the remedy 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 Cleanup Goals in Groundwater, Seeps and Surface Water at ST037

Contaminant of Concern	Medium	Cleanup Goal (µg/L)	Basis for Cleanup Goal
TCE	Groundwater	5	OU5 ROD (USAF, 1995c)
TCE	Surface Water	5	OU5 ROD (USAF, 1995c)
Benzene		5	OU5 ROD (USAF, 1995c)
TAH		10	Memorandum to the Site File for Passive Operation of the Wetland Remediation System at Operable Unit 5 (USAF, 2011a)
TAqH		15	Memorandum to the Site File for Passive Operation of the Wetland Remediation System at Operable Unit 5 (USAF, 2011a)

Notes:
µg/L = microgram(s) per liter
OU = Operable Unit
ROD = Record of Decision
TCE = trichloroethene
USAF = United States Air Force

12.2.1 Land Use Control Inspection

A LUC inspection performed at ST037 on June 15-16, 2015, identified five monitoring wells that required repair. The lock and outer casing lid of monitoring well OU5MW-40 were replaced, and the well was relabeled. Monitoring wells OU5MW-13and -14 received new locks. Monitoring wel1 OU5MW-05 was found to be frost-heaved, the inner PVC casing was cut and resurveyed. Monitoring well OU5MW-15 was also frost heaved requires cutting the PVC casing. This will be performed in 2016. Monitoring well OU5MW-01 was decommissioned on 4 September 2015, and a dig permit was in place for this activity. Water line construction work occurred at the site, and a dig permit was also in place for the construction. A copy of the 2015 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 (USAF, 2016b).

The eastern lobe of the Western ST037 Plume corresponds to the former Kenney Avenue Plume (USAF, 2011c). 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, 2011c).

12.3.1 2015 Field Activities and Results

During 2015, 10 monitoring wells and four seeps (OU5SP-09, OU5SP-10, OU5SP-11, and OU5SP-15) were sampled for TCE. In addition, the monitoring wells were sampled for MNA parameters. 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, a field duplicate sample was collected from well OU5MW-15 and OU5MW-45. The TCE concentrations in select wells and seeps within the Western ST037 Plume continue to exceed the OU5 ROD cleanup goals. The inner PVC casing of monitoring well OU5MW-34 was found to be damaged or obstructed and was not sampled.

Table 12-2 presents a summary of the 2015 analytical results and Table 12-3 presents a summary of the MNA analytical data and field parameters. The 2015 and truncated historical results are on Figure 12-1. Historical results and Mann Kendall trend analysis results are Appendix C and a summary of the Mann-Kendall analysis results are in Table 12-4. The Mann-Kendall contaminant trend graphs are is on Figure 12-2 and Figure 12-3.

On June 24, 2015, water level measurements were collected from thirty monitoring wells across the ST037 site. Monitoring well OU5MW-44 was inaccessible and monitoring well OU5MW-02 was measure instead. Groundwater level measurements were collected from eight additional monitoring wells (401WL-02, 49WL-01, 538WL-02, OU3MW-25, OU5MW-02, OU5MW-30, OU5MW-40 and SP2/6-04) than what was originally proposed. The depth to groundwater measurements were used to calculate groundwater elevations and are summarized in Table 12-5. The groundwater elevations are also provided on Figure 12-1.

The 2015 field parameter results match the historical observation of weakly aerobic to weakly anaerobic conditions across the site, which suggests that the rate of TCE degradation is very low. Total organic carbon concentrations reported for the former Fairchild Avenue Plume area in 2008 indicated a general absence of organic carbon in the downgradient portion of the plume, which explains why biogeochemical conditions at this site are likely to remain weakly aerobic to weakly anaerobic (USAF, 2009b). Therefore, 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.

The Mann-Kendall trend tests for TCE in monitoring wells 403WL-01, OU3MW-02, OU3MW-11 and OU3MW-44 and seeps OU5SP-09 and SP1-02 indicate statistically significant decreasing trends at the 95 percent confidence level. No statistically significant trends were identified for TCE in the seeps OU5SP-10 and OU5SP-11. While not statistically significant at the 95 percent confidence level, TCE concentrations in monitoring well OU3MW-38 are probably increasing based on the MAROS decision matrix. Figure 12-2 and Figure 12-3 presents the TCE trends for the Western ST037 Plume monitoring wells.

Table 12-2 Summary of 2015 Analytical Results at Western ST037 Plumes

Monitoring Well ID	TCE Result (µg/L)
Cleanup Goal[a]	**5**
OU3MW-02	**10.8**
OU3MW-02 (FD)	**11.1**
OU3MW-11	**42.2**
403WL-01	**20.3**
OU5MW-15	ND [0.5]
OU5MW-34	Well Blocked
OU5MW-38	**13**
OU5MW-43	ND [0.5]
OU5MW-44	**22.4**
OU5MW-45 (6/2015)	ND [0.5]
OU5MW-45 (11/2015)	ND [0.5]
OU5MW-46	ND [0.5]
OU5SP-15	ND [0.5]
OU5SP-09	1.48
OU5SP-09 (FD)	1.50
OU5SP-10 Q1 (3/17/15)	**8.27**
OU5SP-10 Q2 (6/10/15)	**5.56**
OU5SP-10 Q3 (9/2/15)	**6.83**
OU5SP-10 Q4 (12/1/15)	Frozen, No Sample
OU5SP-11 Q1 (3/17/15)	**11.0**
OU5SP-11 Q2 (6/10/15)	**9.94**
OU5SP-11 Q3 (9/2/15)	**9.82**
OU5SP-11 Q4 (12/1/15)	**11.4**
SP1-02	**8.81**

Notes:
[a] 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 2015 MNA Analytical and Field Parameters at Western ST037 Plume

MNA Analytical Parameters								
Monitoring Well ID	**Chloride (mg/L)**	**Sulfate (mg/L)**	**Ethane (µg/L)**	**Ethene (µg/L)**	**Methane (µg/L)**	**Total Nitrate/Nitrite (mg/L)**	**Dissolved Iron (µg/L)**	**Dissolved Manganese (µg/L)**
OU3MW-02	20.3	16.3	ND [0.24]	ND [0.22]	1.8	0.180 J	ND [250]	3,690
OU3MW-02 FD	19.2	15.8	ND [0.24]	ND [0.22]	1.7	0.139 J	ND [250]	3,630
OU3MW-11	7.46	7.07	ND [0.24]	0.23 J	3.60	0.216 J	ND [250]	2,250
OU5MW-15	27.6	6.81	ND [0.24]	ND [0.22]	120	ND [0.05] J	738	362
OU5MW-15 FD	27.3	6.89 J	ND [0.24]	ND [0.22]	140	NA	739	352
OU5MW-38	19.7	16.3 J	ND [0.24]	ND [0.22]	ND [0.63]	1.08 J	ND [250]	7.97
OU5MW-43	27.7	23.3 J	ND [0.24]	ND [0.22]	ND [0.63]	2.32 J	ND [250]	760
OU5MW-44	15.4 J	19.3 J	0.098 J	0.55 J	0.50 J	1.08	ND [250]	13 J
OU5MW-46	26.1	22.5 J	ND [0.24]	ND [0.22]	ND [0.63]	2.2 J	ND [250]	337
403WL-01	15.5	10.9	ND [0.24]	ND [0.22]	1,600	0.031 J	2,440	3,470
SP1-02	22.8	19.4 J	ND [0.24]	ND [0.22]	0.71 J	1.21 J	ND [250]	673

MNA Field Parameters								
Monitoring Well ID	**Volume Purged (gallons)**	**Temp (°C)**	**Specific Conductance[a] (mS/cm)**	**DO (mg/L)**	**pH**	**ORP (mV)**	**Turbidity (NTU)**	**Alkalinity (mg/L of $CaCO_3$)**
OU3MW-02	3.8	8.82	0.606	1.86	6.16	140.30	4.66	265
OU3MW-11	1.9	7.58	0.667	0.93	6.54	113.7	2.16	360
OU5MW-15	2.8	12.17	0.584	1.53	7.10	6.40	0.17	300
OU5MW-38	5.9	8.93	0.570	1.84	6.57	28.9	4.14	300
OU5MW-43	3.1	9.93	0.508	0.77	6.37	160.6	2.82	240
OU5MW-44	5.1	10.66	0.812	4.43	6.37	138.7	8.61	220
OU5MW-46	5.5	8.83	0.561	0.42	6.39	146.3	15.55	300
403WL-01	3.1	9.13	0.640	0.46	6.43	-7.7	7.61	280
SP1-02	8.0	8.49	0.518	0.33	6.57	183.0	0.27	240

Notes:

[a] Specific Conductance is a conductivity measurement that has been corrected to 25°C.
[ ] = 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.
°C = Celsius
$CaCO_3$ = calcium carbonate
DO = dissolved oxygen
FD = field duplicate
ID = identification
mg/L = milligram(s) per liter
mV = millivolts
mS/cm = milli-Siemen(s) per centimeter
NA = not analyzed
ND = non-detect [limit of detection]
NTU = Nephelometric Turbidity Units
ORP = oxidation-reduction potential

Table 12-4 Summary of 2015 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-38	NS[a]
OU5MW-44	Decreasing
SP1-02	Decreasing
Seeps	
OU5SP-09	Decreasing
OU5SP-10	NST
OU5SP-11	Increasing

Notes:

NS[a] = No statistically significant trend identified at α=0.05; Probably increasing trend using MAROS matrix
ID = identification
NST = no significant trend
TCE = trichloroethene

Table 12-5 2015 Groundwater Elevations at ST037 Western Plume

Monitoring Well ID	Measuring Point Elevation AMSL (feet)	Depth to Water FTOC (feet)	Groundwater Elevation AMSL (feet)
401WL-02[a]	151.27	32.87	118.40
403WL-01	155.94	40.56	115.38
401WL-03	147.51	34.36	113.15
401WL-04[a]	147.38	32.56	114.82
49WL-01	145.81	15.62	130.19
516MW-02	157.2	38.42	118.78
538WL-02[a]	186.97	33.29	153.68
54WL-02	150.37	19.68	130.69
GW-4A	137.87	5.60	132.27
NS3-02	124.46	4.86	119.60
OU3MW-02	142.66	28.58	114.08
OU3MW-11[a]	118.76	21.28	97.48
OU3MW-25[a]	154.93	15.90	139.03
OU5MW-02	142.26	35.52	106.74
OU5MW-05	156.3	24.06	132.24
OU5MW-06	173.3	34.93	138.37
OU5MW-07[a]	178.48	32.85	145.63
OU5MW-08[a]	155.81	16.77	139.04
OU5MW-09	119.39	4.09	115.30
OU5MW-10	110.1	1.75	108.35
OU5MW-11[a]	123.93	38.40	85.53
OU5MW-12[a]	97.38	6.55	90.83
OU5MW-13	106.67	4.58	102.09
OU5MW-14[a]	86.49	10.37	76.12
OU5MW-15[a]	82.68	11.07	71.61
OU5MW-30[a]	85.22	2.51	82.71
OU5MW-31[a]	136.98	4.67	132.31
OU5MW-33[a]	156.76	13.26	143.50
OU5MW-34	141.34	32.01	109.33
OU5MW-38	142.26	30.83	111.43
OU5MW-40	139.83	32.60	107.23
OU5MW-43	138.12	32.21	105.91
OU5MW-45	135.08	33.20	101.88
OU5MW-46	142.26	35.64	106.62
SP1-02	136.75	35.54	101.21
SP2/6-04[a]	146.06	36.94	109.12
SP2/6-05	142.45	31.78	110.67
SP4/11-03[a]	169.33	37.45	131.88

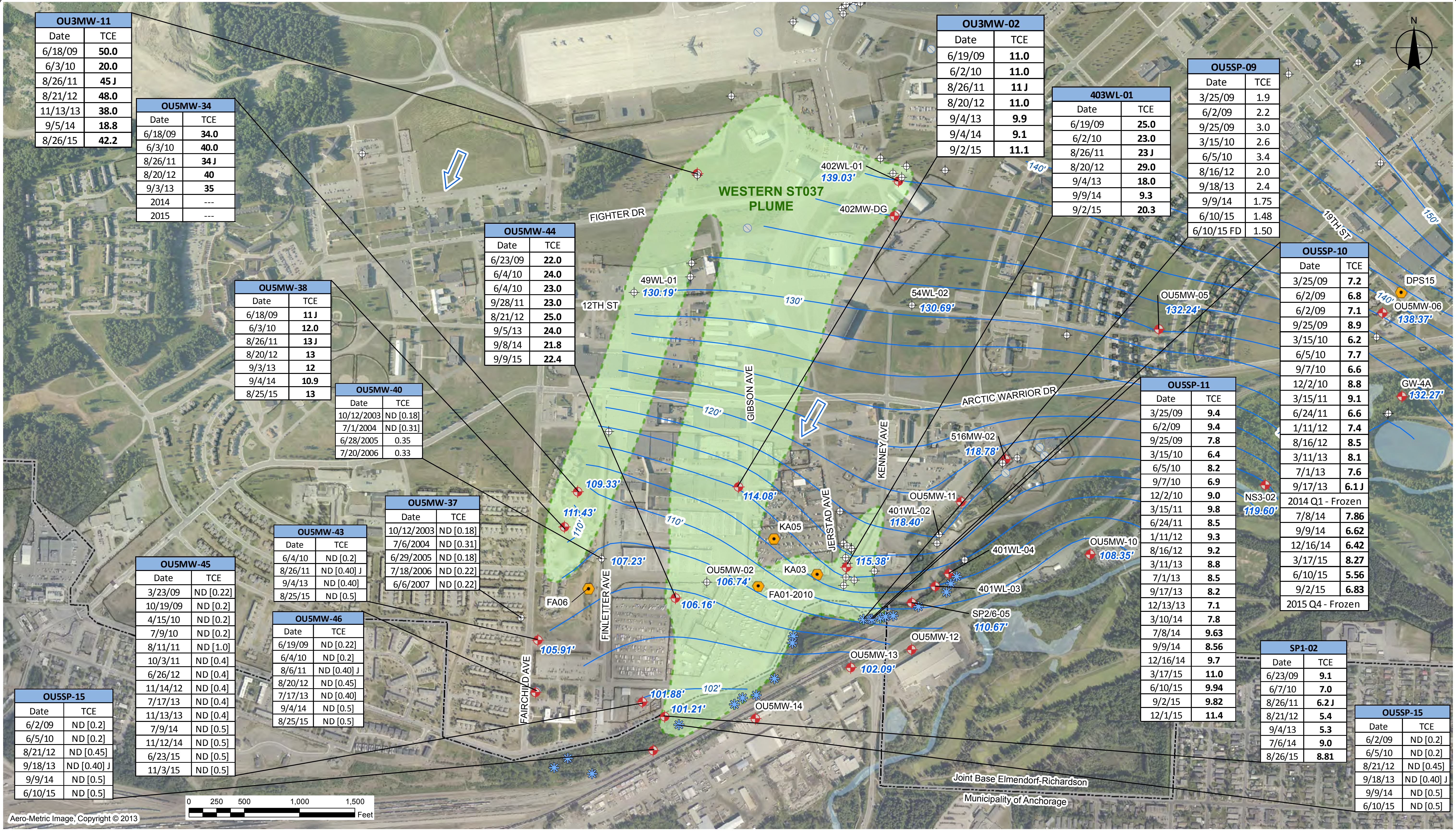
Notes:

[a] Monitoring well was not used in calculation of groundwater contours at the site.
Top of casing Measuring Point Elevations taken from the 2013 Environmental Restoration Program Atlas (USAF, 2013a).
Depth to groundwater measurements were collected on June 24, 2015.
AMSL = above mean sea level
ID = identification
FTOC = from top of casing

12.3.2 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 *ST037 Plume and Source Area Investigation* (USAF, 2011c) and subsequent groundwater monitoring 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.
- 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 installed in 2010.
- In addition, it is recommended that the damaged monitoring well OU5MW-34 be inspected for possible repairs. If the monitoring well cannot be repaired, it should be decommissioned and replaced.



OU3MW-11	
Date	TCE
6/18/09	**50.0**
6/3/10	**20.0**
8/26/11	**45 J**
8/21/12	**48.0**
11/13/13	**38.0**
9/5/14	**18.8**
8/26/15	**42.2**

OU5MW-34	
Date	TCE
6/18/09	**34.0**
6/3/10	**40.0**
8/26/11	**34 J**
8/20/12	**40**
9/3/13	**35**
2014	---
2015	---

OU5MW-38	
Date	TCE
6/18/09	**11 J**
6/3/10	**12.0**
8/26/11	**13 J**
8/20/12	**13**
9/3/13	**12**
9/4/14	**10.9**
8/25/15	**13**

OU5MW-40	
Date	TCE
10/12/2003	ND [0.18]
7/1/2004	ND [0.31]
6/28/2005	0.35
7/20/2006	0.33

OU5MW-44	
Date	TCE
6/23/09	**22.0**
6/4/10	**24.0**
6/4/10	**23.0**
9/28/11	**23.0**
8/21/12	**25.0**
9/5/13	**24.0**
9/8/14	**21.8**
9/9/15	**22.4**

OU5MW-37	
Date	TCE
10/12/2003	ND [0.18]
7/6/2004	ND [0.31]
6/29/2005	ND [0.18]
7/18/2006	ND [0.22]
6/6/2007	ND [0.22]

OU5MW-43	
Date	TCE
6/4/10	ND [0.2]
8/26/11	ND [0.40] J
9/4/13	ND [0.40]
8/25/15	ND [0.5]

OU5MW-45	
Date	TCE
3/23/09	ND [0.22]
10/19/09	ND [0.2]
4/15/10	ND [0.2]
7/9/10	ND [0.2]
8/11/11	ND [1.0]
10/3/11	ND [0.4]
6/26/12	ND [0.4]
11/14/12	ND [0.4]
7/17/13	ND [0.4]
11/13/13	ND [0.4]
7/9/14	ND [0.5]
11/12/14	ND [0.5]
6/23/15	ND [0.5]
11/3/15	ND [0.5]

OU5MW-46	
Date	TCE
6/19/09	ND [0.22]
6/4/10	ND [0.2]
8/6/11	ND [0.40] J
8/20/12	ND [0.45]
7/17/13	ND [0.40]
9/4/14	ND [0.5]
8/25/15	ND [0.5]

OU5SP-15	
Date	TCE
6/2/09	ND [0.2]
6/5/10	ND [0.2]
8/21/12	ND [0.45]
9/18/13	ND [0.40] J
9/9/14	ND [0.5]
6/10/15	ND [0.5]

OU3MW-02	
Date	TCE
6/19/09	**11.0**
6/2/10	**11.0**
8/26/11	**11 J**
8/20/12	**11.0**
9/4/13	**9.9**
9/4/14	**9.1**
9/2/15	**11.1**

403WL-01	
Date	TCE
6/19/09	**25.0**
6/2/10	**23.0**
8/26/11	**23 J**
8/20/12	**29.0**
9/4/13	**18.0**
9/9/14	**9.3**
9/2/15	**20.3**

OU5SP-09	
Date	TCE
3/25/09	1.9
6/2/09	2.2
9/25/09	3.0
3/15/10	2.6
6/5/10	3.4
8/16/12	2.0
9/18/13	2.4
9/9/14	1.75
6/10/15	1.48
6/10/15 FD	1.50

OU5SP-10	
Date	TCE
3/25/09	**7.2**
6/2/09	**6.8**
6/2/09	**7.1**
9/25/09	**8.9**
3/15/10	**6.2**
6/5/10	**7.7**
9/7/10	**6.6**
12/2/10	**8.8**
3/15/11	**9.1**
6/24/11	**6.6**
1/11/12	**7.4**
8/16/12	**8.5**
3/11/13	**8.1**
7/1/13	**7.6**
9/17/13	**6.1 J**
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	

OU5SP-11	
Date	TCE
3/25/09	**9.4**
6/2/09	**9.4**
9/25/09	**7.8**
3/15/10	**6.4**
6/5/10	**8.2**
9/7/10	**6.9**
12/2/10	**9.0**
3/15/11	**9.8**
6/24/11	**8.5**
1/11/12	**9.3**
8/16/12	**9.2**
3/11/13	**8.8**
7/1/13	**8.5**
9/17/13	**8.2**
12/13/13	**7.1**
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**

SP1-02	
Date	TCE
6/23/09	**9.1**
6/7/10	**7.0**
8/26/11	**6.2 J**
8/21/12	**5.4**
9/4/13	**5.3**
7/6/14	**9.0**
8/26/15	**8.81**

OU5SP-15	
Date	TCE
6/2/09	ND [0.2]
6/5/10	ND [0.2]
8/21/12	ND [0.45]
9/18/13	ND [0.40] J
9/9/14	ND [0.5]
6/10/15	ND [0.5]

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

TCE	Trichloroethene (5 ug/L*)
ND	Not Detected [Detection Limit]
Q	Quarter (Yearly)
---	Not Analyzed
*	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
- Direct Push Sample Location
- Groundwater Contour Line (feet AMSL) (JUN 2015)
- 164.82' Groundwater Elevation (feet AMSL) (Collected on 24 JUN 2015)
- General Groundwater Flow Direction (Approximate)
- Groundwater Plume - Solvents

WESTERN ST037 PLUME SITE MAP WITH ANALYTICAL DATA

2015 Annual Remedial Action – Operations and Monitoring for Select CERCLA Sites
Joint Base Elmendorf-Richardson, Alaska

Figure
12-1

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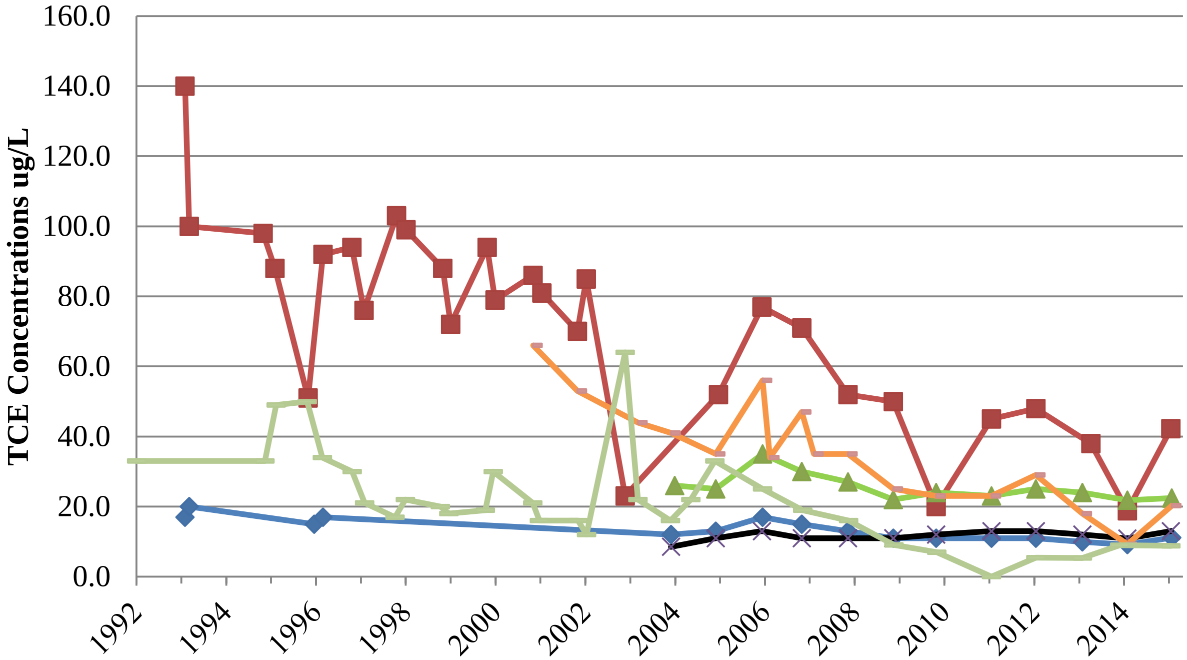

Symbol	Well ID	M-K Concentration Trend
	OU3MW-11	Decreasing Trend
	OU3MW-02	Decreasing Trend
	OU5MW-44	Decreasing Trend
	OU5MW-38	No significant Trend*
	403WL-01	Decreasing Trend
	SP1-02	Decreasing Trend

*** Probably increasing by MAROS decision matrix**

Cleanup Level
TCE = 5 µg/L

WESTERN ST037 PLUME TCE TRENDS IN MONITORING WELLS

2015 Annul RA-O and Monitoring Report, Select CERCLA Sites
Joint Base Elmendorf-Richardson, Alaska

Figure **12-2**

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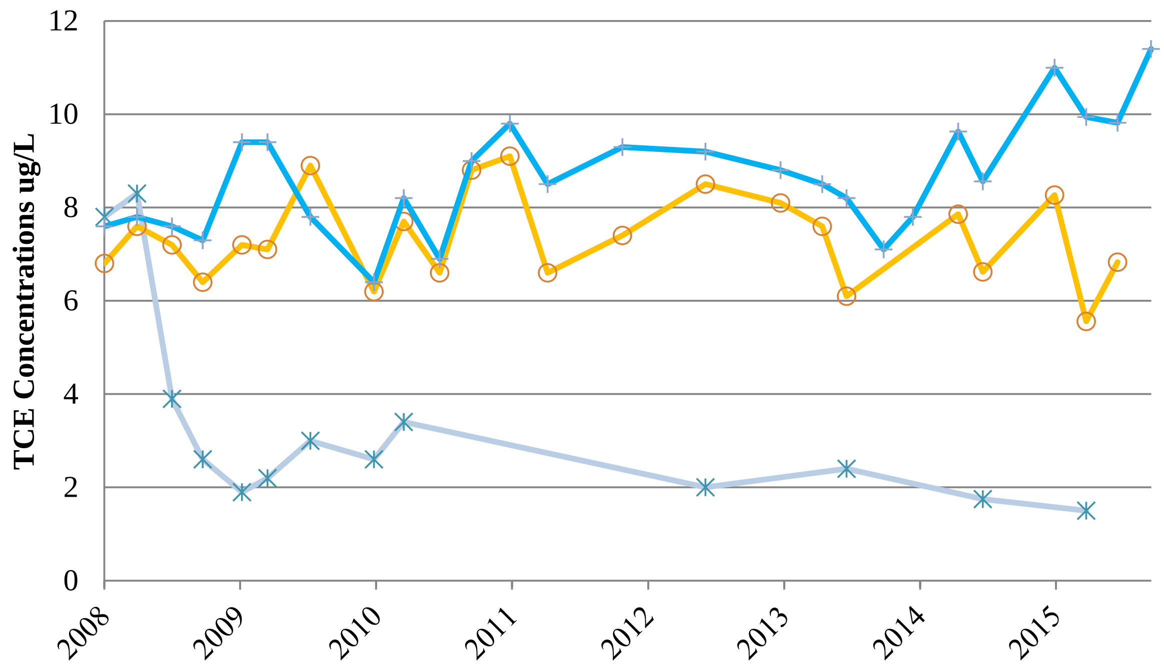

Symbol	Well ID	M-K Concentration Trend
	OU5SP-09	Decreasing Trend
	OU5SP-10	No significant Trend
	OU5SP-11	Increasing Trend

Cleanup Level
TCE = 5 µg/L

WESTERN ST037 PLUME TCE TRENDS IN SEEPS

2015 Annul RA-O and Monitoring Report, Select 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, 2011c). Similarly, the western plume is located hydrogeologically downgradient of Site TU091, which has TCE contamination present in soil and groundwater (USAF, 2016c). 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 2015 Field Activities and Results

During 2015, monitoring wells GW-4A, OU5MW-06, OU5MW-07, and OU5MW-08 were sampled for VOCs and MNA parameters. Additionally, a field duplicate sample was collected from well OU5MW-06. The TCE concentration in wells GW-4A (6.2 µg/L) OU5MW-06 (11.5 µg/L), and OU5MW-07 (15.6 µg/L) exceeded the groundwater cleanup level of 5 µg/L. Table 12-6 presents a summary of the 2015 analytical results and Table 12-7 presents a summary of the MNA analytical data and field parameters. The 2015 and truncated historical results are also presented on Figure 12-4. Historical results and Mann Kendall trend analysis results are in Appendix C and a summary of the Mann-Kendall analysis results are in Table 12-8. The Mann-Kendall contaminant trend graph is on Figure 12-6.

The 2015 field parameter results indicate weakly aerobic to aerobic conditions across the site. This suggests that the rate of TCE degradation is low.

Table 12-6 Summary of 2015 Analytical Results at Slammer Avenue Plume

Analyte	Units	Cleanup Goal[a]	GW-4A	OU5MW-06	OU5MW-06 FD	OU5MW-07	OU5MW-08
TCE	µg/L	5	**6.2**	**11.5**	**11.3**	**15.6**	3.88

Notes:
a - Cleanup levels cited in the OU5 ROD (USAF, 1995c)
Bold result exceeds the cleanup level
µg/L = microgram(s) per liter
FD = field duplicate sample
TCE = trichloroethene

Table 12-7 Summary of 2015 MNA Analytical and Field Parameters at Slammer Avenue

MNA Analytical Parameters								
Monitoring Well ID	Chloride (mg/L)	Sulfate (mg/L)	Ethane (µg/L)	Ethene (µg/L)	Methane (µg/L)	Total Nitrate/Nitrite (mg/L)	Dissolved Iron (µg/L)	Dissolved Manganese (µg/L)
GW-4A	2.44	23.5	ND [0.24]	ND [0.22]	48	0.0425 J	3,150	899
OU5MW-06	5.72 J	33.5 J	ND [0.24]	ND [0.22]	2.6 J	0.084 J	ND [250]	150 J
OU5MW-06 FD	6.01 J	33.4 J	ND [0.24]	ND [0.22]	6.0 J	0.0715 J	ND [250]	152 J
OU5MW-07	3.34 J	27.9 J	ND [0.24]	ND [0.22]	20	1.02	ND [250]	18.9 J
OU5MW-08	2.24	30.7	ND [0.24]	ND [0.22]	ND [0.63]	1.58 J	ND [250]	19.0
MNA Field Parameters								
Monitoring Well ID	Volume Purged (gallons)	Temp (C)	Specific Conductance[a] (mS/cm)	DO (mg/L)	pH	ORP (mV)	Turbidity (NTU)	Alkalinity (mg/L of $CaCO_3$)
GW-4A	1.9	8.21	0.342	2.11	6.20	26.7	1.37	140
OU5MW-06	3.5	8.80	0.828	1.00	6.31	157.7	1.42	240
OU5MW-07	2.85	9.70	0.681	2.34	6.01	157.9	3.78	180
OU5MW-08	1.4	8.89	0.301	1.67	5.51	84.8	0.52	110

Notes:
[a] Specific Conductance is a conductivity measurement that has been corrected to 25°C.
[ ] = 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.
°C = Celsius
$CaCO_3$ = calcium carbonate
DO = dissolved oxygen
FD = field duplicate
ID = identification
mg/L = milligram(s) per liter
mV = millivolt(s)
mS/cm = milli-Siemen(s) per centimeter
ND = non-detect [limit of detection]
NTU = Nephelometric Turbidity Units
ORP = oxidation-reduction potential

Table 12-8 Summary of 2015 Mann-Kendall Concentration Trends for Select Wells Slammer Avenue Plumes

Monitoring Well ID	TCE
GW-4A	Decreasing
OU5MW-06	Decreasing
OU5MW-07	Decreasing
OU5MW-08	NST

Notes:
ID = identification
NST = no significant trend
TCE = trichloroethene

12.4.2 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 2015. The eastern Slammer Avenue Plume crossgradient 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 for the first time.. This eastern plume has been identified as the leading edge of the SS022 Plume and contamination from Site TU091 may be the source of the western Slammer Avenue Plume.

Monitoring well GW-4A is downgradient of the drainage ditch. The 2015 results for GW-4A exceed the TCE 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 screened over the same approximate depth is recommended. Monitoring well SS37MW07 would be the most representative as it completed to 16.0 feet below top of casing 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 the State of Alaska's water quality standards.

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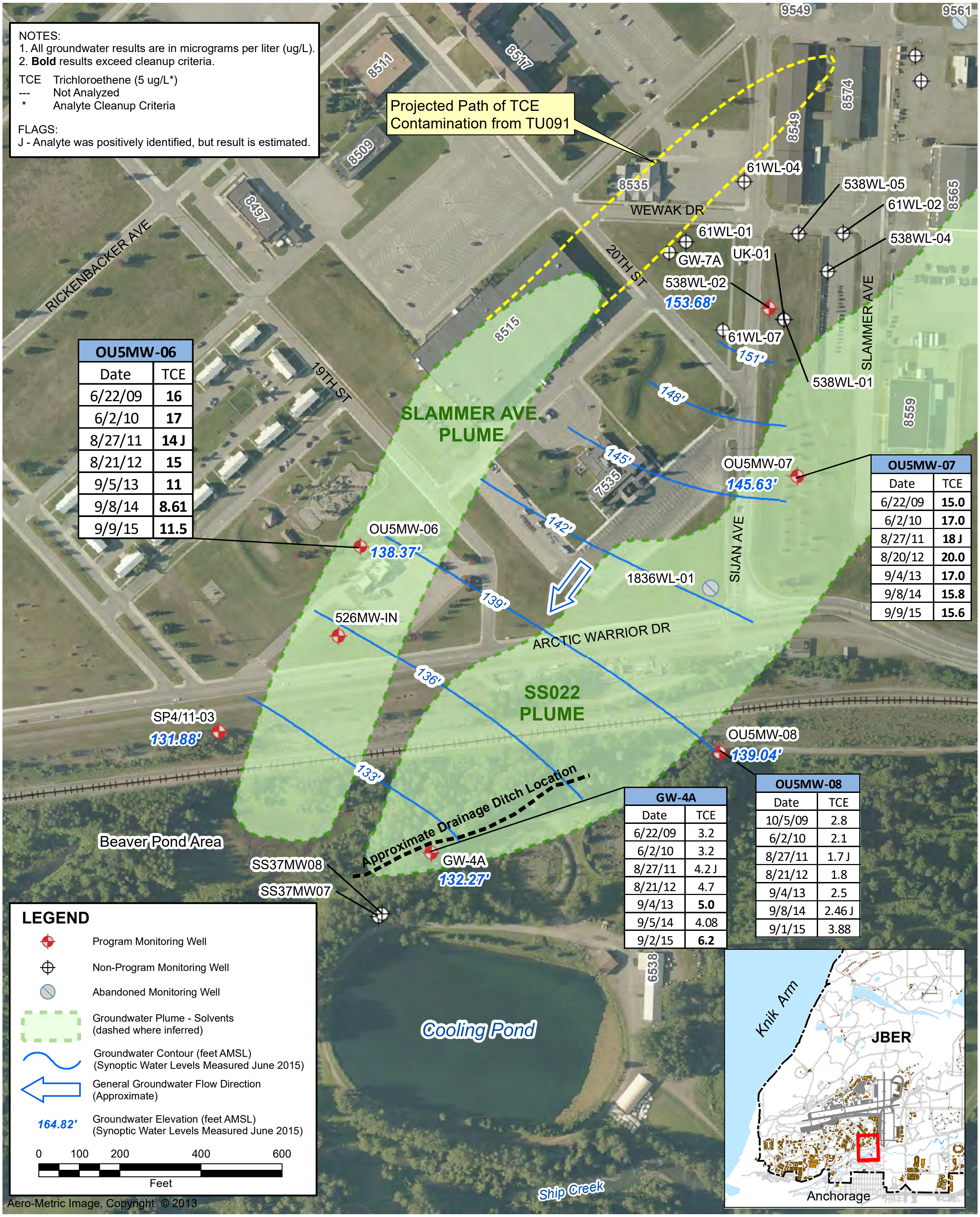

OU5MW-06	
Date	TCE
6/22/09	**16**
6/2/10	**17**
8/27/11	**14 J**
8/21/12	**15**
9/5/13	**11**
9/8/14	**8.61**
9/9/15	**11.5**

OU5MW-07	
Date	TCE
6/22/09	**15.0**
6/2/10	**17.0**
8/27/11	**18 J**
8/20/12	**20.0**
9/4/13	**17.0**
9/8/14	**15.8**
9/9/15	**15.6**

GW-4A	
Date	TCE
6/22/09	3.2
6/2/10	3.2
8/27/11	4.2 J
8/21/12	4.7
9/4/13	**5.0**
9/5/14	4.08
9/2/15	**6.2**

OU5MW-08	
Date	TCE
10/5/09	2.8
6/2/10	2.1
8/27/11	1.7 J
8/21/12	1.8
9/4/13	2.5
9/8/14	2.46 J
9/1/15	3.88

N

SLAMMER AVENUE PLUME SITE MAP WITH ANALYTICAL DATA

2015 Annual Remedial Action – Operations and Monitoring for Select CERCLA Sites
Joint Base Elmendorf-Richardson, Alaska

Figure
12-4

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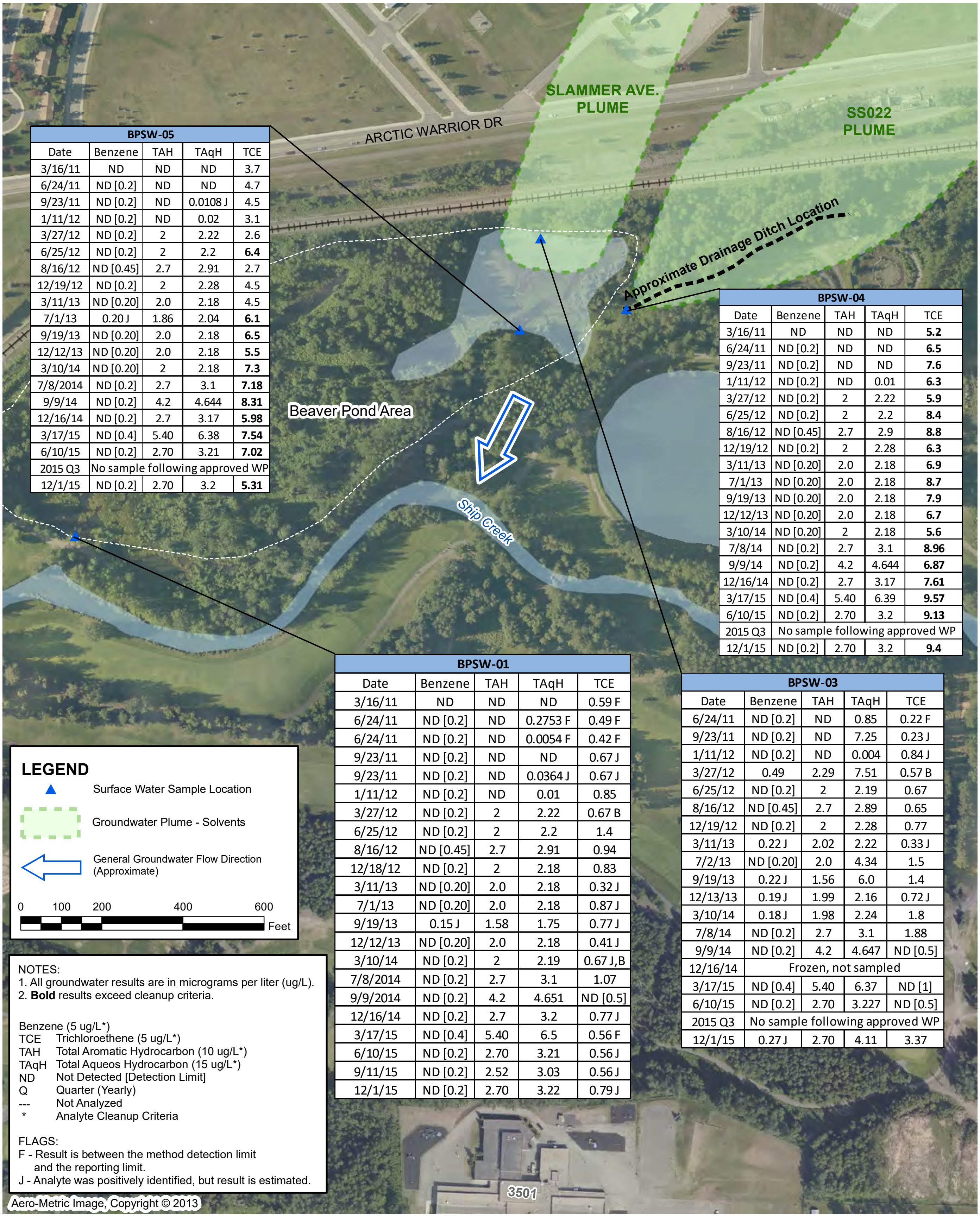

BPSW-05				
Date	Benzene	TAH	TAqH	TCE
3/16/11	ND	ND	ND	3.7
6/24/11	ND [0.2]	ND	ND	4.7
9/23/11	ND [0.2]	ND	0.0108 J	4.5
1/11/12	ND [0.2]	ND	0.02	3.1
3/27/12	ND [0.2]	2	2.22	2.6
6/25/12	ND [0.2]	2	2.2	**6.4**
8/16/12	ND [0.45]	2.7	2.91	2.7
12/19/12	ND [0.2]	2	2.28	4.5
3/11/13	ND [0.20]	2.0	2.18	4.5
7/1/13	0.20 J	1.86	2.04	**6.1**
9/19/13	ND [0.20]	2.0	2.18	**6.5**
12/12/13	ND [0.20]	2.0	2.18	**5.5**
3/10/14	ND [0.20]	2	2.18	**7.3**
7/8/2014	ND [0.2]	2.7	3.1	**7.18**
9/9/14	ND [0.2]	4.2	4.644	**8.31**
12/16/14	ND [0.2]	2.7	3.17	**5.98**
3/17/15	ND [0.4]	5.40	6.38	**7.54**
6/10/15	ND [0.2]	2.70	3.21	**7.02**
2015 Q3	No sample following approved WP			
12/1/15	ND [0.2]	2.70	3.2	**5.31**

BPSW-04				
Date	Benzene	TAH	TAqH	TCE
3/16/11	ND	ND	ND	**5.2**
6/24/11	ND [0.2]	ND	ND	**6.5**
9/23/11	ND [0.2]	ND	ND	**7.6**
1/11/12	ND [0.2]	ND	0.01	**6.3**
3/27/12	ND [0.2]	2	2.22	**5.9**
6/25/12	ND [0.2]	2	2.2	**8.4**
8/16/12	ND [0.45]	2.7	2.9	**8.8**
12/19/12	ND [0.2]	2	2.28	**6.3**
3/11/13	ND [0.20]	2.0	2.18	**6.9**
7/1/13	ND [0.20]	2.0	2.18	**8.7**
9/19/13	ND [0.20]	2.0	2.18	**7.9**
12/12/13	ND [0.20]	2.0	2.18	**6.7**
3/10/14	ND [0.20]	2	2.18	**5.6**
7/8/14	ND [0.2]	2.7	3.1	**8.96**
9/9/14	ND [0.2]	4.2	4.644	**6.87**
12/16/14	ND [0.2]	2.7	3.17	**7.61**
3/17/15	ND [0.4]	5.40	6.39	**9.57**
6/10/15	ND [0.2]	2.70	3.2	**9.13**
2015 Q3	No sample following approved WP			
12/1/15	ND [0.2]	2.70	3.2	**9.4**

BPSW-01				
Date	Benzene	TAH	TAqH	TCE
3/16/11	ND	ND	ND	0.59 F
6/24/11	ND [0.2]	ND	0.2753 F	0.49 F
6/24/11	ND [0.2]	ND	0.0054 F	0.42 F
9/23/11	ND [0.2]	ND	ND	0.67 J
9/23/11	ND [0.2]	ND	0.0364 J	0.67 J
1/11/12	ND [0.2]	ND	0.01	0.85
3/27/12	ND [0.2]	2	2.22	0.67 B
6/25/12	ND [0.2]	2	2.2	1.4
8/16/12	ND [0.45]	2.7	2.91	0.94
12/18/12	ND [0.2]	2	2.18	0.83
3/11/13	ND [0.20]	2.0	2.18	0.32 J
7/1/13	ND [0.20]	2.0	2.18	0.87 J
9/19/13	0.15 J	1.58	1.75	0.77 J
12/12/13	ND [0.20]	2.0	2.18	0.41 J
3/10/14	ND [0.2]	2	2.19	0.67 J,B
7/8/2014	ND [0.2]	2.7	3.1	1.07
9/9/2014	ND [0.2]	4.2	4.651	ND [0.5]
12/16/14	ND [0.2]	2.7	3.2	0.77 J
3/17/15	ND [0.4]	5.40	6.5	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

BPSW-03				
Date	Benzene	TAH	TAqH	TCE
6/24/11	ND [0.2]	ND	0.85	0.22 F
9/23/11	ND [0.2]	ND	7.25	0.23 J
1/11/12	ND [0.2]	ND	0.004	0.84 J
3/27/12	0.49	2.29	7.51	0.57 B
6/25/12	ND [0.2]	2	2.19	0.67
8/16/12	ND [0.45]	2.7	2.89	0.65
12/19/12	ND [0.2]	2	2.28	0.77
3/11/13	0.22 J	2.02	2.22	0.33 J
7/2/13	ND [0.20]	2.0	4.34	1.5
9/19/13	0.22 J	1.56	6.0	1.4
12/13/13	0.19 J	1.99	2.16	0.72 J
3/10/14	0.18 J	1.98	2.24	1.8
7/8/14	ND [0.2]	2.7	3.1	1.88
9/9/14	ND [0.2]	4.2	4.647	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	3.227	ND [0.5]
2015 Q3	No sample following approved WP			
12/1/15	0.27 J	2.70	4.11	3.37

LEGEND

- Surface Water Sample Location
- Groundwater Plume - Solvents
- General Groundwater Flow Direction (Approximate)

0 100 200 400 600 Feet

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

Benzene (5 ug/L*)
TCE Trichloroethene (5 ug/L*)
TAH Total Aromatic Hydrocarbon (10 ug/L*)
TAqH Total Aqueos Hydrocarbon (15 ug/L*)
ND Not Detected [Detection Limit]
Q Quarter (Yearly)
--- Not Analyzed
* Analyte Cleanup Criteria

FLAGS:
F - Result is between the method detection limit and the reporting limit.
J - Analyte was positively identified, but result is estimated.

N

ST037 BEAVER POND SURFACE WATER SAMPLE LOCATIONS WITH ANALYTICAL DATA

2015 Annual Remedial Action – Operations and Monitoring for Select CERCLA Sites
Joint Base Elmendorf-Richardson, Alaska

Figure 12-5

Date: 20 Apr 2017 Drawn by: SJ K:\PROJECTS\Air_Force\JBER\PBR\LTM\MXDs\2017\2017_JBER_Beaver_Pond_LTM-01.mxd

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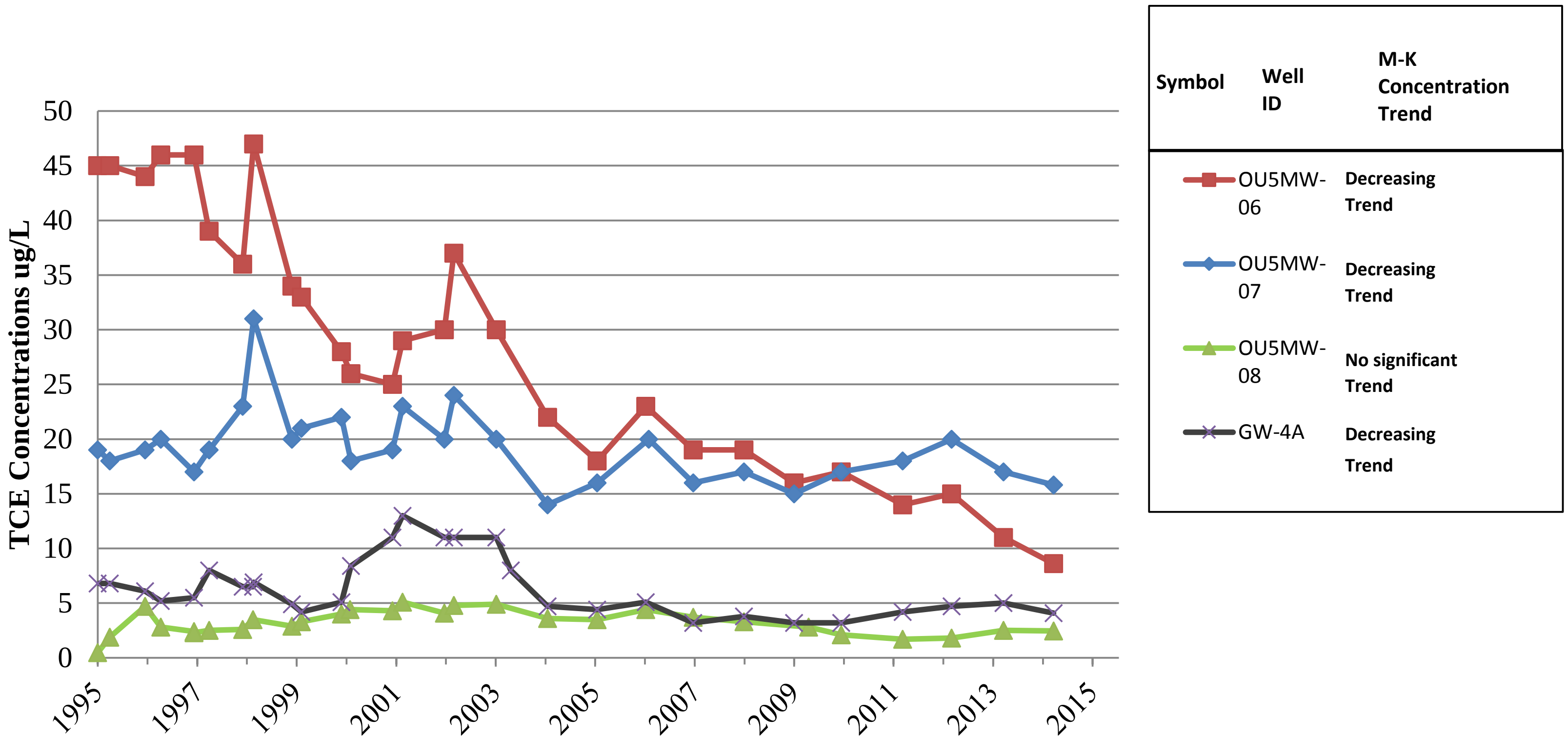

Cleanup Level
TCE = 5 µg/L

SLAMMER AVE PLUME TCE TRENDS IN MONITORING WELLS

2015 Annul RA-O and Monitoring Report, Select 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 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 and was sampled for VOCs. The results were above cleanup goals so the Wetland Treatment Cell was modified to receive surface water from the new seep. 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 12.5.2 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).

12.5.2 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 and TCE in five other seeps (OU5SP-09, OU5SP-10, OU5SP-11, OU5SP-17, and OU5SP-18). 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 shut down to prevent flooding. While the Overland Flow Cell was shut down, water from the seep collection areas was pumped directly into the Wetland Treatment Cell. The treatment processes active in the Wetland Treatment Cell include volatilization, sorption, phytoremediation, and biodegradation. Retention time in the wetland is controlled and maintained at greater than five days to ensure that adequate remediation occurs. 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, 2009c) 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 the seep collection 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 the exception that 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 that formally changes the OU5 Wetland Remediation System treatment approach from an active (i.e., pumping) to a passive system.

12.5.3 2015 Field Activities and Results

In 2015, ten seeps, nine surface water locations, two control points (OU5CP-01 and OU5CP-02), and one sediment location (WCSD-09) were sampled at varying frequencies. Field duplicate samples were collected from OU5CP-01, OU5CP-02, OU5SP-09, WCSW-03 and WCSD-09. 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 (WSCD-09) in the Wetland Treatment Cell near the outfall of the discharge points for seeps OU5SP-09, OU5SP-10, and OU5SP-11. Tables 12-9 and 12-10 present a summary of the 2015 analytical results and the 2015 and truncated historical results are on Figure 12-5 and Figure 12-7. 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 12-11. Mann-Kendall contaminant trend graphs are on Figure 12-9 through Figure 12-13.

The TCE concentrations measured at seeps OU5SP-10 and OU5SP-11 exceeded the cleanup level of 5 µg/L in each quarterly sample collected in 2015. This is consistent with previous results. The Mann-Kendall trend analysis for TCE in seeps OU5SP-10 and OU5SP-11 indicated no statistically significant trends at the 95 percent confidence level (Figure 12-9). Based on the MAROS decision matrix, stable conditions were indicated for TCE in OU5SP-10.

A new seep (OU5SP-11A) located approximately five feet east of OU5SP-11 emerged in June. OU5SP-11A was sampled for VOCs in June (Table 12-9). TCE exceeded the cleanup level of 5 µg/L. A confirmation sample was collected in October before action was taken to include the new seep within the Seeps 10 and 11 collection area.

During November, the seep collection area for OU5SP-10 and OU5SP-11 was expanded laterally to the east by 20 feet to incorporate Seep OU5SP-11A. This collection area flows into the Wetland Treatment Cell. In addition, 160 cubic yards of gravel was added to the Seep 1 and 2 collection area due to approximately 6 to 12 inches of water ponding on the surface. The location of standing water was delineated by pin flags earlier in the year. Gravel was spread to a thickness of approximately 6 inches in the delineated areas, with the exception of the outflow area, which was filled to approximately 12 inches. The addition of gravel at the Seep 1 and 2 collection area is a protective measure to reduce the potential for receptors to be exposed to contaminated water.

The TAH and TAqH concentrations calculated for seeps OU5SP-01 and OU5SP-02 exceeded the water quality standards of 10 µg/L for TAH, and 15 µg/L for TAqH in each quarterly sample collected. Samples were not collected from OU5SP-01 and OU5SP-02 during the first quarter or the fourth quarter for OU5SP-01 because the seeps were frozen. Benzene concentrations measured at seep OU5SP-02 exceeded the cleanup level of 5 µg/L during all three sampling events in 2015 (Figure 12-7). These results are consistent with previous results. The two control points are at the exit point of the seep collection area downgradient of the seep sample collection points. The OU5SP-01 and -02 collection points are inside the designed seep collection area. The area between the seeps and the collection point is functioning as a natural wetland and is remediating the contaminants.

The Mann-Kendall trend tests for benzene in seeps OU5SP-01 and OU5SP-02 indicated no statistically significant trends at the 95 percent confidence level. The Mann-Kendall trend tests for TAH and TAqH concentrations in seep OU5SP-02 indicated statistically significant decreasing trends at the 95 percent confidence interval (Figures 12-10 through Figure 12-12).

Sample collection point OU5CP-01 is located near the former inlet of Pump Station #1. Sample collection point 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. All constituent concentrations measured at seeps OU5CP-01 and OU5CP-02 did not exceed the OU5 ROD cleanup goals during any of the sample events. In addition, the TAH and TAqH concentrations in the surface water sample collected from control points OU5CP-01 and OU5CP-02 did not exceed the OU5 ROD cleanup level.

Inspections at the OU5 Wetland Remediation System occurred monthly from January through May and September through December. Weekly wetland inspections occurred during the summer months, from June through September. Routine monthly and weekly monitoring occurred for the first half of 2015, with no damage to the wetland cell or beaver activity noted.

Beavers began accessing the V-notch weir area (the discharge point of the wetland remediation system) and blocking the outlet with tree branches to reduce water flow through the wetland treatment cell where they had established a beaver lodge. A meeting with a representative from the United States Department of Agriculture (USDA) took place in June to discuss mitigation of the beaver activity and evaluate the beaver fencing that was in place around the V-notch weir and its design. In July, based on the USDA's suggestions, more fencing material was added vertically to the top of the concrete walls of the V-notch so that fencing extended past the upper portion of the weir to block access from the top. The weir was completely surrounded by fencing.

From July to August, daily maintenance at the weir occurred to clear out debris left by beaver activity. In August, a wire mesh floor was installed inside the beaver fence to prevent beavers from entering the weir from under the vertical fence and depositing debris in the weir. In September, debris from beaver activity dammed a south-flowing culvert by the east end of the Wetland Treatment Cell causing water to overflow into the wetland cell. Seeps 10 and 11 were also clogged with beaver generated debris causing water to pond on the seep collection area. In the beginning of November, Seeps 10 and 11 and the culvert were cleared using a truck-mounted water jet.

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 2015. All VOC (both methanol-preserved and low-level methods) and PAH results for the sample collected from sediment location WCSD-09 were below cleanup goals. Additional work was conducted at the Wetland Remediation System in response to the Alaska Railroad Corporation (ARRC) request regarding potential sources for water that was ponding immediately south of the ARRC rail Spur #117. Spur #117 is located at the east end of the Wetland Remediation System near former Pump Station #3 (Figure 12-7a) in the ARRC Anchorage Railyard.

In May 2015, an evaluation was conducted to assess whether the source of ponding water was from either a bluff groundwater discharge point (also known as seep OU5SP-06), which flows into the drainage ditch immediately north of the spur and flows westerly into the Wetland Remediation System, or residual water present in the formerly active wet wells and force main associated with the Wetland Remediation System (now operated as a passive system). This evaluation included a relative water elevation survey on 10-foot intervals along two separate alignments. The first alignment included the surface water elevations in the ditch. The second alignment included ground surface elevations south of rail Spur #117 passing through the ponding water.

The surface water elevations in the ditch were 0.15 to 0.35 feet lower than the ground elevations in the ponding water (Figure 12-7a). Based on the elevation difference, it was determined that the water in the ditch was not the source of the ponding water south of the rail spur. It was also noted that no water had accumulated in two other areas south of the rail spur with ground elevations of 0.11 to 0.22 feet below the corresponding surface water elevation in the ditch.

As a follow on to the elevation survey, water levels in the force main and the pump wet wells were investigated as a potential source for the ponding water. During the initial inspection of the wet well at formerly active Pump Station #3, it was observed to be full of water; however, the water level was below the outlet pipe to the force main. To eliminate the force main plumbed into the wet well as a potential source, the water was pumped from the wet well to an elevation below the elevation of the force main and the force main valve was opened to ensure there was no water in the main. The other three wet wells (all formerly active pump stations – Pump Stations #1, #2, and #4) were also inspected and none of them contained water above the invert elevation of the force main. The elevation of the water in the wet wells is measured during each inspection (monthly – October through April and weekly – May through September) and the water levels have remained constant since they were pumped out in May 2015. This evaluation has demonstrated that the Wetland Remediation System's piping is not a source of the ponding water south of Spur #117. The collection of water level measurements in the wet wells has been added as a task to the routine Wetland Remediation System inspection checklist. Wet well water levels continue to be below elevation of the force main, yet the ponding water still remains. It appears that this ponding water is driven by groundwater, which is transported along a preferential hydraulic pathway east (hydrologically upgradient) of the site.

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 cleanup level of 5 µg/L during all 2015 quarterly sample events (Figure 12-5).

The TCE concentrations measured from BPSW-04 and BPSW-05 were above the cleanup level for TCE but were below the TAH and TAqH criteria. All VOCs, TAH, and TAqH concentrations were below cleanup goals at surface water sample points BPSW-03 and BPSW-01, which is located at the Beaver Pond Area discharge point. The Mann-Kendall trend tests for TCE in surface water samples BPSW-04 and BPSW-05 indicated statistically significant increasing trends at the 95 percent confidence level (Figure 12--13).

All VOCs, TAH, and TAqH concentrations were below cleanup goals in surface water samples collected from Ship Creek (SC-01B and SC-08) in 2015 (Table 12-9).

Table 12-9 Summary of Analytical Results of Seeps, Surface Water and Wetlands Remediation System

Analyte	Units	Cleanup Goal[a]	BPSW-01 (Q1)	BPSW-01 (Q1) (FD)	BPSW-01 (Q2)	BPSW-01 (Q3)	BPSW-01 (Q3) (FD)	BPSW-01 (Q4)	BPSW-01 (Q4) (FD)	BPSW-03 (Q1)	BPSW-03 (Q2)	BPSW-03 (Q3)	BPSW-03 (Q4)
Benzene	µg/L	5	ND [0.2]	ND [0.2]	ND [0.2]	ND [0.2]	ND [0.2]	ND [0.2]	ND [0.2]	ND [0.4]	ND [0.2]	NA[d]	0.27 J
TAH[c]	µg/L	10	5.40	5.40	2.70	2.62	2.53	2.70	2.70	5.40	2.70		2.77
TAqH[c]	µg/L	15	6.39	6.50	3.21	NA[b]	3.03	3.22	3.21	6.37	3.23		4.43
TCE	µg/L	5	ND [-0.51]	0.56 F	0.56 J	0.52 J	0.56 J	0.79 J	0.75 J	ND [1]	ND [0.5]		3.37
Analyte	**Units**	**Cleanup Goal[a]**	**BPSW-04 (Q1)**	**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]	NA[d]	ND [0.2]	ND [0.4]	ND [0.2]	NA[d]	ND [0.2]	Frozen, not sampled	0.65	0.80
TAH[c]	µg/L	10	5.40	2.70		2.70	5.40	2.70		2.70		3.65	4.23
TAqH[c]	µg/L	15	6.39	3.20		3.20	6.38	3.20		3.20		4.38	5.06
TCE	µg/L	5	**9.57**	**7.02**		**9.4**	**7.54**	**9.13**		**5.31**		ND [0.5]	ND [0.5]
Analyte	**Units**	**Cleanup Goal[a]**	**OU5CP-01 (Q3)**	**OU5CP-01 (Q4)**	**OU5CP-02 (Q1)**	**OU5CP-02 (Q2)**	**OU5CP-02 (Q3)**	**OU5CP-02 (Q3) (FD)**	**OU5CP-02 (Q4)**	**WCSW-02 (Q1)**	**WCSW-02 (Q2)**	**WCSW-02 (Q3)**	**WCSW-02 (Q4)**
Benzene	µg/L	5	0.18 J	Frozen, not sampled	0.56	0.22 J	ND [0.2]	ND [0.2]	0.38 J	ND [0.4]	ND [0.2]	ND [0.2]	ND [0.2]
TAH[c]	µg/L	10	2.68		8.92	2.51	2.70	2.70	4.30	5.40	2.70	2.66	2.70
TAqH[c]	µg/L	15	3.63		12.18	3.34	3.36	3.21	5.28	6.41	3.20	3.17	3.20
TCE	µg/L	5	ND [0.5]		ND [1]	ND [0.5]	ND [0.5]	ND [0.5]	ND [0.5]	ND [1]	ND [0.5]	ND [0.5]	0.78 J
Analyte	**Units**	**Cleanup Goal[a]**	**WCSW-02 (Q4) (FD)**	**WCSW-03 (Q1)**	**WCSW-03 (Q1) (FD)**	**WCSW-03 (Q2)**	**WCSW-03 (Q3)**	**WCSW-03 (Q4)**	**WCSW-04 (Q1)**	**WCSW-04 (Q2)**	**WCSW-04 (Q3)**	**WCSW-04 (Q4)**	**OU5SP-01 (Q1)**
Benzene	µg/L	5	ND [0.2]	ND [0.2]	ND [0.2]	ND [0.2]	ND [0.2]	ND [0.2]	ND [0.2]	ND [0.2]	ND [0.2]	ND [0.2]	Frozen, not sampled
TAH[c]	µg/L	10	2.70	5.40	5.40	2.70	2.70	2.70	4.75	2.70	2.70	2.70	
TAqH[c]	µg/L	15	3.20	6.38	6.40	3.20	3.49	3.19	5.68	3.21	3.23	3.22	
TCE	µg/L	5	0.96 J	ND [0.5]	ND [0.5]	4.83	ND [0.5]	4.75	ND [0.5]	ND [0.5]	ND [0.5]	ND [0.5]	

Notes:

[a] Cleanup levels as cited in the OU5 ROD (USAF, 1995c).
[b] TAqH was not calculated because the PAH analysis was not conducted.
[c] Water quality standards (18 AAC 75) for TAH and TAqH are 10 µg/L and 15 µg/L, respectively.
[d] Samples were not collected from this sample point as per the *2015Remedial Action-Operations and Monitoring Letter Work Plan Addendum* (USAF, 2015a).
J = analyte was positively identified: the associated numerical value is the approximate concentration of the analyte in the sample.
[ ] = limit of detection
µg/L = microgram(s) per liter
F = indicates interference occurred and result is biased high
FD = field duplicate
NA = not applicable
ND = non-detect [limit of detection]
PAH = polycyclic aromatic hydrocarbon
Q = quarter
TAH = total aromatic hydrocarbons
TAqH = total aqueous hydrocarbons
TCE = trichloroethene

Table 12-9 Summary of Analytical Results of Seeps, Surface Water and Wetlands Remediation System *(Continued)*

Analyte	Units	Cleanup Goal[a]	OU5SP-01 (Q2)	OU5SP-01 (Q3)	OU5SP-01 (Q4)	OU5SP-02 (Q1)	OU5SP-02 (Q2)	OU5SP-02 (Q3)	OU5SP-02 (Q4)	OU5SP-03	OU5SP-07 (Q1)	OU5SP-07 (Q2)	OU5SP-07 (Q3)
Benzene	µg/L	5	1.73	3.83	Frozen, not sampled	Frozen, not sampled	**18.0**	**18.9**	**16.8**	0.43	ND [0.2]	ND [0.2]	0.27 J
TAH[b]	µg/L	10	**61.1**	**140**			**95.3**	**98.4**	**90.4**	2.95	5.40	2.70	3.84
TAqH[b]	µg/L	15	**143**	**161**			**112**	**113**	**112**	3.48	6.37	3.20	4.33
TCE	µg/L	5	ND [0.5]	ND [0.5]			ND [0.5]	ND [0.5]	ND [0.5]	1.93	2.77	3.29	4.62
Analyte	**Units**	**Cleanup Goal[a]**	**OU5SP-07 (Q4)**	**OU5SP-09**	**OU5SP-09 (FD)**	**OU5SP-10 (Q1)**	**OU5SP-10 (Q2)**	**OU5SP-10 (Q3)**	**OU5SP-10 (Q4)**	**OU5SP-11 (Q1)**	**OU5SP-11 (Q2)**	**OU5SP-11 (Q3)**	**OU5SP-11 (Q4)**
Benzene	µg/L	5	ND [0.2]	ND [0.2]	ND [0.2]	ND [0.2]	ND [0.2]	0.15 J	Frozen, not sampled	ND [0.2]	ND [0.2]	0.27 J	ND [0.2]
TAH[b]	µg/L	10	2.70	2.70	2.70	5.40	2.70	3.17		5.40	2.70	3.72	2.70
TAqH[b]	µg/L	15	3.22	3.21	3.20	6.41	3.19	3.61		6.40	3.20	4.20	3.21
TCE	µg/L	5	3.97	1.48	1.50	**8.27**	**5.56**	**6.83**		**11**	**9.94**	**9.82**	**11.4**
Analyte	**Units**	**Cleanup Goal[a]**	**OU5SP-11A 6/10/15**	**OU5SP-11A 10/23/15**	**OU5SP-11A 10/23/15 (FD)**	**OU5SP-15**	**OU5SP-17**	**OU5SP-18**	**SC-01B**	**SC-08**			
Benzene	µg/L	5	ND [0.2]	ND [0.2]	NA	ND [0.2]	ND [0.2]	ND [0.2]	ND [0.2]	ND [0.2]			
TAH[b]	µg/L	10	2.70	NA	NA	3.43	2.74	2.70	2.64[c]	2.69[c]			
TAqH[b]	µg/L	15	3.20	NA	NA	3.91	3.23	3.16	3.02[c]	3.21[c]			
TCE	µg/L	5	**11.7**	**10.7**	**10.6**	ND [0.5]	1.44	0.4 J	ND [0.5]	ND [0.5]			

Notes:

[a] Cleanup levels as cited in the OU5 ROD (USAF, 1995c).
[b] Water quality standards (18 AAC 75) for total aromatic hydrocarbons (TAH) and total aqueous hydrocarbons (TAqH) are 10 µg/L and 15 µg/L, respectively.
[c] Samples were not analyzed for PAHs.
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
NA = not applicable
ND = non-detect [limit of detection]
Q = quarter
TAH = total aromatic hydrocarbons
TAqH = total aqueous hydrocarbons
TCE = trichloroethene

Table 12-10 Summary of Analytical Results of Sediment at the Wetlands Remediation System

Analyte	Units	WCSD-09[a]	WCSD-09[b]	WCSD-09[b] (FD)
Benzene	µg/kg	ND [9.3]	3.4 J	1.6 J
TCE	µg/kg	ND [9.3]	1.1 J	0.68 J

Notes:

[a] sample analyzed using SW8260 Low-level method
[b] sample analyzed using SW8260 Medium-level method
[ ] = limit of detection
J = analyte was positively identified: the associated numerical value is the approximate concentration of the analyte in the sample
µg/kg = microgram(s) per kilogram
FD = field duplicate
ND = non-detect [limit of detection]
TCE = trichloroethene

Table 12-11 Summary of 2015 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	NS	NST, Stable
OU5CP-02	NE	NE	NST, Stable	NST, Stable
OU5SP-01	NE	NST, Stable	NST	NST
OU5SP-02	NE	NST, Stable	Decreasing	Decreasing
OU5SP-10	NST, Stable	NE	NE	NE
OU5SP-11	NST	NE	NE	NE
BPSW-04	Increasing	NE	NE	NE
BPSW-05	Increasing	NE	NE	NE

Notes:

ID = identification
NE = no exceedance of cleanup goal in 2015
NST = no significant trend
Stable = Stable based on MAROS matrix ($S \leq 0$ and coefficient of variation < 1)
TAH = total aromatic hydrocarbons
TAqH = total aqueous hydrocarbons
TCE = trichloroethene

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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. 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 WCSD-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 daylighting groundwater near Pump Station #3 is not associated with the inactive treatment system nor is it associated with seeps or surface water from the bluff. Water levels in the wet wells and force main are several feet below the ground surface in this area and cannot contribute to the groundwater discharge area by the railroad.

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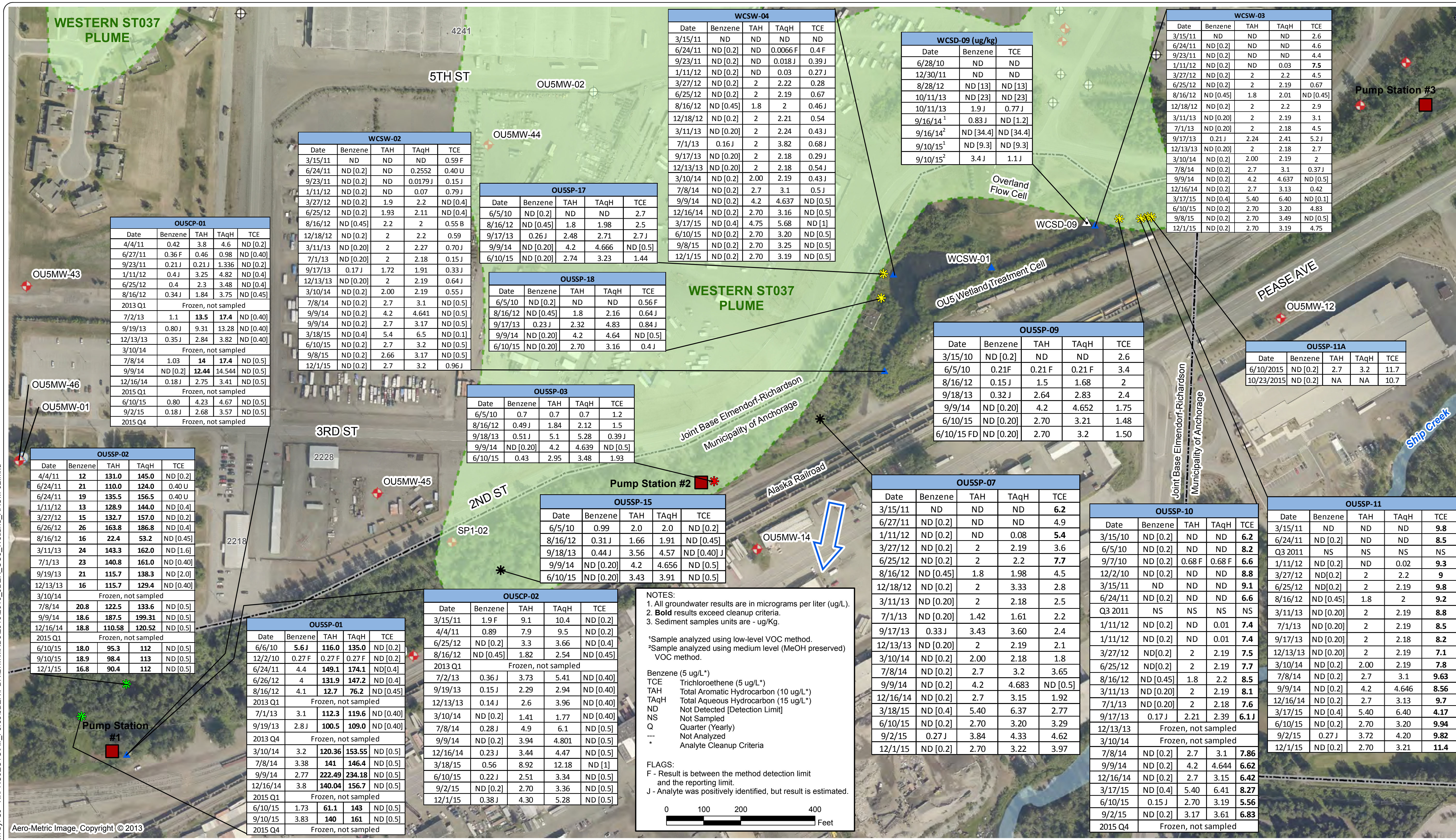

WCSW-04				
Date	Benzene	TAH	TAqH	TCE
3/15/11	ND	ND	ND	ND
6/24/11	ND [0.2]	ND	0.0066 F	0.4 F
9/23/11	ND [0.2]	ND	0.018 J	0.39 J
1/11/12	ND [0.2]	ND	0.03	0.27 J
3/27/12	ND [0.2]	2	2.22	0.28
6/25/12	ND [0.2]	2	2.19	0.67
8/16/12	ND [0.45]	1.8	2	0.46 J
12/18/12	ND [0.2]	2	2.21	0.54
3/11/13	ND [0.20]	2	2.24	0.43 J
7/1/13	0.16 J	2	3.82	0.68 J
9/17/13	ND [0.20]	2	2.18	0.29 J
12/13/13	ND [0.20]	2	2.18	0.54 J
3/10/14	ND [0.2]	2.00	2.19	0.43 J
7/8/14	ND [0.2]	2.7	3.1	0.5 J
9/9/14	ND [0.2]	4.2	4.637	ND [0.5]
12/16/14	ND [0.2]	2.70	3.16	ND [0.5]
3/17/15	ND [0.4]	4.75	5.68	ND [1]
6/10/15	ND [0.2]	2.70	3.20	ND [0.5]
9/8/15	ND [0.2]	2.70	3.25	ND [0.5]
12/1/15	ND [0.2]	2.70	3.19	ND [0.5]

WCSD-09 (ug/kg)		
Date	Benzene	TCE
6/28/10	ND	ND
12/30/11	ND	ND
8/28/12	ND [13]	ND [13]
10/11/13	ND [23]	ND [23]
10/11/13	1.9 J	0.77 J
9/16/14 [1]	0.83 J	ND [1.2]
9/16/14 [2]	ND [34.4]	ND [34.4]
9/10/15 [1]	ND [9.3]	ND [9.3]
9/10/15 [2]	3.4 J	1.1 J

WCSW-03				
Date	Benzene	TAH	TAqH	TCE
3/15/11	ND	ND	ND	2.6
6/24/11	ND [0.2]	ND	ND	4.6
9/23/11	ND [0.2]	ND	ND	4.4
1/11/12	ND [0.2]	ND	0.03	**7.5**
3/27/12	ND [0.2]	2	2.2	4.5
6/25/12	ND [0.2]	2	2.19	0.67
8/16/12	ND [0.45]	1.8	2.01	ND [0.45]
12/18/12	ND [0.2]	2	2.2	2.9
3/11/13	ND [0.20]	2	2.19	3.1
7/1/13	ND [0.20]	2	2.18	4.5
9/17/13	0.21 J	2.24	2.41	5.2 J
12/13/13	ND [0.20]	2	2.18	2.7
3/10/14	ND [0.2]	2.00	2.19	2
7/8/14	ND [0.2]	2.7	3.1	0.37 J
9/9/14	ND [0.2]	4.2	4.637	ND [0.5]
12/16/14	ND [0.2]	2.7	3.13	0.42
3/17/15	ND [0.4]	5.40	6.40	ND [0.1]
6/10/15	ND [0.2]	2.70	3.20	4.83
9/8/15	ND [0.2]	2.70	3.49	ND [0.5]
12/1/15	ND [0.2]	2.70	3.19	4.75

WCSW-02				
Date	Benzene	TAH	TAqH	TCE
3/15/11	ND	ND	ND	0.59 F
6/24/11	ND [0.2]	ND	0.2552	0.40 U
9/23/11	ND [0.2]	ND	0.0179 J	0.15 J
1/11/12	ND [0.2]	ND	0.07	0.79 J
3/27/12	ND [0.2]	1.9	2.2	ND [0.4]
6/25/12	ND [0.2]	1.93	2.11	ND [0.4]
8/16/12	ND [0.45]	2.2	2	0.55 B
12/18/12	ND [0.2]	2	2.2	0.59
3/11/13	ND [0.20]	2	2.27	0.70 J
7/1/13	ND [0.20]	2	2.18	0.15 J
9/17/13	0.17 J	1.72	1.91	0.33 J
12/13/13	ND [0.20]	2	2.19	0.64 J
3/10/14	ND [0.2]	2.00	2.19	0.55 J
7/8/14	ND [0.2]	2.7	3.1	ND [0.5]
9/9/14	ND [0.2]	4.2	4.641	ND [0.5]
9/9/14	ND [0.2]	2.7	3.17	ND [0.5]
3/18/15	ND [0.4]	5.4	6.5	ND [0.1]
6/10/15	ND [0.2]	2.7	3.2	ND [0.5]
9/8/15	ND [0.2]	2.66	3.17	ND [0.5]
12/1/15	ND [0.2]	2.7	3.2	0.96 J

OU5CP-01				
Date	Benzene	TAH	TAqH	TCE
4/4/11	0.42	3.8	4.6	ND [0.2]
6/27/11	0.36 F	0.46	0.98	ND [0.40]
9/23/11	0.21 J	0.21 J	1.336	ND [0.2]
1/11/12	0.4 J	3.25	4.82	ND [0.4]
6/25/12	0.4	2.3	3.48	ND [0.4]
8/16/12	0.34 J	1.84	3.75	ND [0.45]
2013 Q1	Frozen, not sampled			
7/2/13	1.1	**13.5**	**17.4**	ND [0.40]
9/19/13	0.80 J	9.31	13.28	ND [0.40]
12/13/13	0.35 J	2.84	3.82	ND [0.40]
3/10/14	Frozen, not sampled			
7/8/14	1.03	**14**	**17.4**	ND [0.5]
9/9/14	ND [0.2]	**12.44**	14.544	ND [0.5]
12/16/14	0.18 J	2.75	3.41	ND [0.5]
2015 Q1	Frozen, not sampled			
6/10/15	0.80	4.23	4.67	ND [0.5]
9/2/15	0.18 J	2.68	3.57	ND [0.5]
2015 Q4	Frozen, not sampled			

OU5SP-17				
Date	Benzene	TAH	TAqH	TCE
6/5/10	ND [0.2]	ND	ND	2.7
8/16/12	ND [0.45]	1.8	1.98	2.5
9/17/13	0.26 J	2.48	2.71	2.7 J
9/9/14	ND [0.20]	4.2	4.666	ND [0.5]
6/10/15	ND [0.20]	2.74	3.23	1.44

OU5SP-18				
Date	Benzene	TAH	TAqH	TCE
6/5/10	ND [0.2]	ND	ND	0.56 F
8/16/12	ND [0.45]	1.8	2.16	0.64 J
9/17/13	0.23 J	2.32	4.83	0.84 J
9/9/14	ND [0.20]	4.2	4.64	ND [0.5]
6/10/15	ND [0.20]	2.70	3.16	0.4 J

OU5SP-09				
Date	Benzene	TAH	TAqH	TCE
3/15/10	ND [0.2]	ND	ND	2.6
6/5/10	0.21F	0.21 F	0.21 F	3.4
8/16/12	0.15 J	1.5	1.68	2
9/18/13	0.32 J	2.64	2.83	2.4
9/9/14	ND [0.20]	4.2	4.652	1.75
6/10/15	ND [0.20]	2.70	3.21	1.48
6/10/15 FD	ND [0.20]	2.70	3.2	1.50

OU5SP-11A				
Date	Benzene	TAH	TAqH	TCE
6/10/2015	ND [0.2]	2.7	3.2	11.7
10/23/2015	ND [0.2]	NA	NA	10.7

OU5SP-03				
Date	Benzene	TAH	TAqH	TCE
6/5/10	0.7	0.7	0.7	1.2
8/16/12	0.49 J	1.84	2.12	1.5
9/18/13	0.51 J	5.1	5.28	0.39 J
9/9/14	ND [0.20]	4.2	4.639	ND [0.5]
6/10/15	0.43	2.95	3.48	1.93

OU5SP-02				
Date	Benzene	TAH	TAqH	TCE
4/4/11	**12**	**131.0**	**145.0**	ND [0.2]
6/24/11	**21**	**110.0**	**124.0**	0.40 U
6/24/11	**19**	**135.5**	**156.5**	0.40 U
1/11/12	**13**	**128.9**	**144.0**	ND [0.4]
3/27/12	**15**	**132.7**	**157.0**	ND [0.2]
6/26/12	**26**	**163.8**	**186.8**	ND [0.4]
8/16/12	**16**	**22.4**	**53.2**	ND [0.45]
3/11/13	**24**	**143.3**	**162.0**	ND [1.6]
7/1/13	**23**	**140.8**	**161.0**	ND [0.40]
9/19/13	**21**	**115.7**	**138.3**	ND [2.0]
12/13/13	**16**	**115.7**	**129.4**	ND [0.40]
3/10/14	Frozen, not sampled			
7/8/14	**20.8**	**122.5**	**133.6**	ND [0.5]
9/9/14	**18.6**	**187.5**	**199.31**	ND [0.5]
12/16/14	**18.8**	**110.58**	**120.52**	ND [0.5]
2015 Q1	Frozen, not sampled			
6/10/15	**18.0**	**95.3**	**112**	ND [0.5]
9/10/15	**18.9**	**98.4**	**113**	ND [0.5]
12/1/15	**16.8**	**90.4**	**112**	ND [0.5]

OU5SP-15				
Date	Benzene	TAH	TAqH	TCE
6/5/10	0.99	2.0	2.0	ND [0.2]
8/16/12	0.31 J	1.66	1.91	ND [0.45]
9/18/13	0.44 J	3.56	4.57	ND [0.40] J
9/9/14	ND [0.20]	4.2	4.656	ND [0.5]
6/10/15	ND [0.20]	3.43	3.91	ND [0.5]

OU5SP-07				
Date	Benzene	TAH	TAqH	TCE
3/15/11	ND	ND	ND	**6.2**
6/27/11	ND [0.2]	ND	ND	4.9
1/11/12	ND [0.2]	ND	0.08	**5.4**
3/27/12	ND [0.2]	2	2.19	3.6
6/25/12	ND [0.2]	2	2.2	**7.7**
8/16/12	ND [0.45]	1.8	1.98	4.5
12/18/12	ND [0.2]	2	3.33	2.8
3/11/13	ND [0.20]	2	2.18	2.5
7/1/13	ND [0.20]	1.42	1.61	2.2
9/17/13	0.33 J	3.43	3.60	2.4
12/13/13	ND [0.20]	2	2.19	2.1
3/10/14	ND [0.2]	2.00	2.18	1.8
7/8/14	ND [0.2]	2.7	3.2	3.65
9/9/14	ND [0.2]	4.2	4.683	ND [0.5]
12/16/14	ND [0.2]	2.7	3.15	1.92
3/18/15	ND [0.4]	5.40	6.37	2.77
6/10/15	ND [0.2]	2.70	3.20	3.29
9/2/15	0.27 J	3.84	4.33	4.62
12/1/15	ND [0.2]	2.70	3.22	3.97

OU5SP-10				
Date	Benzene	TAH	TAqH	TCE
3/15/10	ND [0.2]	ND	ND	**6.2**
6/5/10	ND [0.2]	ND	ND	**8.2**
9/7/10	ND [0.2]	0.68 F	0.68 F	**6.6**
12/2/10	ND [0.2]	ND	ND	**8.8**
3/15/11	ND	ND	ND	**9.1**
6/24/11	ND [0.2]	ND	ND	**6.6**
Q3 2011	NS	NS	NS	NS
1/11/12	ND [0.2]	ND	0.01	**7.4**
1/11/12	ND [0.2]	ND	0.01	**7.4**
3/27/12	ND[0.2]	2	2.19	**7.5**
6/25/12	ND[0.2]	2	2.19	**7.7**
8/16/12	ND [0.45]	1.8	2.2	**8.5**
3/11/13	ND [0.20]	2	2.19	**8.1**
7/1/13	ND [0.20]	2	2.18	**7.6**
9/17/13	0.17 J	2.21	2.39	**6.1 J**
12/13/13	Frozen, not sampled			
3/10/14	Frozen, not sampled			
7/8/14	ND [0.2]	2.7	3.1	**7.86**
9/9/14	ND [0.2]	4.2	4.644	**6.62**
12/16/14	ND [0.2]	2.7	3.15	**6.42**
3/17/15	ND [0.4]	5.40	6.41	**8.27**
6/10/15	0.15 J	2.70	3.19	**5.56**
9/2/15	ND [0.2]	3.17	3.61	**6.83**
2015 Q4	Frozen, not sampled			

OU5SP-11				
Date	Benzene	TAH	TAqH	TCE
3/15/11	ND	ND	ND	**9.8**
6/24/11	ND [0.2]	ND	ND	**8.5**
Q3 2011	NS	NS	NS	NS
1/11/12	ND [0.2]	ND	0.02	**9.3**
3/27/12	ND[0.2]	2	2.2	**9**
6/25/12	ND[0.2]	2	2.19	**9.8**
8/16/12	ND [0.45]	1.8	2	**9.2**
3/11/13	ND [0.20]	2	2.19	**8.8**
7/1/13	ND [0.20]	2	2.19	**8.5**
9/17/13	ND [0.20]	2	2.18	**8.2**
12/13/13	ND [0.20]	2	2.19	**7.1**
3/10/14	ND [0.2]	2.00	2.19	**7.8**
7/8/14	ND [0.2]	2.7	3.1	**9.63**
9/9/14	ND [0.2]	4.2	4.646	**8.56**
12/16/14	ND [0.2]	2.7	3.13	**9.7**
3/17/15	ND [0.4]	5.40	6.40	**4.17**
6/10/15	ND [0.2]	2.70	3.20	**9.94**
9/2/15	0.27 J	3.72	4.20	**9.82**
12/1/15	ND [0.2]	2.70	3.21	**11.4**

OU5CP-02				
Date	Benzene	TAH	TAqH	TCE
3/15/11	1.9 F	9.1	10.4	ND [0.2]
4/4/11	0.89	7.9	9.5	ND [0.2]
6/25/12	ND [0.2]	3.3	3.66	ND [0.4]
8/16/12	ND [0.45]	1.82	2.54	ND [0.45]
2013 Q1	Frozen, not sampled			
7/2/13	0.36 J	3.73	5.41	ND [0.40]
9/19/13	0.15 J	2.29	2.94	ND [0.40]
12/13/13	0.14 J	2.6	3.96	ND [0.40]
3/10/14	ND [0.2]	1.41	1.77	ND [0.40]
7/8/14	0.28 J	4.9	6.1	ND [0.5]
9/9/14	ND [0.2]	3.94	4.801	ND [0.5]
12/16/14	0.23 J	3.44	4.47	ND [0.5]
3/18/15	0.56	8.92	12.18	ND [1]
6/10/15	0.22 J	2.51	3.34	ND [0.5]
9/2/15	ND [0.2]	2.70	3.36	ND [0.5]
12/1/15	0.38 J	4.30	5.28	ND [0.5]

OU5SP-01				
Date	Benzene	TAH	TAqH	TCE
6/6/10	**5.6 J**	**116.0**	**135.0**	ND [0.2]
12/2/10	0.27 F	0.27 F	0.27 F	ND [0.2]
6/24/11	4.4	**149.1**	**174.1**	ND[0.4]
6/26/12	4	**131.9**	**147.2**	ND [0.4]
8/16/12	4.1	**12.7**	**76.2**	ND [0.45]
2013 Q1	Frozen, not sampled			
7/1/13	3.1	**112.3**	**119.6**	ND [0.40]
9/19/13	2.8 J	**100.5**	**109.0**	ND [0.40]
2013 Q4	Frozen, not sampled			
3/10/14	3.2	**120.36**	**153.55**	ND [0.5]
7/8/14	3.38	**141**	**146.4**	ND [0.5]
9/9/14	2.77	**222.49**	**234.18**	ND [0.5]
12/16/14	3.8	**140.04**	**156.7**	ND [0.5]
2015 Q1	Frozen, not sampled			
6/10/15	1.73	**61.1**	**143**	ND [0.5]
9/10/15	3.83	**140**	**161**	ND [0.5]
2015 Q4	Frozen, not sampled			

NOTES:
1. All groundwater results are in micrograms per liter (ug/L).
2. **Bold** results exceed cleanup criteria.
3. Sediment samples units are - ug/Kg.

[1]Sample analyzed using low-level VOC method.
[2]Sample analyzed using medium level (MeOH preserved) VOC method.

Benzene (5 ug/L*)
TCE Trichloroethene (5 ug/L*)
TAH Total Aromatic Hydrocarbon (10 ug/L*)
TAqH Total Aqueous Hydrocarbon (15 ug/L*)
ND Not Detected [Detection Limit]
NS Not Sampled
Q Quarter (Yearly)
--- Not Analyzed
* Analyte Cleanup Criteria

FLAGS:
F - Result is between the method detection limit and the reporting limit.
J - Analyte was positively identified, but result is estimated.

LEGEND

- Program Monitoring Well
- Non-Program Monitoring Well
- Abandoned Monitoring Well
- Seep Not Routed to Wetland
- Seep Routed to Wetland Until April 2009
- Seep Routed to Wetland Until August 2009
- Seep Currently Routed to Wetland
- Surface Water Sample Location
- Sediment Sample Location
- General Groundwater Flow Direction (Approximate)
- Groundwater Plume - Solvents

N

ST037 WETLAND REMEDIATION SITE MAP WITH SEEP AND SURFACE WATER ANALYTICAL DATA

2015 Annual Remedial Action – Operations and Monitoring for Select CERCLA Sites
Joint Base Elmendorf-Richardson, Alaska

Figure
12-7

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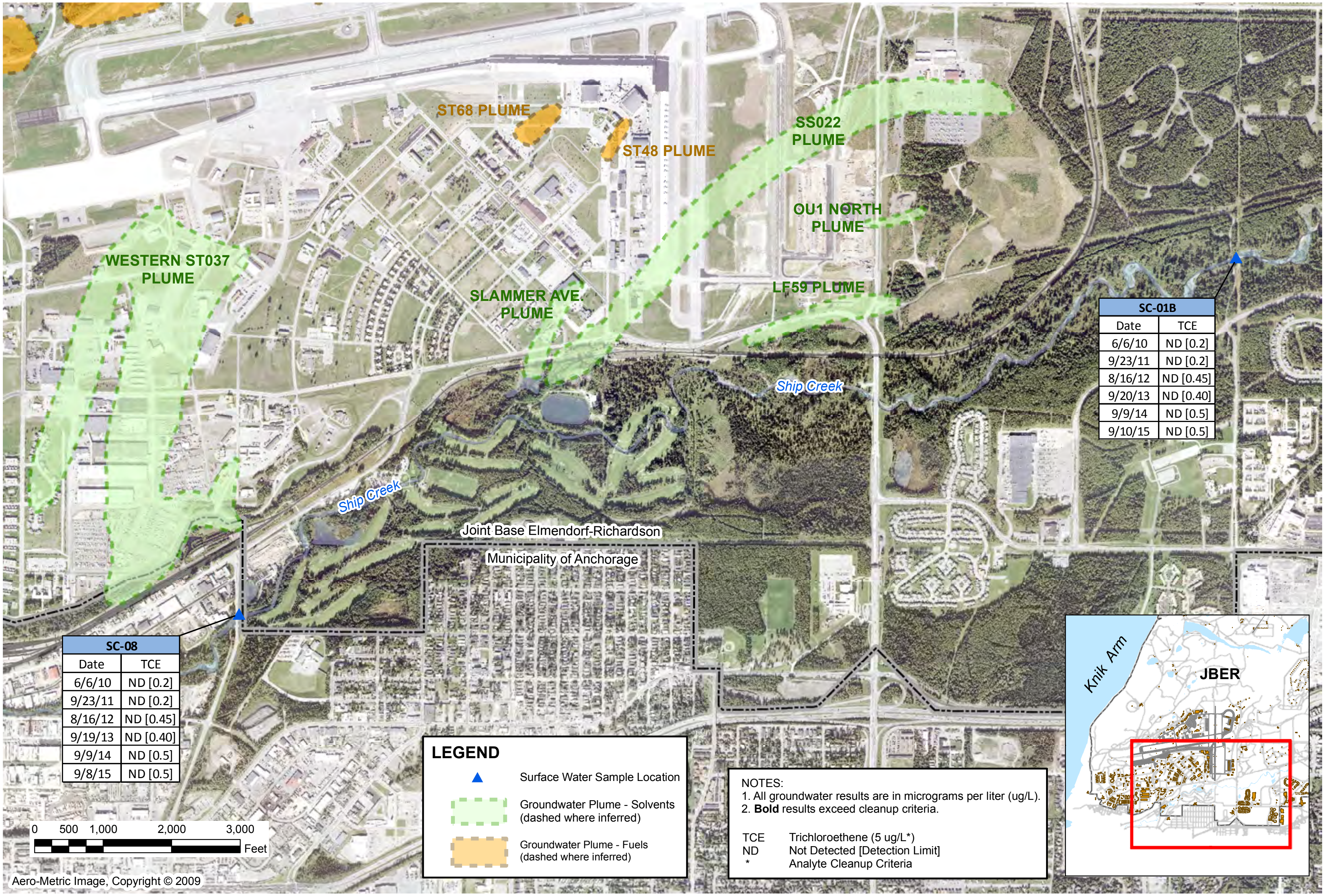

SC-01B	
Date	TCE
6/6/10	ND [0.2]
9/23/11	ND [0.2]
8/16/12	ND [0.45]
9/20/13	ND [0.40]
9/9/14	ND [0.5]
9/10/15	ND [0.5]

SC-08	
Date	TCE
6/6/10	ND [0.2]
9/23/11	ND [0.2]
8/16/12	ND [0.45]
9/19/13	ND [0.40]
9/9/14	ND [0.5]
9/8/15	ND [0.5]

LEGEND

- Surface Water Sample Location
- Groundwater Plume - Solvents (dashed where inferred)
- Groundwater Plume - Fuels (dashed where inferred)

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

TCE Trichloroethene (5 ug/L*)
ND Not Detected [Detection Limit]
* Analyte Cleanup Criteria

N

SHIP CREEK SITE MAP WITH ANALYTICAL DATA

2015 Annual Remedial Action – Operations and Monitoring for Select CERCLA Sites
Joint Base Elmendorf-Richardson, Alaska

Figure
12-8

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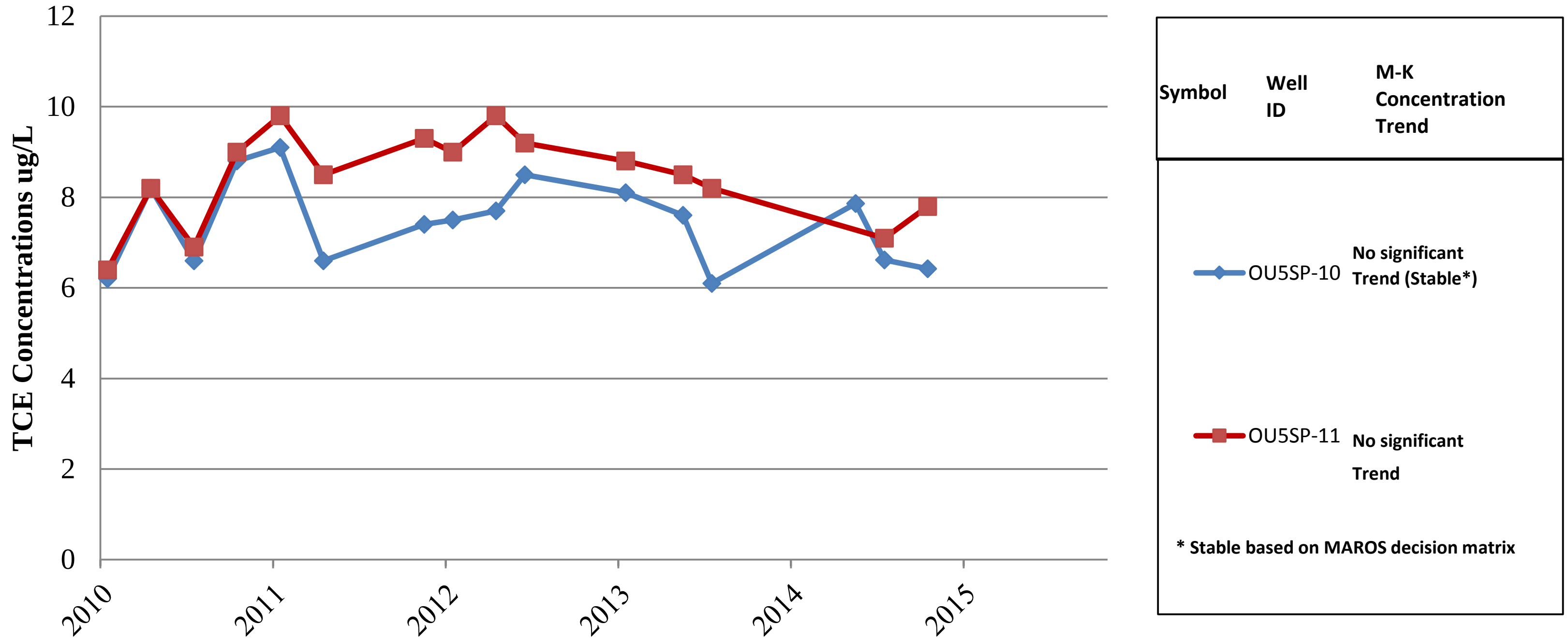

Cleanup Level
TCE = 5 µg/L

OU5 TCE TRENDS IN SEEPS

2015 Annul RA-O and Monitoring Report, Select CERCLA Sites
Joint Base Elmendorf-Richardson, Alaska

Figure
12-9

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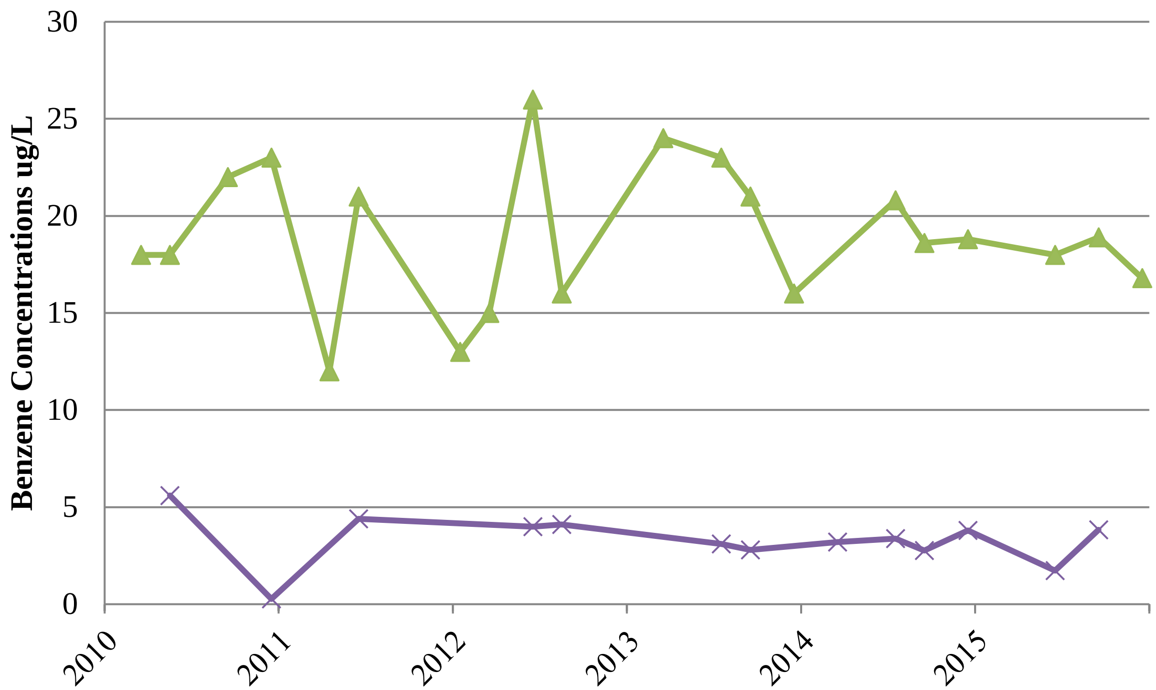

Symbol	Well ID	M-K Concentration Trend
	OU5SP-01 Benzene	No significant Trend (Stable*)
	OU5SP-02 Benzene	No significant Trend (Stable*)

* Stable based on MAROS decision matrix

Cleanup Level
Benzene = 5 µg/L

OU5 BENZENE TRENDS IN SEEPS

2015 Annul RA-O and Monitoring Report, Select CERCLA Sites
Joint Base Elmendorf-Richardson, Alaska

Figure
12-10

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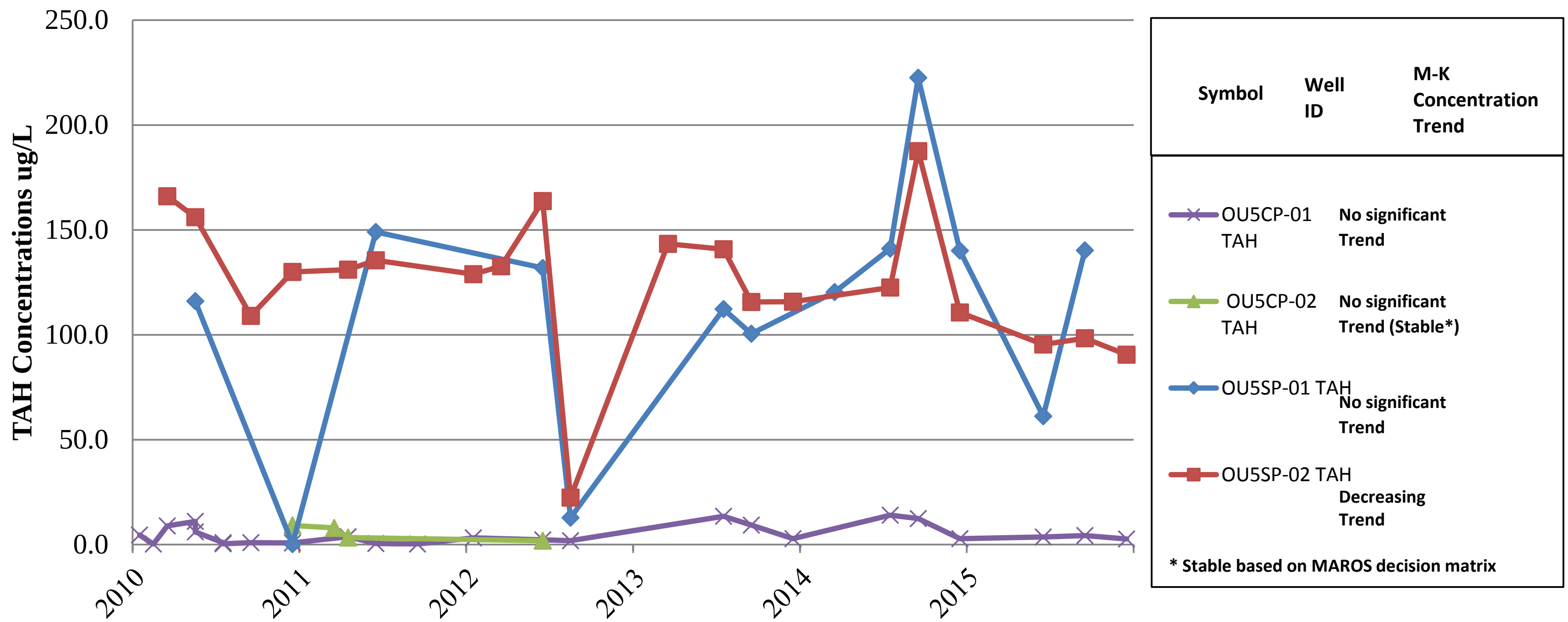

Cleanup Level
TAH = 10 µg/L

OU5 TAH TRENDS IN SEEPS

2015 Annul RA-O and Monitoring Report, Select CERCLA Sites
Joint Base Elmendorf-Richardson, Alaska

Figure
12-11

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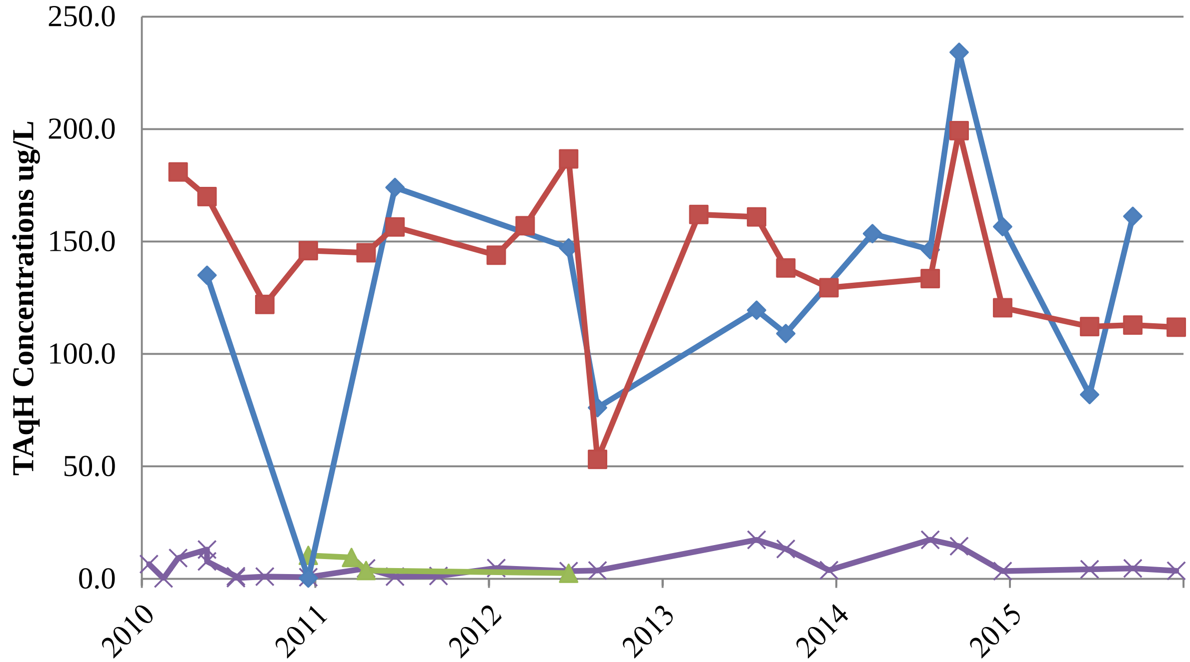

Symbol	Well ID	M-K Concentration Trend
	OU5CP-01 TAqH	No significant Trend (Stable*)
	OU5CP-02 TAqH	No significant Trend (Stable*)
	OU5SP-01 TAqH	No significant Trend
	OU5SP-02 TAqH	Decreasing Trend

*Stable based on MAROS decision matrix

Cleanup Level
TAqH = 15 µg/L

OU5 TAqH TRENDS IN SEEPS

2015 Annul RA-O and Monitoring Report, Select CERCLA Sites
Joint Base Elmendorf-Richardson, Alaska

Figure
12-12

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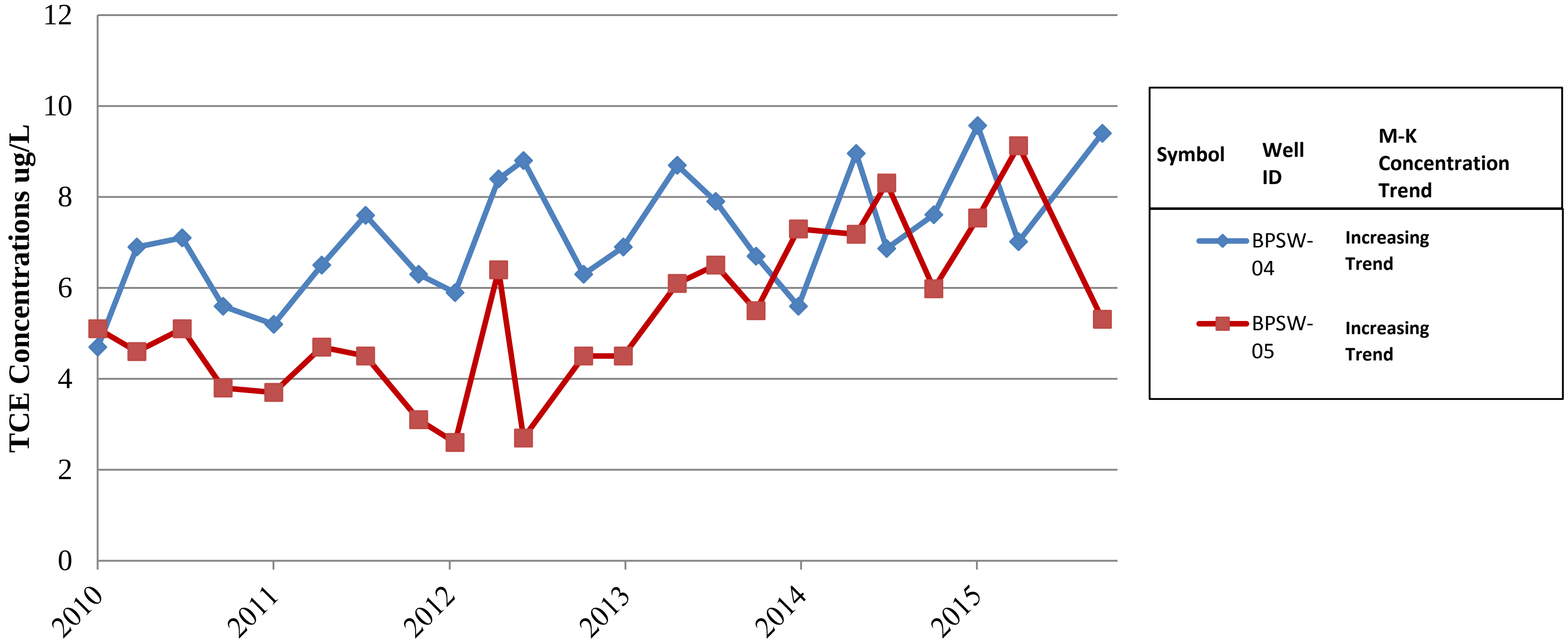

Cleanup Level
TCE = 5 µg/L

BEAVER POND TCE TRENDS IN SURFACE WATER

2015 Annul RA-O and Monitoring Report, Select CERCLA Sites
Joint Base Elmendorf-Richardson, Alaska

Figure
12-13

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12.6 EARLY WARNING AND SENTRY MONITORING WELL NETWORK

The 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. The Sentry Well network consists of 11 monitoring wells located downgradient of the Early Warning network and OU5 plumes (Figure 12-14). 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-01, OU5MW-05, OU5MW-11, and OU5MW-45. Damaged well 76WL-01 was replaced in 2011 with well 516MW-02.
- 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 2015 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 wells on June 9, 2015, and sampled on June 23, 2015. For the second semiannual sampling event, PDBs were placed on October 16, 2015, and sampled on November 3, 2015. The PDBs were deployed for 14 days during the first sampling event and deployed for 18 days during the second sampling event. A PDB was not placed in OU5MW-01 due to an obstruction in the monitoring well. Instead, a PDB was placed in monitoring well OU5MW-46. 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 2015, 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 12-12 and on Figure 12-14.

Table 12-12 Summary of 2015 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 9 June 2015		Deployed on 16 October 2015	
	Sampled on 23 June 2015		Sampled on 3 November 2015	
401WL-03	ND [0.5]	--	ND [0.5]	--
401WL-04	ND [0.5]	--	ND [0.5]	--
516MW-02	ND [0.5]	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]	--
OU5MW-14	0.38	--	0.47 J	--
OU5MW-31	1.35	--	0.99 J	0.86 J
OU5MW-33	0.41	--	0.58 J	0.53 J
OU5MW-45	ND [0.5]	ND [0.5]	ND [0.5]	--
OU5MW-46	ND [0.5]	--	ND [0.5]	--
SP/11-03	ND [0.5]	--	ND [0.5]	--
SP2/6-05	ND [0.5]	--	ND [0.5]	--
NS3-02	2.78	--	3.1	--

Notes:

[ ] = 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 Summary and Recommendations

Analytical samples collected from Early Warning and Sentry Monitoring Wells in 2015 were all below the OU5 ROD groundwater cleanup level for TCE. Monitoring well OU5MW-01 was decommissioned in 2015 because there was an obstruction in the well. The monitoring well does not require replacement because monitoring well OU5MW-46 is located approximately 10 feet downgradient and is sampled via the low flow sampling technique. It is recommended to use sample results from monitoring well OU5MW-46 for inclusion into the Early Warning and Sentry Monitoring Well network.

12.7 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.

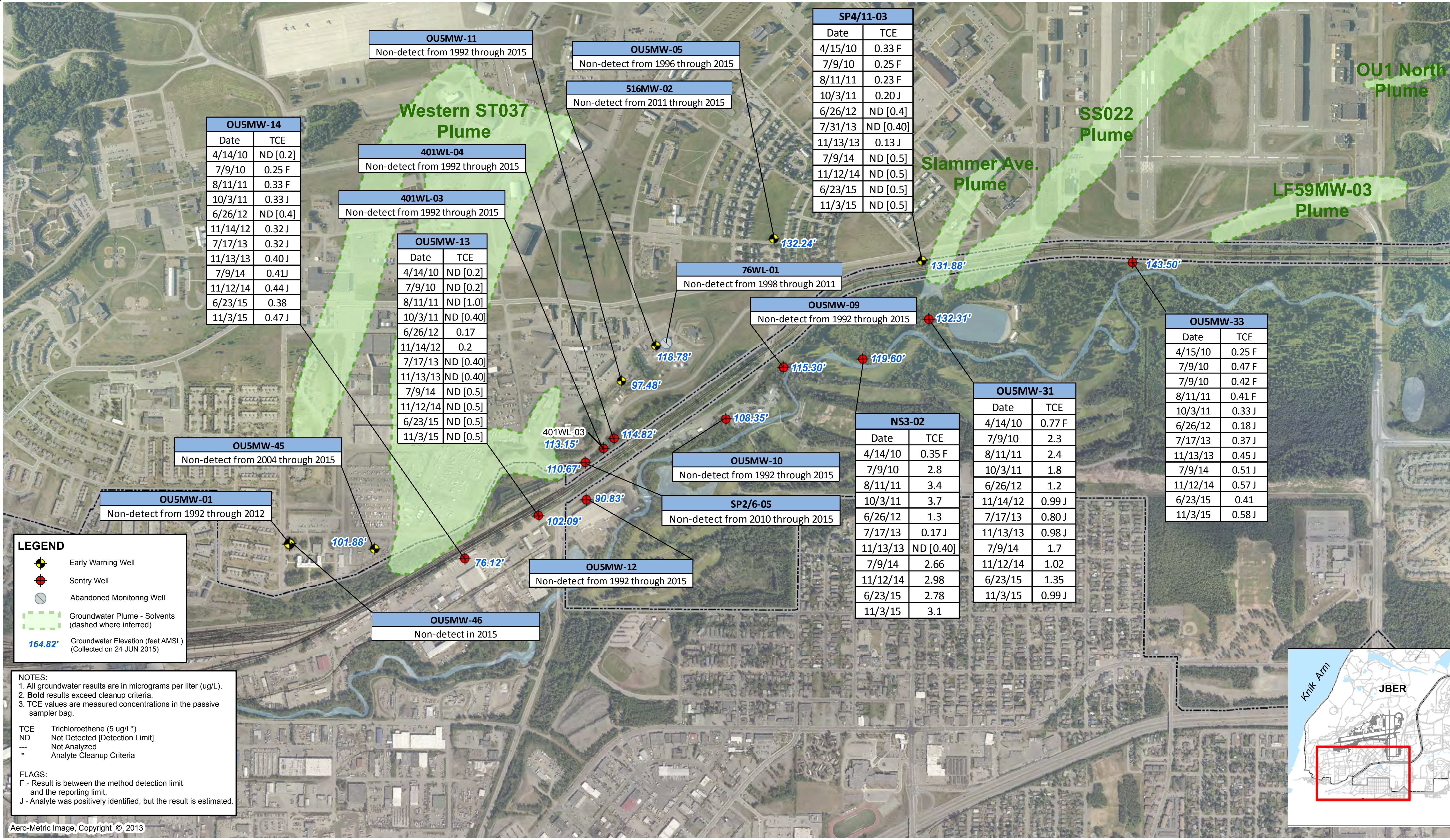
12.7.1 Five-Year Review

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 were no recommendations for ST037 documented during the first five-year review (USAF, 1998c). The second five-year review recommended re-sampling of monitoring well OU3MW-25 (OU3MW-25 plume) to confirm that TCE concentrations remain below the cleanup level. If confirmed, prepare a Memorandum to the Site File to document that sampling for this plume should be discontinued (USAF, 2003d). The third five-year review recommended sampling for 1,4-dioxane to identify if concentrations exist at a level that presents an unacceptable risk. The review also recommended optimization of early warning and sentry monitoring well networks in order to eliminate monitoring wells that are not downgradient of plumes and consider additional monitoring wells where there is a greater probability of contaminant migration (USAF, 2008c). 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 *ST037 TCE Plume and Source Area Investigation Report* (USAF, 2011c). 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

12.7.2 Recommendations

Based on the results of the 2010 investigation, five-year reviews and 2015 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.
- Sample frequency to remain quarterly at the Beaver Ponds for all surface water locations.
- Inspect and repair or replace monitoring well OU5MW-34.
- Inclusion of monitoring well OU5MW-46 (previously sampled using low flow sample methods) into the Early Warning and Sentry Monitoring Well network, replacing OU5MW-01 (sampled using PDB methods). Inclusion of OU5MW-46 into the Early Warning and Sentry Monitoring Well network would change the sampling method from a low flow method to a PDB sampling method.



OU5MW-14

Date	TCE
4/14/10	ND [0.2]
7/9/10	0.25 F
8/11/11	0.33 F
10/3/11	0.33 J
6/26/12	ND [0.4]
11/14/12	0.32 J
7/17/13	0.32 J
11/13/13	0.40 J
7/9/14	0.41J
11/12/14	0.44 J
6/23/15	0.38
11/3/15	0.47 J

OU5MW-11 Non-detect from 1992 through 2015

OU5MW-05 Non-detect from 1996 through 2015

516MW-02 Non-detect from 2011 through 2015

401WL-04 Non-detect from 1992 through 2015

401WL-03 Non-detect from 1992 through 2015

SP4/11-03

Date	TCE
4/15/10	0.33 F
7/9/10	0.25 F
8/11/11	0.23 F
10/3/11	0.20 J
6/26/12	ND [0.4]
7/31/13	ND [0.40]
11/13/13	0.13 J
7/9/14	ND [0.5]
11/12/14	ND [0.5]
6/23/15	ND [0.5]
11/3/15	ND [0.5]

OU5MW-13

Date	TCE
4/14/10	ND [0.2]
7/9/10	ND [0.2]
8/11/11	ND [1.0]
10/3/11	ND [0.40]
6/26/12	0.17
11/14/12	0.2
7/17/13	ND [0.40]
11/13/13	ND [0.40]
7/9/14	ND [0.5]
11/12/14	ND [0.5]
6/23/15	ND [0.5]
11/3/15	ND [0.5]

76WL-01 Non-detect from 1998 through 2011

OU5MW-09 Non-detect from 1992 through 2015

OU5MW-33

Date	TCE
4/15/10	0.25 F
7/9/10	0.47 F
7/9/10	0.42 F
8/11/11	0.41 F
10/3/11	0.33 J
6/26/12	0.18 J
7/17/13	0.37 J
11/13/13	0.45 J
7/9/14	0.51 J
11/12/14	0.57 J
6/23/15	0.41
11/3/15	0.58 J

OU5MW-31

Date	TCE
4/14/10	0.77 F
7/9/10	2.3
8/11/11	2.4
10/3/11	1.8
6/26/12	1.2
11/14/12	0.99 J
7/17/13	0.80 J
11/13/13	0.98 J
7/9/14	1.7
11/12/14	1.02
6/23/15	1.35
11/3/15	0.99 J

NS3-02

Date	TCE
4/14/10	0.35 F
7/9/10	2.8
8/11/11	3.4
10/3/11	3.7
6/26/12	1.3
7/17/13	0.17 J
11/13/13	ND [0.40]
7/9/14	2.66
11/12/14	2.98
6/23/15	2.78
11/3/15	3.1

OU5MW-45 Non-detect from 2004 through 2015

OU5MW-01 Non-detect from 1992 through 2012

OU5MW-10 Non-detect from 1992 through 2015

SP2/6-05 Non-detect from 2010 through 2015

OU5MW-12 Non-detect from 1992 through 2015

OU5MW-46 Non-detect in 2015

LEGEND

- Early Warning Well
- Sentry Well
- Abandoned Monitoring Well
- Groundwater Plume - Solvents (dashed where inferred)
- 164.82' Groundwater Elevation (feet AMSL) (Collected on 24 JUN 2015)

NOTES:
1. All groundwater results are in micrograms per liter (ug/L).
2. **Bold** results exceed cleanup criteria.
3. TCE values are measured concentrations in the passive sampler bag.

TCE Trichloroethene (5 ug/L*)
ND Not Detected [Detection Limit]
--- Not Analyzed
* Analyte Cleanup Criteria

FLAGS:
F - Result is between the method detection limit and the reporting limit.
J - Analyte was positively identified, but the result is estimated.

N

0 500 1,000 2,000 Feet

EARLY WARNING AND SENTRY WELLS MONITORING SITE MAP WITH ANALYTICAL DATA

2015 Annual Remedial Action – Operations and Monitoring for Select CERCLA Sites
Joint Base Elmendorf-Richardson, Alaska

Figure 12-14

Date: 29 Aug 2016 Drawn by: SJ K:\PROJECTS\Air_Force\JBER\PBRLTM\MXDs\2016\2016_JBER_Sentry_RAOM-01.mxd

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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).

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 1997 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 surface water quality standards for TAH (USAF, 1995a). Table 13-1 presents COCs and cleanup goals in groundwater and surface water at ST041.

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), ST41-10R (every two years), ST41-20 (every five years), ST41-28 (annually), 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. 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)	Basis for Cleanup Goal
Benzene	Groundwater	5	OU2 ROD (USAF, 1995a)
Ethylbenzene		700	
Toluene		1,000	OU2 ROD (USAF, 1995a)
Xylenes		10,000	OU2 ROD (USAF, 1995a)
TAH[a]	Surface Water	10[a]	OU2 ROD (USAF, 1995a)

Notes:
[a] The sum of benzene, ethylbenzene, and toluene concentrations must also be below surface water criteria for total aromatic hydrocarbons (TAH) (10 µg/L) in accordance with Section 10.2.2 of the OU2 ROD (USAF, 1995a).
µg/L = microgram(s) per liter
OU = Operable Unit
ROD = Record of Decision
TAH = total aromatic hydrocarbons
USAF = United States Air Force

13.3 2015 FIELD ACTIVITIES AND RESULTS

During 2015, two monitoring wells from the South Plume (ST41-16 and ST41-25) were sampled for BTEX compounds and MNA parameters. One surface water sample was collected downgradient of the North Plume (ST41SW-13) and was analyzed for BTEX. Monitoring well ST41-28 had free product measuring 0.34 feet so a sample was not collected. The product was bailed out. Following the product removal, approximately 0.2 feet recovered.

Concentrations of benzene exceeded the cleanup level for monitoring wells ST41-16 (6,090 µg/L), ST41-25 (19.5 µg/L). In the South Plume monitoring well ST41-16, concentrations of ethylbenzene (1,350 µg/L) and toluene (4,760 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 2015 analytical results and Table 13-3 presents a summary of the MNA analytical data and field parameters. The 2015 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 and Figure 13-3.

On July 13, 2015, water level measurements were collected from seven monitoring wells across the ST041 site. Monitoring wells ST41-24, ST41-34 and T40001 could not be located. The depth to groundwater measurements were used to calculate groundwater elevations and are summarized in Table 13-5. The groundwater elevations are also provided on Figure 13-1.

Field parameters in the ST041 South plume in 2014 were similar to those observed in previous years. The DO concentration in monitoring wells ST41-10R and ST41-16 was higher than in previous sampling events. The field MNA parameters in monitoring wells ST41-16 were mixed with DO measurements suggesting an oxidizing environment and ORP measurements indicating a reducing environment. ST41-25 showed low DO concentrations indicative of reducing conditions but a weakly oxidizing ORP. These results could be interpreted to be due to microbial decay of hydrocarbons.

A LUC inspection was performed for ST041 on 6 June 2015. During the inspection, a lock was replaced at monitoring well ST41-08. The information kiosk is accessible on site, but the Plexiglas covering has been ripped off and is lying on the ground. Most of the photographs and text on the kiosk are faded and illegible. In addition, a discarded metal cable (1 in thick) was draped on the sign. The monitoring well ST41-ES02 outer casing was bent and required abandonment. The abandonment took place on September 4, 2015. A copy of the 2015 LUC inspection form for ST041 is in Appendix B.

Table 13-2 Summary of 2015 Analytical Results at ST041

Analyte	Units	Cleanup Goal[a]	ST41-16	ST41-25	ST41SW-13
Benzene	µg/L	5	**6,090**	**19.5**	ND [0.2]
Ethylbenzene	µg/L	700	**1,350**	48.2 J	ND [0.5]
Toluene	µg/L	1,000	**4,760**	2.59	ND [0.5]
Xylenes	µg/L	10,000	6,490	6.82	ND [1.5]
TAH	µg/L	10	NA	NA	1.2

Notes:

a – Cleanup levels as cited in OU2 ROD (USAF, 1995a)
Bold result exceeds cleanup level
µg/L = microgram(s) per liter
[ ] = limit of detection
NA = not applicable
ND = non-detect [limit of detection]
TAH = total aromatic hydrocarbons

Table 13-3 Summary of 2015 MNA Analytical and Field Parameters at ST041

MNA Analytical Parameters								
Monitoring Well ID	**Chloride (mg/L)**	**Sulfate (mg/L)**	**Ethane (µg/L)**	**Ethene (µg/L)**	**Methane (µg/L)**	**Total Nitrate/Nitrite (mg/L)**	**Dissolved Iron (µg/L)**	**Dissolved Manganese (µg/L)**
ST41-16	22.8 J	0.132 J	ND [0.24]	ND [0.22]	520	ND [0.05]	60,700	22,000
ST41-25	53.5 J	2.16 J	0.2 J	ND [0.22]	1,100 J	ND [0.05]	30,200 J	13,000 J
MNA Field Parameters								
Monitoring Well ID	**Volume Purged (gallons)**	**Temp (°C)**	**Specific Conductance[a] (mS/cm)**	**DO (mg/L)**	**pH**	**ORP (mV)**	**Turbidity (NTU)**	**Alkalinity (mg/L of $CaCO_3$)**
ST41-16	2.5	7.26	1.686	1.83	6.30	-26.7	83.06	940
ST41-25	1.9	9.51	0.923	0.43	5.05	54.4	1.97	NA

Notes:

[a] Specific Conductance is a conductivity measurement that has been corrected to 25°C.
[ ] = 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.
°C = Celsius
$CaCO_3$ = calcium carbonate
DO = dissolved oxygen
ID = identification
mg/L = milligram(s) per liter
mS/cm = milli-Siemen(s) per centimeter
NA = not analyzed
ND = non-detect [limit of detection]
mV = millivolt(s)
NTU = Nephelometric Turbidity Units
ORP = oxidation-reduction potential

Table 13-4 Summary of 2015 Mann-Kendall Concentration Trends for Select Wells at ST041

Monitoring Well ID	Benzene	Ethylbenzene	Toluene	Total Xylenes
ST41-16	Decreasing	Decreasing	Decreasing	Decreasing
ST41-25	Decreasing	NE	NE	NE

Notes:
ID = identification
NE = no exceedance of cleanup goal in 2015

Table 13-5 2015 Groundwater Elevations at ST041

Monitoring Well ID	Measuring Point Elevation AMSL (ft)	Depth to Water from TOC (ft)	Groundwater Elevation AMSL (ft)
ST41-10R	242.11	9.61	232.50
ST41-16	257.75	17.22	240.53
ST41-20	223.25	4.72	218.53
ST41-25	223.51	8.12	215.39
ST41-28[a]	249.19	23.77	225.61
ST41-30	231.42	5.75	225.67
ST41-15	259.18	11.21	247.97

Notes:
[a] Monitoring well was not used in calculation of groundwater contours at the site.
Top of casing (TOC) Measuring Point Elevations taken from the 2012 Monitoring Well Survey
Depth to groundwater measured July 13, 2015
AMSL = above mean sea level
ft = feet
FTOC = from top of casing
ID = identification

13.4 SITE SUMMARY AND RECOMMENDATIONS

During 2015, the two monitoring wells sampled had concentrations of contaminants that exceeded cleanup goals. The Mann-Kendall trend tests for benzene, ethylbenzene, toluene, and xylene in monitoring well ST41-16 and benzene in monitoring well ST41-25 indicated statistically significant decreasing trends at the 95 percent confidence level.

Site ST041 is identified as a **Yellow** priority because contaminant concentrations continue to exceed ROD cleanup goals but do not show an increasing trend.

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 were no recommendations for ST41 documented during the first or second five-year review period (USAF, 1998c; USAF, 2003d). The third five-year review report recommended that surface water point of compliance (ST41SW-13) be monitored annually and seep ST41SP-01 every 5 years to assess the natural attenuation remedy for OU2 surface water. It was also recommended that monitoring wells ST41-28 (North Plume) and ST41-16 (South Plume) be incorporated back into the monitoring program for OU2 when free product is no longer present in these wells. Groundwater COC concentrations from monitoring well ST41-07 were below cleanup goals and so a reduction of the sampling frequency or elimination of the monitoring well was also recommended. 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

It is recommended to keep sample frequency consistent for 2016 and continue LUC inspections. A treatability study should be conducted to evaluate remedial technologies for the reduction of dissolved phase benzene as applicable. A modeled natural attenuation rate and time to reach ROD cleanup levels (as modeled in Source DK) should be evaluated and presented to ADEC and EPA to for discussion of whether the natural attenuation rates of benzene for the North and South Plumes are acceptable. In addition, it is also recommended that the information and the Plexiglas of the kiosk be replaced.

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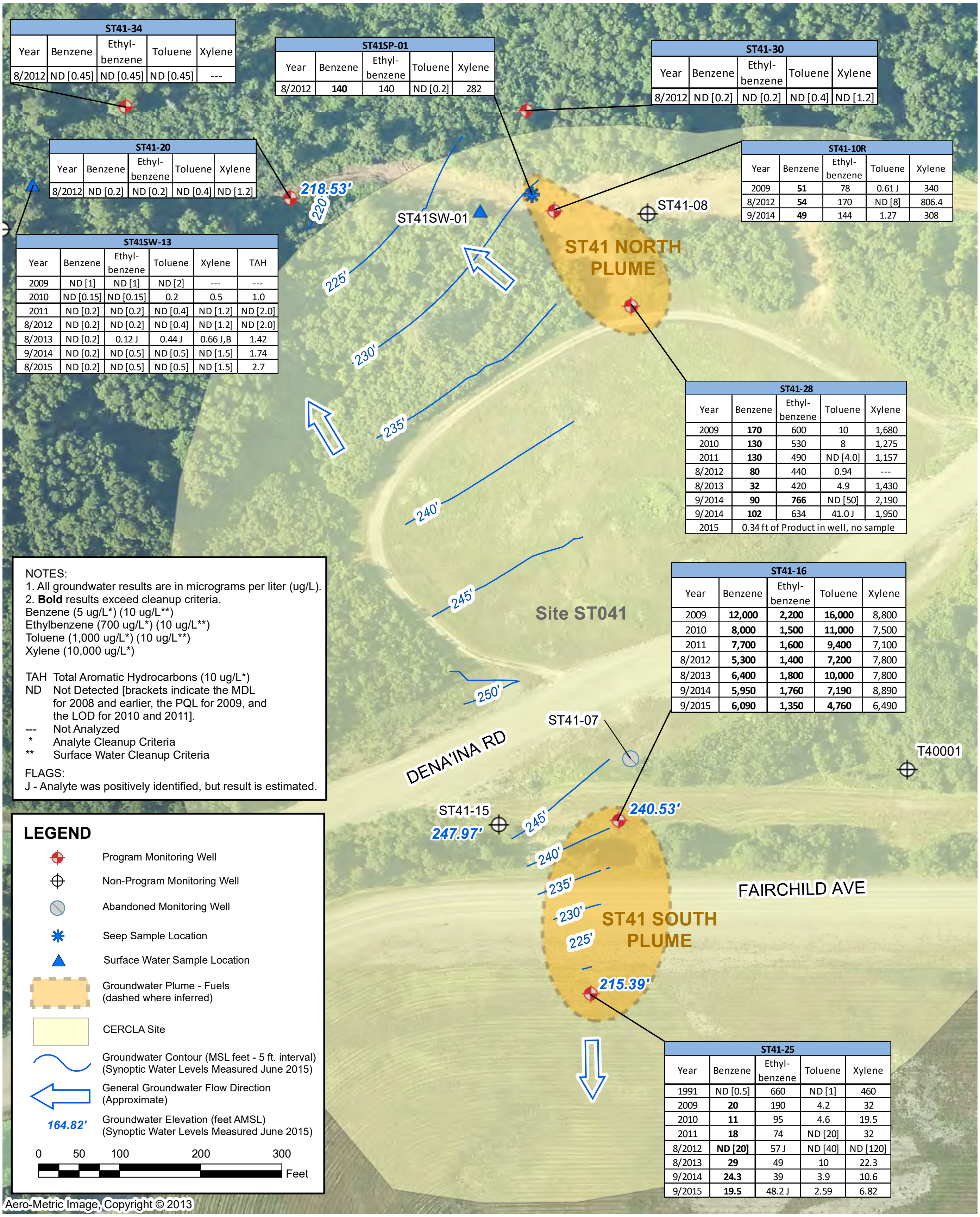

ST41-34

Year	Benzene	Ethyl-benzene	Toluene	Xylene
8/2012	ND [0.45]	ND [0.45]	ND [0.45]	---

ST41SP-01

Year	Benzene	Ethyl-benzene	Toluene	Xylene
8/2012	**140**	140	ND [0.2]	282

ST41-30

Year	Benzene	Ethyl-benzene	Toluene	Xylene
8/2012	ND [0.2]	ND [0.2]	ND [0.4]	ND [1.2]

ST41-20

Year	Benzene	Ethyl-benzene	Toluene	Xylene
8/2012	ND [0.2]	ND [0.2]	ND [0.4]	ND [1.2]

ST41-10R

Year	Benzene	Ethyl-benzene	Toluene	Xylene
2009	**51**	78	0.61 J	340
8/2012	**54**	170	ND [8]	806.4
9/2014	**49**	144	1.27	308

ST41SW-13

Year	Benzene	Ethyl-benzene	Toluene	Xylene	TAH
2009	ND [1]	ND [1]	ND [2]	---	---
2010	ND [0.15]	ND [0.15]	0.2	0.5	1.0
2011	ND [0.2]	ND [0.2]	ND [0.4]	ND [1.2]	ND [2.0]
8/2012	ND [0.2]	ND [0.2]	ND [0.4]	ND [1.2]	ND [2.0]
8/2013	ND [0.2]	0.12 J	0.44 J	0.66 J,B	1.42
9/2014	ND [0.2]	ND [0.5]	ND [0.5]	ND [1.5]	1.74
8/2015	ND [0.2]	ND [0.5]	ND [0.5]	ND [1.5]	2.7

ST41-28

Year	Benzene	Ethyl-benzene	Toluene	Xylene
2009	**170**	600	10	1,680
2010	**130**	530	8	1,275
2011	**130**	490	ND [4.0]	1,157
8/2012	**80**	440	0.94	---
8/2013	**32**	420	4.9	1,430
9/2014	**90**	766	ND [50]	2,190
9/2014	**102**	634	41.0 J	1,950
2015	0.34 ft of Product in well, no sample			

ST41-16

Year	Benzene	Ethyl-benzene	Toluene	Xylene
2009	**12,000**	**2,200**	**16,000**	8,800
2010	**8,000**	**1,500**	**11,000**	7,500
2011	**7,700**	**1,600**	**9,400**	7,100
8/2012	**5,300**	**1,400**	**7,200**	7,800
8/2013	**6,400**	**1,800**	**10,000**	7,800
9/2014	**5,950**	**1,760**	**7,190**	8,890
9/2015	**6,090**	**1,350**	**4,760**	6,490

ST41-25

Year	Benzene	Ethyl-benzene	Toluene	Xylene
1991	ND [0.5]	660	ND [1]	460
2009	**20**	190	4.2	32
2010	**11**	95	4.6	19.5
2011	**18**	74	ND [20]	32
8/2012	**ND [20]**	57 J	ND [40]	ND [120]
8/2013	**29**	49	10	22.3
9/2014	**24.3**	39	3.9	10.6
9/2015	**19.5**	48.2 J	2.59	6.82

NOTES:
1. All groundwater results are in micrograms per liter (ug/L).
2. **Bold** results exceed cleanup criteria.
Benzene (5 ug/L*) (10 ug/L**)
Ethylbenzene (700 ug/L*) (10 ug/L**)
Toluene (1,000 ug/L*) (10 ug/L**)
Xylene (10,000 ug/L*)

TAH Total Aromatic Hydrocarbons (10 ug/L*)
ND Not Detected [brackets indicate the MDL for 2008 and earlier, the PQL for 2009, and the LOD for 2010 and 2011].
--- Not Analyzed
* Analyte Cleanup Criteria
** Surface Water Cleanup Criteria

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

LEGEND

- Program Monitoring Well
- Non-Program Monitoring Well
- Abandoned Monitoring Well
- Seep Sample Location
- Surface Water Sample Location
- Groundwater Plume - Fuels (dashed where inferred)
- CERCLA Site
- Groundwater Contour (MSL feet - 5 ft. interval) (Synoptic Water Levels Measured June 2015)
- General Groundwater Flow Direction (Approximate)
- 164.82' Groundwater Elevation (feet AMSL) (Synoptic Water Levels Measured June 2015)

0 50 100 200 300 Feet

N

ST041 SITE MAP WITH ANALYTICAL DATA

2015 Annual Remedial Action - Operations and Monitoring for Select CERCLA Sites
Joint Base Elmendorf-Richardson, Alaska

Figure 13-1

Date: 03 May 2017 Drawn by: SJ K:\PROJECTS\Air_Force\JBER\PBRLTM\MXDs\2016\2016_JBER_ST041_RAOM-01.mxd

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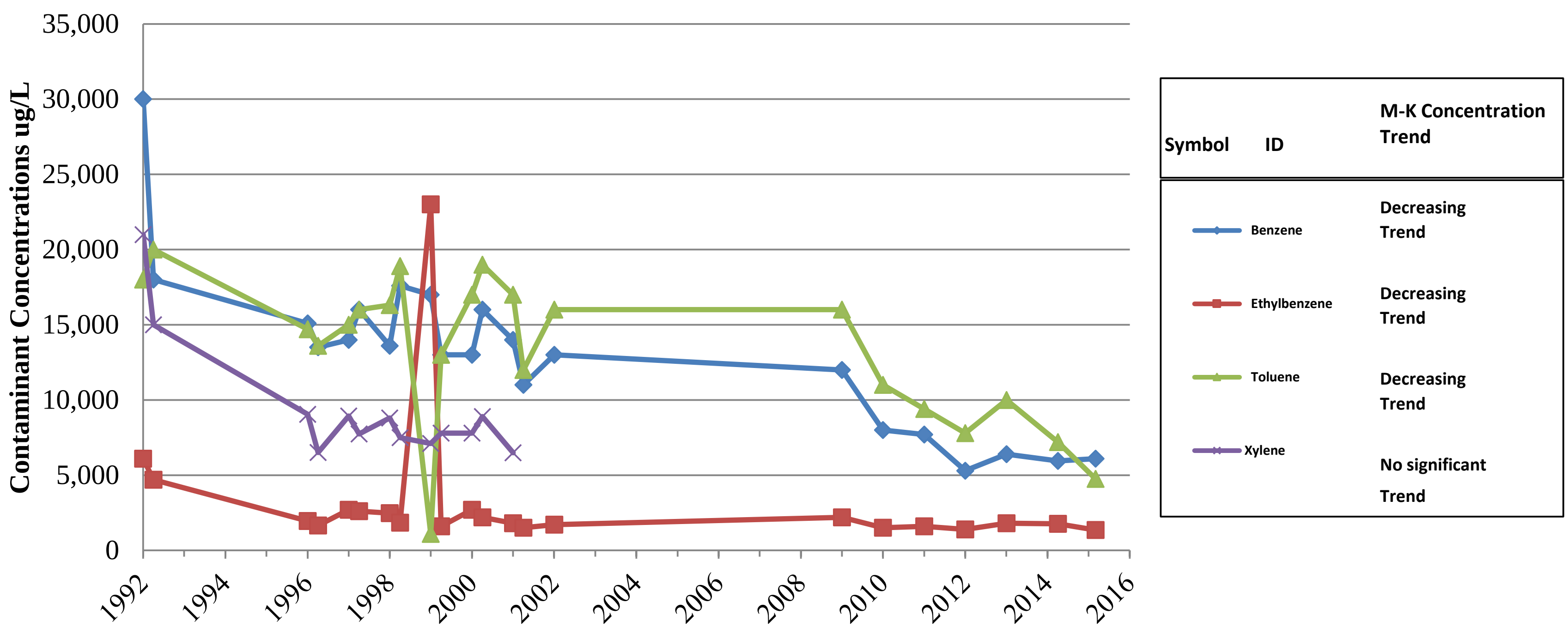

Cleanup Levels
Benzene = 5 µg/L
Ethylbenzene = 700 µg/L

ST041 CONTAMINANT TRENDS IN ST41-16

2015 Annul RA-O and Monitoring Report, Select CERCLA Sites
Joint Base Elmendorf-Richardson, Alaska

Figure
13-2

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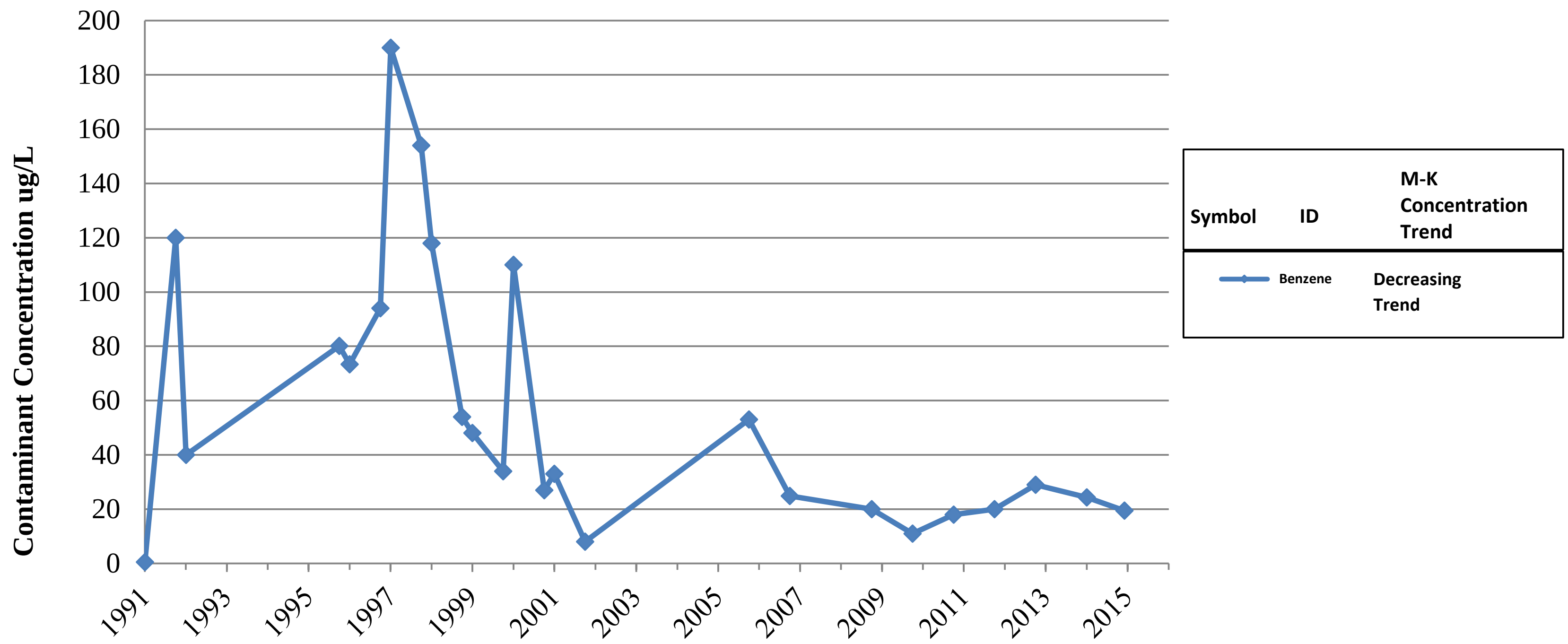

Cleanup Level
Benzene = 5 µg/L

ST041 BENZENE TREND IN ST41-25

2015 Annul RA-O and Monitoring Report, Select CERCLA Sitess
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-feet by 300-feet 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, 2005a).

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 plume (OU6MW-46 plume) is a smaller plume crossgradient 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, 2011d). 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. Monitoring well OU6MW-67 is interpreted to be screened in the lower aquifer. 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 MNA 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).

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 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 (µg/L)	Basis for Cleanup Goal
Benzene	5	OU6 ROD (USAF, 1997b)
Ethylbenzene	700	
Toluene	1,000	

Notes:
µg/L = microgram(s) per liter
OU = Operable Unit
ROD = Record of Decision
USAF = United States Air Force

14.3 2015 FIELD ACTIVITIES AND RESULTS

During 2015, monitoring wells OU6MW-13, OU6MW-92, OU6MW-93, 14MW-120 and 14MW-121 were sampled for VOCs and MNA parameters. Monitoring well OU6MW- 91 was not sampled because free product was present in the well at a thickness of 0.28 feet. The product levels for monitoring well OU6MW-77 were measured at 0.18 feet thick. Free product was removed from OU6MW-77 and OU6MW-91 using a bailer to the maximum extent possible. The free product and groundwater mixture were placed in two 5-gallon buckets and stored in a fire cabinet at the field connex. For cost efficiency, fluid disposal will occur once the 2016 and 2017 sampling activities are finished and so that any possible product recovered can be combined with 2015 fluids.

Seeps LF04SP-03 and LF04SP-04 were sampled quarterly for VOCs. One field duplicate sample was collected from OU6MW-13. Concentrations of benzene exceeded the cleanup goal in monitoring well OU6MW-92 (66.8 µg/L). Concentrations of benzene also exceeded the cleanup goal in seep LF04SP-03 during the second and third quarters and seep LF04SP-04 in the second and fourth quarters. Table 14-2 presents a summary of the 2015 analytical results and Table 14-3 presents a summary of the MNA analytical data and field parameters. The 2015 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 through Figure 14-4.

On June 1, 2015, water levels were measured in 13 monitoring wells at the WP014 site. Groundwater levels were not measured at wells OU6MW-61, OU6MW-63 and OU6MW-46 due to oversight or inability to locate the well and levels were measured at 14MW-111 and OU6MW-12 instead of well 14MW-121. Groundwater levels were also measured at four locations (monitoring wells OU6MW-06, OU6MW-60, OU6MW-77 and OU6MW-78) not originally proposed for measurement. The depth to groundwater measurements were used to calculate groundwater elevations and are summarized in Table 14-5. The groundwater elevations are also provided on Figure 14-1.

The low DO and reducing ORP measured in well 14MW-121 are indicative of weakly reducing conditions. These conditions can be interpreted to be consistent with microbial decay of hydrocarbons. This location lies just upgradient of the mapped plume and the 2015 benzene results are below the ROD cleanup level. ORP measurements indicative of weakly reducing conditions are present within the plume at OU6MW-92, and OU6MW-93, and at the upgradient location 14MW-120. However, DO measurements in these wells do not indicate a reducing environment. Methanogenesis is indicated in several wells with the greatest methane concentration reported from OU6MW-92 at 895 µg/L in the middle of the plume. Low nitrate conditions are expected in wells where microorganism are biodegrading BTEX. Compared to the relatively high nitrate values seen in OU6MW-13 outside the plume, monitoring wells OU6MW-92 and OU6MW-93 within the plume boundary are depleted in nitrate. Varying degrees of sulfate reduction are indicated in OU6MW-92 and OU6MW-93 in the plume as compared to OU6MW-13 outside the plume.

Well OU6MW-92 was purged dry and a grab sample was collected the following day. Field parameters were not measured when the grab sample was collected due to limited volume. Because OU6MW-92 is screened across the saturated zone table in low permeability formations and was bailed dry during purging, groundwater recharge to the well will tend occur throughout the saturated zone of the formation. Recharge occurring in this situation could be expected to cascade down the filter pack as a thin film and would result in a potential low bias for VOCs. This well would be a good candidate for PDB sampling. Free product was present in monitoring well OU6MW-91 and it was not sampled in 2015.

A LUC inspection performed for WP014 on June 15, 2015 identified damage to monitoring well OU6MW-05. This well should be evaluated for repair or decommissioning. However, the well is not currently being monitored at the WP014 Plume. One new monitoring well (OU6MW-95) was installed in September for the *WP014 Limited Site Investigation* that will be finalized in 2017. Well OU6MW-95 was installed as part of the site investigation and was not sampled as part of the annual RA-O and Monitoring program. Results from the *WP014 Limited Site Investigation* will be reported under a separate cover. A copy of the 2015 LUC inspection form for WP014 is in Appendix B.

Table 14-2 Summary of 2015 Analytical Results at WP014

Analyte	Units	Cleanup Goal[a]	LF04SP-03 (Q1)	LF04SP-03 (Q2)	LF04SP-03 (Q3)	LF04SP-03 (Q4)	LF04SP-04 (Q1)	LF04SP-04 (Q2)	LF04SP-04 (Q3)
Benzene	µg/L	5	4.51	**17.6**	**12.4**	ND [0.2]	4.31	**5.09**	4.71
Ethylbenzene	µg/L	700	ND [1]	ND [0.5]	ND [0.5]	ND [0.5]	11.9	18.1	18.6
Toluene	µg/L	1,000	ND [1]	ND [0.5]	ND [0.5]	ND [0.5]	0.61 F	0.71 J	0.85 J
Analyte	**Units**	**Cleanup Goal[a]**	**LF04SP-04 (Q4)**	**OU6MW-13**	**OU6MW-13 (FD)**	**OU6MW-92[b]**	**OU6MW-93**	**14MW-120**	**14MW-121**
Benzene	µg/L	5	**5.28**	ND [0.2]	ND [0.2]	**66.8**	ND [0.2]	3.66	4.89
Ethylbenzene	µg/L	700	17.0	ND [0.5]	ND [0.5]	340	ND [0.5]	55.3	50.9
Toluene	µg/L	1,000	0.77 J	0.56 J	0.56 J	24.6	0.59 J	50.2	85.8

Notes:

[a] Cleanup levels as cited in the OU6 ROD (USAF, 1997b).
[b] 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
F = indicates value that is greater than or equal to the detection limit
FD = field duplicate
ND = non-detect [limit of detection]
Q = quarter

Table 14-3 Summary of 2015 MNA Analytical and Field Parameters at WP014

MNA Analytical Parameters									
Monitoring Well ID	**Chloride (mg/L)**	**Sulfate (mg/L)**	**Ethane (µg/L)**	**Ethene (µg/L)**	**Methane (µg/L)**	**Dissolved Iron (µg/L)**	**Dissolved Manganese (µg/L)**	**Nitrate (µg/L)**	**Nitrite (µg/L)**
14MW-120	4,140	5,160	ND [13.4]	ND [12.5]	6.94 J	1,300	1,680	431	ND [100]
14MW-121	5,740	1,260 J	ND [13.4]	ND [12.5]	52.9	18,500	5,100	NA	NA
OU6MW-13	3,110	79,800	ND [13.4]	ND [12.5]	ND [7.1]	ND [500]	196	1,400	ND [100]
OU6MW-13 FD	3,170	79,700	ND [13.4]	ND [12.5]	ND [7.1]	ND [500]	196	1,420	ND [100]
OU6MW-92	3,940	101 J	ND [13.4]	ND [12.5]	895	6,150	9,220	ND [100]	ND [100]
OU6MW-93	4,920	2,390 J	ND [13.4]	ND [12.5]	11.7	ND [500]	300	93 B	ND [100]

MNA Field Parameters								
Monitoring Well ID	**Volume Purged (gallons)**	**Temp (°C)**	**Specific Conductance[e] (mS/cm)**	**DO (mg/L)**	**pH**	**ORP (mV)**	**Turbidity (NTU)**	**Alkalinity (mg/L of $CaCO_3$)[d]**
14MW-120[a]	4.25	7.05	209	1.21	6.80	-59.2	0.08	NA
14MW-121[b]	1.8	3.30	0.400	0.13	6.59	-39.3	14.40	NA
OU6MW-13	3.0	4.13	0.938	4.62	6.97	180.1	19.56	NA
OU6MW-92[b,c]	0.4	4.36	0.634	1.22	6.27	-36.2	NA	NA
OU6MW-93	4.1	6.17	0.434	0.64	6.13	201.3	1.34	NA

Notes:

[a] Sample collected after 3 well volumes collected.
[b] Well is very slow to recharge and was pumped dry. A groundwater sample was collected the following day using a bailer.
[c] Well pumped to quickly to turbidity reading, less than one foot of water on well.
[d] Sample not analyzed for alkalinity because samples were collected during the LSI and the *2015 Remedial Action-Operations and Monitoring Letter Work Plan Addendum* was not approved at that time.
[e] Specific Conductance is a conductivity measurement that has been corrected to 25°C.
[ ] = 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.
°C = Celsius
$CaCO_3$ = calcium carbonate
DO = dissolved oxygen
ID = identification
mg/L = milligram(s) per liter
mS/cm = milli-Siemen(s) per centimeter
mV = millivolt(s)
NA = not analyzed
ND = non-detect [limit of detection]
NTU = Nephelometric Turbidity Units
ORP = oxidation-reduction potential

Table 14-4 Summary of 2015 Mann-Kendall Concentration Trends for Select Wells at WP014

Monitoring Well ID	Benzene	Ethylbenzene
LF04SP-03	NST	NE
LF04SP-04	NST	NE
OU6MW-92	NST	NST

Notes:
ID = identification
NE = no exceedance of cleanup goal in 2015
NST = no significant trend

Table 14-5 2015 Groundwater Elevations at WP014

Monitoring Well ID	Measuring Point Elevation AMSL (ft)	Depth to Water FTOC (ft)	Groundwater Elevation AMSL (ft)
14MW-111	205.83	23.19	182.64
14MW-120	224.15	24.91	199.24
14MW-123	256.65	41.56	215.09
14MW-138	206.90	27.04	179.86
OU6MW-06	215.37	18.59	196.78
OU6MW-12	196.27	22.31	173.96
OU6MW-13[a]	186.31	54.14	132.17
OU6MW-60	216.30	12.20	204.10
OU6MW-67[a]	226.07	66.11	159.96
OU6MW-75	223.69	41.08	182.61
OU6MW-77	200.95	29.58	171.51[b]
OU6MW-91	199.24	26.60	172.86[b]
OU6MW-92	204.55	34.44	170.11
OU6MW-93	216.72	56.04	160.68
OU6MW-94	188.22	20.70	167.52

Notes:

Top of casing Measuring Point Elevations taken from the 2013 Environmental Restoration Program Atlas (USAF, 2013a), except for monitoring wells 14MW-111, 14MW-123, 14MW-138, OU6MW-75 and OU6MW-77; measuring points for these wells were taken from the UFP-QAPP WP014 Limited Site Investigation Work Plan (USAF, 2015d).

Depth to groundwater measurements were collected on June 1, 2015.

[a] Monitoring well was not used in calculation of groundwater contours at the site.
[b] Groundwater elevation was adjusted to account for the difference (0.8) in the specific gravity of petroleum.
AMSL = above mean sea level
ft = foot
FTOC = from top of casing
ID = identification

14.4 SITE SUMMARY AND RECOMMENDATIONS

The 2015 monitoring results are consistent with the plume in the shallow aquifer that extends from the WP014 site to points of discharge at seeps LF04SP-03 and LF04SP-04 on the bluff overlooking Knik Arm. Dissolved benzene concentrations are probably maintained by ongoing dissolution of residual product in the contaminated smear zone and will continue to be present at similar levels 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 two of four quarterly sampling events in 2015. In 2013, the benzene concentration in seep LF04SP-04 was above the cleanup level for the first time since 2007; therefore, this seep was sampled quarterly. In 2015, benzene concentrations continued to exceed the cleanup level in the second and fourth 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.

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 and 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.

The Mann-Kendall trend tests for benzene and ethylbenzene in monitoring well OU6MW-92 and benzene in the seeps LF04SP-03 and LF04SP-04 indicated no statistically significant trends at the 95 percent confidence level (Table 14-4, Figures 14-2, 14-3 and 14-4).

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 were no recommendations for WP014 documented during the first or second five-year review period (USAF, 1998c; USAF, 2003d). The third five-year review report recommended monitoring well OU6MW-77 be incorporated back into the monitoring program for WP14 once free product is no longer present in the well (USAF, 2008c). 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. Well OU6MW-67 exhibited a benzene concentration of 5.2 μg/L that exceeded the cleanup level in 2013 after being below the cleanup level since 1999; it was sampled in 2014 and 2015. This monitoring well is also used to monitor groundwater at LF004. It is recommended that this well be sampled annually to determine whether benzene concentrations significantly decrease. In 2016, monitoring well OU6MW-13 will be sampled for 2-methylnaphthalene in addition to VOCs, as recommended in the fourth five-year review. It is also recommended that if OU6MW-91 continues to have measurable product in the well then samples should be collected from OU6MW-94 as a replacement.

Additional characterization work for 2015 is being conducted at the WP014 site under the *WP014 UFP-QAPP Limited Site Investigation Work Plan* (USAF, 2015d). The results of the LSI are anticipated to be finalized in 2017, additional recommendations will be provided after the results are evaluated.

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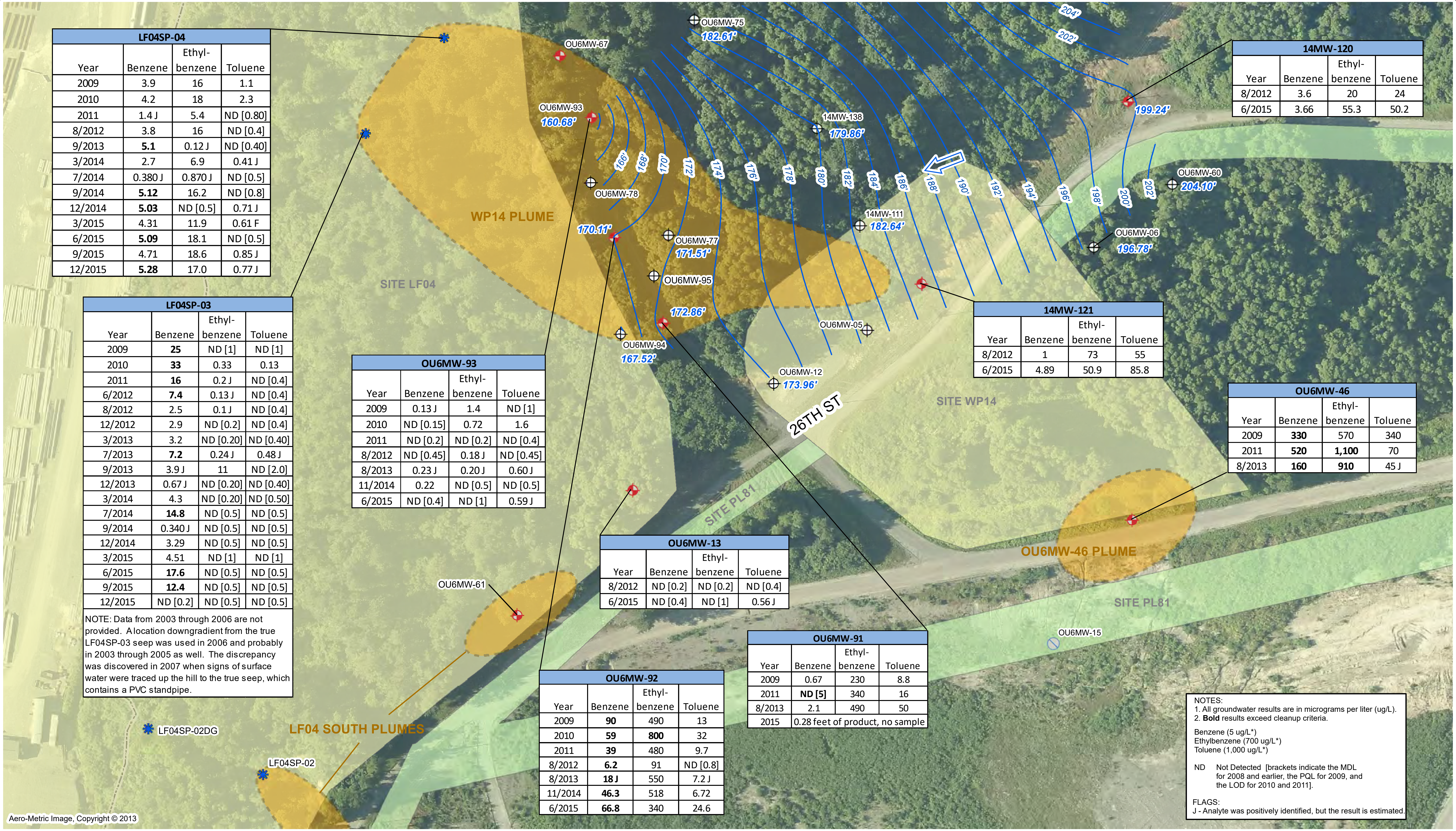

LF04SP-04

Year	Benzene	Ethyl-benzene	Toluene
2009	3.9	16	1.1
2010	4.2	18	2.3
2011	1.4 J	5.4	ND [0.80]
8/2012	3.8	16	ND [0.4]
9/2013	**5.1**	0.12 J	ND [0.40]
3/2014	2.7	6.9	0.41 J
7/2014	0.380 J	0.870 J	ND [0.5]
9/2014	**5.12**	16.2	ND [0.8]
12/2014	**5.03**	ND [0.5]	0.71 J
3/2015	4.31	11.9	0.61 F
6/2015	**5.09**	18.1	ND [0.5]
9/2015	4.71	18.6	0.85 J
12/2015	**5.28**	17.0	0.77 J

LF04SP-03

Year	Benzene	Ethyl-benzene	Toluene
2009	**25**	ND [1]	ND [1]
2010	**33**	0.33	0.13
2011	**16**	0.2 J	ND [0.4]
6/2012	**7.4**	0.13 J	ND [0.4]
8/2012	2.5	0.1 J	ND [0.4]
12/2012	2.9	ND [0.2]	ND [0.4]
3/2013	3.2	ND [0.20]	ND [0.40]
7/2013	**7.2**	0.24 J	0.48 J
9/2013	3.9 J	11	ND [2.0]
12/2013	0.67 J	ND [0.20]	ND [0.40]
3/2014	4.3	ND [0.20]	ND [0.50]
7/2014	**14.8**	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	**17.6**	ND [0.5]	ND [0.5]
9/2015	**12.4**	ND [0.5]	ND [0.5]
12/2015	ND [0.2]	ND [0.5]	ND [0.5]

NOTE: Data from 2003 through 2006 are not provided. A location downgradient from the true LF04SP-03 seep was used in 2006 and probably in 2003 through 2005 as well. The discrepancy was discovered in 2007 when signs of surface water were traced up the hill to the true seep, which contains a PVC standpipe.

OU6MW-93

Year	Benzene	Ethyl-benzene	Toluene
2009	0.13 J	1.4	ND [1]
2010	ND [0.15]	0.72	1.6
2011	ND [0.2]	ND [0.2]	ND [0.4]
8/2012	ND [0.45]	0.18 J	ND [0.45]
8/2013	0.23 J	0.20 J	0.60 J
11/2014	0.22	ND [0.5]	ND [0.5]
6/2015	ND [0.4]	ND [1]	0.59 J

OU6MW-13

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

OU6MW-92

Year	Benzene	Ethyl-benzene	Toluene
2009	**90**	490	13
2010	**59**	**800**	32
2011	**39**	480	9.7
8/2012	**6.2**	91	ND [0.8]
8/2013	**18 J**	550	7.2 J
11/2014	**46.3**	518	6.72
6/2015	**66.8**	340	24.6

OU6MW-91

Year	Benzene	Ethyl-benzene	Toluene
2009	0.67	230	8.8
2011	**ND [5]**	340	16
8/2013	2.1	490	50
2015	0.28 feet of product, no sample		

14MW-120

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

14MW-121

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

OU6MW-46

Year	Benzene	Ethyl-benzene	Toluene
2009	**330**	570	340
2011	**520**	**1,100**	70
8/2013	**160**	**910**	45 J

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 2011].

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

N

0 30 60 120 180 Feet

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)
- 164.82' Groundwater Elevation (feet AMSL) (Synoptic Water Levels Measured June 2015)
- Groundwater Contour Line (feet AMSL) (Synoptic Water Levels Measured June 2015)

WP014 SITE MAP WITH ANALYTICAL DATA

2015 Annual Remedial Action - Operations and Monitoring for Select CERCLA Sites
Joint Base Elmendorf-Richardson, Alaska

Figure 14-1

Date: 03 May 2017 Drawn by: SJ K:\PROJECTS\Air_Force\JBER\PBRLTM\MXDs\2017\2017_JBER_WP014_LTM-01.mxd

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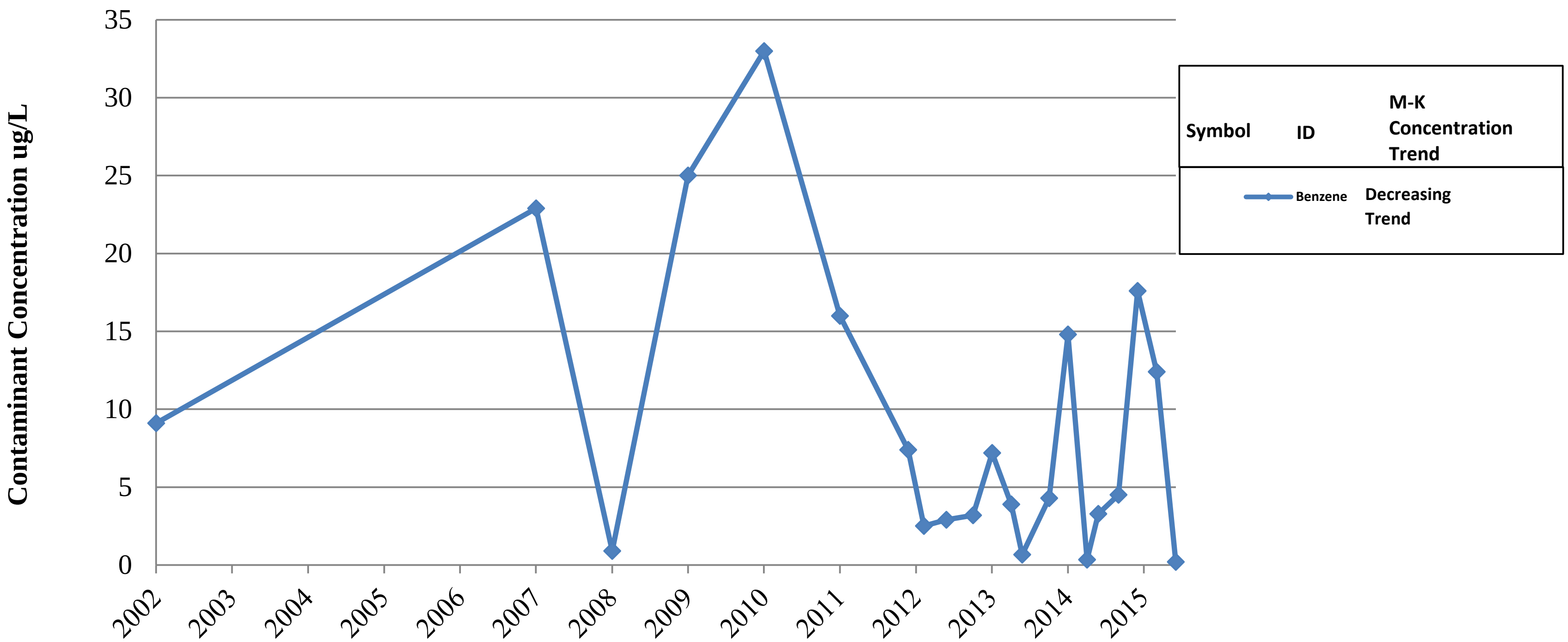

Cleanup Level
Benzene = 5 µg/L

WP014 BENZENE TREND IN LF04SP-03

2015 Annul RA-O and Monitoring Report, Select CERCLA Sites
Joint Base Elmendorf-Richardson, Alaska

Figure
14-2

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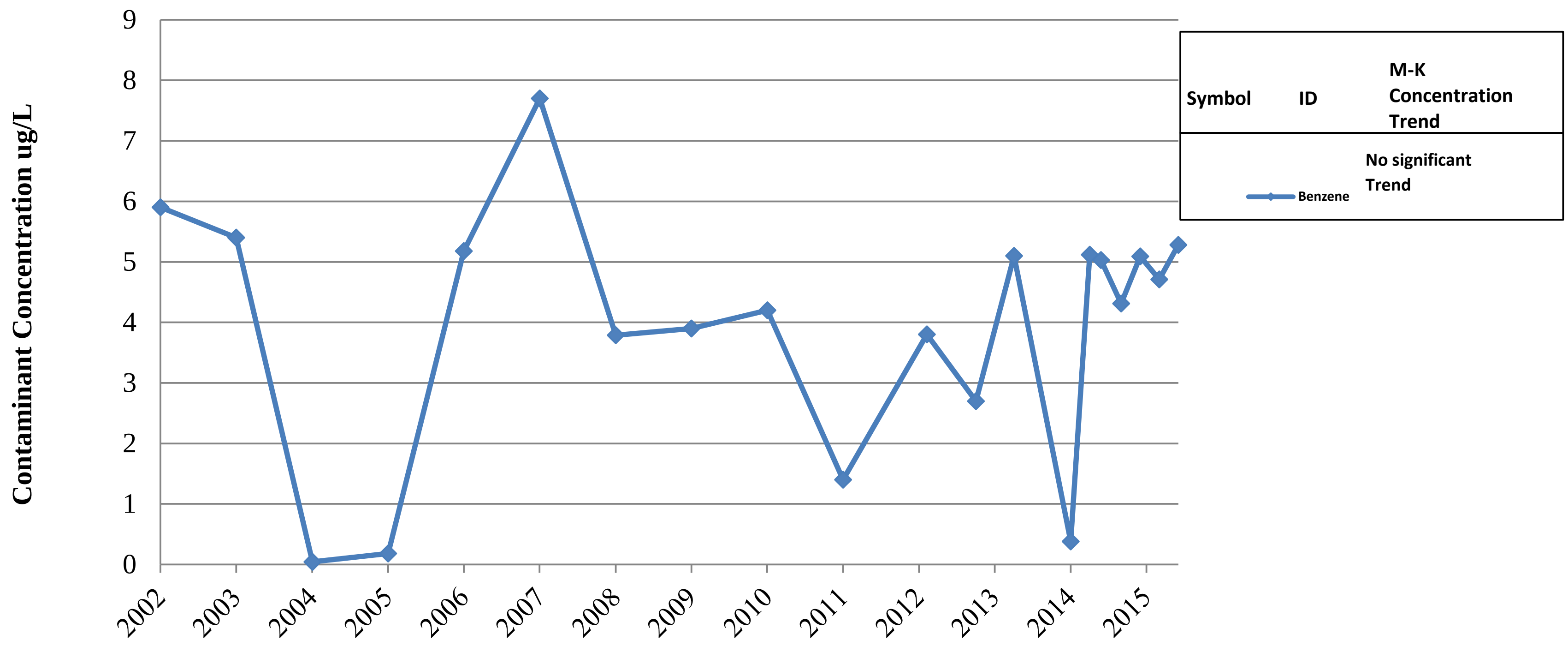

Cleanup Level
Benzene = 5 µg/L

WP014 BENZENE TREND IN LF04SP-04

2015 Annul RA-O and Monitoring Report, Select CERCLA Sites
Joint Base Elmendorf-Richardson, Alaska

Figure
14-3

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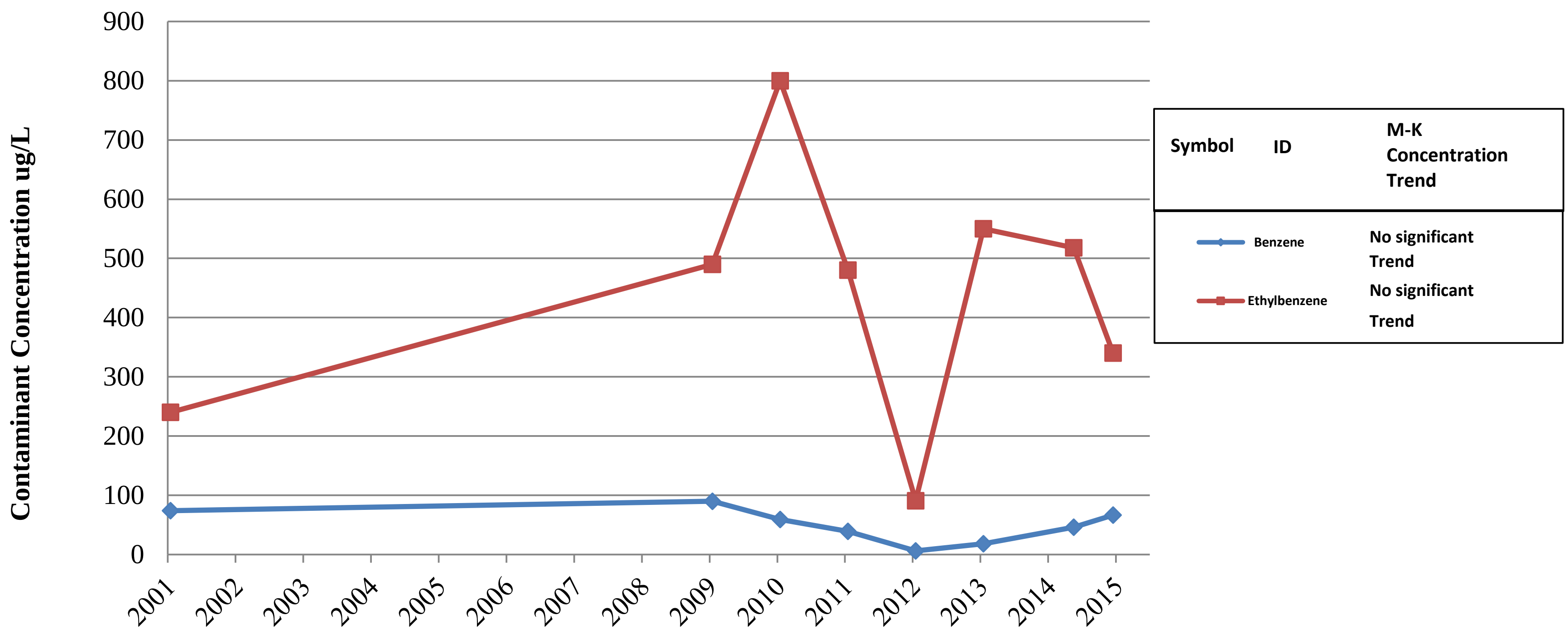

Cleanup Levels
Benzene = 5 µg/L
Ethylbenzene = 700 µg/L

WP014 CONTAMINANT TREND IN OU6MW-92

2015 Annul RA-O and Monitoring Report, Select CERCLA Sites
Joint Base Elmendorf-Richardson, Alaska

Figure **14-4**

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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 southwest 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 [U.S. Army 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 northwest 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.

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).

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 in Table 15-1. In the ROD, risk-based concentrations (RBCs) were adopted as cleanup goals for PCA in groundwater and soil and for PCE in soil at CG039 because neither federal nor state cleanup goals were available. In 2013, the Third CERCLA Five-Year Review Report for JBER-R (USAF, 2013b) recommended updating the cleanup goals to provide future protectiveness of human health because chemical-specific toxicity factors for PCA and PCE 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 PCA in groundwater and soil and for PCE in soil after the Operable Units A and B ROD was signed (see Table 15-1). The ADEC cleanup levels are lower than the cleanup goals established in the ROD (U.S. Army, 1997), and the cleanup goals are no longer considered protective. A technical memorandum has been prepared (USAF, 2016d) that recommends the promulgated cleanup levels for PCA in soil and groundwater and PCE in soil (18 AAC 75, June 17, 2015) are adopted as revised cleanup goals for CG039 and documented in the Addendum for the Third CERCLA Five-Year Review Report..

Table 15-1 Cleanup Goals for Site CG039

COC in Soil	Cleanup Goal[a] (mg/kg)	ADEC Cleanup Level[b] (mg/kg)
PCE	4[c]	0.017
1,1,2,2-PCA	0.1[c]	0.024
COC in Groundwater	**Cleanup Goal[a] (µg/L)**	**ADEC Cleanup Level[b] (µg/L)**
Benzene	5	--
Carbon tetrachloride	5	--
cis-1,2-DCE	70	--
trans-1,2-DCE	100	--
PCE	5	--
TCE	5	--
1,1,2,2-PCA	5.2[c]	4.3

Notes:
[a] U.S. Army, 1997
[b] 18 AAC 75 Table B1 and C Cleanup Levels; see the conclusions and recommendations in the *Technical Memorandum; Risk-Based Concentrations for PCA and PCE; CG039 – Poleline Road Disposal Area, Operable Unit B* (USAF, 2016e)
[c] RBCs were adopted as cleanup goals for PCA in groundwater and soil and PCE in soil because neither federal nor state cleanup goals were available prior to the signing of the ROD.
-- = 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
mg/kg = milligram(s) per kilogram
PCA = tetrachloroethane
PCE = tetrachloroethene
RBC = risk-based concentration
TCE = trichloroethene

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 (USAF, 2011a).

Historical groundwater data (Figures 15-2 and 15-3) suggest that the deep groundwater plume is well defined and stable (CH2M HILL, 2012). While concentrations of VOCs are generally decreasing in both the shallow and deep aquifers (see Section 15.3), 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, 2013b) 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) verifying that the shallow groundwater plume boundary has been delineated downgradient of AP 3747. This delineation addresses the 2013 Five-Year Review recommendation (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 2015, groundwater samples were collected at CG039 as part of the monitoring program and continued monitoring of the ongoing enhanced reductive dechlorination (ERD) treatability study. A summary of the sampling and analysis performed at each well is in Table 15-2. Field forms are included in Appendix A-2. LUC inspections and site inspections were also conducted; inspection forms are included in Appendix B-2.

Table 15-2 2015 CG039 Sampling and Analysis Summary

Monitoring Well ID	VOCs (SW8260B)	TOC (9060)	VFA (300.0M)	Sulfide (376.2)	Alkalinity (310.1)	Natural Attenuation Parameters[a]	Ferrous Iron Field Test
LTM Program Wells							
Shallow, Unconfined Aquifer Wells							
AP-4353	x					x	
Deep, Semi-Confined Aquifer Wells							
AP-3748	x					x	
AP-4344	x					x	
AP-5246	x					x	
AP-5683	x					x	
Treatability Study Program Wells							
Shallow, Unconfined Aquifer Wells							
AP-3983R	x	x	x	x	x	x	x
AP-3744	x	x	x	x	x	x	x
AP-3989	x	x	x	x	x	x	x
Deep, Semi-Confined Aquifer Wells							
AP-4525	x	x	x	x	x	x	x
AP-4551	x	x	x	x	x	x	x
LTM and Treatability Study Program Wells							
Shallow, Unconfined Aquifer Wells							
AP-3747	x	x	x	x	x	x	x
AP-4550	x	x	x	x	x	x	x

Notes:

[a] Natural attenuation parameters include chloride/sulfate (E300.0); nitrite/nitrate (E323.3); methane, ethane, ethene (RSK 175); dissolved iron and manganese (SW6020).
"x" = was sampled and analyzed for
ID = identification
LTM = long-term management
TOC = total organic carbon
VFA = volatile fatty acid
VOC = volatile organic compound

15.4 LTM PROGRAM RESULTS

15.4.1 Groundwater Elevation Measurements

On September 15, 2015, depth to groundwater was measured at 24 monitoring wells at the site. Depth to groundwater measurements are summarized in Table 15-3 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 A-2, and groundwater elevations are shown on Figures 15-2 and 15-3.

Table 15-3 2015 Groundwater Elevations at CG039

Monitoring Well ID	Top of Casing Elevation [a] (feet AMSL)	Total Depth of Well (feet FTOC)	Depth to Groundwater[b] (feet FTOC)	Groundwater Elevation (feet AMSL)
Shallow, Unconfined Aquifer				
AP-3744	307.11	37.60	29.12	277.99
AP-3745	303.46	29.80	22.89	280.57
AP-3747	303.07	32.20	27.09	275.98
AP-3749	311.97	24.60	22.89	289.08
AP-3981	306.12	40.70	24.43	281.69
AP-3982	305.74	32.00	27.84	277.90
AP-3983R	307.40	45.00	27.15	280.25
AP-3989	307.99	36.30	29.37	278.62
AP-4347	305.74	46.20	37.53	268.21
AP-4352	312.52	33.00	dry	-
AP-4353	305.27	69.40	35.07	270.20
AP-4354	305.37	14.00	13.57	291.80
AP-4518	306.98	46.80	26.65	280.33
AP-4519	307.30	47.10	26.19	281.11
AP-4550	307.56	43.00	26.42	281.14
Deep, Semi-Confined Aquifer				
AP-3748	300.24	171.60	134.22	166.02
AP-4344	313.52	163.50	150.54	162.98
AP-4349	306.24	84.23	75.82	230.42
AP-4345	321.46	186.50	156.57	164.89
AP-4350	309.11	188.60	148.85	160.26
AP-4525	306.29	127.20	126.53	179.76
AP-4551	307.20	98.00	94.91	212.29
AP-5246	313.65	161.00	150.93	162.72
AP-5683	303.10	150.70	138.10	165.00

Notes:

[a] Top of casing elevations reference June 2003 and August 2004 surveys, except for AP-5246, which was installed and surveyed in 2007
[b] Depth to Groundwater measurements from September 9, 2015 Water Level Survey located in Appendix A-2
AMSL = above mean sea level FTOC = from top of casing

15.4.2 Groundwater Sample Analytical Results

Groundwater samples were collected from seven monitoring wells as part of the LTM program at CG039 and were analyzed for the compounds listed in Table 15-2. Analytical results for the CG039 COCs and other select compounds historically detected above MCLs are summarized in Table 15-4 and shown on Figures 15-2 and 15-3. Complete analytical results are included in Appendix A-2.

In the shallow aquifer, TCE, cis-1,2-DCE, vinyl chloride, 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 cleanup criteria. Acetone, benzene, carbon tetrachloride, chloroform, PCE, trans-1,2-DCE, 1,1,2-TCA, 1,1-DCE, and 1,2-DCA were detected in groundwater but at concentrations below their respective cleanup levels.

Table 15-4 Summary of Select 2015 Analytical Results at CG039

Contaminant	***Well:***	AP-3744	AP-3747	AP-3748	AP-3983R	AP-3989	AP-4344	AP-4353	AP-4525	AP-4550	AP-4551	AP-5246	AP-5683 [a]
	Aquifer:	Shallow	Shallow	Deep	Shallow	Shallow	Deep	Shallow	Deep	Shallow	Deep	Deep	Deep
	Program:	TS	LTM/TS	LTM	TS	TS	LTM	LTM	TS	LTM/TS	TS	LTM	LTM
	Cleanup Goal or MCL (µg/L)												
PCE	5	ND (0.3)	3.96	ND (0.3)	ND (1.5)	ND (1.5)	ND (0.3)	2.44	ND (12)	0.3J	ND (1.5)	ND (0.3)	ND (0.3)
TCE	5	**22.1**	**391**	ND (0.3)	3.6	1.64J	**8.16**	**180**	**361**	4.19	**9.36**	ND (0.3)	ND (0.3)
cis-1,2-DCE	70	41.6	29	ND (0.3)	**3480**	**1540**	0.24J	33.5	**216**	**1630**	**1870**	ND (0.3)	ND (0.3)
trans-1,2-DCE	100	0.38J	6.51	ND (0.3)	84.9	45.6	ND (0.3)	12.1	ND (12)	55.2	28.3	ND (0.3)	ND (0.3)
1,1-DCE	7[b]	0.2J	1.37	ND (0.3)	**7.8**	4.72	ND (0.3)	1.12	ND (12)	4.78	**15.8**	ND (0.3)	ND (0.3)
Vinyl chloride	2 [b]	ND (0.3)	ND (0.3)	ND (0.3)	**42.1**	**11**	ND (0.3)	ND (0.3)	ND (12)	**18.5**	**2.3J**	ND (0.3)	ND (0.3)
1,1,2,2-PCA	4.3[c]	**11.3**	**18.6**	ND (0.3)	**279**	**58.2**	ND (0.3)	**26.9**	**38**	**94.4**	**78.8**	ND (0.3)	ND (0.3)
Carbon tetrachloride	5	0.22J	2.21	ND (0.3)	ND (1.5)	ND (1.5)	0.25J	ND (0.3)	ND (12)	ND (0.3)	ND (1.5)	ND (0.3)	ND (0.3)
1,1,2-trichloroethane	5[b]	0.58	1.9	ND (0.3)	**10.9**	2.92	ND (0.3)	1.17	**8.89J**	4.13	**9.04**	ND (0.3)	ND (0.3)

Notes:

[a] AP-5683 is a replacement well for AP-4019.
[b] MCL, cleanup level not established in the Operable Units A and B ROD (U.S. Army, 1997)
[c] 18 AAC 75 Table C Cleanup Level
All units are µg/L
Cleanup goals established in the Operable Units A and B ROD (U.S. Army, 1997), unless otherwise noted.
Bold = result exceeded cleanup goal or MCL
B = The analyte was detected in the associated method and/or calibration blank.
J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
µg/L= microgram(s) per liter
DCE = dichloroethene
LTM = long term monitoring well
MCL = United States Environmental Protection Agency Maximum Contaminant Level
ND = analyte was not detected
PCA = tetrachloroethane
PCE = tetrachloroethene
TCE = trichloroethene
TS = treatability study well

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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 in Tables 15-5 and 15-6, respectively.

Table 15-5 Summary of 2015 Laboratory Measured Natural Attenuation Parameter 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)
Shallow, Unconfined Aquifer								
AP-3747	0.300	0.14	0.001B	10.90	2.6	ND(0.205)	ND(0.215)	0.4120B
AP-4353	0.094	13.70	1.040	1.04B	2.0	0.230J	0.154J	424
AP-4550	0.208J	78.90J	3.130	0.52B	4.2	ND(2.470)J	ND(2.33)J	13,500J
Deep, Semi-Confined Aquifer								
AP-3748	0.849	ND(0.02)	0.002B	29.30B	105.0	ND(0.197)	ND(0.208)	0.0650B
AP-4344	0.371	ND(0.02)	ND(0.002)	13.00B	15.0 B	ND(0.182)	ND(0.195)	0.0570B
AP-5246	0.949	0.01B	0.013	19.00B	72.5	ND(0.177)	ND(0.190)	0.0629B
AP-5683	0.346	ND(0.02)	ND(0.002)	12.90B	11.1B	ND(0.180)	ND(0.192)	0.0691B

Notes:

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 15-6 Summary of 2015 Field Measured Natural Attenuation Parameters at CG039 LTM Monitoring Wells

Monitoring Well ID	Date	Time	Water Level (ft bgs)	Volume Purged (gallons)	pH	Conductivity (mS/cm)	Turbidity (NTU)	DO (mg/L)	Temp (°C)	ORP (mV)
Shallow, Unconfined Aquifer										
AP-3747	9/17/2015	1545	27.55	0.5	6.90	0.327	10.0	11.6	4.0	130
AP-4353	9/17/2015	1415	36.08	1.2	6.45	0.371	1.46	0.50	5.0	2.7
AP-4550	9/18/2015	1410	27.65	1.5	5.84	0.958	8.79	0.32	5.8	5.5
Deep, Semi-Confined Aquifer										
AP-3748	9/16/2015	1405	134.21	1.8	7.35	0.678	17.8	8.0	5.0	125
AP-4344	9/16/2015	1700	150.55	4.0	7.58	0.305	8.85	10.3	5.0	126
AP-5246	9/17/2015	1125	150.97	0.9	7.15	0.487	8.64	10.3	4.5	141
AP-5683	9/16/2015	1140	138.15	2.0	7.30	0.270	1.43	10.3	5.2	146

Notes:
°C = degree(s) Celsius
DO = dissolved oxygen
ft bgs = feet below ground surface
mg/L = milligram(s) per liter
mS/cm = milliSiemen(s) per centimeter
mV = millivolt(s)
NTU = nephelometric turbidity unit

Natural attenuation parameter results indicate the following:

- In the shallow aquifer, anaerobic/reducing conditions are observed in AP-4550 and AP-4353. In addition to being part of the LTM monitoring network, AP-4550 is also within the treatment zone of the ERD treatability study where reducing conditions are expected. Results of the treatability study are further discussed in Section 15.5. At AP-4353, geochemical conditions have historically been consistently anaerobic/reducing. While the reasons for those conditions are uncertain, the anaerobic geochemistry at AP-4353 may be associated with the well's relatively deeper location in the shallow aquifer (Figure 15-1).
- 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 traveled. 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, 2015e). 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, 2015e) 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-3983 and AP-4550, and deep aquifer monitoring well AP-4551) and four monitoring wells downgradient of the treatability study target treatment zones (shallow aquifer wells AP-3744, AP-3747 and AP-3989, and deep aquifer monitoring well AP-4525) (Figures 15-2 and 15-3). 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 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). Due to the small volume of groundwater in monitoring well AP-4525, only a sample for VOC analysis could be collected at that location. Field forms are included in Appendix A-2. The complete analytical results and DQE and laboratory analytical report is included as Appendix C-2.

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 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 on Figure 15-2. Graphs presenting AP-3983R CAH concentration, geochemical parameter, and total CAH molar concentration trends are 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 in Table 15-7.

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 µmol/L of daughter product represents the reduction of 1 µmol/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.

While a variety of bacteria, such as Dehalobacter, Dehalogenimonas, and Desulfitobacterium, can degrade TCE to cis-1,2-DCE, Dehalococcoides (DHC) are the only bacteria currently known that can completely degrade TCE to ethene, via reductive dechlorination, producing cis-1,2-DCE and vinyl chloride sequentially as intermediate daughter products (Adrian and Loffler, 2016). Slow degradation rates for or accumulation of cis-1,2-DCE and vinyl chloride in groundwater can be associated with a poor or unviable population of DHC within the subsurface. However, other degradation pathways, such as aerobic cometabolic, aerobic oxidation, or abiotic degradation may also contribute to degradation of cis-1,2-DCE and VC (Alvarez-Cohen and Speital, 1997; He et al., 2015).

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 91 percent of the CAHs at AP-3983R.
- The latest molar concentration of cis-1,2-DCE (35.9 µmol/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 µmol/L).
- The total CAH molar concentration at AP-3983R has increased from 19.4 to 39.3 µmol/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 may be evidence that a sufficient population of DHC is not 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. Increases in cis-1,2-DCE concentrations relative to TCE concentrations after implementation of biostimulation has been observed at many sites (Suthersan and Payne, 2005) and has been attributed to the higher relative rate of TCE-to-DCE degradation versus DCE-to-VC degradation combined with the higher solubility and lower organic carbon partition coefficient of less chlorinated VOCs compared to TCE. Other researchers have reported on the effects of substrate addition itself on enhanced dissolution of VOCs after biostimulation and/or bioaugmentation and the processes that cause this effect (Nelson and Novak, 2009; Carr et al., 2000; Sleep et al., 2006).
- This increase in cis-1,2-DCE molar concentration could also 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.

Table 15-7 AP-3983R Chlorinated Aliphatic Hydrocarbon Results

Analyte (µg/L)	Cleanup Goal or MCL (µg/L)	August 2013 (baseline)	Oct 2013	Jan 2014	April 2014	Sept 2014	Sept 2015	Comments
PCE	5	**30.5**	**20.9**	**27.8**	3.44 J	0.79	1.5 U	PCE is non-detect and has been completely degraded.
TCE	5	**1,880**	**1,820**	**1,190**	**118**	**12.4**	3.6	TCE has been degraded to below the cleanup goal.
cis-1,2-DCE	70	**180**	**207**	**1,470**	**2,260**	**4,070**	**3,480**	TCE to cis-1,2-DCE is the primary dechlorination pathway. Slight decrease from 2014 to 2015 indicates that cis-1,2-DCE is being degraded.
trans-1,2-DCE	100	62	71.4	**113**	99.9	98.8	84.9	Low concentrations indicate that TCE to trans-1,2-DCE is not a primary dechlorination pathway.
1,1-DCE	7[a]	3.88	3.62	6.71	6.74	**8.12**	**7.8**	Low concentrations indicate that TCE to 1,1-DCE is not a primary dechlorination pathway.
Vinyl chloride	2[a]	0.25 U	0.32 J	**14.1**	**16.5**	**43.7**	**42.1**	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	Increase indicates that complete dechlorination is occurring.
1,1,2,2-PCA	4.3[b]	**407**	**472**	**521**	**301**	**332**	**279**	1,1,2,2-PCA has been degraded, likely as a result of ERD treatment.
1,1,2-TCA	5	**10.5**	**12.4**	**65.5**	**71.6**	**24.4**	**10.9**	Increase and subsequent decrease in 1,1,2-TCA likely the result of ERD treatment.

Notes:

[a] MCL, cleanup goal not established in the Operable Units A and B ROD (U.S. Army, 1997)
[b] 18 AAC 75 Table C Cleanup Level
J = The analyte was positively identified: the associated value is the approximate concentration of the analyte in the sample.
µg/L= microgram(s) per liter
Bold values indicate the result exceeded the MCL
DCE = dichloroethene
ERD = enhanced reductive dechlorination
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.

15.5.1.1.2 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 in Table 15-8.

Table 15-8 AP-3983R Geochemical Parameter Results

Analyte	August 2013 (baseline)	Oct 2013	Jan 2014	April 2014	Sept 2014	Sept 2015	Comments
ORP (mV)	52	60.1	-79	-112	-94.2	-38.8	Negative value indicates reduced conditions, favorable for dechlorination.
DO (mg/L)	4.89	6.37	4.56	0.0	1.2	0.31	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	Greater than 20 mg/L is considered a sufficient carbon and energy source to drive dechlorination.
VFAs[a] – acetic acid (µg/L)	60 U	15,700	148,000	152,000	179,000	447,000	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	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	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	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). Although the ferrous iron result from the field test kit was only 0.12 mg/L, the other geochemical parameters indicate groundwater is sufficiently reducing for anaerobic dechlorination to occur.
Sulfate (mg/L)	25.3	369	84.5	3.01	0.557	3.63	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	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.
Nitrate (mg/L)	0.0611	0.191	0.0847	0.155	0.173	0.152	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	pH value is within the ideal range (6 to 8) for reductive dechlorination.

Table 15-8 AP-3983R Geochemical Parameter Results *(Continued)*

Notes:

[a] Acetic acid is the most prevalent VFA at AP-3983R; see data table in Appendix C-2.
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)
ORP = oxidation-reduction potential
TCE = trichloroethene
TOC = total organic carbon
VFA = volatile fatty acid

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 on Figure 15-2. Graphs presenting CAH concentration, geochemical parameter, and total CAH molar concentration trends are 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 cleanup goal 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 in Table 15-9.

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 (16.8 µmol/L) is greater than the baseline molar concentration of TCE and 1,1,2,2-PCA combined (14.4 µmol/L).
- The total CAH molar concentration at AP-4550 has increased from 16.8 to 18.4 µmol/L (and as high as 24.9 µmol/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 may be evidence that a sufficient population of DHC is 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-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 15-9 AP-4550 Chlorinated Aliphatic Hydrocarbon Results

Analyte (µg/L)	Cleanup Goal or MCL (µg/L)	August 2013 (baseline)	Oct 2013	Jan 2014	April 2014	Sept 2014	Sept 2015	Comments
PCE	5	**29.3**	**8.76**	1.68	1.5	0.52	0.3 J	PCE has been dechlorinated to below the cleanup goal.
TCE	5	**1,500**	**822**	**34.9**	**6.89**	**10.6**	4.19	TCE has been dechlorinated to below the cleanup goal.
cis-1,2-DCE	70	**160**	**115**	**2,040**	**1,130**	**924**	**1,630**	TCE to cis-1,2-DCE is the primary dechlorination pathway. Slight decrease between 2014 and 2015 indicates that cis-1,2-DCE is being dechlorinated.
trans-1,2-DCE	100	58.4	38.6	62.2	37.5	31.8	55.2	Low concentrations indicate that TCE to trans-1,2-DCE is not a primary dechlorination pathway.
1,1-DCE	7	4.05	1.94 J	**7.94**	3.94	3.14	4.78	Low concentrations indicate that TCE to 1,1-DCE is not a primary dechlorination pathway.
Vinyl chloride	2	0.28 U	1.25 U	**40.3**	**11.1**	**5.25**	**18.5**	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	Detections of ethene indicate that complete dechlorination is occurring.
1,1,2,2-PCA	4.3[a]	**501**	**164**	**362**	**150**	**97.2 J**	**94.4**	1,1,2,2-PCA has been degraded, likely as a result of ERD treatment.
1,1,2-TCA	5	**11**	**6.33**	**13.6**	**6.18**	3.39	4.13	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:
[a] MCL, cleanup goal not established in the Operable Units A and B ROD (U.S. Army, 1997)
[b] 18 AAC 75 Table C Cleanup Level
J = analyte was positively identified: the associated value is the approximate concentration of the analyte in the sample.
NA = Not available
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.
Bold values indicate the result exceeded the cleanup goal or MCL.
µg/L = microgram(s) per liter
DCE = dichloroethene
ERD = enhanced reductive dechlorination
MCL = maximum contaminant level
PCA = tetrachloroethane
PCE = tetrachloroethene
TCA = trichloroethane
TCE = trichloroethene

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 in Table 15-10.

Table 15-10 AP-4550 Geochemical Parameter Results

Analyte	August 2013 (baseline)	Oct 2013	Jan 2014	April 2014	Sept 2014	Sept 2015	Comments
ORP (mV)	40.5	40.7	-50.5	-71.8	-96.2	5.5	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)	0.35	5.01	4.21	0.18	0.90	0.32	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	Greater than 20 mg/L is considered a sufficient carbon and energy source to drive dechlorination.
VFAs[a] – acetic acid (µg/L)	60 U	NA	129,000	52,900	98,100	625,000 J	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	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. However, methane in ERD systems is also generated by fermentation o acetate by methanogens, a process that neither produces nor consumes hydrogen. Therefore the presence of methane is not evidence that inhibition of DHC due to competition for hydrogen is occurring.
Manganese (mg/L)	0.775	1.19	1.75	1.07	0.983	3.13	An increase in manganese concentrations can indicate that groundwater is sufficiently reducing for anaerobic dechlorination to occur.

Table 15-10 AP-4550 Geochemical Parameter Results *(Continued)*

Analyte	August 2013 (baseline)	Oct 2013	Jan 2014	April 2014	Sept 2014	Sept 2015	Comments
Dissolved Iron (mg/L)	8.36	14.7	35.9	27.3	25.6	78.9 J	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 exceeded the range of the test kit (3.3 mg/L), which, along with reducing conditions in the groundwater environment, indicate that most of the dissolved iron concentration is likely to be in the ferrous form of iron.
Sulfate (mg/L)	30.3	115	0.222	0.353	0.1 U	0.532 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	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	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	pH value is just outside the ideal range (6 to 8) for reductive dechlorination.

Notes:

[a] Acetic acid is the most prevalent VFA at AP-3983R; see data table in Appendix C-2.
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
DHC = Dehalococcoides bacteria
DO = dissolved oxygen
EVO = emulsified vegetable oil
mg/L = milligram(s) per liter
mV = millivolt(s)
NA = not applicable
ORP = oxidation-reduction potential
TCE = trichloroethene
TOC = total organic carbon
VFA = volatile fatty acid

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 on Figure 15-3. Graphs presenting CAH concentration, geochemical parameter, and total CAH molar concentration trends are 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 in Table 15-11.

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 through time. The following observations can be made from total CAH molar concentration trends:

- Practically all of the TCE has be 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 95 percent of the CAHs at AP-4551
- The latest molar concentration of cis-1,2-DCE (19.3 µmol/L) is greater than the baseline molar concentration of TCE and 1,1,2,2-PCA combined (18.1 µmol/L)
- The total CAH molar concentration at AP-4551 has increased from 19.5 to 20.4 µmol/L (and as high as 27.4 µmol/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 may be evidence that a sufficient population of DHC is 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-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.

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Table 15-11 AP-4551 Chlorinated Aliphatic Hydrocarbon Results

Analyte (µg/L)	Cleanup Goal or MCL (µg/L)	August 2013 (baseline)	Oct 2013	Jan 2014	April 2014	Sept 2014	Sept 2015	Comments
PCE	5	5	0.64	2.42	3 U	0.3 U	1.5 U	PCE has been dechlorinated to below the cleanup goal.
TCE	5	**2,300**	**698**	**1,190**	**14.7**	**8.43**	**9.36**	TCE has been dechlorinated to near the cleanup goal.
cis-1,2-DCE	70	**113**	**82.7**	**730**	**2,370**	**2,520**	**1,870**	TCE to cis-1,2-DCE is the primary dechlorination pathway. Slight decrease between 2014 and 2015 indicates that cis-1,2-DCE is being dechlorinated.
trans-1,2-DCE	100	9.59	8.92	14.2	24.1	28.2	28.3	Low concentrations indicate that TCE to trans-1,2-DCE is not a primary dechlorination pathway.
1,1-DCE	7	**10.4**	2.11	4.76	**15.2**	**16.7**	**15.8**	Low concentrations indicate that TCE to 1,1-DCE is not a primary dechlorination pathway.
Vinyl chloride	2	0.25 U	0.25 U	**2.43**	**7.87**	**5.55**	**2.3 J**	Presence of vinyl chloride indicates that DCE is being dechlorinated.
Ethene	NA	0.123	0.293 J	0.0858 J	0.115 J	0.219 J	0.0702 J	Detections of ethene indicate that complete dechlorination is occurring.
1,1,2,2-PCA	4.3[a]	**106**	**51.6**	**121**	**108**	**119**	**78.8**	No indication that ERD treatment is degrading 1,1,2,2-PCA.
1,1,2-TCA	5	**6.91**	**5.09**	**7.85**	**15.3**	**12.9**	**9.04**	No indication that ERD treatment is degrading 1,1,2-TCA.

Notes:

[a] MCL, cleanup goal not established in the Operable Units A and B ROD (U.S. Army, 1997)
[b] 18 AAC 75 Table C Cleanup Level
J = The analyte was positively identified: the associated value is the approximate concentration of the analyte in the sample.
NA = Not available
U = The analyte was analyzed for, but was not detected above the reported sample quantitation limit.
Bold values indicate the result exceeded the cleanup goal or MCL.
µg/L = microgram(s) per liter
DCE = dichloroethene
ERD = enhanced reductive dechlorination
MCL = maximum contaminant level
PCA = tetrachloroethane
PCE = tetrachloroethene
TCA = trichloroethane
TCE = trichloroethene

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 in Table 15-12.

Table 15-12 AP-4551 Geochemical Parameter Results

Analyte	August 2013 (baseline)	Oct 2013	Jan 2014	April 2014	Sept 2014	Sept 2015	Comments
ORP (mV)	45.1	48.6	-102	-68.8	-41.3	12.6	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)	12.73	11.98	4.21	0.58	1.02	1.21	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	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	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[a] – lactic acid (µg/L)	60 U	60 U	60 U	100 U	31,800	250	
Methane (µg/L)	0.463	0.364 B	0.849	119	849	1,090	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	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	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). Although the ferrous iron result from the field test kit was only 0.9 mg/L, the other geochemical parameters indicate groundwater is sufficiently reducing for anaerobic dechlorination to occur.
Sulfate (mg/L)	9.53	117	12	0.289	1.11	1.05 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	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	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	pH value is within the ideal range (6 to 8) for reductive dechlorination.

Table 15-12 AP-4551 Geochemical Parameter Results *(Continued)*

Notes:

[a] Acetic acid and lactic acid are the most prevalent VFAs at AP-4551; see data tables in Appendix C-2.
B = The analyte was detected in the associated method and/or calibration blank.
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)
ORP = oxidation-reduction potential
TOC = total organic carbon
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 in order 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 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 on Figure 15-2. Graphs presenting CAH concentration trends are 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 and concentrations of cis-1,2-DCE, which has slightly increased compared to pre-injection concentrations. These results indicate that lower TCE concentrations and daughter products of upgradient reductive dechlorination are arriving at AP-3744. A summary of the concentration trends observed for the CAHs at AP-3744 is in Table 15-13.

Table 15-13 AP-3744 Chlorinated Aliphatic Hydrocarbon Results

Analyte (µg/L)	Cleanup Goal or MCL (µg/L)	September 2012	September 2014	September 2015	Comments
PCE	5	0.4 U	0.33 J	0.3 U	Concentrations are below the cleanup goal of 5 µg/L.
TCE	5	**42**	**47.2**	**22.1**	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	1.5	13.7	41.6	Increase in concentration could indicate that daughter products from upgradient dechlorination of TCE are arriving at this well.
trans-1,2-DCE	100	0.38 J	0.82	0.38 J	Concentration is stable.
1,1-DCE	7[a]	0.2 U	0.3 U	0.2 J	Concentration is stable.
Vinyl chloride	2[a]	0.8 U	0.3 U	0.3 U	Vinyl chloride is not present.
Ethene	NA	0.64 U	0.118 U	0.167 U	Ethene is not present.
1,1,2,2-PCA	4.3[b]	**5.2**	**9.3**	**11.3**	No indication that ERD treatment is degrading 1,1,2,2-PCA.
1,1,2-TCA	5	0.4 U	0.29 J	0.58	Concentration is stable.

Notes:

[a] MCL, cleanup goal not established in the Operable Units A and B ROD (U.S. Army, 1997)
[b] 18 AAC 75 Table C Cleanup Level
J = The analyte was positively identified: the associated value is the approximate concentration of the analyte in the sample.
NA = Not available
U = The analyte was analyzed for, but was not detected above the reported sample quantitation limit.
Bold values indicate the result exceeded the cleanup goal or MCL.
µg/L = microgram(s) per liter
DCE = dichloroethene
ERD = enhanced reductive dechlorination
MCL = maximum contaminant level
PCA = tetrachloroethane
PCE = tetrachloroethene
TCA = trichloroethane
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 in Table 15-14.

Table 15-14 AP-3744 Geochemical Parameter Results

Analyte	September 2014	September 2015	Comments
ORP (mV)	6.4	135	Positive value indicates that conditions are not reduced enough for dechlorination to occur.
DO (mg/L)	6.94	10.25	DO values greater than 1 mg/L indicate that conditions are not reduced enough for dechlorination to occur.
TOC (mg/L)	1.01 B	1.6 B	Insufficient carbon and energy source to drive dechlorination (>20 mg/L is considered sufficient).
VFAs[a] - lactic acid (µg/L)	40 U – 80 U	72.1 J	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	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	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	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	Lack of sulfide is consistent with the presence of sulfate.
Nitrate (mg/L)	0.394	0.21	A nitrate level of <1.0 mg/L is desirable for dechlorination.
pH	7.08	6.68	pH value is within the acceptable range (6 to 8) for reductive dechlorination.

Notes:

[a] Lactic acid was the only VFA detected at AP-3744; see data tables in Appendix C-2.

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 on Figure 15-2. Graphs presenting CAH concentration trends are 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. When compared with only the 2012 result (88 µg/L), it appears as if the TCE concentration (391 µg/L in 2015) is rapidly increasing at AP-3747. However, the TCE concentrations from 2010 and 2011 were 680 and 600 µg/L, respectively. It is likely that the results from 2012 represented an anomalously low result, and it does not seem likely that the TCE plume is expanding. These results indicate that reductive dechlorination resulting from upgradient injections is not occurring at AP-3747. A summary of the concentration trends observed for the CAHs at AP-3747 is in Table 15-15.

Table 15-15 AP-3747 Chlorinated Aliphatic Hydrocarbon Results

Analyte (µg/L)	Cleanup Goal or MCL (µg/L)	September 2012	September 2014	September 2015	Comments
PCE	5	0.87 J	1.96	3.96	Concentrations are below the cleanup goal of 5 µg/L.
TCE	5	**88**	**209**	**391**	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	5.1	13.4	29	Likely related to increase in TCE concentration.
trans-1,2-DCE	100	1.7	3.17	6.51	Concentration is stable.
1,1-DCE	7[a]	0.33 J	0.79	1.37	Concentration is stable.
Vinyl chloride	2[a]	0.8 U	0.3 U	0.3 U	Vinyl chloride is not present.
Ethene	NA	0.64 U	0.119 U	0.215 U	Ethene is not present.
1,1,2,2-PCA	4.3[b]	0.81 J	**27.8**	**18.6**	Concentration has increased from 2012 value, but the 2012 value is suspiciously low compared to 2009 sample results. No indication that ERD treatment is degrading 1,1,2,2-PCA.
1,1,2-TCA	5	0.52 J	1.57	1.9	Concentration is stable.

Notes:

[a] MCL, cleanup goal not established in the Operable Units A and B ROD (U.S. Army, 1997)
[b] 18 AAC 75 Table C Cleanup Level
J = The analyte was positively identified: the associated value is the approximate concentration of the analyte in the sample.
NA = Not available
U = The analyte was analyzed for, but was not detected above the reported sample quantitation limit.
Bold values indicate the result exceeded the cleanup goal or MCL.
µg/L = microgram(s) per liter
DCE = dichloroethene
ERD = enhanced reductive dechlorination
MCL = maximum contaminant level
PCA = tetrachloroethane
PCE = tetrachloroethene
TCA = trichloroethane
TCE = trichloroethene

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 in Table 15-16.

Table 15-16 AP-3747 Geochemical Parameter Results

Analyte	September 2014	September 2015	Comments
ORP (mV)	250.3	130	Positive value indicates that conditions are not reducing enough for dechlorination to occur.
DO (mg/L)	1.81	11.59	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	Insufficient carbon and energy source to drive dechlorination (>20 mg/L is considered sufficient).
VFAs[a] (µg/L)	40 U – 80 U	100 U – 180 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	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	Ferrous iron was measured at 0.0 mg/L using a field test kit, indicating that conditions are not sufficiently reduced.
Sulfate (mg/L)	11.4	10.9	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	Lack of sulfide is consistent with the presence of sulfate.
Nitrate (mg/L)	0.334	0.3	A nitrate level of <1.0 mg/L is desirable for dechlorination.
pH	7.60	6.90	pH value is within the acceptable range (6 to 8) for reductive dechlorination.

Notes:

[a] VFAs include acetic acid, butyric acid, formic acid, lactic acid, propionic acid, and pyruvic acid.
B = The analyte was detected in the associated method and/or calibration blank.
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

15.5.2.3 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 on Figure 15-2. Graphs presenting CAH concentration trends are 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. However, the slow degradation of cis-1,2-DCE may be evidence that a sufficient population of DHC is not present within the subsurface. A summary of the concentration trends observed for the CAHs at AP-3989 is in Table 15-17.

Table 15-17 AP-3989 Chlorinated Aliphatic Hydrocarbon Results

Analyte (µg/L)	MCL	September 2012	September 2014	September 2015	Comments
PCE	5	4.1	0.3 U	1.5 U	Decrease indicates that PCE is being dechlorinated.
TCE	5	**610**	2.47	1.64 J	Decrease indicates that TCE is being dechlorinated.
cis-1,2-DCE	70	83	**1,250**	**1,540**	Increase indicates that TCE is being dechlorinated.
trans-1,2-DCE	100	26	39.9	45.6	Increase indicates that TCE is being dechlorinated.
1,1-DCE	7	1.7 J	3.2	4.72	Not a primary dechlorination pathway.
Vinyl chloride	2	1.6 U	**8.71**	**11**	Increase indicates that DCE is also being dechlorinated.
Ethene	NA	0.64 U	0.368 J	1.19 U	Detection indicates that complete dechlorination is occurring.
1,1,2,2-PCA	4.3[a]	**150**	**97.4**	**58.2**	Concentration of 1,1,2,2-PCA is decreasing, could indicate degradation via ERD.
1,1,2-TCA	5	**6.6**	3.73	2.92	Concentration is stable.

Notes:

[a] 18 AAC 75 Table C Cleanup Level
J = The analyte was positively identified: the associated value is the approximate concentration of the analyte in the sample.
NA = Not available
U = The analyte was analyzed for, but was not detected above the reported sample quantitation limit.
Bold values indicate the result exceeded the MCL.
µg/L = microgram(s) per liter
DCE = dichloroethene
ERD = enhanced reductive dechlorination
MCL = maximum contaminant level
PCA = tetrachloroethane
PCE = tetrachloroethene
TCA = trichloroethane
TCE = trichloroethene

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. A summary of the results observed for the geochemical parameters at AP-3989 is in Table 15-18.

Table 15-18 AP-3989 Geochemical Parameter Results

Analyte	September 2014	September 2015	Comments
ORP (mV)	-119	-45.1	Negative value indicates reducing conditions, favorable for dechlorination.
DO (mg/L)	1.03	0.51	DO values less than 1 mg/L indicate that conditions are favorable for dechlorination.
TOC (mg/L)	63.3	176 B	Sufficient carbon and energy source to drive dechlorination (>20 mg/L is considered sufficient).
VFAs[a] – acetic acid (µg/L)	116,000	404,000	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	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	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). Although the ferrous iron result from the field test kit was only 0.07 mg/L, the other geochemical parameters indicate groundwater is sufficiently reducing for anaerobic dechlorination to occur.
Sulfate (mg/L)	0.1 U	3.12 J	Low sulfate indicates that the groundwater is sufficiently reduced for dechlorination to occur.
Sulfide (mg/L)	0.0304	0.0107 J	Low concentrations could indicate that FeS minerals have been formed.
Nitrate (mg/L)	0.228	0.143	A nitrate level of <1.0 mg/L is desirable for dechlorination.
pH	7.43	6.59	pH value is within the acceptable range (6 to 8) for reductive dechlorination.

Notes:

[a] Acetic acid is the most prevalent VFA at AP-3989; see data tables in Appendix C-2.
B = The analyte was detected in the associated method and/or calibration blank.
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

15.5.2.4 AP-4525 – Deep Downgradient Monitoring Well

Analyte concentration trends are summarized in the following subsections. CAH results for AP-4525 and an updated representation of the deep TCE plume are on Figure 15-3. Due to the limited amount of pre- and post-injection data, no concentration graphs are presented for AP-4525.

15.5.2.4.1 AP-4525 – Chlorinated Aliphatic Hydrocarbons

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, only enough water for a VOC sample could be obtained. Therefore, there are not enough data to determine whether reductive dechlorination is occurring at AP-4525. However, it does appear that lower TCE concentrations and some daughter products from upgradient reductive dechlorination may be arriving at AP-4525. A summary of the concentration trends observed for the CAHs at AP-4525 is in Table 15-19.

Table 15-19 AP-4525 Chlorinated Aliphatic Hydrocarbon Results

Analyte (µg/L)	MCL	October 2009	September 2015	Comments
PCE	5	20.0 U	12 U	Concentration is non-detect but at value greater than MCL.
TCE	5	**2,270**	**361**	TCE has decreased but no increase in cis-1,2-DCE to indicate dechlorination is occurring.
cis-1,2-DCE	70	**199**	**216**	Concentration is stable.
trans-1,2-DCE	100	36.5	12 U	Concentration is stable.
1,1-DCE	7	4.86	12 U	Concentration is stable.
Vinyl chloride	2	NA	12 U	Concentration is non-detect at value greater than MCL.
Ethene	NA	NA	NA	Ethene is present which could indicate dechlorination is occurring.
1,1,2,2-PCA	4.3[a]	**108**	**38**	Concentration of 1,1,2,2-PCA is decreasing, could indicate degradation via ERD.
1,1,2-TCA	5	NA	**8.89 J**	No evaluation could be due to lack of 2009 1,1,2-TCA data.

Notes:

J = The analyte was positively identified: the associated value is the approximate concentration of the analyte in the sample.
NA = Not available
U = The analyte was analyzed for, but was not detected above the reported sample quantitation limit.
Bold values indicate the result exceeded the MCL.
µg/L = microgram(s) per liter
DCE = dichloroethene
ERD = enhanced reductive dechlorination
MCL = maximum contaminant level
PCA = tetrachloroethane
PCE = tetrachloroethene
TCA = trichloroethane
TCE = trichloroethene

15.5.2.4.2 AP-4525 – Geochemical Parameters

Due to the limited volume of water in monitoring well AP-4525, only VOCs were analyzed. As a result, geochemical parameters could not be assessed at AP-4525.

15.6 MANN-KENDALL TREND ANALYSIS

A Mann-Kendall trend analysis was performed for a CG039 monitoring well if (1) there are four or more data points available to run the calculation and (2) cleanup goals for COCs or daughter products have been exceeded one or more times in the past 5 years. In addition, Mann-Kendall trend analysis was also conducted for monitoring wells associated with the treatability study at CG039 for all COCs and daughter products.

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. In 2015, five of the wells (AP-3744, AP-3747, AP-3983R, AP-3989, and AP-4550) were monitored as part of the Treatability Study. Mann-Kendall trend analysis was also performed for two wells (AP-4344 and AP-4551) located within the deep aquifer plume. The Mann-Kendall analysis for the three wells located in treatability study target treatment zones (AP-3983R, AP-4550, and AP-4551) used a start date of August 2013 (i.e., the pre-injection baseline for the treatability study) to assess concentration trends associated with the treatability study. A summary of Mann-Kendall concentration trends is in Table 15-20 and on Figures 15-4 through 15-11. Historical data used to calculate the Mann-Kendall concentrations trends are in Appendix C-2.

Trend results indicate that statistically significant (95 percent confidence level or greater) decreasing trends are present for the following constituents and locations:

- TCE in all monitoring wells with the exception of (1) the shallow aquifer downgradient monitoring well AP-3747, which has no significant trend, and (2) the deep aquifer downgradient well AP-4344, which has a probable decreasing trend
- PCE in monitoring wells AP-3983R, AP-4550, and AP-4551
- Cis-1,2-DCE in monitoring well AP-3989
- 1,1,2,2-PCA in monitoring wells AP-3744, AP-3989, AP-4353, and AP-4550
- 1,1,2-TCA in monitoring wells AP-3989 and AP-4550

The current Mann-Kendall trend analysis of monitoring well AP-3989 includes 25 data points since November 1996 and indicates that (1) a decreasing trend for cis-1,2-DCE is present, and (2) no significant trends for vinyl chloride exist. However, this location has been impacted by treatability study resulting in the last two data points showing substantial increasing concentrations for both cis-1,2-DCE and vinyl chloride. It is anticipated that future Mann-Kendall analyses will reflect the change in trends for these constituents at this well over time.

Increasing trends are present for the following constituents and locations:

- Cis-1,2-DCE at monitoring wells AP-3983R and AP-4551
- Trans-1,2-DCE at AP-4551
- 1,1-DCE at AP-3983R and AP-4551
- Vinyl chloride at AP-3983R

There are no statistically significant trends present for carbon tetrachloride or benzene.

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Table 15-20 Summary of 2015 Mann-Kendall Concentration Trends for Select Wells at CG039

Well	Aquifer	PCE[a]	TCE[a]	cis-1,2-DCE [a]	trans-1,2-DCE[a]	1,1-DCE	1,1,2,2-PCA[a]	1,1,2-TCA	Vinyl Chloride	Carbon Tetrachloride[a]	Benzene
Treatability Study Wells – Target Treatment Zone[b]											
AP-3983R[b]	Shallow	Decreasing (99.9)	Decreasing (99.9)	Increasing (99.9)	NST	Increasing (97.2)	NST	NST	Increasing (99.9)	NST	NST
AP-4550[b,c]	Shallow	Decreasing (97.2)	Decreasing (99.9)	NST	NST	NST	Decreasing (99.9)	Decreasing (97.2)	NST	NST	NST
AP-4551[b]	Deep	Decreasing (95.2)	Decreasing (97.2)	Increasing (97.2)	Increasing (99.9)	Increasing (97.2)	NST	NST	NST	NST	NST
Treatability Study Wells – Downgradient											
AP-3744	Shallow	NST	Decreasing (100)	NE	NE	NE	Decreasing (100)	NE	NE	NE	NE
AP-3747[c]	Shallow	NST	NST	NE	NE	NE	NST	NE	NE	NE	NE
AP-3989	Shallow	NE	Decreasing (100)	Decreasing (98.8)	NE	NE	Decreasing (100)	Decreasing (100)	NST	NE	NE
LTM Only Program Wells											
AP-4344	Deep	NE	Probably Decreasing (93.1)	NE	NE	NE	NE	NE	NE	NE	NE
AP-4353	Shallow	NE	Decreasing (99.4)	NE	NE	NE	Decreasing (100)	NE	NE	NE	NE

Table 15-20 Summary of 2015 Mann-Kendall Concentration Trends for Select Wells at CG039 *(Continued)*

Notes:

[a] COCs

[b] 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 in this table.

[c] 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 this table were sampled during the 2015 monitoring event and (1) have four or more data points available to run the calculation and (2) cleanup levels for COCs have been exceeded one or more times in the past 5 years. 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

LTM = long-term management

NE = No Exceedance of cleanup level in the past 5 years

NST = No significant trend.

PCA = tetrachloroethane

PCE = tetrachloroethene

TCA = trichloroethane

TCE = trichloroethene

15.7 SITE SUMMARY AND RECOMMENDATIONS

Ongoing activities at CG039 include long-term groundwater monitoring in accordance with the 2011 *Memorandum to the Site File for OUB/Poleline Road Disposal Area* (Memo to Site File) (USAF, 2011a) and follow-up monitoring related to an enhanced reductive dechlorination treatability study.

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 may be insufficient to completely degrade cis-1,2-DCE to vinyl chloride and then to ethene.

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, only enough water for a VOC sample could be obtained. Therefore, there are not enough data to evaluate whether reductive dechlorination is occurring at AP-4525; however, it appears that lower TCE concentrations and some daughter products from upgradient reductive dechlorination may be arriving at AP-4525.

15.7.2 Five-Year Review

CG039 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 (in 2003, 2008, and 2013) have been performed for JBER-R (which includes CG039).

The Third CERCLA Five-Year Review Report for JBER-R (USAF, 2013b) included the following recommendations for CG039:

- Augment the monitoring well network in the shallow aquifer to define the downgradient limit of the plume.

- Update the OUB COC RA-Os to provide future protectiveness of human health.

An attempt to locate the downgradient extent of the shallow aquifer at CG039 and install one monitoring well (CG039-NMW) was made in September 2015. Based on the absence of any saturated lithologic intervals encountered during the drilling of soil boring CG039-NMW, it was concluded that the shallow aquifer does not exist in the vicinity of existing deep monitoring well AP-3748 (Figures 15-1 and 15-2) (USAF, 2016e). Therefore, it was determined 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 was considered to be delineated downgradient of shallow monitoring well AP-3747, and the recommendation in the 2013 Five-Year Review is considered addressed (USAF, 2016f).

As described in Section 15.2, a technical memorandum is being prepared that documents the updated RBCs, and revised cleanup goals for CG039 will be documented in the Addendum for the Third CERCLA Five-Year Review Report.

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.

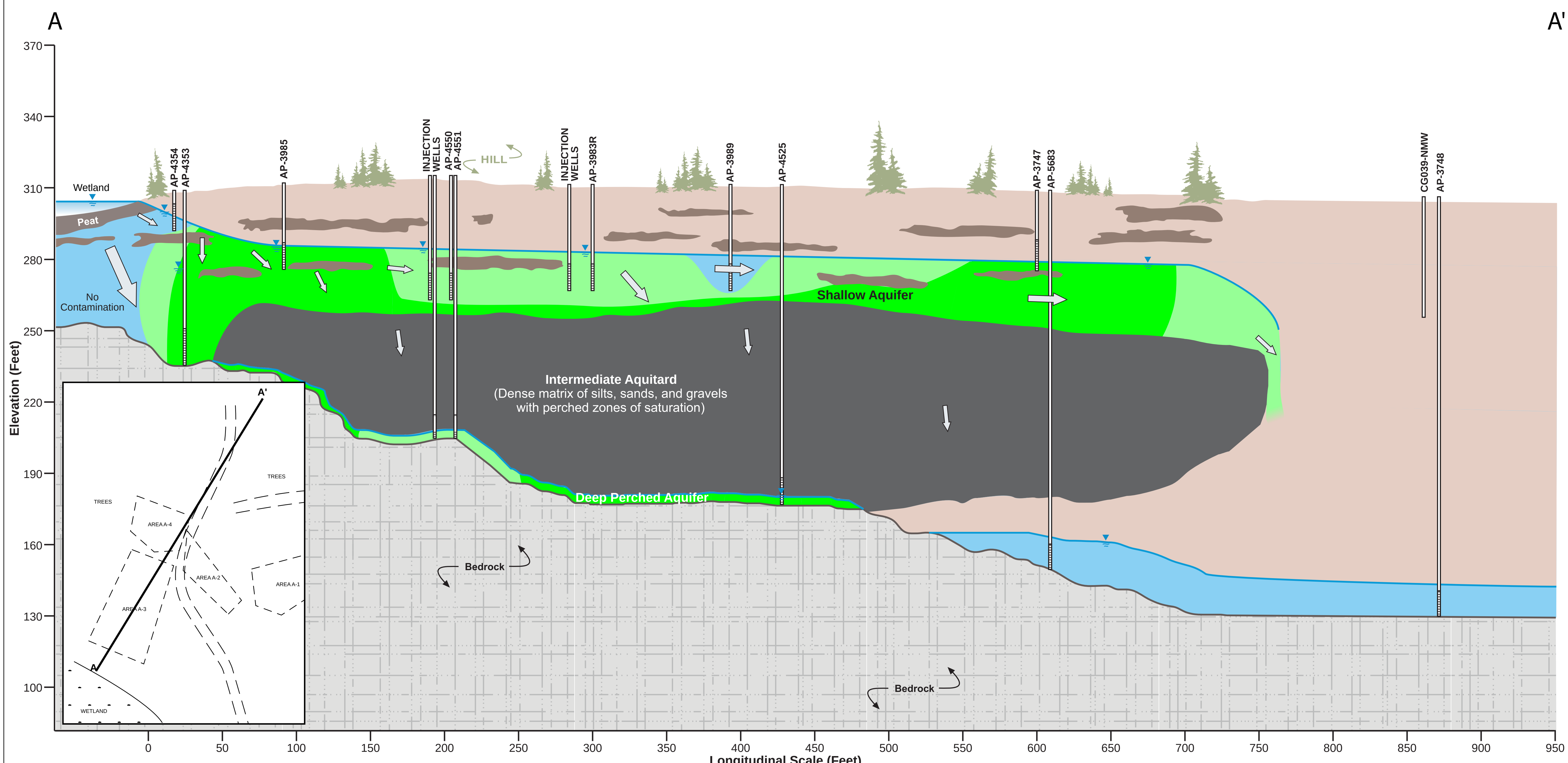
Specific recommendations for ongoing groundwater monitoring are as follows:

- Annual groundwater monitoring will continue in accordance with the 2011 Memo to Site File.
- Continue with annual groundwater monitoring of the treatability study wells AP-3744, AP-3747, AP-3983R, AP-3989, AP-4525, AP-4550, and AP-4551) to assess potential rebound of TCE concentrations, degradation of TCE daughter products, and persistence of reducing groundwater conditions.
- All requirements of the Memo to Site File will continue to be monitored, but analytical and field parameters will be added as necessary so that the treatability study wells (AP-3744, AP-3747, AP-3983R, AP-3989, AP-4525, AP-4550, and AP-4551) continue to be monitored as outlined in Table 2 of the 2015 *Remedial Action – Operations and Monitoring Letter Work Plan Addendum* (USAF, 2015a) (LTM Work Plan). The annual sampling will be modified as follows:
    - Five wells will be sampled annually as prescribed by the Memo to Site File: AP-3748, AP-4344, AP-4353, AP-5246, and AP-5683 (AP-4019 replacement well).
    - Two wells identified for annual sampling in the Memo to Site File will still be sampled as prescribed, with the addition of the treatability study parameters listed in Table 2 of the LTM Work Plan: AP-3747 and AP-4550.
    - Two wells identified as Sentinel Wells to be sampled in the year preceding the Five-Year Review (2017) will also be sampled annually for the treatability study parameters listed in Table 2 of the LTM Work Plan: AP-3744 and AP-3989.
    - Three wells that are not identified to be sampled in the Memo to Site File, either annually or every 5 years, will be sampled annually for the treatability study parameters listed in Table 2 of the LTM Work Plan: AP-3983R, AP-4525, and AP-4551.
    - The 2016 annual LTM Work Plan will formally outline this plan.
- The monitoring results from the seven treatability study wells will be reported in the 2016 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, 2015e).

- Continue the treatability study to evaluate whether bioaugmentation with a DHC microbial culture (scheduled for 2016) can degrade cis-1,2-DCE and possibly 1,1,2,2-PCA to accelerate the remedial time frame at the site.



Legend

- Interpreted Groundwater Flow Direction
- Low Permeability Lens
- Potentiometric Surface

Note: This site model is conceptual, and based on site data, interpreted data, and professional judgement. Therefore, the contaminated zones and geologic features depicted in this figure should be used only for conceptual purposes.

µg/L = micrograms per liter

TCE Contour Interval (September 2014)

- 5 to 100 µg/L
- 100 to 500 µg/L

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CONCEPTUAL SITE MODEL

CG039 - Poleline Road Disposal Area
2015 Annual Remedial Action Operations and Monitoring Report for Select CERCLA Sites
Joint Base Elmendorf-Richardson, Alaska

Figure **15-1**

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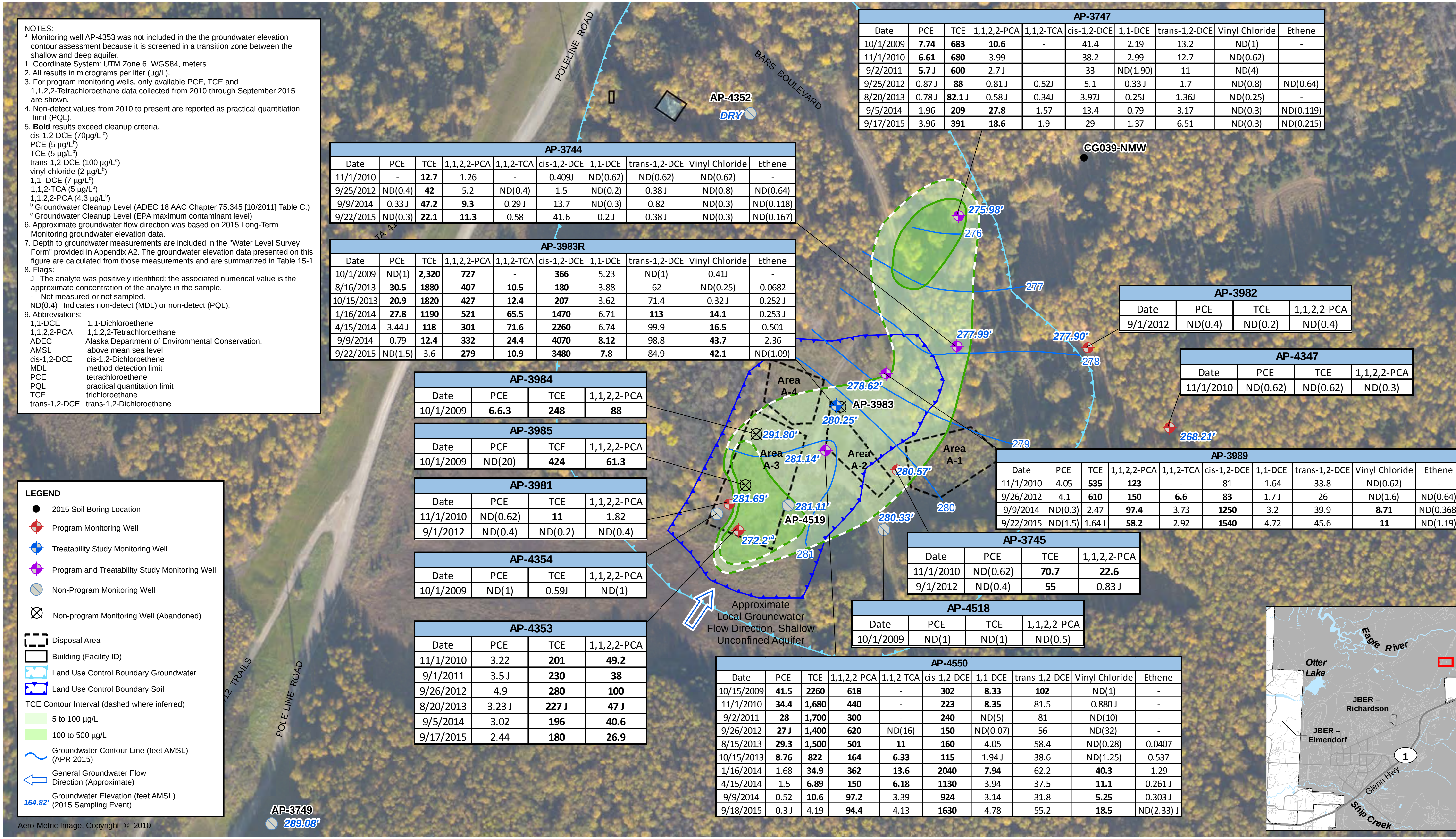
NOTES:
[a] Monitoring well AP-4353 was not included in the the groundwater elevation contour assessment because it is screened in a transition zone between the shallow and deep aquifer.
1. Coordinate System: UTM Zone 6, WGS84, meters.
2. All results in micrograms per liter (µg/L).
3. For program monitoring wells, only available PCE, TCE and 1,1,2,2-Tetrachloroethane data collected from 2010 through September 2015 are shown.
4. Non-detect values from 2010 to present are reported as practical quantitiation limit (PQL).
5. **Bold** results exceed cleanup criteria.
   cis-1,2-DCE (70µg/L [c])
   PCE (5 µg/L[b])
   TCE (5 µg/L[b])
   trans-1,2-DCE (100 µg/L[c])
   vinyl chloride (2 µg/L[b])
   1,1- DCE (7 µg/L[c])
   1,1,2-TCA (5 µg/L[b])
   1,1,2,2-PCA (4.3 µg/L[b])
   [b] Groundwater Cleanup Level (ADEC 18 AAC Chapter 75.345 [10/2011] Table C.)
   [c] Groundwater Cleanup Level (EPA maximum contaminant level)
6. Approximate groundwater flow direction was based on 2015 Long-Term Monitoring groundwater elevation data.
7. 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.
8. 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).
9. Abbreviations:

1,1-DCE	1,1-Dichloroethene
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
PCE	tetrachloroethene
PQL	practical quantitation limit
TCE	trichloroethane
trans-1,2-DCE	trans-1,2-Dichloroethene



AP-3747

Date	PCE	TCE	1,1,2,2-PCA	1,1,2-TCA	cis-1,2-DCE	1,1-DCE	trans-1,2-DCE	Vinyl Chloride	Ethene
10/1/2009	**7.74**	**683**	**10.6**	-	41.4	2.19	13.2	ND(1)	-
11/1/2010	**6.61**	**680**	3.99	-	38.2	2.99	12.7	ND(0.62)	-
9/2/2011	**5.7 J**	**600**	2.7 J	-	33	ND(1.90)	11	ND(4)	-
9/25/2012	0.87 J	**88**	0.81 J	0.52J	5.1	0.33 J	1.7	ND(0.8)	ND(0.64)
8/20/2013	0.78 J	**82.1 J**	0.58 J	0.34J	3.97J	0.25J	1.36J	ND(0.25)	-
9/5/2014	1.96	**209**	**27.8**	1.57	13.4	0.79	3.17	ND(0.3)	ND(0.119)
9/17/2015	3.96	**391**	**18.6**	1.9	29	1.37	6.51	ND(0.3)	ND(0.215)

AP-3744

Date	PCE	TCE	1,1,2,2-PCA	1,1,2-TCA	cis-1,2-DCE	1,1-DCE	trans-1,2-DCE	Vinyl Chloride	Ethene
11/1/2010	-	**12.7**	1.26	-	0.409J	ND(0.62)	ND(0.62)	ND(0.62)	-
9/25/2012	ND(0.4)	**42**	5.2	ND(0.4)	1.5	ND(0.2)	0.38 J	ND(0.8)	ND(0.64)
9/9/2014	0.33 J	**47.2**	**9.3**	0.29 J	13.7	ND(0.3)	0.82	ND(0.3)	ND(0.118)
9/22/2015	ND(0.3)	**22.1**	**11.3**	0.58	41.6	0.2 J	0.38 J	ND(0.3)	ND(0.167)

AP-3983R

Date	PCE	TCE	1,1,2,2-PCA	1,1,2-TCA	cis-1,2-DCE	1,1-DCE	trans-1,2-DCE	Vinyl Chloride	Ethene
10/1/2009	ND(1)	**2,320**	**727**	-	**366**	5.23	ND(1)	0.41J	-
8/16/2013	**30.5**	**1880**	**407**	**10.5**	**180**	3.88	62	ND(0.25)	0.0682
10/15/2013	**20.9**	**1820**	**427**	**12.4**	**207**	3.62	71.4	0.32 J	0.252 J
1/16/2014	**27.8**	**1190**	**521**	**65.5**	**1470**	6.71	**113**	**14.1**	0.253 J
4/15/2014	3.44 J	**118**	**301**	**71.6**	**2260**	6.74	99.9	**16.5**	0.501
9/9/2014	0.79	**12.4**	**332**	**24.4**	**4070**	**8.12**	98.8	**43.7**	2.36
9/22/2015	ND(1.5)	3.6	**279**	**10.9**	**3480**	**7.8**	84.9	**42.1**	ND(1.09)

AP-3982

Date	PCE	TCE	1,1,2,2-PCA
9/1/2012	ND(0.4)	ND(0.2)	ND(0.4)

AP-4347

Date	PCE	TCE	1,1,2,2-PCA
11/1/2010	ND(0.62)	ND(0.62)	ND(0.3)

AP-3984

Date	PCE	TCE	1,1,2,2-PCA
10/1/2009	**6.6.3**	**248**	**88**

AP-3985

Date	PCE	TCE	1,1,2,2-PCA
10/1/2009	ND(20)	**424**	**61.3**

AP-3981

Date	PCE	TCE	1,1,2,2-PCA
11/1/2010	ND(0.62)	**11**	1.82
9/1/2012	ND(0.4)	ND(0.2)	ND(0.4)

AP-4354

Date	PCE	TCE	1,1,2,2-PCA
10/1/2009	ND(1)	0.59J	ND(1)

AP-4353

Date	PCE	TCE	1,1,2,2-PCA
11/1/2010	3.22	**201**	**49.2**
9/1/2011	3.5 J	**230**	**38**
9/26/2012	4.9	**280**	**100**
8/20/2013	3.23 J	**227 J**	**47 J**
9/5/2014	3.02	**196**	**40.6**
9/17/2015	2.44	**180**	**26.9**

AP-3989

Date	PCE	TCE	1,1,2,2-PCA	1,1,2-TCA	cis-1,2-DCE	1,1-DCE	trans-1,2-DCE	Vinyl Chloride	Ethene
11/1/2010	4.05	**535**	**123**	-	81	1.64	33.8	ND(0.62)	-
9/26/2012	4.1	**610**	**150**	**6.6**	**83**	1.7 J	26	ND(1.6)	ND(0.64)
9/9/2014	ND(0.3)	2.47	**97.4**	3.73	**1250**	3.2	39.9	**8.71**	ND(0.368)
9/22/2015	ND(1.5)	1.64 J	**58.2**	2.92	**1540**	4.72	45.6	**11**	ND(1.19)

AP-3745

Date	PCE	TCE	1,1,2,2-PCA
11/1/2010	ND(0.62)	**70.7**	**22.6**
9/1/2012	ND(0.4)	**55**	0.83 J

AP-4518

Date	PCE	TCE	1,1,2,2-PCA
10/1/2009	ND(1)	ND(1)	ND(0.5)

AP-4550

Date	PCE	TCE	1,1,2,2-PCA	1,1,2-TCA	cis-1,2-DCE	1,1-DCE	trans-1,2-DCE	Vinyl Chloride	Ethene
10/15/2009	**41.5**	**2260**	**618**	-	**302**	**8.33**	**102**	ND(1)	-
11/1/2010	**34.4**	**1,680**	**440**	-	**223**	**8.35**	81.5	0.880 J	-
9/2/2011	**28**	**1,700**	**300**	-	**240**	ND(5)	81	ND(10)	-
9/26/2012	**27 J**	**1,400**	**620**	ND(16)	**150**	ND(0.07)	56	ND(32)	-
8/15/2013	**29.3**	**1,500**	**501**	**11**	**160**	4.05	58.4	ND(0.28)	0.0407
10/15/2013	**8.76**	**822**	**164**	**6.33**	**115**	1.94 J	38.6	ND(1.25)	0.537
1/16/2014	1.68	**34.9**	**362**	**13.6**	**2040**	**7.94**	62.2	**40.3**	1.29
4/15/2014	1.5	**6.89**	**150**	**6.18**	**1130**	3.94	37.5	**11.1**	0.261 J
9/9/2014	0.52	**10.6**	**97.2**	3.39	**924**	3.14	31.8	**5.25**	0.303 J
9/18/2015	0.3 J	4.19	**94.4**	4.13	**1630**	4.78	55.2	**18.5**	ND(2.33) J

0 75 150 300 450 Feet

CG039 SITE MAP WITH ANALYTICAL DATA FOR THE SHALLOW, UNCONFINED AQUIFER

CG039 - Poleline Road Disposal Area
2015 Annual Remedial Action - Operations and Monitoring Report for Select CERCLA Sites
Joint Base Elmendorf-Richardson, Alaska

Figure 15-2

\\brookside\GIS_SHARE\ENBG\00_Proj\A\AirForce\AFCEE_JBER_20001102\MapFiles\CERCLA_Sites\CG039\2015\CG039 Figure 15-2_(Shallow_Aquifer).mxd 4/18/2017 jcarr3

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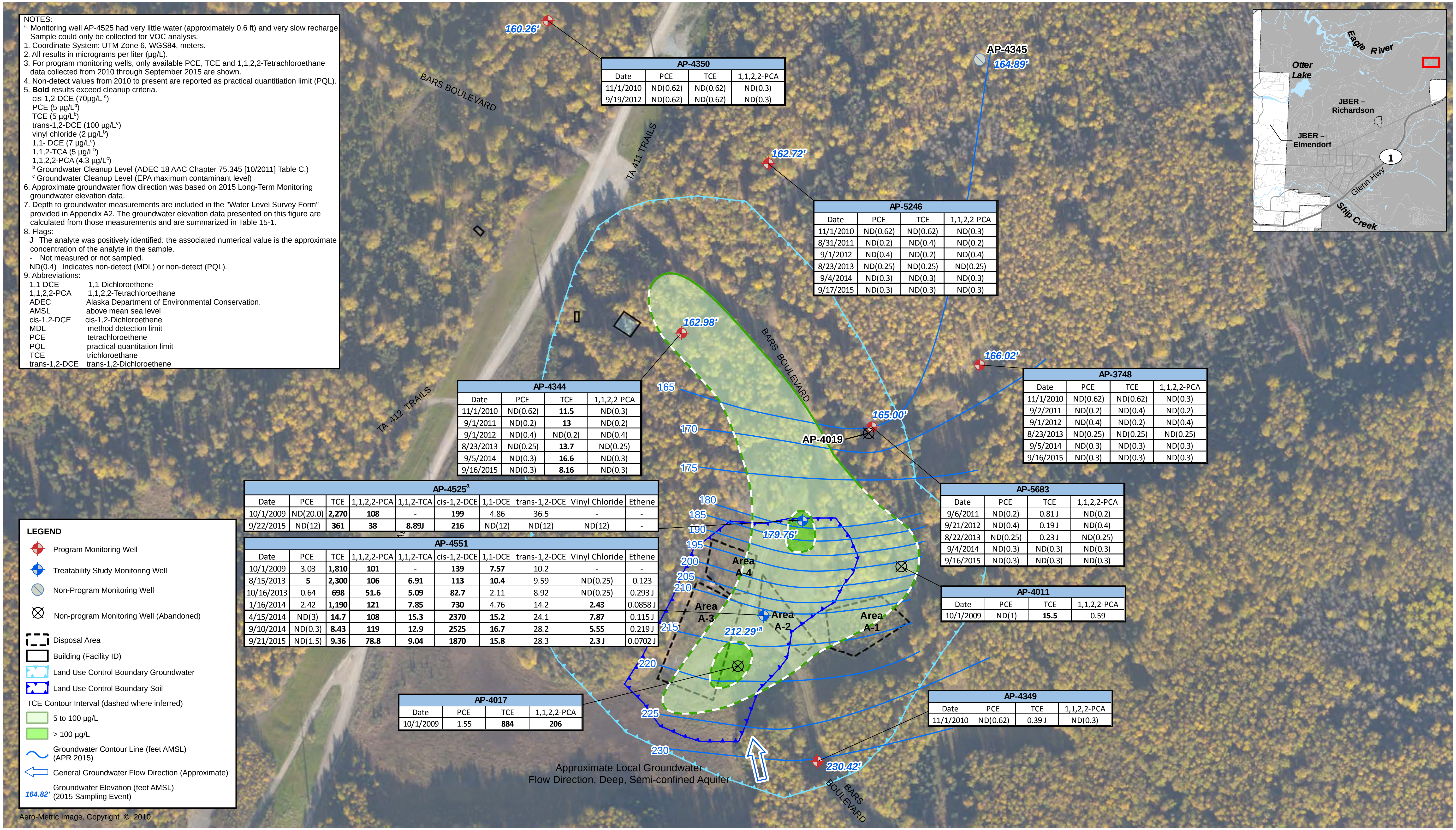

NOTES:

[a] Monitoring well AP-4525 had very little water (approximately 0.6 ft) and very slow recharge. Sample could only be collected for VOC analysis.

1. Coordinate System: UTM Zone 6, WGS84, meters.
2. All results in micrograms per liter (µg/L).
3. For program monitoring wells, only available PCE, TCE and 1,1,2,2-Tetrachloroethane data collected from 2010 through September 2015 are shown.
4. Non-detect values from 2010 to present are reported as practical quantitiation limit (PQL).
5. **Bold** results exceed cleanup criteria.
   - cis-1,2-DCE (70µg/L [c])
   - PCE (5 µg/L[b])
   - TCE (5 µg/L[b])
   - trans-1,2-DCE (100 µg/L[c])
   - vinyl chloride (2 µg/L[b])
   - 1,1- DCE (7 µg/L[c])
   - 1,1,2-TCA (5 µg/L[b])
   - 1,1,2,2-PCA (4.3 µg/L[c])
   - [b] Groundwater Cleanup Level (ADEC 18 AAC Chapter 75.345 [10/2011] Table C.)
   - [c] Groundwater Cleanup Level (EPA maximum contaminant level)
6. Approximate groundwater flow direction was based on 2015 Long-Term Monitoring groundwater elevation data.
7. 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.
8. 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).
9. Abbreviations:

1,1-DCE	1,1-Dichloroethene
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
PCE	tetrachloroethene
PQL	practical quantitation limit
TCE	trichloroethane
trans-1,2-DCE	trans-1,2-Dichloroethene

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) (APR 2015)
- General Groundwater Flow Direction (Approximate)
- 164.82' Groundwater Elevation (feet AMSL) (2015 Sampling Event)

AP-4350

Date	PCE	TCE	1,1,2,2-PCA
11/1/2010	ND(0.62)	ND(0.62)	ND(0.3)
9/19/2012	ND(0.62)	ND(0.62)	ND(0.3)

AP-5246

Date	PCE	TCE	1,1,2,2-PCA
11/1/2010	ND(0.62)	ND(0.62)	ND(0.3)
8/31/2011	ND(0.2)	ND(0.4)	ND(0.2)
9/1/2012	ND(0.4)	ND(0.2)	ND(0.4)
8/23/2013	ND(0.25)	ND(0.25)	ND(0.25)
9/4/2014	ND(0.3)	ND(0.3)	ND(0.3)
9/17/2015	ND(0.3)	ND(0.3)	ND(0.3)

AP-3748

Date	PCE	TCE	1,1,2,2-PCA
11/1/2010	ND(0.62)	ND(0.62)	ND(0.3)
9/2/2011	ND(0.2)	ND(0.4)	ND(0.2)
9/1/2012	ND(0.4)	ND(0.2)	ND(0.4)
8/23/2013	ND(0.25)	ND(0.25)	ND(0.25)
9/5/2014	ND(0.3)	ND(0.3)	ND(0.3)
9/16/2015	ND(0.3)	ND(0.3)	ND(0.3)

AP-4344

Date	PCE	TCE	1,1,2,2-PCA
11/1/2010	ND(0.62)	**11.5**	ND(0.3)
9/1/2011	ND(0.2)	**13**	ND(0.2)
9/1/2012	ND(0.4)	ND(0.2)	ND(0.4)
8/23/2013	ND(0.25)	**13.7**	ND(0.25)
9/5/2014	ND(0.3)	**16.6**	ND(0.3)
9/16/2015	ND(0.3)	**8.16**	ND(0.3)

AP-4525[a]

Date	PCE	TCE	1,1,2,2-PCA	1,1,2-TCA	cis-1,2-DCE	1,1-DCE	trans-1,2-DCE	Vinyl Chloride	Ethene
10/1/2009	ND(20.0)	**2,270**	**108**	-	**199**	4.86	36.5	-	-
9/22/2015	ND(12)	**361**	**38**	**8.89J**	**216**	ND(12)	ND(12)	ND(12)	-

AP-4551

Date	PCE	TCE	1,1,2,2-PCA	1,1,2-TCA	cis-1,2-DCE	1,1-DCE	trans-1,2-DCE	Vinyl Chloride	Ethene
10/1/2009	3.03	**1,810**	**101**	-	**139**	**7.57**	10.2	-	-
8/15/2013	**5**	**2,300**	**106**	**6.91**	**113**	**10.4**	9.59	ND(0.25)	0.123
10/16/2013	0.64	**698**	**51.6**	**5.09**	**82.7**	2.11	8.92	ND(0.25)	0.293 J
1/16/2014	2.42	**1,190**	**121**	**7.85**	**730**	4.76	14.2	**2.43**	0.0858 J
4/15/2014	ND(3)	**14.7**	**108**	**15.3**	**2370**	**15.2**	24.1	**7.87**	0.115 J
9/10/2014	ND(0.3)	**8.43**	**119**	**12.9**	**2525**	**16.7**	28.2	**5.55**	0.219 J
9/21/2015	ND(1.5)	**9.36**	**78.8**	**9.04**	**1870**	**15.8**	28.3	**2.3 J**	0.0702 J

AP-5683

Date	PCE	TCE	1,1,2,2-PCA
9/6/2011	ND(0.2)	0.81 J	ND(0.2)
9/21/2012	ND(0.4)	0.19 J	ND(0.4)
8/22/2013	ND(0.25)	0.23 J	ND(0.25)
9/4/2014	ND(0.3)	ND(0.3)	ND(0.3)
9/16/2015	ND(0.3)	ND(0.3)	ND(0.3)

AP-4011

Date	PCE	TCE	1,1,2,2-PCA
10/1/2009	ND(1)	**15.5**	0.59

AP-4017

Date	PCE	TCE	1,1,2,2-PCA
10/1/2009	1.55	**884**	**206**

AP-4349

Date	PCE	TCE	1,1,2,2-PCA
11/1/2010	ND(0.62)	0.39 J	ND(0.3)

N
W E
S

0 87.5 175 350 525 Feet

CG039 SITE MAP WITH ANALYTICAL DATA FOR THE DEEP, SEMI-CONFINED AQUIFER

CG039 - Poleline Road Disposal Area
2015 Annual Remedial Action - Operations and Monitoring Report for Select CERCLA Sites
Joint Base Elmendorf-Richardson, Alaska

Figure
15-3

Date: 18 Apr 2017 Drawn by: jcarr3 \\brookside\GIS_SHARE\ENBG\00_Proj\A\AirForce\AFCEE_JBER_20001102\MapFiles\CERCLA_Sites\CG039\2015\CG039 Figure 15-3_(Deep_Aquifer).mxd

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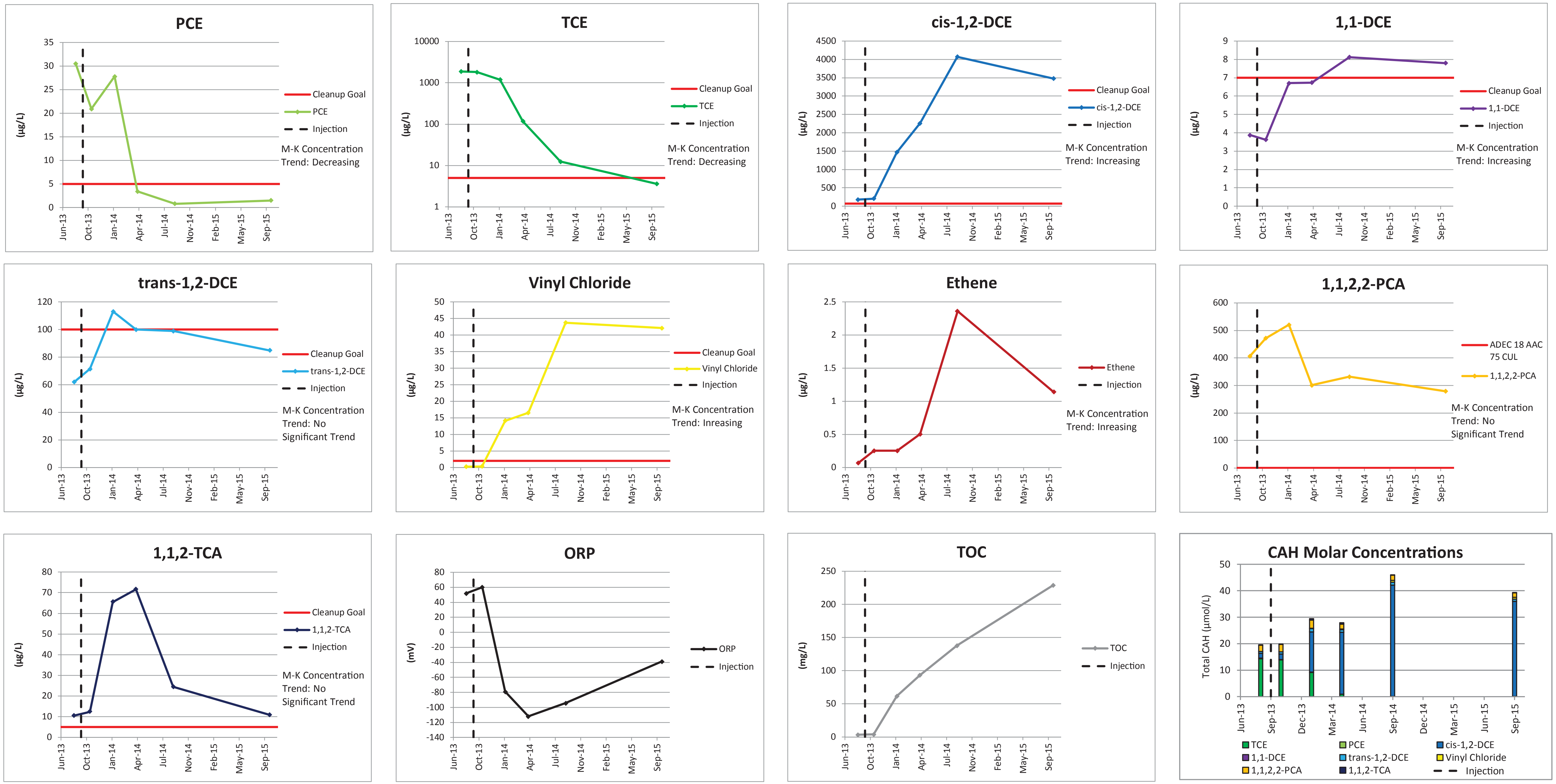

NOTES:

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 Cleanup 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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CONCENTRATION TRENDS FOR SELECT ANALYTES AT MONITORING WELL AP-3983R

2015 Annual Remedial Action - Operations and Monitoring Report for Select CERCLA Sites
Joint Base Elmendorf-Richardson, Alaska

Figure **15-4**

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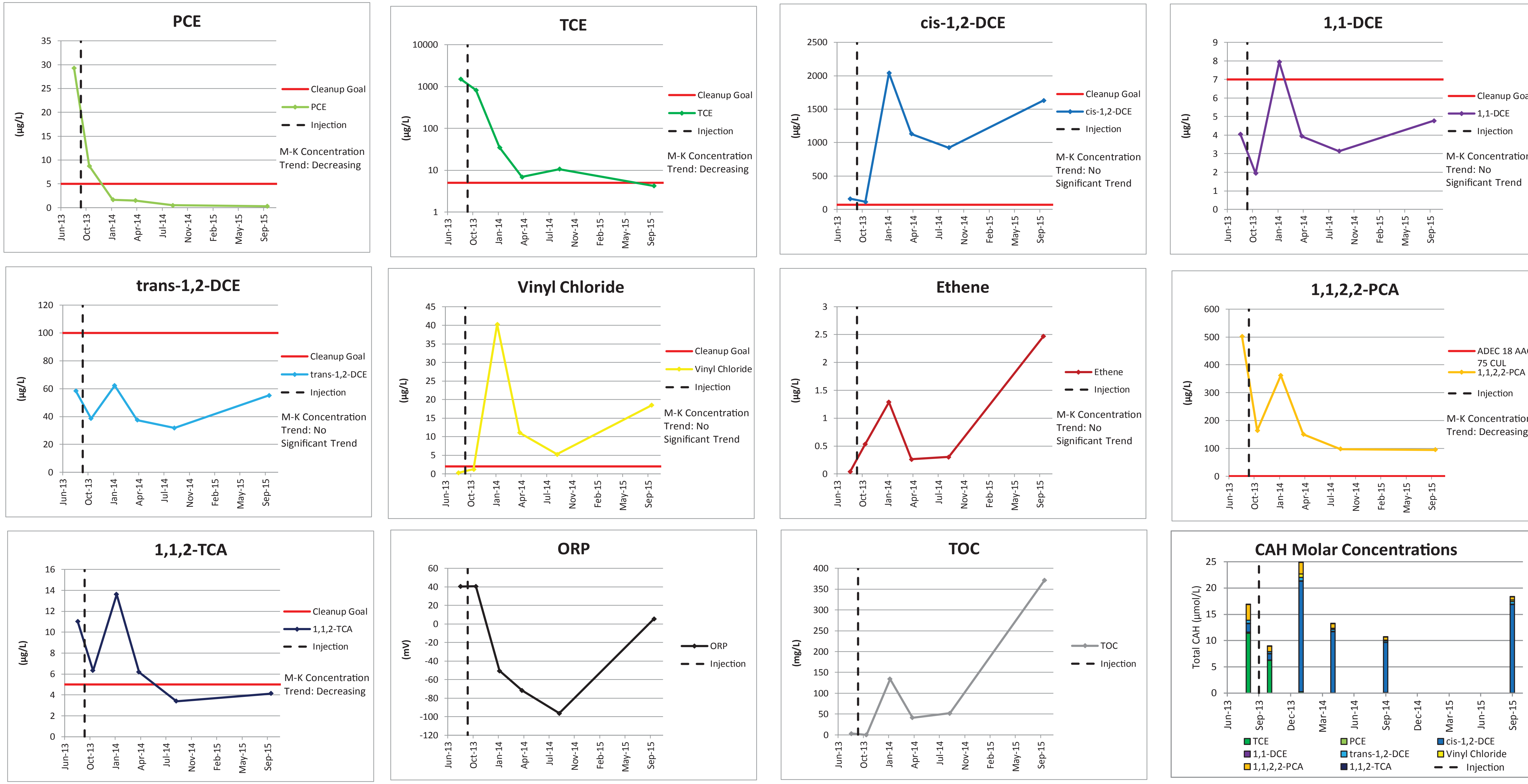

NOTES:

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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CONCENTRATION TRENDS FOR SELECT ANALYTES AT MONITORING WELL AP-4550

2015 Annual Remedial Action - Operations and Monitoring Report for Select CERCLA Sites
Joint Base Elmendorf-Richardson, Alaska

Figure
15-5

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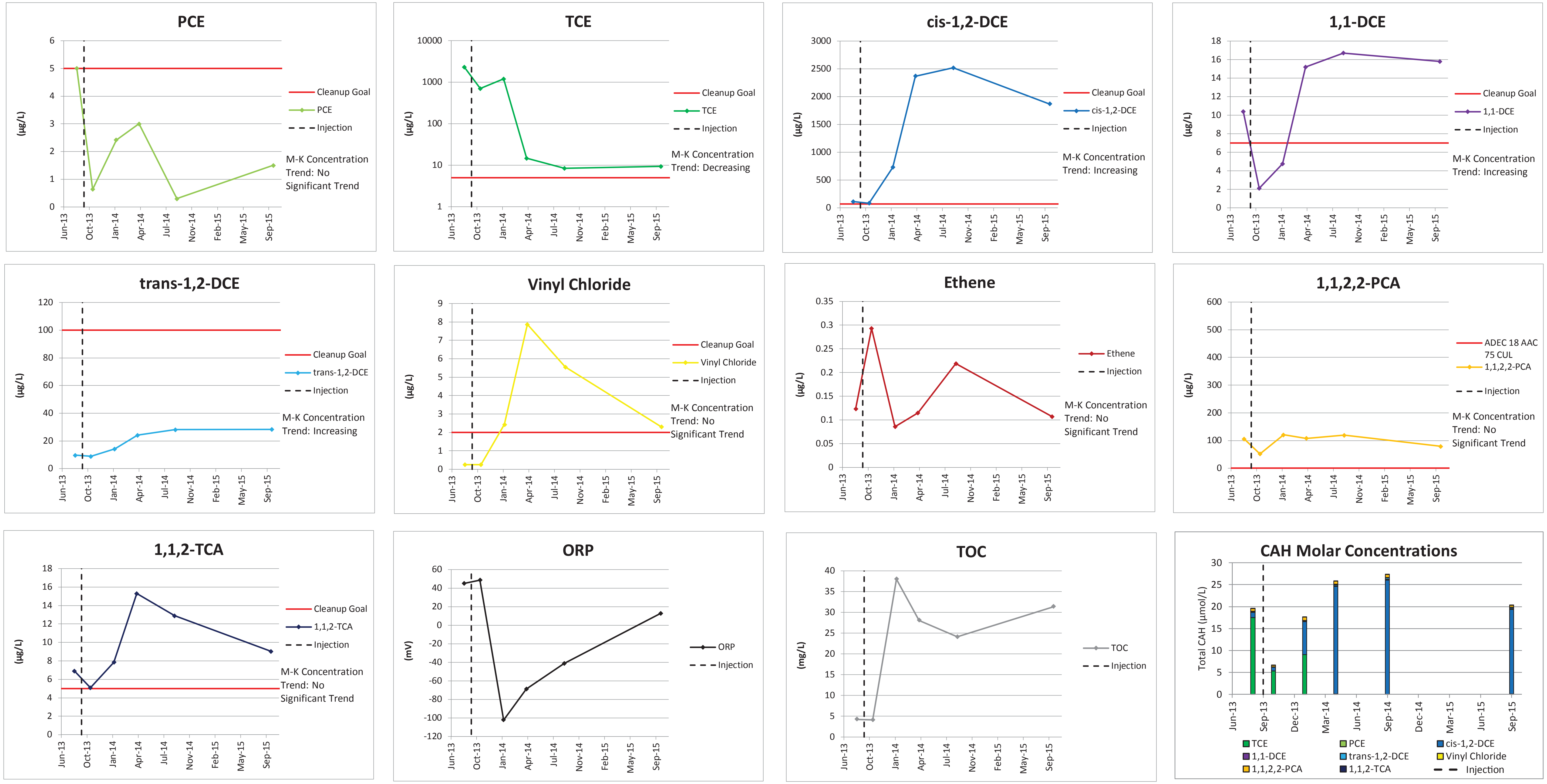

NOTES:

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 Cleanup 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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CONCENTRATION TRENDS FOR SELECT ANALYTES AT MONITORING WELL AP-4551

2015 Annual Remedial Action - Operations and Monitoring Report for Select CERCLA Sites
Joint Base Elmendorf-Richardson, Alaska

Figure **15-6**

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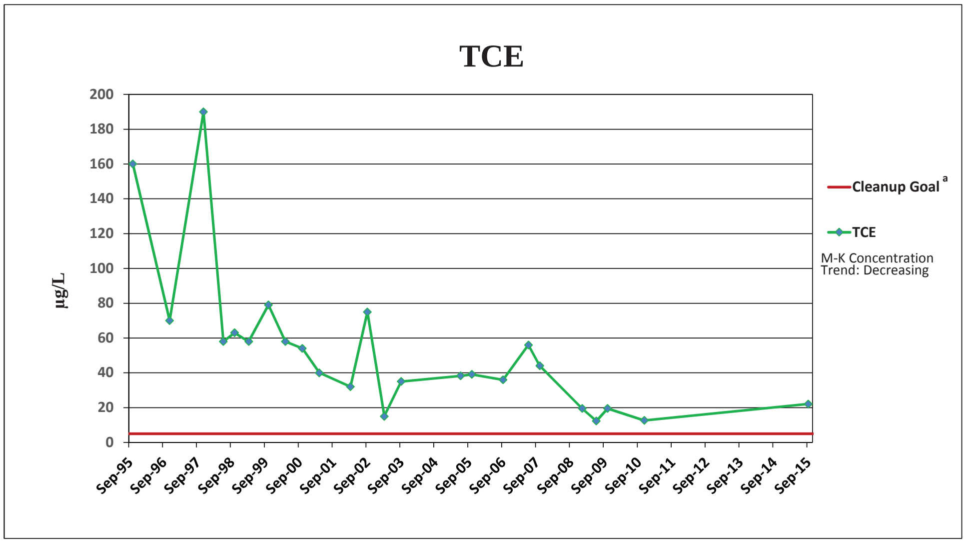

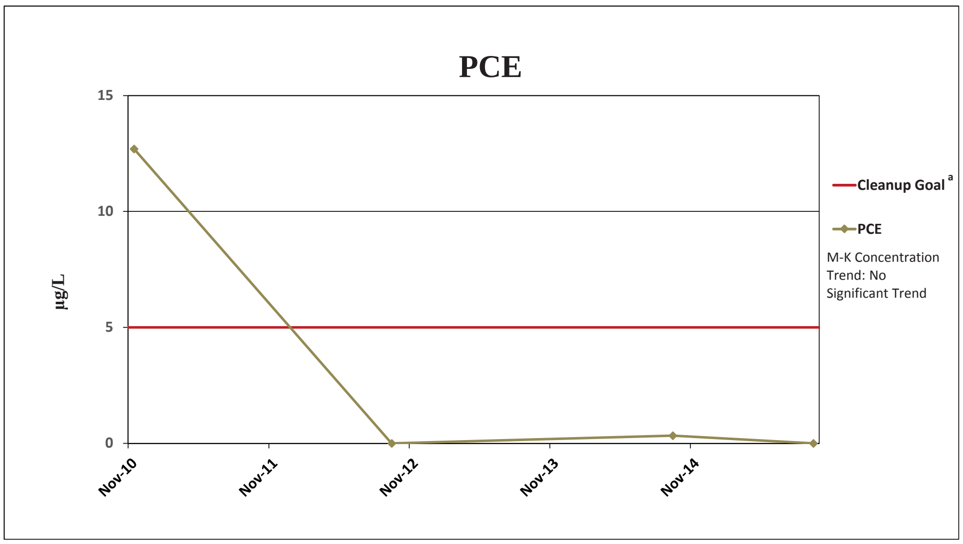

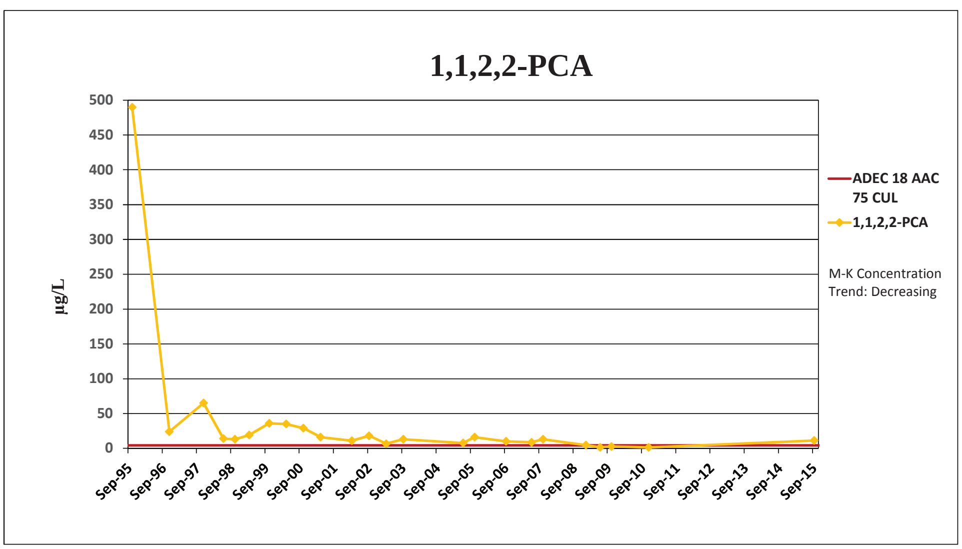

NOTES:

[a]Cleanup goals are presented in Table 15-1

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 Cleanup Level
PCE	Tetrachloroethene
TCE	Trichloroethene

CONCENTRATION TRENDS FOR SELECT ANALYTES AT MONITORING WELL AP-3744

2015 Annual Remedial Action - Operations and Monitoring Report for Select CERCLA Sites
Joint Base Elmendorf-Richardson, Alaska

Figure **15-7**

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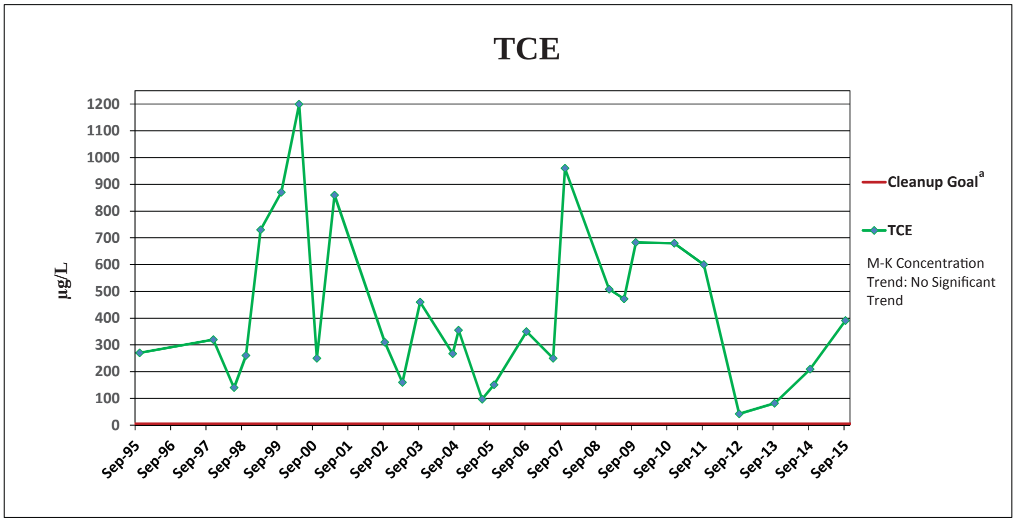

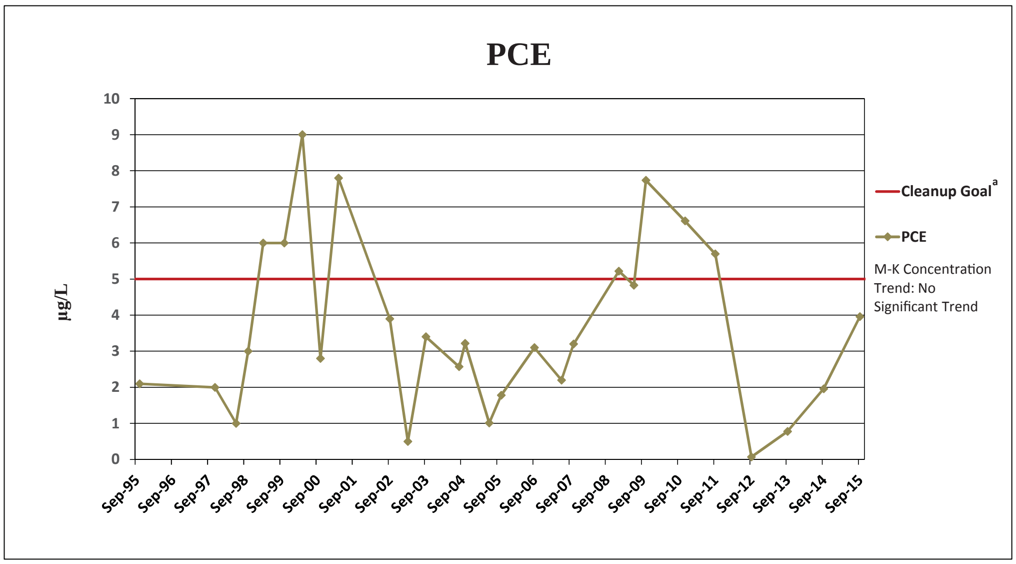

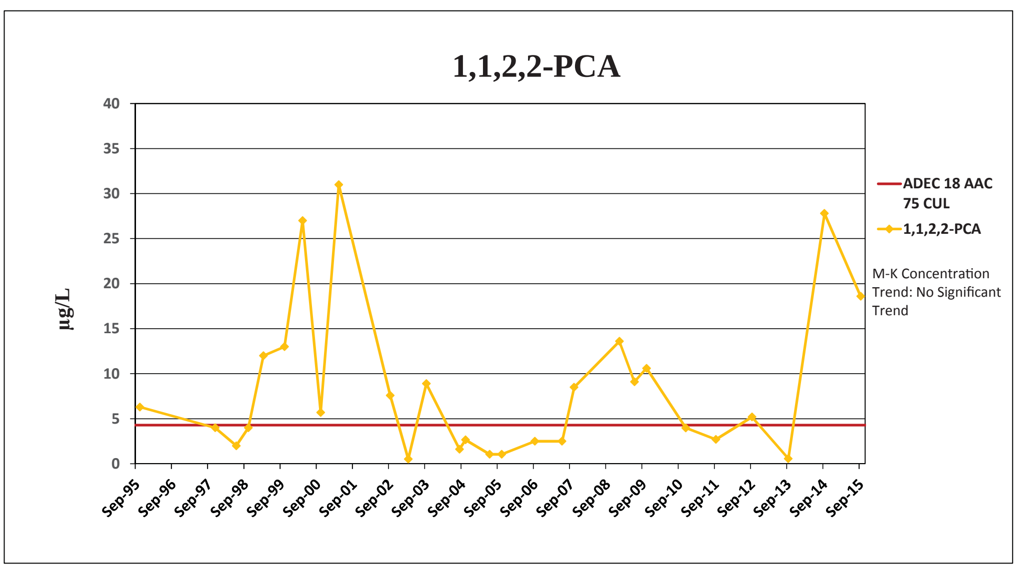

NOTES:

[a]Cleanup goals are presented in Table 15-1

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 Cleanup Level
PCE	Tetrachloroethene
TCE	Trichloroethene

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CONCENTRATION TRENDS FOR SELECT ANALYTES AT MONITORING WELL AP-3747

2015 Annual Remedial Action - Operations and Monitoring Report for Select CERCLA Sites
Joint Base Elmendorf-Richardson, Alaska

Figure **15-8**

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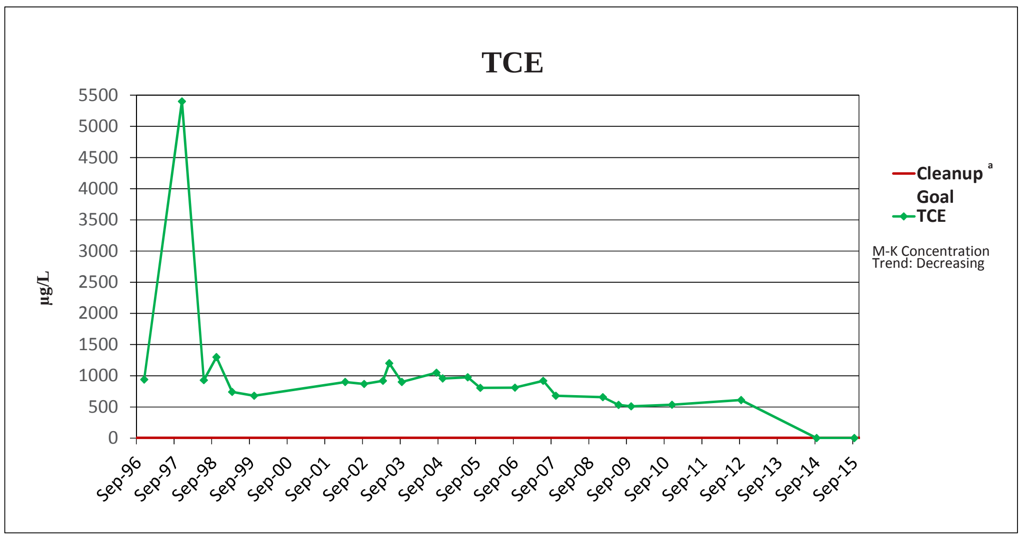

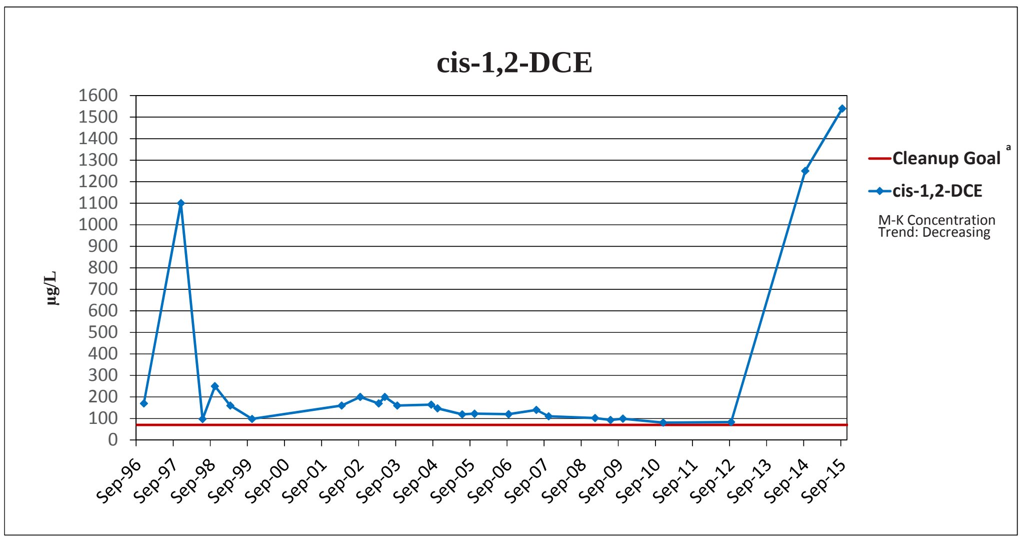

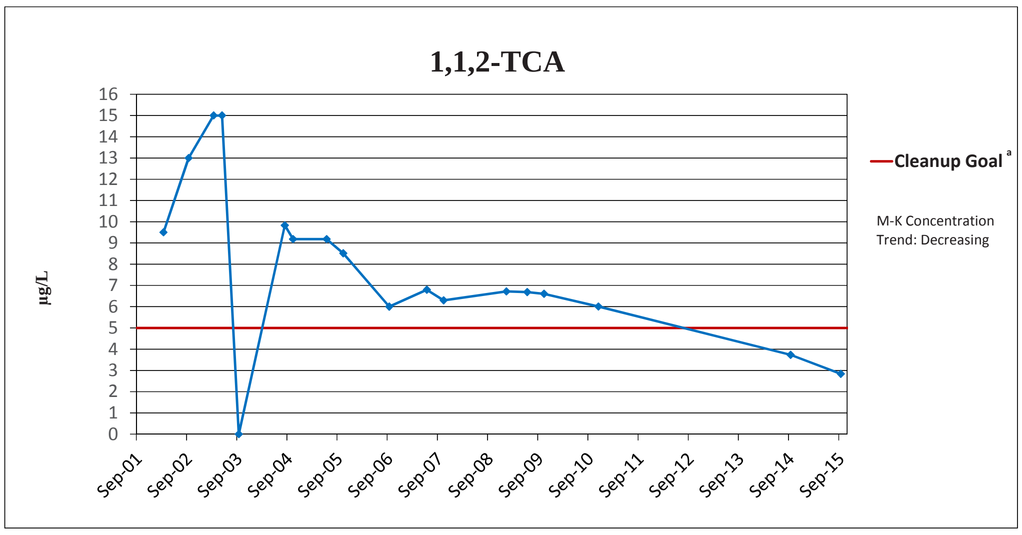

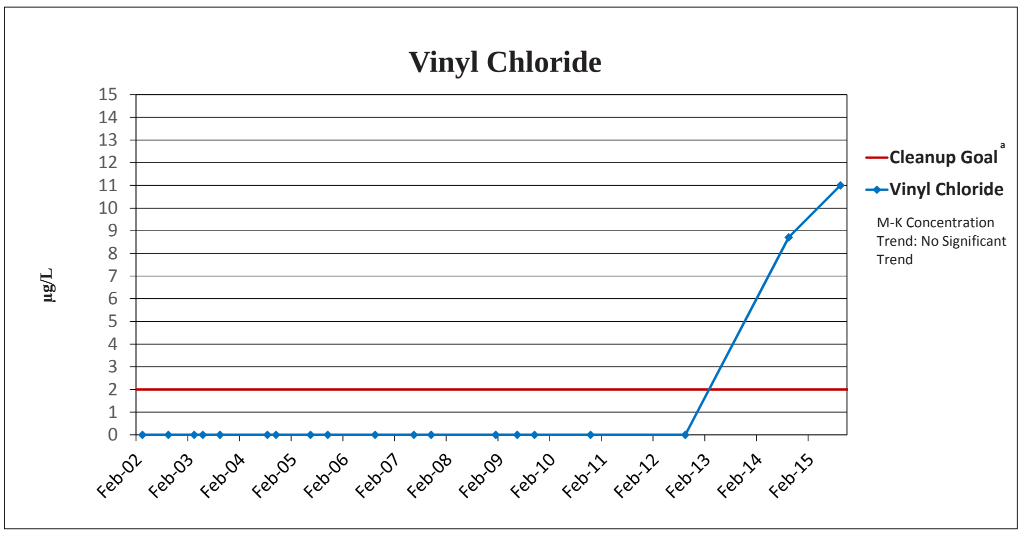

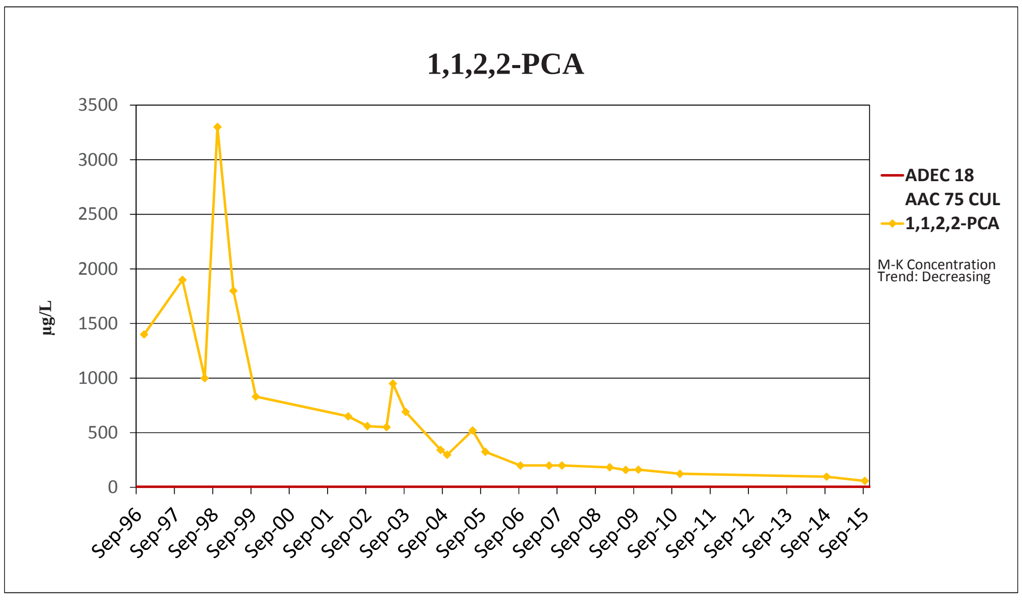

NOTES:

[a] Cleanup goals are presented in Table 15-1

µg/L	micrograms per liter
1,1,2,2-PCA	1,1,2,2-Tetrachloroethane
1,1,2-TCA	1,1,2-Trichloroethane
ADEC 18 AAC 75 CUL	2008 Alaska Department of Environmental Conservation 18 AAC Chapter 75.345 Table C Groundwater Cleanup Level
cis-1,2-DCE	cis-1,2-Dichloroethene
PCE	Tetrachloroethene
TCE	Trichloroethene

CONCENTRATION TRENDS FOR SELECT ANALYTES AT MONITORING WELL AP-3989R

2015 Annual Remedial Action - Operations and Monitoring Report for Select CERCLA Sites
Joint Base Elmendorf-Richardson, Alaska

Figure
15-9

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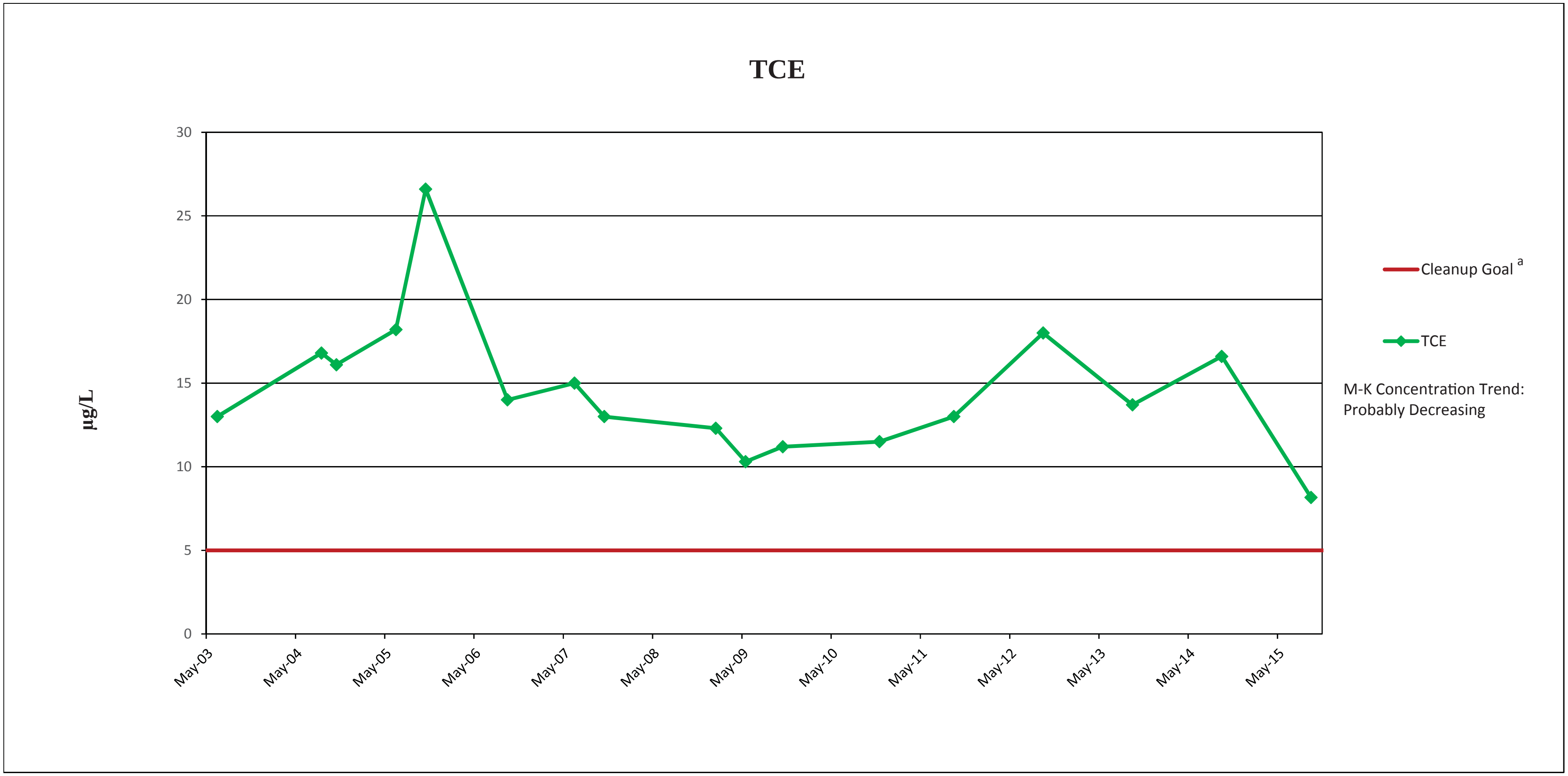

NOTES:

[a] Cleanup Goal is presented in Table 15-1

µg/L micrograms per liter

TCE Trichloroethene

CONCENTRATION TRENDS FOR SELECT ANALYTES AT MONITORING WELL AP-4344

2015 Annual Remedial Action - Operations and Monitoring Report for Select CERCLA Sites
Joint Base Elmendorf-Richardson, Alaska

Figure
15-10

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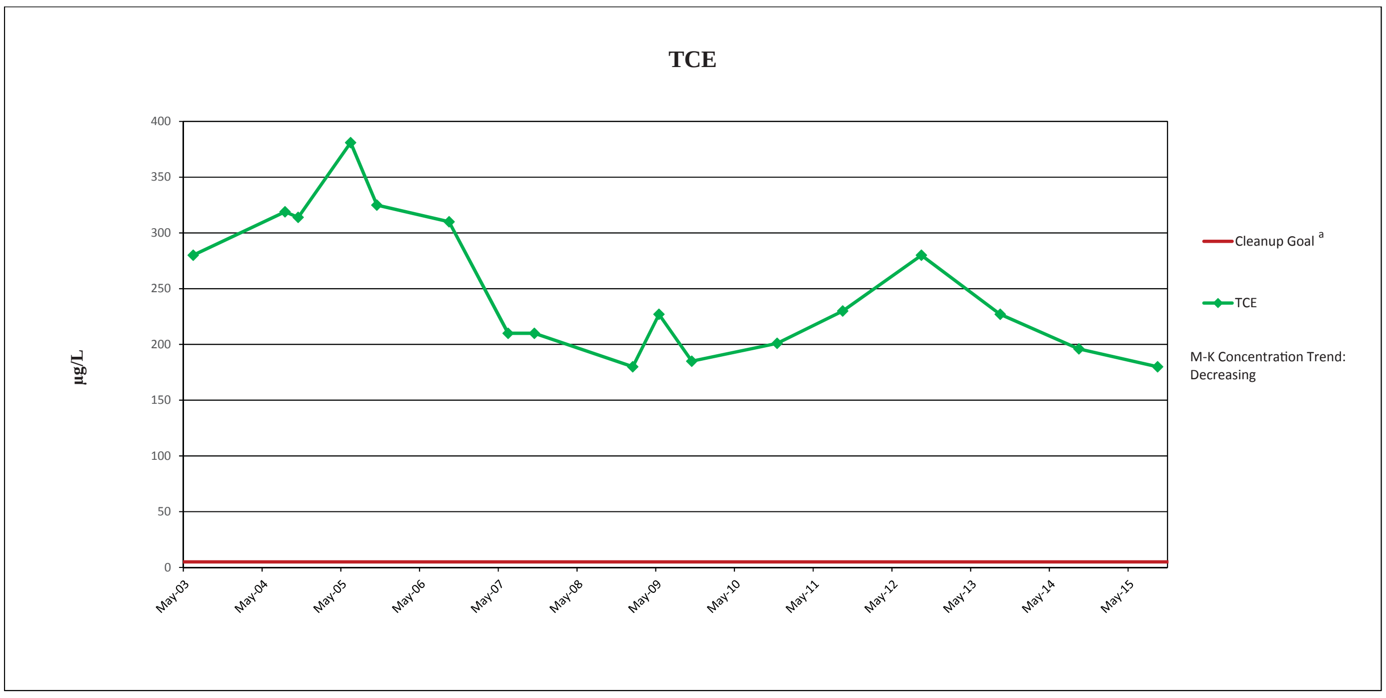

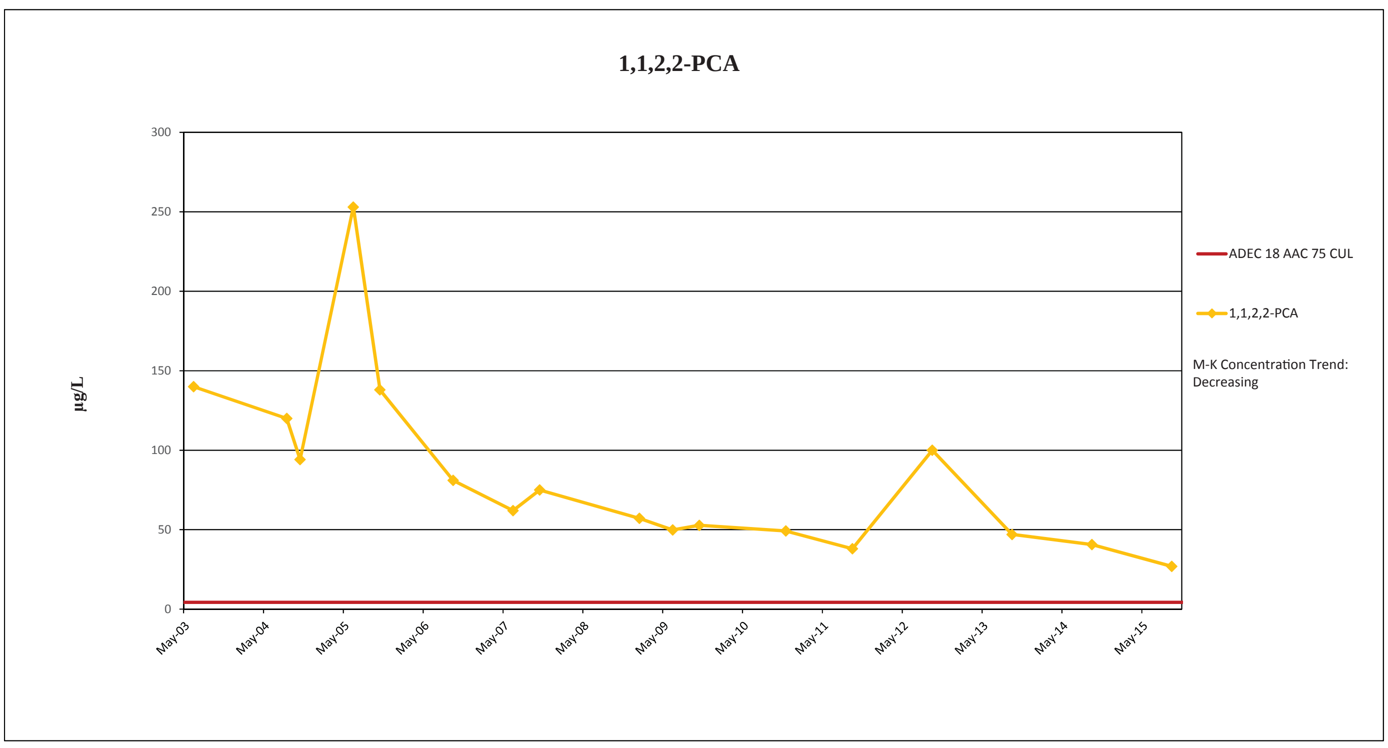

NOTES:
[a] Cleanup Goal is presented in Table 15-1

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 Cleanup Level
TCE	Trichloroethene

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CONCENTRATION TRENDS FOR SELECT ANALYTES AT MONITORING WELL AP-4353

2015 Annual Remedial Action - Operations and Monitoring Report for Select CERCLA Sites
Joint Base Elmendorf-Richardson, Alaska

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 FTRS-89) – Armored Vehicle Maintenance Area (AVMA) is located southeast of the intersection of Otter Lake Road and D Street (Figure 16-1). 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) was PCE in groundwater (Table 16-1). No COCs were 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 OUD ROD (U.S. Army, 2000).

Table 16-1 Cleanup Goals for Site DA089

Contaminant of Concern in Groundwater	Cleanup Goal (µg/L)	Basis for Cleanup Goal
PCE	5	Operable Unit E ROD (USACE, 2005)

Notes:
µg/L = microgram(s) per liter
PCE = tetrachloroethene
ROD = Record of Decision

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 s 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 16.5).

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]). The boundaries of the plume do not appear to be expanding, and no statistically significant increasing trends in the PCE concentrations are apparent from the historical monitoring data, indicating that the plume is stable (see Section 16.5 and CH2M HILL, 2012). 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 A-2), and the lack of PCE daughter products suggest that biodegradation plays a limited role in PCE attenuation.

16.3 2015 FIELD ACTIVITIES

In September 2015, groundwater samples were collected at DA089 as part of the monitoring program. Sampling was also performed as part of the ongoing ERD treatability study at the site, but those results will be reported under separate cover as part of the treatability study report. Field forms are included in Appendix A-2. LUC inspections and site inspections were also conducted; inspection forms are included in Appendix B-2.

16.4 LONG-TERM MANAGEMENT PROGRAM RESULTS

16.4.1 Groundwater Elevation Measurements

On September 18, 2015, depth to groundwater was measured at ten 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 A-2, and groundwater elevations are shown on Figure 16-1.

Table 16-2 2015 Groundwater Elevations at DA089

Monitoring Well ID	Top of Casing Elevation[a] (feet AMSL)	Total Depth of Well (feet FTOC)	Depth to Groundwater[b] (feet FTOC)	Groundwater Elevation (feet AMSL)
AP-3468	293.38	114.7	110.12	183.26
AP-3534	293.05	138.4	110.85	182.20
AP-3774	289.46	116.4	107.34	182.12
AP-3870	281.92	109.9	100.56	181.36
AP-3871	293.46	120.2	111.70	181.76
AP-3893	307.49	124.1	88.22	219.27
AP-4341	294.23	68.1	64.23	230.00
AP-4342	293.36	100.8	97.67	195.69
AP-4411	292.82	72.8	68.11	224.71
AP-4413	291.57	75.4	72.55	219.02

Notes:

[a] Top of casing elevations measured during June 2003 and August 2004 surveys, except for AP-4413, which was resurveyed in 2013
[b] Depth to Groundwater measurements from September 18, 2015 Water Level Survey located in Appendix A-2
AMSL = above mean sea level
ft = feet
FTOC = from top of casing

16.4.2 Groundwater Sample Analytical Results

Groundwater samples were collected from ten groundwater monitoring wells. Analytical results for PCE and other select compounds are summarized in Table 16-3 and shown on Figure 16-1.

PCE was detected above the cleanup goal in six of the ten monitoring wells sampled. Figure 16-2 presents a graphical representation of PCE concentration trends since 2002. Cis-1,2-DCE and vinyl chloride were also detected above the cleanup level in monitoring well AP-4413. No other compounds were detected above their respective cleanup levels.

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Table 16-3 Summary of Select 2015 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[a]
PCE	5[b]	**31.2J**	**13.8J**	0.63	ND (0.3)	ND (0.3)	ND (0.3)	**13.2**	**34.1**	**11J**	**14.9**
TCE	5[b]	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	4.26
cis-1,2-DCE	70[b]	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	**88.4**
Vinyl Chloride	2[b]	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	**3.31**
Carbon tetrachloride	5[b]	ND (0.3)J	ND (0.3)J	0.21J	0.21J	0.23J	ND (0.3)	0.42J	0.61	0.24J	ND (0.3)
DRO	1,500[c]	--	--	--	--	--	--	66.4	--	--	--
GRO	2,200[c]	--	--	--	--	--	--	ND (75)	--	--	--

Notes:

[a] Analytical results have been affected by the ongoing treatability study which began in Fall 2013
[b] Operable Unit E ROD (U.S. Army, 2005)
[c] 18 AAC 75 Table C Groundwater Cleanup Level
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

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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 in Tables 16-4 and 16-5, respectively.

Table 16-4 Summary of 2015 Field Measured Natural Attenuation Parameters at DA089

Monitoring Well ID	Date	Time	Water Level (ft bgs)	Volume Purged (gallons)	pH	Conductivity (mS/cm)	Turbidity (NTU)	DO (mg/L)	Temp (ºC)	ORP (mV)
Shallow/Perched Wells Within PCE Plume										
AP-3468	9/25/2015	1317	110.55	0.8	7.32	0.562	21.7	11.2	6.5	137
AP-3534	9/25/2015	1203	110.91	1.2	7.38	0.333	8.8	4.3	6.0	140
AP-4341	9/24/2015	1534	66.55	1.8	7.25	0.480	65.7	10.6	7.36	1845
AP-4342	9/28/2015	1535	97.83	3.0	7.29	0.527	11.4	8.9	8.0	145
AP-4411	9/25/2015	1428	70.15	1.6	7.52	0.519	221	9.4	7.9	138
AP-4413	9/28/2015	1650	72.33	0.8	6.36	1.167	4.71	1.8	6.7	44.7
Crossgradient (Background) Well Outside PCE Plume										
AP-3893	9/23/2015	1140	88.73	0.9	7.76	0.327	1.8	0.84	6.0	129
Downgradient Wells										
AP-3774	9/24/2015	1029	107.45	0.8	6.94	0.480	6.8	4.0	4.8	184
AP-3870	9/23/2015	1402	100.60	2.7	6.92	0.439	13.9	4.6	6.4	167
AP-3871	9/24/2015	1141	111.77	0.5	7.25	0.461	3.2	6.2	5.6	197

Notes:

ºC = degree(s) Celsius
ft bgs = feet below ground surface
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 16-5 Summary of 2015 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)	Ethane (µg/L)	Ethene (µg/L)	Methane (µg/L)
Shallow/Perched Wells Within PCE Plume							
AP-3468	2.52J	ND(0.02)	ND(0.002)	21.4J	ND(0.182)J	ND(0.194)J	0.0802B
AP-3534	1.35J	ND(0.02)	ND(0.002)	29.3J	ND(0.169)J	ND(0.182)J	0.0624B
AP-4341	1.05	ND(0.02)	0.0007J	14.5	ND(0.186)	ND(0.198)	0.0802B
AP-4342	1.67	0.0117J	0.0008J	21.2	ND(0.168)	ND(0.181)	0.068B
AP-4411	2.6J	ND(0.02)	ND(0.002)	23.3J	ND(0.177)J	ND(0.190)J	0.0693B
AP-4413	0.11B	25.80	22.000	1.2B	0.059J	0.141J	397
Crossgradient (Background) Well Outside PCE Plume							
AP-3893	ND(0.006)	0.06B	0.043	23.9	0.106B	ND(0.147)	0.106B
Downgradient Wells							
AP-3774	0.98	ND(0.02)	ND(0.002)	28.1	ND(0.167)	ND(0.180)	0.0685B
AP-3870	1.38J	0.02B	0.001J	27.7	ND(0.154)	ND(0.168)	ND(0.0811)
AP-3871	1.33	ND(0.02)	0.001J	29.4	ND(0.181)	ND(0.193)	0.8030B

Notes:

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
ID = identification
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. Conditions are assessed by examining the parameter results at AP-4413, and in some cases comparing those results to those from other wells. 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 MANN-KENDALL TREND ANALYSIS

A Mann-Kendall trend analysis was performed for a DA089 monitoring well if (1) there are four or more data points available to run the calculation, and (2) cleanup goals for COCs or daughter products have been exceeded one or more times in the past 5 years. A Mann-Kendall trend analysis was performed for six monitoring wells (AP-3468, AP-3534, AP-4341, AP-4342, AP-4411, and AP-4413). One of these monitoring wells (AP-4413) is located within the ERD treatability study treatment zone.

A summary of Mann-Kendall concentration trends is in Table 16-6. A statistically significant decreasing trend was identified at monitoring well AP-4413, which is within the target treatment zone of the treatability study being conducted at DA089 (USAF, 2014e). A probable decreasing trend of PCE is also present at downgradient monitoring well AP-3468. No other wells show a statistically significant trend in the PCE-affected area (see Figure 16-2 and Table 16-6).

16.6 SITE SUMMARY AND RECOMMENDATIONS

In addition to the ongoing long-term monitoring requirements at DA089, an in situ bioremediation treatability study is also underway. A summary of the treatability study, a summary of the Third Five Year Review for DA089, and overall recommendations for the site are included below.

16.6.1 Treatability Study Summary

Implementation of the treatability study began in September 2013, when injection wells were installed and an EVO substrate was injected into the shallow perched aquifer near AP-4413. Following the initial EVO injection, three quarters of groundwater monitoring followed. Results showed that, although geochemically reducing conditions were evolving, PCE concentrations were not decreasing. Therefore, decisions were made prior to analyzing the final round of quarterly performance monitoring data in an effort to implement a contingency action during the 2014 field season (USAF, 2014e).

The contingency action included conducting another round of EVO injections and adjusting the design parameters as follows:

- The EVO volume was tripled to increase the mass of carbon in the aquifer.
- The total injection volume was tripled to improve distribution.
- The mass of lactate injected into the aquifer was tripled to accelerate the evolution of anaerobic conditions.

Table 16-6 Summary of 2015 Mann-Kendall Statistical Analysis at DA089

Monitoring Well	Total Well Depth (feet)	PCE Concentrations - No Qualifiers[a] (µg/L)																				PCE Standard Deviation (µg/L)	PCE Range (µg/L)	PCE Average (µg/L)	Mann-Kendall Result
		Aug-02	Nov-02	Jun-03	Sep-03	Aug-04	Oct-04	May-05	Oct-05	Sep-06	Jun-07	Oct-07	Dec-08	May-09	Sep-09	Nov-10	Aug-11	Sep-12	Aug-13	Sep-14	Sep-15				
AP-3468	114.7	**30.0**	NS	**69.0**	NS	**60.0**	**53.3**	**93.6**	**59.4**	**72**	**47**	**61**	**63**	**53.4**	**64.7**	**54.3**	**55**	**58**	**44.7**	**32.3**	**31.2**	15.52	30 to 93.6	55.7	94.4% (-)
AP-3534	138.4	**21**	NS	**28**	**19**	**25.4**	**24.1**	**81.5**	**59.1**	**43**	**18**	**18**	**23**	**24.5**	**21.9**	**23.1**	**22**	**40**	**37.4**	**32.5**	**13.8**	16.49	13.8 to 81.5	30.3	59.7% (-)
AP-4341	68.1	1.8	NS	**23**	NS	**12.7**	**14.6**	**20.8**	**19.0**	**13**	**12.0**	**9.3**	1	**27.9**	**16.2**	**7.67**	**18**	**8.9**	**19.8**	**21.2**	**13.2**	7.23	1.8 to 23	14.39	56.0% (+)
AP-4342	100.85	**38.0**	**49.0**	NS	**53.0**	**41.1**	**62.5**	**61.3**	**55.9**	**66**	**52.0**	**52**	**62.9**	**55.8**	**58.0**	**52.1**	**51**	**51**	**54.9**	**51.9**	**34.1**	8.24	34.1 to 66	52.8	68.8% (-)
AP-4411	72.8	NS	NS	**9.8**	**8.9**	**11.2**	**20.4**	**23.9**	**24.6**	**11**	**10**	**12**	**6.64**	**7.94**	**15.6**	**10.5**	**16**	**6.8**	3.33	**9.53**	**11**	5.82	3.33 to 24.6	12.17	84.7% (-)
AP-4413[b]	75.4	NS	NS	100	120	**175**	**171**	**120**	**143**	**190**	**150**	**120**	**120**	**113**	**121**	**88.8**	**140**	**88**	**78.8**	**52.8**	**14.9**	43.32	14.9 to 190	117	99.7% (-)

Notes:

[a] Qualifiers have been removed to perform Mann-Kendall analysis
[b] Analytical results have been affected by the ongoing treatability study which began in September 2013
Bold = Result exceeded cleanup criteria
Mann-Kendall results are considered statistically significant when results are 90% or greater:
- indicates decreasing trend
+ indicates increasing trend
96.8% (-) = Mann-Kendall analysis indicates with 96.8% confidence that the data have a decreasing trend
µg/L = microgram(s) per liter
NS = not sampled
PCE = tetrachloroethene

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- The EVO substrate was changed to 100 percent Terra Systems SRS-FR (5-micrometer [µm] droplet size), which has larger droplets to help retain more EVO near the injection zone.

This second round of EVO injections was completed on October 15, 2014. Quarterly groundwater sampling of monitoring well AP-4413 to further evaluate the performance began in March 2015 and was completed in December 2015. Discussions of those results will be in the Treatability Study Report (USAF, 2016f).

16.6.2 Five-Year Review

DA089 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 have been performed for JBER-R, which includes DA089, in 2003, 2008, and 2013.

The third five-year report conducted in 2013 recommended that the potential vapor intrusion pathway be assessed for the site. Additionally, because natural attenuation had been shown to be limited at DA089, and in an effort to meet the 30-year time frame stated in the OUE ROD, a pilot study of an enhanced natural attenuation technology (Anaerobic Biodegradation using EVO) was recommended (USAF, 2013b).

The first recommendation is being addressed by a forthcoming vapor intrusion investigation. The ongoing treatability study satisfies the second recommendation.

16.6.3 Recommendations

Site DA089 has been identified as a **Yellow** priority because there are no significant decreasing PCE trends outside of the well within the target treatment zone of the treatability study.

Based on the results of this annual field activities report and the treatability study implementation report (USAF, 2014e), the following actions are recommended:

- In accordance with the recommendation from the *2014 Field Activities Report CERCLA Sites* (USAF, 2014f), groundwater sampling and analysis at monitoring wells AP-3870 and AP-3893 will cease in 2016. Measurement of water levels will continue at these wells during annual monitoring events.
- Continue annual groundwater monitoring at the remaining wells within the monitoring program.

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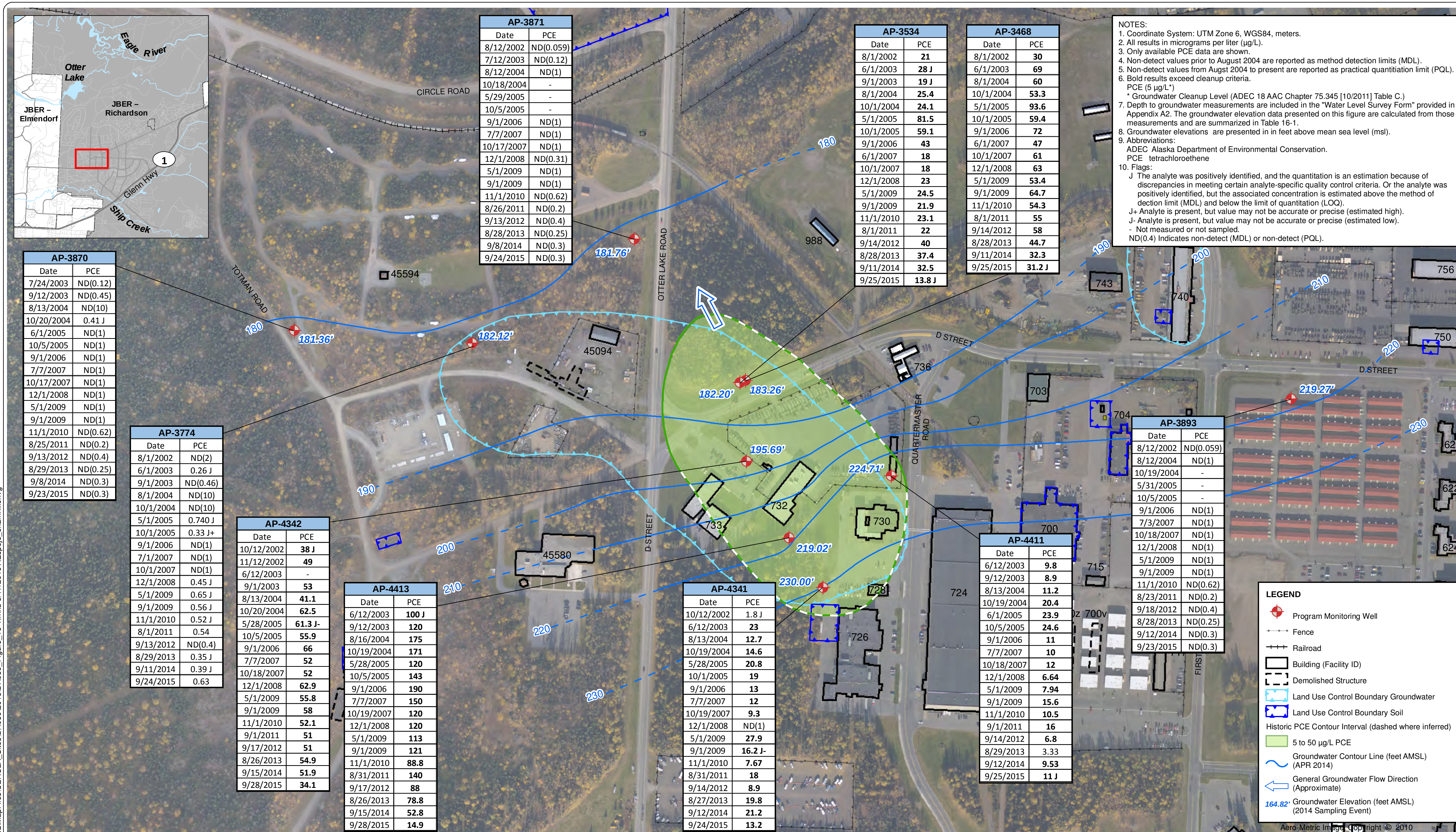

AP-3870	
Date	PCE
7/24/2003	ND(0.12)
9/12/2003	ND(0.45)
8/13/2004	ND(10)
10/20/2004	0.41 J
6/1/2005	ND(1)
10/5/2005	ND(1)
9/1/2006	ND(1)
7/7/2007	ND(1)
10/17/2007	ND(1)
12/1/2008	ND(1)
5/1/2009	ND(1)
9/1/2009	ND(1)
11/1/2010	ND(0.62)
8/25/2011	ND(0.2)
9/13/2012	ND(0.4)
8/29/2013	ND(0.25)
9/8/2014	ND(0.3)
9/23/2015	ND(0.3)

AP-3871	
Date	PCE
8/12/2002	ND(0.059)
7/12/2003	ND(0.12)
8/12/2004	ND(1)
10/18/2004	-
5/29/2005	-
10/5/2005	-
9/1/2006	ND(1)
7/7/2007	ND(1)
10/17/2007	ND(1)
12/1/2008	ND(0.31)
5/1/2009	ND(1)
9/1/2009	ND(1)
11/1/2010	ND(0.62)
8/26/2011	ND(0.2)
9/13/2012	ND(0.4)
8/28/2013	ND(0.25)
9/8/2014	ND(0.3)
9/24/2015	ND(0.3)

AP-3534	
Date	PCE
8/1/2002	**21**
6/1/2003	**28 J**
9/1/2003	**19 J**
8/1/2004	**25.4**
10/1/2004	**24.1**
5/1/2005	**81.5**
10/1/2005	**59.1**
9/1/2006	**43**
6/1/2007	**18**
10/1/2007	**18**
12/1/2008	**23**
5/1/2009	**24.5**
9/1/2009	**21.9**
11/1/2010	**23.1**
8/1/2011	**22**
9/14/2012	**40**
8/28/2013	**37.4**
9/11/2014	**32.5**
9/25/2015	**13.8 J**

AP-3468	
Date	PCE
8/1/2002	**30**
6/1/2003	**69**
8/1/2004	**60**
10/1/2004	**53.3**
5/1/2005	**93.6**
10/1/2005	**59.4**
9/1/2006	**72**
6/1/2007	**47**
10/1/2007	**61**
12/1/2008	**63**
5/1/2009	**53.4**
9/1/2009	**64.7**
11/1/2010	**54.3**
8/1/2011	**55**
9/14/2012	**58**
8/28/2013	**44.7**
9/11/2014	**32.3**
9/25/2015	**31.2 J**

NOTES:
1. Coordinate System: UTM Zone 6, WGS84, meters.
2. All results in micrograms per liter (µg/L).
3. Only available PCE data are shown.
4. Non-detect values prior to August 2004 are reported as method detection limits (MDL).
5. Non-detect values from Augst 2004 to present are reported as practical quantitiation limit (PQL).
6. Bold results exceed cleanup criteria.
   PCE (5 µg/L*)
   * Groundwater Cleanup Level (ADEC 18 AAC Chapter 75.345 [10/2011] Table C.)
7. 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 16-1.
8. Groundwater elevations are presented in in feet above mean sea level (msl).
9. Abbreviations:
   ADEC Alaska Department of Environmental Conservation.
   PCE tetrachloroethene
10. Flags:
   J The analyte was positively identified, and the quantitation is an estimation because of discrepancies in meeting certain analyte-specific quality control criteria. Or the analyte was positively identified, but the associated concentration is estimated above the method of dection limit (MDL) and below the limit of quantitation (LOQ).
   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-3774	
Date	PCE
8/1/2002	ND(2)
6/1/2003	0.26 J
9/1/2003	ND(0.46)
8/1/2004	ND(10)
10/1/2004	ND(10)
5/1/2005	0.740 J
10/1/2005	0.33 J+
9/1/2006	ND(1)
7/1/2007	ND(1)
10/1/2007	ND(1)
12/1/2008	0.45 J
5/1/2009	0.65 J
9/1/2009	0.56 J
11/1/2010	0.52 J
8/1/2011	0.54
9/13/2012	ND(0.4)
8/29/2013	0.35 J
9/11/2014	0.39 J
9/24/2015	0.63

AP-3893	
Date	PCE
8/12/2002	ND(0.059)
8/12/2004	ND(1)
10/19/2004	-
5/31/2005	-
10/5/2005	-
9/1/2006	ND(1)
7/3/2007	ND(1)
10/18/2007	ND(1)
12/1/2008	ND(1)
5/1/2009	ND(1)
9/1/2009	ND(1)
11/1/2010	ND(0.62)
8/23/2011	ND(0.2)
9/18/2012	ND(0.4)
8/28/2013	ND(0.25)
9/12/2014	ND(0.3)
9/23/2015	ND(0.3)

AP-4342	
Date	PCE
10/12/2002	**38 J**
11/12/2002	**49**
6/12/2003	-
9/1/2003	**53**
8/13/2004	**41.1**
10/20/2004	**62.5**
5/28/2005	**61.3 J-**
10/5/2005	**55.9**
9/1/2006	**66**
7/7/2007	**52**
10/18/2007	**52**
12/1/2008	**62.9**
5/1/2009	**55.8**
9/1/2009	**58**
11/1/2010	**52.1**
9/1/2011	**51**
9/17/2012	**51**
8/26/2013	**54.9**
9/15/2014	**51.9**
9/28/2015	**34.1**

AP-4413	
Date	PCE
6/12/2003	**100 J**
9/12/2003	**120**
8/16/2004	**175**
10/19/2004	**171**
5/28/2005	**120**
10/5/2005	**143**
9/1/2006	**190**
7/7/2007	**150**
10/19/2007	**120**
12/1/2008	**120**
5/1/2009	**113**
9/1/2009	**121**
11/1/2010	**88.8**
8/31/2011	**140**
9/17/2012	**88**
8/26/2013	**78.8**
9/15/2014	**52.8**
9/28/2015	**14.9**

AP-4341	
Date	PCE
10/12/2002	1.8 J
6/12/2003	**23**
8/13/2004	**12.7**
10/19/2004	**14.6**
5/28/2005	**20.8**
10/1/2005	**19**
9/1/2006	**13**
7/7/2007	**12**
10/19/2007	**9.3**
12/1/2008	ND(1)
5/1/2009	**27.9**
9/1/2009	**16.2 J-**
11/1/2010	**7.67**
8/31/2011	**18**
9/14/2012	**8.9**
8/27/2013	**19.8**
9/12/2014	**21.2**
9/24/2015	**13.2**

AP-4411	
Date	PCE
6/12/2003	**9.8**
9/12/2003	**8.9**
8/13/2004	**11.2**
10/19/2004	**20.4**
6/1/2005	**23.9**
10/5/2005	**24.6**
9/1/2006	**11**
7/7/2007	**10**
10/18/2007	**12**
12/1/2008	**6.64**
5/1/2009	**7.94**
9/1/2009	**15.6**
11/1/2010	**10.5**
9/1/2011	**16**
9/14/2012	**6.8**
8/29/2013	3.33
9/12/2014	**9.53**
9/25/2015	**11 J**

LEGEND
- Program Monitoring Well
- Fence
- Railroad
- Building (Facility ID)
- Demolished Structure
- Land Use Control Boundary Groundwater
- Land Use Control Boundary Soil

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) (2014 Sampling Event)

N W E S

0 150 300 600 900 Feet

DA089 SITE MAP WITH ANALYTICAL DATA

DA089 - Armored Vehicle Maintenance Area
2015 Annual Remedial Action - Operations and Monitoring Report for Select CERCLA Sites
Joint Base Elmendorf-Richardson, Alaska

Figure
16-1

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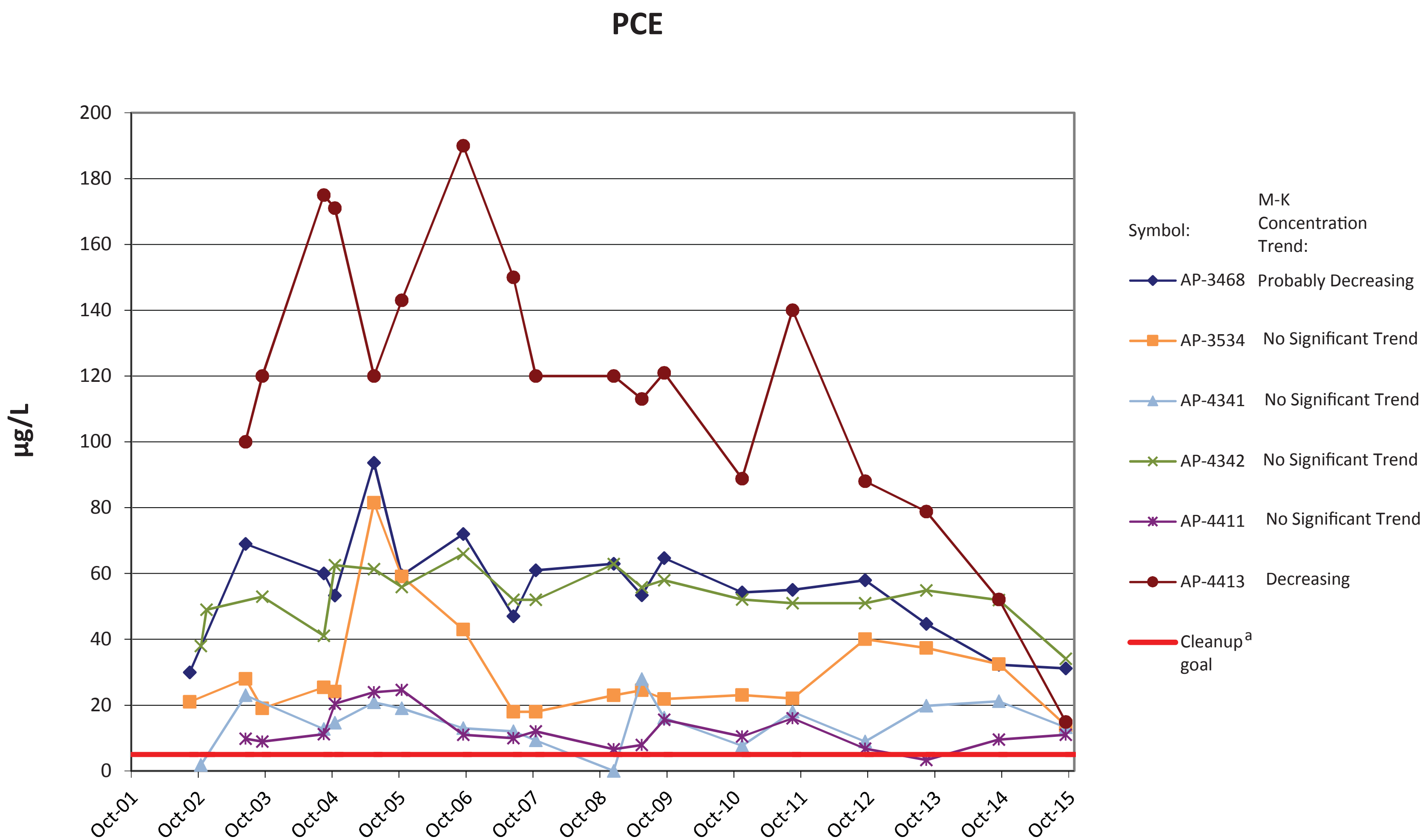

NOTES:
[a] Cleanup Goal is presented in Table 16-1
µg/L micrograms per liter
PCE Tetrachloroethene

ES062612224557SAC DA089_Figure_16-2.ai tdaus 05.18.2016

PCE TRENDS IN SELECT WELLS

2015 Annual Remedial Action - Operations and Monitoring Report for Select CERCLA Sites
Joint Base Elmendorf-Richardson, Alaska

Figure **16-2**

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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 17-1). 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 removed from the site and replaced (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 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. 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 have decreased from 5 μg/L in 2008 to 0.77 μg/L in 2013 (USAF, 2014g).

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, 2014h). 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.

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.

17.3 2015 FIELD ACTIVITIES

A site inspection was performed at SS044 on October 23, 2015. No issues were identified during the inspection. A copy of the 2015 inspection form is in Appendix B-2.

17.4 SITE SUMMARY AND RECOMMENDATIONS

No deficiencies were observed during the inspection in 2015. Inspections will continue to be conducted annually in accordance with the OUE ROD (U.S. Army, 2005).

17.4.1 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 have been performed for JBER-R, which includes SS044, in 2003, 2008, and 2013.

No recommendations specific to SS044 were made in the *Third CERCLA Five-Year Review Report for JBER-R, Alaska* (USAF, 2013b).

One round of groundwater sampling at monitoring well AP-3231 will be performed in 2016, prior to the Fourth Five-Year Review in 2018.

17.4.2 Recommendations

Site SS044 is identified as a **Green** priority. NFA, continuation of internal administrative control inspections, and groundwater sampling at monitoring well AP-3231 prior to the 2018 Five-Year Review are recommended for this site.

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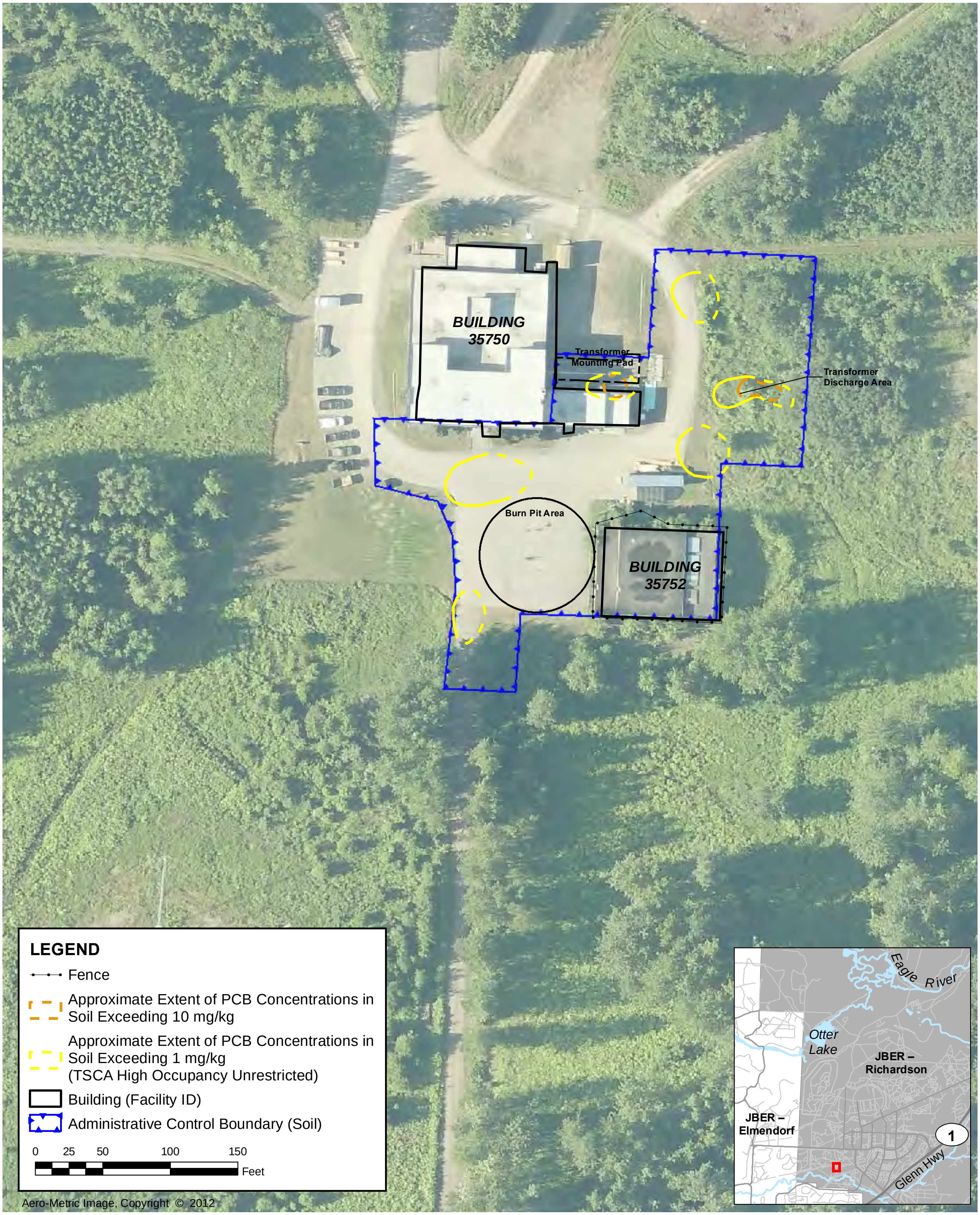

SS044 SITE MAP

SS044 - Building 35-752 PCB Site
2015 Annual Remedial Action -
Operations and Monitoring Report for Select CERCLA Sites
Joint Base Elmendorf-Richardson, Alaska

Figure
17-1

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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, phentaerythritol 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 ERF. 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 or RDX) and High-velocity Military Explosive (cyclotetramethylene-tetranitramine or HMX) were detected in groundwater along with metals; however, all detected concentrations were below applicable EPA MCLs or ADEC groundwater cleanup levels. 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 (USAF, 2013c and 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 at XE023 ranges from 19 to

36 feet bgs, and the hydraulic gradient is approximately 0.0004 ft/ft to the southwest (CH2M HILL, 1997). It is believed that the tides and Eagle River influence groundwater flow and the coarse-grained sediments allow precipitation to infiltrate to the water table.

18.2 REGULATORY REQUIREMENTS

XE023 is regulated under CERCLA as part of OUC and is 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 2015 FIELD ACTIVITIES

A LUC inspection was performed at XE023 on October 23, 2015. No issues were identified during the inspection. A copy of the 2015 LUC inspection form is in Appendix B-2.

18.4 SITE SUMMARY AND RECOMMENDATIONS

No deficiencies were observed during the LUC inspection in 2015. 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).

18.4.1 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 have been performed for JBER-R, which includes XE023, in 2003, 2008, and 2013.

No recommendations specific to XE023 were made in the *Third CERCLA Five-Year Review Report for JBER-R, Alaska* (USAF, 2013b).

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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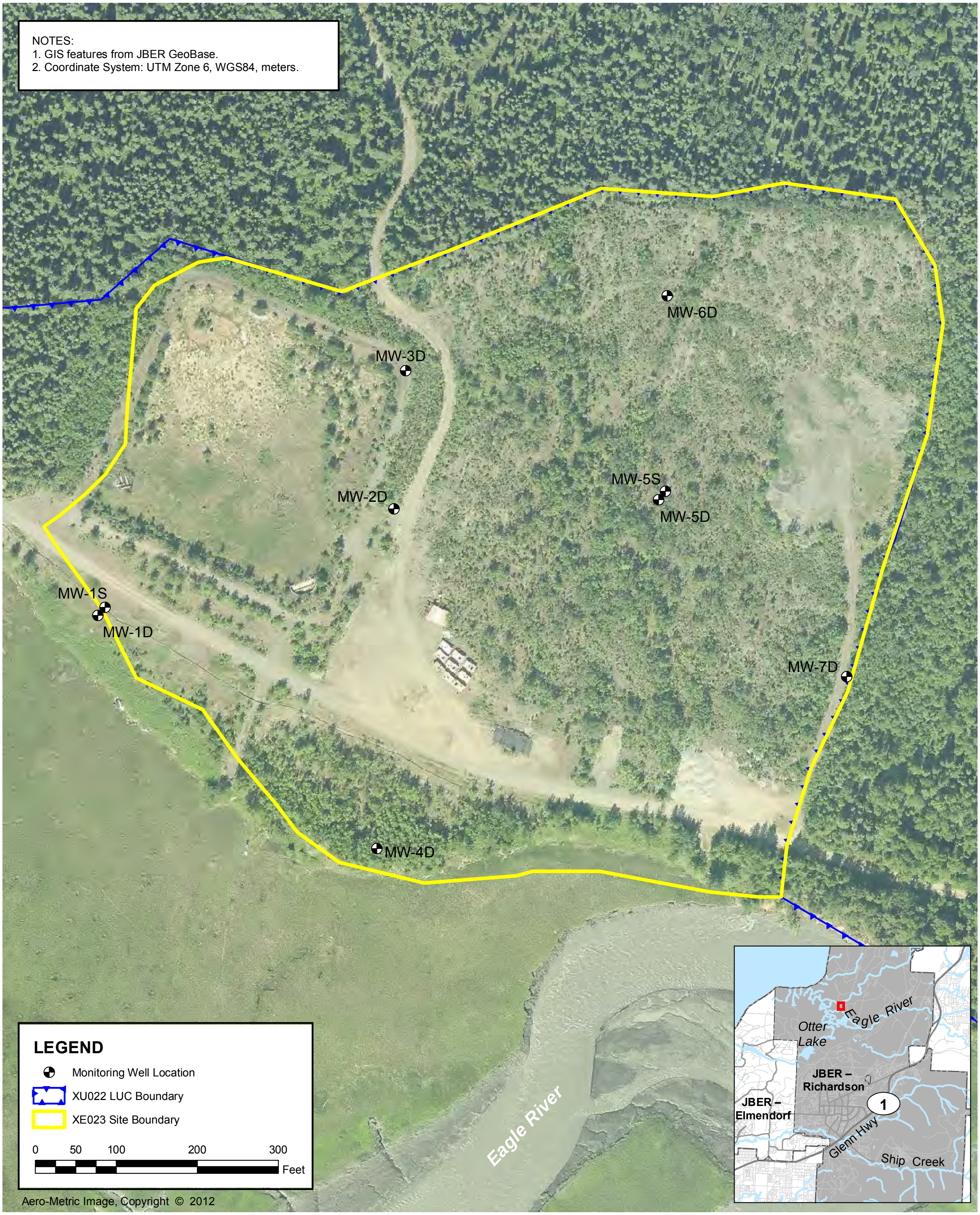

XE023 SITE MAP

XE023 - EOD Area (2 EA) (OB/OD pad)
2015 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 (OUC/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. Prior to this LUC inspection, the most recent live-fire training exercises were performed on April 1-3 and 13-14, 2015.

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 (µg/g) for sediment collected from within the spent rounds to hundreds of µg/g for sediment co-located (immediately surrounding) with the spent rounds, and to less than 10 µg/g in sediment within a few meters of the spent rounds. Sediment with a concentration over 1 µg/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 RA-Os were established for OUC as follows:

1) Within 5 years of the ROD being signed, reduce the dabbling duck mortality rate attributable to WP to 50 percent of the 1996 mortality rate attributable to WP. Radio tracking and aerial surveys suggest that about 1,000 birds died from WP at ERF in 1996. Therefore, the allowable number of duck deaths from WP would be approximately 500.
2) Within 20 years of the ROD being signed, reduce the mortality attributable to WP to no more than 1 percent of the total annual fall population of dabbling ERF ducks. Currently, that population is about 5,000. Therefore, the allowable number of duck deaths from WP would be approximately 50. This long-term goal could be adjusted based on future population studies conducted during the monitoring program.

The mortality rate of dabbling ducks at XU022 indicates that both RA-Os 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 RA-O, 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. Based on the mortality data, the short-term RA-O 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 significantly in ERF since remedial activities have begun. This decreasing trend is expected to continue following the capping operations performed in February 2013. Mortality monitoring will next be conducted in 2016.

Remedial action (active pond pumping/draining) began in 1999. Although treated pond acreage is not a specific RA-O 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 were not. 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 were 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 detected in 2015. ICs will remain in place as long as hazardous substances remain onsite at levels that preclude unrestricted use.

19.3 2015 FIELD ACTIVITIES

On April 1-3 and 13-14 of 2015, the US Army conducted live fire exercises at XU022. These exercises occurred outside of the window of November 1 through March 31; this timeframe represents a period when a) ice cover is generally sufficient to prevent impacts from reaching the sediment and the gravel caps covering remaining WP-contaminated sediment and b) waterfowl are not yet present. Two Record of Environmental Consideration documents (USAF, 2001c; and USAF, 2005b) have identified ice-cover thickness requirements to prevent impact to sediments by specific types of live fire munitions. As summarized in the Resumption of Live-fire Training Exercises at XU022 – Eagle River Flats Impact Area, Operable Unit C (USAF, 2015f), site conditions during the live-fire training exercises were determined to be protective of both migratory waterfowl and the gravel caps. The USAF, ADEC, and EPA concurred that any impacts to gravel caps or habitat (e.g., impact craters) that may have resulted from the live fire exercises in April of 2015 would be recorded during the next XU022 remedial action long-term management event in the fall of 2016.

A LUC inspection was performed at XU022 on October 23, 2015. No issues were identified during the inspection. A copy of the 2015 LUC inspection form is in Appendix B-2.

19.4 SITE SUMMARY AND RECOMMENDATIONS

No deficiencies were observed during the LUC inspection in 2015. LUC inspections will continue to be conducted annually in accordance with the OUC ROD (U.S. Army, 1998).

19.4.1 Five-Year Review

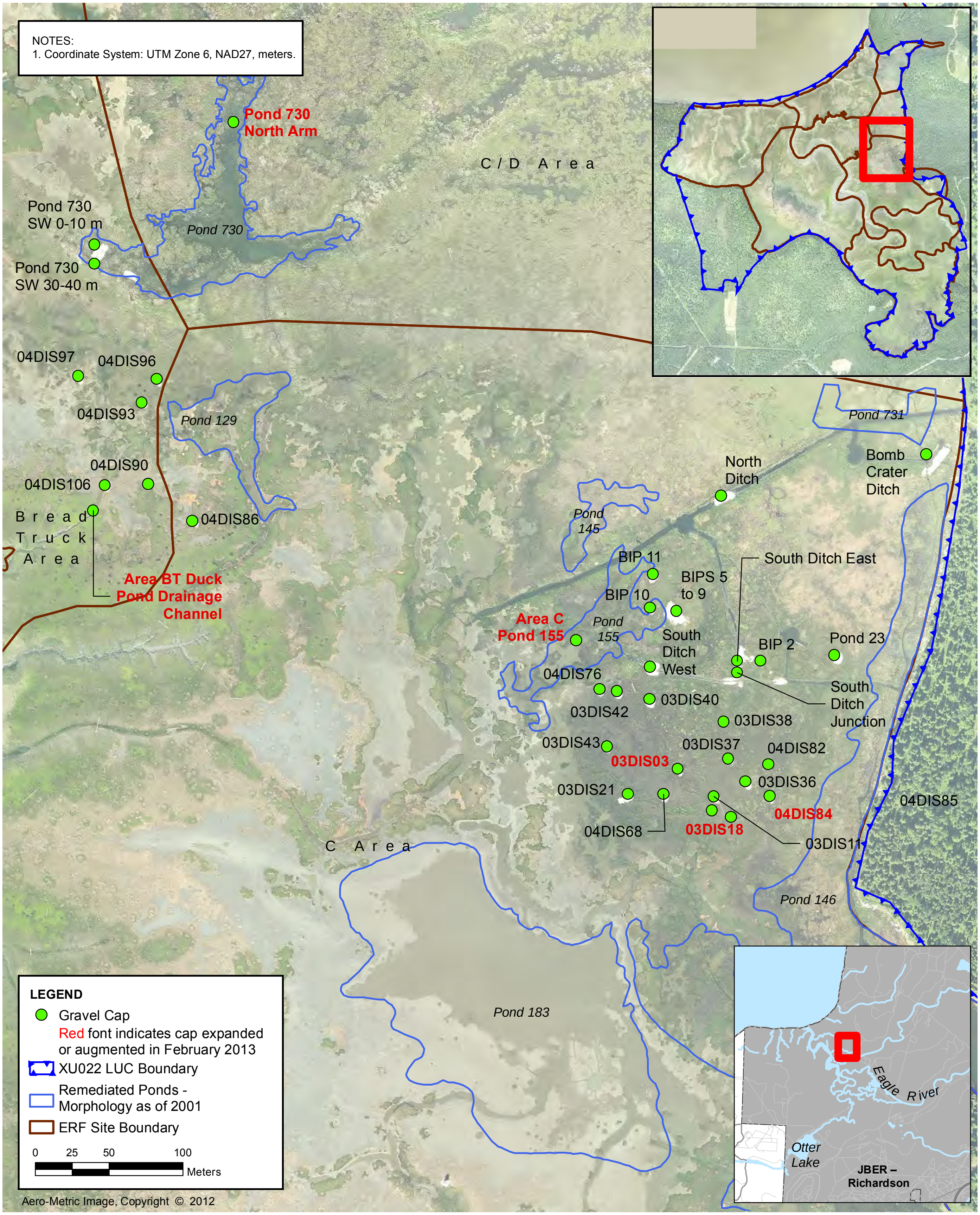
XU022 is required to have CERCLA five-year reviews conducted until the cleanup goals are achieved. The purpose of the five-year review is to evaluate the implementation and performance of the remedial actions. To date, three CERCLA five-year reviews have been performed for JBER-R, which includes XU022, in 2003, 2008, and 2013.

The Third CERCLA Five-Year Review Report for JBER-R, Alaska (USAF, 2013b) 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 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). Based on early telemetry studies, actual daily counts are divided by 0.83 to help account for uncertainty. It is unlikely that any unintentional hazing significantly skews aerial counts in one direction or another to significantly bias the overall estimates.

A total of 21 aerial census surveys were conducted from August 16 to October 29, 2012, to determine the fall 2012 waterfowl population. In comparison, 24 aerial surveys were conducted in 2011, and 28 census surveys were conducted in 2010 during similar time periods. Observed waterfowl species were similar in types and relative numbers as in previous years. Details of the 2012 aerial census survey results and a comparison of population numbers from previous surveys are included in the 2012-2013 Remedial Action Summary Report for XU022 – Operable Unit C, Eagle River Flats Joint Base Elmendorf-Richardson, Alaska (USAF, 2013d). Similar analyses will be performed based on the forthcoming 2016-2017 monitoring efforts.

19.4.2 Recommendations

Site XU022 is identified as a **Green** priority. Long-term monitoring and continuation of LUC inspections are recommended for this site.



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XU022 SITE MAP

XU022 - OUC/Impact Area Eagle River Flats
2015 Annual Remedial Action –
Operations and Monitoring Report for Select CERCLA Sites
Joint Base Elmendorf-Richardson, Alaska

Figure
19-1

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