DEPARTMENT OF THE ARMY
INSTALLATION MANAGEMENT COMMAND
HEADQUARTERS, U.S. ARMY GARRISON, FORT WAINWRIGHT

RECORD OF DECISION
OPERABLE UNIT 6
FORMER COMMUNICATIONS SITE
FORT WAINWRIGHT, ALASKA

FINAL

JANUARY 2014

U.S. Army Corps of Engineers, Alaska District
Environmental Remediation Services
Contract No. W911KB-06-D-0006
Task Order No. 07

RECORD OF DECISION
OPERABLE UNIT 6
FORMER COMMUNICATIONS SITE
FORT WAINWRIGHT, ALASKA

FINAL

JANUARY 2014

U.S. Army Corps of Engineers, Alaska District
Environmental Remediation Services
Contract No. W911KB-06-D-0006
Task Order No. 07

Prepared by
Jacobs Engineering Group Inc.
4300 B Street, Suite 600
Anchorage, Alaska 99503

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

SECTION **PAGE**

TABLE OF CONTENTS (Continued)

SECTION **PAGE**

TABLE OF CONTENTS (Continued)

SECTION **PAGE**

TABLES

APPENDICES

ACRONYMS AND ABBREVIATIONS

AAC	Alaska Administrative Code
ADEC	Alaska Department of Environmental Conservation
AKNHP	Alaska Natural Heritage Program
ARAR	applicable or relevant and appropriate requirement
ATSDR	Agency for Toxic Substances and Disease Registry
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and xylenes
CDFA	1-chloro-1,1-difluoroethane
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFC	chlorofluorocarbons
CFR	Code of Federal Regulations
COC	contaminant of concern
COI	chemical of interest
COPEC	contaminant of potential ecological concern
CSM	conceptual site model
cy	cubic yard(s)
DBCP	1,2-dibromo-3-chloropropane
DCE	dichloroethene
DDE	dichlorodiphenyldichloroethene
DDT	dichlorodiphenyltrichloroethane
DFA	1,1-difluoroethane
DMM	discarded military munitions
DNAPL	dense nonaqueous phase liquid
DPW	Directorate of Public Works
DRMO	Defense Reutilization and Marketing Office
DRO	diesel-range organics
EcoSSL	ecological soil screening levels
ELCR	excess lifetime cancer risk
EM	electromagnetic
EOD	explosive ordnance disposal

ACRONYMS AND ABBREVIATIONS (Continued)

EPA	U.S. Environmental Protection Agency
ERA	ecological risk assessment
ERBSC	ecological risk-based screening concentrations
ESD	explanation of significant differences
EZ	exclusion zone
FCS	Former Communications Site
FFA	Federal Facilities Agreement
FS	feasibility study
FWA	Fort Wainwright, Alaska
gpm	gallon(s) per minute
GRO	gasoline-range organics
HEAST	Health Effects Assessment Summary Tables
HHRA	human health risk assessment
HI	hazard index
HLA	Harding Lawson Associates Group, Inc.
HQ	hazard quotient
IDW	investigation-derived waste
IEUBK	Integrated Exposure Uptake Biokinetic
INRMP	Integrated Natural Resources Management Plan
IRIS	Integrated Risk Information System
ISCO	in situ chemical oxidation
IUR	inhalation unit risk
MAG	magnetometer
MCL	maximum contaminant level
MD	munitions debris
MDL	method detection limit
MEC	munitions and explosives of concern
mg/kg	milligram(s) per kilogram
MNA	monitored natural attenuation
mV	millivolts
MW	monitoring well

ACRONYMS AND ABBREVIATIONS (Continued)

NCP	National Contingency Plan
NNSM	n-nitrosodimethylamine
NPL	National Priorities List
O&M	operations and maintenance
Oasis	Oasis Environmental, Inc.
OSWER	Office of Solid Waste and Emergency Response
OU	Operable Unit
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
PCL	project cleanup level
PEC	probable effects concentration
PEL	probable effects levels
PID	photoionization detector
POL	petroleum, oil, and lubricants
ppm	part(s) per million
PRB	permeable reactive barrier
PSE	Preliminary Source Evaluation
PSL	project screening level
PV_{30}	present value (30 years)
PX	Post Exchange
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act of 1976
RDX	hexahydro-1,3,5-trinitro-1,3,5-triazine
RfC	reference concentration
RfD	reference dose
RI	remedial investigation
ROD	Record of Decision
RRD	range-related debris
RRO	residual-range organics
SARA	Superfund Amendments and Reauthorization Act of 1986

ACRONYMS AND ABBREVIATIONS (Continued)

SSL	EPA Soil Screening Level
SVOC	semivolatile organic compound
TBC	to be considered
TCE	trichloroethene
TCP	trichloropropane
TCRA	time-critical removal action
TIC	tentatively identified compounds
USGS	U.S. Geological Survey
UU/UE	unlimited use and unrestricted exposure
UXO	unexploded ordnance
VOC	volatile organic compound
WQC	water quality criteria
μg/L	micrograms per liter
$\mu g/m^3$	micrograms per cubic meter

1.0 DECLARATION

1.1 SITE NAME AND LOCATION

Site Name:	*Former Communications Site, Fort Wainwright (Taku Gardens)*
Site Location:	*Fort Wainwright, Alaska; Section 18; Township 001; Range 001; Fairbanks Meridian*
Latitude and Longitude:	*64.822970°N, -147.668090°W*
Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) ID Number:	*AK6210022426*
Alaska Department of Environmental Conservation Contaminated Sites Hazard ID Number:	*4140, site status is active*
Operable Unit/Site:	*Operable Unit 6*

The Former Communications Site (FCS) is located on Fort Wainwright, Alaska (FWA). FWA is within the Fairbanks North Star Borough in central Alaska and now covers approximately 1,577,095.91 acres on the eastern and southern sides of the City of Fairbanks (Figure A-1). FWA is a federally-owned facility managed by the U.S. Army Garrison FWA, an installation-level command overseen by the U.S. Army Installation Management Command Pacific. The 54-acre FCS has a history of multiple site uses including a communications and radar facility, barracks and company headquarters, salvage/reclamation yard, debris disposal, garden plots, possible ammunition storage, and firefighter training. The FCS currently consists of the completed Taku Gardens family housing development (Figure A-2).

1.2 STATEMENT OF BASIS AND PURPOSE

This Record of Decision (ROD) for Operable Unit 6 (OU6) is being issued in accordance with the Federal Facilities Agreement (FFA) between the U.S. Army, U.S. Environmental Protection Agency (EPA), and Alaska Department of Environmental Conservation (ADEC). The FCS is part of the Fort Wainwright Federal Facility Site listed on the National Priorities List (NPL) on 30 August 1990, as amended (Administrative Docket No, 1092-04-10-120).

The U.S. Army and EPA have selected the remedy for the FCS, which has been designated as OU6. Further, the ADEC concurs with the selected remedy. The selected remedy was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), 42 United States Code Section 9601 et seq., as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA); and to the extent practicable, the National Contingency Plan (NCP), Code of Federal Regulations (CFR) Title 40, Chapter 300. The selected remedy is Alternative S2/GW2 (Institutional Controls for Soil/Monitored Natural Attenuation [MNA] and Institutional Controls for Groundwater) which is described in detail in Section 3.6 of this ROD.

The decision presented herein for the remedial action is based on information in the Administrative Record for the FCS, maintained in accordance with Section 113(k) of CERCLA, 42 United States Code Section 9613(k). This Administrative Record file is located at the FWA Directorate of Public Works (DPW) CERCLA Library. The Record is also available for review at the Noel Wien Library in Fairbanks, Alaska, and the FWA Post Library. The Proposed Plan and this Record were made available for public review and comment. Comments received from the public were considered in the remedy selection process. Responses to comments received during the public comment period for the Proposed Plan are included in Section 4.0 (Responsiveness Summary) of this ROD. In making this decision, the U.S. Army, EPA Region 10, and ADEC have considered all comments received from the public.

1.3 ASSESSMENT OF SITE UNDER CERCLA

The response action selected in this ROD is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment. Such a release or threat of release may present an imminent and substantial danger to public health or welfare or the environment. A response action is required to address contamination in both subsurface soil and groundwater at the FCS. Contaminants of concern (COC) are those chemicals with historic or current concentrations exceeding project cleanup levels (PCL). At the completion of the remedial investigation (RI), COCs in the groundwater included trichloroethene (TCE), 1,2,3-trichloropropane (TCP), diesel-range organics (DRO), and residual-range organics (RRO). At the completion of the RI, COCs in the soil included chlorinated volatile organic compounds (VOC), semivolatile organic compounds (SVOC), DRO, and metals. At the time of the RI, CERCLA hazardous substances were commingled with petroleum.

1.4 DESCRIPTION OF THE CERCLA SELECTED REMEDY

The FCS is the sixth operating unit to reach a final-action ROD at the FWA NPL site. This ROD selects Alternative S2/GW2 (Institutional Controls for Soil/MNA and Institutional Controls for Groundwater) as the final remedy for OU6 soil and groundwater. The estimated cost for the OU6 remedy is $920,040. The components of this alternative are described in detail in Section 3.6. The selected remedy will address low-level threat wastes remaining in subsurface soil and contaminated groundwater at the FCS and was selected to reduce or prevent risks to human health and the environment associated with potential current or future exposure to the contaminants.

The remedial action objectives (RAO) of this ROD are designed to perform the following:

- Protect against human exposure to COCs in soil (Table 1). This RAO will be achieved if soil containing COCs at concentrations exceeding PCLs is managed through administrative processes, or if COCs in soil are reduced to meet PCLs.
- Protect against human exposure to COCs in groundwater (Table 2). This RAO will be attained if the exposure pathway to human receptors is limited or eliminated through administrative processes, or if COC concentrations in groundwater are reduced to meet PCLs.
- Return groundwater to its beneficial use as a drinking water source. VOCs are expected to reach PCLs within 25 years; it is expected that remediation of DRO and RRO will take longer. This RAO will be achieved when groundwater COCs are below PCLs.

Institutional controls will be implemented to ensure that residents and workers will not come into contact with potentially contaminated soil. MNA and institutional controls prohibiting the use of onsite groundwater will be implemented to address groundwater contaminants above the PCLs. The selected remedy includes the following components:

- Institutional controls will prohibit excavation and removal of soil from the FCS without the permission of the U.S. Army DPW and concurrence of EPA and ADEC.
- Institutional controls prohibiting onsite groundwater use will eliminate human exposure to COCs in groundwater exceeding PCLs.
- Groundwater sampling will be implemented to monitor the progress of natural attenuation processes and to ensure that contamination is not migrating toward the Post drinking water supply wells located outside the northeast corner of the site.

Although not part of the selected remedy for soil and groundwater, the Army will implement a voluntary, proactive five-year sub-slab soil gas monitoring plan to monitor soil gas under the concrete slabs. Although the risk assessment identified no unacceptable risk due to vapor intrusion and soil gas was not retained as a medium of concern in the Feasibility Study (FS) evaluation, sub-slab soil gas monitoring will be implemented by the Army as a conservative, proactive measure. The Army and ADEC will review the data following each monitoring event and the Army will provide EPA an opportunity to review the data.

The selected remedy for the FCS is consistent with remedial approaches in place at OU1 through OU5.

1.5 STATUTORY DETERMINATIONS

The selected remedy for the FCS attains the mandates of CERCLA Section 121 and the regulatory requirements of the NCP. This remedy is protective of human health and the environment, complies with federal and state applicable or relevant and appropriate requirements (ARAR) for the remedial action, and is cost-effective. The selected remedy represents the maximum extent to which permanent solutions can be used in a practicable manner at the FCS. The remedy provides the best balance of trade-offs in terms of the balancing criteria, while also considering state and community acceptance.

CERCLA and the NCP establish an expectation that treatment will be used to address the principal threats posed by a site wherever practicable [see 40 CFR 300.430(a)(1)(iii)(A)]. Contaminated soil and hazardous debris were excavated to the greatest extent practicable during the RI and two time-critical removal actions (TCRA). The remaining subsurface soil is contaminated with low levels of metals, VOCs, and SVOCs, and higher concentrations of DRO. This soil is considered to be “low-level threat waste” because the remaining contamination is non-mobile, it can be reliably contained, and/or concentrations are generally near or below health-based cleanup levels (EPA 2001). The selected remedy for soil in this ROD does not satisfy the statutory preference for treatment as a principal element of the remedy; however, contaminated soil and potentially hazardous debris and munitions-related items at the FCS were characterized, delineated, removed, and properly disposed of during the TCRAs and the RI to the greatest extent practicable (U.S. Army 2007; CH2M HILL 2010a; USACE 2012). At the FCS, institutional controls will be implemented to eliminate exposure pathways to contaminants and to ensure that remaining contamination continues to pose no unacceptable risk. Institutional controls, which include excavation and groundwater use restrictions, are necessary because the selected remedy will result in hazardous substances remaining on the site in subsurface soil at depths deeper than 6 feet below ground surface (bgs), and hazardous substances in the groundwater which are above levels that allow for unlimited use and unrestricted exposure (UU/UE). MNA will be utilized to ensure that groundwater contamination continues to decrease to meet PCLs and poses no threat to the FWA drinking water supply wells.

The selected remedy is readily implementable, cost-effective, and compliant with federal and state ARARs. Institutional controls will offer short- and long-term protection of human health and the environment. While natural attenuation is not an active treatment method, it is expected to reduce the toxicity and volume of remaining groundwater contaminants permanently. Groundwater monitoring will be conducted as part of the MNA remedy to demonstrate continued effectiveness of the natural degradation processes in reducing concentrations of COCs in groundwater. This selected remedy is acceptable to the State of Alaska and there was no objection expressed by the neighboring community.

The remedy provided in this ROD is intended to minimize or eliminate exposure of receptors to low-level threat wastes. Because the remedy for the FCS will result in CERCLA hazardous substances, pollutants, or contaminants remaining on the site above levels that allow for UU/UE, a statutory review will be conducted within five years after initiation of the remedial action to ensure that the remedy continues to be protective of human health and the environment. This review will be conducted at least once every five years until OU6 is acceptable for UU/UE. The effectiveness of institutional controls implemented for the site will be evaluated annually and a report will be provided to EPA and ADEC. Results of the evaluation and annual inspections will also be included in each five-year review.

1.6 DATA CERTIFICATION CHECKLIST

The following information is included in the Decision Summary (Section 2.0) or Comparative Analysis (Section 3.0) of this ROD:

- List of COCs and their respective concentrations (Table 1 and Table 2)
- Human health and ecological risk evaluation represented by the COCs (Section 2.7)
- Cleanup levels established for COCs and the basis for these levels (Table 1 and Table 2)
- How source materials constituting principal threat wastes will be addressed (Section 3.5)
- Current and reasonably anticipated future land use assumptions utilized in the baseline risk calculations and this ROD (Section 2.6 and Section 2.7)
- Potential land and groundwater use that will be available at the site as a result of the selected remedy (Section 2.6)
- Estimated capital, annual operations and maintenance (O&M), total present worth costs, discount rate, and the number of years over which the remedy cost estimates are projected (Section 3.3; Table 12)
- Key factors that led to selecting the remedy (Section 3.6.1).

Additional information regarding the site history, investigations, and remedial actions can be found in the Administrative Record file at the following locations:

- Noel Wien Library, 1214 Cowles Street, Fairbanks
- FWA Post Library (Building 3700)
- FWA DPW CERCLA Library (Building 3023)
- Online at: http://www.wainwright.army.mil/env/PDFs/DERA/Former%20 Communications %20Site%20Administrative%20Records%20Index.pdf.

(intentionally blank)

1.7 AUTHORIZING SIGNATURES

This is the signature sheet for Operable Unit 6, Fort Wainwright, Record of Decision between the U.S. Army and the U.S. Environmental Protection Agency, Region 10, with concurrence by the Alaska Department of Environmental Conservation.

Mark A. Lee
Colonel, U.S. Army Environmental Command
Fort Sam Houston, Texas

27 Jan 14
Date

(intentionally blank)

1.7 AUTHORIZING SIGNATURES

This is the signature sheet for Operable Unit 6, Fort Wainwright, Record of Decision between the U.S. Army and the U.S. Environmental Protection Agency, Region 10, with concurrence by the Alaska Department of Environmental Conservation.

Cami Grandinetti — Date: 1/29/14

Cami Grandinetti
Remedial Cleanup Program Manager
Office of Environmental Cleanup, Region 10
United States Environmental Protection Agency

(intentionally blank)

1.7 AUTHORIZING SIGNATURES

This is the signature sheet for Operable Unit 6, Fort Wainwright, Record of Decision between the U.S. Army and the U.S. Environmental Protection Agency, Region 10, with concurrence by the Alaska Department of Environmental Conservation.

for, Jennifer Roberts
Federal Facilities Section Manager
Contaminated Sites Program
Alaska Department of Environmental Conservation

1/27/2014
Date

(intentionally blank)

2.0 DECISION SUMMARY

This Decision Summary provides a description of the site-specific factors and analyses that led to the selection of the soil and groundwater remedy for the FCS, also referred to as OU6. It includes background information, the nature and extent of contamination found, the assessment of human health and environmental risks posed by low-level contamination, and the identification and evaluation of remedial action alternatives for OU6. This Decision Summary identifies the selected remedy for soil and groundwater, explains how the remedy fulfills statutory and regulatory requirements, and provides a substantive summary of the Administrative Record files that support the remedy selection decision.

The OU6 remedy addresses soil and groundwater contamination that originated within a 54-acre fenced area on FWA. The information presented in the OU6 RI (CH2M HILL 2010a) and FS (CH2M HILL 2011b) support the basis for action and the selected remedy. In addition, the Army conducted pre-RI and post-RI removal actions where soil and debris were removed to the greatest extent practicable and natural attenuation processes in groundwater are continuing to reduce groundwater COC concentrations. Therefore, the risk estimates described in this ROD are likely conservative.

2.1 SITE NAME, LOCATION, AND BRIEF DESCRIPTION

The FCS is located in the western central portion of FWA (Figure A-1).

The Point of Contact for this ROD is:

Mr. Joseph Malen, Remedial Project Manager
joseph.s.malen.civ@mail.mil
IMFW-PWE
1060 Gaffney Road #4500
Ft. Wainwright, Alaska 99703

FWA is a federally-owned facility managed by the U.S. Army Garrison FWA (an installation-level command overseen by the U.S. Army Installation Management Command Pacific. The FCS has a history of mixed uses, including barracks and company headquarters, communication and radar systems, salvage/reclamation yard activities, debris disposal, a concrete batch plant and railroad spur, garden plots, possible ammunition storage, and firefighter training. The FCS currently consists of the completed but unoccupied Taku Gardens family housing development, which covers approximately 54 acres (Figure A-2). Environmental contamination and buried debris containing munitions-related items discovered during construction of the Taku Gardens family housing development have impacted soil and groundwater at the site. Construction of the 110 housing units (55 buildings) is complete, but the housing will not be released for occupancy until the Army, EPA, and ADEC sign the ROD.

The U.S. Army Garrison FWA is the lead cleanup agency and Responsible Party for the OU6 remedial actions. The EPA and ADEC are the regulatory agencies overseeing the cleanup as outlined in the FFA (U.S. Army 1991).

2.2 SITE HISTORY AND ENFORCEMENT ACTIVITIES

This section provides background information and summarizes previous site activities and investigations that led to this ROD.

2.2.1 Site History

FWA has been used continuously by the U.S. Department of Defense for military operations since 1938. Originally known as Ladd Army Airfield, the Post was established for cold weather experimentation. During decades of military use at FWA, routine operations and storage practices resulted in accidental releases of chemicals to the ground and underlying groundwater or nearby surface water. Former disposal practices were responsible for other releases to the environment. Beginning in the late 1950s, most non-hazardous waste was disposed of in the sanitary landfill located in the north-central portion of FWA. Naturally occurring surface depressions such as former slough channels were also historically used for disposal of construction debris and were covered with fill.

Other disposal practices at FWA included spreading used oil for dust control on unpaved roads and for firefighting drills; spreading coal ash on icy roads; burning used oil and other used flammable liquids for energy recovery in the power plant; and discharging or dispersing used oils, solvents, or fuel spills into floor drains in buildings across the installation (Agency for Toxic Substances and Disease Registry [ATSDR] 2003). Hazardous wastes generated by FWA include pesticides; polychlorinated biphenyls (PCB); petroleum, oil, and lubricants (POL); and battery fluids. Such chemicals were largely associated with spent solvents and ignitable wastes from aircraft and vehicle maintenance shops, contaminated motor vehicle and aviation fuels, paint, coal fly ash, and spent vehicle batteries. FWA also generated small quantities of radioactive tritium waste and low-level radioactive materials such as radium dials (ATSDR 2003).

The U.S. military has occupied the general area of the FCS for over 60 years and has conducted a variety of activities in the area during this time. Between the late 1940s and late 1950s, several areas were cleared for the construction of troop billets, motor pools, dining halls, and other essential facilities. A significant portion of the eastern side of the FCS was used for equipment and vehicle disposal, salvage, and maintenance activities, as well as a staging area for railroad construction activities and a concrete batch plant. The Air Force Secret Security Service facilities were also located in this area. Some of these activities were associated with the dumping of solid waste and debris into a former meander channel of the Chena River (Hoppe’s Slough) as a convenient means of filling the historical river channel and other various depressions located on the site. Such activities were common practice for filling swampy, mosquito-breeding areas. Unusable military equipment and hardware discarded by both the U.S. Army and U.S. Air Force was buried within the FCS during this period. Temporary billets built for the arrival of the 3rd Battalion, 4th Infantry Regiment, as well as several Air Force units also occupied a portion of the site from 1951 to 1956. Historical uses of the FCS include the following:

- Barracks and company headquarters, extending into the northwestern corner of the site
- Equipment salvage and reclamation
- Debris and salvage material disposal in the Chena River oxbow that extends through the site, in trenches in the salvage yard area, and possibly in other local depressions

- Garden plots
- Concrete batch plant and railroad spur
- Communications and radar system installations
- Possible ammunition storage

Only a limited number of written records describing specific activities occurring at the FCS during the course of its history are available. Much of what is known about the site was inferred from examining and comparing historical photographs dating from 1947 to present, the 1958 FWA "Master Plans," past geographical surveys, and military operations concurrent with similar missions conducted at other locations.

The building numbers up through Building 65 used in this document are those used during construction planning and are not the same as the physical addresses of the now-completed buildings.

A salvage yard was active in the southeastern portion of the FCS from the 1940s to the 1960s. During this time, the eastern portions of Hoppe's Slough were filled, likely with debris from the salvage yard. Aerial photographs taken between 1948 and 1967 show stockpiles of drums, fire training burn areas, and the remains of a wrecked U.S. Air Force aircraft in the area between the current locations of Buildings 16, 21, and 49, and accumulations of drums and debris near the current locations of Buildings 11 through 19, 21 through 29, 31, 32, 33, 35, 47, 48, and 49. During the 1950s and 1960s, a concrete batch plant and railroad spur were active in the northeastern corner of the FCS in the area between the current locations of Buildings 15, 17, and 19 and the Post Exchange (PX) Service Station (gas station). Some former salvage yard stockpiling activities also occurred in this area (Oasis Environmental, Inc. [Oasis] 2007; CH2M HILL 2010a).

By 1956, a large, white structure had been constructed and the ground surface was cleared near the planned locations for Buildings 50 through 52 for operation of communication and radar systems.

The FCS property was selected for military family housing in 2002 and 2003. Pre-construction geotechnical samples were collected in late 2003 and again in 2004. Geophysical testing completed during this time indicated areas of surface and buried debris near the former salvage yard on the eastern side of the FCS. Low concentrations of PCBs (less than 2 milligrams per kilogram [mg/kg]) were discovered in two borehole soil samples. Additional boreholes were installed near these first two boreholes and additional samples were collected; PCBs were not detected in those samples. The Army cleared surface vegetation to facilitate the pre-construction environmental survey. During the clearing, a considerable amount of metal debris and some munitions debris (MD) were uncovered. Army munitions experts determined that the MD did not contain any explosive hazards. As part of site clearing and development, a sound berm was constructed along the east and south sides of the housing area to reduce the noise from passing trains. The sound berm was built using topsoil and vegetation cleared from the FCS. The site was deemed suitable for housing based on the results of initial sampling and surveys, and excavations for building foundations, utilities, and other infrastructure began on the Taku Gardens family housing development in April 2005.

During housing construction in July 2005, equipment operators uncovered soil contaminated with PCBs near planned Building 52, as well as an extensive array of buried debris including crushed drums, scrapped equipment, and munitions-related items across the site. The EPA and ADEC were informed about the initial PCB discovery, and have been integrally involved in all site investigation activities since that time.

2.2.2 History of Investigations, Sampling Strategy, and Removal Actions

The overriding purpose of sampling and characterization at the FCS has been to determine the suitability of the site for family housing and to identify any unacceptable human health or ecological risks associated with exposure to site contamination. The locations, media, materials, and contaminants sampled at the FCS over time have followed a biased approach based on such factors as the proposed location of the housing units; the known or suspected locations of debris or source material; review of historical records and photographs; follow-on investigation from preliminary sampling results; debris, stains, and odors encountered during construction activities; and confirmation of contaminant removal following the excavation of debris and soil. Spanning the period between 2003 and 2011, sampling events, investigations, construction support activities, and observational discoveries have identified buried materials and COCs that resulted in follow-on sampling, investigation, removal actions, and excavation and disposal of potentially hazardous soil and debris. The following sections describe site characterization activities, sampling strategy, and removal of soil and debris.

A timeline of site discovery, investigation, and remedial actions is provided in Figure A-3.

Characterization and Soil/Debris Removal 2003 – 2005

Investigation of the FCS began in 2003 following selection of the land for construction of military housing, and included geophysical, geotechnical, and subsurface soil sampling. The initial geophysical investigation of the FCS began in October 2003 and consisted of a limited electromagnetic (EM) geophysical survey in the northeast "snow dump and site trails" portions of the FCS where historical aerial photographs showed debris piles (Oasis 2007). The geophysical anomalies identified by the 2003 survey led to the May 2004 comprehensive EM and magnetometer (MAG) geophysical survey of the entire FCS to further delineate identified anomalies (R&M Consultants, Inc. 2004). These early investigations provided the first indications of significant buried debris, munitions-related items, and contaminated soil at the FCS.

Eleven munitions-related items were unearthed by the FWA DPW in spring of 2004 during the limited debris removals performed in the northeast corner of the FCS behind the PX Service Station. The excavated debris included suspected munitions-related items, and military unexploded ordnance (UXO) technicians were contacted and were present during subsequent examinations of soil piles and excavations at the FCS. All of these munitions-related items were determined to be MD.

The 2004 EM and MAG surveys identified widespread surface anomalies at the FCS, as well as large areas of buried metal debris within the southern portions of former Hoppe's Slough and in the vicinity of the former salvage yard. Suspected soil contamination included low concentrations of PCBs, which were discovered in the southwest corner of the site near

Building 51. A follow-up investigation in March 2005 failed to confirm the presence of PCBs in this location (North Wind, Inc. 2005). Based on this evidence, foundation excavation and housing construction activities began at the Taku Gardens family housing development in April 2005.

Building foundations and utility trenches were excavated between April and August 2005. Field screening for petroleum contamination was conducted during excavation activities. Excavated soil and encountered debris were stockpiled on the FCS. Unidentified solvent-like odors were noted by construction personnel on 30 June 2005 while excavating the foundation for the original Building 52. Initial testing to characterize the soil identified trichlorophenol contamination but did not conclusively detect PCBs. Construction work in this area was suspended in July 2005 while additional soil samples from the Building 52 area were collected and analyzed. A second set of field samples collected from this same area detected PCBs (Aroclor 1260) at concentrations as high as 111,000 mg/kg. Additionally, chlorinated contaminants associated with PCBs in transformer oil were detected at concentrations above their respective cleanup levels. These chlorinated compounds associated with PCB-contaminated soil included trichlorophenol, trichlorobenzene, dichlorobenzene, dioxins, and dibenzofurans. Based on these results, an exclusion zone (EZ) was established around the Building 52 foundation excavation.

In late August 2005, when it became apparent that construction activities might have spread PCB-contaminated soil to other areas, construction workers were evacuated from the site and all construction work at the Taku Gardens family housing development was suspended. An environmental site characterization effort was initiated that focused on protecting site workers and nearby residents. Contaminant characterization focused primarily on PCBs. During this investigation, samples were collected from surface and subsurface soils across the construction site; stockpiled soils; a nearby residence (Building 4394) where soil excavated from the FCS had been used as fill; three permanent groundwater monitoring wells and seven temporary groundwater monitoring wells; four outdoor recreational areas; adjacent residences; and construction equipment remaining at the site after construction workers were evacuated. Low-level PCBs were detected in wipe samples collected from recreational equipment located within the construction site boundaries but were not detected in samples collected from offsite recreational equipment or residences. Low levels of PCBs were detected on construction equipment. Low-level PCB contamination (less than 1 mg/kg) was identified in soil samples collected near offsite Building 4394; this soil was immediately excavated and replaced with clean fill. Workers were not permitted on the site until the project team (Army, EPA, and ADEC) determined it was safe to reenter an area and all construction equipment had been decontaminated.

The highest PCB concentrations were restricted to approximately 5 acres in the southern portion of the construction site in the vicinity of Building 52. Although low concentrations of PCBs were detected at other locations of the FCS, these concentrations were less than 1 mg/kg and construction in these areas resumed after EPA and ADEC provided their concurrence (North Wind, Inc. 2006).

Petroleum contamination was discovered in the north-central portion of the FCS during foundation excavation and construction activities in June 2005. Following this discovery, characterization of site groundwater conditions began in July 2005 and continued through completion of the Preliminary Source Evaluation (PSE) II investigation in 2006. Three temporary groundwater monitoring wells were installed and sampled in July 2005. Petroleum constituents were detected in soil and groundwater samples collected in the area around Buildings 5 through 9, where DRO concentrations in several samples exceeded the ADEC Method Two cleanup levels (North Wind, Inc. 2006). Petroleum-contaminated soil at three locations in the vicinity of Buildings 5 through 9 was excavated in 2005, and was temporarily stockpiled onsite before being transferred to long-term stockpiles at the Defense Reutilization and Marketing Office (DRMO) yard (North Wind, Inc. 2006). This soil was later thermally treated at an offsite treatment facility. The treated soil was returned to FWA and disposed of at the FWA solid waste landfill.

Results of the 2005 characterization indicated that additional site characterization and potential corrective actions were necessary to address the PCB- and petroleum-contaminated soil discovered at the FCS (North Wind, Inc. 2006). The Army completed a TCRA of the most highly contaminated PCB soil from the original Building 52 foundation excavation in September 2005 (U.S. Army 2007). During the 2005 TCRA, air monitoring samples were collected from the site and from the site perimeter near the housing area located to the west of the FCS. PCBs were not detected in any of the air samples collected. During this effort, 215 tons (approximately 186 cubic yards [cy]) of PCB-contaminated soil was excavated and shipped offsite for disposal at a permitted hazardous waste landfill.

Approximately 5 acres around the original Building 52 foundation excavation (the area surrounding Buildings 50 through 59) were designated as the PCB EZ and a gated and locked fence was erected around this expanded area (Figure A-2). The fenced area included areas known or suspected to be contaminated with PCBs, and what had been identified as a former electrical grid. Signs warning of PCB contamination were placed around the EZ and entry was restricted to authorized personnel on an as-needed basis. The Building 52 excavation was temporarily backfilled with PCB-contaminated soil that had been excavated and stockpiled during construction activities, and covered with plastic sheeting, as documented in the 2007 Action Memorandum (U.S. Army 2007). (All soil with PCB contamination greater than 1 mg/kg was subsequently removed in 2007 and 2008.) Remaining excavated soil piles were covered. The duplexes originally scheduled for construction in the EZ (Buildings 50 through 59) were removed from the housing construction contract and the partially built foundations were later demolished.

The 2007 Action Memorandum described the activities and findings leading up to and including the removal of highly contaminated PCB soil in the Building 52 area (U.S. Army 2007). In addition, it established interim land use controls for the FCS. These restrictions would remain in place until permanent land use controls are established in this ROD and implemented through the Remedial Design/Remedial Action Work Plan.

Preliminary Source Evaluations 2005 – 2006

After PCBs were identified in soil near Building 52 and the findings from initial construction support investigations had been reviewed, the Army, EPA, and ADEC agreed that a PSE was required at the FCS. At that time, the Army transitioned from emergency removal to remedial response activities in accordance with 40 CFR 300.415(g) and the FFA (included in the Administrative Record). The scope of the PSE was to evaluate releases or threatened releases of hazardous substances, pollutants, or contaminants from a source area with the potential to constitute a threat to the public health, welfare, or the environment. The purpose of the PSE was not to fully characterize the FCS, but to provide sufficient information to determine if a CERCLA RI was required.

A review of all existing historical information on FCS activities, waste disposal practices, and prior investigations was undertaken during the first phase of the PSE (PSE I), which was conducted during the winter of 2005–2006. The PSE I concluded that surface and subsurface soil in most areas of the FCS was potentially contaminated (Oasis 2007). Only the southeast portion of the FCS, where potential impacts could not be fully determined, was excluded from this general conclusion.

Data gathered during the PSE I was used to divide the FCS into five subareas (A through E). These potential source area designations were based on historical usage, review of historical aerial photographs and maps, field notes taken by the construction contractor's environmental consultant, and the types of contamination and debris encountered. These subareas are shown in Figure A-4 and are described as follows:

- Subarea A consisted of the northeast quadrant of the housing development, where buried debris containing munitions-related items was identified.
- Subarea B was located along the northern boundary of the development, where company headquarters and barracks buildings were constructed over Hoppe's Slough, and where petroleum contamination was identified during preliminary investigations.
- Subarea C was located along the northwestern corner of the development, where company headquarters and barracks buildings were constructed over Hoppe's Slough.
- Subarea D consisted of the southeast corner of the development that was part of a salvage yard in the 1940s. The Subarea was potentially used for ammunition storage in the 1950s, and the Golden Valley Electric Association station was constructed there in the late 1970s.
- Subarea E was the southwest corner of the development and consisted of land that housed communications operations in the 1950s, but was cleared and used for personal gardens through the late 1990s. During initial construction activities, soil in the area was found to be contaminated with PCBs and other types of contaminants.

During summer and fall 2006, the U.S. Army commissioned a second phase for the PSE (PSE II). The PSE II focused on characterizing buried debris, soil, soil gas, stockpiles, and groundwater at the FCS. The PSE II investigation was guided by information gathered during the PSE I. As additional information became available, the PSE II investigation was expanded.

Potentially contaminated soil and debris removed during building foundation construction and utility trench excavation in 2005 had been stockpiled at the FCS (Figure A-5). As part of the PSE II efforts, all soil and debris piles generated during construction were characterized based on photoionization detector (PID) readings. Material with a PID reading greater than 20 parts per million (ppm) was excavated and further segregated into two stockpiles: one for material with PID readings between 20 and 100 ppm and one for material with readings greater than 100 ppm. Soil or material with PID readings greater than 100 ppm was considered petroleum-contaminated. Approximately 1,500 cy of petroleum-contaminated soil were stockpiled near the PX Service Station. In September 2005, this soil was tested for fuel analytes and PCBs, and was then transported and stored in three long-term stockpiles at the FWA DRMO Yard. Approximately 150 cy of this petroleum-contaminated soil was transported to an offsite thermal treatment facility in Fairbanks. Treated soil was returned to FWA and disposed of at the FWA solid waste landfill. The remaining untreated soil was stored in the DRMO yard until 2008, when further characterization, treatment, and final disposal occurred.

In addition to screening for contaminants, UXO and environmental technicians sorted each soil/debris pile generated during construction based on the type of material found, such as soil, drums, scrap metal, or concrete. Small to mid-sized excavators with thumb attachments were used to sort the piles. Each soil pile was inspected by removing soil and debris from the stockpile in approximately 6-inch lifts to enable thorough inspection. On a few occasions, items with the potential to contain hazardous waste (i.e., batteries and light ballasts) were found. Such items were placed into drums and transferred to the FWA Resource Conservation and Recovery Act (RCRA) facility contractor for proper disposal. Non-hazardous metallic debris was segregated from soil and disposed of at the FWA solid waste landfill. In total, 97,100 cubic feet (3,600 cy) of soil were thoroughly sorted, visually inspected, field screened, and sampled during the PSE II to determine whether physical or chemical hazards were present. In general, VOCs, SVOCs, and metals were the most prevalent contaminants in the soil piles; however, explosive residues, PCBs, pesticides, and polynuclear aromatic hydrocarbons (PAH) were also detected.

The PSE subsurface investigations conducted at the FCS included both indirect (geophysical studies) and direct (test pits and exploratory excavations) methods to identify areas of buried debris. The 2006 PSE I identified uncertainties and data gaps in the 2004 geophysical survey, including the discovery that an area north-northwest of Buildings 1 through 4 had not been included in previous pre-construction geophysical surveys. To address these data gaps, a dense set of data was collected using EM, MAG, and ground-penetrating radar geophysical surveys over approximately 25 acres of the FCS. The results of these surveys were used to assist in buried debris investigation and test pit activities (Sage Earth Sciences 2007). Numerous magnetic anomalies were detected and excellent correlation between magnetic anomalies and the presence of buried ferrous debris was observed.

Buried debris was investigated during the PSE II primarily through excavation of small test pits. These test pits were located within 30 general areas of interest which were chosen after a thorough review of photographs and field notes taken during the 2005 construction work, and previous geophysical surveys (Figure A-5). During test pit excavation, UXO and environmental technicians visually inspected all debris that was encountered. Significant effort was made to identify any items that had the potential to be a source of contamination or other hazard. The PSE debris investigation confirmed earlier observations by the construction contractor that the majority of the material buried at the FCS was scrap material that did not have potential to be a source of contamination. Scrap material was defined as debris that, had it been generated today, would not be regulated under RCRA or the Toxic Substances Control Act. Scrap metal identified during the PSE II included heavy equipment parts, vehicle parts, airplane parts, structural steel, and empty and crushed steel drums. It is important to note that a primary objective of the PSE was to determine whether chemical or physical hazards were associated with the buried debris.

Field notes and photographs taken during construction activities in 2005 and the 2006 PSE II investigation of some of the soil piles accumulated during construction confirmed that munitions-related items had been buried at the FCS. During the 2006 PSE II, an intrusive investigation with UXO-qualified personnel confirmed that munitions-related items, drums, and large quantities of scrap metal were still buried onsite. The major items of interest excavated during this time were two un-fuzed M47 bombs, one of which contained a liquid. The U.S. Army Technical Escort Unit analyzed the suspect M47 bombs using portable isotopic neutron spectroscopy and determined the liquid was water and that no trace of hazardous chemicals was present. Results were confirmed with the Materiel Assessment Review Board. The two M47 bombs and six other un-fuzed munitions suspected of containing explosives were turned over to the Army Explosives Ordnance Disposal (EOD) for disposal by detonation.

MD and range-related debris (RRD) was also identified during the PSE II. The debris encountered appeared to be from the World War II/Korean War era and included numerous empty shipping tubes for 105mm artillery rounds, empty shipping tubes for 2.36-inch rockets, empty ammunition cans, an M10 chemical smoke tank, 75mm recoilless rifle (RR) casings, 57mm RR casings, and shipping plugs. Non-energetic MD items such as these were segregated during the excavation work and secured in drums. At the end of the test pit investigation, all MD items were properly inspected by contractor UXO technicians, determined to be free of energetic material, and disposed of at the FWA solid waste landfill.

Soil samples were collected from soil borings distributed across the site to assist in characterization of possible subsurface soil contamination. Borings in the northwestern and north-central portions of the FCS confirmed the presence of petroleum contamination. Samples with positive PCB field screening results were sent to the offsite laboratory for confirmation. Soil and groundwater samples were collected in the areas around Building 52 and Buildings 5 through 9 in late June and July 2005 and were analyzed for PCBs, VOCs, SVOCs, and petroleum constituents; petroleum-related contamination was confirmed in this area. In addition to PCBs, other chlorinated compounds were detected in soil samples from the Building 52 foundation excavation and from associated stockpiled soil.

The investigation found that the highest concentrations of PCB contamination were present in the southern portion of the construction site near Building 52, with highest concentrations reported from samples collected from the Building 52 foundation excavation floor, but that low levels of PCBs (below the ADEC residential cleanup level of 1 mg/kg) were sporadically detected in soils across the FCS at depths ranging from 0 to 8 feet bgs (North Wind, Inc. 2006). All PCBs were identified as Aroclor 1260, with the exception of four results that were identified as Aroclor 1254 and one result identified as Aroclor 1232. All PCB concentrations outside of the EZ were below 1 mg/kg with the exception of a few samples located along the eastern boundary of the FCS in a former transformer storage area, where PCB concentrations were less than 10 mg/kg.

Groundwater characterization initiated in 2005 continued as part of the PSE. The PSE II included installation of seven temporary and ten permanent groundwater monitoring wells. Groundwater data gathered during the PSE II determined that the groundwater flow direction was approximately from the southeast to northwest direction (North Wind, Inc. 2007). Groundwater samples collected from monitoring wells (MW) MW01 through MW12 during the PSE II were analyzed for PCBs, VOCs, SVOCs, pesticides, metals, mercury, anions, explosives, dioxins/furans, gasoline-range organics (GRO) and DRO/RRO.

The results of the PSE II groundwater investigation suggested that at least one area at the Taku Gardens family housing development in the north-central portion of the FCS was affected by past practices. The PSE II concluded that the groundwater contamination in this area was composed primarily of DRO, explosives, and at least one VOC (p-isopropyltoluene). After continued investigation and discussion with the analytical laboratory, the reported detections of explosive compounds in the north-central portion of the FCS are now believed to have been caused by analytical interferences from the high concentrations of petroleum compounds in this area. The primary source area for petroleum contamination was suspected to be in the vicinity of Building 10 and MW12 (North Wind, Inc. 2006).

A passive shallow soil gas survey was conducted during September 2006 as part of the PSE II to determine whether previous use of the area had resulted in VOC impacts on soil gas. The survey was limited to a relatively small area of the FCS in the vicinity of known VOC contamination near Building 7 and a buried drum cache identified near Building 49. Three classes of analytes were detected in the soil gas: petroleum constituents, chlorinated solvents, and chlorofluorocarbons (CFC) (North Wind, Inc. 2007). Petroleum constituents were detected in almost every soil gas sample. CFCs were also detected in nearly all sample locations, but these CFC detections were later determined to be most likely associated with materials used during housing construction (i.e., spray foam insulation used for utility lines and foam board). Chlorinated solvents, TCE, and tetrachloroethene (PCE) were detected at five sample locations near Buildings 4, 14, 45, 46, and 49. One location near Building 4 had the highest measured values for petroleum constituents and PCE, suggesting a common source. In other areas, petroleum constituents, chlorinated solvents, and CFCs were not collocated; therefore, it was concluded that the petroleum, chlorinated solvents, and CFCs in these areas were derived from separate sources.

When construction of the Taku Gardens housing development began, the site was originally fenced with temporary chain-link construction fencing. As more information became available, remedial project managers recognized the need for tighter restrictions on site access. In addition to the chain-link security fence surrounding the EZ (implemented as part of the 2005 TCRA, (U.S. Army 2007), an 8-foot high permanent chain-link fence with three-stranded barbed wire was installed around the perimeter of the entire 54-acre FCS site. The majority of this fence was completed in November 2006, with a short remaining section completed in spring 2007. Signs stating *Restricted Area*, *Keep Out* were placed every 100 feet along the fence. Gated and locked entry points are located in the north and south of the site. Site access remains restricted to authorized personnel on an as-needed basis. Access is controlled by the DPW and military police frequently patrol the perimeter. The Army has conducted annual inspections of the fence. This fence will be removed after this ROD is signed by the Army, EPA, and ADEC.

Remedial Investigation 2007 – 2010

Investigations conducted between 2003 and 2006 confirmed the presence of a variety of contaminants in soil and groundwater, and identified a number of potential source areas associated with historical uses and past disposal practices. Conclusions from the investigations led the Army, with EPA and ADEC concurrence, to conduct a comprehensive RI to characterize known and suspected contamination of soil, groundwater, and other environmental media at the FCS. The RI, initiated in 2007, was designed to collect sufficient data of appropriate quality to assess the nature and extent of soil and groundwater contamination at the FCS, determine whether other environmental media had been affected by contamination, conduct risk assessments, and support the development of remedial alternatives.

Due to the history of investigations and removal actions completed at the FCS, RI data collection included judgmental and systematic sampling. For example, judgmental samples were collected as confirmation samples at targeted drum and debris removal areas where geophysical anomalies had been identified, and at areas with confirmed or suspected contamination. Systematic samples, such as the surface soil samples obtained from the yards of each residential unit, were collected at locations and depths where sources and/or contaminants were thought to be absent. The RI sampling events in 2007, 2008, 2009, and 2010 were each designed to build on data from previous investigations and to complete data sets required to define the nature and extent of contamination.

The preliminary conceptual site model (CSM) presented in the *Remedial Investigation Management Plan* (CH2M HILL 2008) was used to guide the FCS RI and evaluate the nature and extent of contamination. This CSM provided a framework for understanding site-specific features and physical processes that influence the potential risk, and it describes potential human and ecological exposure pathways for site-related chemicals. The preliminary CSM included the following components:

- **Sources of contaminants.** Based on known or suspected historical uses, practices, and releases at the FCS.
- **Receptors.** Human and ecological populations that could be exposed to the contaminants at or near the FCS.
- **Pathways.** The mechanisms by which a chemical could come into contact with receptors. An exposure pathway is considered complete when a contaminant can be tracked from its source to a receptor.

The preliminary CSM was developed based on review of the known physical characteristics of the FCS, operational history of the FCS, historical aerial photographs and maps, and the results of pre-RI investigations. The preliminary CSM for the FCS is illustrated in Figure A-6 and presented graphically in Figure A-7.

During the RI, conservative screening levels called project screening levels (PSL) were developed to identify chemicals of interest (COI) and to determine the nature and extent of those COIs in soil and groundwater. PSLs and COIs are identified as follows:

- PSLs for soil are based on regulatory levels for exposure through direct contact and outdoor inhalation.
- PSLs for soil gas were based upon shallow or sub-slab soil gas target levels.
- PSLs for groundwater are based on regulatory levels for drinking water.
- COIs are those chemicals with one or more exceedances of the PSLs, which are conservative risk-based values used to evaluate the nature and extent of contamination at the FCS.

There are no established cleanup levels for soil gas. For soil gas, the PSL was generally 1/10th of the target levels for shallow or sub-slab soil gas as listed in Appendix E (Residential Target Levels) of the *Draft Vapor Intrusion Guidance for Contaminated Sites* (ADEC 2009). The PSLs used to evaluate the nature and extent of COIs were based primarily on the 2009 ADEC Method Two cleanup levels, as listed in Section 75 of the Alaska Administrative Code, Title 18 (75 AAC 18) Tables B1 and B2 for soil and Table C for groundwater and adjusted to account for possible cumulative exposure from multiple chemicals.[1] For soil, the PSL is generally $1/10^{th}$ of the lowest of the adjusted under 40-inch zone direct contact value and the adjusted under 40-inch zone outdoor inhalation value. Background concentrations were used if the COI concentration was greater than the lowest Method Two–based value. For groundwater, the PSL was generally $1/10^{th}$ of the adjusted ADEC Table C value for drinking water, or background if higher. For analytes without a Table C value, 1/10th of the residential

[1] The ADEC Method Two cleanup levels are based on an excess lifetime cancer risk (ELCR) of 1×10^{-5} and a hazard index (HI) of 1. Consequently, the ADEC values for direct contact and outdoor inhalation listed in Tables B1/B2 and for groundwater ingestion in Table C were divided by 10 prior to selection of the lowest applicable value.

and tap water Regional Screening Levels (RSL) listed in the *Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites* (EPA 2009a), were used.[2]

Although most of the PSLs were derived by using health-conservative, exposure-based assumptions, their use was not intended to infer the existence of unacceptable risk. Most COIs identified did not exceed PCLs or health-based risk levels. Rather, the risk assessment conducted as part of the RI provides site-specific estimates of risk intended for management decision-making.

To evaluate the nature and extent of contamination, analytical results were compared to PSLs to identify residual contamination remaining in soil, groundwater, and soil gas at the FCS after the investigation and removal of contaminated soil and debris. Fieldwork associated with the RI was conducted in 2007 through 2010 and focused on the following tasks:

- **PCB Investigation/Removal Activities.** PCB-contaminated soil in the PCB EZ and other localized areas of contamination across the FCS was excavated and disposed in accordance with applicable federal and state regulations. Over 3,300 cy of PCB-contaminated soil were excavated, characterized, and properly disposed of during these investigations.
- **Contaminated Soil Investigations.** Previously identified contaminated soil associated with releases of petroleum, pesticides, and other chemicals was investigated, characterized, and delineated. Over 120 cy of petroleum- and pesticide-contaminated soil were excavated, characterized, and properly disposed of during these investigations.
- **Drum and Debris Investigation.** Buried drums, debris, and munitions-related items from areas identified through geophysical surveys and disposal of any contaminated soil collocated with the buried debris was investigated, removed, and disposed. The drum and debris investigation consisted of 13 large excavations and several smaller excavations covering more than 8 acres of the FCS. Excavations reached a total depth of up to 18 feet bgs. Large volumes of metal debris and 1,061 mostly crushed and empty drums were found in the excavations. Approximately 1,500 cy of contaminated soil were excavated, characterized, and properly disposed of during the investigations. Approximately 3,000 non-hazardous munitions-related items were excavated and properly disposed of or recycled; of these, only two practice 3.5-inch rocket motors contained residual quantities of propellant. The 3.5-inch rocket motors were disposed of at the FWA Range Complex by military EOD specialists. Scrap metal unearthed during these investigations was taken to the FWA solid waste landfill or recycled.

[2] The residential RSLs for non-carcinogenic chemicals are based on a HI of 1. Therefore, to account for possible cumulative risk associated with multiple chemical exposures, the listed RSLs for non-carcinogens were divided by 10.

- **Debris Removal beneath Building 49.** In 2009, debris beneath Building 49 was removed. In preparation, an engineering design was developed by a licensed structural engineer for building support, excavation, and backfill efforts. Precautions were taken to protect the structure and local utilities, including supporting the western garage foundation with seven permanent helical pier supports and three temporary I-beams, and constructing the entrance ramp to avoid the water line near the south side of the building. Drums were encountered between 7 and 11 feet bgs and extended 15 feet beneath the garage foundation. Materials removed from the excavation included 42 crushed and empty drums, three drums containing water with a sheen, and 3 cy of grease-affected soil.

- **Excavation Confirmation Sampling.** Excavation sidewalls and floors were sampled following removal of buried drums, debris, munitions-related items and PCB-, petroleum-, VOC-, SVOC-, and pesticide-contaminated soils to confirm that contaminants had been removed to meet PCLs.

- **Soil Characterization.** Soil borings were installed across the FCS and sampled to evaluate site-wide surface and subsurface soil conditions. The borings were completed as groundwater monitoring wells and sampled to evaluate groundwater conditions and delineate contaminant plumes at the FCS. In total, 77 soil borings were drilled and sampled. An additional 87 surface soil samples were collected to complete characterization of the entire FCS area. Surface soil samples were also obtained from the earthen sound berm extending around the south and southeast portions of the FCS that was constructed with soil accumulated during site clearing and construction activities. Together with the soil characterization and excavation confirmation samples identified above, over 3,500 surface and subsurface soil samples were collected at the FCS during the RI.

- **Groundwater Characterization.** Thirteen monitoring wells were installed at the site before the RI. Seventy-two additional shallow monitoring wells and four deep monitoring wells were installed during the RI. All wells were sampled at least once, and five rounds of semi-annual groundwater sampling were conducted at wells located within or adjacent to identified source areas and/or contaminant plumes, and sentry wells located directly upgradient of the FWA drinking water supply wells.

- **Hydrogeological Investigation.** The groundwater flow direction at the FCS and estimated capture zones for the FWA water supply wells that are located in Building 3559, adjacent to the northeast corner of the FCS were modeled to assess the potential for contaminant migration from OU6.

- **Soil Gas Investigation.** A total of 110 sub-slab soil gas probes (one in each housing unit garage) and 53 vadose zone soil gas probes were installed in open areas of the FCS to characterize soil gas and evaluate the potential for contaminants to affect indoor and outdoor air. In addition, 67 passive soil gas samples were installed to locate a possible source area and delineate the extent of 1,2,3-TCP contamination in the eastern portion of OU6.

- **Geophysical Surveys.** Geophysical surveys were conducted in 2007 to guide the drum and debris investigations and in 2009 to document final excavation conditions following investigation and removal of buried materials.

- **Drainage Swale Sampling.** Sediment samples were collected from the main FCS drainage swale to identify any contamination that could pose a risk to terrestrial and downstream aquatic wildlife.
- **Soil Pile Sampling and Inspection.** The soil piles created during excavation of housing foundations and utility trenches were characterized to determine the types of debris, munitions-related items, and contamination present and to facilitate proper disposal. This characterization effort was followed by sampling the surface soil remaining after removal and disposal of soil piles to determine whether the soil beneath the piles had been impacted by potential contaminants in the piles. Over 17,500 cy of construction-generated soil was properly disposed of during these investigations.

Because the sampling was roughly evenly spaced with high spatial density across the FCS and soil was analyzed for all suspected contaminants, it is believed that the data gathered during the RI generally reflect the nature and extent of contamination at the FCS. The target analyte lists for the samples included a wide range of analytes tailored to the types of wastes and chemicals thought to be present at the FCS. In most cases, target analyte method detection limits (MDL) were less than the PSLs used to determine the nature and extent contamination at the FCS. For samples collected to delineate the extent of contamination, this means that the MDLs were low enough to conclude that a target analyte was not present at concentrations of concern or that the extent of contamination had been delineated.

Groundwater conditions at the FCS were characterized by 85 monitoring wells screened in the upper part of the aquifer and four monitoring wells screened in deeper portions of the aquifer. Groundwater elevation data indicate that groundwater flow is generally to the northwest, toward the Chena River and away from the Post drinking water supply wells (Figure A-8). A modified pump test was conducted in 2007 to update the FWA groundwater flow model and to better understand what effects pumping from the FWA water supply wells in Building 3559 (adjacent to the northeast corner of the FCS) might have on groundwater flow at the FCS. Two pumping rates (1,000 and 1,700 gallons per minute [gpm]) were modeled based on the approximated range of monthly production rates for 2005 and 2006. The average pumping rate (1,327 gpm) is about halfway between the two modeled capture zones, and the 1,700-gpm rate was exceeded only three times in almost 5 years of operations. A historically used local-scale model of groundwater flow for the FWA area was adapted and used to characterize both the physical properties of the aquifer in the vicinity of the FCS and the magnitude of the hydraulic stresses that would be imposed on the aquifer system by groundwater production. The finite element model was developed by using the MicroFEM package for groundwater flow modeling as described in Hemker and Nijsten (1996).

The hydraulic conductivity derived from analysis of the pumping test (1,400 feet/day) was used in the capture zone calculations. An analysis to evaluate the sensitivity of the simulated extent of the hydraulic capture zone to the assumed aquifer hydraulic conductivity was conducted in 2010. The results of the modeling analysis suggest that the extent of hydraulic capture generated by operating the Building 3559 water supply well at the upper-range production rate (1,700 gpm) extends into a very limited area on the eastern edge of the FCS. This modeled hydraulic capture zone represents the capture zone expected at maximum pumping rates (CH2M HILL 2010b). Concentrations of 1,2,3-TCP at three monitoring wells within the modeled 1,700 gpm capture zone have historically exceeded ADEC cleanup levels; however, groundwater samples collected at wells closer to the production well meet all applicable drinking water standards, as does the Post drinking water supply well (Figure A-9).

Post-Remedial Investigation, Time-Critical Removal Action and Monitoring 2010 – Present

Although the RI and risk assessment were completed in 2010, biannual groundwater sampling continues, and additional soil sampling and removal actions were conducted in 2010 and 2011. The RI identified three localized areas of subsurface soil with VOC and SVOC concentrations above the ADEC cumulative (multi-chemical) risk threshold of 1×10^{-5}. These locations included an area north of Building 11 and near MW62 (benzo(a)pyrene and dibenzo(a,h)anthracene), an area east of Building 48 (n-nitrosodimethylamine, benzo(a)pyrene, and dibenzo(a,h)anthracene), and an area south of Building 24 (1,2,3-TCP). This subsurface soil was originally left in place because, due to their locations, it seemed unlikely that the soil would be disturbed or that it would be exposed in the future; however, changes in the 2011 construction plan required that these areas be excavated. Consequently, site workers were at risk of being exposed and the Army decided to remove this soil in a second TCRA (USACE 2012). Following excavation of these areas, confirmation sample results indicated that no contaminants above cleanup levels remained in the walls or floors of these three excavations. Approximately 48 cy of contaminated soil from these excavations were properly disposed.

During the 2011 construction work, five additional areas of concern were discovered:

- **Building 8**: While excavating a drainage swale approximately 50 feet south of Building 8, the contractor reported a strong petroleum odor. Initial soil sampling indicated high concentrations of DRO exceeding ADEC cleanup levels, with contamination extending to groundwater at approximately 13 feet bgs). Excavation continued until clean soil was reached on the eastern, western, and southern sides of the excavation, however, excavation was stopped near the foundation of Building 8 to avoid structural damage and a clean northern edge was not found. High concentrations of DRO remain on the northern edge of the excavation in the soil at 6 feet bgs and extend to groundwater. DRO contamination also exists in the monitoring well downgradient of Building 8. A total of 1,430 cy of soil was removed and disposed of during this effort**.**
- **Building 27:** While grading the driveway of Building 27, a charcoal gas mask filter and a crushed, empty drum were uncovered. Additional investigation of this area revealed a large quantity of buried metal debris, including 12 pieces of non-hazardous MD and 10 pieces of RRD, and oxidized charcoal from discarded gas mask canisters. Soil samples from the excavation were analyzed for VOC, SVOC, RCRA metals, and explosives. Approximately 4,240 pounds of metal debris, three 90-gallon overpacks of expended charcoal filters, and 34 cy of potentially chromium-contaminated soil associated with the charcoal filters were removed and properly disposed.
- **Building 38**: While excavating a drainage swale to the north of Building 38, the contractor reported a strong petroleum odor. Characterization and investigation results indicated DRO, TCE, and benzene above ADEC Method Two cleanup levels. Soil was excavated until confirmation results indicated that no contaminants above the ADEC Method Two cleanup levels remained. A total of 65 cy of soil were removed and properly disposed.
- **Building 42:** During grading activities on the western side of the site, the contractor reported a strong chemical odor. Characterization soil samples contained carbon tetrachloride above EPA maximum contaminant level (MCL)-based soil screening levels (SSL) and DRO above ADEC Method Two cleanup levels. Approximately 330 cy of contaminated soil were excavated and properly disposed. All confirmation sample results indicated that no contamination remained above ADEC Method Two cleanup levels.

Groundwater monitoring of selected wells was conducted in the spring and fall of 2010, 2011, and 2012. Groundwater samples have been analyzed for COIs and natural attenuation parameters to track the progress of MNA and determine if contaminant plumes are changing in size, shape, or location. In addition to biannual sampling, three new deep monitoring wells were installed downgradient of the 1,2,3-TCP plume and upgradient of the Post drinking water supply wells in 2011 and 2012. These deep sentry wells were installed to determine if 1,2,3-TCP was present in the capture zone of the FWA drinking water supply wells and to allow continued monitoring in the future. No COIs were detected in the new deep sentry wells.

Summary of Site Characterization and Soil and Debris Removed

A variety of buried metal and debris, including empty drums, some drums with contents, and munitions-related items were found at the surface and in the subsurface at the FCS. The debris, along with associated contaminated soil, tended to be concentrated in former low-lying areas (for example, the former channel of Hoppe's Slough) and in pits that were filled and covered before the FCS was developed. These source areas appear to be related to historical uses of the area for salvage, housing, and offices. Materials and chemicals placed in these former disposal areas are assumed to be the primary sources of contaminated soil and groundwater at the FCS. The pre-construction investigations and surveys, the PSE, RI, and post-RI activities conducted between 2003 and 2011 have investigated all significant potential disposal and contaminant source areas at FCS. The overall goals of the RI were accomplished: sufficient data were collected from media of interest in the FCS to characterize the nature and extent of contamination, evaluate potential hazards from munitions-related items, and assess potential risks to human and ecological receptors. The post-RI removal action successfully removed subsurface contaminated soil that could have potentially posed a risk to site workers (USACE 2012). The investigation efforts of 2007, 2008, 2009, 2010, and 2011 covered over 8 acres. Investigation-derived waste (IDW) and waste removed from the site included:

- 3,368 cy of PCB-contaminated soil
- 66 cy of pesticide-contaminated soil
- 3,354 cy of petroleum/solvent-contaminated soil
- 2,943 items classified as munitions-related debris
- 1,061 drums, all but 8 of which were empty and crushed.

The following paragraphs summarize remaining contamination at the completion of the RI.

Soil: Debris, drums, munitions-related items, and contaminated soil encountered during investigation activities and removal actions were removed to the greatest extent practicable and properly disposed of to prevent future groundwater contamination and to protect the health of future residents, site visitors and site workers. Soil samples were collected from the sidewalls and floors of each excavation to ensure that potentially contaminated soil had been removed. Soil contaminated with POL and residual concentrations of 1,2,3-TCP, VOCs, SVOCs, pesticides, herbicides, and explosive compounds remained in the subsurface between 5 and 15 feet bgs. The distribution of contaminants in subsurface soil at the time the RI was completed is presented in Figure A-10, Figure A-11, and Figure A-12. With the exception of DRO-contaminated soil in the north-central portion of the site, remaining soil contaminants are present at concentrations that do not exceed human health-based cleanup levels.

Groundwater: Groundwater at the FCS is contaminated with POL and VOCs. Presumed source areas for this groundwater contamination have been removed to the greatest extent practicable. This material was removed during pre-RI construction activities, as IDW during the RI, and during two time-critical removal actions (TCRA) (one pre-RI and one post-RI). Groundwater monitoring at this site began in 2005, continued through the RI, and continues as a biannual MNA sampling program. Historical or current exceedances define five groundwater plumes: the TCE plume, the TCP plume, the main DRO plume, the MW62 DRO plume, and the MW77 DRO plume.

Descriptions of these plumes are as follows:

- **TCE plume.** Natural attenuation and presumed source removal during the RI appears to have already remediated this plume. TCE concentrations in groundwater were below the MCL in all wells in 2011 and 2012. This is consistent with geometric regression analysis, which indicated that PCLs would be met for the final well (MW61) in 2012. Historical data indicate that TCE was commingled with POL in the three DRO plumes.
- **TCP plume.** This plume has been shrinking since monitoring began in 2007, with geometric regression analysis predicting cleanup in 2019. Natural attenuation prevents downgradient migration of 1,2,3-TCP at detectable levels, as demonstrated by undetectable 1,2,3-TCP concentrations measured at the sentry wells between the plume

and the FWA water supply well. Historical data indicate that 1,2,3-TCP was commingled with DRO in the Main DRO plume.

- **Main DRO plume.** The 2011 POL source removal near Building 8 may result in lower groundwater concentrations of DRO in the next several years. Mann-Kendall analysis indicates that this plume is stable. Historical data indicate that DRO in this plume was commingled with TCE and 1,2,3-TCP.
- **MW62 and MW77 DRO plumes.** These plumes are stable, with natural attenuation (likely biodegradation) along the flow path preventing downgradient advection of DRO. These plumes are likely derived from nearby contaminated smear zones and thus will persist until DRO in those zones is depleted through natural attenuation processes. Historical data indicate that DRO in these plumes was commingled with TCE.

Based on the information presented in the 2012 *Former Communications Site Groundwater Summary* (USACE 2012), MNA is a viable remedial alternative at the FCS for remaining groundwater contaminants. Figures A-13 through A-17 show the distribution of groundwater contaminants, and illustrate how natural attenuation and source removal have resulted in reduced contaminant concentrations. Figure A-18 shows the source removal areas from 2007 through 2011.

Debris: Minor amounts of metal debris remain beneath several buildings at the FCS. However, the presence of such materials is not a direct indication that chemical contamination is present; in most locations, only limited volumes of contaminated soil were associated with subsurface debris. In addition, sub-slab soil gas sampling conducted at each of the residences has not provided any evidence of significant soil contamination beneath any building, including those buildings where debris may be present beneath the foundations. The RI concluded that the distribution of chlorinated VOCs in soil gas appeared to be random and not necessarily located in areas where VOC contamination was confirmed in subsurface soil. Figure A-19 shows the distribution of VOCs in soil gas. Figure A-20 and Figure A-21 show the distribution of subsurface metallic anomalies before and after the debris investigation, respectively. Figure A-22 identifies structures under which buried debris is confirmed or likely to be present.

Of the 1,061 drums found in RI excavations, including the excavation and removal of drums beneath Building 49, the majority of the drums were empty and only eight drums (less than

1 percent) contained sufficient liquid contents to allow for sampling and analysis. The remainder of the drums with contents contained tar, asphalt, and other non-hazardous solid and semi-solid materials. Liquids in the eight drums were characterized primarily as fuel and water mixtures, with few VOCs. None of the drums contained chlorinated solvents, which tend to be more of concern in terms of volatility, migration, and toxicity. The findings from the PSE II drum investigation were very similar to those of the RI. Two drums were removed with contents: one drum contained liquid with petroleum hydrocarbons; the other contained sludge with petroleum hydrocarbons, pesticides, and metals.

Munitions-related items were unearthed and identified during pre-construction, construction, PSE, RI, and post-RI activities. MD was generally intermingled with other scrap material and tended to be concentrated in former low-lying areas (such as the former channel of Hoppe's Slough) and in pits that were filled and covered before the FCS was developed for housing. A complete listing of these items is provided in the *Explosives Safety Submission and After Action Report for Former Ladd Air Force Base Communications Site, Fort Wainwright, Alaska* (U.S. Army 2010) and the *2012 Former Communications Site Action Memorandum* (USACE 2012).

National Contingency Plan Expectations

The NCP expectations are intended to help streamline the remedy selection process when determining whether treatment or containment is appropriate (EPA 1991). The following terms are used:

- **Source Material.** "Source material" is defined as material that includes or contains hazardous substances, pollutants or contaminants that act as a reservoir for migration of contamination to groundwater, to surface water, to air, or acts as a source for direct exposure. Contaminated groundwater generally is not considered to be a source material although nonaqueous phase liquids (NAPL) may be viewed as source materials. (EPA 1991).
- **Principal Threat Wastes.** Source materials considered to be highly toxic or highly mobile that generally cannot be reliably contained or would present a significant risk to human health or the environment should exposure occur.

- **Low-Level Threat Wastes**. Source materials that generally can be reliably contained and that would present only a low risk in the event of a release and includes source materials present at concentrations near health-based levels.

The remaining subsurface soil contamination at the FCS is considered to be low-level threat waste because it is not highly mobile, is residual contamination remaining after excavation and disposal of potentially contaminated soil and debris, and with the exception of DRO, is present at concentrations below health-based cleanup levels.

2.2.3 Regulatory Framework and Enforcement History

In August 1990, FWA was placed on the CERCLA NPL because a number of sites associated with known or suspected releases of hazardous chemicals were identified on the Post. Remedial activities on FWA are to be conducted in accordance with the FWA FFA among the Army, EPA, and ADEC (U.S. Army 1991). The FFA identifies the authorities and responsibilities of the parties, and defines schedules and general requirements for investigation and/or remediation at areas suspected of being historical sources of hazardous waste. The FFA also states that the intent of the parties is that that activities covered by the FFA will satisfy RCRA corrective action requirements and meet or exceed all federal and state ARARs to extent required by CERCLA Section 121. Remedial actions implemented under this ROD will be protective of human health and the environment and will meet or exceed all federal and state ARARs to extent required by CERCLA Section 121.

The general purposes of the FFA, as defined in Section III of the agreement, are to ensure the following:

- Environmental impacts associated with past and present activities at FWA are thoroughly investigated and appropriate removal and/or remedial action(s) is taken, as necessary, to protect the public health, welfare, and the environment.
- A procedural framework and schedule are established for developing, implementing, and monitoring appropriate response actions at FWA in accordance with CERCLA, the NCP, national Superfund guidance and policy, RCRA, national RCRA guidance and policy, and applicable state law.
- Cooperation, exchange of information, and participation of the parties in such actions are facilitated.

The FFA (U.S. Army 1991) was amended in 2007 (U.S. Army 2007) to incorporate the FCS; this was accomplished by creating a new OU (OU6) for the site and providing remedial project managers with the authority to create additional OUs should new source areas be discovered. The FFA and the 2007 amendment to the FFA are included in the Administrative Record.

In 1992, the Army and the State of Alaska signed a two-party agreement specifically addressing petroleum contamination. This agreement defined the processes by which the Army agreed to investigate and clean up petroleum-contaminated areas. These areas are generally associated with underground storage tanks that have leaked or surface spills of petroleum products such as lubricating oils/grease, heating fuels, and motor fuels (included in the Administrative Record).

2.3 COMMUNITY PARTICIPATION

The Army has been actively engaged in dialogue and collaboration with the affected community and has strived to advocate and strengthen early and meaningful community participation during investigation and remedial activities at the site. These community participation activities during the remedy selection process meet the public participation requirements of CERCLA and the NCP.

In response to the CERCLA requirement that each NPL site have an established Community Involvement Plan (CIP), the Army established a CIP in cooperation with the EPA and ADEC. The current CIP (2003) revises the original Areawide Community Relations Plan (CRP) written in April 1993 and the revised CRP written in October 1997. The activities in the CIP were designed to inform interested citizens and local officials about the progress of remedial activities on FWA and to provide the public with opportunities to participate during the planning and implementation of remedial actions. The FCS is covered under the existing CIP. The Army will continue to support community educational efforts aimed at limiting access to restricted areas and to assist in educating the community regarding potential chemical and munitions-related safety hazards, and land use restrictions.

The Army has held annual meetings to provide updates to the public including the status of contaminated sites, potential risks to human health and the environment, and remedial actions proposed or implemented to address contamination. Additionally, the Army issues annual newsletters to provide the public with information regarding Post-wide cleanup activities, including the FCS.

The Proposed Plan and the Administrative Record for the FCS were made available to the public on 2 January 2013. The Administrative Record is available at the following locations:

- Noel Wien Library, 1214 Cowles Street, Fairbanks
- FWA Post Library (Building 3700)
- DPW CERCLA Library (Building 3023)
- Online at http://www.wainwright.army.mil/env/PDFs/DERA/Former%20Communications%20Site%20Administrative%20Records%20Index.pdf

The notice of the availability of these documents was published in the Fairbanks Daily News Miner on 30 December 2012, 6 January 2013, and 14 January 2013. Radio announcements were also aired on several commercial and public radio stations in Fairbanks on 13 through 15 January 2013.

The formal public review and comment period began on 14 January 2013. The comment period was open until 12 February 2013. A public meeting was held on 15 January 2013 to provide the public with an opportunity to offer comments and to discuss the Proposed Plan and preferred alternatives. At this meeting, representatives from the Army, EPA, and ADEC answered questions about problems at the site and the proposed remedial alternatives. The Army also used this meeting to solicit a wider cross-section of community input on the reasonably anticipated future land uses. Comments received from the public during the public comment period were considered in the remedy selection process. Responses to comments received during the public comment period are included in Section 4.0 (Responsiveness Summary) of this ROD. An official transcript of the public meeting is provided in Appendix C.

2.4 SCOPE AND ROLE OF OPERABLE UNITS AND RESPONSE ACTION

As with many CERCLA sites at large installations with multiple source areas, the environmental response actions at FWA are complex. The potential source areas were grouped into OUs based on existing information, the similarity of potential hazardous substance contamination, and the level of effort required to complete an RI. OU6 will be the sixth OU to have completed the RI/FS process and begin remedial activities. OU1, OU2, OU3, OU4, and OU5 have been addressed in previous RODs; only OU6 is addressed in this ROD.

OU6 contains source area units resulting from past fuel leaks, spills, waste storage and disposal, other facility activities, and groundwater underneath these source area units. A TCRA of the most heavily contaminated PCB soil was completed in September 2005 (U.S. Army 2007). The RI fieldwork was completed and reported with the risk assessment in the *Remedial Investigation, FWA Former Communications Site, Fort Wainwright, Alaska* (CH2M HILL 2010a). The RI and risk assessments defined and quantified potential risks posed by uncontrolled exposure to remaining soil and groundwater contamination. The FS was completed and reported in the *Feasibility Study, Former Communications Site, Fort Wainwright, Alaska* (CH2M HILL 2011b). A post-RI TCRA was completed in 2011 (USACE 2012). This action consisted of the targeted removal of subsurface soil contamination that could have posed a risk to future residents and workers. All of these removal actions and investigative activities were consistent with previous RCRA corrective actions and CERCLA actions taken at other FWA OUs.

This ROD presents the selected remedial actions for contaminated soil and groundwater for OU6 source areas in accordance with CERCLA as amended by SARA and, to the extent practicable, the NCP. The decision for OU6 is based on information and documents that are in the Administrative Record. The response action selected in this ROD under the authority of CERCLA will satisfy substantive ARARs under state law to protect the public health and welfare or the environment from actual or threatened release of hazardous substances into the environment.

The actions identified in this ROD are intended to address risks to human health and the environment associated with contamination resulting from past activities at FWA. The primary source materials at the FCS (i.e., buried hazardous wastes and contaminated soil and debris) have already been removed to the greatest extent practicable. These removal actions are expected to reduce concentrations of COCs in groundwater by removing contamination sources. The residual subsurface soil contamination constitutes low-level threat waste; however, contamination it is present at concentrations that do not allow for UU/UE.

Based on the 2010 RI, a response action is required to address site risks associated with both soil and groundwater directly below the FCS. The primary COCs in soil identified in the RI included metals, chlorinated VOCs, SVOCs, and petroleum hydrocarbons. Ingestion and exposure to these contaminants in soil provide the basis for taking an action to address current and future risk because the results of the human health risk assessment (HHRA) indicate that the EPA hazard index (HI) is greater than 1 for systemic toxicants. Groundwater COCs identified in the RI include 1,2,3-TCP, TCE, DRO, and RRO. Ingestion and exposure to these contaminants in groundwater provide the basis for taking an action to address potential current and future risk to human health because results of the HHRA indicate that EPA's cumulative carcinogenic risk range of 1×10^{-6} to 1×10^{-4} is exceeded for 1,2,3-TCP and several SVOCs and historical concentrations of TCE exceeded the MCL specified for drinking water.

The selected remedy does not include treatment as a principal element but will address risks posed by exposure to low-level threat wastes in soil and exposure to contaminated groundwater. Under the selected remedy the Army will ensure the following:

- Institutional controls will restrict access to subsurface soil at a depth greater than 6 inches bgs. The specific institutional control requirements restricting access to soil will be detailed in and implemented through the Remedial Design/Remedial Action Work Plan.
- A MNA program and institutional controls prohibiting the use of onsite groundwater will be implemented to address contaminants remaining above the PCLs. The specific institutional control requirements restricting access to groundwater will be detailed in and implemented through the Remedial Design/Remedial Action Work Plan.

2.5 SITE CHARACTERISTICS

2.5.1 Overview

FWA covers approximately 1,577,095.91 acres in central Alaska, located on the eastern and southern sides of the City of Fairbanks. The FCS is located in the central-western portion of FWA. The Taku Gardens family housing development covers 54 acres of the FCS and includes 110 new housing units in 55 buildings. The buildings are intended for use as family housing for FWA military personnel and their families, but are currently unoccupied. The FCS is enclosed on all sides by an 8-foot high chain-link fence with three-strand barbed wire and access is controlled by the DPW. Construction of the 110 housing units in 55 buildings is complete. The 20 planned housing units in the southwestern portion of the FCS (Buildings 50 through 59) were not completed and their partially installed foundations were removed in 2009. There are no current plans to develop this area.

FWA is in the continental climate zone of interior Alaska. This zone is generally characterized by extreme summer and winter temperatures and light precipitation. Average monthly mean temperatures range from a minimum of -18.7 °F in January to 72.3 °F in July. The area is classified as semiarid, with an average annual total precipitation of approximately 10.5 inches, including an annual average snowfall of 67 inches (CH2M HILL 2010b). Surface winds are generally light. Prevailing winds are from the north during most of the year, except for June and July when winds are typically from the southwest (Ecology and Environment, Inc. 1993). Winds are strongest in May, at an average of 7.7 mph. Because of generally low wind speeds, moderate to heavy ice fog is prevalent in the area during cold weather (Harding Lawson Associates Group, Inc. [HLA] 1996.)

FWA and the adjacent Fairbanks area are part of the Highlands Area of Interior Alaska and Western Alaska Physiographic Province. The main Post, which includes the FCS, is within the Tanana-Kuskokwim Lowlands topographic area, characterized by relatively flat terrain, with a typical elevation of about 450 feet above main sea level. Most of the topographic relief at the FCS is the result of man-made features and includes sound berms and drainage swales. The northern portion of the main Post falls more in the Yukon-Tanana Uplands and has higher terrain, characterized by large rolling hills with elevations rising to above 1,000 feet above mean sea level (Oasis 2007).

Upland vegetation provides terrestrial habitat for large numbers of birds, mammals, and insects. Rivers, channels, and ponds provide aquatic habitat for various fish species, waterfowl, and benthic organisms. Of the 36 species listed by Kerns (1993) as potentially occurring at FWA, 17 are indicated as common inhabitants. Moose are probably the most abundant and widespread large mammal in the area. While black bear and grizzly bears have been sighted at the Post, their presence in the cantonment area is considered rare. The red fox is the most common of the canids. Mammals commonly found at FWA include shrews, pine martens, woodchuck, red squirrel, beaver, deer mouse, lemming, snowshoe hare, and several species of vole (Kerns 1993).

More than 150 bird species are known to migrate through or reside in the Fairbanks area, including waterfowl, raptors, game birds, and perching birds (Kerns 1993; Spindler 1976). Breeding waterfowl species include mallard, pintail, green-wing teal, American widgeon, northern shoveler, rednecked and horned grebes, lesser scaup, and bufflehead. The only resident hawk is the northern goshawk, but several others nest and breed in the area including sharp-shinned, red tailed, and marsh hawk. Bald eagle nesting sites are known to occur along the Tanana River (HLA 1996). Spruce grouse, ruffed grouse, and willow and rock ptarmigan are year-round residents that winter on willow, birch, and spruce buds and berries left over from the past summer. Other common resident birds include the rock dove; great horned, boreal, and hawk owls; hairy and downy woodpeckers; the gray jay; black-capped and boreal chickadees; the northern shrike; and the pine grosbeak (HLA 1996).

Reptiles are absent from interior Alaska, and amphibians are rare because few have adapted to the long, harsh winters and dry summers. Only the wood frog is known to occur throughout most of the state, including the Fairbanks area (Hodge 1976). Terrestrial invertebrates present in the area include mosquitoes, flies, ants, bees, wasps, beetles, spiders, mites, and nematodes. Much of the diversity of birds in summer depends on the abundance of insects, spiders, and mites for food. The saw fly, which feeds on willows, is one of the most numerous species of insects in Alaska (Selkregg 1976).

The Chena River, approximately 1,500 feet downgradient of the FCS, is an important aquatic habitat and sport fishery. The Chena River supports numerous fish species, including arctic grayling, burbot, humpback whitefish, sheefish, lake chub, least cisco, longnose sucker, northern pike, round whitefish, slimy sculpin, and arctic lamprey. Anadromous species that migrate upstream from the ocean to spawn in the waters of the Chena River include chum salmon, silver salmon, and the largest of all salmons, the king salmon (HLA 1996).

To identify any potential impact to federal, state, or otherwise listed sensitive species, the FWA's Integrated Natural Resources Management Plan (INRMP) (U.S. Army 2006) was examined and the Alaska Natural Heritage Program (AKNHP) was contacted to determine whether any such species may be found or might have been documented on FWA. According to both the INRMP and AKNHP, there are no known federally-listed, threatened, or endangered animal or plant species on FWA. Six bird species recognized as state species of concern have been recorded within a 5-kilometer radius of the site by the AKNHP or have been confirmed on FWA (U.S. Army 2006; Lenz 2009), but suitable habitats for these species are not present around recently constructed or fully established housing at the FCS. Six sensitive plant species have been recorded by AKNHP as currently occurring in the FWA area. None of these species are likely to occur at the FCS because of the lack of suitable habitat and the highly disturbed nature of the site (Lenz 2009).

The FCS was cleared in 2005 in preparation for the construction of the Taku Gardens housing development. Since then, much of the area has been subject to traffic consisting of heavy vehicles and earth-moving equipment, resulting in little vegetation regrowth. The areas disturbed less recently, however, such as those along fence lines and in the large open area north of the main housing area and west of the main north-south road, have experienced some regrowth of herbaceous plants. These areas may provide some limited habitat for rodents, insects, and birds. Larger mammals, such as moose, are excluded from the FCS by the 8-foot perimeter fence, though smaller predators such as foxes may find (or create) gaps large enough to gain access. The FCS has been filled, landscaped, and re-vegetated. When the fence is removed, the area will reintegrate with the existing FWA ecosystem.

2.5.2 Conceptual Site Model

Through the progression of the RI and improved characterization of the FCS, the preliminary CSM was updated and a modified CSM showing investigative activity (Figure A-23) was developed by CH2M HILL (2010b). The modified CSM is summarized as follows:

- **Sources**. Potential primary contaminant sources at the FCS include leaks from heating fuel tanks or pipelines used at headquarters and barracks, disposal of scrap metal and munitions-related items at the former salvage yard, burial of drums of waste oil and chemicals, discharge of transformer oil, and chemicals spilled during possible fire fighter-training activities. The majority of such sources, as well as contaminated soil that may have acted as a secondary source, were found in discrete, localized areas such as PCBs in Subarea E and former transformer locations, and drums and debris used to fill in low-lying areas near the former salvage yard in Subarea A. These sources were excavated and eliminated during the course of Taku Gardens subdivision construction, completion of the RI, and pre- and post-RI removal actions.
- **Release and Transport Mechanisms**. Release and transport mechanisms for site contaminants include surface runoff and overland flow (from spring thawing or flooding), physical soil movement (excavation and accidental and deliberate movement), fugitive dust emission, volatilization, leaching to groundwater, construction dewatering activities, and breakdown resulting from biodegradation and mixture with other chemicals.
- **Transport and Exposure Media.** Surface soil, subsurface soil, groundwater, and soil gas were identified as possible transport and exposure media for contaminants.
- **Potentially Complete Human Exposure Pathways and Receptors.** On the basis of the current understanding of land and water beneficial use conditions at or near the FCS, the most reasonably anticipated exposure scenarios considered for characterizing human health risks include future maintenance workers, future excavation workers, future recreational/site visitors, and future residents. However, a hypothetical future unrestricted exposure scenario was also considered to evaluate the No Action scenario.
- **Potentially Complete Ecological Exposure Pathways and Receptors.** Plausible ecological exposure pathways considering the chemicals of potential ecological concern (COPEC), available habitat, and available food sources at the FCS consist of potential exposures of aquatic resources and piscivorous (fish-eating) wildlife to chemicals in groundwater that could reach the Chena River, potential exposure of terrestrial wildlife (mammals and birds) to site-related chemicals in sediment from drainage swales adjacent to the FCS, and hypothetical exposure of benthic macroinvertebrates to drainage swale sediments that could migrate to the Chena River.

Figure A-24 shows the CSM potential human and ecological receptors based on the results of the risk assessment.

2.5.3 Surface and Subsurface Features

The FCS is characterized by relatively flat terrain typical of the Tanana-Kuskokwim Lowlands topographic area. Topographic relief at the FCS is primarily related to the former Hoppe's Slough and several man-made features, including sound berms and drainage swales. Hoppe's Slough used to flow through what is now the middle of the FCS. The now-filled meander entered the northern portion of the FCS and continued south approximately 1,500 feet, where it curved around along the western edge of the FCS and exited again at the north.

FWA lies in the boreal forest ecosystem typical of the broad geographic lowland that covers interior Alaska. Vegetation distribution in the boreal forest is determined by several factors including slope, aspect, history of fire and other disturbances, and the hydrologic regime (specifically, the presence or absence of permafrost). Upland vegetation of the boreal forest, such as that found in the vicinity of the FCS, is characterized by spruce-hardwood stands that occur on warm, dry, south-facing hillsides and adjacent to rivers where permafrost is absent. The spruce-hardwood forest may be characterized by other dominant tree species, including quaking aspen and paper birch, under various stages of forest succession as a result of fires or other disturbances. There are no wetlands on or adjacent to the FCS.

FWA is underlain by soil and unconsolidated sediment of Chena Formation fluvial deposits consisting of silt, sand, and gravel, ranging in thickness from 10 feet to more than 400 feet above bedrock. A 5-foot-thick surficial layer of fine-grained soil overlies the deeper alluvial deposits. Alluvial floodplain deposits underlay the surface soils and consist of varying proportions of sand and gravel, which are commonly layered. Soil borings drilled during the RI and previous investigations indicate that soil at the FCS consists generally of sandy silt nearest the surface changing to sand and sand with silt and gravel at around 8 to 10 feet bgs. Permafrost and corresponding low subsurface temperatures have only been reported in borings advanced in the southeastern portion of the FCS.

FWA lies entirely within the Tanana River drainage basin and also lies within the floodplain of the Chena River, a tributary of the Tanana River. The Chena River lies 1,500 feet north of the FCS. It meanders westward through the main Post, forming several oxbows, flowing into the Tanana River approximately 8 miles west-southwest of FWA (ATSDR 2003). Many creeks and smaller rivers on FWA eventually flow into the Chena or Tanana Rivers, but none of the creeks or small rivers are within the FCS. There are engineered drainage swales installed along the west side of the new Taku Gardens housing, and also along the northwest section. For a brief time each year during periods of heavy spring runoff and summer storms, runoff from the FCS area may join overland flow that eventually discharges to the Chena River (CH2M HILL 2008).

The main aquifer in the FWA area is the Tanana Basin alluvial aquifer. This aquifer ranges to at least 300 feet thick under the main cantonment area of the Post. Groundwater movement between the Tanana and Chena Rivers generally follows a northwest regional direction similar to the flow direction of the rivers. Seasonal changes in groundwater flow directions of up to 180 degrees are not uncommon adjacent to the rivers because of the effects of changing seasonal river stages in the Tanana and the Chena Rivers. Typically, groundwater levels rise during spring breakup and late-summer runoff and drop during fall and winter, when rainfall decreases and precipitation becomes snow. The Chena Formation has a relatively high horizontal hydraulic conductivity in this area, estimated to be as much as 600 feet per day, and the vertical hydraulic conductivity has been estimated to be approximately 30 feet per day (U.S. Geological Survey [USGS] 1996). The Chena Formation deposits are extensive and, thus, provide a large capacity for groundwater storage. Groundwater in the Tanana–Chena floodplain is considered to be generally unconfined in permafrost-free areas.

2.5.4 Known or Suspected Sources of Contamination

A variety of buried metal and debris, including empty drums, some drums with contents, and munitions-related items was found at the surface and in the subsurface at FCS. The debris and associated contaminated soil tended to be concentrated in former low-lying areas such as the former channel of Hoppe’s Slough and in pits that were filled and covered before the FCS was developed. These source areas appeared to be related to historical uses of the area for salvage, housing, and offices. Materials and chemicals placed in these former disposal areas and chemicals released at the surface such as PCBs from transformers, as well as leaking pipelines, are assumed to be the primary sources of contaminated soil and groundwater at the FCS. The possible firefighter-training area in the northern portion of the salvage yard near Buildings 21 and 23 did not appear to be a source of contaminants because only limited evidence of burning was found in nearby excavations, and soil and groundwater beneath the area were not affected by petroleum, solvents, or other chemicals typically associated with firefighter-training areas.

The soil and waste samples analyzed during the RI source characterization evaluation were obtained from soil piles left at the site and adjacent areas during housing construction, from waste and soil samples obtained during the drum and debris investigations and PCB removal excavations, and samples of soil from other areas known to have been graded or reconfigured. The source characterization group included 57 samples taken from soil piles, over 100 soil samples taken from PCB sites and drum and debris investigations, 66 samples from material identified as waste, and over 900 surface soil samples. While most of the surface soil samples were analyzed only for PCBs, the other sample types were analyzed for a broad list of target analytes that included VOCs, SVOCs, PAHs, pesticides, explosives, and metals.

All significant potential disposal and contaminant source areas at FCS have been investigated. It is important to understand that, unlike many CERCLA-driven RIs, all accessible buried debris, munitions-related items, and contaminated soil encountered in these areas were removed and appropriately disposed of during the course of the RI, the time-critical PCB removal action, and the post-RI TCRA to the greatest extent practicable (Figure A-18). Minor amounts of metal debris remain beneath several buildings and utilities at the FCS. However, the presence of such materials is not a direct indication that chemical contamination is present; in most locations, only limited volumes of contaminated soil were associated with subsurface debris. Of the more than 1,000 drums encountered during investigation, construction, and removal activities, only eight drums contained measurable liquid. In addition, sub-slab soil gas sampling conducted at each residence has not detected evidence of significant soil contamination beneath any building, including those where debris may be present.

The following sections summarize contaminant sources by media identified by the RI (CH2M HILL 2010a).

Surface Soil (0 to 2 feet below ground surface)

Very few PSL exceedances were identified in surface soil at FCS. The magnitude of these few exceedances for the surface soil COIs were low, less than 10 times their respective PSLs and, therefore, also below applicable cleanup levels. Samples with exceedances were present primarily along the sidewalls of excavations, indicating that while there may have been surface sources present in the area in the past, only residual, low levels of contamination remain. No previously unidentified sources of surface contamination were identified.

Subsurface Soil

Eleven COIs were identified in subsurface soil at the FCS. The highest concentrations were located in areas where contaminated soil and debris were removed during pre-RI or RI field activities, indicating that only residual contamination beneath these areas remains. No previously unidentified subsurface sources of contamination were identified during the RI.

Groundwater

The nature and extent of contaminants in groundwater are consistent with the locations and types of contaminant sources found and removed at FCS, as summarized below:

- **Petroleum.** The primary area of petroleum-affected groundwater extends along the direction of groundwater flow from an area south of Building 8, where petroleum-contaminated soils were removed, and continues northward beneath the former School-Aged Services building to Neely Road. Petroleum contamination has historically been commingled with CERCLA hazardous substances. The petroleum-affected zones are not located within the capture zone for the FWA water supply wells.

- **Chlorinated VOCs.** A zone of TCE- and PCE-affected groundwater is present just north of Building 48. Other chlorinated organic compounds, which may be degradation products of TCE and PCE, have also been detected in the plume. The plume boundaries have been delineated and contaminants were commingled with the POL plumes to the north. The TCE plume is not located within the capture zone for the FWA water supply wells.
- **1,2,3-Trichloropropane.** 1,2,3-TCP was detected at concentrations above the PSL in several monitoring wells located within the modeled 1,700 gpm capture zone for the water supply wells. The extent of 1,2,3-TCP-affected groundwater has been delineated, the plume appears stable, and 1,2,3-TCP is not detected in sentry wells located between TCP-affected groundwater and the FWA water supply wells.

Analytical results for waste soil samples from locations near the apparent source areas for the groundwater plumes as determined from groundwater concentration gradients were evaluated to identify possible source/release relationships for the contaminant plumes. Aside from POL, there appeared to be little evidence of such relationships.

Extensive investigation of debris disposal areas and associated subsurface soil did not identify sources for the chlorinated VOC groundwater plumes. A number of potential sources of solvents, including metals salvage operations, took place in the area and buried drums were found in the former slough channel near Building 48. The relatively low concentrations of PCE and TCE do not suggest that extensive releases occurred, and neither chemical was detected above its PSL in a deep well located in the apparent source area. Therefore, ongoing releases from a separate dense nonaqueous phase liquid (DNAPL) layer of solvent within the aquifer are not suspected.

Soil Gas

There appears to be no correlation with exceedances of soil gas PSLs and identified contaminant source areas or residual contamination in soil or groundwater at FCS.

2.5.5 Potential Routes of Migration

Possible mechanisms of contaminant transport to potential receptors include the following:

- Volatilization of vapors from groundwater and subsurface soil to soil gas and indoor air
- Dust or vapors generated from wind or mechanical erosion

- Infiltration/percolation and leaching of contaminants to groundwater
- Migration of groundwater to the deeper FWA water supply wells
- Discharge of groundwater to offsite surface water and sediment
- Surface drainage and runoff during storm events or snowmelt
- Movement of contaminated soil associated with construction or remedial activities

Organic compounds detected in subsurface soil and groundwater at OU6 may volatilize and be transported to soil gas, indoor air, and outdoor air. Because of the significant dilution caused by the atmosphere, volatilization to outdoor air is expected to be an insignificant transport pathway. Results of sub-slab vapor monitoring and the risk assessment indicate that the vapor intrusion pathway does not result in unacceptable risk. When wind speed is sufficient to suspend small surface soil particles (dust), site contaminants sorbed to the dust particles could be transported offsite. Because remaining contamination at OU6 is present in the subsurface, transport of airborne particles is not expected to represent a significant transport pathway.

Surface water runoff at FWA is relatively insignificant, because the majority of precipitation infiltrates directly into the porous soils, then returns to the atmosphere through evapotranspiration. When surface water runoff occurs, surface water migration occurs as intermittent overland flow during rainfall or snowmelt. Surface water runoff from OU6 eventually drains toward the Chena River. The Chena River flows through the northern portion of the cantonment area, then through Fairbanks before it joins the Tanana River approximately 8 miles west-southwest of Fairbanks. Because remaining contamination at OU6 is present below the ground surface, contaminant transport via surface water runoff is not expected to represent a significant transport pathway.

Petroleum hydrocarbons, VOCs, and SVOC, and metals were the primary COCs identified in OU6 subsurface soil. DRO and VOCs were the primary COCs in identified in OU6 groundwater. No evidence of DNAPL has been found in saturated or unsaturated soil at the FCS. High concentrations of DRO remain in two areas in the north-central portion of the site, although DRO is not present as a recoverable NAPL.

In general, POL and solvents were likely released to the soil as free-phase liquids, most of which migrated down through the soil by gravity. No significant source of VOC or SVOC contamination has been identified and any potential areas that might have existed appear to have been removed during the RI and the removal actions. Some of the POL liquid remains held in the soil pores by capillary forces and becomes immiscible. This condition is referred to as residual saturation. For sand and gravel at this site, concentrations of POL at residual saturation is expected to be in the range of several thousand to tens of thousands mg/kg. Free product at or below residual saturation will not migrate downward through the soil by gravity, but may be transported down by percolating water, both as immiscible globules and in solution. Sources of percolating water at OU6 include infiltrating snowmelt and rainfall. The extent of contaminant infiltration into subsurface soil depends on the ability of specific contaminants to adsorb to or react with subsurface soil particles. The majority of the groundwater contamination at OU6 is believed to be the result of numerous small surface spills and possible subsurface releases such as pipeline breaks and/or leaking tanks or drums. POL present at concentrations representative of residual saturation are potential sources of contaminants dissolving into groundwater at OU6.

The aquifer beneath the OU6 area consists of glacially derived sands and gravels (Chena alluvium) that have been transported and reworked by the Tanana and Chena Rivers. The alluvium has been described as a heterogeneous mixture of coarser and finer soil lenses of relatively small size, a description that is consistent with logs of borings installed in the area. The aquifer ranges from a few feet thick at the base of Birch Hill to at least 300 feet thick under the cantonment area, and may reach thicknesses of up to 700 feet in the Tanana River valley. The water table at the FCS is generally encountered within 10 to 15 feet bgs. Groundwater flow direction is approximately southeast to northwest with a hydraulic gradient of 2.2×10^{-5} feet/foot (North Wind, Inc. 2007). The site-specific horizontal conductivity is estimated to be 1,400 feet per day, based upon pump tests conducted in 2009 (CH2M HILL 2010b). The aquifer is considered unconfined in permafrost-free areas. Permafrost has been found only in soil borings advanced in the southeastern portions of the FCS, and therefore it does not affect groundwater flow at the FCS.

Dissolved contaminants migrate in groundwater by advection and dispersion and there has been concern that operation of the nearby Post drinking water supply wells could potentially induce the migration of groundwater contamination toward, and eventually into, the production wells, compromising Post drinking water quality. Dissolved contaminants (DRO, TCP, PCE, TCE, and RRO) have been historically detected in groundwater at concentrations greater than the Federal MCL and/or Alaska Water Quality Standards at the FCS. Contaminant concentrations do not exceed these federal and state standards in sentry wells positioned between groundwater plumes beneath the FCS and the Post drinking water supply wells. Groundwater monitoring data collected between 2005 and 2012 indicate that contaminant plume boundaries are stable or shrinking and contaminant concentrations are largely decreasing.

Shallow groundwater flows into or out of the Chena riverbed and riverbanks depending on the elevation of the water in the river relative to the groundwater table. Seasonally, the discharge of the river fluctuates from a high stage during late May or early June snowmelt to a low in late April or early May, which is late winter and pre-snowmelt. The river stage may also rise in response to summer rainfall. The groundwater table generally rises and falls in response to these river fluctuations, but is less affected with increasing distance from the river.

High-flow events in the Chena River produce transient changes in the groundwater flow regime, temporarily reversing the groundwater flow direction and gradient. The duration of these transient events is typically several days. These transient events generally occur during two periods: the spring snowmelt and late-summer precipitation, which results in peak flows in the Chena River. Considering that the distance between the northern perimeter monitoring wells and the Chena River is greater than 1,500 feet, significant attenuation of groundwater contamination is expected to occur before groundwater reaches actual aquatic or benthic receptors in the Chena River. This attenuation would result from biodegradation, dispersion, advection, dilution, dispersion, adsorption, volatilization, and chemical or biological stabilization or destruction of contaminants. Groundwater plume boundaries do not extend to the Chena River and no evidence of flow reversals has been documented at the FCS, therefore, discharge of contaminated groundwater to the Chena River is not expected to be a significant transport mechanism at this site.

Drainage swales at the Taku Gardens housing development direct surface water flow from the housing development into a series of drainage swales and retention ponds before eventually discharging into the Chena River. There was concern that these swales might transport contaminated sediment from the FCS into the Chena River, and subsequently to aquatic and benthic resources. Sediment samples collected during the RI confirmed that none of the 29 identified COPECs in drainage swale sediments were present at concentrations expected to pose a meaningful risk to aquatic and benthic organisms in the Chena River. Remaining COCs at the FCS are present in the subsurface; therefore it is unlikely they will migrate to the drainage swales or to the Chena River.

At OU6, chemicals in soil and groundwater are potentially available to human and ecological receptors. Ecoscoping and ecological screening indicated that the risk to onsite and offsite ecological receptors was low. Transport pathways considered for an evaluation of human health risks included ingestion, dermal contact, and inhalation of particles for soil; and ingestion, dermal contact and inhalation of VOCs (through air) for groundwater contaminants. The potential future receptors assessed included maintenance workers, excavation workers, residents, and recreational/site visitors.

2.5.6 Nature and Extent of Residual Contamination

COCs identified for soil and groundwater at the FCS are presented in Table 1 and Table 2. The PCLs for soil are based primarily on the ADEC Method Two direct contact and inhalation risk-based cleanup levels, with the exception of aluminum and manganese. The aluminum and manganese PCLs are based on the EPA RSL. The PCLs for groundwater are based on MCLs and the ADEC Table C cleanup levels.

Residual soil contamination at the FCS is limited to localized subsurface soil “hot spots” (isolated sample locations where the concentration of a COC exceeds the PCL) near areas where contaminated soil and debris were removed during pre-RI and RI activities and represent the residual low-level contamination remaining in the floors and walls of excavations at the completion of the RI (CH2M HILL 2010a). All contaminant concentrations in these "hot spots" are below human health-based cleanup levels, with the exception of DRO, which remains in the vicinity of Buildings 7, 8, and 9 at depths between 6 and 16 feet bgs.

The location of contaminated groundwater is consistent with the locations and types of contaminant sources found and removed at the FCS. Elevated concentrations of petroleum hydrocarbons, chlorinated solvents and their breakdown products, 1,2,3-TCP, and several other analytes were detected in groundwater at the FCS. The lateral and vertical extents of the affected groundwater have been determined for all COCs, groundwater impacts are limited to localized areas of the FCS, and groundwater contamination does not extend into the modeled 1,000-gpm capture zone for the FWA water supply wells.

The approach used to evaluate the nature and extent of contamination included comparing analytical data for samples collected across the FCS to the PSLs to determine which chemicals exceeded those levels in surface soil, subsurface soil, groundwater, and soil gas, and then evaluating the distributions of the identified COIs in FCS media. Since many of the COIs are related to particular types of chemicals or fuels, they were grouped together in the distribution analyses below. The following summary reflects the current distribution of residual contaminants after potentially hazardous debris and soil were removed during the investigative and removal actions.

Polychlorinated Biphenyls

The RI did not identify PCBs as a COI in any medium at the FCS. As documented in Section 2.2.2, all soils with PCB concentrations greater than the 1 mg/kg action level were excavated and properly disposed of during the course of the TCRA and RI activities.

Petroleum and Petroleum-Related Chemicals

Soil. Although petroleum-contaminated soil has been removed to the greatest extent practicable, several localized areas of petroleum contamination remain in subsurface soil. Subsurface DRO contamination is present in the vicinity of Buildings 7, 8, and 9. The highest concentrations occurred at depths of 12 to 16 feet bgs Figure A-10 shows the distribution of petroleum hydrocarbons in subsurface soil at the completion of the RI.

Groundwater. Three contiguous petroleum-affected groundwater plumes are located in the north-central portion of the FCS, where a substantial quantity of petroleum-contaminated soil has been removed. These groundwater plumes originate in the vicinity of Buildings 07, 08, and 09 (the main DRO plume and the MW77 plume) and Building 11 (the MW62 plume). These three petroleum plumes are stable and concentrations may start to decrease as a result of previous removal actions. DRO concentrations in these three plumes exceed the ADEC Table C cleanup level of 1.5 mg/L with recent exceedances ranging between 2 and 19 mg/L. In addition, RRO concentrations have exceeded ADEC Table C cleanup level of 1.1 mg/L in several monitoring wells located in this area (MW12, MW33, and MW62), with recent exceedances ranging between 1.3 and 5.0 mg/L. Historical TCE and 1,2,3-TCP concentrations exceeded PCLs within these plumes.

The concentration of benzene exceeded the PSL at MW69 in 2008. Although benzene was identified as a COI, it does not exceed the ADEC Table C cleanup level or the Federal MCL and is not identified as a groundwater COC.

Figure A-17 shows the historical distribution of petroleum hydrocarbons in groundwater.

Soil gas. A few scattered exceedances of PSLs for naphthalene, ethylbenzene, and 1,2,4-trimethylbenzene co-occurred with the petroleum-affected soil and groundwater in the north-central portion of the site. There were several other isolated soil gas exceedances for these petroleum-related VOCs that do not appear to be related to elevated concentrations of petroleum-affected soil and groundwater. Although screening levels for these COIs were exceeded, naphthalene, ethylbenzene and 1,2,4-trimethylbenzene do not exceed the PCLs in soil and are not identified as COCs.

Polynuclear Aromatic Hydrocarbons

Soil. At the completion of the RI, benzo(a)pyrene exceeded the PSL in three surface soil samples. Concentrations of benzo(a)pyrene in these samples were below the ADEC Method Two health-based levels and no unacceptable risk was associated with these samples. After the RI had been completed, low-level concentrations of benzo(a)pyrene and dibenzo(a,h)anthracene still remained in subsurface soil in several discrete locations, at levels above their respective PSLs. One PSL exceedance was located near Building 11, in the general vicinity of identified petroleum contamination in the north-central portion of the site. The other two exceedances occurred in confirmation samples which were collected close together from the Building 48 debris excavation. These subsurface sample locations with PSL exceedances were removed in 2011. Neither benzo(a)pyrene or dibenzo(a,h)anthracene is identified as a COC. Figure A-12 shows the distribution of SVOCs in subsurface soil at the completion of the RI.

Groundwater. Benzo(a)pyrene and dibenzo(a)anthracene were detected above their respective PSLs in monitoring wells MW62, MW69 and MW08 and were identified as COIs however, these concentrations do not exceed ADEC Table C cleanup levels or federal MCLs.

Soil gas. No PAHs were identified as COIs in soil gas.

Chlorinated VOCs

Soil. Low-level VOCs have been identified in surface and subsurface soil. Concentrations of these COCs do not exceed health-based cleanup levels. Most of the samples with PSL exceedances were obtained from sidewalls or floors of excavations intended to remove debris and/or contaminants, suggesting that the source of these contaminants was removed and that remaining contamination is residual.

Chlorinated VOC exceedances in surface soil were limited to scattered exceedances for TCE in three locations (two in the former Subarea D excavation confirmation samples, one in a Building 1 excavation confirmation sample), and a single 1,2,4-trichlorobenzene exceedance north of Building 9. Concentrations were below their respective ADEC Method Two health-based cleanup levels. TCE was detected above its respective PSL in several subsurface soil samples, mostly in the vicinity of Building 22 and 24 excavations. These subsurface TCE results were below the ADEC Method Two health-based cleanup level.

Chloroform was detected above its PSL in several isolated subsurface soil samples but at concentrations below the ADEC Method Two health-based cleanup level. The distribution of these exceedances appeared to be random and was not associated with other contaminants.

Figure A-11 shows the distribution of chlorinated VOCs in subsurface soil at the completion of the RI.

Groundwater. Groundwater monitoring wells with low concentrations of chlorinated VOCs are located in the central and north-central portion of the site and appear to be aligned with the overall north-northwesterly groundwater flow direction. Concentrations of TCE, PCE, 1,1-dichloroethene (DCE), cis-1,2-DCE, vinyl chloride, 1,1,2,2-trichloroethane (PCA), and 1,1,2-trichloroethane (TCA) have historically exceeded their respective PSLs and were commingled with the DRO plumes in the northern portion of the FCS. The downgradient extent of the VOC-affected groundwater has been established and contaminant concentrations have been decreasing, with all concentrations below PCLs for several consecutive sampling events. Chlorinated VOCs have not been detected above PSLs in samples collected from the deep well (MW80) installed in the apparent source area. The chlorinated VOC plume is well outside of the modeled FWA drinking water supply well capture zones and there is no evidence suggesting that a DNAPL source area exists at the FCS. Figure A-14 and Figure A-15 show the historical distribution of TCE and its breakdown products in groundwater.

Soil Gas. Chlorinated VOCs have been detected in soil gas at concentrations above PSLs across the FCS, with chloroform being the most frequently detected chemical. Chlorinated VOCs whose concentrations have exceeded their respective PSLs include: chloroform, TCE, PCE, 1,1-DCE, and carbon tetrachloride. There are no established cleanup levels for soil gas.

Figure A-19 shows the distribution of chlorinated VOCs in soil gas at the completion of the RI.

1,2,3-Trichloropropane

Soil. 1,2,3-TCP concentrations were not above PSLs in any surface soil samples. However, one subsurface confirmation soil sample exceeded the 1,2,3-TCP PSL at a depth of 4 feet in the excavation between Buildings 22 and 24. This concentration was included in the RI risk assessment and found to be a primary contributor to potential risk under the unrestricted residential exposure scenario; however, 1,2,3-TCP-contaminated soil was removed from this area during the 2011 post-RI removal action. Figure A-11 shows the distribution of chlorinated VOCs in subsurface soil at the completion of the RI.

Groundwater. The 1,2,3-TCP exceedances in groundwater are scattered around the FCS, but the higher-magnitude exceedances (greater than 10 times the PSL) are clustered in the east-central portion of FCS, north and east of the Buildings 22 and 24 excavation. Groundwater flow in this portion of the FCS is generally to the north-northwest, and the downgradient extent of the 1,2,3-TCP-affected groundwater in that direction has been determined by the existing well network. 1,2,3-TCP has not been detected in the modeled 1,000 gpm capture zone for the Post drinking water supply wells, nor has it been detected in the deep sentry wells which were installed to ensure that 1,2,3-TCP is not migrating toward the Post drinking water supply wells. Concentrations of 1,2,3-TCP have decreased during the last few sampling events and plume boundaries appear to be shrinking. Figure A-16 shows the historical distribution of 1,2,3-TCP in groundwater.

Soil gas. The single 1,2,3-TCP exceedance in soil gas does not coincide with the 1,2,3-TCP-affected soil and groundwater in the vicinity of Buildings 22 and 24. Figure A-19 shows the distribution of chlorinated VOCs in soil gas at the completion of the RI.

Explosives

Soil. Explosive compounds were not detected in surface or subsurface soil at concentrations above the PSLs. Figure A-12 shows the distribution of explosive compounds in subsurface soil at the completion of the RI.

Groundwater. Dinitrotoluene and hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) were detected above their respective PSLs in groundwater samples collected from several wells located in the north-central portion of FCS. The dinitrotoluene and RDX exceedances were collocated with the highest concentrations of DRO and were determined to be due to analytical interference.

Soil Gas. Based upon analytical results for soil and groundwater and low volatility, significant quantities of explosive compounds are not expected to be present in soil gas.

Pesticides

Soil. The pesticide 4,4'-dichlorodiphenyltrichloroethane (DDT) was detected at concentrations above the PSL in soil samples collected from the Building 11, Building 19, and former Subarea D excavations. DDT was removed from the Building 11 area in 2008 and from the Building 19 area in 2010 (USACE 2012). The single remaining sample with a DDT PSL exceedance was collected from the Subarea D excavation; the concentration in this sample was below the ADEC Method Two health-based cleanup level and DDT was not identified as a COC. Figure A-12 shows the distribution of pesticides in subsurface soil at the completion of the RI.

Groundwater. Heptachlor, gamma-BHC (lindane), and dieldrin were detected above their respective PSLs in samples collected from several wells located in the north-central portion of the FCS. The dieldrin concentration was also greater than the MCL and state cleanup level. All pesticide detections were collocated with the highest concentrations of DRO and were determined to be the result of matrix interference. Subsequent analyses did not detect these chemicals and they were not identified as COIs. The extent of the affected groundwater has been delineated.

Soil Gas. Based upon the fact that the vapor pressures of pesticide compounds detected at this site are generally quite low and residual concentrations of pesticides do not exceed health-based screening levels, significant concentrations of pesticides are not expected to be present in soil gas.

Semivolatile Organic Compounds

Soil. Two SVOCs (n-nitrosodi-n-propylamine and n-nitrosodimethylamine) were detected above their PSLs near Building 48 in the central portion of FCS. The n-nitrosodi-n-propylamine exceedances occurred in samples collected at depths of 12 and 16 feet bgs during the PSE II, and the n-nitrosodimethylamine exceedance occurred in a sample collected at 7 feet bgs from the floor of an excavation at Building 48. These contaminants were included in the RI risk assessment and found to be primary contributors to potential risk under the unrestricted residential exposure scenario; however, soil from both locations was removed in the post-RI removal action (USACE 2012). Figure A-12 shows the distribution SVOCs in subsurface soil at the completion of the RI.

Groundwater. Bis(2-ethylhexyl)phthalate was detected above its PSL in samples collected from several monitoring wells located in the eastern part of the FCS during the fall 2008 sampling event (CH2M HILL 2010a). Concentrations of the SVOC were all below the ADEC Table C groundwater cleanup level and the PSL-exceeding concentrations were not repeated during subsequent sampling events.

Soil gas. No SVOCs were identified in soil gas.

Summary of Changes to the PCLs

The Proposed Plan included a table with soil PCLs and COCs, which were primarily based on the Alaska Method Two migration to groundwater cleanup levels. The baseline risk assessment concluded there was a potential unacceptable risk based on a potential future UU/UE scenario due to a few localized “hot spots” of contaminated soil exceeding the Alaska Method Two migration to groundwater cleanup levels. Subsequent to the RI being completed, known “hot spots” other than DRO were excavated and contaminated soil was removed (USACE 2012). Based on current data, there are no known COCs in soil at the site, except for DRO, that exceed human health-based risk levels of a HI of 1 and an excess lifetime cancer risk (ELCR) of 1×10^{-5}. The selected groundwater remedy addresses risk posed by contaminated groundwater.

Table 1
Contaminants of Concern for FCS Soil

Contaminant of Concern	Maximum Contaminant Concentration (mg/kg)	Project Cleanup Levels (mg/kg)
1,2,3-Trichloropropane	0.5[a]	0.17**
DRO	31,900	10,250*
Aluminum	664,000[b]	77,000***
Copper	36,300[b]	4,160*
Manganese	4,360	1,800***

Notes:
[a]Soil from this location removed in 2011
[b]Soil from these locations removed in 2008
*Based upon ADEC direct contact risk-based cleanup level
**Based upon ADEC inhalation risk-based cleanup level
***Based upon EPA risk-based screening level

Table 2
Contaminants of Concern for FCS Groundwater

Contaminant	Maximum Concentration (μg/L)	Maximum Concentration 2012 (μg/L)	Project Cleanup Level (μg/L)
1,2,3-Trichloropropane (TCP)	0.8	0.4	0.12[a]
Diesel-range organics (DRO)	31,000	19,000	1,500[a]
Residual-range organics (RRO)	5,000	1,200	1,100[a]
Trichloroethene (TCE)	14	2.6	5[b]

Notes:
[a]Based upon ADEC Table C cleanup level
[b]Based upon MCL

2.6 CURRENT AND POTENTIAL FUTURE LAND AND WATER USES

This section of the ROD discusses the current and reasonably anticipated future land uses, and current and potential groundwater and surface water uses at the site. This section also discusses the basis for future use assumptions.

2.6.1 Current and Potential Future Land Uses

The major active unit at FWA is the 1st Stryker Brigade Combat Team, 25th Infantry Division, U.S. Army Garrison FWA with multiple tenant units. Altogether, approximately 7,700 Army personnel and 8,200 family members are stationed at FWA. Roughly 1,250 civilian jobs with the Army or Department of Defense also contribute to the workforce. The Post provides housing for approximately 1,600 families, with the remaining personnel living off-Post, often in nearby Fairbanks (U.S. Army Alaska 2012).

Structures at the FCS include the 55 residential buildings (110 residential units) and two mechanical buildings centered on the western edge of the housing area. The following structures are adjacent to, but not situated within, the FCS (Figure A-4):

- Residential housing along the western boundary of the FCS
- Fire Station 2 immediately to the northwest
- The former School Age Services building directly to the north
- The PX gas station immediately northeast of the FCS
- The FWA water treatment plant and water supply wells at Building 3559 adjacent to the northeastern corner of the FCS
- Alaska Railroad tracks running parallel to the eastern boundary
- Golden Valley Electric Association electrical substation directly south of the southeast corner of the FCS.

The FCS is zoned and planned for future residential use by Army families that will be stationed at the Post. The Taku Gardens family housing development covers 54 acres. The buildings are intended for use as family housing for FWA military personnel and their families, but are currently unoccupied. Construction of the 110 housing units in the 55 buildings is complete. The 20 additional housing units in the southwestern portion of the FCS

(Buildings 50 through 59) were not completed and their partially installed foundations were removed in 2009.

Interim land use controls were established after discovery and removal of the most heavily contaminated PCB soil in the southwestern corner of the site. Specifically, the Commander U.S. Army Garrison Alaska directed that residential occupancy of the housing at the FCS will not be allowed until all investigation and cleanup required under CERCLA to protect human health and the environment is complete. This prohibition on occupancy was documented in the 2007 Action Memorandum (U.S. Army 2007). Signature of this ROD will rescind the prohibition of occupancy and requirements for the fence, but interim restrictions on excavation and prohibition of groundwater use will be retained until the CERCLA remedy is implemented through the Remedial Design/Remedial Action Work Plan.

Families are expected to reside in the housing units for approximately 3 years. In addition to the personal yard areas near the residential buildings, other common areas and open space that could be used by all residents or other site visitors include recreational areas such as playgrounds, a sledding hill, picnic areas, and an ice skating rink.

Extensive investigation, excavation, and removal of buried debris and surface and subsurface soils contaminated with PCB, petroleum, pesticides, metals, VOCs, and/or SVOCs have substantially reduced the magnitude of exposure risks for future site residents and workers. Although some residual contamination still exists in the subsurface at depths greater than 6 feet bgs, institutional controls will prevent exposure of residents and site workers to these contaminants. Institutional controls will restrict access to subsurface soil at the FCS and will be implemented through the Remedial Design/Remedial Action Work Plan.

2.6.2 Current and Potential Future Groundwater Use

Groundwater is the only potable water source for FWA and the Fairbanks area. Approximately 95 percent of the potable water on FWA is supplied through a single distribution system fed by two large-capacity wells in Building 3559, which is located outside the northeastern corner of the FCS (Figure A-8). These supply wells are installed to a depth of approximately 100 feet bgs with a screened interval of 60 to 80 feet bgs. The wells provide between 1.6 million and 2.4 million gallons of water per day (approximately 59 million gallons per month) to the FWA water treatment plant for processing and distribution based on average water production for the period between January 2005 and August 2010.

The water production system at Building 3559 has a maximum production capacity of 2,400 gpm; however, this rate is attained only during short-term tests of the system. Average monthly pumping rates for the period between January 2005 and August 2010 were between 294 and 2,167 gpm, with an average pumping rate of 1,327 gpm. Site-specific modeling analysis indicates that, at maximum operating rates and conservative hydraulic conductivity (i.e., a “worst-case scenario”), the hydraulic capture zone of the water supply wells at Building 3559 would extend into a very limited area on the eastern edge of the FCS (CH2M HILL 2010b). In addition to the main drinking water supply wells, five emergency standby supply wells are located around the cantonment area, with a standby well in Building 3563 located approximately 300 feet northeast of Building 3559. These standby wells are completed at depths between 58 and 160 feet bgs and are capable of pumping approximately 250,000 gallons per day per well.

There is no current use of groundwater at the FCS outside of the simulated capture zone for the FWA water supply wells. Institutional controls will be implemented to prevent individuals from being exposed to contaminated groundwater. Groundwater use at the FCS will be prohibited by institutional controls implemented through the Remedial Design/Remedial Action Work Plan until PCLs are achieved and verified through groundwater monitoring.

2.6.3 Current and Potential Surface Water Use

The Chena River is located about 1,500 feet north of the FCS, draining approximately 2,000 square miles, and flows into the Tanana River approximately 8 miles west-southwest of FWA. The river is used seasonally for recreational hunting and fishing, trapping, subsistence, and boating. The Chena River supports seasonal populations of fish for recreation and provides spawning areas for salmon. Fishing in the river is limited to catch and release only, in accordance with regulations established by the Alaska Department of Fish and Game for protection of arctic grayling.

There are no major surface water features at the FCS, however, several drainage swales were built to channel surface runoff away from structures at the FCS. A large drainage swale runs along the western property boundary and directs surface water drainage into a series of drainage swales and retention ponds that eventually drain into the Chena River; another swale runs along the northern property boundary and discharges into the large swale to the west. Several other smaller drainage swales across the site also discharge runoff into the large drainage swale. These smaller swales were completed in 2011 and were, therefore, not considered in the RI.

Surface water features located within and near the FCS are not used for drinking water, irrigation, or fire suppression and are not expected to be used for these purposes in the foreseeable future.

2.7 SUMMARY OF SITE RISKS

This section summarizes risks posed to human health and ecological receptors by contamination at the FCS, and defines the risk basis for remedial action at the site. The results of the risk assessments along with other factors serve as the basis for FCS risk management decisions. The overall objective of the risk assessments was to identify whether any risk to human health and the environment posed by the FCS is of sufficient magnitude to require remedial action at the site.

2.7.1 Summary of Human Health Risk Assessment

The potential for cancer effects to humans is evaluated by estimating the ELCR. This risk is the incremental increase in the probability of developing cancer during one's lifetime in addition to the background probability of developing cancer. For example, an ELCR of 2×10^{-6} means that, for every 1 million people exposed to one or more carcinogen(s) throughout their lifetimes, the average incidence of cancer could increase by two cases of cancer. By comparison, the background probability of developing cancer in the United States is a little less than one in two for men and a little more than one in three for women (American Cancer Society 2003).

For non-cancer effects, the likelihood that a receptor will develop an adverse effect is estimated by comparing the predicted level of exposure for a particular chemical with the highest level of exposure that is considered protective, known as the reference dose (RfD). The RfD is an estimate of a daily exposure of the human population that is not likely to result in an appreciable risk of harmful effects during a lifetime. The ratio of the chemical intake divided by RfD is termed the hazard quotient (HQ). When the HQ for a chemical exceeds 1.0, there is a concern for potential non-cancer health effects.

To assess the potential for non-cancer effects posed by exposure to multiple chemicals, a HI was calculated following EPA guidance (EPA 1989). This conservative approach assumes that the non-cancer hazard associated with exposure to more than one chemical is additive; therefore, synergistic or antagonistic interactions between chemicals are not accounted for. The HI may exceed 1 even if all the individual HQs are less than 1.0. In this case, the chemicals may be segregated by similar mechanisms of toxicity and toxicological effects. Separate HIs may then be derived based on mechanism and effect.

Identification of Chemicals of Potential Concern

Chemicals of potential concern (COPC) are those chemicals that are carried through the risk quantification process. This section summarizes those chemicals detected in environmental media at the FCS and identifies the COPCs for media that are potentially accessible to human or ecological receptors. During the course of the risk assessments, the COPCs were evaluated to identify and prioritize which chemicals, if any, are estimated to pose unacceptable risks. The analytical data used in the risk assessments include data from surface soil (0 to 2 feet bgs), subsurface soil (0 to 15 feet bgs), drainage swale sediment (0 to 2 feet bgs), sub-slab soil gas, and groundwater samples collected during various field investigations conducted during pre-RI (pre-2007), and the 2007, 2008, and 2009 RI activities. Samples used in the risk assessments are listed by medium, sample identification number, date of collection, sampling depth interval, and target receptor types in Appendix I of the RI (CH2M HILL 2010a).

COPCs were identified separately for surface soil, subsurface soil, drainage swale sediment, sub-slab soil gas, and groundwater. All detected chemicals were considered to be COPCs. Surface soil, subsurface soil, groundwater, and soil gas were analyzed for a wide variety of potential contaminants over the course of investigation at the FCS. Summaries of all chemical analytes, the frequency of detection, minimum and maximum concentrations, and screening levels for each medium are presented in Appendix I of the RI (CH2M HILL 2010a).

The inorganic chemicals detected at the FCS occur naturally at varying background levels. Previously established background concentrations in soil at FWA (USACE 1994) were used to establish whether FCS metals concentrations were within levels typical of background near the FCS. For soil, only arsenic was considered for exclusion from the exposure estimates because arsenic concentrations at the FCS were within levels typical of background at FWA. For groundwater, metals that were detected below reported background concentrations were excluded from the exposure estimates. The remaining metals (those above background and those without background values) are carried through the risk assessment for each monitoring well.

Inorganic substances essential for human nutrition (calcium, magnesium, potassium, and sodium) were excluded from risk estimates because these are considered to be naturally occurring and are generally recognized as being of low toxicity.

Only those chemicals that have a toxicity factor available from a reliable source were included in the risk assessment as COPCs. For some chemicals without toxicity factors, a surrogate toxicity factor for a structurally similar chemical (when available) was used. For example, the toxicity factor for acenaphthene was used for acenaphthylene, for which none was available. For cases in which the species of the metal is unknown, the HHRA conservatively assumed the most toxic form is present. For example, the HHRA assumed that total chromium present in soil at the FCS is in the form of hexavalent chromium.

The following list summarizes all COPCs retained for risk estimates:

- **Surface Soil.** A total of 126 chemicals were detected at least once in FCS surface soil samples and were identified as COPCs for the future maintenance worker, future recreational/site visitor, and reasonably anticipated future use (residential) scenarios.
- **Subsurface Soil.** A total of 160 chemicals were detected at least once in FCS subsurface soil samples and were identified as COPCs for the future excavation worker and hypothetical unrestricted exposure scenarios.
- **Drainage Swale Sediment.** A total of 41 chemicals were detected at least once in the sediment samples from drainage swales and were identified as COPCs for both human health and ecological exposure scenarios.
- **Sub-Slab Soil Gas.** A total of 54 chemicals were detected at least once in sub-slab soil gas samples and were identified as COPCs for the future indoor residential exposure scenario.
- **Capture Zone Groundwater.** A total of 40 chemicals were detected at least once in the groundwater data from wells within the hypothetical high-end 1,700-gpm capture zone and were identified as COPCs for the reasonably anticipated future use (residential) scenario.
- **Groundwater Outside of Capture Zone.** A total of 103 chemicals were detected at least once in groundwater from wells outside the hypothetical high-end 1,700-gpm capture zone, and were identified as COPCs for the hypothetical unrestricted exposure scenario (assuming that groundwater can be used anywhere across the site) for the HHRA. A total of 41 chemicals were detected at least once in downgradient perimeter wells (that is, wells nearest to exposure points along the northern edge of the FCS) and were identified as COPECs for screening during the ecological risk assessment (ERA).

The highest detected concentrations of each COPC in each medium were conservatively used as the default exposure point concentrations. This approach is very conservative because it assumes that concomitant exposure to maximum levels occurs even though the maximum levels are not necessarily collocated. With this approach, areal averaging of data was not considered necessary.

Data Usability

Numerous investigations were conducted at the FCS and a wide variety of sample results were available for possible inclusion in the risk assessment. The key consideration for determining the usability of different data sets was whether the MDLs for each study type were low enough to conclude that the analyte was not present at levels that might pose a potential risk if that analyte was not detected in any sample.

Data usability was evaluated by investigation activity (i.e., PSE I investigation) and medium. To accomplish the usability evaluations, data for each investigation and medium were consolidated into summary statistics tables that list the following for each analyte: number of samples analyzed, number of detects and nondetects, minimum and maximum detected values, minimum and maximum MDLs for nondetects, the PSL, and the number of nondetect results with MDLs greater than the PSL. These tables are available electronically as an enclosure in the RI (CH2M HILL 2010a).

The usability evaluation considered the following:

- Identification of the adequacy of MDLs for available analytical data to detect potential risks posed by the FCS.
- Evaluation of the spatial, chemical, and temporal representativeness of the available analytical data, which included an assessment of whether these data are relevant to plausible exposure pathways at the FCS.

These criteria were considered collectively to judge whether FCS data were usable and representative of exposure for the risk assessment, and to identify any associated uncertainties to be reported as uncertainties for the risk assessments.

Soil/Sediment Data. The RI and four pre-RI investigations conducted at the FCS included the collection of soil and sediment samples. The information in Table 3-5 of the RI (CH2M HILL 2010a) indicated that the analytical soil data from all the investigations appeared to be fully usable. Although a few analytes consistently had nondetect MDLs that exceeded the PSLs, the elevated MDLs occurred in multiple investigations and appear to be more a function of analytical method limitations than an indication of poor data quality.

The numbers of specific sample types used in the risk assessment are as follows:

- Surface soil: 347 samples collected between 0 and 2 feet bgs
- Subsurface soil: 1,500 samples collected between 0 and 15 feet bgs

- Drainage swale sediment: 3 samples collected in drainage swales

For surface soil, the maximum nondetect MDLs for two analytes (1,2,3-TCP and 1,2-dibromo-3-chloropropane [DBCP]) exceeded the Method Two cleanup level or RSL from which the PSL was derived. Neither chemical was detected in surface soil and the MDLs for almost half of the surface soil samples were below the PSL. Therefore, it is unlikely that the elevated MDLs for these analytes mask contamination that requires delineation. Nonetheless, potential risks associated with these chemicals were considered in the risk assessment.

For subsurface soil, the maximum nondetect MDLs for three analytes (DBCP, 2-methyl-4,6-dinitrophenol, and n-nitrosodimethylamine [NNSM]) exceeded the Method Two cleanup level or RSL that the PSL was based on. The elevated MDLs for these chemicals are unlikely to have masked contamination that requires delineation. This is because the first two chemicals were not detected in any subsurface soil samples and are unlikely to have been used or disposed of at the FCS. And, although NNSM was detected in one subsurface soil sample, the chemical is not associated with operations or the types of waste disposed of at the FCS, and its detection may be the result of interferences from other chemicals in the area. However, potential risks associated with these chemicals were considered in the risk assessment.

The drainage swale samples were judgmentally collected at locations where the highest contaminant concentrations were anticipated and are considered adequate for decisions regarding offsite migration into this intermittent drainage during snowmelt. The swale has been re-engineered/improved and is now lined with gravel.

Groundwater Data: The analytical data for groundwater samples collected during investigations that preceded the RI are limited in terms of the number of samples and target analytes. In addition, many of the target analytes had nondetect MDLs considerably above the PSLs. Groundwater data used in the risk assessments were collected during five semi-annual sampling events in 2007, 2008, and 2009 (October 2007, May 2008, October 2008, May-June 2009, and August-September 2009). Data from these investigations provide better coverage in terms of sample locations and target analytes and, for the most part, appear to have MDLs that are consistent with the PSLs. While the nondetect MDLs for certain analytes in these data sets also contain a high number of PSL exceedances, the elevated MDLs occurred with multiple sampling events and appear to be more a function of analytical method limitations than an indication of poor data quality.

The two primary beneficial uses of groundwater are as follows:

- As a potential future source of domestic water for residential use (drinking water, showering, and irrigation). Two exposure cases were evaluated:
  - **Reasonably anticipated future use (residential) scenario:** Two capture zones were modeled for the FWA water supply wells at Building 3559 to provide hypothetical bounding estimates on potential water use: one for the lower end of the anticipated future pumping rate (1,000 gpm) and one for the high-end of the range (1,700 gpm). These values bracket the actual long-term production rate of 1,327 gpm.
  - **Hypothetical unrestricted exposure scenario:** To evaluate the No Action scenario, a conservative default assumption regarding domestic use of groundwater anywhere across the site was included for this exposure case.
- As a source of recharge water to offsite surface water (Chena River). This scenario was represented by analytical data from ten groundwater samples collected in the downgradient monitoring wells (MW35, MW36, MW37, MW38, MW40, MW41, MW77, MW82, MW83, and MW84) nearest the Chena River (Figure A-8).

Sub-Slab Soil Gas Data. Sub-slab soil gas samples were evaluated comprehensively on an individual housing unit basis. The specific samples used in the risk assessments include 110 individual housing units. To provide some indication of the potential confounding influences from ambient air sources (that is, offsite anthropogenic sources), ambient air samples were also collected from each of two outdoor sampling locations (one at the east fence and one at the west fence). A total of ten ambient air samples were collected throughout the course of the RI (CH2M HILL 2010a).

The following conclusions were drawn from a review of the existing data at the completion of the RI:

- The soil, drainage swale sediment, groundwater, and sub-slab soil gas data collected for the RI are considered to have adequate levels of detection for assessment of risk.

- Historical surface soil (after site development) and subsurface soil data from past investigations are considered representative and usable for risk assessment, particularly when supplemented with the additional data collected during the RI.
- Because of the history of investigations and removal actions completed at the FCS, soil sampling strategies have been both judgmental and systematic across the FCS. Judgmental samples were collected, for example, as confirmation samples at targeted drum and debris removal areas where geophysical anomalies were observed and at known or suspected hot spot areas.
- Because the sampling was roughly evenly spaced with high spatial density across the FCS, and soil was analyzed for all suspected contaminants, the data generally reflect what people could be exposed to if they reside, visit, or work at the FCS.
- Because sub-slab soil gas sampling included complete coverage of all 110 residential living units, the sampling was roughly evenly spaced with adequate spatial density across the FCS.
- Groundwater data collected before the RI (pre-2007) lack temporal representativeness.
- Groundwater data collected from monitoring wells during the RI (2007 through 2009) are considered the most representative of site conditions at the time of the RI. These data were collected near or downgradient of potential source areas, were analyzed for all suspected contaminants, and provide a conservative evaluation of the current and future conditions at the FCS.

Exposure Assessment

The exposure assessment estimates the type and magnitude of exposures to the COPCs at the source areas. It considers the current and potential future uses of the site, characterizes the potentially exposed populations, identifies the important exposure pathways, and quantifies the intake of each COPC from each medium for each population at risk.

On the basis of current understanding of land and water beneficial use conditions at or near the FCS as defined by the CSM, the most reasonable exposure scenarios considered for characterizing human health risks include the following:

- Future maintenance worker scenario
- Future excavation worker scenario
- Future recreational/site visitor scenario
- Reasonably anticipated future use (residential) scenario

A CSM provides a framework for understanding site-specific features and physical processes that influence the potential for risk and describes potential human and ecological exposure pathways for site-related chemicals. The development of the revised CSM (Figure A-23 and Figure A-24) was a dynamic process based upon currently available information (at the time) and existing levels of contamination, the latest understanding of reasonably anticipated future land and water uses, and reasonably anticipated future exposure scenarios. The CSM for the FCS included the following:

- **Sources of COPCs.** These are fully described in Section 2.2.1, based on known historical uses, practices, and releases at the FCS.
- **Receptors.** These are human and ecological populations potentially exposed to the COPC at or in the locality of the FCS. These have been described in Section 2.2.1.
- **Pathways.** These describe the mechanism through which a chemical could come into contact with receptors. An exposure pathway is considered complete when a contaminant can be tracked from its source to a receptor.

An exposure pathway can be described as the physical course that a COPC takes from the point of release to a receptor. Chemical intake or route of exposure is the means by which a COPC enters a receptor. For an exposure pathway to be complete all of the following must be present:

- A source
- A mechanism of chemical release and transport
- An environmental transport medium
- An exposure point
- An exposure route
- A receptor or exposed population

In the absence of any one of these components, an exposure pathway is considered incomplete. The updated CSM is provided in Figure A-23 and Figure A-24. The following describes the potential exposure pathways that were considered for the risk estimates:

- For the maintenance and future excavation worker exposure scenarios, and future recreational/site visitor exposure scenario, a conservative screening approach was used to select exposure concentrations by assuming exposure to the maximum detected chemical concentrations across the entire FCS. This screening approach is very conservative because it assumes regular exposure to maximum levels measured across the site in all media, even though maximum levels are not necessarily collocated.

- Pursuant to the Department of Defense (DoDM) 4715.20, *Defense Environmental Restoration Program Management* (DoD 2003), the reasonably anticipated future land use scenario was evaluated, which considers residents (adult and child living at the FCS) being exposed to chemicals via the following three exposure media: surface soil (0 to 2 feet bgs), soil gas potentially migrating to indoor air, and the FWA supply groundwater being used for domestic use purposes.
- The hypothetical unrestricted exposure scenario was evaluated assuming no action and includes default assumptions regarding domestic use of groundwater and direct contact with soil to a depth of up to 15 feet bgs anywhere across the site regardless of any current or future measures that might restrict exposure to these media. The risk estimates associated with the hypothetical unrestricted exposure scenario provide values for comparative purposes to document the difference between unrestricted access versus the potential risk when considering existing restrictions that preclude digging onsite, and prevent the use of groundwater beneath the FCS.

The hypothetical unrestricted exposure scenario was evaluated assuming no action and includes default assumptions regarding domestic use of groundwater and direct contact with soil to a depth of to 15 feet bgs anywhere across the site regardless of any current or future measures that might restrict exposure to these media. The risk estimates associated with the hypothetical unrestricted exposure scenario provide values for comparative purposes to document the difference between unrestricted access versus the potential risk when considering restrictions that preclude digging onsite, and prevent use of groundwater beneath the FCS. Based on the ecoscoping and other information obtained during the RI, plausible ecological exposure pathways considering the COPECs, available habitat, and available food sources at the FCS include the following:

- Potential exposures of aquatic resources and piscivorous (fish-eating) wildlife to chemicals in groundwater that could reach the Chena River.
- Potential exposure of terrestrial wildlife (mammals and birds) to site-related chemicals in sediment from drainage swales adjacent to the FCS.
- Hypothetical exposure of benthic macroinvertebrates to drainage swale sediments potentially migrating to the Chena River.

Both EPA guidance (EPA 1998) and the ADEC 2009 Ecoscoping Guidance (ADEC 2009c) consider the quality and availability of habitat as an important factor for determining whether an ERA for onsite exposure to soil is needed. The ADEC guidance states that “industrialized or densely populated urban areas usually do not contain important habitats. Typically, most of the natural vegetation that could support wildlife has been removed” (ADEC 2009c). Because no quality habitat exists or will exist at the site, it was determined that an ERA for onsite soil was unnecessary.

Toxicity Assessment

A complete presentation and discussion of all equations used to calculate the various intake values for ingestion of soil, dermal contact with soil, ingestion of groundwater, and dermal contact with groundwater; the equations for calculating the exposure concentrations for inhalation of ambient dusts or vapors, inhalation of vapors from contaminants in groundwater, inhalation of soil gas migrating into indoor air; and mutagenic COPCs, RfDs, slope factors, and potential exposure to POL are provided in Sections 7.5.2 and 7.5.3 of the *Remedial Investigation Report* (CH2M HILL 2010a).

Chemicals were divided into two broad groups based upon their effects to human health: carcinogens and non-carcinogens. Some chemicals (such as benzene and PCBs) are capable of eliciting both carcinogenic and non-carcinogenic responses; therefore, these chemicals were evaluated for both effects.

For non-cancer effects, toxicity values were derived on the basis of the critical toxic endpoint (that is, the most sensitive adverse event following exposure). The toxicity value describing the dose-response relationship for non-cancer effects is the RfD, or in the case of inhalation, the reference concentration (RfC). EPA uses the apparent toxic threshold value, in conjunction with uncertainty factors based on the strength of the toxicological evidence, to derive an RfD or RfC. EPA defines an RfD (also applies to RfC) as follows (EPA 1989):

> *In general, the RfD is an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of*

deleterious effects during a lifetime. The RfD is generally expressed in units of mg/kg of body weight each day (mg/kg-day).

The FCS HHRA uses available chronic RfDs and RfCs for the oral and inhalation exposure routes, respectively. Because EPA has not derived toxicity values specific to skin contact, dermal RfDs were derived in accordance with the EPA (EPA 2004c). The RfD that reflects the absorbed dose was calculated by using the following equation:

$$RfD_{ABS} = RfD_o \times ABS_{GI}$$

where:
RfD_{ABS} = absorbed reference dose
RfD_o = oral reference dose
ABS_{GI} = gastrointestinal absorption efficiencies

Gastrointestinal absorption efficiencies were obtained from the *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual Part E, Supplemental Guidance for Dermal Risk Assessment* (EPA 2004a).

For carcinogens, the EPA carcinogen classification system (EPA 1986) was used. In this system, carcinogens are classified as known (Group A), probable (Groups B1 and B2), or possible (Group C) human carcinogens. The dose-response relationship for cancer effects is expressed as a cancer slope factor that converts estimated intake directly to ELCR. Slope factors are presented in units of risk per levels of exposure (or intake).

Because EPA has not derived toxicity values specific to skin contact, dermal slope factors were derived in accordance with EPA's *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual Part E, Supplemental Guidance for Dermal Risk Assessment* (EPA 2004). The slope factor that reflects the absorbed dose was calculated by using the following equation:

$$SF_{ABS} = \frac{SF_o}{ABS_{GI}}$$

where:

SF_{ABS} = absorbed slope factor
SF_o = oral slope factor
ABS_{GI} = GI absorption efficiencies

GI absorption efficiencies were obtained from the *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual Part E, Supplemental Guidance for Dermal Risk Assessment* (EPA 2004a).

For the inhalation route, this HHRA uses the inhalation unit risk (IUR) to estimate risk in accordance with *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual Part F, Supplemental Guidance for Inhalation Risk Assessment* (EPA 2009b). EPA defines an IUR as “the upper-bound [ELCR] estimated to result from continuous exposure to an agent at a concentration of 1 $\mu g/m^3$ [microgram per cubic meter] in air” (EPA 2008).

In accordance with EPA guidance (2003), the toxicity values (cancer slope factors and non-cancer RfD) used were obtained from the following sources:

- The Integrated Risk Information System (IRIS) database available through the EPA Environmental Criteria and Assessments Office in Cincinnati, Ohio. IRIS, prepared and maintained by EPA, is an electronic database containing health risk and EPA regulatory information on specific chemicals.
- EPA provisional peer-reviewed toxicity values, provided by the Office of Research and Development, National Center for Environmental Assessment, Superfund Health Risk Technical Support Center, which develops these values on a chemical-specific basis when requested under the EPA Superfund program.
- Other toxicity values such as those from CalEPA, ATSDR minimal risk levels, or Health Effects Assessment Summary Tables (HEAST), provided by the EPA Office of Solid Waste and Emergency Response (EPA 1997c). HEAST is a compilation of toxicity values published in various health effects documents issued by EPA.

The toxicity factors used in the HHRA were obtained from the EPA RSL tables (EPA 2009a). One exception for which toxicity factors were not obtained from the RSL tables was TCE. Instead, the oral slope factor and IUR for TCE were obtained from the ADEC cleanup levels calculation sheets, as requested by ADEC. For cases where TCE contributed to risk estimates using the ADEC toxicity factors, a corresponding risk was estimated using the draft oral slope factor and IUR currently proposed by EPA (EPA 2009b). These side-by-side risk estimates allowed risk managers to make the most informed risk management decision, considering the most current understanding of the toxicology of TCE.

Risk Characterization

For carcinogens, risks are generally expressed as the incremental probability of an individual's developing cancer over a lifetime as a result of exposure to the carcinogen. ELCR is calculated from the following equation:

$Risk = CDI \times SF$ where:

Risk = ELCR, a unitless probability (e.g., 2×10^{-5}) of an individual's developing cancer

CDI = chronic daily intake averaged over a lifetime (mg/kg-day)

SF = cancer slope factor, expressed as $(mg/kg\text{-}day)^{-1}$

Inhalation risk is calculated by multiplying intake by the IUR. The IUR is expressed in different units than the cancer slope factor (above), and a conversion factor is needed to normalize units between the IUR and intake values. Inhalation risk is estimated by using the following formula:

$Risk_{inh} = Intake_{inh} \times IUR \times CF$ where:

$Risk_{inh}$ = ELCR from inhalation (unitless probability)

$Intake_{inh}$ = Chronic inhalation intake averaged over a lifetime (mg/m^3)

IUR = Inhalation unit risk $(\mu g/m^3)^{-1}$

CF = Conversion factor (µg/mg)

Although synergistic or antagonistic interactions might occur between cancer-causing chemicals and other chemicals, information is generally lacking in the toxicological literature to predict quantitatively the effects of these potential interactions. Therefore, cancer risks are treated as additive within an exposure route in this assessment. This approach is consistent with the EPA guidelines on chemical mixtures (EPA 1986). For estimating the cancer risks from exposure to multiple carcinogens from a single exposure route, the following equation is used:

$Risk_T = \Sigma_i^N Risk_i$ where:

$Risk_T$ = total cancer risk from route of exposure

$Risk_i$ = cancer risk for the i^{th} chemical

N = number of chemicals

These risks are probabilities that usually are expressed in scientific notation (e.g., 1 x 10^{-6}). An ELCR of 1 x 10^{-6} indicates that an individual experiencing the reasonable maximum exposure estimate has a 1 in 1,000,000 chance of developing cancer as a result of site-related exposure. This is referred to as an "ELCR" because it would be in addition to the risks of cancer individuals face from other causes such as smoking or exposure to too much sun. The chance of an individual's developing cancer from all other causes has been estimated to be as high as one in three. EPA's generally acceptable risk range for site-related exposures is 10^{-4} to 10^{-6}; ADEC's acceptable risk threshold is 1 x 10^{-5}.

The potential for non-carcinogenic effects is evaluated by comparing an exposure level over a specified time period (e.g., lifetime) with an RfD derived for a similar exposure period. An RfD represents a level that an individual may be exposed to that is not expected to cause any deleterious effect. The ratio of exposure to toxicity is the HQ. An HQ less than 1 indicates that a receptor's dose of a single contaminant is less than the RfD, and that toxic non-carcinogenic effects from that chemical are unlikely. The HI is generated by adding the HQs for all chemical(s) of concern that affect the same target organ (e.g., liver) or that act through the same mechanism of action within a medium or across all media to which a given individual may reasonably be exposed. An HI less than 1 indicates that, based on the sum of all HQ's from different contaminants and exposure routes, toxic non-carcinogenic effects from all contaminants are unlikely. An HI greater than 1 indicates that site-related exposures may present a risk to human health.

The HQ is calculated as follows:

HQ = Intake/RfD

where:
HQ = non-cancer hazard quotient from route of exposure
Intake = chronic daily intake averaged over the exposure duration (mg/kg-day)
RfD = non-cancer reference dose (mg/kg-day).

Intake and RfD are expressed in the same units and represent the same exposure period (i.e., chronic, subchronic, or short-term).

For non-cancer effects by inhalation exposure, the following equation is used:

$HQ_{inh} = Intake / RfC$

where:
HQ_{inh} = Non-cancer hazard quotient from inhalation
$Intake_{inh}$ = Chronic inhalation intake averaged over the exposure duration (mg/m^3)
RfC = Non-cancer reference concentration (mg/m^3)

When the HQ for a chemical exceeds 1.0 (that is, exposure exceeds RfD or RfC), there is a concern for potential non-cancer health effects. To assess the potential for non-cancer effects posed by exposure to multiple chemicals, an HI approach was used according to EPA guidance (EPA 1986). This approach assumes that the non-cancer hazard associated with exposure to more than one chemical is additive; therefore, synergistic or antagonistic interactions between chemicals are not accounted for. The HI may exceed 1 even if all the individual HQs are less than 1.0. In this case, the chemicals may be segregated by similar mechanisms of toxicity and toxicological effects. Separate HIs may then be derived based on mechanism and effect. The HI is calculated as follows:

$HI = Intake_1/RfD_1 + Intake_2/RfD_2 + \ldots Intake_i/RfDi$

where:
HI = hazard index
$Intake_i$ = daily intake of the i^{th} chemical (mg/kg-day)
RfD_i = reference dose of the i_{th} chemical (mg/kg-day)

Both intake and RfD are expressed in the same units (mg/kg-day) and represent the same exposure period (that is, chronic exposure).

Potential risks from lead concentrations were evaluated by using different methods than those conventionally used for other carcinogens and non-carcinogens. For direct contact pathways, the concentrations of lead in soil were compared with the ADEC Table B1 value of 400 mg/kg for residential land use and 800 mg/kg for worker exposures. The concentrations of lead in groundwater were compared with the ADEC Table C value and EPA drinking water action level of 0.015 mg/L.

The comparison values for residential land use were derived by using the Integrated Exposure Uptake Biokinetic (IEUBK) Lead Model (EPA 2004c). The IEUBK model is designed to predict probable blood-lead concentrations for children between 6 months and 7 years of age who have been exposed to lead through various sources (e.g., air, water, soil, dust, and in utero contributions from the mother). A predicted blood-lead concentration of 10 µg/dL in greater than 5 percent of the potentially exposed population is considered to be a level of concern that triggers intervention to reduce exposure. The soil comparison value for worker scenarios was derived based on EPA's adult lead model (EPA 2003). The adult lead model develops a risk-based soil concentration that is protective of fetuses carried by women who may be exposed to lead in soil.

This section summarizes the risk estimates for each of the exposure scenarios identified for the FCS as follows:

- Future maintenance worker scenario
- Future excavation worker scenario
- Future recreational/site visitor scenario
- Reasonably anticipated future use (residential) scenario
- Hypothetical unrestricted exposure scenario

The cancer and non-cancer risk estimates for soil, sub-slab soil gas, and groundwater, under future conditions, are summarized by exposure scenario in the following sections. The COPCs identified for each medium included all detected chemicals with available toxicity factors (unless demonstrated to be less than natural background, such as arsenic in soil and a few metals in groundwater). For each potentially exposed population, risk estimates were calculated for individual exposure routes, as well as cumulative risks across all exposure routes. For the residential exposure scenario, for which exposure to more than one environmental medium can occur, multimedia risk estimates are also provided.

Future Maintenance Worker: The future maintenance worker was assumed to be a 70-kilogram adult exposed to surface soil anywhere across the site for 250 days per year over a duration of 6.6 years (mean work tenure) (EPA 1997d). Potential routes of exposure to surface soil (0 to 2 feet bgs) were evaluated and include incidental ingestion, dermal contact, and inhalation of ambient dusts and vapors.

Future Excavation Worker: Potential routes of exposure to subsurface soil (0 to 15 feet bgs) were evaluated and include incidental ingestion, dermal contact, and inhalation of ambient dusts and vapors. The future excavation worker was assumed to be a 70-kilogram adult exposed to subsurface soil anywhere on the FCS for 20 days per year (4 work weeks) over a duration of 6.6 years (mean work tenure) (EPA 1997d).

Future Recreational/Site Visitor: Potential exposure to surface soil (0 to 2 feet bgs) was evaluated and included incidental ingestion, dermal contact, and inhalation of ambient dusts and vapors. The future recreational/site visitor was assumed to be a 36-kilogram child (10 years old) exposed to surface soil anywhere across the FCS for 28 days per year (1 day per week, 7 months per year) for a duration of 8 years (assumed reasonable residence time at FWA).

A conservative screening approach was used to select exposure concentrations for future maintenance, excavation, and recreational/site visitor scenarios by assuming exposure occurs to the maximum detected chemical concentrations across the entire FCS. This screening approach is very conservative because it assumes that concomitant exposure to maximum levels occurs even though maximum levels are not necessarily collocated. With this approach, areal averaging was considered unnecessary. A total of 347 surface soil samples were used for these risk evaluations.

The HHRA results for the maintenance worker, future excavation worker, and future recreational/site visitor exposure scenarios indicate that the HIs for non-carcinogenic chemicals in soil are below the EPA and ADEC threshold value of 1. The ELCR estimates are within or below the EPA target risk range of 1×10^{-6} to 1×10^{-4} and below the ADEC risk threshold of 1×10^{-5}. Therefore, no unacceptable risk is identified for these scenarios. The maximum concentration of lead in surface soil (254 mg/kg) for this exposure scenario does not exceed the ADEC Table B1 value of 800 mg/kg for industrial land use or the 400 mg/kg level for residential land use. These risk estimates are summarized in Table 3.

Table 3
Summary of Risk and Hazard Estimates for Non-Residential Exposure Scenarios

Exposure Scenario	Exposure Route	ELCR	Non-Cancer HI	Primary Contributors*
Future Maintenance Worker—Direct Contact with Soil (0 to 2 feet bgs)	Ingestion Dermal Inhalation **Total**	3×10^{-6} 6×10^{-7} 2×10^{-7} $\mathbf{3 \times 10^{-6}}$	0.4 0.06 0.05 **0.5**	None identified
Future Excavation Worker—Direct Contact with Soil (0 to 15 feet bgs)	Ingestion Dermal Inhalation **Total**	1×10^{-6} 2×10^{-7} 5×10^{-8} $\mathbf{2 \times 10^{-6}}$	0.7 0.05 0.008 **0.7**	None identified
Future Recreational/Site Visitor—Direct Contact with Soil (0 to 2 feet bgs)	Ingestion Dermal Inhalation **Total**	2×10^{-6} 2×10^{-7} 9×10^{-8} $\mathbf{2 \times 10^{-6}}$	0.2 0.01 0.02 **0.2**	None identified

Note:
* Primary contributors to the total risk are listed when ELCR > 10^{-5} or HI > 1.

Reasonably Anticipated Future Residential Use

Future residents living at the FCS were evaluated for potential exposure to COPCs detected in surface soil (0 to 2 feet bgs), soil gas potentially migrating to indoor air, and FWA supply groundwater currently used for domestic purposes. Potential routes of exposure to surface soil include incidental ingestion, dermal contact, and inhalation of ambient dusts and vapors (collectively referred to as "direct contact with soil"). The future resident was assumed to be exposed for 350 days per year for a duration of 30 years (for the first 6 years as a 15-kilogram child followed by 24 years as a 70-kilogram adult). This EPA default assumption is considered conservative for the FCS because the maximum residence time for military housing at FWA is anticipated to be no longer than about 8 years. A total of 347 surface soil samples were used for the residential scenario risk evaluation.

A conservative, sample-specific, risk evaluation approach was used to evaluate potential exposure to surface soil for the future residential exposure scenario. This is considered a screening-level approach because long-term exposure (30-year duration) is assumed to occur at each individual sample location. In reality, exposure would be spatially integrated over a much larger area than represented by a single sample location. This conservatism and other health-conservative factors that influence the interpretation of the risk evaluation for surface soil are described in the uncertainty section (Section 2.7.2). Because of the results seen with use of this screening approach, areal averaging of data was not considered necessary for this exposure scenario.

The estimated HIs for non-carcinogenic chemicals in surface soil samples range from less than 0.001 to a maximum of 0.5 (at location 07FWCDSS01-01) for this scenario, which is below the EPA and ADEC threshold value of 1. The estimated ELCR from all carcinogenic chemicals in surface soil samples ranges from 2×10^{-10} to a maximum of 8×10^{-6} (at location 08-FW-A-EXBLD22-23-0-5), which is within the EPA target risk range of 1×10^{-6} to 1×10^{-4} and below the ADEC risk threshold of 1×10^{-5}. Of the 347 samples with detected COPCs, 27 samples had risk estimates exceeding 1×10^{-6}.

For the residential exposure scenario under reasonably anticipated future land use conditions, the multimedia HI for combined exposure by direct contact with surface soil, inhalation of indoor air originating from sub-slab soil gas, and domestic use of FWA supply well groundwater is below the EPA and ADEC threshold value of 1. The multimedia ELCR for combined exposure to these media is within the EPA target risk range of 1×10^{-6} to 1×10^{-4} and below the ADEC risk threshold of 1×10^{-5}. The risk assessment results for this scenario indicate that, even if cumulative exposure occurs to the highest levels at any surface soil and sub-slab soil gas locations, and are combined with exposure to domestic use of the FWA supply water, HI and ELCR estimates do not exceed the EPA and ADEC risk threshold values. Therefore, no unacceptable risk is identified for the residential exposure scenario under reasonably anticipated future land use conditions.

For groundwater wells located within the hypothetical high-end pumping rate (1,700-gpm) capture zone, the ELCR from all carcinogenic chemicals in shallow groundwater samples exceeds the EPA target risk range of $1 \text{ x } 10^{-6}$ to $1 \text{ x } 10^{-4}$, and the ADEC risk threshold of $1 \text{ x } 10^{-5}$ in wells MW08, MW47, and MW79 (the ELCR at MW39 exceeds the ADEC risk threshold only). This ELCR is primarily a result of the presence of 1,2,3-TCP at low levels (less than 2 micrograms per liter [µg/L]) in these wells; however, 1,2,3-TCP has neither been detected within other groundwater monitoring (sentry) wells located closer to the supply well, nor has it been detected in the supply well itself. Furthermore, solute transport calculations (Appendix B of the RI) suggest that the concentrations of 1,2,3-TCP in monitoring wells MW08, MW47, and MW79 are not strong enough to adversely affect groundwater quality at the supply well. Summary results of this reasonably anticipated future residential use scenario assessment are shown in Table 4.

Table 4
Summary of Multimedia Risk and Hazard Estimates for the Reasonably Anticipated Future Land Use (Residential Exposure) Scenario

Exposure Scenario and Medium	Exposure Route	ELCR	Non-Cancer HI
Future Resident (maximum location)— Direct Contact with Soil (0 to 2 feet bgs)	Ingestion Dermal Inhalation **Total**	5×10^{-6} 2×10^{-6} 1×10^{-7} **8×10^{-6}[a]**	0.5 0.0004 0.01 **0.5[a]**
Future Resident (maximum location)— Vapor Intrusion to Indoor Air	Inhalation	6×10^{-6}[b]	0.05[b]
Future Resident— Domestic Use of Post Supply Water	Ingestion[d] Dermal[d] Inhalation **Total**	-- -- 5×10^{-7} **5×10^{-7}[c]**	0.001 0.00001 0.003 **0.005[c]**
Cumulative Multimedia Risk and Hazard		**1×10^{-5}**	**0.5**

Notes:
[a] Surface soil direct contact values represent the maximum risk and hazard estimates from any single sample across the entire FCS.
[b] Vapor intrusion values represent the maximum risk and hazard estimates from any single sub-slab sample across the entire FCS.
[c] Groundwater use values represent the risk and hazard estimates from the Post supply well at Building 3559 prior to treatment. Although there is no indication of contaminant migration from the FCS toward the water supply well, the results for that well are conservatively included since they represent current and reasonably anticipated future water use conditions.
[d] ELCRs are not calculated for the ingestion of and dermal exposure to drinking water from the Post drinking water supply well because the naturally occurring constituents in untreated Post supply well water used in the risk assessment do not cause cancer via these exposure pathways; therefore, oral and dermal slope factors are not available.

Hypothetical Unrestricted (Residential) Use Scenario

The hypothetical unrestricted (residential) exposure scenario was evaluated to address a No Action remedial alternative and includes conservative default assumptions regarding domestic use of groundwater and direct contact with soil down to 15 feet bgs, anywhere across the site, and regardless of current or future measures which preclude exposure to these media. The hypothetical unrestricted exposure scenario was evaluated for potential exposure to COPCs detected in the following four exposure media:

- Surface soil
- Soil gas potentially migrating to indoor air
- Groundwater from well points across the site
- Subsurface soil

The unrestricted user exposure assumptions were identical to those used for the reasonably anticipated future user (residential) scenario, where exposure was assumed be for 350 days per year over a duration of 30 years (for the first 6 years as a 15-kilogram child, followed by 24 years as a 70-kilogram adult). A total of 1,500 subsurface soil samples from 0 to 15 feet bgs were used for the unrestricted user scenario. Because the risk estimates for the 347 samples in the top 2 feet bgs would be the same as those for the reasonably anticipated future use (residential) scenario, they are not repeated here. Potential routes of exposure include incidental ingestion, inhalation of dusts and vapors, and direct contact with soil. As was done for the reasonably anticipated future use (residential) scenario, a conservative, sample-specific, risk evaluation approach is used to evaluate potential exposure to potential exposure to subsurface soil for this hypothetical use scenario.

Inhalation exposure to COPCs in indoor air potentially originating from soil gas was evaluated under the reasonably anticipated future residential exposure scenario, and the results presented under that scenario are anticipated to be the same for the hypothetical unrestricted exposure scenario.

Potential routes of exposure to COPCs in groundwater under the hypothetical unrestricted use scenario include ingestion, dermal contact, and inhalation of vapors during bathing/ showering. The hypothetical unrestricted exposure scenario assumed exposure for 350 days per year over a duration of 30 years (for the first 6 years as a 15-kilogram child, followed by 24 years as a 70-kilogram adult). A total of 76 additional wells (other than the 12 wells evaluated under the reasonably anticipated future residential exposure scenario) were included in the evaluation of the unrestricted exposure scenario.

The estimated HIs for non-carcinogenic chemicals in subsurface soil samples range from less than 0.001 to a maximum of 5 (at location 06TP19S02[3]) for this scenario, which exceeds the EPA and ADEC threshold value of 1. Only one (6 feet bgs at location 06TP19S02) of the 1,500 samples (less than 0.1 percent) evaluated under this scenario had a HI exceeding 1. The estimated ELCR from all carcinogenic chemicals in subsurface soil samples ranges from 9×10^{-12} to a maximum of 8×10^{-5} (at location 08-FW-A-EXBLD24-19-4), which is within the EPA target risk range of 1×10^{-6} to 1×10^{-4} but above the ADEC risk threshold of 1×10^{-5}. Of the 1,500 samples evaluated under this scenario, only four samples (0.3 percent) had risk estimates exceeding 1×10^{-6}. These locations and associated sample depths include the following:

- 08-FW-A- EXBLD24-19-4 (4 feet bgs)
- 07FW-A-EXBLD4806R1B (8 feet bgs)
- 07FW-A-EXBLD48-43 (3 feet bgs)
- 07FWAMW62-3.0 (3 feet bgs)

Soil from these locations was excavated during the post-RI TCRA (USACE 2012).

The maximum concentration of lead in surface soil (289 mg/kg) for this exposure scenario does not exceed the ADEC Table B1 value of 400 mg/kg.

[3] Soil at the location of sample 06TP19SO2 was excavated and disposed of during the debris removal north of Building 17 in 2008.

The estimated HIs for non-carcinogenic chemicals range from less than 0.0001 to a maximum of 16 (at MW12), which exceeds the EPA and ADEC threshold value of 1. The estimated ELCR from all carcinogenic chemicals in onsite groundwater samples ranges to a maximum of 8×10^{-4} at well MW03, which exceeds the EPA target risk range of 1×10^{-6} to 1×10^{-4} and the ADEC risk threshold of 1×10^{-5}. Arsenic contributes nearly all (more than 99 percent) of the risk at this well. However, the arsenic concentration detected at this well was 36.4 µg/L, which is consistent with the background concentration of 36.24 µg/L.

Under the assumption that hypothetical unrestricted users would be exposed to more than one medium at the FCS, the cumulative multimedia risk and hazard estimates were calculated as the sum of the risks and hazards for each exposure medium. The multimedia HI and ELCR estimates for the hypothetical unrestricted scenario are summarized in Table 5. The multimedia HI for combined exposure by direct contact with subsurface soil, inhalation of indoor air originating from sub-slab soil gas, and domestic use of onsite groundwater is 21 for this scenario, which is above the EPA and ADEC threshold value of 1. The multimedia ELCR for combined exposure to these media is 2×10^{-3}, which is above the EPA target risk range of 1×10^{-6} to 1×10^{-4} and the ADEC risk threshold of 1×10^{-5}. The primary medium contributing to the multimedia risk is groundwater, contributing 95 percent of the cumulative risk.

Table 5
Summary of Multimedia Risk and Hazard Estimates for the Hypothetical Future Unrestricted Exposure Scenario

Exposure Scenario and Medium	Exposure Route	ELCR	Non-cancer HI
Hypothetical Unrestricted Use (maximum location)— Direct Contact with Soil (0 to 15 feet bgs)	Ingestion Dermal Inhalation **Total**	8×10^{-5} 5×10^{-8} $\underline{1 \times 10^{-7}}$ 8×10^{-5}*	5 0.0003 0.1 5*
Hypothetical Unrestricted Use (maximum location)— Vapor Intrusion to Indoor Air	Inhalation	6×10^{-6}**	0.05**
Hypothetical Unrestricted Use— Domestic Use of Groundwater	Ingestion Dermal Inhalation **Total**	2×10^{-3} 1×10^{-5} $\underline{4 \times 10^{-7}}$ 2×10^{-3}***	16 0.004 0.04 16***
Cumulative Multimedia Risk and Hazard		$\mathbf{2 \times 10^{-3}}$	**21**

Notes:
* Subsurface soil direct contact values represent the maximum risk and hazard estimates from any single sample across the entire FCS.
** Vapor intrusion values represent the maximum risk and hazard estimates from any single sub-slab sample across the entire FCS.
*** Groundwater use values represent the maximum risk and hazard estimates from any monitoring well across the entire FCS.

An important component of the HHRA was the vapor intrusion evaluation to address potential indoor exposures to future residents. The approach for evaluating vapor intrusion of volatile compounds into indoor air at the FCS is consistent with the tiered process recommended in EPA Vapor Intrusion Guidance (EPA 2002) and included an evaluation of multiple lines of evidence. Based upon monitoring data generated during the RI and afterwards, all lines of evidence support the conclusion that the vapor intrusion pathway does not represent an unacceptable risk at the FCS.

Risk Evaluation for Munitions and Explosives of Concern

In addition to the quantitative risk estimates in the HHRA, the Army evaluated the potential risk of encountering munitions and explosives of concern (MEC). The evaluation, which was conducted following the process approved by the Department of Defense Explosives Safety Board and the U.S. Army Technical Center for Explosives Safety, was designed to determine whether MEC was intermingled with the large amounts of metal debris and other debris. The munitions evaluation had three primary purposes: (1) protect site workers, (2) ensure the general public's safety during the evaluation, and (3) identify necessary response actions (removal, remedial action, institutional controls, or combinations of these) that may be required to ensure safe residential use (Jacobs 2009). As part of the evaluation, the Army investigated large anomalies identified during the Cold Regions Research and Engineering Laboratory geophysical surveys conducted in 2006 and 2007.

The MD and RRD discovered were intermingled with large quantities of metal debris and trash. It is believed that MD and RRD comprised a small fraction of materials that were managed and disposed of in the FCS area during historical operations. The drum and debris investigations conducted during the RI essentially eliminated any residual explosives-related risk that might have been present by removing buried scrap metal and debris. Approximately 8 acres to a depth of up to 18 feet bgs (160,000 cy of soil and 50,000 cy of debris) were excavated within the FCS. The excavated soil was inspected visually and with magnetometers each time it was moved. The bottoms and sides of each excavation were inspected with a Schonstedt magnetometer to ensure the margins of the excavation were free of anomalies before backfilling. After backfilling, each excavation was surveyed with an EM61 to ensure the soil was free of anomalies. Munitions-related items were only found intermingled with other debris. The FCS was never used as a firing range for any military munitions (USACE 2010a).

Only two practice rockets, 3.5 inch M29 series rocket motors with propellant residue were positively identified as discarded military munitions (DMM). Each M29 rocket motor was destroyed at the FWA Range Control by military EOD. Originally, there was concern that DMM included un-fuzed and unarmed M41 20-pound fragmentation bombs, M47 100 pound dual purpose bombs, and M106 8-inch projectiles. However, the following factors make this highly unlikely:

- The M106 projectiles found in 2006 were inert-filled, practice/training rounds.
- The Army EOD team used very large donor charges in 2007 (more than 15 pounds per item) on each suspected DMM (M106 and M41). From the appropriate safe distance, one cannot absolutely distinguish whether or not the explosion is due solely to the donor charge or if there is a contribution from the suspected DMM.
- The contractor's UXO-qualified personnel found the same items (M106, M47, and M41) in 2008. The EOD team, at the request of the FWA environmental team used small donor

charges to determine if the items were inert or explosively filled. In each instance, the suspected DMM was inert-filled with plaster of Paris or empty.

- Of the nearly 3,000 munitions-related items located, only five could not be positively identified as inert or training. These five were detonated with such a large donor charge the filler could not be positively determined.

Based on the types of munitions located and results of military EOD disposal activities, the Army's third-party UXO expert concluded that no fuzed or un-fuzed explosive-filled munitions were ever present at the FCS. The Army realizes that this determination cannot be absolute because there were different contractors who performed excavation for construction or intrusive work associated with the investigation, there was some early intrusive work conducted without UXO-qualified personnel present, and a number of different military EOD personnel responded to dispose of the suspected DMM. This conclusion was reached using professional judgment and considered that the results of field activities gave no indication that hazardous DMM was present. The conclusion that no fuzed or un-fuzed explosively filled munitions were ever present on this site is based upon the following facts:

- No fuzed munitions were found.
- No fuzes were found either separately or in a fuze container.
- When detonated with the appropriate donor charge, the suspected 8-inch M106 projectiles, M41 fragmentation bombs, and M47 smoke bombs were all empty or filled with plaster.
- Those suspected M106, M41, and M47 destroyed in 2007 were destroyed using very large amounts of donor explosives and, thus, left no evidence.
- The DMM (3.5 inch rocket motors with propellant residue) was found in only one area of the site, previously referred to as Subarea A.
- EM-61 anomalies identified by the Army, EPA, and ADEC for investigation have been completely removed.
- An additional 10 percent of the unknown anomalies greater than 75 millivolts (mV) were investigated as a means of providing "ground truthing" that the smaller anomalies do not contain either drums with hazardous material or DMM.
- An additional ground truthing effort was conducted on anomalies less than 75 mV throughout the entire site, which provided additional evidence that anything less than 75 mV was caused by one of the following: small pockets of construction debris; small pockets of banding material; bundles of discarded communication wire; miscellaneous fasteners; or high concentrations of rust in the soil.

- The contractor's UXO personnel onsite during the RI inspected large quantities of scrap metal found both prior to their arrival and uncovered during the investigation. Only two rocket motors (3.5-inch M29 rockets) used in training were determined to be DMM due to the presence of propellant residue.

It is unlikely that any explosive ordnance is present at the site; furthermore, the probability of residents encountering any buried munitions that might be present is unlikely because any residual debris that could contain munitions is inaccessible. In addition, institutional controls already in place at the site are designed to prevent unsupervised exposure to any hazards that may be present such as buried utilities, contaminated soil or groundwater, or residual munitions-related items. Based upon evidence collected during this extensive investigative effort, the Army and EPA have determined that the Taku Gardens family housing development is safe for residential use regarding the issue of explosives safety. Further, ADEC concurs with this determination.

HHRA Uncertainty Analysis

It is important to identify the primary limitations and areas of uncertainty in a risk assessment, so that risk management decisions may be informed and accurate. Many assumptions used in this HHRA are conservative, to avoid underestimating the risk for anyone potentially exposed at the site. Several sources of uncertainty can affect the overall estimates of human and ecological health. The sources are generally associated with the following:

- Sampling, analysis, and data evaluation
- Chemical fate and transport estimation
- Exposure assessment
- Toxicity assessment
- Risk estimation

Uncertainties Associated With Sampling, Analysis, and Data Evaluation

Uncertainties associated with soil, soil gas, and groundwater sampling and analysis include the inherent variability (standard error) in the analysis, the representativeness of the samples, sampling errors, and heterogeneity of the sample matrix. The quality assurance and quality control program used during the various investigations serves to maintain acceptable precision and accuracy in measurement of chemical concentrations, but it cannot eliminate all errors associated with sampling and analysis.

The degree to which sample collection and analyses reflect real exposure concentrations will influence the reliability of the risk estimates. Because of the history of investigations and removal actions completed at the FCS, soil sampling strategies have been both judgmental and systematic across the FCS. Judgmental samples were collected, for example, as confirmation samples at targeted drum and debris removal areas where geophysical anomalies were observed and at known or suspected hot spot areas. Sub-slab soil gas sampling included complete coverage of all 110 residential living units. Because the sampling for these media was roughly evenly spaced with high spatial density across the FCS, it is anticipated that the concentrations generally reflect what people could be exposed to if they reside, visit, or work at the FCS.

Other specific assumptions made related to sampling, analysis, and data evaluation include the following:

- Although a few analytes consistently had nondetect MDLs that exceeded their PSLs, the elevated MDLs occurred in multiple investigations and appear to be more a function of limitations inherent in the standard analytical methods (relative to very low PSLs) than an indication of poor data quality. As previously noted, this usually occurred for chemicals not associated with historic operations or the types of waste disposed of at the FCS (for example, DBCP) and whose detection may be the result of interferences from other chemicals in the area. For some constituents in some samples, matrix interferences caused detection limits to be elevated above the PSLs. In cases where undetected constituents are actually present below MDLs but above the PSL, there is a potential for some undetected risk. However, because PSLs are set at one-tenth the actual risk-based concentration, considerable margin of safety is afforded.
- Dioxins and furans were not included as analytes during the RI because research (de Voogt and Brinkman 1989; DeGrandchamp and Barron 2005) has shown that only trace levels of dioxins and furans are present in the type of PCB found at the FCS (Aroclor 1260) and because areas of burned debris were not collocated with evidence of chlorinated solvent use. The following lines of evidence support the decision not to analyze samples for dioxins and furans:
    - PCB-contaminated soil that might have contained PCB-associated dioxins/furans has been removed from the site.

- Soil samples collected from sidewalls and floors of excavations where burned material was found were analyzed for VOCs and none of the results suggested possible use of chlorinated solvents as an accelerant.
- IDW (e.g., soil cuttings) associated with installation of MW80 (located in the footprint of the TCE plume) and MW81 (located near the former Building 52 foundation) were analyzed for dioxins and furans and only trace levels were detected at concentrations attributable to typical anthropogenic background sources and below any cleanup levels.

Uncertainties Associated with Chemical Fate and Transport Estimation

This risk assessment made simplifying assumptions about the environmental fate and transport of COPCs; specifically, that no chemical loss or transformation has occurred since the sampling data were collected, or will occur over the course of the assessed 30-year residential exposure duration. In cases for which natural attenuation or other degradation processes are moderate or high, the analytical data chosen to represent exposure concentrations likely overstate actual long-term exposure levels. This uncertainty is likely to be more relevant for organic chemicals that biodegrade (e.g., benzene, toluene, ethylbenzene, and xylenes [BTEX], DRO, and PAH) than for those that are persistent in the environment (for example, PCBs and metals). But even more persistent chemicals will attenuate to some degree over a 30-year period.

Other specific assumptions made related to fate and transport of COPCs include the following:

- For developing a conservative estimate of the sub-slab soil gas to indoor air attenuation factor, site-specific radon data were collected for these media. The attenuation factor was derived as the 95 percent upper confidence level from sampling 19 housing units of five styles for the HHRA. As an added conservative measure, the portion of the measured indoor concentrations of radon that is attributable to ambient background was not considered in the derivation of the attenuation factor (that is, background was not subtracted from measured indoor radon levels). Radon is considered a conservative tracer because of its inert nature as a noble gas (e.g., it does not biodegrade) and lack of chemical interaction with soil, as would be expected for organic VOCs.
- To provide a reliable representation of potential exposure concentrations, the sub-slab soil gas sampling was conducted during seasonal extremes, once in winter in December 2008, and once in summer in August 2009. The heating and ventilation systems in each home were set to simulate typical living conditions. (Units were generally around 68 ºF at the time of sampling.)

- Two capture zones were modeled for the FWA water supply wells at Building 3559 to provide hypothetical bounding estimates on potential water use, one assuming a lower-end long-term average pumping rate (1,000 gpm); and one assuming a high-end rate (1,700 gpm) for the pumps installed in the wells. These values bracket the actual (as evidenced by data records from 2005 through 2010) long-term production rate of 1,327 gpm, as described previously. The wells affected by 1,2,3-TCP are located outside the 1,000-gpm capture zone for the FWA water supply well and, based on passive soil gas sample data and groundwater data for wells installed between the locations where 1,2,3-TCP was detected and the water supply wells, there is no indication of migration toward the water supply wells.

Uncertainties Associated with Exposure Assessment

The estimation of exposure in these risk assessments required many assumptions. There are uncertainties regarding the likelihood of exposure, frequency of contact with contaminated media, concentrations of chemicals at exposure points, and total duration of exposure. The human exposure assumptions used in the risk estimates are intended to be conservative and likely overestimate the actual risk or hazard. Specific assumptions made related to estimation of exposure include the following:

- A conservative screening approach was used to select exposure concentrations for the future maintenance worker, excavation worker, and recreational/site visitor exposure scenarios, by assuming exposure occurs to the maximum detected chemical concentrations across the entire FCS. This screening approach is very conservative because it assumes that concomitant exposure to maximum levels occurs even though maximum levels are not necessarily collocated. Because of the results seen with use of this screening approach, areal averaging of data was not considered necessary for these scenarios.
- A conservative sample-specific risk evaluation approach was used to evaluate potential exposure to surface soil for the future residential exposure scenario. This is considered a screening-level approach because long-term exposure (30-year duration) is assumed to occur at each individual sample location. In reality, exposure would be spatially integrated over a much larger area than represented by a single sample location. There would be a potential for some additive risk if an individual receptor is equally exposed to two or more locations that are in close proximity. However, when the ten highest risk locations (those with highest risk estimates) were evaluated to determine proximity to each other, none co-occur within the same residential yard. Therefore, combined exposure to these locations is not expected.
- A conservative residence time of 30 years was assumed for the future residential exposure scenario. This value is the EPA default assumption representing the national upper-bound time at one residence (EPA 1989), and is considered conservative for the FCS because the reasonable maximum residence time for military housing at FWA is anticipated to be no

longer than about 8 years. As a result, exposure will likely be less than a third of the level assumed in this HHRA.

- Any future exposures to soil will be further minimized by the clean soil cover (about 2 feet) that will be placed during completion of construction at the FCS.
- Another uncertainty for the risk assessments is the bioavailability of the forms of metals that occur in soil and drainage swale sediment at the FCS. Site-specific bioavailability data were unavailable for all detected chemicals. The HHRA and ERA conservatively assume that bioavailability from soil/sediment is the same as that in the toxicological studies from which the toxicity values were derived. Depending on whether the chemical form at the site is less or more bioavailable than assumed, actual risk would be proportionately lower or higher, respectively.
- For locations where sub-slab soil gas was sampled and analyzed during both December 2008 and August 2009, the annual average concentration was considered most representative of chronic exposure, commensurate with the toxicity factors used for risk assessment. Averaging the winter and summer sub-slab soil gas results to derive an annual average was conducted to characterize the inherent cyclical nature of soil gas at the temperature extremes present in Fairbanks. Thus, they are anticipated to capture the annual variation in the long-term (30-year) exposure assumed for the risk assessment. More recent soil gas sampling results from July 2010 showed that TCE concentrations were lower than those seen in the previous August 2009 event, but still within the range considered for averaging in the risk assessment. These more recent results indicate that the values used for the risk assessment are sufficiently conservative.
- It is important to note that the risk assessment conducted as part of the RI used data that was available at the time. Results of the risk assessment identified three areas of subsurface soil with VOC and SVOC concentrations above the ADEC cumulative (multi-chemical) risk threshold. Three of these areas (Building 24 contaminated with 1,2,3-TCP at 4 feet bgs; Building 48 contaminated with n-nitrosodimethylamine, dibenzo(a,h)anthracene, and benzo(a)pyrene at 8 feet bgs; and monitoring well 62 (MW62) contaminated with benzo(a)pyrene and dibenzo(a,h)anthracene at 3 feet bgs) were excavated in 2011 during the post-RI TCRA (USACE 2012). Sample data from these locations were the primary contributors to the ELCR under the hypothetical unrestricted exposure to subsurface soil scenario and, since these areas have been excavated, risk estimates presented in the HHRA may overestimate current risk.

  In addition, TCE groundwater concentrations have decreased substantially and have not exceeded PCLs in several years. Since TCE was the primary contributor to the ELCR at several monitoring points, it likely that the risk estimate for unrestricted exposure to groundwater outside the capture zone conservatively overestimates actual risk.

  The risk assessment identified one location with metal concentrations that resulted in a HI greater than the EPA and ADEC threshold of 1 under the hypothetical unrestricted use scenario. This determination was based upon one sample collected during the 2006 PSE at a depth of 6 feet bgs (sample 06TP19SO2). Aluminum and copper concentrations in this one sample resulted in a HI of 5. In 2008, soil in this area was excavated so the HI of 5 presented in this ROD conservatively overestimates actual non-cancer risk.

- During both the December 2008 and August 2009 sub-slab soil gas sampling events, the heating and ventilation systems in each home were set to simulate typical living conditions (units were generally around 68 ºF at the time of sampling). As a result, the data are anticipated to represent reasonably anticipated future use (residential) conditions. The HHRA does not address potential exposures should the heating and ventilation systems require maintenance and be off intermittently. However, it is not anticipated that the frequency and duration of such events would be long enough to significantly alter the characteristics of vapor intrusion (if any), when compared with the long-term chronic exposures assumed for the characterization of risk for this pathway.

Uncertainties Associated with Toxicity Assessment

Uncertainties in toxicological data can also influence the reliability of risk management decisions. The toxicity values used for quantifying risk in this risk assessment have varying levels of confidence that could affect the confidence in the resulting risk estimates. The general sources of toxicological uncertainty include the following:

- Extrapolation of dose-response data derived from high dose exposures to adverse health effects that could occur at the low levels seen in the environment
- Extrapolation of dose-response data derived from short-term tests to predict effects of chronic exposures
- Extrapolation of dose-response data derived from animal studies to predict effects on humans
- Extrapolation of dose-response data from homogeneous populations to predict effects on the general population.

The levels of uncertainty associated with the RfDs and RfCs for the COPCs (as judged by EPA) are expressed as uncertainty factors and modifying factors, and provided in IRIS or HEAST. For chemicals suspected of resulting in cancer effects, uncertainty is in part expressed in terms of the EPA weight-of-evidence classification.

Other specific areas of toxicological uncertainty associated with the risk assessments are as follows:

- The HHRA used available chronic RfDs for the oral exposure route. This approach may represent a conservative measure for the future maintenance worker, excavation worker, and recreational/site visitor exposure scenarios, because it is most likely that any exposure would be intermittent and of shorter-than-lifetime duration.

- Toxicity values were not available for several chemicals detected; therefore, a surrogate toxicity factor for a structurally similar chemical was used. If a structurally similar compound could not be identified, it was not carried forward into the risk assessment. Inclusion of these surrogates in the HHRA could result in an overestimation of risk at the site, if they, in fact, have higher toxicity than the chemical they are representing. Most often, chemicals without available toxicity data are generally considered less toxic because most of the toxicological literature focuses on the chemicals considered more toxic to human receptors.

- In cases for which the species of metal is unknown, the HHRA conservatively assumed the most toxic form is present. For example, the HHRA assumed that total chromium present in soil at the FCS is in the form of hexavalent chromium. It is very likely that only a small portion of total chromium in soil is present in the more toxic hexavalent form. Because hexavalent chromium is considered a carcinogen, assuming it is present when it is not results in ELCR overestimation.

- Dermal exposures are different from oral exposures because not all of a chemical that comes into contact with a person's skin travels across the various layers of epidermal tissue, as indicated by a skin permeability factor, and because the toxic effects produced from this route of exposure might not be the same as when the chemical is ingested. In lieu of available toxicity values for the dermal route, this HHRA uses oral toxicity values to estimate the effects of dermally available chemicals. This approach could result in an underestimation or an overestimation of risks, depending on whether a chemical is more or less toxic by the dermal route versus by ingestion.

- At the time of the RI, the EPA was reevaluating the toxicology supporting the assessment of cancer risk from exposure to TCE. While the RI was being conducted, EPA released an External Review Draft of the *IRIS Toxicological Review of Trichloroethylene* (EPA 2009d), and revised TCE cancer slope factors were added to its IRIS database in 2011. ADEC requires the use of factors based on the upper-bound cancer slope factor identified in the EPA draft risk assessment for TCE (EPA 2001). These draft slope factors are about 28-fold more stringent than the factors released by EPA prior to the 2011 update.

  This HHRA uses the more conservative slope factors provided by ADEC. However, for cases where risk estimates are found to be contributed by TCE using the ADEC toxicity factors, a corresponding risk is also estimated using the draft oral slope factor and IUR, adopted by EPA in 2011 (EPA 2009d). These side-by-side risk estimates were included to allow risk managers to make the most informed risk management decisions, considering the most current understanding of the toxicology of TCE. The IRIS TCE toxicity values updated in 2011 reflect the 28-fold more stringent values.

- Since the 2010 HHRA was completed, EPA's Office of Research and Development finalized its toxicological review of TCE in 2011, and its IRIS database file was updated in October of that year with values for chronic oral and inhalation exposures to TCE. Then in December 2012, EPA Region 10 issued *OEA Recommendations Regarding Trichloroethylene Toxicity in Human Health Risk Assessments* (EPA 2012) related to potential risks from short-term TCE exposure in women of reproductive age in a residential setting. These action levels are based on the potential occurrence of developmental health effects (fetal cardiac malformations) related to exposures in pregnant women during a critical window of time in the first trimester of pregnancy.

As described in a technical memorandum (CH2M HILL 2013) the conclusions of the 2010 HHRA for the FCS remain unchanged by the recent EPA Region 10 recommendations, and no unacceptable short-term risk is identified for the residential exposure scenario under reasonably anticipated future land use conditions. A risk-based concentration of 909 micrograms per cubic meter ($\mu g/m^3$) in soil gas is computed to result in a short-term non-cancer HQ of 1.0; sub-slab soil TCE concentrations measured at the FCS have never approached this level. Using the site-specific attenuation factor of 0.0022, the highest sub-slab TCE concentration measured (110 $\mu g/m^3$) results in a projected indoor maximum concentration of 0.24 $\mu g/m^3$ and an HQ of 0.12, nearly an order of magnitude lower than the EPA screening level and risk threshold, respectively.

- As discussed previously, during initial 2007 soil gas sampling for the RI, MDLs for many of the target analytes were elevated because of the unanticipated presence of high levels of Freon-like compounds in the soil gas. The Freon-like compounds were believed to be related to foam board and spray foam insulation used during construction of the housing development and were not considered target analytes for the RI. To address this interference, special analytical methods were used during the December 2008 sub-slab soil gas sampling, to remove the negative influence on MDLs. At the request of ADEC, a risk screening of the Freon-like compounds that were tentatively identified compounds (TIC) during 2007 was conducted. The TICs reported at 55 locations in 2007 included 1,1-difluoroethane (DFA) and 1-chloro-1,1-difluoroethane (CDFA). Indoor air concentrations were estimated from soil gas concentrations by using a site-specific attenuation factor, and the results were compared with EPA RSLs for these chemicals. Using the maximum detects for these two Freon-like compounds, HQs are 0.02 for DFA and 0.002 for CDFA. These results indicate that DFA and CDFA do not represent a source of unacceptable risk at the FCS.
- The toxicity reference values used to develop the ecological SSLs (EcoSSL), benchmarks used for the ecological screening evaluation, are typically based on no observed adverse effect levels. However, actual toxicity is expected within the range between a no observed adverse effect levels and the lowest bounded lowest observed adverse effect level.

Uncertainties Associated with Risk Characterization

In the risk characterization, the assumption was made that the total risk of developing cancer from exposure to site contaminants is the sum of the risk attributed to each individual contaminant. Likewise, the potential for the development of non-cancer adverse effects is the sum of the HQs estimated for exposure to each individual contaminant. This approach, in accordance with EPA guidance, did not account for the possibility that chemicals act synergistically or antagonistically. Other specific assumptions made related to risk characterization include the following:

- The HHRA evaluated both the reasonably anticipated future use (residential) exposure scenario and the hypothetical unrestricted exposure scenario for comparative purposes to document the difference between unrestricted access versus the potential risk when considering existing restrictions that preclude digging onsite, and prevent use of groundwater from areas other than the existing FWA supply wells. When interpreting the results of this risk assessment, it should be noted that the hypothetical unrestricted exposure scenario results do not represent a reasonably likely outcome, but are provided as a comparative perspective.
- To address the possibility that future residents could be exposed to more than one medium at the FCS, the cumulative multimedia risk and hazard estimates were calculated as the sum of the risks and hazards for each exposure medium. The multimedia risk characterization conservatively assumed that cumulative exposure occurs to the highest levels at any surface soil and sub-slab soil gas locations, combined with exposure from domestic use of FWA water supply water. Yet even with the use of this very conservative approach, HI and ELCR estimates are below the EPA and ADEC risk threshold values.
- Because some chemicals detected in site media occur naturally or are found regionally because of general anthropogenic sources, it is important, when interpreting risks, to consider the relative level of potential risk posed by naturally occurring or anthropogenic levels. For soil, only arsenic was excluded from the exposure estimates because arsenic concentrations are within levels typical of background near the FCS. The maximum, mean, and median detected arsenic levels in the background data set were 38, 7.1, and 6.9 mg/kg, respectively, compared with the maximum, mean, and median levels in the FCS data set of 37.1, 9.0, and 8.0 mg/kg, respectively. However, even natural levels of arsenic exceed risk-based concentrations, including the ADEC Table B1 value of 4.5 mg/kg. Depending on the actual bioavailability of the arsenic from soil found around Fairbanks (which is likely well below the conservative 100 percent bioavailability assumed for the Table B1 value), if the natural levels of arsenic were to be included into the exposure estimates reported in the risk assessments, risks could be somewhat higher than reported. The maximum arsenic concentration detected in soil at the FCS equates to a residential ELCR of 7×10^{-5} and a HQ of 0.4, and the maximum background arsenic equates to a residential ELCR of 8×10^{-5} and a HQ of 0.4.
- Ambient air contains anthropogenic levels of some VOCs that were also detected in sub-slab soil gas at the FCS. To provide some perspective on the influence of ambient air background, risk estimates were calculated for samples collected at the perimeter fence at the FCS. However, ambient background levels were not subtracted from the levels measured in sub-slab soil gas. This conservative approach provides added confidence that the risk and hazard estimates for the vapor intrusion pathway are reliable for decision-making.

As discussed previously, some residual debris could not be removed because of concerns about the structural stability of nearby buildings. Buildings where debris appeared to continue beneath the foundation and could not be removed are shown on Figure A-22. The presence of buried metal does not always correlate with the presence of intact drums of chemicals or contaminated soil; it is only a suggestion that such conditions are possible. A weight-of-evidence evaluation was conducted to determine the plausibility that 1) a drum could exist that was intact, and 2) what the most plausible contents of such a drum could be. The available lines of evidence seem to indicate that, based on past observations, the probability of intact drums remaining is low, because less than 0.5 percent of those found had enough liquid or tar-like substance in them to collect samples for analysis, and any liquid contents of such a drum would most reasonably contain some type of petroleum-based liquid.

Petroleum compounds tend to have higher degradation rates and lower toxicity than halogenated solvents. Estimated concentrations of petroleum compounds in sub-slab vapor that might pose intermediate exposure risk to residents would be many orders of magnitude higher than any of the concentrations observed during the RI. For example, the levels of BTEX necessary to pose intermediate exposure risk (based on the published ATSDR minimal risk levels; ATSDR 2009) would be 8.7, 136, 1,372, and 1,177 mg/m^3, for benzene, toluene, ethylbenzene, and xylene, respectively. These values were calculated by dividing the ATSDR intermediate (or in the case of toluene, chronic) MRLs by the site-specific sub-slab soil gas to indoor air attenuation factor of 0.0022 for radon. These sub-slab soil gas levels are greater than 7,900-fold, 22,000-fold, 150,000-fold, and 12,700-fold higher than the maximum levels detected during the RI of 0.0011, 0.0061, 0.0089, and 0.092 mg/m^3, respectively, for BTEX.

2.7.2 Summary of Ecological Risks

The ERA presents an analysis of the potential for adverse ecological effects associated with contaminants at the FCS and was conducted in accordance with ADEC guidance (2009b) and EPA guidance (1992, 1997a, 1997b, 1998). Both ADEC and EPA recommend using a phased approach, with each phase more detailed than the preceding. Use of this approach focuses the ERA on the COPECs, receptors, and areas where the greatest potential for ecological exposure would be expected. The ERA consisted of a Phase 1 ecoscoping assessment and Phase 2 screening assessment.

Ecoscoping

Ecoscoping provides a conservative qualitative determination of whether there is any reason to believe that ecological receptors, exposure pathways, or both are present or potentially present at or near the facility to determine whether further ecological evaluation is warranted (ADEC 2009b). A number of factors are considered during the ecoscoping process such as visual determination of obvious signs of toxicity and identification of areas that are obviously devoid of ecological exposures or where ecological exposures could occur. The ecoscoping assessment concluded the following:

- Potential ecological exposure to onsite soil is considered incomplete because of the lack of suitable habitat to support ecological populations.
- A screening-level ERA was warranted to evaluate potential exposures of aquatic resources and piscivorous wildlife to chemicals in groundwater that could reach the Chena River.
- A screening-level ERA was warranted to evaluate risks to terrestrial wildlife (mammals and birds) potentially exposed to site-related chemicals in sediment from swales adjacent to the FCS.

The drainage swales only contain flowing water for a limited time during the spring snowmelt/runoff season. Therefore, aquatic resources do not reside in the drainage swales. However, the ERA conservatively screened sediment samples collected from these swales to address the possibility of migration to the Chena River where benthic macroinvertebrates could be exposed.

Screening Assessment

Screening of media-specific concentrations was determined to be necessary as part of the second phase of the ERA. Data used for the screening ERA were obtained from samples collected in 2007 through 2009 as part of the FCS RI. The data set included drainage swale surface soil/sediment (0 to 2 feet bgs) and groundwater collected for the purpose of site characterization.

As recommended in ADEC guidance (ADEC 2009b, 2009c), the screening-level risk assessment should provide further evaluation of site data exceeding ADEC ecological risk-based screening concentrations (ERBSC) (ADEC 2009b) or that have been identified as potentially bioaccumulative. Therefore, drainage swale soil/sediment and groundwater concentrations for COPECs identified in the section titled, *Identification of Chemicals of Potential Ecological Concern* (below), were compared directly with levels believed to be protective of ecological receptors near the FCS.

The following screening benchmarks were used to determine the potential for adverse effects on ecological receptors:

- For riparian and aquatic birds and mammals potentially exposed through the food chain, individual drainage swale samples were compared directly with EPA EcoSSL protective of birds and mammals (EPA 2005a, 2005b, 2008). EcoSSLs incorporate both direct exposure (e.g., incidental ingestion of soil) and exposure through bioaccumulation into food items. EcoSSLs are conservative benchmarks developed specifically for use in Step 2 of the EPA ERA process.
- Drainage swale samples were compared with threshold effects concentrations (TEC) and probable effects concentrations (PEC) (MacDonald et al. 2000), and with threshold effects levels and probable effects levels (PEL) from the *Screening Quick Reference Tables* (National Oceanic and Atmospheric Administration [NOAA] 2009).
- For benthic and aquatic resources at the Chena River, results from individual groundwater samples were compared directly with EPA chronic and acute ambient water quality criteria (WQC) (EPA 2009c).

In addition to the benchmark screening, spatial attenuation of contaminant concentrations and naturally occurring levels of metals were considered as other lines of evidence in the ERA. Metals with site concentrations within the reported range of natural conditions would not require additional evaluation.

Identification of Contaminants of Potential Ecological Concern

Drainage swale samples. Analytical data from three surface soil/sediment samples (and one duplicate) were collected from the drainage swale running along the western property boundary. This swale ultimately drains the entire FCS and feeds into a culvert that drains into the Chena River. At the time of sample collection, straw bales were positioned to collect sediment in the runoff before any water discharged to the culvert. This trapped sediment was judgmentally sampled, as it was considered to be representative of the highest concentrations of any contaminated sediment that might enter the Chena River. The swale has since been re-engineered/improved and is now lined with gravel. A total of 41 chemicals, including metals, PAHs, organochlorine pesticides, VOCs, SVOCs, and petroleum compounds were detected in the drainage swale samples.

Groundwater samples. Analytical data from ten groundwater locations were used for the ERA. These samples were collected from the northern-most, downgradient monitoring wells along the northern property boundary of the FCS (MW35, MW36, MW37, MW38, MW40, MW41, MW77, MW82, MW83, and MW84; Figure A-8). A total of 54 chemicals including metals, PAHs, organochlorine pesticides, VOCs, SVOCs, explosive compounds, and DRO were detected in at least one of the perimeter monitoring wells. Groundwater data from nearby wells were used to assess the degree of spatial attenuation.

All chemicals detected, including estimated values, were used in the ERA. Consistent with ADEC guidance (ADEC 2009), detected chemicals were considered COPECs requiring further evaluation if they met one of the following criteria:

- Maximum detected chemical concentrations exceed ERBSC provided in Appendix D of Ecoscoping Guidance (ADEC 2009b).
- Chemical is identified as potentially bioaccumulative according to Appendix C of Ecoscoping Guidance (ADEC 2009b).

On the basis of these selection criteria, 29 COPECs were identified for drainage swale soil/sediment and 16 COPECs were identified for groundwater. As noted by ADEC (2009b, 2009c), the screening criteria used for COPEC selection are the most conservative of a number of benchmarks. Chemical concentrations exceeding those benchmarks were identified as COPECs. Per ADEC's Scoping Factor 5 (ADEC 2009b), these COPECs require a more in depth analysis that may include use of other applicable screening benchmarks protective of site receptors and conditions. This evaluation was done through additional screening, as described in the RI section titled, Screening Methodology and Results.

Exposure Assessment

The ecological setting and CSM are provided in Section 2.5.1 and Section 2.5.2 of this ROD, respectively. Both EPA guidance (EPA 1998) and the ADEC 2009 Ecoscoping Guidance (Scoping Factor 3) (ADEC 2009b) consider the quality and availability of habitat as important factors for determining whether an ERA for onsite exposure to soil is needed. The ADEC guidance states that "Industrialized or densely populated urban areas usually do not contain important habitats" (ADEC 2009b). Typically, most of the natural vegetation that could support wildlife has been removed. Because no quality habitat exists or will exist at the FCS that is capable of supporting ecological populations, an ERA for onsite soil is unnecessary.

Based on ecoscoping and information obtained during the RI, plausible ecological exposure pathways identified in the CSM are as follows:

- Potential exposures of aquatic resources and piscivorous (fish-eating) wildlife to chemicals in groundwater that could reach the Chena River
- Potential exposure of terrestrial wildlife (mammals and birds) to site-related chemicals in sediment from drainage swales adjacent to the FCS
- Hypothetical exposure of benthic macroinvertebrates to drainage swale sediments potentially migrating to the Chena River; however, it should be noted that there are no sediment-dwelling organisms present in the drainage swale.

Considering this, the Phase 2 screening assessment evaluates ecological exposures associated with soil/sediment in the drainage swales, and groundwater in monitoring wells nearest to the Chena River and downgradient (north) from the FCS.

Ecological Effects Assessment

No toxicity tests or field studies were considered to be necessary for this screening evaluation.

Ecological Risk Characterization

The results for the ecological screening at the FCS are summarized below.

Screening Results for Birds and Mammals. Of the 41 chemicals detected in drainage swale soil/sediment, 29 were selected as COPECs. Ten of the 29 COPECs (antimony, cadmium, chromium, copper, lead, selenium, vanadium, zinc, dichlorodiphenyldichloroethene (DDE), and DDT exceeded either bird or mammal EcoSSLs. Several COPECs were also identified as potentially bioaccumulative through application of ADEC criteria (bioconcentration factor greater than 1,000 or log octanol-water partition coefficient [K_{ow}] greater than 3.5).

For COPECs exceeding EcoSSLs for either birds or mammals, exceedances by the maximum detected concentrations are relatively low; that is, all factors of exceedances are 10 or less, as follows:

- **Antimony:** Maximum detected concentration (1.8 mg/kg) exceeds the EcoSSL for mammals by a factor of 6.7
- **Cadmium:** Maximum detected concentration (0.67 mg/kg) exceeds the EcoSSL for mammals by a factor of 1.9
- **Chromium:** Maximum detected concentration (33.9 mg/kg) exceeds the EcoSSL for birds by a factor of 1.3
- **Copper:** Maximum detected concentration (55.1 mg/kg) exceeds the EcoSSL for birds by a factor of 2.0
- **Lead:** Maximum detected concentration (60 mg/kg) exceeds the EcoSSL for birds by a factor of 5.5
- **Selenium:** Maximum detected concentration (0.93 mg/kg) exceeds the EcoSSL for mammals by a factor of 1.5
- **Vanadium:** Maximum detected concentration (49.5 mg/kg) exceeds the EcoSSL for birds by a factor of 6.3
- **Zinc:** Maximum detected concentration (252 mg/kg) exceeds the EcoSSL for mammals by a factor of 5.5
- **DDE:** Maximum detected concentration exceeds the EcoSSL for mammals by a factor of 1.7
- **DDT:** Maximum detected concentration exceeds the EcoSSL for mammals by a factor of 7.6.

Because the EcoSSLs used for the screening assessment conservatively assume that all wildlife exposure is limited to the small location (less than 0.5 acre) where ecological exposures are possible, exceedance of some screening levels can be expected. The screening results summarized above are based on the highly conservative assumption that ecological receptors receive all their food from the small swale northeast of the FCS. In reality, only a small portion of their forage (and thus exposure) would come from such a small area. When considering the documented home ranges (Table 7) for potential ecological receptors that might be expected at FWA such as the northern harrier, kestrel, mallard, red fox, mink, and hare (refer to Appendix D of the *Post-Wide Risk Assessment*; HLA 1997), the exposure rate is expected to be well below the unacceptable levels. For example, the hare has a reported home range of about 14.5 acres and the drainage swale represents only about 3.4 percent of this hare foraging area. This fraction can be used as a numerical adjustment to the exceedance factors listed above. Given the low factors of exceedance listed above and the foraging areas for representative wildlife, it is not anticipated that the levels found in 2007 would pose meaningful risk of ecological importance.

Screening Results for Aquatic and Benthic Resources. The screening levels used are considered protective of benthic and aquatic resources. The results by medium are provided below.

Drainage Swale Surface Soil/Sediment. Of the 29 COPECs identified, only arsenic and nickel were detected at maximum concentrations exceeding the corresponding PEL:

- Arsenic—maximum detected concentration exceeds the PEL by a factor of 1.5
- Nickel—maximum detected concentration exceeds the PEL by a factor of 1.1

None of the COPECs (including arsenic and nickel) exceeds its respective PEC. The PEC is considered a more reliable benchmark than the PEL because it represents a consensus-based sediment quality guideline (MacDonald et al. 2000) that includes consideration of multiple reported guidelines, including PELs. Given that none of the COPECs exceeds its PEC, the exceedances of PELs are low, and without consideration of the degree of attenuation associated with migration of drainage swale sediments to the Chena River, the risk posed by drainage swale samples to aquatic/benthic organisms is considered low.

The likelihood of significant migration of sediment from the drainage swale to the Chena River is considered very low as a result low gradient and limited surface drainage flows. The drainage swale receives seasonal runoff water from offsite (the adjacent housing area to the west). Additionally, given the large distance (1,500 feet) between the drainage swale and the Chena River, significant attenuation would be expected over a relatively short distance. This can be clearly seen from the concentration gradient exhibited for 4,4'-DDT, with levels of 0.16, 0.023, and 0.008 mg/kg at sample locations DSS01-01, DSS01-03, and DSS01-02, respectively (locations listed from upstream to downstream). Since the swale samples were collected in 2007, the swale has been re-engineered to include a bed of 3 to 6 inches of coarse gravel and is vegetated.

Consideration of Background Levels for Metals. Although site-specific background data for soil/sediment are not available for the metals above, it should be noted that the background concentrations in Alaska soils as reported by USACE (1994) and USGS (1988) are as follows:

Table 6
Background Metals Concentrations, Fort Wainwright and Fairbanks, Alaska Area

Metal	Maximum Detected Concentration (mg/kg)	Background Concentration (mg/kg)	Source
Antimony	1.8	not available	none
Cadmium	0.67	0.6	USACE 1994
Chromium	33.9	15 (5-390, mean 55)	USACE 1994 (USGS 1988)
Copper	55.1	3-810, mean 24	USGS 1988
Lead	60	11 (<4-310, mean 12)	USGS 1994 (USGS 1988)
Selenium	0.93	not available	none
Vanadium	49.5	11-490, mean 112	USGS 1988
Zinc	252	<20 – 2,700, mean 70	USGS 1988

These concentrations indicate that the maximum concentrations of metals in drainage swale samples appear to be within levels that could naturally occur within Alaska, although background data were not available for all metals (for example, antimony and selenium).

Potential Offsite Discharge of Groundwater. Of the 54 chemicals detected in groundwater along the northern perimeter of the FCS, 16 were selected as COPECs because they exceeded the ADEC ERBSCs. Of these 16 chemicals, only selenium (once over five sampling events) was detected at a maximum concentration exceeding acute WQC; only total aluminum, total copper, total iron, total nickel, total selenium, alpha-chlordane, gamma-chlordane, and DDT concentrations exceeded chronic WQC:

- Aluminum, arsenic, barium, iron, lead, and manganese concentrations were detected at concentrations consistent with background levels.
- Selenium exceeded the chronic WQC in only two wells (MW35 and MW36) by a maximum factor of 3.6.
- Alpha- and gamma-chlordane exceeded the chronic WQC by maximum factors of 1.5 and 2.2, respectively. Detected levels were measured in only one sample each (occurring during October 2008 for alpha-chlordane at MW36 and gamma-chlordane at MW77). Two subsequent results for alpha- and gamma-chlordane at each well resulted in nondetect levels; however, detection limits were about two times the chronic WQC.
- DDT was detected at only one (MW38) of the seven perimeter wells evaluated. DDT exceeded the chronic WQC by a maximum factor of 13 (in October 2007). Four subsequent results for MW38 resulted in nondetect levels of DDT; however, the detection limits were above the chronic WQC.

Boron, cobalt, naphthalene, and toluene were identified as COPECs because they exceeded ADEC ERBSC aquatic screening levels. WQC were not available for use in evaluating these COPECs. Boron and cobalt background data were unavailable; however, detected levels in wells throughout the area indicate that boron is ubiquitous and no source areas are apparent.

Naphthalene was not detected above the ADEC ERBSC in the two most recent sampling events. Toluene was not detected in any well during the two most recent sampling events. Additionally, the maximum detected toluene concentration (2.9 μg/L) was below its respective chronic screening benchmark (9.8 μg/L) recommend by NOAA (2009). Considering that the distance between the northern perimeter monitoring wells and the Chena River is greater than 1,500 feet, significant attenuation is expected before groundwater reaches actual aquatic or benthic receptors in the Chena River. This attenuation would be a result of biodegradation, dispersion, dilution, adsorption, volatilization, and chemical or biological stabilization or destruction of constituents. To provide some indication of the degree of spatial attenuation that could occur at the site, levels of TCE were evaluated because this chemical is relatively persistent in groundwater and is believed to have originated from onsite groundwater and migrated north of the FCS. TCE concentrations were compared between MW77 and MW84, which is located approximately 450 feet downgradient of MW77. The TCE measured at MW77 were 1.81 and 1.28 µg/L in June and September 2009, respectively, while TCE was not detected (the MDL was 0.014 µg/L) in MW84 in November 2009. This indicates that TCE concentrations have attenuated about a hundredfold over this distance. Given the distance between the wells evaluated in this ERA and the Chena River, and the inferred extent of attenuation observed prior to reaching the river, the level of exposure and risk posed to offsite aquatic resources through groundwater migration from the FCS to the Chena River is considered to be low. Another line of evidence in support of this conclusion is the observation that residual contamination is relatively isolated onsite, fairly well understood, and likely to remain contained onsite (CH2M HILL 2010a).

Table 7
Home Range Information for Representative Wildlife

Wildlife	Description
Northern Harrier	Several home range/territory area studies on northern harriers have been summarized by the California Department of Fish and Game and estimate their home range to be between 40 and 2,200 acres (1990). An extensive study of feeding territories among birds indicated that the mean feeding territory for northern harriers is 623 acres.
American Kestrel	Literature estimates of the American kestrel home range are from 52 to 1,235 acres.
Mallard	Literature estimates of the mallard home range are from 98 to >3,000 acres.
Red Fox	Literature estimates of the red fox home range are from 680 to 8,450 acres.
Mink	Literature estimates of the mink home range are from 19 to 1,900 acres.
Snowshoe Hare	Mean home range of 14.5 acres; no significant difference in home range sizes between males and females.

Note:
Source: *Fort Wainwright Post-Wide Risk Assessment* (HLA 1997)

The ERA was conducted in accordance with ADEC and EPA guidance, focusing on COPECs, receptors, and areas where the greatest potential for ecological exposure might be expected. The risk to offsite terrestrial wildlife and offsite aquatic resources potentially exposed to the

COPECs occurring in the drainage swale and groundwater is considered to be low. This conclusion was drawn in consideration of the following:

- The likely infrequent use of small drainage swales
- The ephemeral nature of the drainage swales
- The relatively low magnitudes by which COPEC concentrations exceed conservative screening levels
- The expected amount of spatial attenuation, indicating that unacceptable risk to ecological populations is unlikely.

Given these findings, no COPECS or areas were identified that would require additional sampling and evaluation from the drainage swale or perimeter well points to protect ecological resources potentially using the FCS.

2.7.3 Basis for Action

When interpreting estimates of ELCR, EPA under the Superfund program generally considers action to be warranted when the multi-chemical aggregate cancer risk for all exposure routes within a specific exposure scenario exceeds 10^{-4}. Under both EPA and ADEC guidance, unacceptable non-cancer hazard exists if the multi-chemical aggregate non-cancer hazard for all exposure routes within a specific exposure scenario exceeds a target non-cancer HI of 1.

The results of the hypothetical unrestricted residential exposure scenario indicate that, under the default assumptions for domestic use of groundwater and direct contact with soil down to 15 feet bgs anywhere across the site, HI and ELCR estimates are above target risk thresholds. Based on the RI data, the HI for direct contact with soil was 5 and the ELCR for domestic use of groundwater was 2×10^{-3}, which exceeds target risk thresholds. Based on the RI results, response actions selected in this ROD are necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances, pollutants or contaminants into the environment that may pose an imminent and substantial endangerment to public health, welfare or the environment. The specific reasons for conducting remedial actions at the FCS include the following:

- Subsurface soil contained DRO, VOCs, SVOCs, and metals at concentrations that exceed risk-based cleanup levels (PCLs).
- Groundwater contains VOCs at concentrations exceeding risk-based cleanup levels (PCLs).
- Hazardous substances and contaminants in subsurface soil pose a potential risk to future users of the FCS under the unrestricted use scenario.
- Hazardous substances and contaminants in groundwater pose a potential risk to future users of the FCS under the unrestricted use scenario.

2.8 REMEDIAL ACTION OBJECTIVES

RAOs are media-specific cleanup goals for a selected remedial action. They describe what the remedial action is expected to accomplish. For the FCS, PCLs are based primarily on ADEC Method Two direct contact and inhalation risk-based cleanup levels for soil and ADEC Table C cleanup levels for groundwater. For those substances that do not have Method Two cleanup levels, the most stringent EPA RSL was used. Background metals concentrations are used as PCLs for metals with background concentrations higher than the ADEC and EPA risk-based cleanup or screening levels.

The RAOs for protection of human health and the environment at the FCS are as follows:

- Protect against human exposure to COCs in soil (Table 1). This RAO will be achieved if soil containing COCs at concentrations exceeding PCLs is managed through administrative processes, or if COCs in soil are reduced to meet PCLs.

- Protect against human exposure to COCs in groundwater (Table 2). This RAO will be attained if the exposure pathway to human receptors is limited or eliminated through administrative processes, or if COC concentrations in groundwater are reduced to meet PCLs.
- Return groundwater to its beneficial use as a drinking water source. VOCs are expected to reach PCLs within 25 years; it is expected that remediation of DRO and RRO will take longer. This RAO will be achieved when groundwater COCs are below PCLs.

2.8.1 Significant Applicable or Relevant and Appropriate Requirements

Section 121(d) of the CERCLA requires that CERCLA remedial actions must attain (or justify the waiver of) any federal or more stringent state environmental standards, requirements, criteria, or limitations that are determined to be ARARs. Applicable requirements are those cleanup standards, standards of control and other substantive requirements, criteria, or limitations promulgated under federal or state environmental or facility siting law that specifically address a hazardous substance, pollutant or contaminant, remedial action, location, or other circumstance found at a CERCLA site. A full list of ARARs is provided in Appendix B. Substantive requirements of the following ARARs apply to the remedy selected for the FCS:

- 40 CFR Part 141Maximum Contaminant Levels
- State of Alaska regulation 18 AAC 75.345
- State of Alaska regulation 18 AAC 75.355
- State of Alaska regulation 18 AAC 75.360
- State of Alaska regulation 18 AAC 75.375(c).

2.9 DESCRIPTION OF ALTERNATIVES

This section describes the identification and screening of remedial technologies to satisfy the RAOs defined for the FCS. The approach taken is consistent with the *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA 1988). General response actions are intended to: (1) mitigate potential exposure to, (2) control the migration of, and/or (3) remediate the COCs. General response actions may include treatment, containment, excavation, extraction, disposal, institutional controls, or a combination of these. A No Action general response is included as a baseline for comparison.

Except for the No Action alternative, each general response action can be achieved by several remedial technologies. Remedial technologies are defined as the general categories of remedies under a general response action. For example, capping is one of the remedial technologies under the general response action of containment. Process options are specific categories of remedies within each remedial technology and are used to implement each remedial technology. For example, the remedial technology of capping could be implemented by using one of several types of capping options (e.g., soil cap or multi-layered cap).

This section identifies the general response actions and associated remedial technologies and process options deemed applicable for addressing contaminated soil and groundwater. Results of applicability screening are presented in the FS (CH2M HILL 2011a), Table 4-1, *Applicability Screening of Remediation Technologies and Process Options*.

2.9.1 Description of Remedy Components

Following the development of the general response actions, process options deemed applicable for implementing the general response actions are evaluated for effectiveness, institutional implementability, and relative cost. After this screening, reasonable remedial alternatives for the FCS were selected. The assembly of selected process options into remedial alternatives chosen for additional evaluation is shown in Table 8.

Table 8
Remedial Alternatives from Selected Representative Process Options

General Response Action	Remedial Technology	Representative Process Option	Alternative					
			S1	S2	GW1	GW2	GW3	GW4
No Action	None	None	●		●			
Institutional Controls	Governmental controls	U.S. Army Garrison FWA		●		●	○	●
Monitoring	Monitoring	Groundwater monitoring					○	
		MNA				○		○
Treatment	In situ chemical treatment	PRB						●
		Chemical oxidation/reduction					○	

Notes:
Alternative S1/GW1 = No Action
Alternative S2 = Institutional Controls to Restrict Excavation of Soil
Alternative GW2 = MNA and Institutional Controls to Prohibit Groundwater Use
Alternative GW3 = ISCO and Institutional Controls to Prohibit Groundwater Use
Alternative GW4 = PRB, MNA, and Institutional Controls to Prohibit Groundwater Use
○ = Process option can be discontinued when remedial action is complete and preliminary cleanup goals are met. The remedial action includes any post-remediation sample collection and/or monitoring required to demonstrate that RAOs and preliminary cleanup goals have been met.
● = Process option to continue into the foreseeable future.

Alternatives were developed separately for soil and groundwater to facilitate the evaluation of alternatives for each media, and the proper selection of appropriate remedies. The alternatives developed for the FCS consist of the following:

- **Alternative S1/GW1**: No Action
- **Alternative S2:** Institutional Controls to Restrict Excavation of Soil
- **Alternative GW2:** MNA and Institutional Controls to Prohibit Groundwater Use
- **Alternative GW3:** In Situ Chemical Oxidation (ISCO) and Institutional Controls to Prohibit Groundwater Use
- **Alternative GW4:** Permeable Reactive Barrier (PRB), MNA, and Institutional Controls to Prohibit Groundwater Use.

Cost estimates for each alternative that was carried through the FS were escalated to reflect 2013 costs for materials, equipment, and labor. The discount rate used for these calculations was 1.1 percent and was taken from Appendix C of the Office of Management and Budget Circular A-94 (December 2012) for real discount rates over a 30-year period. These changes are not considered to be significant as they do not affect the comparative analysis of alternatives and do not change the remedy selected. These changes in estimated costs were reasonably anticipated.

2.9.2 Alternative S1/GW1 – No Action

Under the No Action alternative, there would be no remedial actions implemented for soil or groundwater to address contamination. The No Action alternative does not include monitoring, site controls, or decommissioning of existing wells and sampling points. Although natural attenuation would occur under this alternative, it would not be measured or evaluated, because no sampling or monitoring would be conducted.

Development of the No Action alternative is required by the NCP to serve as a baseline for comparison with other alternatives. This alternative serves as a baseline by reflecting current conditions without any cleanup effort. The No Action alternative was evaluated consistently with NCP requirements. No present worth, capital, O&M, or groundwater monitoring costs are associated with the No Action alternative.

Alternative S1/GW1 Costs
Capital Cost: $0
Annual O&M Cost: $0
Total Cost (30-year present value [PV_{30}]): $0

2.9.3 Alternative S2 – Institutional Controls to Restrict Excavation of Soil

Under Alternative S2, institutional controls would be used to restrict excavation of soil at the FCS. Institutional control boundaries are shown in Figure A-25.

The Army would implement institutional controls under this alternative to restrict excavation of soil at a depth greater than 6 inches bgs without approval of FWA DPW and concurrence of EPA and ADEC. These institutional controls would remain in place until the FCS is suitable for UU/UE. Restrictions would control access to or use of soil until PCLs are met. The specifics of the institutional controls to be implemented would be in the Remedial Design/Remedial Action Work Plan.

Alternative S2 Costs
Institutional Controls (Includes facilitation of permit process and inspections)
Total Cost (PV_{30}): $52,294

2.9.4 Alternative GW2 – Monitored Natural Attenuation and Institutional Controls to Prohibit Groundwater Use

Under Alternative GW2, institutional controls would eliminate or limit exposure pathways for COCs in groundwater to human receptors and the environment. In addition, groundwater monitoring and data evaluation would be performed periodically to assess the effectiveness of natural attenuation processes to reduce contaminant concentrations, as well as to track the extent of contaminant migration. Institutional control boundaries are shown in Figure A-25.

Under Alternative GW2, institutional controls would be implemented to eliminate or limit unacceptable exposure pathways for COCs in groundwater to human receptors and the environment through the use of non-engineered methods. These institutional controls would remain in place until the concentrations of hazardous substances in groundwater are at such levels to allow for UU/UE. Institutional controls implemented by the Army would prohibit installation of dewatering wells, monitoring wells, irrigation wells, fire suppression wells, or potable water wells without prior approval from the FWA DPW and concurrence of EPA and ADEC. This institutional control will prevent access to or use of groundwater until PCLs are met.

To the extent practicable, an MNA program would be conducted using existing groundwater monitoring wells at the FCS. Upgradient wells would be used to provide information on the background groundwater quality. Downgradient wells would be used to assess attenuation and/or degradation rates, and potential contaminant migration. MNA would target all groundwater plumes and groundwater COCs including TCE and potential degradation products, 1,2,3-TCP, RRO and DRO, and general water quality parameters (e.g., dissolved oxygen, redox-sensitive species, and oxidation-reduction potential) that would assist in the assessment of natural degradation processes. Existing data indicate that all groundwater contaminant plumes are stable or shrinking and that TCE concentrations have been below MCLs since 2011. Geometric regression analysis indicates that the TCE concentrations will meet PCLs by 2012 and that 1,2,3-TCP concentrations will meet PCLs by 2019. Concentrations of DRO have stabilized in the petroleum-affected plumes with natural attenuation processes (likely biodegradation) along the flow path preventing downgradient advection of DRO. Source removals in these areas are expected to result in decreasing contaminant concentrations in the next several years. Institutional controls would remain in place until COC concentrations meet PCLs.

Sample collection, analysis, and data evaluation would continue until contaminant concentrations reached cleanup goals. For cost estimation purposes, it is assumed that groundwater monitoring would be conducted during the entire period of MNA evaluation (30 years). The monitoring frequency is assumed to be semi-annually during the first 2 years and annually thereafter.

Alternative GW2 Costs
Institutional Control Cost: $52,294
Reports—Capital Cost: $100,000
MNA Cost: $767,746
Total Cost (PV_{30}): $920,040

2.9.5 Alternative GW3 – In Situ Chemical Oxidation and Institutional Controls to Prohibit Groundwater Use

Under Alternative GW3, ISCO would be used to decrease concentrations of COCs below cleanup goals and thereby restore groundwater use at the FCS. The same institutional controls as GW2, described in Section 2.9.4, would be implemented to address COCs and source areas not treated by the PRB to eliminate or limit exposure pathways for COCs in groundwater to human receptors and the environment. Under this alternative, the implementation of institutional controls would cease once cleanup goals were met. For cost estimation purposes, it was assumed that cleanup goals would be met after 2 years.

Peroxide-activated persulfate was selected as the representative oxidant for the ISCO remediation system at the FCS because of the wide variety of contaminants it targets, including fuel-related hydrocarbons and chlorinated VOCs. The persulfate ion ($S_2O_8^{-2}$) is a strong oxidant capable of oxidizing a wide range of organic compounds into carbon dioxide, hydrogen, chloride, and water. Persulfate would be activated by either sodium peroxide or hydrogen peroxide. The decomposition of these peroxides in the subsurface would generate localized heating, which could increase contaminant solubility in groundwater and desorption rates from soil surfaces. In addition, there is evidence suggesting that peroxide-activated persulfate generates a superoxide radical, which is able to enhance the oxidation of more recalcitrant compounds. Persulfate would remain in the subsurface for a longer period than other oxidants. Secondary effects, such as increases in total dissolved solids, and oxidation and mobilization of certain redox-sensitive metals such as arsenic, chromium, and manganese may also occur and would require monitoring.

ISCO would treat groundwater by injecting peroxide-activated persulfate within the source area portion of the following:

- The 1,2,3-TCP plume located in the east-central portion of the FCS
- The VOC (TCE and PCE) plume located in the central portion of the FCS between Buildings 14 and 49
- The fuel-related (DRO and RRO) plume located in the northern-central portion of the FCS between Buildings 07 and 08 extending northwest beyond the FCS boundaries

For cost estimation purposes, it was assumed that temporary injection points would be required to deliver the activated persulfate to the subsurface. No long-term injection wells or aboveground storage or pumping facilities would be required for the ISCO system. A small-scale pilot test would be conducted to evaluate the radius of influence of injection wells and injection effectiveness, determine the success and benefit of the technology, and assist with final design.

Groundwater monitoring would be conducted to determine the effectiveness of the remedy. The performance monitoring would target the COCs, potential degradation products, and byproducts such as sodium, sulfate, and metals. Performance monitoring, including sample collection, analysis, and data evaluation, would continue until sufficient data relative to the effectiveness of the remedy were gathered and cleanup goals met. In addition, following the attainment of cleanup goals, post-remedy monitoring would be conducted to ensure that there was no rebound of contaminant concentrations. For cost estimation purposes, it was assumed that groundwater performance and post-remedy monitoring would be conducted quarterly for an overall period of 2 years.

Alternative GW3 Costs
Institutional Controls: $52,294
ISCO—Capital Cost: $1,532,060
Groundwater Performance Monitoring—Capital Cost: $187,795
Reports—Capital Cost: $100,000
Total Cost (PV_{30}): $1,872,149

2.9.6 Alternative GW4 – Permeable Reactive Barrier, Monitored Natural Attenuation and Institutional Controls to Prohibit Groundwater Use

Under Alternative GW4, a PRB would be used to prevent 1,2,3-TCP migration into the water supply well capture zone at concentrations that represent a risk to human health. The same institutional controls as GW2, described in Section 2.9.4, would be implemented to address COCs and source areas not treated by the PRB to eliminate or limit exposure pathways for COCs in groundwater to human receptors and the environment.

PRBs represent an innovative in situ treatment technology for remediating chlorinated VOCs in groundwater. This is a passive remedial technology in which a wall of a permeable reactive media (e.g., iron filings or an iron/sand mixture) is installed across the flow path of the groundwater plume. As dissolved groundwater contaminants pass through a PRB, they react with the PRB substrate and are chemically reduced, producing environmentally benign end products. No aboveground treatment facility is required. The objective of the PRB would be to reduce contaminant concentrations and prevent the 1,2,3-TCP groundwater plume from migrating to the FWA water supply wells, thereby preventing human exposure to contaminated groundwater. Of the COCs in groundwater, 1,2,3-TCP near the FWA water supply wells northeast of the FCS represents the greatest human health risk associated with groundwater contamination.

Because fuel-related contaminants would be left in place under Alternative GW4, an MNA program would be implemented until PCLs are met. Groundwater monitoring under Alternative GW4 would include an appropriate monitoring well network to assess the PRB performance as well as natural degradation processes. For cost estimation purposes, it was assumed that groundwater monitoring would be conducted during the entire period of evaluation (30 years). MNA would be implemented as described for Alterative GW2.

PRB was not retained for further evaluation because after considering site-specific conditions, it was determined to be an ineffective or impractical alternative. Although a PRB is capable of treating 1,2,3-TCP, the hydraulic conductivity of the formation (10^{-1} centimeters per second [cm/s]) is approximately one order of magnitude greater than typical PRB materials (10^{-2} cm/s); therefore, there is likely to be no flow through the barrier, rendering this treatment approach ineffective. In addition, because the PRB would need to be installed to a depth greater than 20 feet bgs, installation of the PRB would be highly disruptive and costly. (CH2M HILL 2011a, 2011b).

3.0 COMPARATIVE ANALYSIS OF ALTERNATIVES

3.1 CERCLA EVALUATION CRITERIA

In accordance with the NCP, the remedial alternatives for the FCS were evaluated in the FS using the nine criteria described in 40 CFR Section 300.430 (e)(9)(iii) as cited in NCP Section 300.430(f)(5)(i). These nine criteria are classified as threshold criteria, balancing criteria, and modifying criteria.

3.1.1 Threshold Criteria

According to 40 CFR Section 300.430(f)(1)(i)(A), two threshold criteria must be met. An alternative must satisfy each of the following in order to be considered (TBC) for implementation:

Overall Protection of Human Health and the Environment

This criterion requires that the alternative adequately protect human health and the environment [40 CFR Section 300.430(e)(9)(iii)(A)]. It assesses how each alternative provides and maintains adequate protection of human health and the environment from unacceptable risks posed by site contaminants over both the short and long term. This criterion is also used to evaluate how risks would be eliminated, reduced, or controlled through treatment, engineering, institutional controls, or other remedial activities.

Compliance with ARARs

This criterion addresses whether a remedy will meet all of the ARARs under federal and state environmental laws or provides a basis for invoking a waiver. Section 121(d) of CERCLA and NCP Section 300.430(f)(1)(ii)(B) requires that remedial actions at CERCLA sites must, at a minimum, meet legally applicable or relevant and appropriate federal and state environmental requirements, standards, criteria, and limitations, collectively referred to as "ARARs," unless such ARARs are waived under CERCLA Section 121(d)(4).

Applicable requirements are cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. State standards identified in a timely manner that are more stringent than federal requirements may be applicable. Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site (relevant) that their use is well-suited (appropriate) to the particular site. Only those state standards that are identified in a timely manner and that are more stringent than federal requirements may be relevant and appropriate. The chemical- and action-specific ARARs identified for the FCS are presented in Appendix B; no location-specific ARARs were identified. A third type of requirement, while not an ARAR, consists of non-promulgated advisories of guidance issued by the federal or state governments. These are TBC requirements. TBCs are not legally binding, but may be used to establish cleanup goals in the absence of ARARs.

3.1.2 Primary Balancing Criteria

The five balancing criteria weigh the trade-offs between alternatives. These criteria represent the standards upon which the detailed evaluation and comparative analysis of alternatives are based. In general, a high rating on one balancing criterion can offset a low rating on another.

Long-Term Effectiveness and Permanence

This criterion considers the magnitude and nature of the residual risks and the adequacy and reliability of any associated engineering controls to maintain reliable protection of human health and the environment over time once clean-up levels have been met. This criterion normally focuses on the magnitude and nature of the risks associated with untreated waste/treatment residuals. This criterion includes consideration of the adequacy and reliability of any associated engineering controls, as well as monitoring and maintenance requirements.

Reduction of Toxicity, Mobility, or Volume Through Treatment

This criterion evaluates the degree to which the alternative employs treatment to reduce the toxicity, mobility, or volume of contamination.

Short-Term Effectiveness

This criterion evaluates the effect of implementing the alternative relative to potential risks to the general public, potential threat to workers, and time required to implement the remedial action and meet the RAOs. Potential impacts are evaluated as well as appropriate mitigative measures for maintaining protectiveness for the community, workers, environmental receptors, and potentially sensitive resources.

Implementability

This criterion addresses the technical and administrative feasibility of a remedy from design through construction and operation. Factors such as availability of services and materials, administrative feasibility, and coordination with other governmental entities are considered.

Cost

This criterion evaluates the cost of implementing each alternative. The cost of an alternative encompasses all engineering, construction administrative, and O&M costs incurred over the life of the project. The assessment against this criterion is based on the estimated present worth of these costs for each alternative. Present worth is used to estimate expenditures such as construction and O&M that occur over different time frames. This allows costs for remedial alternatives to be compared by discounting all costs to the year that the alternative is implemented. Cost estimates developed during the FS are expected to provide an accuracy of +50 percent to -30 percent.

Estimated costs for alternatives include capital costs and O&M costs. Capital costs are those expenditures required to initiate and perform a remedial action, including characterization, design, and construction costs. Capital costs consist of direct and indirect costs. Direct costs include construction (e.g., material, labor, and equipment), service equipment, buildings, and utilities. Indirect costs include such elements as Title I and Title II engineering, Title III inspection, project integration, project administration, and management.

3.1.3 Modifying Criteria

The modifying criteria allow for the influences of the state and community. The CERCLA modifying criteria rely on stakeholder participation and feedback on the Proposed Plan, which documents the evaluation of the remedial alternatives and presents the preferred alternative. Public comments on the Proposed Plan and any other components of the Administrative Record are addressed in this ROD.

State Acceptance

This criterion requires the consideration of any comments from the State regarding any action proposed for implementation.

Community Acceptance

This criterion requires the consideration of any comments from the community regarding any action proposed for implementation.

The comparative analysis of alternatives in this ROD identifies the advantages and disadvantages of the alternatives relative to one another based on the first seven of the nine CERCLA evaluation criteria. The modifying criteria were also considered. The comparative analysis using the threshold and balancing criteria is conducted separately for soil and groundwater in order to better facilitate the evaluation of alternatives for each medium of concern.

3.2 COMPARATIVE ANALYSIS OF SOIL ALTERNATIVES

The alternatives for soil at the FCS are as follows:

- **Alternative S1:** No Action
- **Alternative S2:** Institutional Controls to Restrict Excavation of Soil

3.2.1 Overall Protection of Human Health and the Environment

Overall protection of human health and the environment addresses whether each alternative provides adequate protection of human health and the environment and describes how risks posed through each exposure pathway are eliminated, reduced, or controlled, through treatment, engineering controls, and/or institutional controls.

Under the unrestricted use scenario, contaminated subsurface soil at the FCS poses an unacceptable risk to human health and the environment. If excavated, soil containing contaminants at concentrations above PCLs may pose a risk to the health of future residents. Alternative S1 would not reduce the potential threat to human health because no measures would be taken to restrict access to contaminated soil. Alternative S2 would be protective because it would prevent future residents from unauthorized excavation, which will prevent unacceptable risk resulting from exposure to remaining subsurface contaminants.

3.2.2 Compliance with Applicable or Relevant and Appropriate Requirements

Section 121(d) of CERCLA and NCP Section 300.430(f)(1)(ii)(B) require that remedial actions at CERCLA sites at least attain ARARs, unless such ARARs are waived under CERCLA Section 121(d)(4). Compliance with ARARs addresses whether a remedy will meet all of the ARARs under other federal and state environmental laws or provides a basis for invoking a waiver.

Alternative S1 would implement no cleanup or preventative measures. Alternative S2 would comply with ARARs for protection of human health and the environment.

3.2.3 Long-Term Effectiveness and Permanence

Long-term effectiveness and permanence refers to expected residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time, once clean-up levels have been met. This criterion includes the consideration of residual risk that will remain onsite following remediation and the adequacy and reliability of controls.

Under Alternative S1, there would be no controls implemented to prevent human exposure to residual soil contamination. This alternative would not ensure long-term effectiveness and permanence if soil with residual contamination were excavated from the FCS. Alternative S2 would limit human exposure to remaining subsurface soil contamination. Institutional controls implemented under Alternative S2 would provide continued protection as long as they are monitored and enforced.

Reviews at least every five years are required by CERCLA in order to evaluate the effectiveness of any of these alternatives because hazardous substances would remain onsite in concentrations above health-based levels.

3.2.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Reduction of toxicity, mobility, or volume through treatment refers to the anticipated performance of the treatment technologies that may be included as part of a remedy.

Neither Alternative S1 nor S2 would reduce toxicity, mobility, or volume of contaminants present at the site through treatment because no treatment technologies would be employed. Some toxicity, mobility, and volume reductions would occur through natural physical, chemical, and biological processes.

3.2.5 Short-Term Effectiveness

Short-term effectiveness addresses the period of time needed to implement the remedy and any adverse impacts that may be posed to workers, the community, and the environment during construction and operation of the remedy until cleanup levels are achieved.

Alternative S1 is not acceptable because potential risks from direct contact to subsurface soil contamination would remain. There would be no short-term risks to the community, workers, or the environment during implementation of Alternative S1 as no remedial action would be implemented; however, no measures would be taken to prevent human exposure to subsurface soil contaminants. Alternative S2 would limit human exposure to excavated soil. Implementation of institutional controls would pose no risk to human health or the environment and can be readily implemented without adverse impact.

3.2.6 Implementability

Implementability addresses the technical and administrative feasibility of a remedy from design through construction and operation. Factors such as availability of services and materials, administrative feasibility, and coordination with other governmental entities are also considered.

There would be no implementation associated with Alternative S1. The institutional controls specified by Alternative S2 would be readily implemented through the Remedial Design/Remedial Action Work Plan.

3.2.7 Cost

Costs for the soil alternatives are summarized in Table 9. There is no cost associated with implementation of the No Action alternative, S1. The total cost for implementation of Alternative S2 over 30 years is $62,000 with a present value of $52,294.

Table 9
Summary of Costs for 30-year Period for FCS Soil Alternatives

Alternative	Total Cost (30 years)	PV_{30}
Alternative S1	$0	$0
Alternative S2	$62,000	$52,294

3.2.8 State Acceptance

The State agrees with the selection of alternative S2 which will comply with state ARARs when properly implemented.

3.2.9 Community Acceptance

The community has expressed no objection to alternative S2.

3.3 COMPARATIVE ANALYSIS OF GROUNDWATER ALTERNATIVES

The NCP provides that the ROD must explain how the nine criteria were used to select the remedy [NCP Section 300.430(f)(5)(i)]. The alternatives compared for groundwater are as follows:

- **Alternative GW1:** No Action
- **Alternative GW2:** MNA and Institutional Controls to Prohibit Groundwater Use
- **Alternative GW3:** ISCO and Institutional Controls to Prohibit Groundwater Use

3.3.1 Overall Protection of Human Health and the Environment

Overall protection of human health and the environment addresses whether each alternative provides adequate protection of human health and the environment and describes how risks posed through each exposure pathway are eliminated, reduced, or controlled, through treatment, engineering controls, and/or institutional controls.

Alternative GW1 would not reduce the risk to human health because exposure to contaminants in groundwater would still be possible. Alternative GW2 would protect human health by preventing exposure to contaminants through the implementation of institutional controls prohibiting onsite groundwater use until protective cleanup levels are achieved through MNA. Alternative GW3 would protect human health and the environment through ISCO, which would reduce concentrations of contaminants in groundwater. Institutional controls would be also implemented under Alternative GW3 to prohibit exposure to groundwater until cleanup goals are met.

3.3.2 Compliance with Applicable or Relevant and Appropriate Requirements

Section 121(d) of CERCLA and NCP Section 300.430(f)(1)(ii)(B) require that remedial actions at CERCLA sites at least attain ARARs, unless such ARARs are waived under CERCLA Section 121(d)(4). Compliance with ARARs addresses whether a remedy will meet all of the ARARs under other federal and state environmental laws or provides a basis for invoking a waiver.

- Alternative GW1 would implement no cleanup or preventative measures and therefore would not comply with ARARs.
- Alternative GW2 would comply with chemical- and action-specific ARARs for the protection of human health and the environment by MNA and by implementing institutional controls to prohibit groundwater use until PCLs are met. In addition, Alternative GW2 would assess natural attenuation through continued monitoring.
- Alternative GW3 would comply with chemical-specific ARARs by reducing concentrations of contaminants below PCLs. Institutional controls prohibiting groundwater use would protect human health until cleanup goals were met. Alternative GW3 would comply with action-specific ARARs.

3.3.3 Long-Term Effectiveness and Permanence

Long-term effectiveness and permanence refers to expected residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time, once clean-up levels have been met. This criterion includes the consideration of residual risk that will remain onsite following remediation and the adequacy and reliability of controls.

There would be no controls implemented to manage untreated wastes and risks that remain at the FCS for Alternative GW1. The criterion for long-term effectiveness and permanence would be met only to the extent that organic compounds would attenuate naturally through volatilization, diffusion, and biological degradation, which would provide some degree of long-term reduction in risk at the site; however, Alternative GW1 does not include a means to assess the effectiveness of natural attenuation.

As long as they are enforced, institutional controls to prohibit groundwater use under Alternative GW2 would provide continued protection of human health and the environment.

Groundwater monitoring would provide data to evaluate the long-term effectiveness of natural attenuation and the potential migration of contaminants toward drinking water supply wells east of the FCS. It is expected that groundwater cleanup levels for chlorinated compounds will be met within 25 years. It is expected that it will take longer for petroleum-related COCs to meet groundwater cleanup levels. COCs remaining at the site are not expected to negatively affect drinking water quality on Post. Based on groundwater flow direction, hydrological modeling, and source strength of COCs, Fort Wainwright's water supply wells are not expected to be affected by contaminated groundwater beneath the FCS.

Alternative GW3 would remediate the contaminant plumes by reducing contaminant concentrations in groundwater to achieve site cleanup goals, including 1,2,3-TCP. Alternative GW3 would be an effective long-term and permanent remedy that is protective of human health and the environment. Groundwater monitoring would provide data to demonstrate the long-term effectiveness of the treatment technology, and the potential migration of contaminants toward the drinking water supply east of the FCS. This alternative would provide greater long-term effectiveness and permanence than Alternative GW2.

Reviews at least every five years, as required by CERCLA, would be necessary to evaluate the effectiveness of any of these alternatives because hazardous substances would remain onsite in concentrations above health-based levels.

3.3.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Reduction of toxicity, mobility, or volume through treatment refers to the anticipated performance of the treatment technologies that may be included as part of a remedy.

Alternatives GW1 and GW2 would not reduce toxicity, mobility, and volume of contaminants at the site through treatment, as no treatment technologies would be employed. A reduction in toxicity, mobility, and volume would occur through natural physical, chemical, and biological processes; however, Alternative GW1 does not provide a means to assess such reductions resulting from natural attenuation. Under Alternative GW2, the mobility and the reduction of toxicity and volume of contaminants through natural attenuation would be assessed through groundwater monitoring. Alternative GW3 would significantly reduce the toxicity, mobility, and volume of contaminants in groundwater at the FCS through treatment. This alternative would provide for the greatest reduction of contaminant toxicity, mobility, or volume through treatment.

3.3.5 Short-Term Effectiveness

Short-term effectiveness addresses the period of time needed to implement the remedy and any adverse impacts that may be posed to workers, the community, and the environment during construction and operation of the remedy until cleanup levels are achieved.

Alternative G1 is not an acceptable alternative because potential risk due to groundwater exposure would continue to exist. There would be no environmental impacts or short-term risks to the community or site workers associated with Alternative GW1 as no remedial action would take place. There would be a risk to human health and the environment over the short term associated with contaminants left in place.

Institutional controls implemented under Alternative GW2 would prevent exposures to human receptors over the short term. The implementation of institutional controls and groundwater monitoring to evaluate the progress of natural attenuation and potential for plume migration would require activities that would present no risk to the public, and no appreciable risk to onsite workers or the environment.

Institutional controls to prohibit groundwater use under Alternative GW3 implemented prior to residential use and the implementation of the ISCO treatment would be protective of human health and the environment. Implementation of in situ treatment would entail construction activities at the FCS with the potential to affect the current housing development through noise, dust, and traffic. Potential risks to site workers and the community during implementation of the remedy would be minimized through implementation of a site-specific health and safety plan. Because of the increased construction activity, there would be greater potential short-term risk from implementation of Alterative GW3. This alternative could also result in an increase of total suspended solids in groundwater and therefore reduce the groundwater quality.

3.3.6 Implementability

Implementability addresses the technical and administrative feasibility of a remedy from design through construction and operation. Factors such as availability of services and materials, administrative feasibility, and coordination with other governmental entities are also considered.

There would be no implementation associated with Alternative GW1. Institutional controls and monitoring under Alternative GW2 are readily implementable. Groundwater monitoring wells are currently installed at the FCS, and vendors and contractors are available should the installation of additional groundwater monitoring wells be necessary. A biannual MNA program is already in place at the FCS.

The ISCO system under Alternative GW3 is technically implementable; however, injection of the oxidant could be difficult to control. Temporary oxidant storage facilities are likely to be in place near the injection zones. Site surface features could interfere with the construction activities considering the importance of the location for injection points. ISCO is commercially available and does not generate a waste stream that requires treatment or disposal.

3.3.7 Cost

There is no cost associated with implementation of the No Action alternative, GW1. Total costs for 30 years and present value (PV_{30}) costs for Alternatives GW2 and GW3 are summarized in Table 10. Costs were estimated in accordance with EPA guidelines (2000). According to the guidelines, the discount rate used for the calculations was 1.1 percent and was taken from Appendix C of the Office of Management and Budget Circular A-94 (December 2012) for real discount rates over a 30-year period.

Table 10
Summary of Costs for 30-year Period for FCS Groundwater Alternatives

Alternative	Total Cost (30 years)	PV_{30}
Alternative GW1	$0	$0
Alternative GW2	$1,091,822	$920,040
Alternative GW3	$1,881,855	$1,872,149

3.3.8 State Acceptance

The State agrees with the selection of alternative GW2 which will comply with state ARARs when properly implemented.

3.3.9 Community Acceptance

The community has expressed no objection to GW2.

3.4 COMPARATIVE ANALYSIS SUMMARY

The remaining alternatives for soil and groundwater were ranked relative to one another based on seven of the nine CERCLA evaluation criteria. A summary of this ranking is provided in Table 11. The first two criteria (overall protection of human health and compliance with ARARs) are threshold criteria and were not ranked numerically, instead, each alternative was determined to either meet or not meet these criteria. The No Action alternatives (S1 and GW1) do not meet the threshold criteria. For each of the five balancing criteria, each alternative was assigned a value between 1 and 3, with 1 representing the most preferable and 3 representing the least preferable. The values for each alternative were then added to determine an overall ranking of alternatives. As shown in Table 11, Alternative S2 is the highest ranking alternative for soil and Alternative GW2 is the highest ranking alternative for groundwater. The selected alternative for the FCS is S2/GW2.

Table 11
Comparison of Alternatives for Contaminated Soil and Groundwater

Criteria	Soil Alternatives		Groundwater Alternatives		
	S1	S2	GW1	GW2	GW3
Overall protection of human health and the environment*	No	Yes	No	Yes	Yes
Compliance with ARARs*	No	Yes	No	Yes	Yes
Long-term effectiveness and permanence	3	2	3	2	1
Reduction of toxicity, mobility, or volume through treatment	3	2	3	3	2
Short-term effectiveness	3	1	3	1	2
Implementability	1	2	1	2	3
Cost	1	2	1	2	3
Total (lowest total indicates highest ranking among each set of alternatives)	**11**	**9**	**11**	**10**	**11**

3.5 PRINCIPAL THREAT WASTES

The NCP establishes the expectation that treatment will be used to address the principal threats posed by a site wherever practicable [NCP Section 300.430(a)(1)(iii)]. A principal threat refers to any source materials at a CERCLA site considered to be highly toxic or highly mobile that generally cannot be reliably controlled in place, or presents a significant risk to human health or the environment should exposure occur. A source material contains hazardous substances, pollutants, or contaminants that can migrate to groundwater, surface water, or air, or that act as a source for direct exposure.

Conversely, non-principal threat wastes are those source materials that generally can be reliably contained and that would present only a low risk in the event of exposure. The manner in which principal threats are addressed generally will determine whether the statutory preference for treatment as a principal element is satisfied. Although no threshold level of toxicity/risk has been established to equate to “principle threat”, EPA guidance recommends that when toxicity and mobility combine to pose a potential risk of 10^{-3} or greater, then, generally, treatment alternatives should be evaluated (EPA 1991).

Hazardous wastes that might have posed a potentially significant risk have already been removed from the FCS to the greatest extent practicable. However, some contaminated subsurface soil still exists at the FCS. Individually, the maximum concentrations of remaining subsurface soil contaminants generally do not exceed human health-based cleanup levels (with the exception of DRO). The cumulative ELCR for a hypothetical future unrestricted exposure to maximum soil contamination is 8×10^{-5}, which is within EPA's acceptable range of 10^{-4} to 10^{-6} and only slightly above the ADEC threshold of 10^{-5}. The corresponding non-cancer HI is 5. Based on current information, both of these values conservatively overestimate actual cancer and non-cancer risk. Groundwater is not considered to be a principal threat waste. Based on these criteria, remaining contamination at the FCS represents a low-level threat waste and no source materials constituting principal threats exist at the FCS.

3.6 SELECTED REMEDY

Based on the information presented in the Administrative Record, the Army, EPA, and ADEC believe the preferred alternatives satisfy the following statutory requirements of CERCLA Section 121(b):

- They are protective of human health and the environment.
- They are cost-effective and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable.

The selected remedial alternatives reduce the risk posed by contaminated soil and groundwater in a manner that is protective of human health and the environment, complies with ARARs, and provide the best balance of trade-offs with respect to balancing and modifying criteria for evaluating the alternatives considered. The other alternatives have deficiencies.

Based on the comparative analysis of alternatives for soil and groundwater using the best information available, the selected remedy for the FCS is as follows:

- **Alternative S2,** Institutional Controls to Restrict Excavation of Soil
- **Alternative GW2,** MNA and Institutional Controls to Prohibit Groundwater Use

3.6.1 Rationale for the Selected Remedy

The following discussion provides a summary of the rationale for the selected remedy.

Soil Remedy

The selected remedy for soil at the FCS is Alternative S2, Institutional Controls to Restrict Excavation of Soil. Under this alternative, institutional controls will be implemented to restrict excavation of soil that could pose a potential threat to human health or the environment. This remedy was selected because it is protective of human health and the environment over both the short- and long-term and complies with ARARs. The remedy is readily implementable and is cost-effective.

Groundwater Remedy

The selected remedy for groundwater at FCS is Alternative GW2, MNA and Institutional Controls to Prohibit Groundwater Use. Institutional controls will eliminate or limit exposure pathways for COCs in groundwater to human receptors and the environment. Groundwater monitoring and data evaluation will be used to assess the effectiveness of natural attenuation and the degradation processes, and to track the extent of any contaminant migration.

The No Action alternative was rejected because it failed to meet the threshold criteria of protection of human health and the environment. Alternative GW3 has disadvantages in that it would be more difficult to implement, would have greater short-term impacts, and would be nearly three times more expensive than Alternative GW2 without providing a proportionate increase in protection. Also, the selected remedy is consistent with the remedial approaches implemented at OUs 1 through 5.

Current estimates indicate that under GW2, cleanup levels will be attained in most areas of the FCS within 25 years. This compares to an estimated timeframe of two years for ISCO treatment of groundwater (Alternative GW3). Although the estimated time for Alternative GW2 to attain remediation objectives is longer than that required for alternatives using ISCO, this remedial option is reasonable because there is no anticipated need for the contaminated groundwater (see Current and Potential Future Site Use, Section 2.6.2).

In addition to the Alternative GW2 modeling estimates, concentrations of COCs have decreased or stabilized since source control measures were completed. This has been confirmed in four successive rounds of sampling over a period of three years, indicating that natural attenuation is an effective remedial alternative and reduces the uncertainty of the modeling predictions. Since two separate lines of evidence (trends in declining COCs and predictive modeling) were used to support Alternative GW2 as a remedial action, there is a high level of confidence that Alternative GW2 will be a successful remedial approach.

Alternative GW2 provides the best trade-offs among the balancing and modifying criteria. It is readily implementable, protective of human health and the environment, satisfies ARARs, and is the most cost-effective option that meets RAOs.

3.6.2 Description of the Selected Remedy

Description of the Soil Remedy

The selected remedy for soil consists of institutional controls to address risks associated with subsurface soil contamination remaining at the FCS. Remaining subsurface soil contamination is typically located around portions of the FCS where contaminated soil and debris were removed during investigation activities. Remaining contamination is not extensive and is present in small, isolated locations in subsurface soil, between 5 and 15 feet bgs where further excavation was not practicable. Excavation of soil at a depth greater than 6 inches bgs will not be permitted without approval of Army DPW and concurrence of EPA and ADEC. Institutional control boundaries are presented in Figure A-25. The Army is responsible for implementing, maintaining, reporting on, and enforcing the institutional controls. The Army shall retain ultimate responsibility for remedy integrity.

Institutional controls restricting access to soil will be implemented and maintained by the Army until the site is acceptable for UU/UE.

Institutional controls will restrict the digging and removal of soil in the area depicted in Figure A-25 without permission of the FWA DPW and the concurrence of EPA and ADEC. These controls would include prohibition of digging by residents without permission of the DPW and concurrence of EPA and ADEC. The selected remedy does not address management of soil excavated from the FCS. Excavated soil must be managed in accordance with all applicable requirements, both substantive and administrative.

A complete description of institutional controls and the procedures for implementing, monitoring, and maintaining them will be provided in the Remedial Design/Remedial Action Work Plan.

The effectiveness of institutional controls implemented for the site will be evaluated annually and a report will be provided to EPA and ADEC. Results of the evaluation and annual inspections will also be included in each five-year review. The Army will not change any portion of the approved Remedial Design/Remedial Action Work Plan without concurrence of EPA and ADEC, as provided in the FFA.

Measures that are necessary to ensure continuation of institutional controls shall be taken before any lease or transfer of land subject to institutional controls. The Army will provide notice to EPA and ADEC at least six months prior to any transfer or sale of OU6 so that EPA and ADEC can be involved in discussions to ensure that appropriate provisions are included in the transfer terms or conveyance documents to maintain effective institutional controls. If it is not possible for the Army to notify EPA and ADEC at least six months prior to any transfer or sale, then the Army will notify EPA and ADEC as soon as possible, but no later than 60 days prior to the transfer or sale of any property subject to institutional controls. In addition to the land transfer notice and discussion provisions above, the Army further agrees to provide EPA and ADEC with similar notice, within the same time frames, as to federal-to-federal transfer of property. The Army shall provide a copy of executed deed or transfer assembly to EPA and ADEC. Army shall notify EPA and ADEC immediately upon discovery of any activity inconsistent with the specific institutional controls.

Description of the Groundwater Remedy

The selected remedy for groundwater consists of institutional controls to prohibit the use of groundwater and MNA to address COCs above PCLs. The Army is responsible for implementing, maintaining, reporting on, and enforcing the institutional controls. Institutional control boundaries are presented in Figure A-25. Although the Army intends to transfer procedural responsibilities for institutional controls to another party, the Army shall retain ultimate responsibility for remedy integrity.

Institutional controls will be implemented and maintained in the area depicted on Figure A-25 to eliminate unacceptable exposure of COCs in groundwater to human receptors by prohibiting groundwater use through administrative and informational methods until the groundwater meets the PCLs in Table 2 and is acceptable for UU/UE and EPA and ADEC authorize the removal of restrictions. Institutional controls will prohibit groundwater uses including drinking and other domestic uses and the installation of dewatering wells, monitoring wells, irrigation, fire suppression, or potable water wells without prior approval from FWA DPW and concurrence of EPA and ADEC.

Measures that are necessary to ensure continuation of institutional controls shall be taken before any lease or transfer of any land subject the institutional controls. The Army will provide notice to EPA and ADEC at least six (6) months prior to any transfer or sale of OU6 so that EPA and ADEC can be involved in discussions to ensure that appropriate provisions are included in the transfer terms or conveyance documents to maintain effective institutional controls. If it is not possible for the Army to notify EPA and ADEC at least six months prior to any transfer or sale, then the Army will notify EPA and ADEC as soon as possible, but no later than 60 days prior to the transfer or sale of any property subject to institutional controls. In addition to the land transfer notice and discussion provisions above, the Army further agrees to provide EPA and ADEC with similar notice, within the same time frames, as to federal-to-federal transfer of property. The Army shall provide a copy of executed deed or transfer assembly to EPA and ADEC. The Army shall notify EPA and ADEC immediately upon discovery of any activity inconsistent with the specific institutional controls.

Groundwater monitoring and data evaluation will be conducted periodically as needed to assess the effectiveness of natural attenuation and degradation processes and to ensure that contamination continues to pose no unacceptable risk, as well as to track the extent of any contaminant migration from potential source areas. To the extent practicable, the MNA program will use existing groundwater monitoring wells at the FCS. Upgradient wells will be used to provide information about the background groundwater quality. Downgradient wells will be used to assess attenuation and degradation rates, and potential contaminant migration. Early warning indicator wells (e.g., sentry wells) will be included in the monitoring program. Specifics of the groundwater monitoring program and O&M activities for the monitoring well network will be detailed in the Remedial Design/Remedial Action Work Plan. The operation and maintenance activities will include requirements for maintaining the integrity of monitoring and other systems and equipment to be employed as part of the MNA remedy.

The evaluation of MNA will target groundwater COCs including DRO, RRO, TCE, and 1,2,3-TCP, potential degradation products, and general water quality parameters including dissolved oxygen and oxidation-reduction potential that would assist in the assessment of natural degradation processes. Sample collection, analysis, and data evaluation will continue until it is demonstrated in accordance with the approved Remedial Design/Remedial Action Work Plan that contaminant concentrations are below PCLs in Table 2.

MNA (Alternative GW2) will be used to restore groundwater beneath the FCS to its future beneficial use as a potential drinking water source. Current estimates indicate that PCLs will be attained in most areas of the FCS within approximately 25 years. Details of the MNA plan will be developed and included in the Remedial Design/Remedial Action Work Plan.

Actual performance of the natural attenuation remedy will be carefully monitored on a regular basis and monitoring requirements adjusted as warranted by performance data collected during monitoring. A complete description of institutional controls and the procedures for implementing, monitoring, maintaining, and enforcing them will be provided in the Remedial Design/Remedial Action Work Plan.

The effectiveness of institutional controls implemented for the site will be evaluated annually and a report will be provided to EPA and ADEC. Results of the annual evaluation will be addressed in each five-year review. The Army will not change any portion of the Remedial Design/Remedial Action Work Plan without concurrence of EPA and ADEC.

Submission of Remedial Design and Remedial Action Work Plan

In accordance with Section 24.2 of the FFA, the Army will propose deadlines for completion of the Remedial Design/Remedial Action Work Plan within 21 days of signature of this ROD which shall be submitted for EPA and ADEC review and approval and shall contain implementation, operation and maintenance actions, and shall be prepared in accordance with Office of Solid Waste and Emergency Response (OSWER) Directive 9355.0 4A (June 1986) and the NCP, and as otherwise required by the FFA. The Remedial Design/Remedial Action Work Plan will establish additional primary and secondary documents, deadlines, and/or target dates.

Interim Institutional Controls

This ROD documents the fact that all necessary CERCLA investigations are complete and selects remedial actions to be implemented to ensure Taku Gardens is safe for residential occupation. Interim land use controls prohibiting occupancy of these homes and establishing requirements for fencing and signs are hereby rescinded. The interim land use controls restricting excavation of soil and prohibiting groundwater use will remain in effect until the institutional controls outlined in this ROD are implemented through the Remedial Design/Remedial Action Work Plan.

3.6.3 Summary of Estimated Remedy Costs

The estimated PV30 cost of the selected remedy (S2/GW2) is $920,040. This estimate includes both capital and O&M. In accordance with EPA guidelines, the cost estimates are order of magnitude estimates and are expected to be within plus 50 percent to minus 30 percent. The estimated cost elements of the remedy are detailed in Table 12.

Table 12
Selected Remedy Estimated Costs

Task	Quantity	Unit Cost	Unit	Estimated Cost	Assumptions
Component: Institutional Controls					
Permit Process	12	$100	hour	$1,200	Assumes 1 hour per month to facilitate permit process
Inspections	8	$100	hour	$800	Assumes 8 hours per year for inspections
Total Annual Cost	--	--	--	$2,000	Annual Cost (assumed 30 years)
Total Cost				**$62,000**	
Total PV_{30} Cost				**$52,294**	Assumes 1.1% discount rate over 30 years
Component: Monitored Natural Attenuation					
DRO/RRO Analysis	17	$97	sample	$1,649	Quote from Columbia Analytical Services (January 2013)
VOC Analysis	17	$169	sample	$2,873	Quote from Columbia Analytical Services (January 2013)
Low-Level VOC Analysis	17	$146	sample	$2,482	Quote from Columbia Analytical Services (January 2013)
MNA Parameters	10	$274	sample	$2,740	Quote from Columbia Analytical Services (January 2013)
Labor and Materials	1	$5,625	event	$5,625	Assumes one groundwater well every 2.5 hours by a two-person team and $20 in materials per monitoring point
Reporting	1	$7,500	event	$7,500	Assumes 70 hours at $100 per hour and $500 in materials per report
Shipping	1	$1,600	event	$1,600	Assumes 20 coolers at $80 per cooler via FedEx
Total MNA Costs per Event	--	--	--	$24,469	Total cost per sampling event
Total Sampling Costs	--	--	--	$783,008	Assumes 30 years sampling; biannual first two years, annually thereafter
Contingency Allowance	--	--	--	$73,407	Assumes 10% over 30 years
Project Management and Support	--	--	--	$73,407	Assumes 10% over 30 years
Remedial Action Work Plan	1	--	--	$50,000	One time capital cost
Remedial Action Completion Report	1	--	--	$50,000	One time capital cost
Total Cost for Project				**$1,091,822**	
Total PV_{30}				**$920,040**	Assumes discount rate of 1.1% over 30 years

Note:
-- = not applicable

The information in this cost estimate summary is based on the best available information regarding the anticipated scope of the selected remedy. Changes in the cost elements are likely to occur as a result of new information and data collected during the design of the remedial alternative. Major changes will be documented using a technical memorandum in the Administrative Record, an explanation of significant differences (ESD), or ROD amendment.

3.6.4 Expected Outcomes of Selected Remedy

Expected Outcomes of the Soil Remedy

The selected remedy for soil will provide for protection of human health and the environment through institutional controls to restrict the excavation of contaminated soil. Concentrations detected in soil at the FCS indicate that the remaining contamination is residual and not extensive. Potential threats associated with residual soil contamination are expected to decrease gradually as contaminant concentrations decrease. Implementation of this remedy in conjunction with the groundwater remedy will accomplish the site-specific RAOs. Implementation of institutional controls will enable this property to be opened for beneficial use as Army housing.

CERCLA five-year reviews will be required following implementation of the selected remedy because hazardous substances will remain in place above levels that would allow for UU/UE. It could be determined that institutional controls are unnecessary if contaminant concentrations and the associated potential risk were to reduce sufficiently over time to allow for UU/UE. This or any other changes to the selected remedy as described in this ROD could be made using a technical memorandum in the Administrative Record, an ESD, or ROD amendment, as appropriate.

Expected Outcomes of the Groundwater Remedy

The selected remedy for groundwater will provide for protection of human health and the environment through institutional controls to prohibit the use of groundwater and MNA to address COCs above PCLs. Implementation of institutional controls will enable this property to be opened for use as Army housing. Institutional controls, sample collection, analysis, and data evaluation will continue until contaminant concentrations reach PCLs and no longer present an unacceptable risk to human health or the environment. Implementation of this remedy in conjunction with the soil remedy will accomplish the site-specific RAOs.

Five-year reviews will be required by CERCLA regulations following implementation of the selected remedy because hazardous substances will remain in place above levels that allow for UU/UE. It could be determined that institutional controls are unnecessary if contaminant concentrations and the associated potential risk were to reduce sufficiently over time to allow for UU/UE. This or any other changes to the selected remedy as described in this ROD would be made using a technical memorandum in the Administrative Record, an ESD, or ROD amendment, as appropriate.

3.7 STATUTORY DETERMINATIONS

Selected remedies under CERCLA must satisfy the following:

- Be protective of human health and the environment
- Comply with ARARs unless a waiver is provided
- Be cost-effective
- Use permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable.

Preference is given to remedies that employ treatment that permanently and significantly reduces the volume, toxicity, or mobility of contaminants as a principal element. In addition, five-year reviews are required following initiation of the remedy if hazardous substances, pollutants or contaminants remain in place above levels allowing for UU/UE.

The following sections discuss the soil and groundwater remedies relative to the CERCLA statutory requirements.

3.7.1 Statutory Determinations for the Soil Remedy

Under CERCLA Section 121 and the NCP, the lead agency must select remedies that are protective of human health and the environment, comply with ARARs, are cost-effective, and utilize permanent solutions to the greatest extent practicable. The following sections discuss how the selected soil remedy meets these statutory requirements.

Protection of Human Health and the Environment

The selected soil remedy (Alternative S2) will provide for protection of human health and the environment by controlling risk at the site through institutional controls. Any excavation and removal of soil at the FCS will be limited to those activities approved by the FWA DPW with the concurrence of EPA and ADEC. Implementation of the selected remedy will not pose unacceptable short-term risks or any increase in potential for cross-media impacts.

Compliance with ARARs and To-Be-Considered Guidance

The selected soil remedy will comply with the substantive requirements of all Federal ARARs and any state ARARs that are more stringent. It will comply with all identified action-specific ARARS identified in Appendix B. No location-specific or chemical-specific ARARs or other TBCs have been identified. The selected remedy does not require waivers for any ARARs.

Cost Effectiveness

The selected remedy is cost-effective and represents a reasonable value for the money to be spent. In making this determination, the definition of cost effectiveness from 40 CFR 300.430(f)(1)(ii)(D) was used: "A remedy shall be cost-effective if its costs are proportional to its overall effectiveness." Overall effectiveness was evaluated by assessing the alternatives against five balancing criteria. The relationship of the overall effectiveness of the selected remedy was determined proportional to its costs and, therefore, represents a reasonable value for the money to be spent.

Utilization of Permanent Solutions and Alternative Treatment Technologies to the Maximum Extent Practicable

Potentially hazardous soil and debris has already been removed from the FCS to the greatest extent practicable during construction activities; during the 2005 TCRA; as IDW during the RI; and during the post-RI TCRA. The selected soil remedy represents the maximum extent to which permanent solutions and alternative treatment technologies can be utilized in a practicable manner at the FCS. The selected remedy for soil at the FCS will provide for protection of human health by maintaining institutional controls which will restrict the digging or removal of contaminated soil. No practicable alternative treatment technologies were identified for soil remediation at the FCS.

Preference for Treatment as a Principal Element

The NCP establishes the expectation that treatment will be used to address the principal threats posed by a site wherever practicable [NCP Section 300.430(f)(5)(ii)(F)]. No principal threat wastes exist at the FCS because potentially hazardous soil and debris has already been removed to the greatest extent practicable. The remaining residual contamination is categorized as low-level threat waste because it is a treatment residual, is not mobile, and would present a low risk in the event of human exposure. Containment and/or institutional controls are appropriate for short- and long-term management to prevent or limit exposure to low-level threat waste (EPA 1991). Although the selected soil remedy for the FCS does not satisfy the statutory preference for treatment as a principal element, it is the preferred alternative because: contaminated soil and potentially hazardous debris has already been removed to the greatest extent practicable; residual subsurface soil contamination and potentially hazardous debris is generally not above risk-based cleanup levels; it is generally located between 5 and 15 feet bgs and is very close to or beneath existing structures and utility lines; and, consequently, it would be highly intrusive, disproportionately expensive, and extremely difficult to implement. The selected remedy does not incorporate treatment as a principal element to reduce the toxicity, mobility, or volume of contaminants present at the site; however, low-level threats associated with residual soil contamination are expected to decrease gradually as contaminant concentrations decrease over time through volatilization, diffusion, and biological degradation. All other OUs at FWA (OU1 through OU5) have met the statutory preference for treatment; OU6 is the first OU at FWA to have adequately addressed principal threat wastes before completion of the ROD.

Five-Year Review Requirements

Section 121(c) of CERCLA and the NCP Section 300.430(f)(5)(iii)(C) provide the statutory and legal bases for conducting five-year reviews. Because the soil remedy will result in hazardous substances, pollutants, or contaminants remaining in onsite soils above levels that allow for UU/UE, five-year reviews will be conducted for the FCS to ensure that the remedy is, or will be, protective of human health and the environment. Five-year reviews will be conducted until determined to be unnecessary based on sufficient reduction in contaminant concentrations and the associated potential risk over time.

The first five-year review will be concurrent with the five-year ROD reviews for OU1 through OU5. The next review is scheduled for September 2016. This is consistent with CERCLA requirements which state that the first five-year review must be completed no later than five years after implementation of the selected remedy.

The five-year reviews will be conducted in accordance with EPA's OSWER Directive 9355.7-02, 23 May 1991, *Structure and Components of Five Year Reviews*, and supplemental guidance as required by the FFA. This directive requires conducting different levels of review for sources with ongoing treatment and sources where waste is left in place. This five-year review may result in a decision that the remedy selected in this ROD is no longer protective, and that additional remedial action must be taken by the Army to ensure protection of public health and the environment.

The five-year review for soil will include, but not be limited to, the following components:

- Evaluation of whether the response action remains protective of public health and the environment. Evaluation will consider the effectiveness of the technology for the specific performance levels established in the ROD.
- Evaluation of whether remedial actions remain cost-effective and technically sound.

- Review of remedial actions to determine whether the remedy might be replaced by other more state-of-the-art remedies that would remain protective.
- Assessment of current and reasonable future land use of the site and surrounding area to ensure that the ROD assumptions of land use are still reasonable and consistent with institutional controls specified in Section 3.6.
- Evaluation of ecological exposure pathways to verify that the assumptions and completed ecological risk evaluations remain valid.
- Addition of any new sampling data into the source area databases.

3.7.2 Statutory Determinations for the Groundwater Remedy

Under CERCLA Section 121 and the NCP, the lead agency must select remedies that are protective of human health and the environment, comply with ARARs, are cost-effective, and utilize permanent solutions to the greatest extent practicable. The following sections discuss how the selected groundwater remedy meets these statutory requirements.

Protection of Human Health and the Environment

The selected groundwater remedy (Alternative GW2) will provide for protection of human health and the environment by controlling risk at the site through institutional controls. Prohibiting the use of groundwater use through institutional controls at the FCS will eliminate or limit unacceptable pathways for COCs in groundwater to human or ecological receptors and the environment until PCLs are met through MNA. Data from groundwater monitoring wells will be used to evaluate the potential for migration of groundwater contaminants or an increase in contaminant concentrations. Implementation of the selected remedy will not pose unacceptable short-term risks or any increase in potential for cross-media impacts.

Compliance with ARARs and To-Be-Considered Guidance

The selected groundwater remedy will comply with the substantive requirements of all Federal ARARs and any state ARARs that are more stringent. It will comply with all identified chemical-specific and action-specific ARARS identified in Appendix B. No location-specific ARARs or TBCs have been identified for the groundwater remedy. The selected remedy does not require waivers for any ARARs.

Cost Effectiveness

The selected remedy is cost-effective and represents a reasonable value for the money to be spent. In making this determination, the definition from 40 CFR 300.430(f)(1)(ii)(D) was used: "A remedy shall be cost-effective if its costs are proportional to its overall effectiveness." Overall effectiveness was evaluated by assessing the alternatives relative to the five balancing criteria. The relationship of the overall effectiveness of the selected remedy was determined proportional to its costs and, therefore, represents a reasonable value for the money to be spent.

Utilization of Permanent Solutions and Alternative Treatment Technologies to the Maximum Extent Practicable

The selected groundwater remedy represents the maximum extent to which permanent solutions and alternative treatment technologies can be utilized in a practicable manner at the FCS. Of those alternatives that are protective of human health and the environment and comply with ARARs, the selected remedy provides the best balance of trade-offs in terms of the five balancing criteria. MNA will achieve PCLs and provide a permanent solution over time.

Preference for Treatment as a Principal Element

The NCP establishes the expectation that treatment will be used to address the principal threats posed by a site wherever practicable [40 CFR 300.430(a)(1)(iii)(A)]. Groundwater is not considered to be a principal threat waste under the definition provided in the NCP because it is not a source material. The selected groundwater remedy for the FCS does not satisfy the statutory preference for treatment as a principal element, but is preferred because treatment alternatives that were considered were found to be difficult to implement, were disproportionately expensive, and/or were not likely to be effective. The selected remedy does not incorporate treatment as a principal element to reduce the toxicity, mobility, or volume of contaminants present at the site; however, threats associated with groundwater contamination are expected to diminish over time through natural attenuation and degradation to the point that it no longer presents an unacceptable risk to human health or the environment. Current monitoring data indicate that natural attenuation processes have already significantly reduced contaminant concentrations and plume boundaries.

Five-Year Review Requirements

Section 121(c) of CERCLA and the NCP Section 300.430(f)(5)(iii)(C) provide the statutory and legal bases for conducting five-year reviews. Because the selected remedy will result in hazardous substances, pollutants, or contaminants remaining in onsite groundwater above levels that allow for UU/UE, five-year reviews will be conducted for the FCS to ensure that the remedy is, or will be, protective of human health and the environment. Five-year reviews will be conducted until determined to be unnecessary based on sufficient reduction in contaminant concentrations and the associated potential risk over time.

The first five-year review will be concurrent with the five-year ROD reviews for OU1 through OU5. The next review is scheduled for September 2016. This is consistent with CERCLA requirements which state that the first five-year review must be completed no later than five years after implementation of the selected remedy.

The five-year reviews will be conducted in accordance with the FFA and EPA's OSWER Directive 9355.7-02, 23 May 1991, *Structure and Components of Five Year Reviews*, and supplemental guidance. This guidance requires conducting different levels of review for sources with ongoing treatment and sources where waste is left in place. This five-year review may result in a decision that the remedy selected in this ROD is no longer protective and that additional remedial action must be taken by the Army to ensure protection of public health and the environment.

The five-year review for groundwater will include, but not be limited to, the following components:

- Evaluation of whether the response action remains protective of public health and the environment. Evaluation will consider the effectiveness of the technology for the specific performance levels established in the ROD.

- Evaluation of whether remedial actions remain cost-effective and technically sound.
- Review of remedial actions to determine whether the remedy might be replaced by other more state-of-the-art remedies that would remain protective.
- Assessment of current and reasonable future land use of the site and surrounding area to ensure that the ROD assumptions of land use are still reasonable and consistent with institutional controls specified in Section 3.6.
- Evaluation of ecological exposure pathways to verify that the assumptions and ecological risk evaluations completed remain valid.
- Addition of any new sampling data into the source area databases.

3.8 DOCUMENTATION OF SIGNIFICANT CHANGES

The Proposed Plan for the FCS was released for public comment on 2 January 2013. The Proposed Plan identified institutional controls to eliminate or minimize exposure pathways for contaminants in site soil and groundwater and MNA for groundwater as the preferred alternative. After review of comments received during the public comment period it was determined that no significant changes to the remedy, as originally identified in the Proposed Plan, were necessary or appropriate. As discussed above in section 2.5.6, changes were made to the COC and PCL list to reflect post-RI soil contamination removal. Also, the management, transportation and disposition of excavated contaminated soil is not being addressed by the selected remedy, but instead will be subject to all applicable waste management requirements, both substantive and administrative.

3.9 PROACTIVE SUB-SLAB SOIL GAS MONITORING

The HHRA conducted as part of the RI identified no unacceptable risk due to vapor intrusion and therefore soil vapor was not retained as a medium of concern in the FS. Subsequent to this effort, a reanalysis of the HHRA determined that results of the HHRA were not affected by updates to the IRIS database or EPA Region X recommendations regarding subchronic risk (CH2M HILL 2013). All lines of evidence support the conclusion that the vapor intrusion pathway does not represent unacceptable risk at the FCS.

To determine if potentially changing site conditions due to construction (e.g., road, driveway, and landscaping installations) have affected sub-slab soil gas and findings of the HHRA, the Army will perform periodic sub-slab monitoring as a conservative measure. The proposed fixed-term sub-slab monitoring is not part of the selected CERCLA remedy and must comply with all substantive and administrative requirements, if applicable. The monitoring will be conducted proactively and voluntarily by the Army. The sub-slab monitoring plan will start after the ROD is signed or sooner. The Army and ADEC will review the data following each monitoring event and the Army will provide EPA an opportunity to review the data. The radon-derived, site-specific attenuation factor will be reevaluated in the first and third years.

The plan will include alternating sampling of all 110 residential units at Taku Gardens and a specific group of 12 residential units. The 12 residential units selected for more frequent soil gas monitoring were chosen based on evidence of remaining debris under the foundations and proximity to the TCE groundwater plume. All samples will be analyzed for VOCs by EPA Method TO-15 or a modified EPA Method TO-15 using procedures similar to what have been previously approved for use at the site. Table 13 presents the tentative sampling schedule that was presented in the Proposed Plan.

Table 13
Proposed Sub-Slab Sampling Schedule

Scheduled year	Planned sampling events	To be sampled
Year 1	1st sampling event	110 residential units
	2nd sampling event	12 residential units
	3rd sampling event	12 residential units
	4th sampling event	12 residential units
Year 2	1st sampling event	12 residential units
	2nd sampling event	12 residential units
	3rd sampling event	12 residential units
	4th sampling event	12 residential units
Year 3	1 sampling event	110 residential units
Year 4	1 sampling event	12 residential units
Year 5	1 sampling event	TBD

Note:
TBD = To be determined.

Cost estimates for proactive sub-slab vapor sampling are provided in Table 14. The estimated total cost of the sub-slab vapor monitoring is $1,392,382.

Table 14
Sub-Slab Sampling Estimated Costs

Task	Quantity	Unit Cost	Unit	Estimated Cost	Assumptions
TO-15 Analysis	470	$831	sample	$390,570	Includes charge for modified TO-15 with solvent delay
Labor and Materials	470	$849	sample	$399,124	Assumes one sampling point every 2 hours by a two-person team, travel/per diem expenses, $50 in materials per sampling point, and $250 per day equipment rental. Includes collection of 10% QA samples.
Installation and maintenance of sampling ports	110	$842	each	$84,200	Assumes 3 hours per sampling point and $50 per day equipment rental
Reporting	5	$11,500	year	$57,500	Assumes 110 hours at $100 per hour and $500 in materials per report
Work Plan	1	$50,000	each	$50,000	One Work Plan
Total Cost for five years	--	--	--	$995,110	Assume 146 units Year 1; 48 units Year 2; 110 units Year 3; 12 unit Year 4; 110 unit Year 5
Contingency Allowances	--	--	--	$257,846	Assumes 25% of project costs
Project Management and Support	--	--	--	$103,139	Assumes 10% of project costs
Total Sub-slab Costs (5 Year)				**$1,392,382**	

(intentionally blank)

4.0 RESPONSIVENESS SUMMARY

The purpose of this Responsiveness Summary is to present and respond to public comments submitted to the Army on the Proposed Plan for the FCS, located on FWA. This Responsiveness Summary has been prepared in accordance with Section 117 of CERCLA and July 1999 guidance document entitled *A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents* (EPA 540-R-98-031).

The Proposed Plan for the FCS was prepared by the Army and was issued to the document repositories on 2 January 2013. The release of the Proposed Plan was announced by notices placed in the Fairbanks Daily News Miner and announcements on local radio stations. These notices and announcements informed the public of the opportunity to comment on the proposed remedy. The public comment period was held from 14 January 2013 to 12 February 2013. Copies of the Proposed Plan and public notice are included in the Administrative Record.

The Proposed Plan outlined the remedial actions proposed for contaminated groundwater and soil at the site. During the public comment period, one email inquiry was received from the public and one letter was received from ATSDR. Approximately ten oral comments and questions were offered at the public meeting, which was held on 15 January 2013 at the Princess Lodge in Fairbanks, Alaska. The meeting included a presentation of the site history, investigations, and removal actions and provided the public with an opportunity to discuss their concerns, ask questions, and comment on the proposed remedy. A transcript of the public meeting is provided in Appendix C.

Most comments were generally supportive or asked for clarification. The only agency expressing disagreement with the selected remedy in the Proposed Plan was ATSDR, which believes that additional sub-slab monitoring and installation of sub-slab depressurization systems in some of the housing units is necessary. ATSDR's comments were thoroughly considered but it is believed that the selected remedial actions (S2/GW2) are appropriate for the site and provide adequate protection of human health and the environment.

This Responsiveness Summary addresses all questions and comments raised during the public comment period.

4.1 STAKEHOLDER COMMENTS AND ARMY RESPONSES

4.1.1 Agency Comments

The ATSDR submitted formal written comments to the FCS Proposed Plan in a letter dated 6 February 2013. The following are ATSDR's concerns:

Comment: "The ATSDR has reviewed the *Proposed Plan for Former Communications Site (Taku Gardens) Fort Wainwright, Alaska* (dated December 2012) that was issued for public comment from January 14, 2013 to February 12, 2013. We are in the process of completing a Health Consultation evaluating the potential for vapor intrusion at the proposed housing complex. We have submitted a data validation version to the Army for review. The data validation version includes a number of recommendations to protect public health of residents who will occupy the property in the summer or fall of 2013. We wish to outline these recommendations during the public comment period, so they may be considered during finalization of the Proposed Plan. ATSDR has reviewed the environmental information gathered about the site and concluded that, while the probability of a health hazard occurring from vapor intrusion is low, the lines of evidence presented do not completely eliminate the vapor intrusion pathway. Subsurface containers that could contain volatile chemicals may remain undetected beneath homes onsite. Based on the conclusions in the data validation version of the Health Consultation, our recommendations to protect the future health of families residing at Taku Gardens concentrate on two areas:

1) "Implementing measures to prevent possible exposures to hazardous air pollutants in homes that may be constructed over containers of hazardous materials in the subsurface, and,
2) "Continued and additional precautionary sampling and monitoring of the properties."

Specifically, the ATSDR recommends the following:

1) That the Army consider implementing measures to prevent possible exposures to hazardous air pollutants in homes, such as installing sub-slab depressurization systems in building identified as having observed and possible debris beneath them prior to occupancy as a precautionary measure. NOTE: The Proposed Post-construction Sub-slab Soil Gas Monitoring Program only considers installation of the system after vapor intrusion has been detected by quarterly or annual monitoring. However, the releases of volatile or semivolatile chemicals from a container could occur rapidly and migrate into homes at hazardous levels that are below olfactory detection. Sub-slab depressurization systems could prevent such exposures that may cause a health hazards and would likely go undetected during quarterly or annual monitoring.
2) That the following additional sampling and monitoring is conducted, including:
    a. Monitoring at appropriate intervals following any changes to that site that may affect vapor flow, such as earthquake, building renovation, construction, or landscaping. This applies to future changes as long as contamination may remain onsite above screening levels.
    b. Monitoring semivolatile organic compounds and DBCP in all monitoring plans.
    c. Performing continued sub-slab gas and indoor air monitoring of units where screening levels were exceeded (i.e., a clean round of sampling shouldn't be used to eliminate the building from future study). NOTE: This would result in sampling more units than the 12 houses selected for monitoring in the Proposed Plan Post-construction Sub-slab Soil Gas Monitoring Program.
    d. Sampling sub-slab gas in at least three locations, as advised in ADEC guidance, for a representative number of residences to characterize the spatial variability of contaminant vapors in the sub-slab space.
    e. Sampling during spring for all residences to capture conditions during the spring thaw and snow melt (the dates of future sampling plans are not specified in the Proposed Plan).
    f. Performing at least one of the comprehensive sub-slab soil gas sampling events after construction is complete (the dates for construction completion and future sampling plans are not specified in the Proposed Plan).
    g. Sampling of soil gas collocated within a representative number of utility lines and sampling within utility line access ports (manholes) to provide evidence for or against this as an active vapor migration pathway."

Response: The Army provided a detailed response to ATSDR addressing their comments on the FCS Proposed Plan on March 15, 2013 (Appendix C). As background, the HHRA for the FCS is part of the RI, which was finalized in December 2010 (CH2M HILL 2010a). The HHRA assessed the potential for exposure and risk to future residents from COPCs in site media. Since the 2010 HHRA was completed, EPA's Office of Research and Development (ORD) finalized its toxicological review of TCE in 2011, and its IRIS database file was updated in October of that year with values for chronic oral and inhalation exposures to TCE. In December 2012, EPA Region 10 issued OEA *Recommendations Regarding Trichloroethylene Toxicity in Human Health Risk Assessments* (EPA 2012) to develop threshold exposure concentrations for short-term TCE exposure in women of reproductive age

The Army, EPA, and ADEC share ATSDR’s concerns regarding potential exposure to TCE vapors, and as a result, the Army developed a technical memorandum (CH2MHILL 2013), which assesses risk based on the recent EPA Region 10 recommendations. The additional analysis outlined in the technical memorandum indicates that the conclusions of the 2010 HHRA for the FCS remain unchanged by the recommendations, and that no unacceptable short-term risk[4] is identified. Both EPA and ADEC concur with the Army’s updated risk analysis.

The HHRA and subsequent risk analysis, which utilized the updated TCE toxicity values included in EPA’s IRIS database, demonstrate that no remedial action is necessary to reduce, control, or mitigate exposure to soil gas beneath the FCS buildings. Therefore, the ATSDR recommendations need not be implemented to protect human health and the environment. While not part of the CERCLA remedy, the U.S. Army will implement a Sub-slab Soil Gas Monitoring Program as a conservative, proactive measure to address stakeholder concerns. The Army and ADEC will review the data following each monitoring event.

[4] The TCE IRIS toxicity values and the associated OEA recommendations reduced the level of exposure below which it is unlikely for sensitive populations (e.g., women of reproductive age) to experience potential adverse health effects from short-term TCE exposure. Adverse health effects may occur when contaminant concentrations result in a hazard index greater than 1 or a hazard quotient greater than 1.0.

4.1.2 Public Comments

One comment was submitted to the Army via email.

Comment: Has the contract for the five-year sub-slab vapor monitoring been awarded or will it be put out for bid after the ROD is signed? The commenter also indicated that the Army had done a “nice job” summarizing such a large project at the public meeting.

Response: No. The sub-slab monitoring will likely be put out for bid after the ROD signatures. Interested individuals need to register with the U.S. Army Corps of Engineers, Alaska District to get on the list of approved bidders.

Several members of the public offered comments and asked questions at the public meeting. Summaries of these comments and Army responses follow:

Comment: Is it true that debris remains under the structures except for four—debris remains under some structures except Building 49?

Response: Yes. There are 12 buildings that have either confirmed debris beneath the foundation or evidence of debris in the foundation excavation sidewalls.

Comment: Is the soil that was dumped out by the FWA solid waste landfill in the summer of 2012 part of the FCS project?

Response: No. The soil that was dumped to the side of the FWA solid waste landfill is uncontaminated soil that was excavated during other construction projects on Post. That soil was placed into a clean soil cell just south of the landfill. Any contaminated soil was properly disposed of. Petroleum-contaminated soil was thermally treated, returned to FWA, and disposed of at the landfill.

Comment: Do I need to be wearing a hazmat suit out there? It’s a wood-cutting area.

Response: No. It is not necessary to wear a hazmat suit in this area.

Comment: Was soil with PCB concentrations less than 10 parts per million used as daily cover at the FWA landfill?

Response: If soil was contaminated with PCBs greater than 10 ppm, it was placed into lined shipping containers and transported to a permitted PCB-disposal facility in Oregon. Soil with PCB concentrations between 1 and 10 ppm was disposed of at the FWA solid waste landfill. The State of Alaska granted the Army permission to dispose of soil with less than 10 ppm PCBs at the FWA landfill. The PCB-contaminated soil was then covered with clean soil to prevent migration of PCB-contaminated dust from the landfill. Clean soil from the FCS was used to cover the PCB-contaminated soil with less than 10 ppm. These precautions were taken to ensure public safety.

Comment: And there is limited exposure to soil in the landfill… it's not a residential scenario.

Response: Correct. The installation took all precautions to ensure public safety.

Comment: Was the debris that was initially removed during construction stockpiled somewhere and later sorted and inventoried?

Response: Yes. During construction in 2005, the construction contractor excavated solid waste, crushed drums, and metal debris. This debris was stockpiled until a sufficient quantity had accumulated before taking it to the landfill for disposal. In 2006, the Army's environmental contractor recommended that these debris piles be examined. The Army instructed the construction contractor to stop hauling material to the landfill and hired UXO technicians to physically sort every debris pile. Anything that was determined to be MD was set aside. While sorting the debris piles, the UXO technicians identified a few items that they believed might be live because they claimed that there were never training devices made for these particular items. These items were treated as though they were live and were taken to the FWA Range Control and detonated. After the items were detonated, it was determined that the items were training devices. Additionally, there actually were training devices made for nearly every piece of munitions the Army used during World War I, World War II, and the Korean War. The Army does not believe that live munitions were ever disposed of at the FCS. With the exception of two rocket motors with propellant residue, all items were found to be inert, with no energetic components, fuzes, or explosives. The two rocket motors were also disposed of at the Range.

Comment: Can you give us a quick rundown of the groundwater remediations?

Response: Yes. The Proposed Plan identifies several areas of groundwater contamination. The primary contaminants being monitored are 1,2,3-TCP (a solvent); TCE (a solvent); and diesel fuel. The Army has focused on areas where contaminant concentrations exceed MCLs. Groundwater monitoring has been conducted twice a year since 2006. Contaminant concentrations are decreasing through natural attenuation (i.e., biological processes and dilution). We are not doing any pumping or treating. The Army has taken particular care to ensure that contaminated groundwater is not moving toward the Post drinking water supply wells. We have installed sentry wells between the FCS and the drinking water supply wells. The drinking water supply wells meet all federal and state drinking water standards and the sentry wells are showing no sign of contamination. We will continue monitoring these wells to ensure that the Post drinking water supply remains safe.

Comment: Can you point to the location of the source for the supply wells?

Response: Yes. The Post drinking water supply wells are located adjacent to the northeast corner of the FCS, behind the PX gas station.

Comment: What is the groundwater flow direction?

Response: Groundwater flows toward the northwest (north-northwest). The diesel, 1,2,3-TCP, and TCE are all moving toward the northwest. This was calculated by taking water level measurements across the site. The highest elevation is where the flow direction starts and the lowest point is where the groundwater flow is headed.

5.0 REFERENCES

ADEC (Alaska Department of Environmental Conservation). 2012 (April). *Oil and Other Hazardous Substances Pollution Control*. 18 AAC 75.

ADEC. 2011 (February). *Guidance on Using Institutional Controls in Oil and Other Hazardous Substance Cleanups.*

ADEC. 2010 (July). *ADEC Risk Assessment Procedures Manual*. Division of Spill Prevention and Response, Contaminated Sites Program. July 1.

ADEC. 2009a (July). *Draft Vapor Intrusion Guidance for Contaminated Sites*.

ADEC. 2009b (March). *Ecoscoping Guidance*. Available at: http://www.dec.state.ak.us/spar/csp/guidance/ecoscoping.pdf.

ADEC. 2009c (February). *Risk Assessment Procedures Manual*. Draft.

ADEC. 2008 (August). *Guidelines for Data Reporting, Data Reduction, and Treatment of Nondetect Values*. Technical Memorandum 08-001. August.

ADEC. 2004 (June). *Evaluation of Vapor Intrusion Pathway at Contaminated Sites*. Memorandum.

ADEC. 2002. *Guidance for Treatment of Petroleum-Contaminated Soil and Water and Standard Sampling Procedures*.

Alaska Native Heritage Program. 2009 (March 11). Personal communication between Lenz, Julia/Alaska Native Heritage Program and Stacey Ré/CH2M HILL.

American Cancer Society. 2003. *Cancer Facts and Figures—'03*. Atlanta, Georgia.

Andelman, J.B. 1990. Total Exposure to Volatile Organic Chemicals in Potable Water. Lewis Publishers.

Anderson, G.S. 1970. "Hydrologic Reconnaissance of the Tanana Basin, Central Alaska." *U.S. Geological Survey Hydrologic Investigations Atlas*. HA-319.

ASTM (American Society for Testing and Materials). 1998. *Standard Guide for Remediation of Groundwater by Natural Attenuation at Petroleum Release Sites*. E1943-98.

ATSDR (Agency for Toxic Substances and Disease Registry). 2009. Minimal Risk Levels (MRLs). December.
Available at: http://www.atsdr.cdc.gov/mrls/pdfs/ atsdr_mrls_ december_2009.pdf

ATSDR. 2003. Public Health Assessment. Fort Wainwright, Alaska. Fairbanks North Star Borough. Accessed 30 September 2006: http:www.atsdr.cdc.gov/hac/pha/fortwainwright/wai/toc.html.

CH2M HILL. 2011a (December). *Screening and Evaluation of Remediation Technologies and Process Options, Former Communications Site, Fort Wainwright, Alaska.*

CH2M HILL. 2011b (May). *Feasibility Study, Former Communications Site, Fort Wainwright, Alaska.*

CH2M HILL. 2010a (December). *Remedial Investigation FWA Former Communications Site, Fort Wainwright, Alaska.* Final

CH2M HILL. 2010b. *Groundwater Analysis of the Former Communications Site, Fort Wainwright, Alaska.*

CH2M HILL. 2008. *Interim Remedial Investigation Management Plan*. Draft.

de Voogt, P. and U.A. Brinkman. 1989. "Production, Properties, and Usage of Polychlorinated Biphenyls." In: R.D. Kimbrough and A.A. Jensen, eds., *Halogenated Biphenyls, Terphenyls, Napthalenes, Dibenzodioxins, and Related Products*. Amsterdam: Elsevier/North-Holland Biomedical Press. Pp. 3–46.

DeGrandchamp, Richard L. and Mace G. Barron. 2005. *PCB Analysis and Risk Assessment at Navy Installations*. Part A: Overview of PCB Mixtures. Prepared for Navy Environmental Health Center.

Department of Defense. 2012 (9 March). *Department of Defense Manual*. "Defense Environmental Restoration Program (DERP) Management." 4715.20 2012.

Ecology and Environment. 1997. *Revised Areawide Community Relations Plan*. Fort Wainwright. Anchorage, Alaska.

Ecology and Environment. 1993. *Installation-Wide Community Relations Plan*. Anchorage, Alaska.

Ecology and Environment, Inc. 1993 (April). *Final Management Plan, Operable Unit 5, Fort Wainwright, Fairbanks, Alaska*. April.

EPA (U.S. Environmental Protection Agency). 2012 (13 December). *OEA Recommendations Regarding Trichloroethylene Toxicity in Human Health Risk Assessments*.

EPA. 2009a (December). *Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites*.

EPA. 2009b. *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual*. Part F, Supplemental Guidance for Inhalation Risk Assessment.

EPA. 2009c. *National Recommended Water Quality Criteria*. Office of Water. http://www.epa.gov/ost/criteria/wqctable/

EPA. 2009d. *IRIS Toxicological Review of Trichloroethylene*. (External Review Draft). EPA/635/R-09/011A. Washington, D.C.

EPA. 2008 (March). *Brownfields Technology Primer: Vapor Intrusion Considerations for Redevelopment*. EPA 542-R-08-001.

EPA. 2005a. *Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens*. Risk Assessment Forum. Washington, DC. EPA/630/R-30/003F. Available at: http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=160003.

EPA. 2005b. *Guidelines for Carcinogen Risk Assessment*. EPA/630/P-03/001F.

EPA. 2004a. *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual*. Part E, Supplemental Guidance for Dermal Risk Assessment. EPA/540/R/99/005.

EPA. 2004b. *Final Five-Year ROD Review Repor*t. Eielson Air Force Base, Alaska.

EPA. 2004c. *Integrated Exposure Uptake Biokinetic Model for Lead in Children*. IEUBK.

EPA. 2003 (5 December). *Memorandum—Human Health Toxicity Values in Superfund Risk Assessments*. OSWER Directive 9285.7-53.

EPA. 2002. *OSWER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils* (Subsurface Vapor Intrusion Guidance). EPA 530-D-02-004. Available at http://epa.gov/osw/hazard/correctiveaction/eis/vapor.htm

EPA. 2001. *Health Assessment Document for Trichloroethylene Synthesis and Characterization* (External Review Draft). EPA/600/P-01/002A. Office of Research and Development. National Center for Environmental Assessment. Washington Office, Washington, DC.

EPA. 1998. *Guidelines for Ecological Risk Assessment*.

EPA. 1997a. *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments*. Interim Final.

EPA. 1997b. *Supplemental Ecological Risk Assessment Guidance for Superfund*. Region 10.

EPA. 1997c (July). Health Effects Assessment Summary Tables (HEAST) FY 1997 Update.

EPA. 1997d (August). *Exposure Factors Handbook. Vol. I: General Factors*. EPA/600/P-95/002Fa.

EPA. 1992 (May). *Supplemental Guidance to RAGS: Calculating the Concentration Term*. Office of Solid Waste and Emergency Response. Publication 9285.7-081.

EPA, 1991 (November). *A Guide to Principal Threat and Low level Threat Wastes*. Publication 9380.3-06FS. Office of Solid Waste and Emergency Response. November.

EPA. 1986 (24 September). *Guidelines for Carcinogen Risk Assessment*. *Federal Register*. Vol. 51, 33992–34013.

EPA. 1989 (December). *Risk Assessment Guidance for Superfund, Volume I—Human Health Evaluation Manual.* Part A (Interim Final). Office of Solid Waste and Emergency Response. EPA/540/1-89/002.

EPA. 1998. *Guidelines for Ecological Risk Assessment*.

Hemker, C.J., and G.J. Nijsten. 1996. *Groundwater Flow Modeling Using Micro-Fem: Version 3*. Elandsgracht 83-1016 TR. Amsterdam, The Netherlands.

HLA (Harding Lawson Associates Group, Inc.). 1997. *Post-Wide Risk Assessment*. Fort Wainwright, Alaska. Volume 1. Prepared for U.S. Army Corps of Engineers, Alaska District.

HLA. 1996. *Operable Unit 5 Remedial Investigation Report*. Fort Wainwright, Alaska. Prepared for U.S. Army Corps of Engineers, Alaska District.

Hodge, R.P. 1976. *Amphibians and Reptiles in Alaska, the Yukon, and Northwest Territories*. Alaska Northwest Publishing Company. Anchorage, Alaska.

Jacobs. 2009 (June). *Military Munitions Investigation Activities and Hazard Assessment.* Final.

Kerns, J.D. 1993 (September). *Descriptive Inventory of Wildlife and Vegetation, Operable Unit 3*. Environmental Resource Division. Fort Wainwright, Alaska.

Lenz, Julia/Alaska Native Heritage Program. 2009 (11 March). Personal communication with Stacey re CH2M HILL.

MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. *Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems*. Archives of Environmental Contamination and Toxicology. Vol. 39:20-31.

NOAA (National Oceanic and Atmospheric Administration). 2009. Screening Quick Reference Tables. NOAA OR&R Report 08-1. Office of Response and Restoration Division. Seattle, Washington.

North Wind, Inc. 2007 (May). *Taku Gardens Preliminary Source Evaluation II Report*. Fort Wainwright, Alaska. Final. Prepared for the U.S. Army Corps of Engineers, Alaska District.

North Wind, Inc. 2006 (February). *FWA-Former Communications Site (Taku Gardens) Field Data Report.* Fort Wainwright, Alaska.

North Wind, Inc. 2005 (May). *Taku Gardens and Building 3421 Draft Sampling Data Report*. Fort Wainwright, Alaska. Prepared for U.S. Army Corps of Engineers, Alaska District.

Oasis (Oasis Environmental, Inc.) 2007. *Preliminary Source Evaluation I Narrative Report, Former Communications Site, Fort Wainwright, Alaska*.

R&M Consultants, Inc. 2004 (July). *Geophysical Site Investigations, Family Housing Replacement, Taku Sites FTW251 & FTW283)*. Fort Wainwright, Alaska. Final. Prepared for U.S. Army Corps of Engineers, Alaska District.

Sage Earth Sciences. 2007 (January). "Taku Gardens—Geophysical Survey 07-2006." Presented as Appendix B in North Wind, Inc., *2007 Taku Gardens Preliminary Source Evaluation II Report*. Fort Wainwright, Alaska. Final.

Selkregg, Lidia. 1976. Alaska Regional Profiles. Vol. VI, Yukon Region. University of Alaska. Arctic Environmental Information and Data Center.

Spindler, M.A. 1976 (December). *Ecological Survey of the Birds, Mammals, and Vegetation of the Fairbanks Wildlife Management Area*. Master's thesis, University of Alaska.

U.S. Army. 2007 (November 19). *Action Memorandum for a Department of Army Time-Critical Removal Action at the Communications Site (a/k/a Taku Gardens Housing Expansion Area), and Imposition and Maintenance of Interim Land Use Controls*. Fort Wainwright National Priorities List (NPL), Federal Facility Site, Fort Wainwright, Alaska.

U.S. Army Garrison Fort Wainwright, Alaska. 2006. *Fort Wainwright Integrated Natural Resources Management Plan*.

U.S. Army. 1991 (12 November). *Federal Facility Agreement Under CERCLA Section 120.* Administrative Docket Number: 1089-07-14-120. Received by Hearing Clerk, EPA—Region X 1 April 1992.

U.S. Army Installation Management Command. 2010 (15 September). *Explosives Safety Submission and After Action Report for Former Ladd Air Force Base Communications Site, Fort Wainwright, Alaska.*

USACE. 2012 (September). *Former Communications Site Groundwater Summary, Fort Wainwright, Alaska. Final.* Prepared by Jacobs Engineering Group.

USACE. 2012 (December). *Former Communications Site Action Memorandum Fort Wainwright, Alaska Final*. Prepared by Jacobs Engineering Group Inc.

USACE. 1994. *Background Data Analysis for Arsenic, Barium, Cadmium, Chromium, and Lead on Fort Wainwright, Alaska*.

USGS (U.S. Geological Survey). 1996. *Numerical Simulations of Ground-Water/Surface-Water Interactions at Fort Wainwright, Alaska*. Draft Report.

USGS. 1988. *Element Concentrations in Soils and Other Surficial Materials of Alaska*. USGS Professional Paper 1458.

(intentionally blank)

APPENDIX A

Figures

LEGEND

Project Location

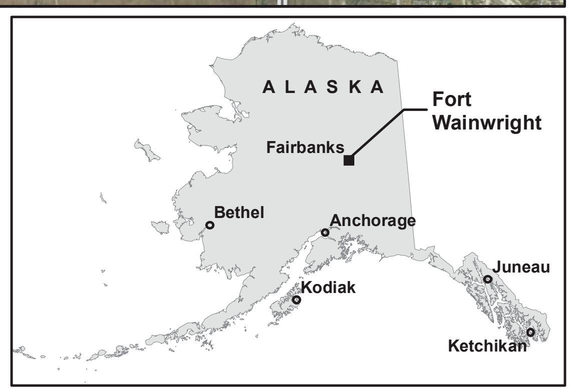
Installation Boundary for Fort Wainwright

River

Railroad

0 0.75
Miles

N



Sources:
1. Imagery U.S. Army Corps of Engineers, May 2005.
2. CH2MHILL. 2010 (December). *Final Remedial Investigation, FWA 102 Former Communications Site, Fort Wainwright, Alaska*

FORMER COMMUNICATIONS SITE LOCATION AND VICINITY MAPS

Fort Wainwright, Alaska

JACOBS	11 FEB 2013	T. HEIKKILA	A-1

Source:
CH2MHILL. 2010 (December). *Final Remedial Investigation, FWA 102 Former Communications Site, Fort Wainwright, Alaska*

FORMER COMMUNICATIONS SITE
TAKU GARDENS FAMILY HOUSING DEVELOPMENT

Fort Wainwright, Alaska

JACOBS	11 FEB 2013	T. HEIKKILA	A-2

Taku Gardens Development and Investigation History

IDW Disposal and Removal Actions

2004
- **Debris/DMM IDW Disposal** (USACE / US Army DPW) Site Preparation

2005
- **Time Critical Removal Action** PCB Soil from Bldg 52 Area (North Wind)
- **Debris Excavated and Stockpiled** (Shannon & Wilson / Watterson)
- **POL soils stockpiled and moved to DRMO Yard** (Watterson / North Wind)

2006
- **Debris and IDW Disposal**

2007
- **Subarea A MEC Clearance & Debris/DMM IDW Disposal**
- **Soil Pile Screening & Disposal**

2008
- **Subarea A MEC Clearance & Debris/DMM IDW Disposal**
- **Soil Pile Screening & Disposal**

2009/2010
- **Foundation Demolition and Disposal**

Contamination Investigations

2003
- **Geophysical Survey** (CRREL)
- **Soil Sampling** (Shannon & Wilson) Soil Borings
- **Soil Sampling** (USACE) Soil Borings

2004
- **Geophysical Survey** (R&M)

2005
- **Follow-up PCB Investigation** Step-out Borings at AP-8960 & AP-8934 (North Wind)
- **Foundation Excavation Field Screening** (Shannon & Wilson)
- **Site PCB & POL Area Investigation** (North Wind / Shannon & Wilson)

2006
- **Geophysical Survey** (Sage Earth Science/ North Wind)
- **PSE I** (Oasis) Previous investigation summary
- **PSE II** (North Wind) Surface / Subsurface Soil Sampling; Monitoring Well Installation; Groundwater Sampling; Soil Gas Sampling; Debris Test Pitting; Stockpile Sampling

2007
- **PCB Soil Removal**
- **Geophysical Survey**
- **2007 Drum & Debris Investigation**
- **Spring 2007 Groundwater Sampling** (North Wind)
- **2007 Drum and Debris Investigation** Building 49; Building 48; Building 15/17
- **2007 Remedial Investigation** (CH2M HILL) Sound Berm Soil MI Sampling; Soil Pile Sampling; Surface / Subsurface Soil Sampling; Drainage Swale Sediment Sampling; Excavation Confirmation Sampling; MW Installation & Water Level Survey; Groundwater Sampling; Vadose Zone Soil Gas Sampling; Subslab Soil Gas Sampling; Supply Well Pump Test; Subarea E PCB Investigation

2008
- **PCB Soil Removal**
- **Geophysical Survey**
- **2008 Drum & Debris Investigation**
- **2008 Remedial Investigation** Follow-up Sound Berm Sampling; Surface Soil Sampling; Additional Subsurface Soil Sampling; Additional MW Installation and Sampling; Subslab Soil Gas/Indoor Air Sampling
- **Drum and Debris Investigations** Building 15/17; Building 12/24; Area D; >75 mV Anomalies; <75 mV Anomalies
- **2008 POL Investigation**
- **2008 DDT Hot Spot Excavation**
- **2008 Soil Pile Removal and Sampling**

2009/2010
- **Drum and Debris Investigations** Building 15/17; Building 11; Building 49; Building 35
- **Building 9 POL Investigation**
- **123 TCP Delineation**
- **Delineation of Northern Plumes**
- **Sound Berm Sampling**
- **Subslab Soil Gas/ Indoor Air Sampling**
- **Additional Surface Soil Sampling**
- **Groundwater Sampling**
- **DDT Hotspot Excavation**

Development

2004
- **Geotechnical Investigation** (USACE) Soil Borings
- **Site Preparation** (US Army DPW) Vegetation Removal & Surface Clearance
- Sound Berm Construction (Watterson)

2005
- **Housing Construction Begins** (Watterson) April 2005
- **Construction Suspended** (Watterson) Aug. – Sept. 2005
- **Housing Construction Continues** (Watterson) Sept. 2005
- Foundation Excavations
- PCB Exclusion Area Established
- Utility Installation
- Improve Site Security & Dust Control
- Construction-Related Dewatering

2006
- **Housing Construction Complete** (Watterson)
- Runoff Control Constructed for PCB Area (North Wind)

2007
- **Investigation Excavation Backfilling** Building 48 Excavation; Building 49 Excavation; Building 52 Excavation (PCB EZ)

2008
- **Investigation Excavation Backfilling** Exposed Utilities Only

2009/2010
- **Foundation Demolition and Disposal**
- **Investigation, Excavation, and Backfilling**

Milestones

2003
- Buried metal identified in northeast portion of FCS

2004
- Buried metal identified at multiple locations across the site
- Buried metal debris and DMM identified and excavated south of PX service station (northeast portion of site)
- PCB concentrations detected in soil in southwest corner and east-central portion of FCS

2005
- Buried metal identified at multiple locations across the FCS
- Strong chemical odors observed during site excavation at Building 52
- POL compounds detected in north-central portion of FCS
- PCBs and chlorinated solvents detected in Bldg 52 area soils
- Public notifications
- FCS public meeting held

2006
- Initiated Preliminary Source Evaluation
- Subareas A through E designated
- Significant volume of buried scrap metal and other non-hazardous debris identified across the site
- Multiple buried crushed drums found near Bldg 49
- Extent of PCB contamination at Building 52 defined
- VOCs identified in soil gas (passive detectors) in north-central portion of FCS
- POL contamination identified in soil and groundwater (north-central portion of FCS)

2007
- Initiated remedial investigation activities
- Initiated drum and debris investigation activities
- Soil piles characterized for disposal at Fort Wainwright landfill
- Capture zones for Building 3552 supply well modeled
- Risk screening conducted to identify data gaps for 2008 remedial investigation
- Ecological risk screening identified no areas or media of concern

2008
- Continued remedial investigation activities
- Continued drum and debris investigation activities

Color Key

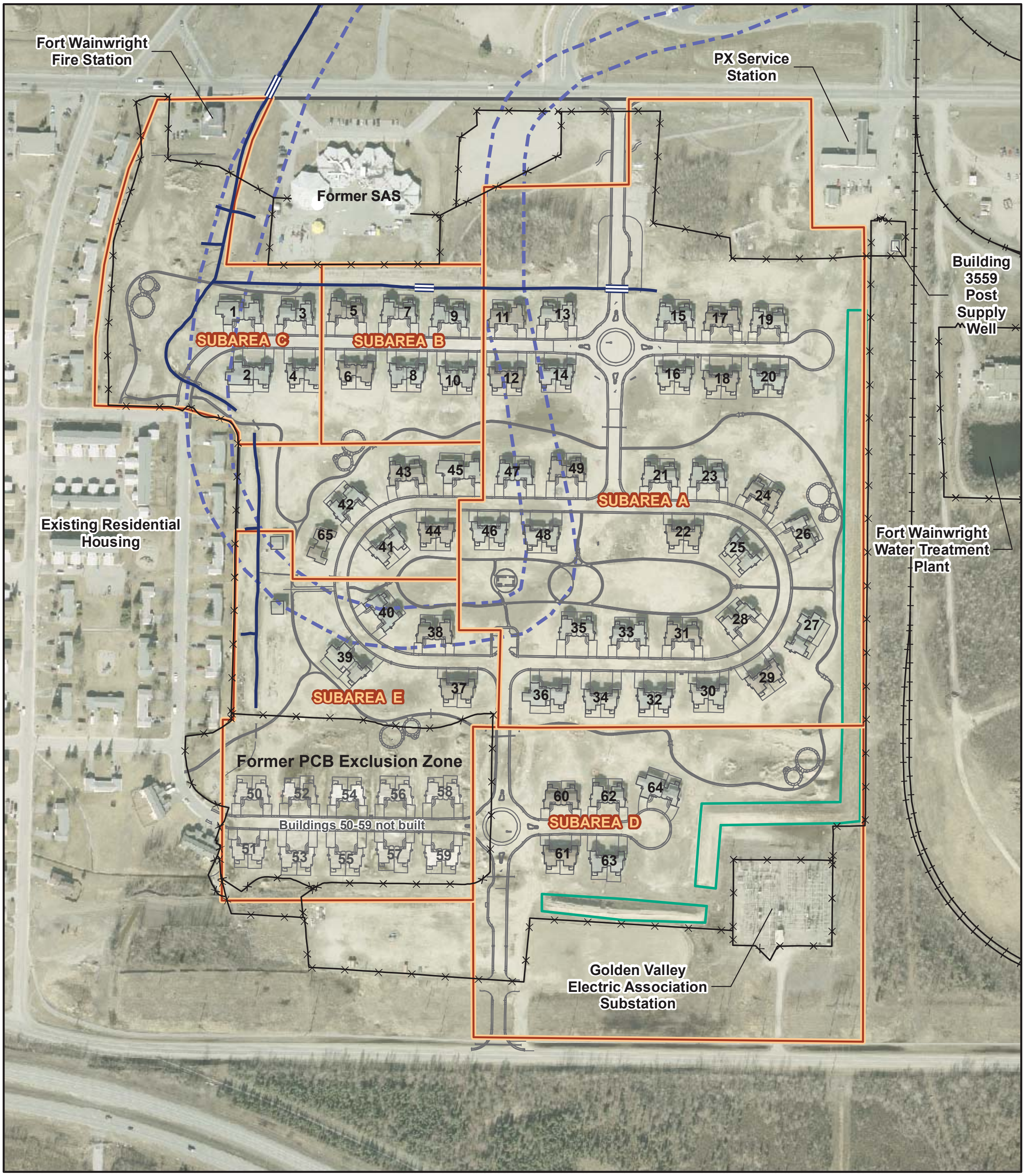
- PCB Soil Investigations and Removal Actions
- Drum & Debris Investigations (Includes Geophysics)
- Multi-Media, Multi-Analyte Contaminant Investigations (includes PCBs)
- Multi-Media, Multi-Analyte Contaminant Investigations (not PCBs)
- Construction/ Development Activities

Source:
CH2MHILL. 2010 (December). *Final Remedial Investigation, FWA 102 Former Communications Site, Fort Wainwright, Alaska*

FORMER COMMUNICATIONS SITE DEVELOPMENT AND INVESTIGATION CHRONOLOGY

Fort Wainwright, Alaska

JACOBS	DATE: 19 AUG 2013	PROJECT MANAGER: T. HEIKKILA	FIGURE NO: A-3



LEGEND

- Subarea Boundary
- Former Hoppe's Slough
- Sound Berm
- Drainage Swale
- Drainage Swale Culvert
- Security Fence
- Railroad
- Infrastructure for Taku Gardens

0 400
Feet

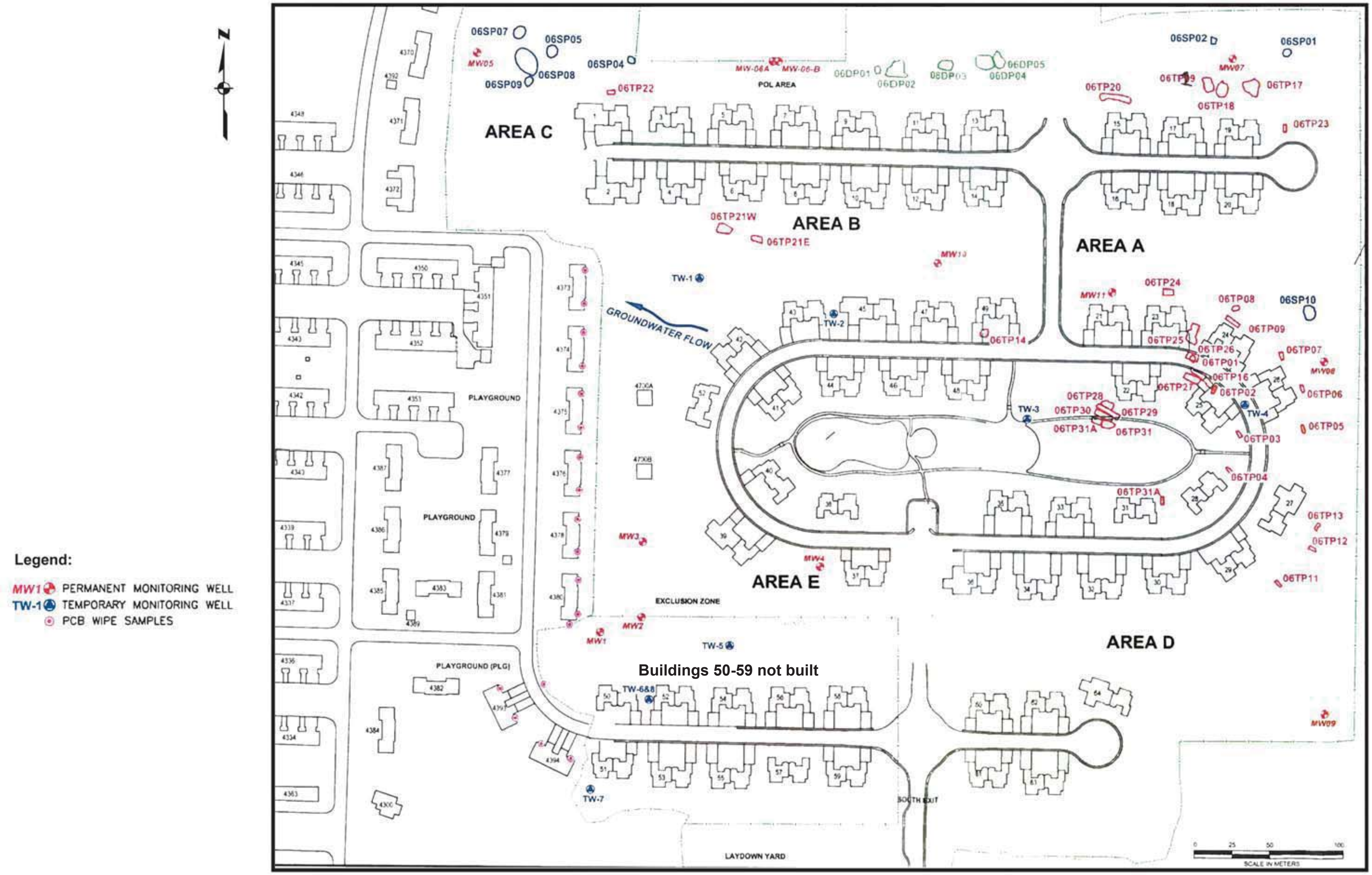
N

Source:
CH2MHILL. 2010 (December). *Final Remedial Investigation, FWA 102 Former Communications Site, Fort Wainwright, Alaska*

TAKU GARDENS DEVELOPMENT AND PRELIMINARY LAYOUT

Fort Wainwright, Alaska

JACOBS	11 FEB 2013	T. HEIKKILA	A-4

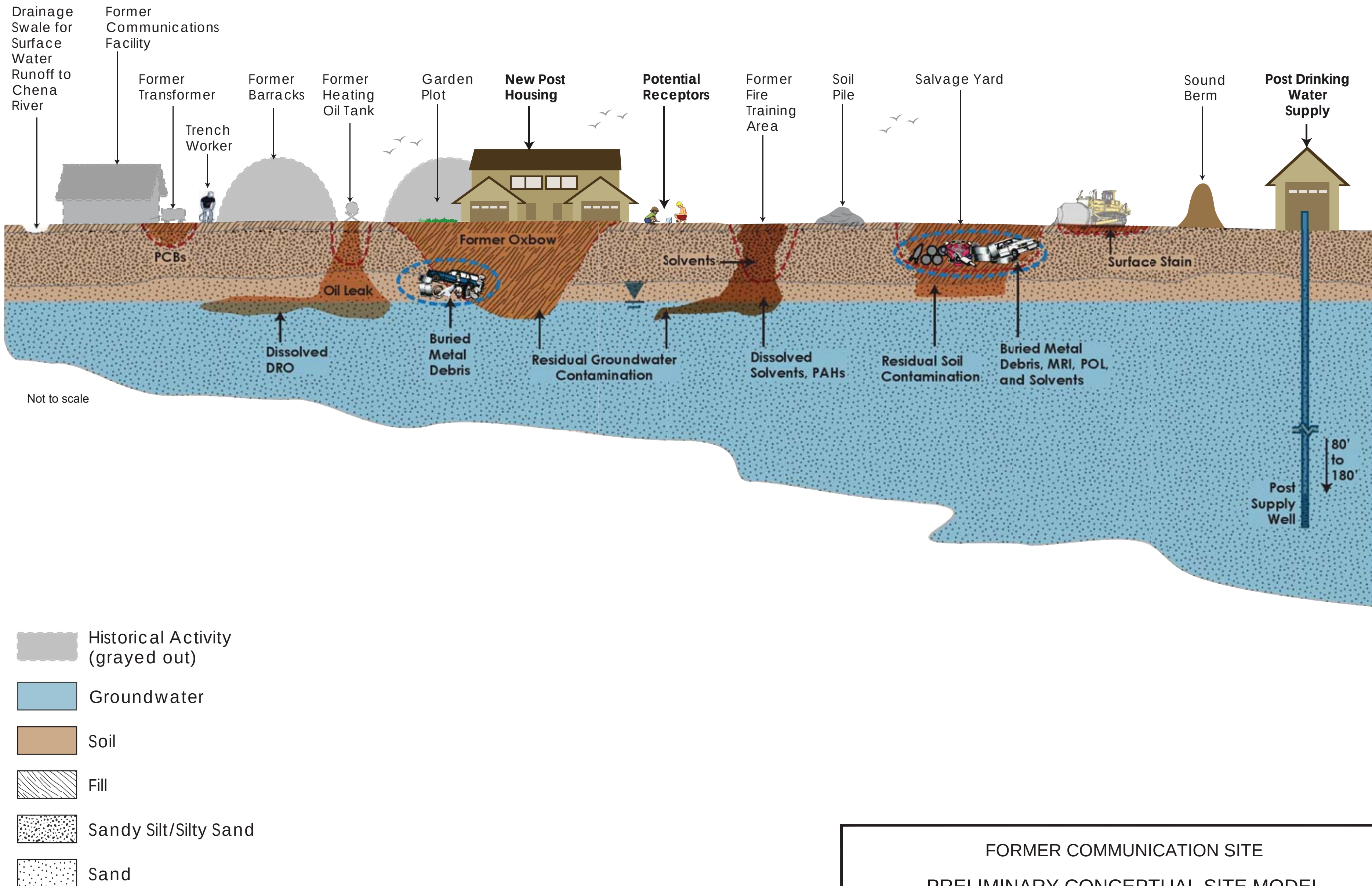


Source:
CH2MHILL. 2010 (December). *Final Remedial Investigation, FWA 102 Former Communications Site, Fort Wainwright, Alaska*

FORMER COMMUNICATION SITE
OASIS SOIL PILE AND TEST PIT INVESTIGATION

FORT WAINWRIGHT, ALASKA

JACOBS	DATE: 11 FEB 2013	PROJECT MANAGER: T.HEIKKILA	FIGURE NUMBER: A-5



SOURCE: CH2M HILL, 2010 (DECEMBER)

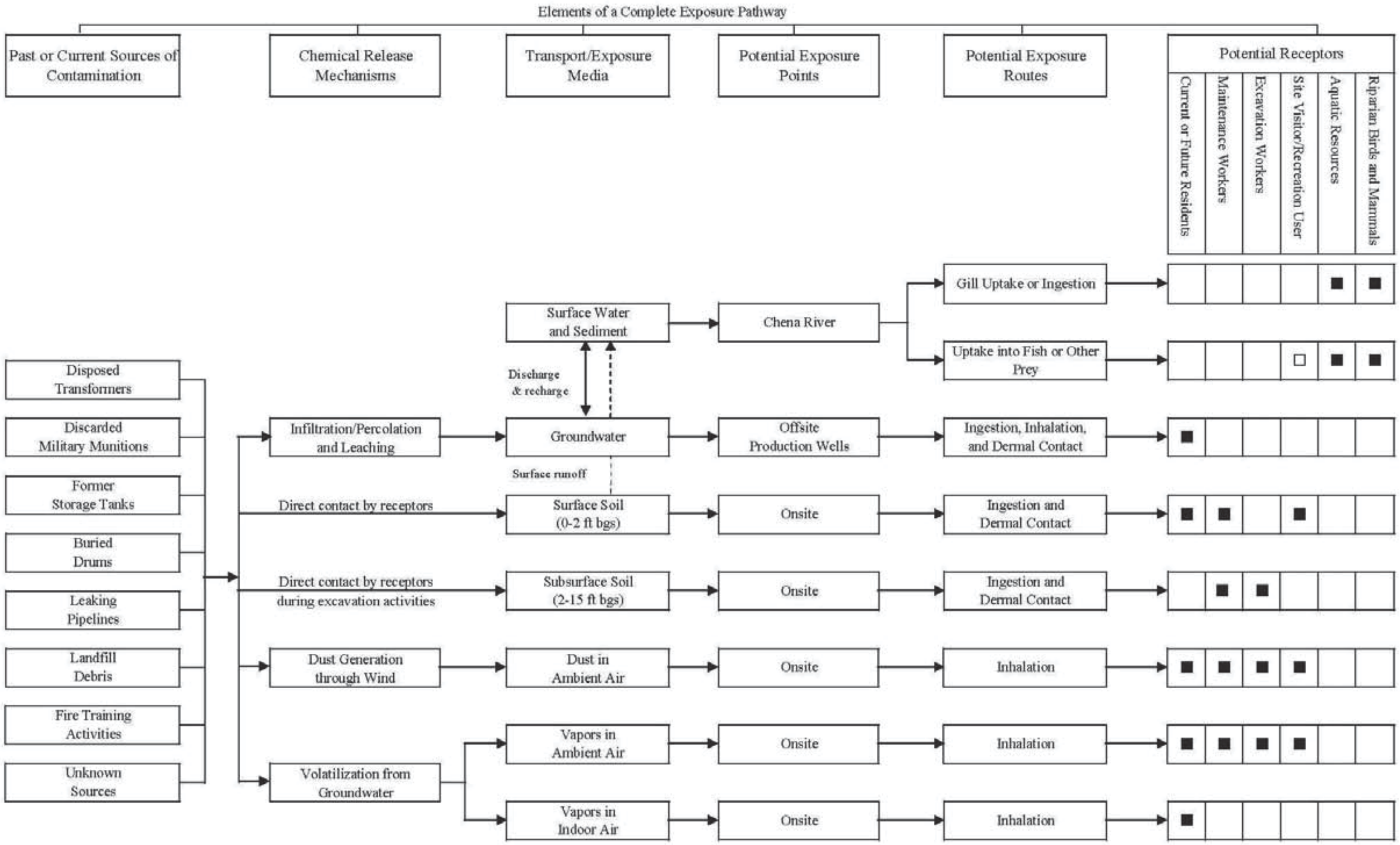
\\anc\fil03\Projects\ERS-URT\O07-Taku Gardens RAW\PROD\Figures\Figure 2-3 Preliminary Conceptual Model.dwg Figure 2-3 Preliminary Conceptual Model 13 February 2013 - jaronij

FORMER COMMUNICATION SITE

PRELIMINARY CONCEPTUAL SITE MODEL

FORT WAINWRIGHT, ALASKA

JACOBS	DATE: 13 Feb 2013	PROJECT MANAGER: T. HEIKKILA	FIGURE NO.: A-6



■ = Potentially complete pathway (to be addressed quantitatively)
□ = Pathway considered minor (to be addressed qualitatively)

Blank = Incomplete pathway

SOURCE: CH2M HILL, 2010 (DECEMBER)

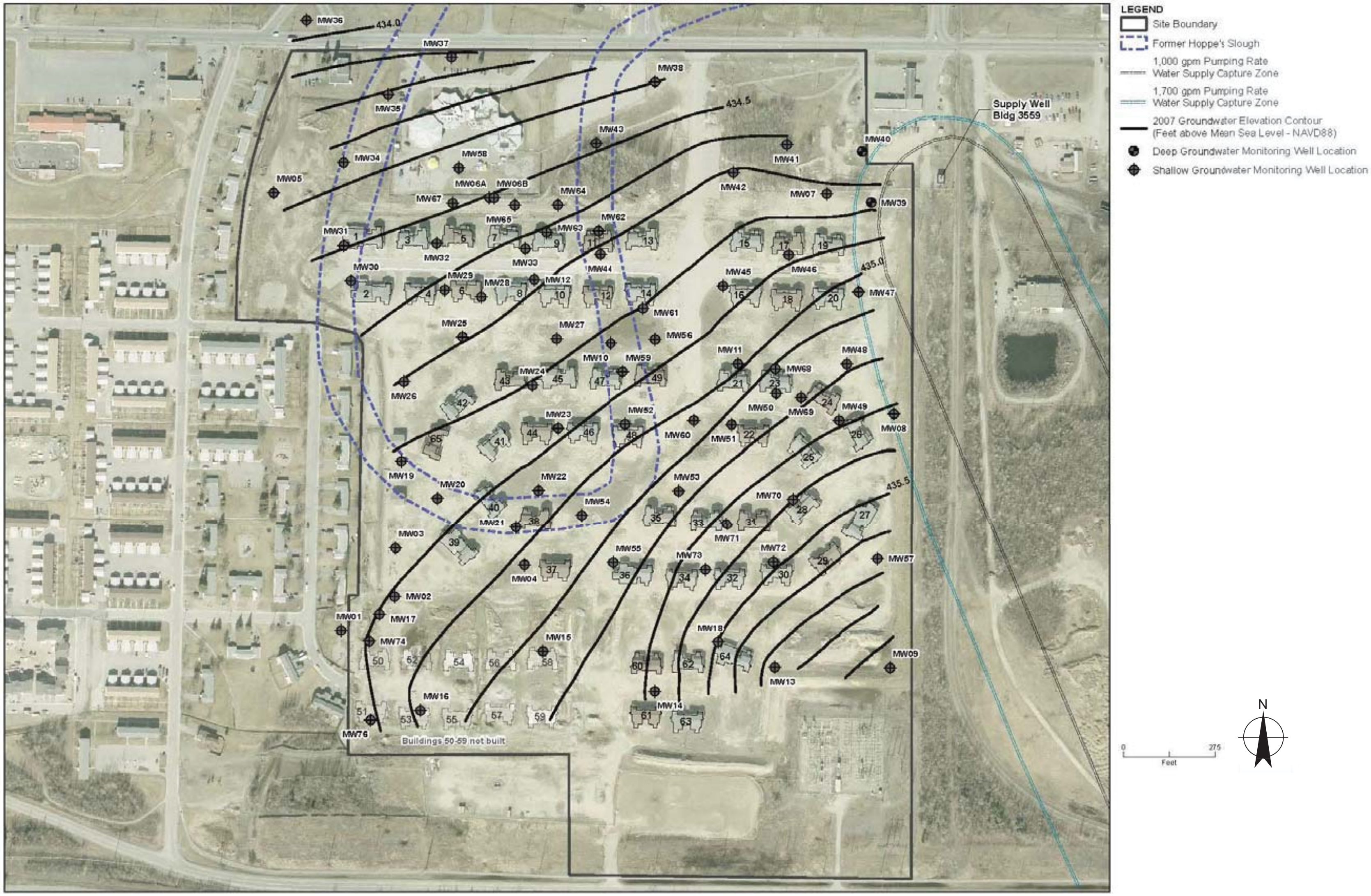
FORMER COMMUNICATION SITE

PRELIMINARY CONCEPTUAL SITE MODEL FOR POTENTIAL HUMAN AND ECOLOGICAL EXPOSURES

FORT WAINWRIGHT, ALASKA

JACOBS®	DATE:	PROJECT MANAGER:	FIGURE NO. :
	13 Feb 2013	T. HEIKKILA	A-7

\\ancfil03\Projects\ERS-UR\TO07-Taku Gardens RAWP\ROD\Figures\Figure 2-4 Conceptual Site Model for Potential Human and Ecological Exposures.dwg Figure 2-4 Conceptual Site Model for Potential Human and Ecological Exposures 13 February 2013 - jaronitj



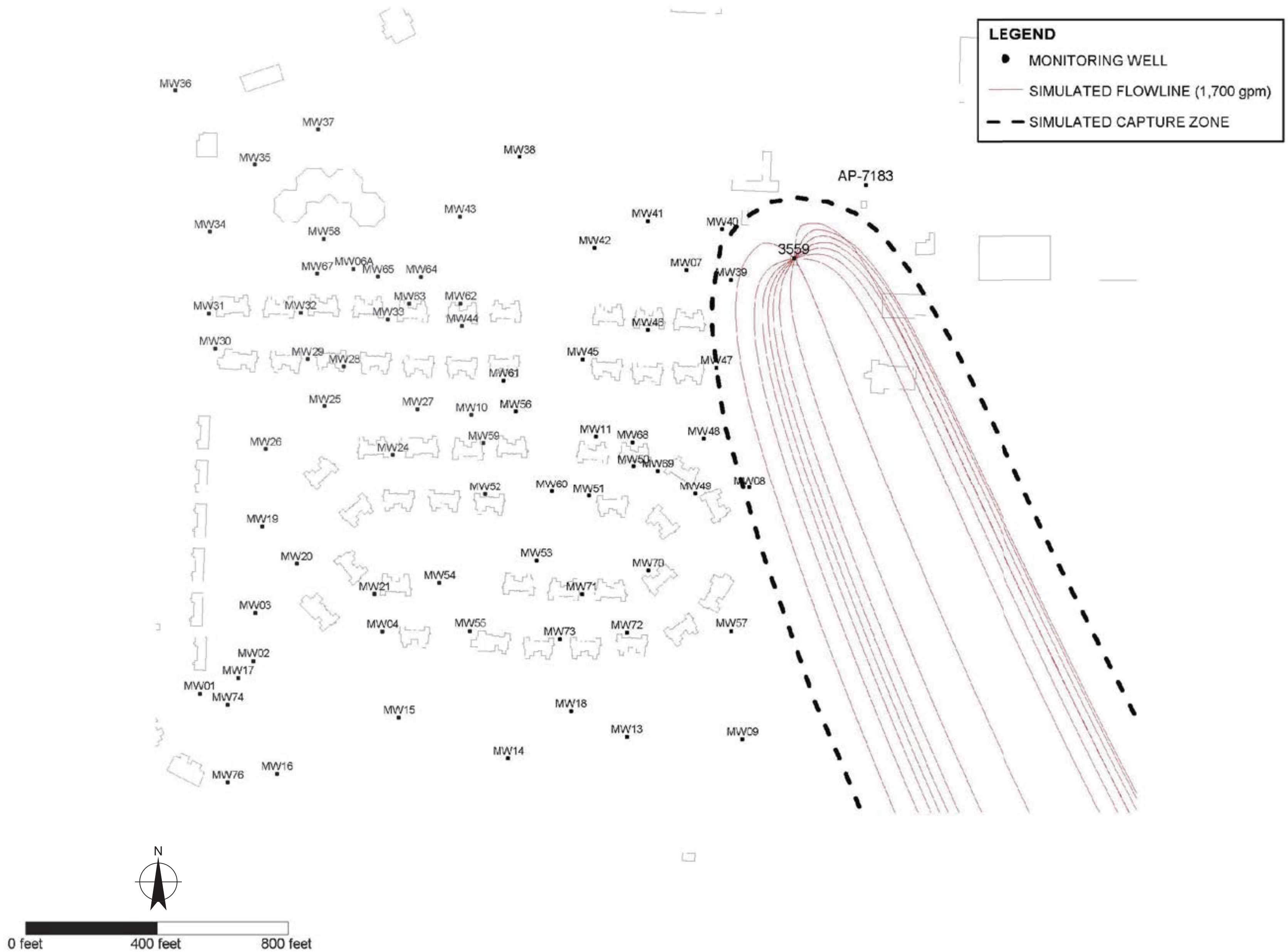
SOURCE: CH2M HILL, 2010 (DECEMBER)

FORMER COMMUNICATION SITE
GROUNDWATER ELEVATION CONTOUR MAP

FORT WAINWRIGHT, ALASKA

JACOBS	DATE: 13 Feb 2013	PROJECT MANAGER: T. HEIKKILA	FIGURE NO.: A-8

\\ancfil03\Projects\ERS-UR\TO07-Taku Gardens RA\WP\ROD\Figures\Figure 2-5 Groundwater Elevation Contour Map.dwg Figure 2-5 Groundwater Elevation Contour Map 13 February 2013 - jaronitj



NOTES:

1. ASSUMED HYDRAULIC CONDUCTIVITY OF 1,400 FEET/DAY.

SOURCE: CH2M HILL, 2010 (DECEMBER)

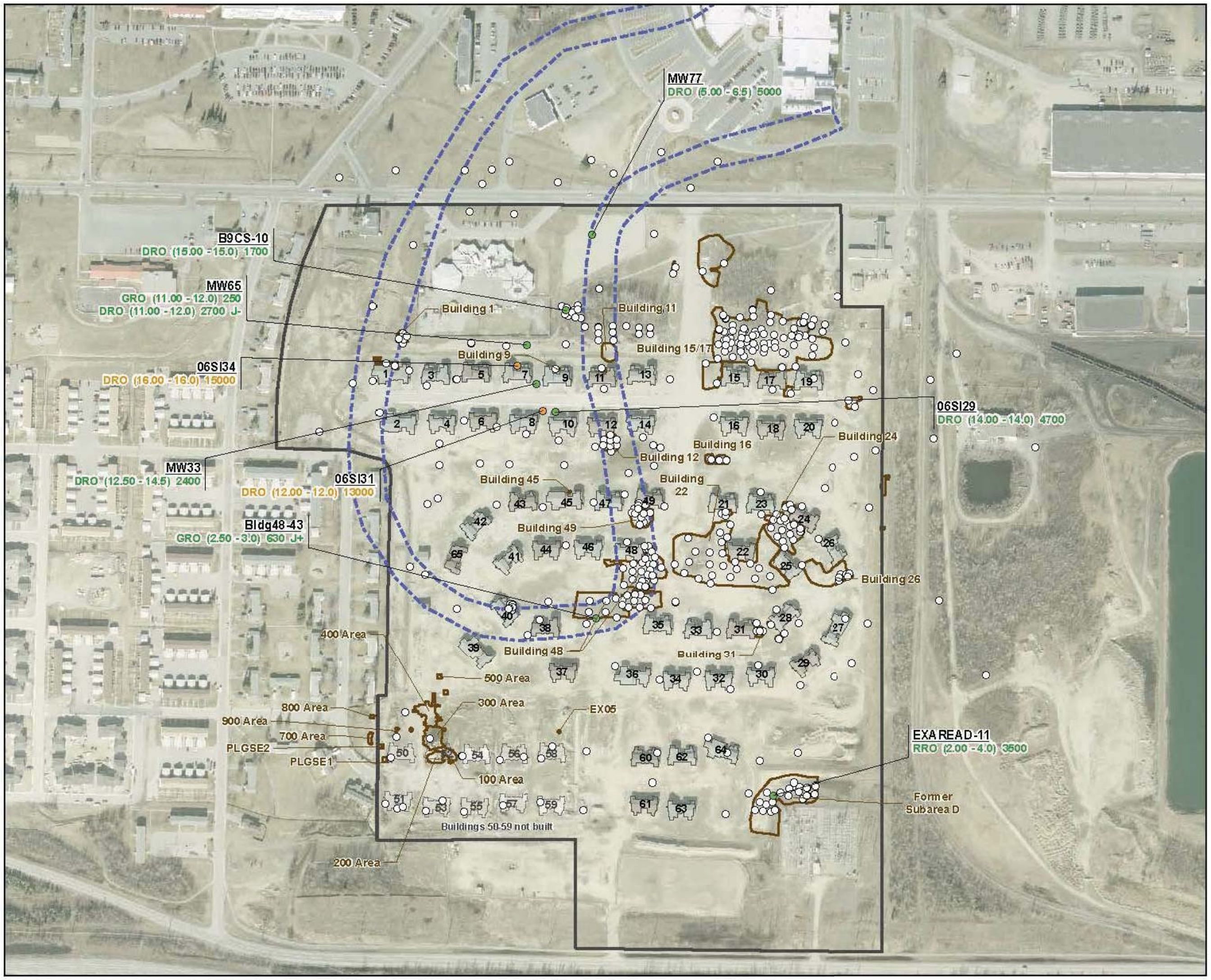
FORMER COMMUNICATION SITE
MODELED HYDRAULIC CAPTURE
ZONE OF PRODUCTION WELL 3559

FORT WAINWRIGHT, ALASKA

JACOBS

DATE:	PROJECT MANAGER:	FIGURE NO. :
13 FEB 2013	T. HEIKKILA	A-9

\\ancfil03\Projects\ERS-URITO07-Taku Gardens RAWP\ROD\Figures\Figure 2-6 Modeled Hydraulic Capture Zone of Production Well 3559.dwg Figure 2-6 Modeled Hydraulic Capture Zone of Production Well 3559 13 February 2013 - jaronti



LEGEND

- Site Boundary
- Former Hoppe's Slough
- PCB and Exploratory Excavation Area

Explanation of Results

- No detected exceedances of PSLs
- One or more exceedance of PSL; detected result >1 and ≤10 x PSL
- One or more exceedance of PSL; detected result >10 and ≤100 x PSL

Explanation of Label

Location ID
Analyte (Depth in ft) Result (mg/kg) Qualifier

*Font color indicates magnitude of exceedence

Analyte	Screening Level
DRO	1025 mg/kg
RRO	1000 mg/kg
GRO	140 mg/kg

0 275
Feet

N

\\ancfil03\Projects\ERS-URT\O07-Taku Gardens RA\WP\ROD\Figures\Figure 2-7 Distribution of Petroleum Hydrocarbons in Subsurface Soil.dwg Figure 2-7 Distribution of Petroleum Hydrocarbons in Subsurface Soil 13 February 2013 - jaronitj

NOTES:

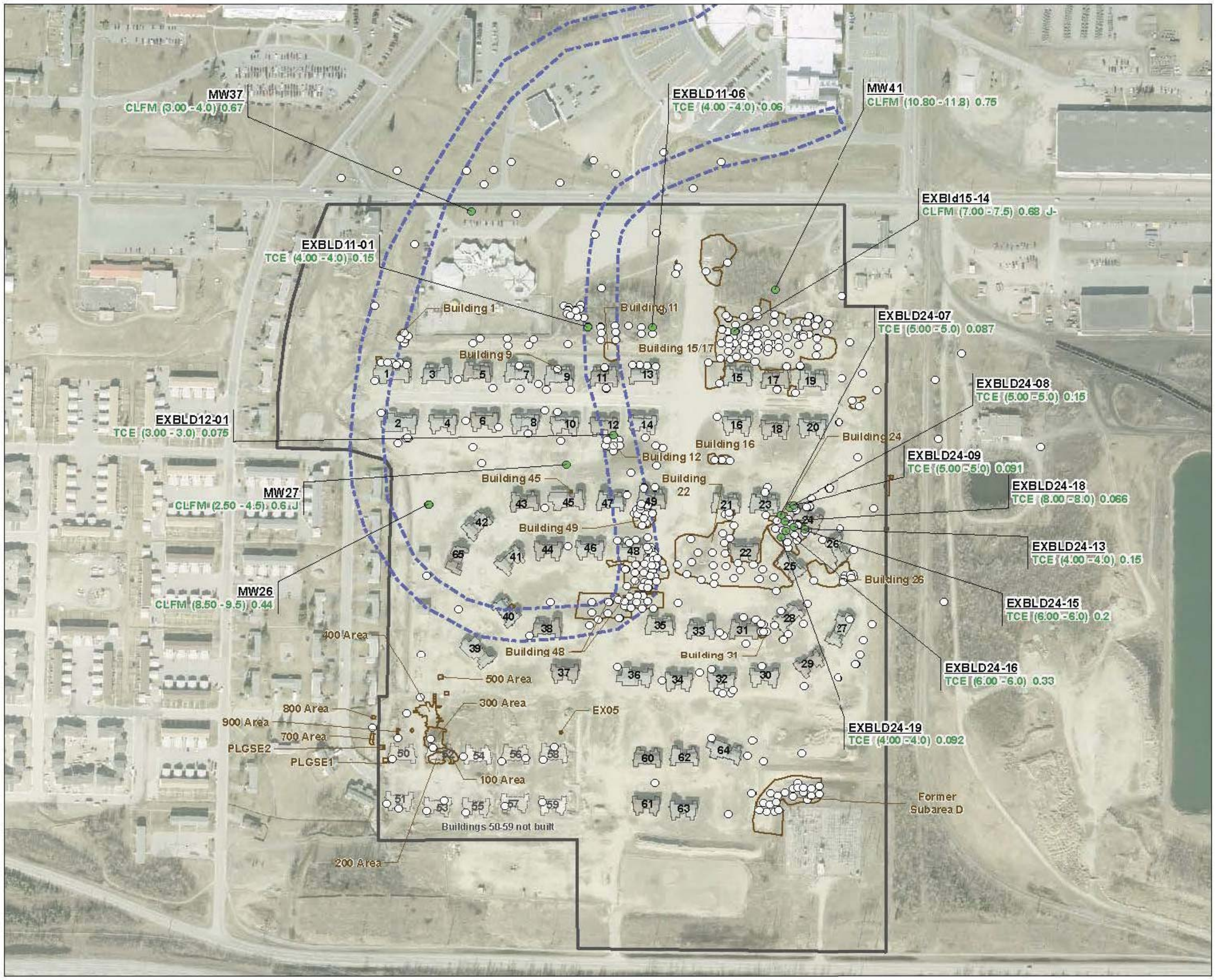
1. ASSUMED HYDRAULIC CONDUCTIVITY OF 1,400 FEET/DAY.

SOURCE: CH2M HILL, 2010 (DECEMBER)

FORMER COMMUNICATION SITE
DISTRIBUTION OF PETROLEUM HYDROCARBONS IN SUBSURFACE SOILS AT THE COMPLETION OF THE REMEDIAL INVESTIGATION

FORT WAINWRIGHT, ALASKA

JACOBS®	DATE: 13 FEB 2013	PROJECT MANAGER: T. HEIKKILA	FIGURE NO.: A-10



LEGEND

- Site Boundary
- Former Hoppe's Slough
- PCB and Exploratory Excavation Area

Explanation of Results

- No detected exceedances of PSLs
- One or more exceedance of PSL; detected result >1 and ≤10 x PSL

Explanation of Label

Location ID
Analyte (Depth in ft) Result (mg/kg) Qualifier

*Font color indicates magnitude of exceedence

Analyte	Screening Level
1,1,2,2-Tetrachloroethane	0.55 mg/kg
1,1,2-Trichloroethane	1.1 mg/kg
1,1-Dichloroethene	0.085 mg/kg
1,2-Dichloroethane	0.48 mg/kg
1,2-Dichloropropane	0.53 mg/kg
1,2,4-Trichlorobenzene	4.1 mg/kg
Carbon tetrachloride	0.31 mg/kg
Chloroform	0.32 mg/kg
cis-1,2-Dichloroethene	13 mg/kg
Hexachlorobutadiene	0.38 mg/kg
Tetrachloroethene (PCE)	1 mg/kg
Trichloroethene (TCE)	0.057 mg/kg
Vinyl chloride	0.43 mg/kg

0 275
Feet

N

SOURCE: CH2M HILL, 2010 (DECEMBER)

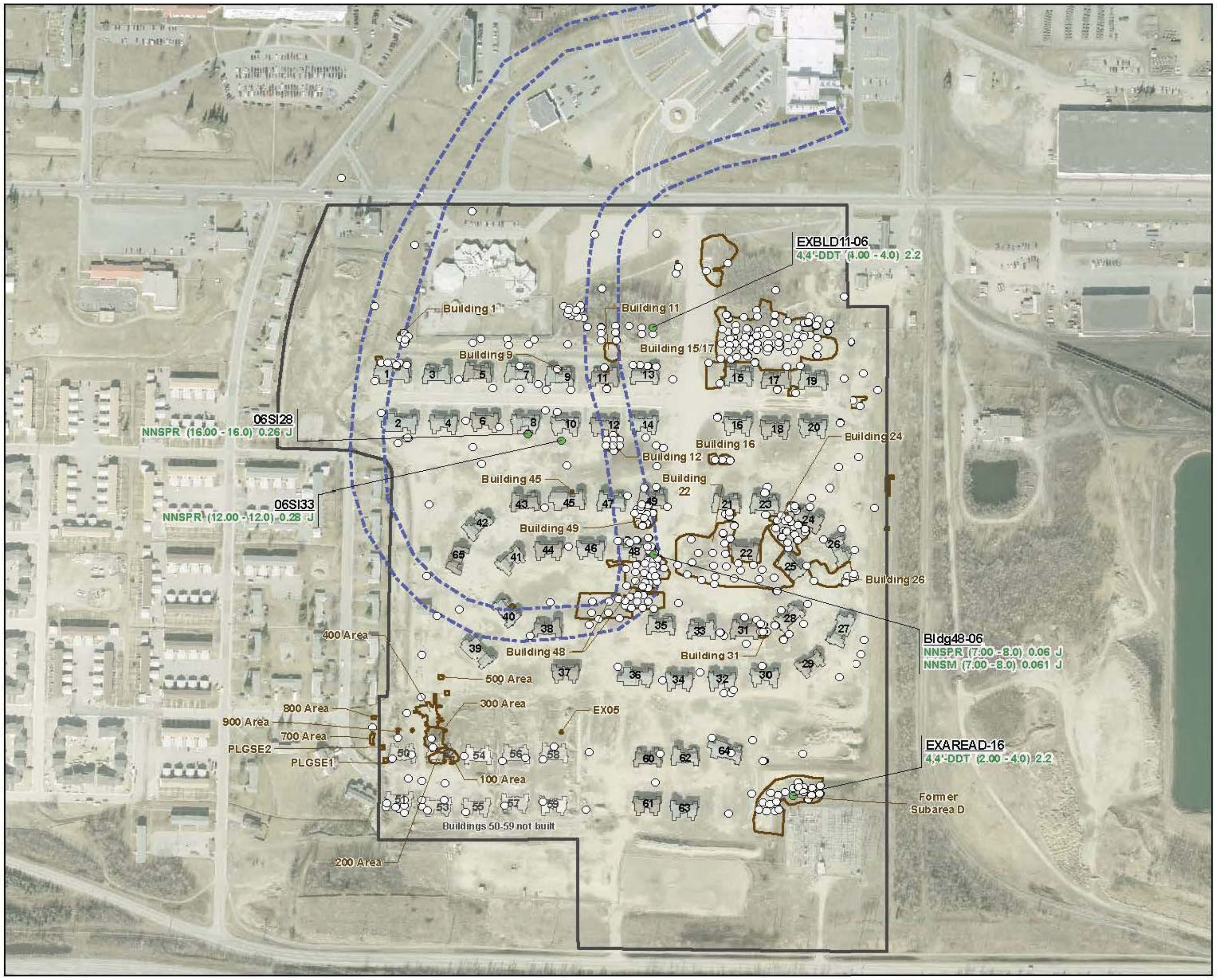
FORMER COMMUNICATION SITE
DISTRIBUTION OF CHLORINATED VOCS IN SUBSURFACE SOILS
AT THE COMPLETION OF THE REMEDIAL INVESTIGATION

FORT WAINWRIGHT, ALASKA

JACOBS®

DATE:	PROJECT MANAGER:	FIGURE NO.:
13 Feb 2013	T. HEIKKILA	A-11

\\ancfil03\Projects\ERS-UR\TO07-Taku Gardens RA\WP\ROD\Figures\Figure 2-8 Distribution of Chlorinated VOCs in Subsurface Soils.dwg Figure 2-8 Distribution of Chlorinated VOCs in Subsurface Soils 13 February 2013 - jaronlj



LEGEND

- Site Boundary
- Former Hoppe's Slough
- PCB and Exploratory Excavation Area

Explanation of Results

- No detected exceedances of PSLs
- One or more exceedance of PSL; detected result >1 and ≤10 x PSL

Explanation of Label

Location ID
Analyte (Depth in ft) Result (mg/kg) Qualifier

*Font color indicates magnitude of exceedence

Analyte	Screening Level
Explosives:	
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	7.2 mg/kg
Pesticides:	
4,4'-DDT	2.1 mg/kg
Dieldrin	0.032 mg/kg
gamma-BHC (Lindane)	0.56 mg/kg
Heptachlor	0.13 mg/kg
SVOCs	
bis-(2-Ethylhexyl)phthalate	22 mg/kg
n-Nitrosodimethylamine	0.016 mg/kg
n-Nitrosodi-n-propylamine	0.052 mg/kg

0 275
Feet

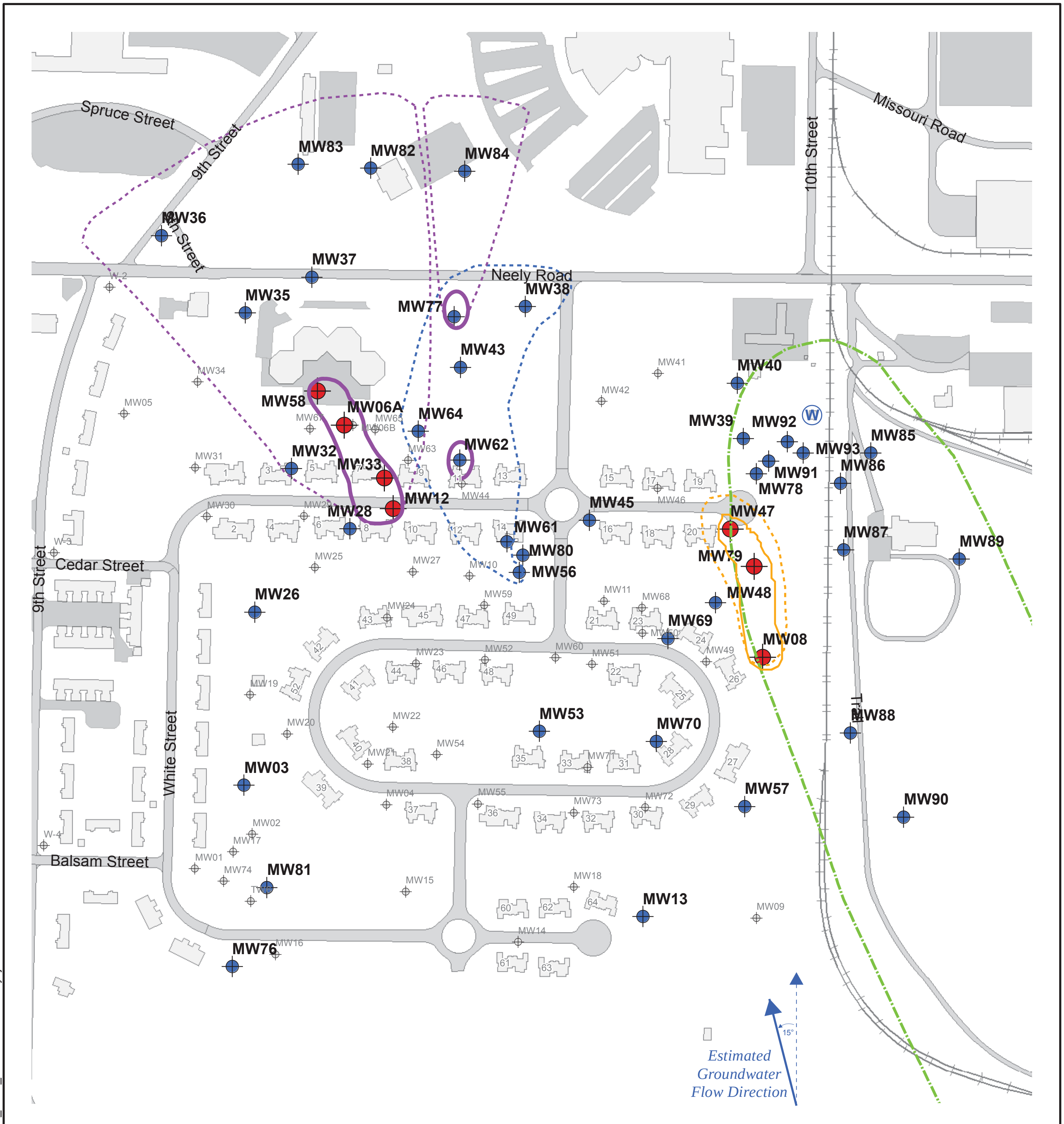
N

FORMER COMMUNICATION SITE
DISTRIBUTION OF PESTICIDES, HERBICIDES, SVOCS AND EXPLOSIVES IN SUBSURFACE SOILS AT THE COMPLETION OF THE REMEDIAL INVESTIGATION
FORT WAINWRIGHT, ALASKA

JACOBS®	DATE: 13 Feb 2013	PROJECT MANAGER: T. HEIKKILA	FIGURE NO.: A-12

SOURCE: CH2M HILL, 2010 (DECEMBER)

\\ancfil03\Projects\ERS-UR\TO07-Taku Gardens RA\WP\ROD\Figures\Figure 2-9 Distribution of Pesticides, Herbicides, SVOCs, and Explosives in Subsurface Soil.dwg Figure 2-9 Distribution of Pesticides Herbicides SVOCs and Explosives in Subsurface Soil 13 February 2013 - jaronti



Post Water Supply Well Capture Zone*

DRO above project cleanup level (plume area)

TCP above project cleanup level (plume area)

DRO below project cleanup level (leading plume edge)

TCE below project cleanup level (leading plume edge)

TCP below project cleanup level (leading plume edge)

Monitoring Well Sampled in 2012 - Exceedance

Monitoring Well Sampled in 2012 - No Exceedance

Onsite Well

Post Water Supply Well

Building

Railroad

Road or Trail

All Locations Are Approximate

0 250 500 750 1,000

Feet

WGS 1984 UTM Zone 6N

N

TCP: 1,2,3-Trichloropropane

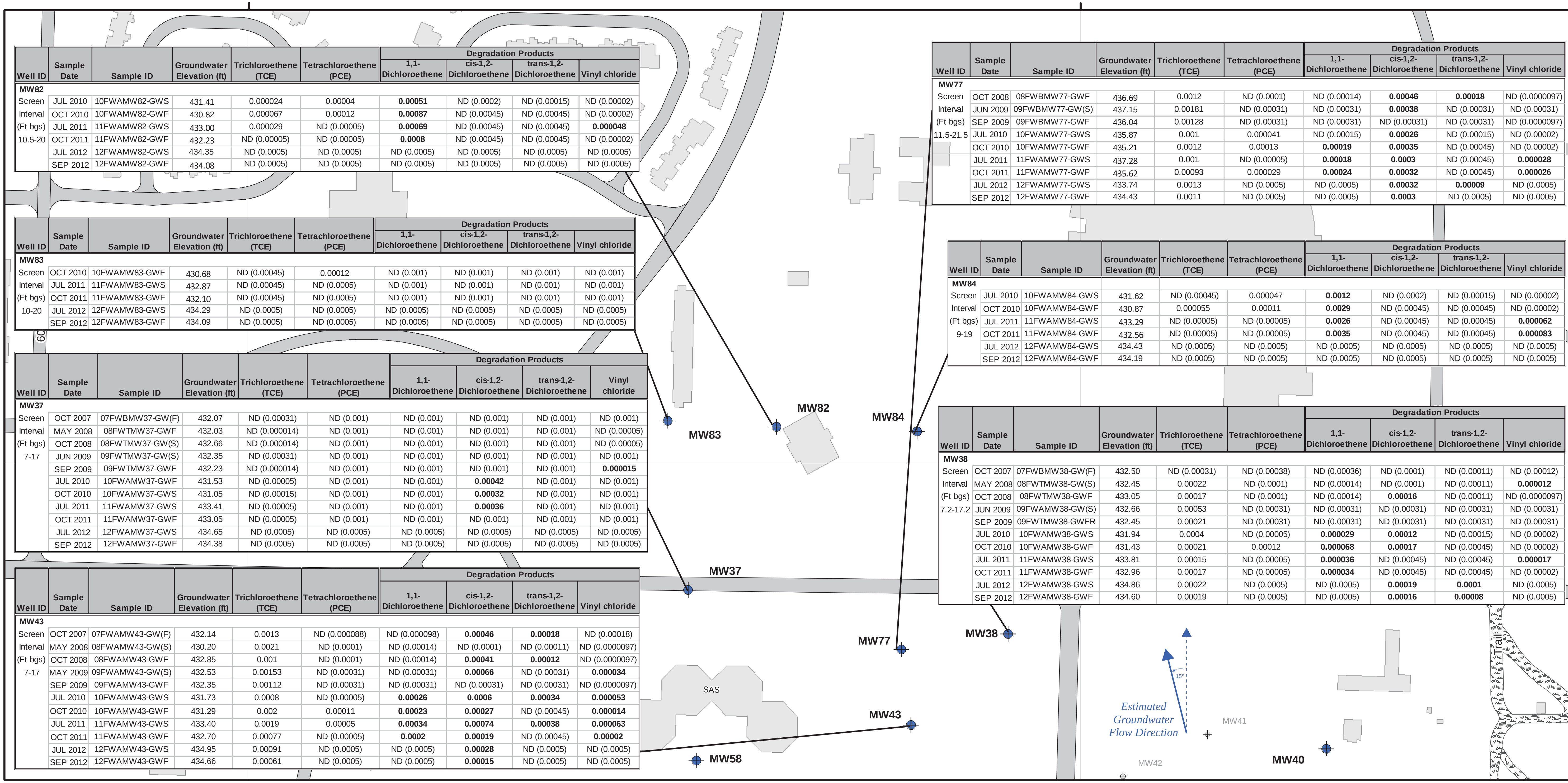
*Modeled by CH2M HILL (UACE 2010 Appendix B), for a pumping rate of 1,700 gpm.

2012 FORMER COMMUNICATIONS SITE IN-PLUME BOUNDARIES

FORT WAINWRIGHT, FAIRBANKS, ALASKA

JACOBS	DATE: 20 MAR 2013	PROJECT MANAGER: T. HEIKKILA	FIGURE NO: A-13

P:\Taku_Gardens\MXD\2012_GWMP\MXD\Taku_GWMP_2012_Plumes.mxd beatycj



Well ID	Sample Date	Sample ID	Groundwater Elevation (ft)	Trichloroethene (TCE)	Tetrachloroethene (PCE)	Degradation Products: 1,1-Dichloroethene	Degradation Products: cis-1,2-Dichloroethene	Degradation Products: trans-1,2-Dichloroethene	Degradation Products: Vinyl chloride
MW82									
Screen	JUL 2010	10FWAMW82-GWS	431.41	0.000024	0.00004	**0.00051**	ND (0.0002)	ND (0.00015)	ND (0.00002)
Interval	OCT 2010	10FWAMW82-GWF	430.82	0.000067	0.00012	**0.00087**	ND (0.00045)	ND (0.00045)	ND (0.00002)
(Ft bgs)	JUL 2011	11FWAMW82-GWS	433.00	0.000029	ND (0.00005)	**0.00069**	ND (0.00045)	ND (0.00045)	**0.000048**
10.5-20	OCT 2011	11FWAMW82-GWF	432.23	ND (0.00005)	ND (0.00005)	**0.0008**	ND (0.00045)	ND (0.00045)	ND (0.00002)
	JUL 2012	12FWAMW82-GWS	434.35	ND (0.0005)	ND (0.0005)	ND (0.0005)	ND (0.0005)	ND (0.0005)	ND (0.0005)
	SEP 2012	12FWAMW82-GWF	434.08	ND (0.0005)	ND (0.0005)	ND (0.0005)	ND (0.0005)	ND (0.0005)	ND (0.0005)

Well ID	Sample Date	Sample ID	Groundwater Elevation (ft)	Trichloroethene (TCE)	Tetrachloroethene (PCE)	Degradation Products: 1,1-Dichloroethene	Degradation Products: cis-1,2-Dichloroethene	Degradation Products: trans-1,2-Dichloroethene	Degradation Products: Vinyl chloride
MW83									
Screen	OCT 2010	10FWAMW83-GWF	430.68	ND (0.00045)	0.00012	ND (0.001)	ND (0.001)	ND (0.001)	ND (0.001)
Interval	JUL 2011	11FWAMW83-GWS	432.87	ND (0.00045)	ND (0.0005)	ND (0.001)	ND (0.001)	ND (0.001)	ND (0.001)
(Ft bgs)	OCT 2011	11FWAMW83-GWF	432.10	ND (0.00045)	ND (0.0005)	ND (0.001)	ND (0.001)	ND (0.001)	ND (0.001)
10-20	JUL 2012	12FWAMW83-GWS	434.29	ND (0.0005)	ND (0.0005)	ND (0.0005)	ND (0.0005)	ND (0.0005)	ND (0.0005)
	SEP 2012	12FWAMW83-GWF	434.09	ND (0.0005)	ND (0.0005)	ND (0.0005)	ND (0.0005)	ND (0.0005)	ND (0.0005)

Well ID	Sample Date	Sample ID	Groundwater Elevation (ft)	Trichloroethene (TCE)	Tetrachloroethene (PCE)	Degradation Products: 1,1-Dichloroethene	Degradation Products: cis-1,2-Dichloroethene	Degradation Products: trans-1,2-Dichloroethene	Degradation Products: Vinyl chloride
MW37									
Screen	OCT 2007	07FWBMW37-GW(F)	432.07	ND (0.00031)	ND (0.001)	ND (0.001)	ND (0.001)	ND (0.001)	ND (0.001)
Interval	MAY 2008	08FWTMW37-GWF	432.03	ND (0.000014)	ND (0.001)	ND (0.001)	ND (0.001)	ND (0.001)	ND (0.00005)
(Ft bgs)	OCT 2008	08FWTMW37-GW(S)	432.66	ND (0.000014)	ND (0.001)	ND (0.001)	ND (0.001)	ND (0.001)	ND (0.00005)
7-17	JUN 2009	09FWTMW37-GW(S)	432.35	ND (0.00031)	ND (0.001)	ND (0.001)	ND (0.001)	ND (0.001)	ND (0.001)
	SEP 2009	09FWTMW37-GWF	432.23	ND (0.000014)	ND (0.001)	ND (0.001)	ND (0.001)	ND (0.001)	**0.000015**
	JUL 2010	10FWAMW37-GWF	431.53	ND (0.00005)	ND (0.001)	ND (0.001)	**0.00042**	ND (0.001)	ND (0.001)
	OCT 2010	10FWAMW37-GWS	431.05	ND (0.00015)	ND (0.001)	ND (0.001)	**0.00032**	ND (0.001)	ND (0.001)
	JUL 2011	11FWAMW37-GWS	433.41	ND (0.00005)	ND (0.001)	ND (0.001)	**0.00036**	ND (0.001)	ND (0.001)
	OCT 2011	11FWAMW37-GWF	433.05	ND (0.00005)	ND (0.001)	ND (0.001)	ND (0.001)	ND (0.001)	ND (0.001)
	JUL 2012	12FWAMW37-GWS	434.65	ND (0.0005)	ND (0.0005)	ND (0.0005)	ND (0.0005)	ND (0.0005)	ND (0.0005)
	SEP 2012	12FWAMW37-GWF	434.38	ND (0.0005)	ND (0.0005)	ND (0.0005)	ND (0.0005)	ND (0.0005)	ND (0.0005)

Well ID	Sample Date	Sample ID	Groundwater Elevation (ft)	Trichloroethene (TCE)	Tetrachloroethene (PCE)	Degradation Products: 1,1-Dichloroethene	Degradation Products: cis-1,2-Dichloroethene	Degradation Products: trans-1,2-Dichloroethene	Degradation Products: Vinyl chloride
MW43									
Screen	OCT 2007	07FWAMW43-GW(F)	432.14	0.0013	ND (0.000088)	ND (0.000098)	**0.00046**	**0.00018**	ND (0.00018)
Interval	MAY 2008	08FWAMW43-GW(S)	430.20	0.0021	ND (0.0001)	ND (0.00014)	ND (0.0001)	ND (0.00011)	ND (0.0000097)
(Ft bgs)	OCT 2008	08FWAMW43-GWF	432.85	0.001	ND (0.0001)	ND (0.00014)	**0.00041**	**0.00012**	ND (0.0000097)
7-17	MAY 2009	09FWAMW43-GW(S)	432.53	0.00153	ND (0.00031)	ND (0.00031)	**0.00066**	ND (0.00031)	**0.000034**
	SEP 2009	09FWAMW43-GWF	432.35	0.00112	ND (0.00031)	ND (0.00031)	ND (0.00031)	ND (0.00031)	ND (0.0000097)
	JUL 2010	10FWAMW43-GWS	431.73	0.0008	ND (0.00005)	**0.00026**	**0.0006**	**0.00034**	**0.000053**
	OCT 2010	10FWAMW43-GWF	431.29	0.002	0.00011	**0.00023**	**0.00027**	ND (0.00045)	**0.000014**
	JUL 2011	11FWAMW43-GWS	433.40	0.0019	0.00005	**0.00034**	**0.00074**	**0.00038**	**0.000063**
	OCT 2011	11FWAMW43-GWF	432.70	0.00077	ND (0.00005)	**0.0002**	**0.00019**	ND (0.00045)	**0.00002**
	JUL 2012	12FWAMW43-GWS	434.95	0.00091	ND (0.0005)	ND (0.0005)	**0.00028**	ND (0.0005)	ND (0.0005)
	SEP 2012	12FWAMW43-GWF	434.66	0.00061	ND (0.0005)	ND (0.0005)	**0.00015**	ND (0.0005)	ND (0.0005)

Well ID	Sample Date	Sample ID	Groundwater Elevation (ft)	Trichloroethene (TCE)	Tetrachloroethene (PCE)	Degradation Products: 1,1-Dichloroethene	Degradation Products: cis-1,2-Dichloroethene	Degradation Products: trans-1,2-Dichloroethene	Degradation Products: Vinyl chloride
MW77									
Screen	OCT 2008	08FWBMW77-GWF	436.69	0.0012	ND (0.0001)	ND (0.00014)	**0.00046**	**0.00018**	ND (0.0000097)
Interval	JUN 2009	09FWBMW77-GW(S)	437.15	0.00181	ND (0.00031)	ND (0.00031)	**0.00038**	ND (0.00031)	ND (0.00031)
(Ft bgs)	SEP 2009	09FWBMW77-GWF	436.04	0.00128	ND (0.00031)	ND (0.00031)	ND (0.00031)	ND (0.00031)	ND (0.0000097)
11.5-21.5	JUL 2010	10FWAMW77-GWS	435.87	0.001	0.000041	ND (0.00015)	**0.00026**	ND (0.00015)	ND (0.00002)
	OCT 2010	10FWAMW77-GWF	435.21	0.0012	0.00013	**0.00019**	**0.00035**	ND (0.00045)	ND (0.00002)
	JUL 2011	11FWAMW77-GWS	437.28	0.001	ND (0.00005)	**0.00018**	**0.0003**	ND (0.00045)	**0.000028**
	OCT 2011	11FWAMW77-GWF	435.62	0.00093	0.000029	**0.00024**	**0.00032**	ND (0.00045)	**0.000026**
	JUL 2012	12FWAMW77-GWS	433.74	0.0013	ND (0.0005)	ND (0.0005)	**0.00032**	**0.00009**	ND (0.0005)
	SEP 2012	12FWAMW77-GWF	434.43	0.0011	ND (0.0005)	ND (0.0005)	**0.0003**	ND (0.0005)	ND (0.0005)

Well ID	Sample Date	Sample ID	Groundwater Elevation (ft)	Trichloroethene (TCE)	Tetrachloroethene (PCE)	Degradation Products: 1,1-Dichloroethene	Degradation Products: cis-1,2-Dichloroethene	Degradation Products: trans-1,2-Dichloroethene	Degradation Products: Vinyl chloride
MW84									
Screen	JUL 2010	10FWAMW84-GWS	431.62	ND (0.00045)	0.000047	**0.0012**	ND (0.0002)	ND (0.00015)	ND (0.00002)
Interval	OCT 2010	10FWAMW84-GWF	430.87	0.000055	0.00011	**0.0029**	ND (0.00045)	ND (0.00045)	ND (0.00002)
(Ft bgs)	JUL 2011	11FWAMW84-GWS	433.29	ND (0.00005)	ND (0.00005)	**0.0026**	ND (0.00045)	ND (0.00045)	**0.000062**
9-19	OCT 2011	11FWAMW84-GWF	432.56	ND (0.00005)	ND (0.00005)	**0.0035**	ND (0.00045)	ND (0.00045)	**0.000083**
	JUL 2012	12FWAMW84-GWS	434.43	ND (0.0005)	ND (0.0005)	ND (0.0005)	ND (0.0005)	ND (0.0005)	ND (0.0005)
	SEP 2012	12FWAMW84-GWF	434.19	ND (0.0005)	ND (0.0005)	ND (0.0005)	ND (0.0005)	ND (0.0005)	ND (0.0005)

Well ID	Sample Date	Sample ID	Groundwater Elevation (ft)	Trichloroethene (TCE)	Tetrachloroethene (PCE)	Degradation Products: 1,1-Dichloroethene	Degradation Products: cis-1,2-Dichloroethene	Degradation Products: trans-1,2-Dichloroethene	Degradation Products: Vinyl chloride
MW38									
Screen	OCT 2007	07FWBMW38-GW(F)	432.50	ND (0.00031)	ND (0.00038)	ND (0.00036)	ND (0.0001)	ND (0.00011)	ND (0.00012)
Interval	MAY 2008	08FWTMW38-GW(S)	432.45	0.00022	ND (0.0001)	ND (0.00014)	ND (0.0001)	ND (0.00011)	**0.000012**
(Ft bgs)	OCT 2008	08FWTMW38-GWF	433.05	0.00017	ND (0.0001)	ND (0.00014)	**0.00016**	ND (0.00011)	ND (0.0000097)
7.2-17.2	JUN 2009	09FWAMW38-GW(S)	432.66	0.00053	ND (0.00031)	ND (0.00031)	ND (0.00031)	ND (0.00031)	ND (0.00031)
	SEP 2009	09FWTMW38-GWFR	432.45	0.00021	ND (0.00031)	ND (0.00031)	ND (0.00031)	ND (0.00031)	ND (0.00031)
	JUL 2010	10FWAMW38-GWS	431.94	0.0004	ND (0.00005)	**0.000029**	**0.00012**	ND (0.00015)	ND (0.00002)
	OCT 2010	10FWAMW38-GWF	431.43	0.00021	0.00012	**0.000068**	**0.00017**	ND (0.00045)	ND (0.00002)
	JUL 2011	11FWAMW38-GWS	433.81	0.00015	ND (0.00005)	**0.000036**	ND (0.00045)	ND (0.00045)	**0.000017**
	OCT 2011	11FWAMW38-GWF	432.96	0.00017	ND (0.00005)	**0.000034**	ND (0.00045)	ND (0.00045)	ND (0.00002)
	JUL 2012	12FWAMW38-GWS	434.86	0.00022	ND (0.0005)	ND (0.0005)	**0.00019**	**0.0001**	ND (0.0005)
	SEP 2012	12FWAMW38-GWF	434.60	0.00019	ND (0.0005)	ND (0.0005)	**0.00016**	**0.00008**	ND (0.0005)

Onsite Well

2012 Sample -No Exceedance

Post Water Supply Well

Notes:

Units: mg/L
ND: not detected
Ft bgs: feet below ground surface
Trichloroethene (TCE) project cleanup level = 0.005 mg/L
cis-1,2-Dichloroethene ADEC action level = 0.07 mg/L
1,1-Dichloroethene ADEC action level = 0.007 mg/L
trans-1,2-Dichloroethene ADEC action level = 0.1 mg/L
Vinyl chloride ADEC action level = 0.002 mg/L
Tetrachloroethene (PCE) ADEC action level = 0.005 mg/L

The F or S at the end of the sample ID indicates the spring or fall sampling event.
(F) or (S) is appended to the sample ID where the original sample ID did not include an F or an S.
Results are presented without qualifiers.
BOLD indicates detections of degradation products.

All Locations Are Approximate

0 150 300 450 600
Feet

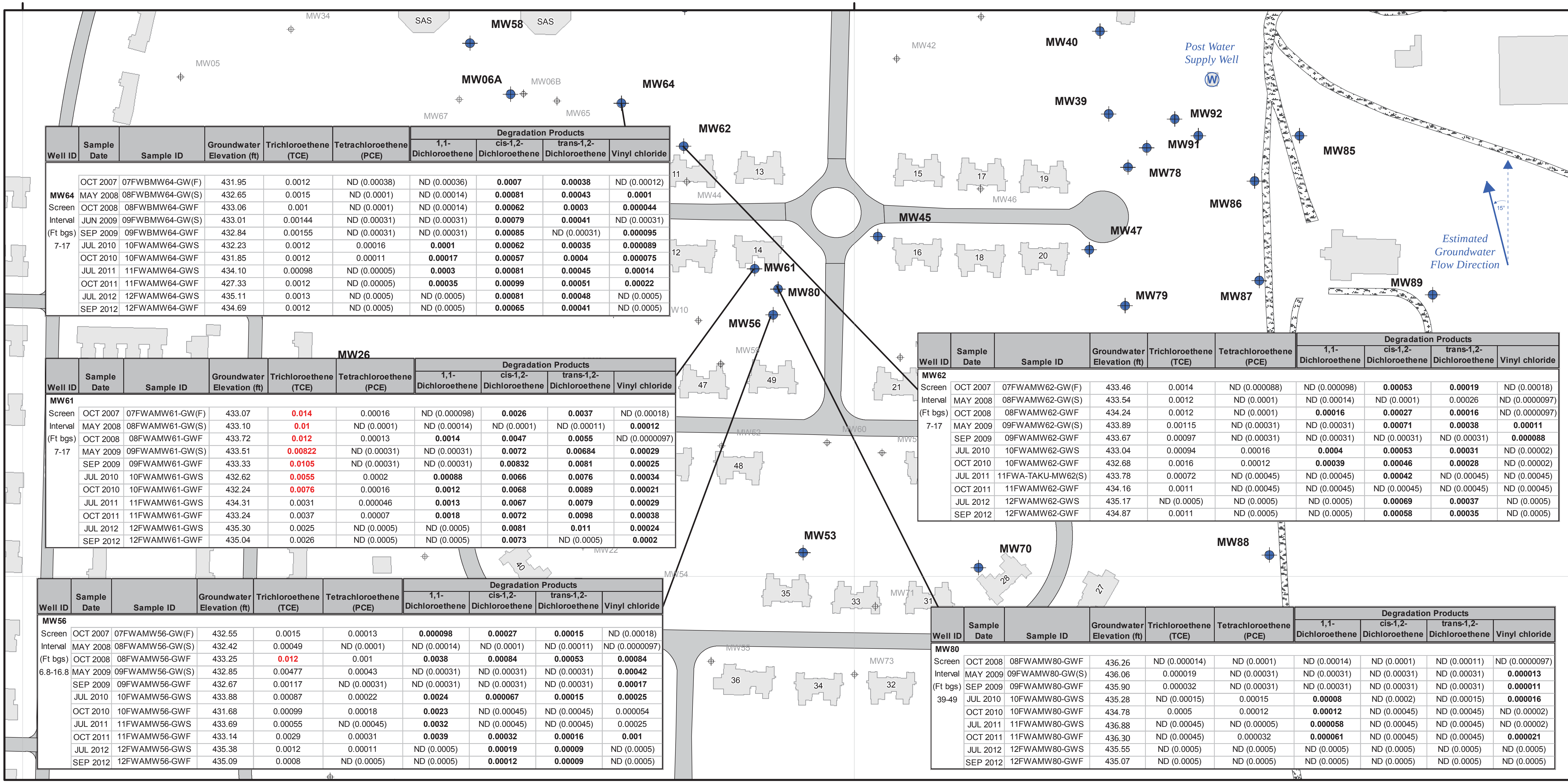
WGS 1984 UTM Zone 6N

N

FORMER COMMUNICATIONS SITE (NORTH)
HISTORICAL TRICHLOROETHENE RESULTS
FOR IN-PLUME AND SURROUNDING WELLS
FORT WAINWRIGHT, FAIRBANKS, ALASKA

JACOBS | DATE: 26 DEC 2013 | PROJECT MANAGER: T. HEIKKILA | FIGURE NO: A-14

P:\Taku_Gardens\MXD\2013_GWMP\2013_Taku_GWMP_TCE_Con_N.mxd beatyc



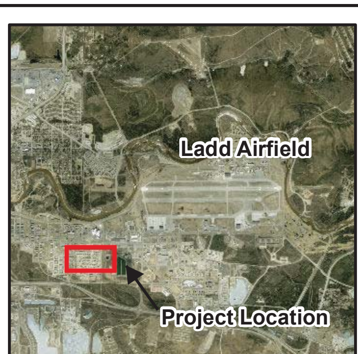
Well ID	Sample Date	Sample ID	Groundwater Elevation (ft)	Trichloroethene (TCE)	Tetrachloroethene (PCE)	Degradation Products			
						1,1-Dichloroethene	cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	Vinyl chloride
	OCT 2007	07FWBMW64-GW(F)	431.95	0.0012	ND (0.00038)	ND (0.00036)	**0.0007**	**0.00038**	ND (0.00012)
MW64	MAY 2008	08FWBMW64-GW(S)	432.65	0.0015	ND (0.0001)	ND (0.00014)	**0.00081**	**0.00043**	**0.0001**
Screen	OCT 2008	08FWBMW64-GWF	433.06	0.001	ND (0.0001)	ND (0.00014)	**0.00062**	**0.0003**	**0.000044**
Interval	JUN 2009	09FWBMW64-GW(S)	433.01	0.00144	ND (0.00031)	ND (0.00031)	**0.00079**	**0.00041**	ND (0.00031)
(Ft bgs)	SEP 2009	09FWBMW64-GWF	432.84	0.00155	ND (0.00031)	ND (0.00031)	**0.00085**	ND (0.00031)	**0.000095**
7-17	JUL 2010	10FWAMW64-GWS	432.23	0.0012	0.00016	**0.0001**	**0.00062**	**0.00035**	**0.000089**
	OCT 2010	10FWAMW64-GWF	431.85	0.0012	0.00011	**0.00017**	**0.00057**	**0.0004**	**0.000075**
	JUL 2011	11FWAMW64-GWS	434.10	0.00098	ND (0.00005)	**0.0003**	**0.00081**	**0.00045**	**0.00014**
	OCT 2011	11FWAMW64-GWF	427.33	0.0012	ND (0.00005)	**0.00035**	**0.00099**	**0.00051**	**0.00022**
	JUL 2012	12FWAMW64-GWS	435.11	0.0013	ND (0.0005)	ND (0.0005)	**0.00081**	**0.00048**	ND (0.0005)
	SEP 2012	12FWAMW64-GWF	434.69	0.0012	ND (0.0005)	ND (0.0005)	**0.00065**	**0.00041**	ND (0.0005)

Well ID	Sample Date	Sample ID	Groundwater Elevation (ft)	Trichloroethene (TCE)	Tetrachloroethene (PCE)	Degradation Products			
						1,1-Dichloroethene	cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	Vinyl chloride
MW61									
Screen	OCT 2007	07FWAMW61-GW(F)	433.07	0.014	0.00016	ND (0.000098)	**0.0026**	**0.0037**	ND (0.00018)
Interval	MAY 2008	08FWAMW61-GW(S)	433.10	0.01	ND (0.0001)	ND (0.00014)	ND (0.0001)	ND (0.00011)	**0.00012**
(Ft bgs)	OCT 2008	08FWAMW61-GWF	433.72	0.012	0.00013	**0.0014**	**0.0047**	**0.0055**	ND (0.0000097)
7-17	MAY 2009	09FWAMW61-GW(S)	433.51	0.00822	ND (0.00031)	ND (0.00031)	**0.0072**	**0.00684**	**0.00029**
	SEP 2009	09FWAMW61-GWF	433.33	0.0105	ND (0.00031)	ND (0.00031)	**0.00832**	**0.0081**	**0.00025**
	JUL 2010	10FWAMW61-GWS	432.62	0.0055	0.0002	**0.00088**	**0.0066**	**0.0076**	**0.00034**
	OCT 2010	10FWAMW61-GWF	432.24	0.0076	0.00016	**0.0012**	**0.0068**	**0.0089**	**0.00021**
	JUL 2011	11FWAMW61-GWS	434.31	0.0031	0.000046	**0.0013**	**0.0067**	**0.0079**	**0.00029**
	OCT 2011	11FWAMW61-GWF	433.24	0.0037	0.00007	**0.0018**	**0.0072**	**0.0098**	**0.00038**
	JUL 2012	12FWAMW61-GWS	435.30	0.0025	ND (0.0005)	ND (0.0005)	**0.0081**	**0.011**	**0.00024**
	SEP 2012	12FWAMW61-GWF	435.04	0.0026	ND (0.0005)	ND (0.0005)	**0.0073**	ND (0.0005)	**0.0002**

Well ID	Sample Date	Sample ID	Groundwater Elevation (ft)	Trichloroethene (TCE)	Tetrachloroethene (PCE)	Degradation Products			
						1,1-Dichloroethene	cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	Vinyl chloride
MW56									
Screen	OCT 2007	07FWAMW56-GW(F)	432.55	0.0015	0.00013	**0.000098**	**0.00027**	**0.00015**	ND (0.00018)
Interval	MAY 2008	08FWAMW56-GW(S)	432.42	0.00049	ND (0.0001)	ND (0.00014)	ND (0.0001)	ND (0.00011)	ND (0.0000097)
(Ft bgs)	OCT 2008	08FWAMW56-GWF	433.25	0.012	0.001	**0.0038**	**0.00084**	**0.00053**	**0.00084**
6.8-16.8	MAY 2009	09FWAMW56-GW(S)	432.85	0.00477	0.00043	ND (0.00031)	ND (0.00031)	ND (0.00031)	**0.00042**
	SEP 2009	09FWAMW56-GWF	432.67	0.00117	ND (0.00031)	ND (0.00031)	ND (0.00031)	ND (0.00031)	**0.00017**
	JUL 2010	10FWAMW56-GWS	433.88	0.00087	0.00022	**0.0024**	**0.000067**	**0.00015**	**0.00025**
	OCT 2010	10FWAMW56-GWF	431.68	0.00099	0.00018	**0.0023**	ND (0.00045)	ND (0.00045)	0.000054
	JUL 2011	11FWAMW56-GWS	433.69	0.00055	ND (0.00045)	**0.0032**	ND (0.00045)	ND (0.00045)	0.00025
	OCT 2011	11FWAMW56-GWF	433.14	0.0029	0.00031	**0.0039**	**0.00032**	**0.00016**	**0.001**
	JUL 2012	12FWAMW56-GWS	435.38	0.0012	0.00011	ND (0.0005)	**0.00019**	**0.00009**	ND (0.0005)
	SEP 2012	12FWAMW56-GWF	435.09	0.0008	ND (0.0005)	ND (0.0005)	**0.00012**	**0.00009**	ND (0.0005)

Well ID	Sample Date	Sample ID	Groundwater Elevation (ft)	Trichloroethene (TCE)	Tetrachloroethene (PCE)	Degradation Products			
						1,1-Dichloroethene	cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	Vinyl chloride
MW62									
Screen	OCT 2007	07FWAMW62-GW(F)	433.46	0.0014	ND (0.000088)	ND (0.000098)	**0.00053**	**0.00019**	ND (0.00018)
Interval	MAY 2008	08FWAMW62-GW(S)	433.54	0.0012	ND (0.0001)	ND (0.00014)	ND (0.0001)	0.00026	ND (0.0000097)
(Ft bgs)	OCT 2008	08FWAMW62-GWF	434.24	0.0012	ND (0.0001)	**0.00016**	**0.00027**	**0.00016**	ND (0.0000097)
7-17	MAY 2009	09FWAMW62-GW(S)	433.89	0.00115	ND (0.00031)	ND (0.00031)	**0.00071**	**0.00038**	**0.00011**
	SEP 2009	09FWAMW62-GWF	433.67	0.00097	ND (0.00031)	ND (0.00031)	ND (0.00031)	ND (0.00031)	**0.000088**
	JUL 2010	10FWAMW62-GWS	433.04	0.00094	0.00016	**0.0004**	**0.00053**	**0.00031**	ND (0.00002)
	OCT 2010	10FWAMW62-GWF	432.68	0.0016	0.00012	**0.00039**	**0.00046**	**0.00028**	ND (0.00002)
	JUL 2011	11FWA-TAKU-MW62(S)	433.78	0.00072	ND (0.00045)	ND (0.00045)	**0.00042**	ND (0.00045)	ND (0.00045)
	OCT 2011	11FWAMW62-GWF	434.16	0.0011	ND (0.00045)	ND (0.00045)	ND (0.00045)	ND (0.00045)	ND (0.00045)
	JUL 2012	12FWAMW62-GWS	435.17	ND (0.0005)	ND (0.0005)	ND (0.0005)	**0.00069**	**0.00037**	ND (0.0005)
	SEP 2012	12FWAMW62-GWF	434.87	0.0011	ND (0.0005)	ND (0.0005)	**0.00058**	**0.00035**	ND (0.0005)

Well ID	Sample Date	Sample ID	Groundwater Elevation (ft)	Trichloroethene (TCE)	Tetrachloroethene (PCE)	Degradation Products			
						1,1-Dichloroethene	cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	Vinyl chloride
MW80									
Screen	OCT 2008	08FWAMW80-GWF	436.26	ND (0.000014)	ND (0.0001)	ND (0.00014)	ND (0.0001)	ND (0.00011)	ND (0.0000097)
Interval	MAY 2009	09FWAMW80-GW(S)	436.06	0.000019	ND (0.00031)	ND (0.00031)	ND (0.00031)	ND (0.00031)	**0.000013**
(Ft bgs)	SEP 2009	09FWAMW80-GWF	435.90	0.000032	ND (0.00031)	ND (0.00031)	ND (0.00031)	ND (0.00031)	**0.000011**
39-49	JUL 2010	10FWAMW80-GWS	435.28	ND (0.00015)	0.00015	**0.00008**	ND (0.0002)	ND (0.00015)	**0.000016**
	OCT 2010	10FWAMW80-GWF	434.78	0.0005	0.00012	**0.00012**	ND (0.00045)	ND (0.00045)	ND (0.00002)
	JUL 2011	11FWAMW80-GWS	436.88	ND (0.00045)	ND (0.00005)	**0.000058**	ND (0.00045)	ND (0.00045)	ND (0.00002)
	OCT 2011	11FWAMW80-GWF	436.30	ND (0.00045)	0.000032	**0.000061**	ND (0.00045)	ND (0.00045)	**0.000021**
	JUL 2012	12FWAMW80-GWS	435.55	ND (0.0005)	ND (0.0005)	ND (0.0005)	ND (0.0005)	ND (0.0005)	ND (0.0005)
	SEP 2012	12FWAMW80-GWF	435.07	ND (0.0005)	ND (0.0005)	ND (0.0005)	ND (0.0005)	ND (0.0005)	ND (0.0005)



Onsite Well

2012 Sample -No Exceedance

Post Water Supply Well

Note:

Units: mg/L
ND: not detected
Ft bgs: feet below ground surface
Trichloroethene (TCE) project cleanup level = 0.005 mg/L
cis-1,2-Dichloroethene ADEC action level = 0.07 mg/L
1,1-Dichloroethene ADEC action level = 0.007 mg/L
trans-1,2-Dichloroethene ADEC action level = 0.1 mg/L
Vinyl chloride ADEC action level = 0.002 mg/L
Tetrachloroethene (PCE) ADEC action level = 0.005 mg/L

The F or S at the end of the sample ID indicates the spring or fall sampling event.
(F) or (S) is appended to the sample ID where the original sample ID did not include an F or an S.
Results are presented without qualifiers.
RED exceeded the project cleanup level.
BOLD indicates detections of degradation products.

All Locations Are Approximate

0 150 300 450 600
Feet

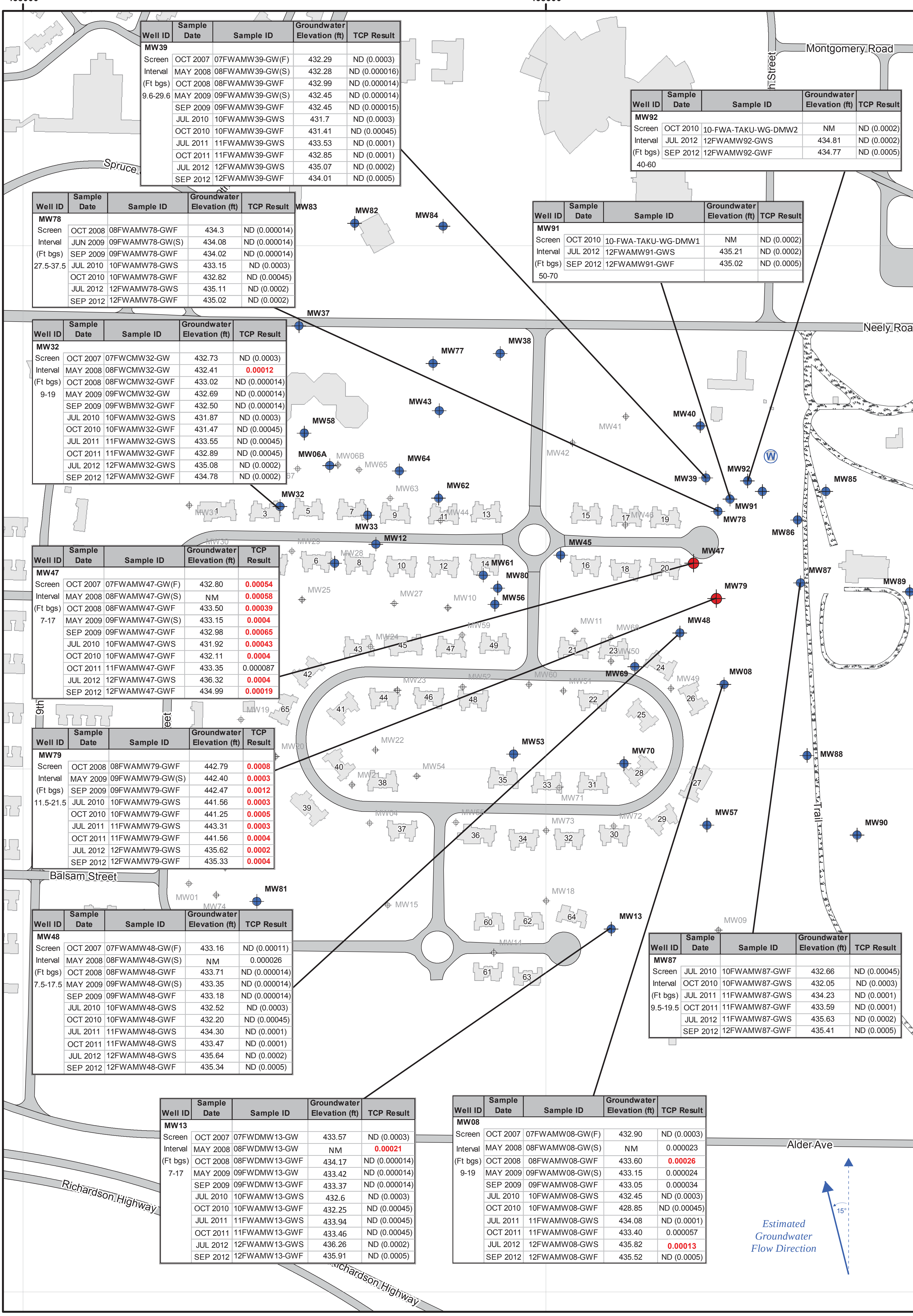
WGS 1984 UTM Zone 6N

N

FORMER COMMUNICATIONS SITE (SOUTH)
HISTORICAL TRICHLOROETHENE RESULTS
FOR IN-PLUME AND SURROUNDING WELLS
FORT WAINWRIGHT, FAIRBANKS, ALASKA

JACOBS	DATE: 26 DEC 2013	PROJECT MANAGER: T. HEIKKILA	FIGURE NO: A-15

P:\Taku_Gardens\MXD\2013_GWMP\2013_Taku_GWMP_TCE_Con_S.mxd beatycj



Well ID	Sample Date	Sample ID	Groundwater Elevation (ft)	TCP Result
MW39				
Screen	OCT 2007	07FWAMW39-GW(F)	432.29	ND (0.0003)
Interval	MAY 2008	08FWAMW39-GW(S)	432.28	ND (0.000016)
(Ft bgs)	OCT 2008	08FWAMW39-GWF	432.99	ND (0.000014)
9.6-29.6	MAY 2009	09FWAMW39-GW(S)	432.45	ND (0.000014)
	SEP 2009	09FWAMW39-GWF	432.45	ND (0.000015)
	JUL 2010	10FWAMW39-GWS	431.7	ND (0.0003)
	OCT 2010	10FWAMW39-GWF	431.41	ND (0.00045)
	JUL 2011	11FWAMW39-GWS	433.53	ND (0.0001)
	OCT 2011	11FWAMW39-GWF	432.85	ND (0.0001)
	JUL 2012	12FWAMW39-GWS	435.07	ND (0.0002)
	SEP 2012	12FWAMW39-GWF	434.01	ND (0.0005)

Well ID	Sample Date	Sample ID	Groundwater Elevation (ft)	TCP Result
MW92				
Screen	OCT 2010	10-FWA-TAKU-WG-DMW2	NM	ND (0.0002)
Interval	JUL 2012	12FWAMW92-GWS	434.81	ND (0.0002)
(Ft bgs)	SEP 2012	12FWAMW92-GWF	434.77	ND (0.0005)
40-60				

Well ID	Sample Date	Sample ID	Groundwater Elevation (ft)	TCP Result
MW78				
Screen	OCT 2008	08FWAMW78-GWF	434.3	ND (0.000014)
Interval	JUN 2009	09FWAMW78-GW(S)	434.08	ND (0.000014)
(Ft bgs)	SEP 2009	09FWAMW78-GWF	434.02	ND (0.000014)
27.5-37.5	JUL 2010	10FWAMW78-GWS	433.15	ND (0.0003)
	OCT 2010	10FWAMW78-GWF	432.82	ND (0.00045)
	JUL 2012	12FWAMW78-GWS	435.11	ND (0.0002)
	SEP 2012	12FWAMW78-GWF	435.02	ND (0.0002)

Well ID	Sample Date	Sample ID	Groundwater Elevation (ft)	TCP Result
MW91				
Screen	OCT 2010	10-FWA-TAKU-WG-DMW1	NM	ND (0.0002)
Interval	JUL 2012	12FWAMW91-GWS	435.21	ND (0.0002)
(Ft bgs)	SEP 2012	12FWAMW91-GWF	435.02	ND (0.0005)
50-70				

Well ID	Sample Date	Sample ID	Groundwater Elevation (ft)	TCP Result
MW32				
Screen	OCT 2007	07FWCMW32-GW	432.73	ND (0.0003)
Interval	MAY 2008	08FWCMW32-GW	432.41	0.00012
(Ft bgs)	OCT 2008	08FWCMW32-GWF	433.02	ND (0.000014)
9-19	MAY 2009	09FWCMW32-GW	432.69	ND (0.000014)
	SEP 2009	09FWBMW32-GWF	432.50	ND (0.000014)
	JUL 2010	10FWAMW32-GWS	431.87	ND (0.0003)
	OCT 2010	10FWAMW32-GWF	431.47	ND (0.00045)
	JUL 2011	11FWAMW32-GWS	433.55	ND (0.00045)
	OCT 2011	11FWAMW32-GWF	432.89	ND (0.00045)
	JUL 2012	12FWAMW32-GWS	435.08	ND (0.0002)
	SEP 2012	12FWAMW32-GWF	434.78	ND (0.0002)

Well ID	Sample Date	Sample ID	Groundwater Elevation (ft)	TCP Result
MW47				
Screen	OCT 2007	07FWAMW47-GW(F)	432.80	0.00054
Interval	MAY 2008	08FWAMW47-GW(S)	NM	0.00058
(Ft bgs)	OCT 2008	08FWAMW47-GWF	433.50	0.00039
7-17	MAY 2009	09FWAMW47-GW(S)	433.15	0.0004
	SEP 2009	09FWAMW47-GWF	432.98	0.00065
	JUL 2010	10FWAMW47-GWS	431.92	0.00043
	OCT 2010	10FWAMW47-GWF	432.11	0.0004
	OCT 2011	11FWAMW47-GWF	433.35	0.000087
	JUL 2012	12FWAMW47-GWS	436.32	0.0004
	SEP 2012	12FWAMW47-GWF	434.99	0.0019

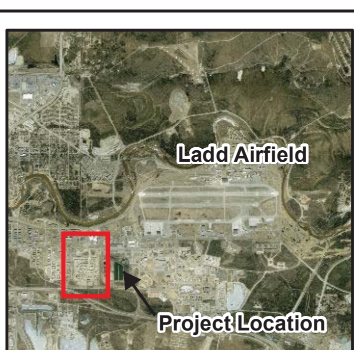
Well ID	Sample Date	Sample ID	Groundwater Elevation (ft)	TCP Result
MW79				
Screen	OCT 2008	08FWAMW79-GWF	442.79	0.0008
Interval	MAY 2009	09FWAMW79-GW(S)	442.40	0.0003
(Ft bgs)	SEP 2009	09FWAMW79-GWF	442.47	0.0012
11.5-21.5	JUL 2010	10FWAMW79-GWS	441.56	0.0003
	OCT 2010	10FWAMW79-GWF	441.25	0.0005
	JUL 2011	11FWAMW79-GWS	443.31	0.0003
	OCT 2011	11FWAMW79-GWF	441.56	0.0004
	JUL 2012	12FWAMW79-GWS	435.62	0.0002
	SEP 2012	12FWAMW79-GWF	435.33	0.0004

Well ID	Sample Date	Sample ID	Groundwater Elevation (ft)	TCP Result
MW48				
Screen	OCT 2007	07FWAMW48-GW(F)	433.16	ND (0.00011)
Interval	MAY 2008	08FWAMW48-GW(S)	NM	0.000026
(Ft bgs)	OCT 2008	08FWAMW48-GWF	433.71	ND (0.000014)
7.5-17.5	MAY 2009	09FWAMW48-GW(S)	433.35	ND (0.000014)
	SEP 2009	09FWAMW48-GWF	433.18	ND (0.000014)
	JUL 2010	10FWAMW48-GWS	432.52	ND (0.0003)
	OCT 2010	10FWAMW48-GWF	432.20	ND (0.00045)
	JUL 2011	11FWAMW48-GWS	434.30	ND (0.0001)
	OCT 2011	11FWAMW48-GWS	433.47	ND (0.0001)
	JUL 2012	12FWAMW48-GWS	435.64	ND (0.0002)
	SEP 2012	12FWAMW48-GWF	435.34	ND (0.0005)

Well ID	Sample Date	Sample ID	Groundwater Elevation (ft)	TCP Result
MW87				
Screen	JUL 2010	10FWAMW87-GWF	432.66	ND (0.00045)
Interval	OCT 2010	10FWAMW87-GWS	432.05	ND (0.0003)
(Ft bgs)	JUL 2011	11FWAMW87-GWS	434.23	ND (0.0001)
9.5-19.5	OCT 2011	11FWAMW87-GWF	433.59	ND (0.0001)
	JUL 2012	11FWAMW87-GWS	435.63	ND (0.0002)
	SEP 2012	12FWAMW87-GWF	435.41	ND (0.0005)

Well ID	Sample Date	Sample ID	Groundwater Elevation (ft)	TCP Result
MW13				
Screen	OCT 2007	07FWDMW13-GW	433.57	ND (0.0003)
Interval	MAY 2008	08FWDMW13-GW	NM	0.00021
(Ft bgs)	OCT 2008	08FWDMW13-GWF	434.17	ND (0.000014)
7-17	MAY 2009	09FWDMW13-GW	433.42	ND (0.000014)
	SEP 2009	09FWDMW13-GWF	433.37	ND (0.000014)
	JUL 2010	10FWAMW13-GWS	432.6	ND (0.0003)
	OCT 2010	10FWAMW13-GWF	432.25	ND (0.00045)
	JUL 2011	11FWAMW13-GWS	433.94	ND (0.00045)
	OCT 2011	11FWAMW13-GWF	433.46	ND (0.00045)
	JUL 2012	12FWAMW13-GWS	436.26	ND (0.0002)
	SEP 2012	12FWAMW13-GWF	435.91	ND (0.0005)

Well ID	Sample Date	Sample ID	Groundwater Elevation (ft)	TCP Result
MW08				
Screen	OCT 2007	07FWAMW08-GW(F)	432.90	ND (0.0003)
Interval	MAY 2008	08FWAMW08-GW(S)	NM	0.000023
(Ft bgs)	OCT 2008	08FWAMW08-GWF	433.60	0.00026
9-19	MAY 2009	09FWAMW08-GW(S)	433.15	0.000024
	SEP 2009	09FWAMW08-GWF	433.05	0.000034
	JUL 2010	10FWAMW08-GWS	432.45	ND (0.0003)
	OCT 2010	10FWAMW08-GWF	428.85	ND (0.00045)
	JUL 2011	11FWAMW08-GWS	434.08	ND (0.0001)
	OCT 2011	11FWAMW08-GWF	433.40	0.000057
	JUL 2012	12FWAMW08-GWS	435.82	0.00013
	SEP 2012	12FWAMW08-GWF	435.52	ND (0.0005)



- 2012 Sample - Exceedance
- Onsite Well
- 2012 Sample -No Exceedance
- Post Water Supply Well

Notes:
Project cleanup level: 0.00012
Units: mg/L
Method: SW8260, SW8260SIM
The F or S at the end of the sample ID indicates Spring or fall sampling.
RED exceeded the project cleanup level.
TCP: 1,2,3-Trichloropropane
Results are presented without qualifiers.
ND = not detected

All Locations Are Approximate

0 250 500 750 1,000
Feet

WGS 1984 UTM Zone 6N

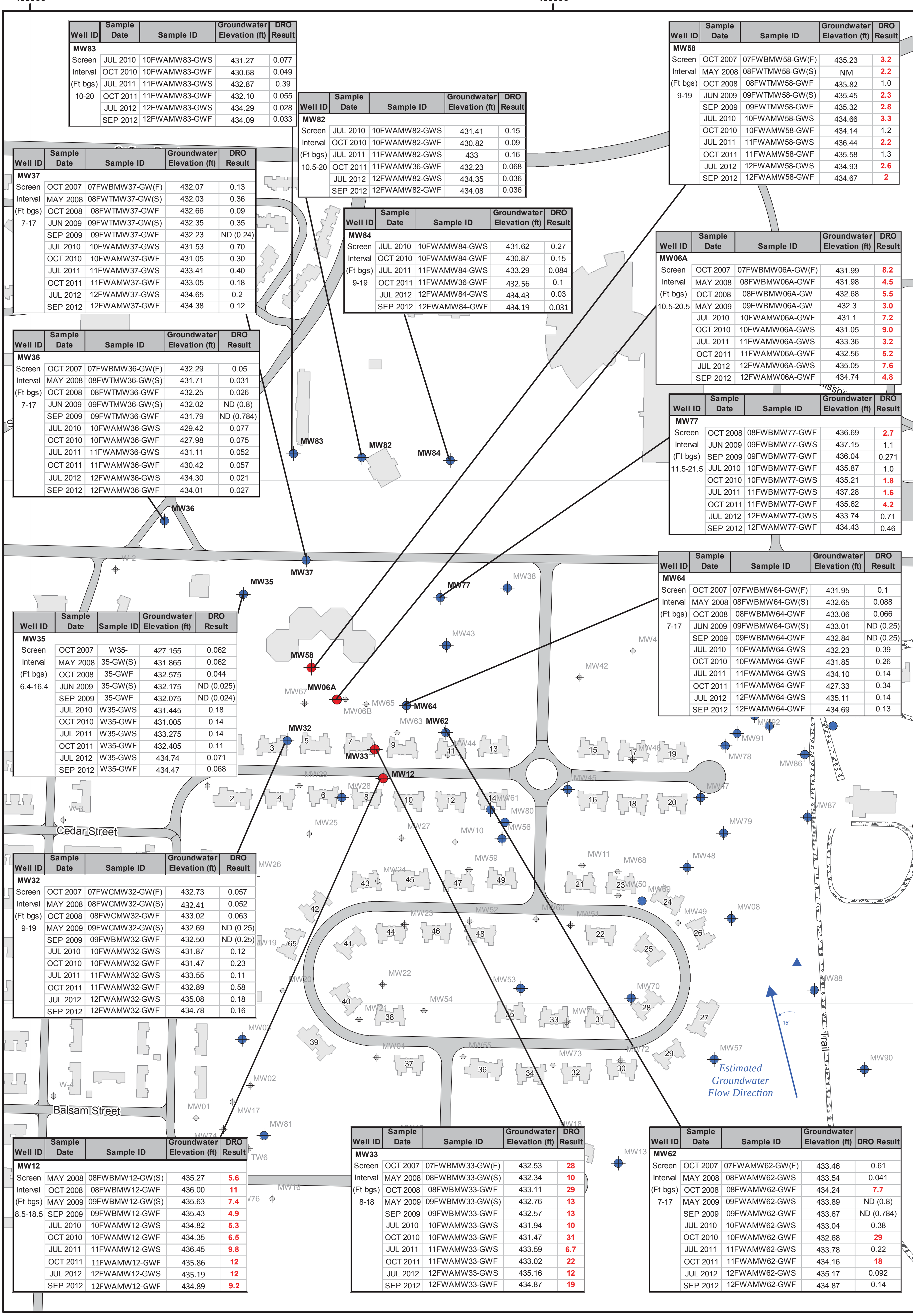
N

FORMER COMMUNICATIONS SITE HISTORICAL 1,2,3-TRICHLOROPROPANE RESULTS FOR IN-PLUME AND SURROUNDING WELLS

FORT WAINWRIGHT, FAIRBANKS, ALASKA

JACOBS	DATE: 26 DEC 2013	PROJECT MANAGER: T. HEIKKILA	FIGURE NO: A-16

P:\Taku_Gardens\MXD\2013_GWMP\2013_Taku_GWMP_TCP.mxd bealycj



Well ID	Sample Date	Sample ID	Groundwater Elevation (ft)	DRO Result
MW83				
Screen	JUL 2010	10FWAMW83-GWS	431.27	0.077
Interval	OCT 2010	10FWAMW83-GWF	430.68	0.049
(Ft bgs)	JUL 2011	11FWAMW83-GWS	432.87	0.39
10-20	OCT 2011	11FWAMW83-GWF	432.10	0.055
	JUL 2012	12FWAMW83-GWS	434.29	0.028
	SEP 2012	12FWAMW83-GWF	434.09	0.033

Well ID	Sample Date	Sample ID	Groundwater Elevation (ft)	DRO Result
MW82				
Screen	JUL 2010	10FWAMW82-GWS	431.41	0.15
Interval	OCT 2010	10FWAMW82-GWF	430.82	0.09
(Ft bgs)	JUL 2011	11FWAMW82-GWS	433	0.16
10.5-20	OCT 2011	11FWAMW36-GWF	432.23	0.068
	JUL 2012	12FWAMW82-GWS	434.35	0.036
	SEP 2012	12FWAMW82-GWF	434.08	0.036

Well ID	Sample Date	Sample ID	Groundwater Elevation (ft)	DRO Result
MW58				
Screen	OCT 2007	07FWBMW58-GW(F)	435.23	3.2
Interval	MAY 2008	08FWTMW58-GW(S)	NM	2.2
(Ft bgs)	OCT 2008	08FWTMW58-GWF	435.82	1.0
9-19	JUN 2009	09FWTMW58-GW(S)	435.45	2.3
	SEP 2009	09FWTMW58-GWF	435.32	2.8
	JUL 2010	10FWAMW58-GWS	434.66	3.3
	OCT 2010	10FWAMW58-GWF	434.14	1.2
	JUL 2011	11FWAMW58-GWS	436.44	2.2
	OCT 2011	11FWAMW58-GWF	435.58	1.3
	JUL 2012	12FWAMW58-GWS	434.93	2.6
	SEP 2012	12FWAMW58-GWF	434.67	2

Well ID	Sample Date	Sample ID	Groundwater Elevation (ft)	DRO Result
MW37				
Screen	OCT 2007	07FWBMW37-GW(F)	432.07	0.13
Interval	MAY 2008	08FWTMW37-GW(S)	432.03	0.36
(Ft bgs)	OCT 2008	08FWTMW37-GWF	432.66	0.09
7-17	JUN 2009	09FWTMW37-GW(S)	432.35	0.35
	SEP 2009	09FWTMW37-GWF	432.23	ND (0.24)
	JUL 2010	10FWAMW37-GWS	431.53	0.70
	OCT 2010	10FWAMW37-GWF	431.05	0.30
	JUL 2011	11FWAMW37-GWS	433.41	0.40
	OCT 2011	11FWAMW37-GWF	433.05	0.18
	JUL 2012	12FWAMW37-GWS	434.65	0.2
	SEP 2012	12FWAMW37-GWF	434.38	0.12

Well ID	Sample Date	Sample ID	Groundwater Elevation (ft)	DRO Result
MW84				
Screen	JUL 2010	10FWAMW84-GWS	431.62	0.27
Interval	OCT 2010	10FWAMW84-GWF	430.87	0.15
(Ft bgs)	JUL 2011	11FWAMW84-GWS	433.29	0.084
9-19	OCT 2011	11FWAMW36-GWF	432.56	0.1
	JUL 2012	12FWAMW84-GWS	434.43	0.03
	SEP 2012	12FWAMW84-GWF	434.19	0.031

Well ID	Sample Date	Sample ID	Groundwater Elevation (ft)	DRO Result
MW06A				
Screen	OCT 2007	07FWBMW06A-GW(F)	431.99	8.2
Interval	MAY 2008	08FWBMW06A-GWF	431.98	4.5
(Ft bgs)	OCT 2008	08FWBMW06A-GW	432.68	5.5
10.5-20.5	MAY 2009	09FWBMW06A-GW	432.3	3.0
	JUL 2010	10FWAMW06A-GWF	431.1	7.2
	OCT 2010	10FWAMW06A-GWS	431.05	9.0
	JUL 2011	11FWAMW06A-GWS	433.36	3.2
	OCT 2011	11FWAMW06A-GWF	432.56	5.2
	JUL 2012	12FWAMW06A-GWS	435.05	7.6
	SEP 2012	12FWAMW06A-GWF	434.74	4.8

Well ID	Sample Date	Sample ID	Groundwater Elevation (ft)	DRO Result
MW36				
Screen	OCT 2007	07FWBMW36-GW(F)	432.29	0.05
Interval	MAY 2008	08FWTMW36-GW(S)	431.71	0.031
(Ft bgs)	OCT 2008	08FWTMW36-GWF	432.25	0.026
7-17	JUN 2009	09FWTMW36-GW(S)	432.02	ND (0.8)
	SEP 2009	09FWTMW36-GWF	431.79	ND (0.784)
	JUL 2010	10FWAMW36-GWS	429.42	0.077
	OCT 2010	10FWAMW36-GWF	427.98	0.075
	JUL 2011	11FWAMW36-GWS	431.11	0.052
	OCT 2011	11FWAMW36-GWF	430.42	0.057
	JUL 2012	12FWAMW36-GWS	434.30	0.021
	SEP 2012	12FWAMW36-GWF	434.01	0.027

Well ID	Sample Date	Sample ID	Groundwater Elevation (ft)	DRO Result
MW77				
Screen	OCT 2008	08FWBMW77-GWF	436.69	2.7
Interval	JUN 2009	09FWBMW77-GWS	437.15	1.1
(Ft bgs)	SEP 2009	09FWBMW77-GWF	436.04	0.271
11.5-21.5	JUL 2010	10FWBMW77-GWF	435.87	1.0
	OCT 2010	10FWBMW77-GWS	435.21	1.8
	JUL 2011	11FWBMW77-GWS	437.28	1.6
	OCT 2011	11FWBMW77-GWF	435.62	4.2
	JUL 2012	12FWAMW77-GWS	433.74	0.71
	SEP 2012	12FWAMW77-GWF	434.43	0.46

Well ID	Sample Date	Sample ID	Groundwater Elevation (ft)	DRO Result
MW64				
Screen	OCT 2007	07FWBMW64-GW(F)	431.95	0.1
Interval	MAY 2008	08FWBMW64-GW(S)	432.65	0.088
(Ft bgs)	OCT 2008	08FWBMW64-GWF	433.06	0.066
7-17	JUN 2009	09FWBMW64-GW(S)	433.01	ND (0.25)
	SEP 2009	09FWBMW64-GWF	432.84	ND (0.25)
	JUL 2010	10FWAMW64-GWS	432.23	0.39
	OCT 2010	10FWAMW64-GWF	431.85	0.26
	JUL 2011	11FWAMW64-GWS	434.10	0.14
	OCT 2011	11FWAMW64-GWF	427.33	0.34
	JUL 2012	12FWAMW64-GWS	435.11	0.14
	SEP 2012	12FWAMW64-GWF	434.69	0.13

Well ID	Sample Date	Sample ID	Groundwater Elevation (ft)	DRO Result
MW35				
Screen	OCT 2007	W35-	427.155	0.062
Interval	MAY 2008	35-GW(S)	431.865	0.062
(Ft bgs)	OCT 2008	35-GWF	432.575	0.044
6.4-16.4	JUN 2009	35-GW(S)	432.175	ND (0.025)
	SEP 2009	35-GWF	432.075	ND (0.024)
	JUL 2010	W35-GWS	431.445	0.18
	OCT 2010	W35-GWF	431.005	0.14
	JUL 2011	W35-GWS	433.275	0.14
	OCT 2011	W35-GWF	432.405	0.11
	JUL 2012	W35-GWS	434.74	0.071
	SEP 2012	W35-GWF	434.47	0.068

Well ID	Sample Date	Sample ID	Groundwater Elevation (ft)	DRO Result
MW32				
Screen	OCT 2007	07FWCMW32-GW(F)	432.73	0.057
Interval	MAY 2008	08FWCMW32-GW(S)	432.41	0.052
(Ft bgs)	OCT 2008	08FWCMW32-GWF	433.02	0.063
9-19	MAY 2009	09FWCMW32-GW(S)	432.69	ND (0.25)
	SEP 2009	09FWBMW32-GWF	432.50	ND (0.25)
	JUL 2010	10FWAMW32-GWS	431.87	0.12
	OCT 2010	10FWAMW32-GWF	431.47	0.23
	JUL 2011	11FWAMW32-GWS	433.55	0.11
	OCT 2011	11FWAMW32-GWF	432.89	0.58
	JUL 2012	12FWAMW32-GWS	435.08	0.18
	SEP 2012	12FWAMW32-GWF	434.78	0.16

Well ID	Sample Date	Sample ID	Groundwater Elevation (ft)	DRO Result
MW12				
Screen	MAY 2008	08FWBMW12-GW(S)	435.27	5.6
Interval	OCT 2008	08FWBMW12-GWF	436.00	11
(Ft bgs)	MAY 2009	09FWBMW12-GW(S)	435.63	7.4
8.5-18.5	SEP 2009	09FWBMW12-GWF	435.43	4.9
	JUL 2010	10FWAMW12-GWS	434.82	5.3
	OCT 2010	10FWAMW12-GWF	434.35	6.5
	JUL 2011	11FWAMW12-GWS	436.45	9.8
	OCT 2011	11FWAMW12-GWF	435.86	12
	JUL 2012	12FWAMW12-GWS	435.19	12
	SEP 2012	12FWAMW12-GWF	434.89	9.2

Well ID	Sample Date	Sample ID	Groundwater Elevation (ft)	DRO Result
MW33				
Screen	OCT 2007	07FWBMW33-GW(F)	432.53	28
Interval	MAY 2008	08FWBMW33-GW(S)	432.34	10
(Ft bgs)	OCT 2008	08FWBMW33-GWF	433.11	29
8-18	MAY 2009	09FWBMW33-GW(S)	432.76	13
	SEP 2009	09FWBMW33-GWF	432.57	13
	JUL 2010	10FWAMW33-GWS	431.94	10
	OCT 2010	10FWAMW33-GWF	431.47	31
	JUL 2011	11FWAMW33-GWS	433.59	6.7
	OCT 2011	11FWAMW33-GWF	433.02	22
	JUL 2012	12FWAMW33-GWS	435.16	12
	SEP 2012	12FWAMW33-GWF	434.87	19

Well ID	Sample Date	Sample ID	Groundwater Elevation (ft)	DRO Result
MW62				
Screen	OCT 2007	07FWAMW62-GW(F)	433.46	0.61
Interval	MAY 2008	08FWAMW62-GWS	433.54	0.041
(Ft bgs)	OCT 2008	08FWAMW62-GWF	434.24	7.7
7-17	MAY 2009	09FWAMW62-GWS	433.89	ND (0.8)
	SEP 2009	09FWAMW62-GWF	433.67	ND (0.784)
	JUL 2010	10FWAMW62-GWS	433.04	0.38
	OCT 2010	10FWAMW62-GWF	432.68	29
	JUL 2011	11FWAMW62-GWS	433.78	0.22
	OCT 2011	11FWAMW62-GWF	434.16	18
	JUL 2012	12FWAMW62-GWS	435.17	0.092
	SEP 2012	12FWAMW62-GWF	434.87	0.14

2012 Sample - Exceedance
Onsite Well
2012 Sample -No Exceedance
Post Water Supply Well

Notes:
Project cleanup level: 1.5
Units: mg/L
Method: AK102

The F or S at the end of the sample ID indicates spring or fall sampling.

RED exceeded the project cleanup level.
DRO: Diesel-range organics (C10-C25)
Results are presented without qualifiers.
ND = not detected

All Locations Are Approximate

0 250 500 750 1,000
Feet

WGS 1984 UTM Zone 6N

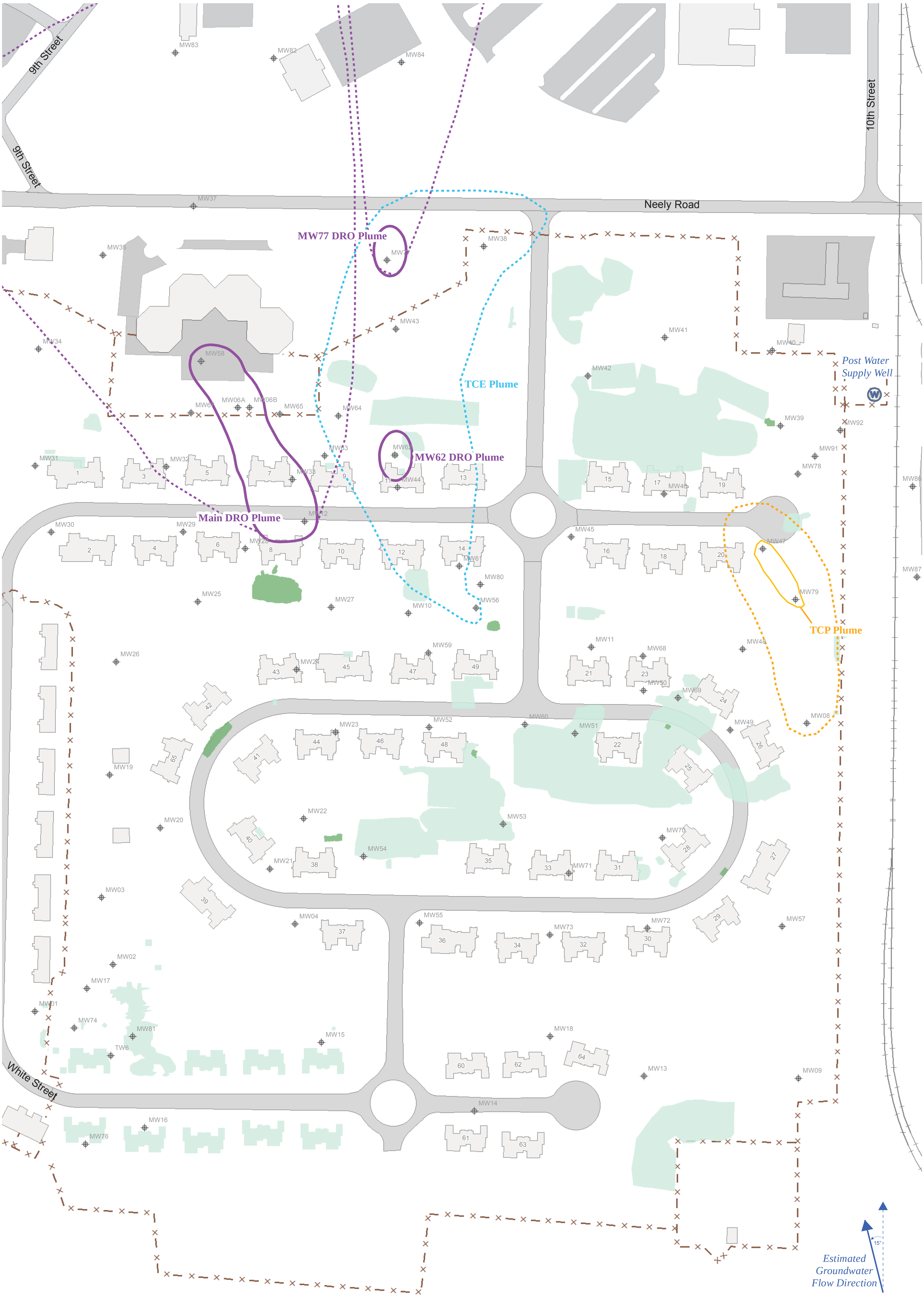
N

FORMER COMMUNICATIONS SITE
HISTORICAL DIESEL RANGE ORGANICS RESULTS FOR IN-PLUME AND SURROUNDING WELLS

FORT WAINWRIGHT, FAIRBANKS, ALASKA

JACOBS | DATE: 31 DEC 2013 | PROJECT MANAGER: T. HEIKKILA | FIGURE NO: A-17

P:\Taku_Gardens\MXD\2013_GWMP\2013_Taku_GWMP_DRO.mxd beatycj



2007-2009 Removal Area
2010-2011 Removal Area
DRO Above Project Cleanup Level (Plume Area)
TCP Above Project Cleanup Level (Plume Area)
DRO Below Project Cleanup Level (Leading Plume Edge)
TCE Below Project Cleanup Level (Leading Plume Edge)
TCP Below Project Cleanup Level (Leading Edge of Plume)
* TCP: 1,2,3-Trichloropropane

Building
Railroad
Road or Trail
Well
Monitoring Well
Fence Line

All Locations Are Approximate

0 125 250 375 500
Feet

WGS 1984 UTM Zone 6N

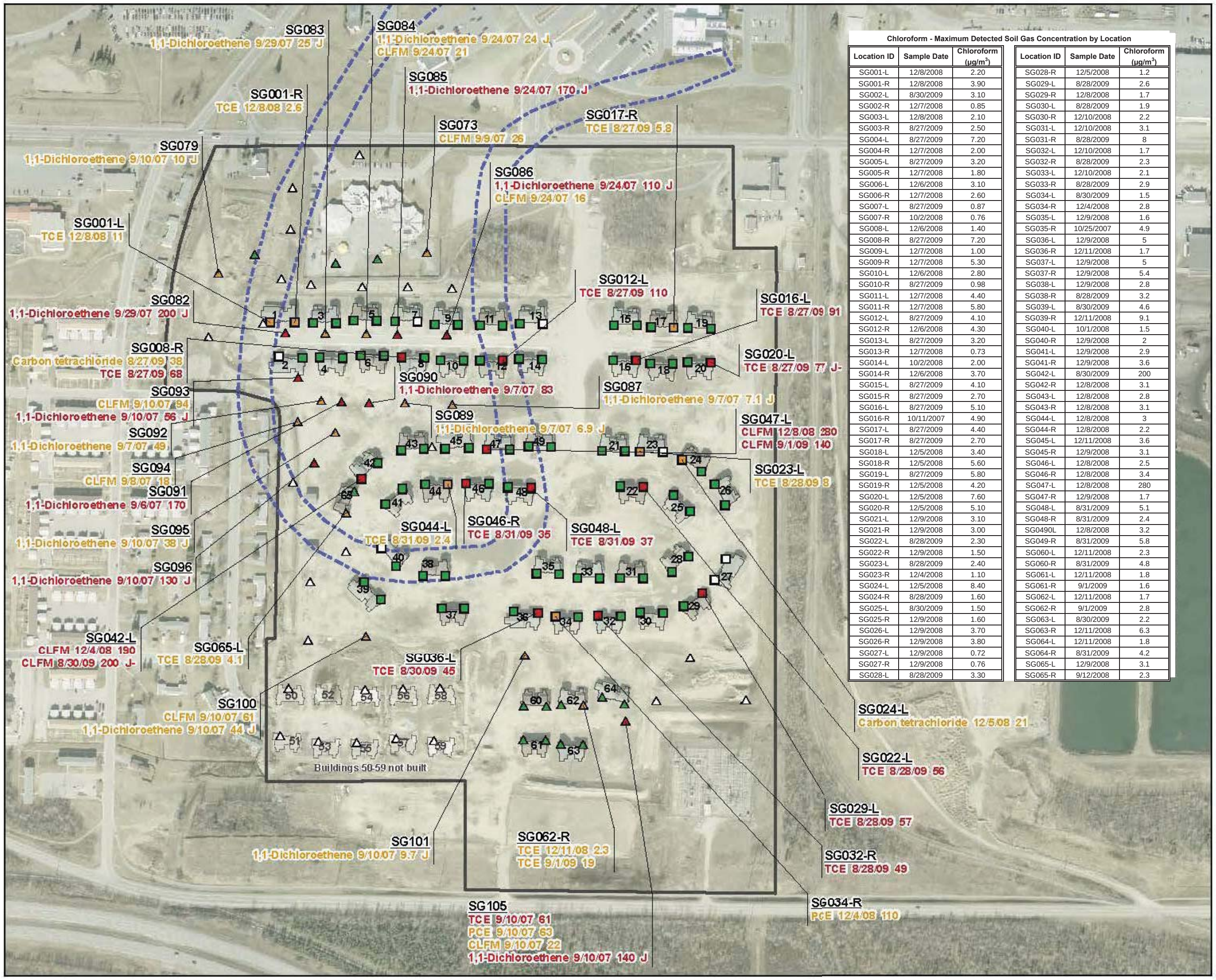
N

SOURCE REMOVAL AREAS 2007 - 2011

FORT WAINWRIGHT, FAIRBANKS, ALASKA

JACOBS	DATE: 16 SEP 2013	PROJECT MANAGER: T. HEIKKILA	FIGURE NO: A-18

P:\Taku_Gardens\MXD\SourceRemovalAreas2007to2011_update.mxd jaronitj



Chloroform - Maximum Detected Soil Gas Concentration by Location

Location ID	Sample Date	Chloroform (µg/m³)
SG001-L	12/8/2008	2.20
SG001-R	12/8/2008	3.90
SG002-L	8/30/2009	3.10
SG002-R	12/7/2008	0.85
SG003-L	12/8/2008	2.10
SG003-R	8/27/2009	2.50
SG004-L	8/27/2009	7.20
SG004-R	12/7/2008	2.00
SG005-L	8/27/2009	3.20
SG005-R	12/7/2008	1.80
SG006-L	12/6/2008	3.10
SG006-R	12/7/2008	2.60
SG007-L	8/27/2009	0.87
SG007-R	10/2/2008	0.76
SG008-L	12/6/2008	1.40
SG008-R	8/27/2009	7.20
SG009-L	12/7/2008	1.00
SG009-R	12/7/2008	5.30
SG010-L	12/6/2008	2.80
SG010-R	8/27/2009	0.98
SG011-L	12/7/2008	4.40
SG011-R	12/7/2008	5.80
SG012-L	8/27/2009	4.10
SG012-R	12/6/2008	4.30
SG013-L	8/27/2009	3.20
SG013-R	12/7/2008	0.73
SG014-L	10/2/2008	2.00
SG014-R	12/6/2008	3.70
SG015-L	8/27/2009	4.10
SG015-R	8/27/2009	2.70
SG016-L	8/27/2009	5.10
SG016-R	10/11/2007	4.90
SG017-L	8/27/2009	4.40
SG017-R	8/27/2009	2.70
SG018-L	12/5/2008	3.40
SG018-R	12/5/2008	5.60
SG019-L	8/27/2009	5.80
SG019-R	12/5/2008	4.20
SG020-L	12/5/2008	7.60
SG020-R	12/5/2008	5.10
SG021-L	12/9/2008	3.10
SG021-R	12/9/2008	3.00
SG022-L	8/28/2009	2.30
SG022-R	12/9/2008	1.50
SG023-L	8/28/2009	2.40
SG023-R	12/4/2008	1.10
SG024-L	12/5/2008	8.40
SG024-R	8/28/2009	1.60
SG025-L	8/30/2009	1.50
SG025-R	12/9/2008	1.60
SG026-L	12/9/2008	3.70
SG026-R	12/9/2008	3.80
SG027-L	12/9/2008	0.72
SG027-R	12/9/2008	0.76
SG028-L	8/28/2009	3.30

Location ID	Sample Date	Chloroform (µg/m³)
SG028-R	12/5/2008	1.2
SG029-L	8/28/2009	2.6
SG029-R	12/8/2008	1.7
SG030-L	8/28/2009	1.9
SG030-R	12/10/2008	2.2
SG031-L	12/10/2008	3.1
SG031-R	8/28/2009	8
SG032-L	12/10/2008	1.7
SG032-R	8/28/2009	2.3
SG033-L	12/10/2008	2.1
SG033-R	8/28/2009	2.9
SG034-L	8/30/2009	1.5
SG034-R	12/4/2008	2.8
SG035-L	12/9/2008	1.6
SG035-R	10/25/2007	4.9
SG036-L	12/9/2008	5
SG036-R	12/11/2008	1.7
SG037-L	12/9/2008	5
SG037-R	12/9/2008	5.4
SG038-L	12/9/2008	2.8
SG038-R	8/28/2009	3.2
SG039-L	8/30/2009	4.6
SG039-R	12/11/2008	9.1
SG040-L	10/1/2008	1.5
SG040-R	12/9/2008	2
SG041-L	12/9/2008	2.9
SG041-R	12/9/2008	3.6
SG042-L	8/30/2009	200
SG042-R	12/8/2008	3.1
SG043-L	12/8/2008	2.8
SG043-R	12/8/2008	3.1
SG044-L	12/8/2008	3
SG044-R	12/8/2008	2.2
SG045-L	12/11/2008	3.6
SG045-R	12/9/2008	3.1
SG046-L	12/8/2008	2.5
SG046-R	12/8/2008	3.4
SG047-L	12/8/2008	280
SG047-R	12/9/2008	1.7
SG048-L	8/31/2009	5.1
SG048-R	8/31/2009	2.4
SG0490L	12/8/2008	3.2
SG049-R	8/31/2009	5.8
SG060-L	12/11/2008	2.3
SG060-R	8/31/2009	4.8
SG061-L	12/11/2008	1.8
SG061-R	9/1/2009	1.6
SG062-L	12/11/2008	1.7
SG062-R	9/1/2009	2.8
SG063-L	8/30/2009	2.2
SG063-R	12/11/2008	6.3
SG064-L	12/11/2008	1.8
SG064-R	8/31/2009	4.2
SG065-L	12/9/2008	3.1
SG065-R	9/12/2008	2.3

LEGEND

Site Boundary

Former Hoppe's Slough

Explanation of Results

- No detected exceedances of PSLs
- One or more exceedance of PSL; detected result >1 and ≤10 x PSL
- One or more exceedance of PSL; detected result >10 and ≤100 x PS
- One or more exceedance of PSL; detected result >100 and ≤1,000 x PSL

Explanation of Label

Location ID
Analyte Result (µg/m³) Qualifier

*Font color indicates magnitude of exceedence

Analyte	Screening Level
1,1,2,2-Tetrachloroethane	0.42 ug/m³
1,1,2-Trichloroethane	1.5 ug/m³
1,1-Dichloroethene	0.49 ug/m³
1,2-Dichloroethane	0.94 ug/m³
1,2-Dichloropropane	1.3 ug/m³
1,2,4-Trichlorobenzene	4.2 ug/m³
Carbon tetrachloride	1.6 ug/m³
Chloroform	1.1 ug/m³
cis-1,2-Dichloroethene	37 ug/m³
Hexachlorobutadiene	1.11 ug/m³
Tetrachloroethene (PCE)	4.1 ug/m³
Trichloroethene (TCE)	0.22 ug/m³
Vinyl chloride	0.81 ug/m³

NOTE:
Vadose Zone sample locations shown as triangles

N

0 275
Feet

\\ancfil03\Projects\ERS-URI\TO07-Taku Gardens RA\WP\ROD\Figures\Figure 2-16 Distribution of Chlorinated VOCs in Soil Gas.dwg Figure 2-16 Distribution of Chlorinated VOCs in Soil Gas 13 February 2013 - jaronij

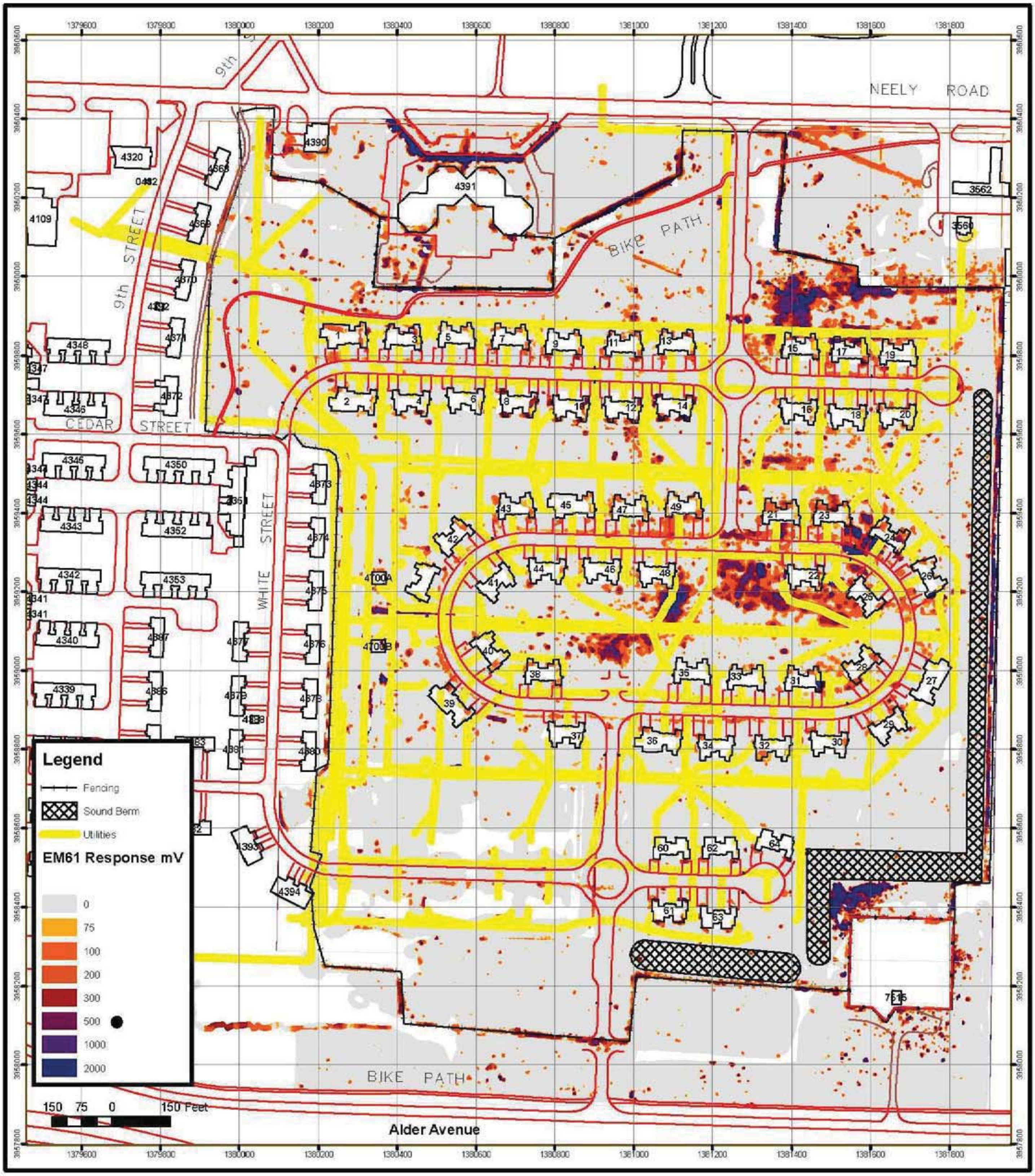
SOURCE: CH2M HILL, 2010 (DECEMBER)

FORMER COMMUNICATION SITE DISTRIBUTION OF CHLORINATED VOCs IN SOIL GAS

FORT WAINWRIGHT, ALASKA

JACOBS®

DATE:	PROJECT MANAGER:	FIGURE NO.:
13 Feb 2013	T. HEIKKILA	A-19



FORMER COMMUNICATION SITE
GEOPHYSICAL SURVEY RESULTS
2007

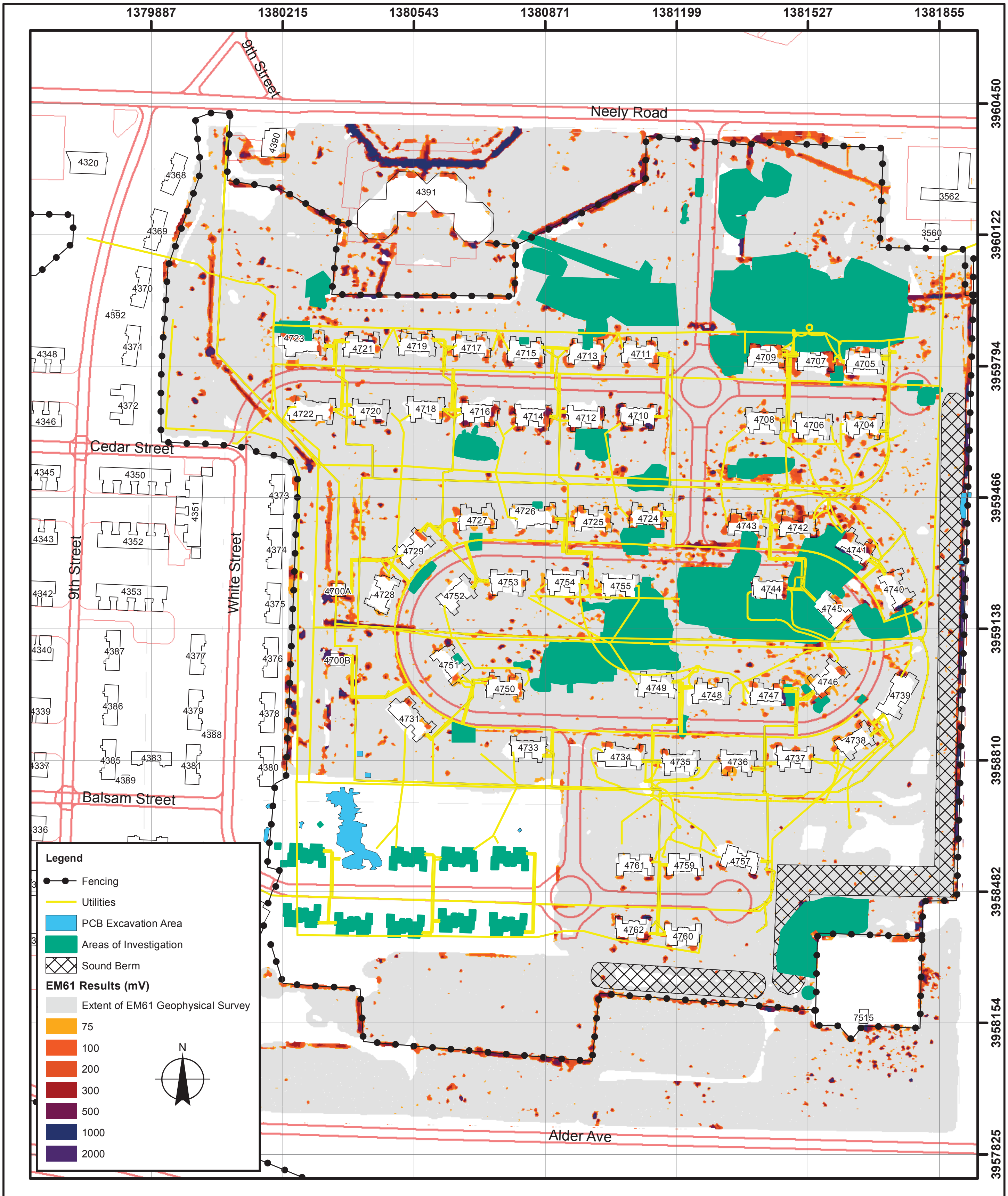
FORT WAINWRIGHT, ALASKA

JACOBS®

DATE:	PROJECT MANAGER:	FIGURE NO. :
13 Mar 2013	T. HEIKKILA	A-20

SOURCE: CH2M HILL, 2010 (DECEMBER)

\\ancfil03\Projects\ERS-UR\TO07-Taku Gardens RA\WP\ROD\Figures\Figure 2-17 Geotechnical Investigation Results, 31 October 2011.dwg Figure 2-17 Geotechnical Investigation Results 31 October 2011 13 February 2013 - jaronti



All Locations Are Approximate

0 250 500 750 1,000

Feet

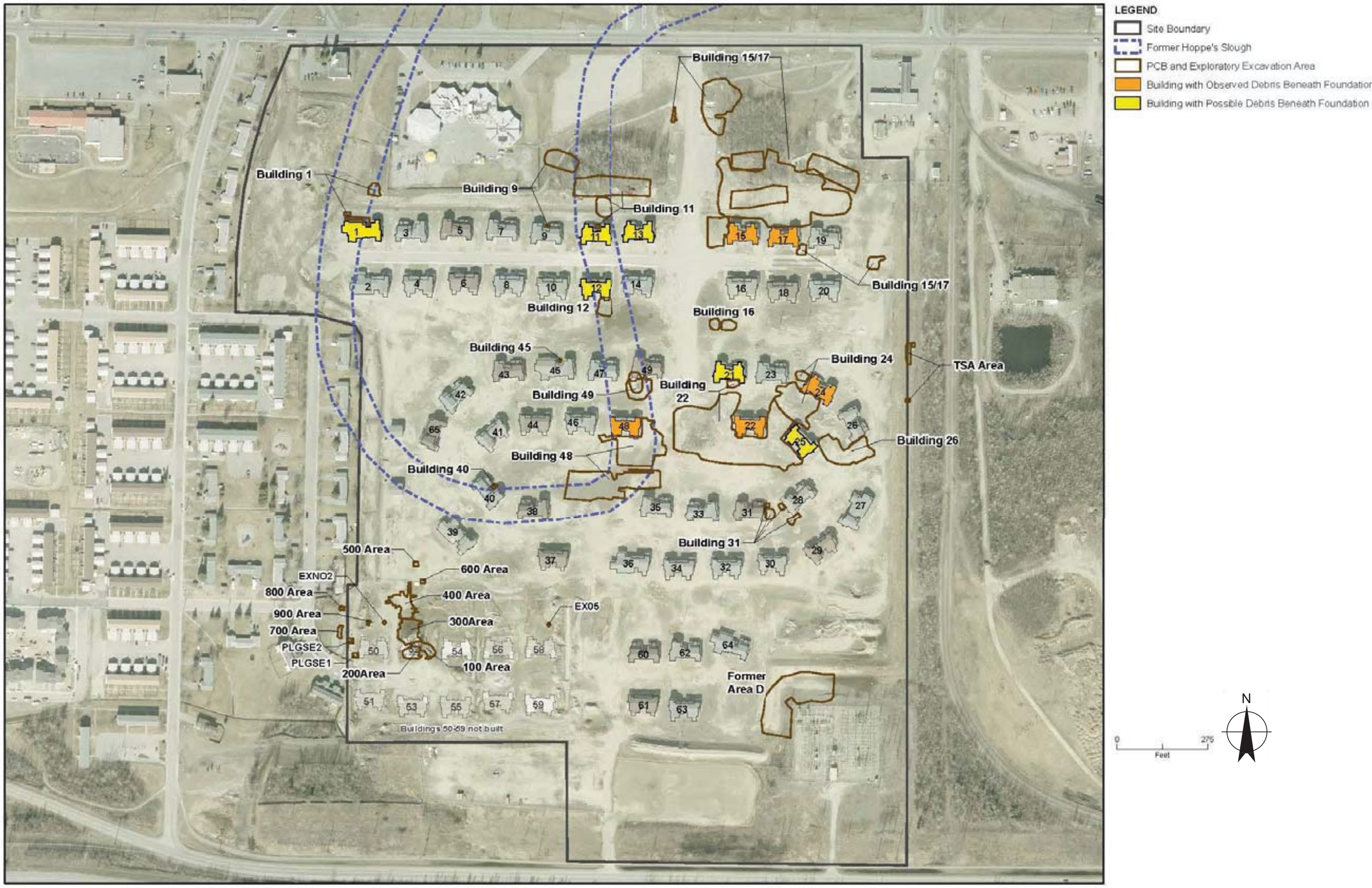
NAD 1983 StatePlane Alaska 3 FIPS 5003 Feet

P:\Taku_Gardens\MXD\GeophysicalSurveyResultsAndAreasOfInvestigation.mxd beatycj

FORMER COMMUNICATIONS SITE
GEOPHYSICAL SURVEY RESULTS AND AREAS OF INVESTIGATION
2007-2011

FORT WAINWRIGHT, ALASKA

JACOBS	DATE: 14 MAR 2013	PROJECT MANAGER: T. HEIKKILA	FIGURE NO: A-21



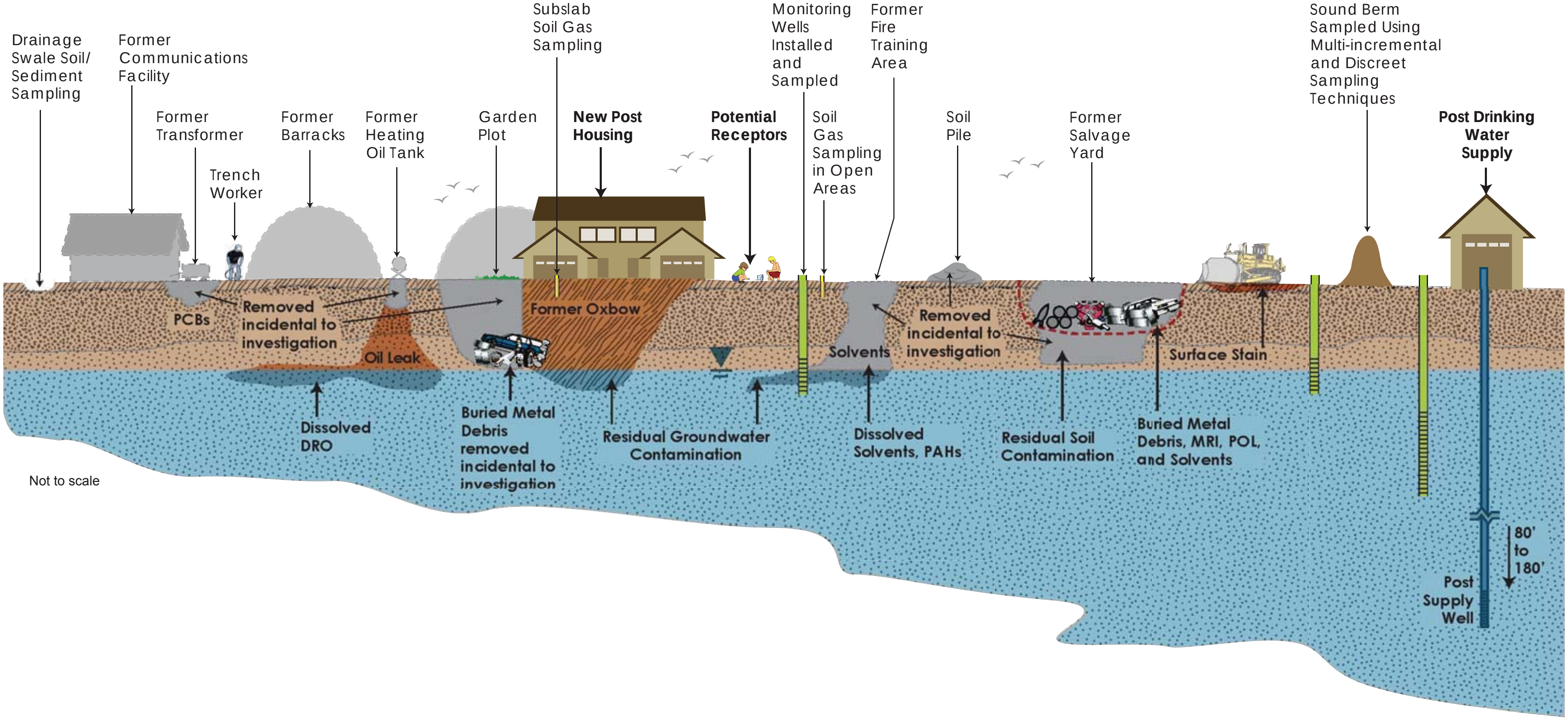
SOURCE: CH2M HILL, 2010 (DECEMBER)

FORMER COMMUNICATION SITE BUILDINGS WITH POSSIBLE DEBRIS BENEATH FOUNDATION

FORT WAINWRIGHT, ALASKA

JACOBS	DATE: 13 Feb 2013	PROJECT MANAGER: T. HEIKKILA	FIGURE NO.: A-22

\\ancfil03\Projects\ERS-UR\TO07-Taku Gardens RA\WP\ROD\Figures\Figure 2-19 Buildings with Possible Debris Beneath Foundation.dwg Figure 2-19 Buildings with Possible Debris Beneath Foundation 13 February 2013 - jaronlj



Historical Activity (grayed out)

Groundwater

Soil

Fill

Sandy Silt/Silty Sand

Sand

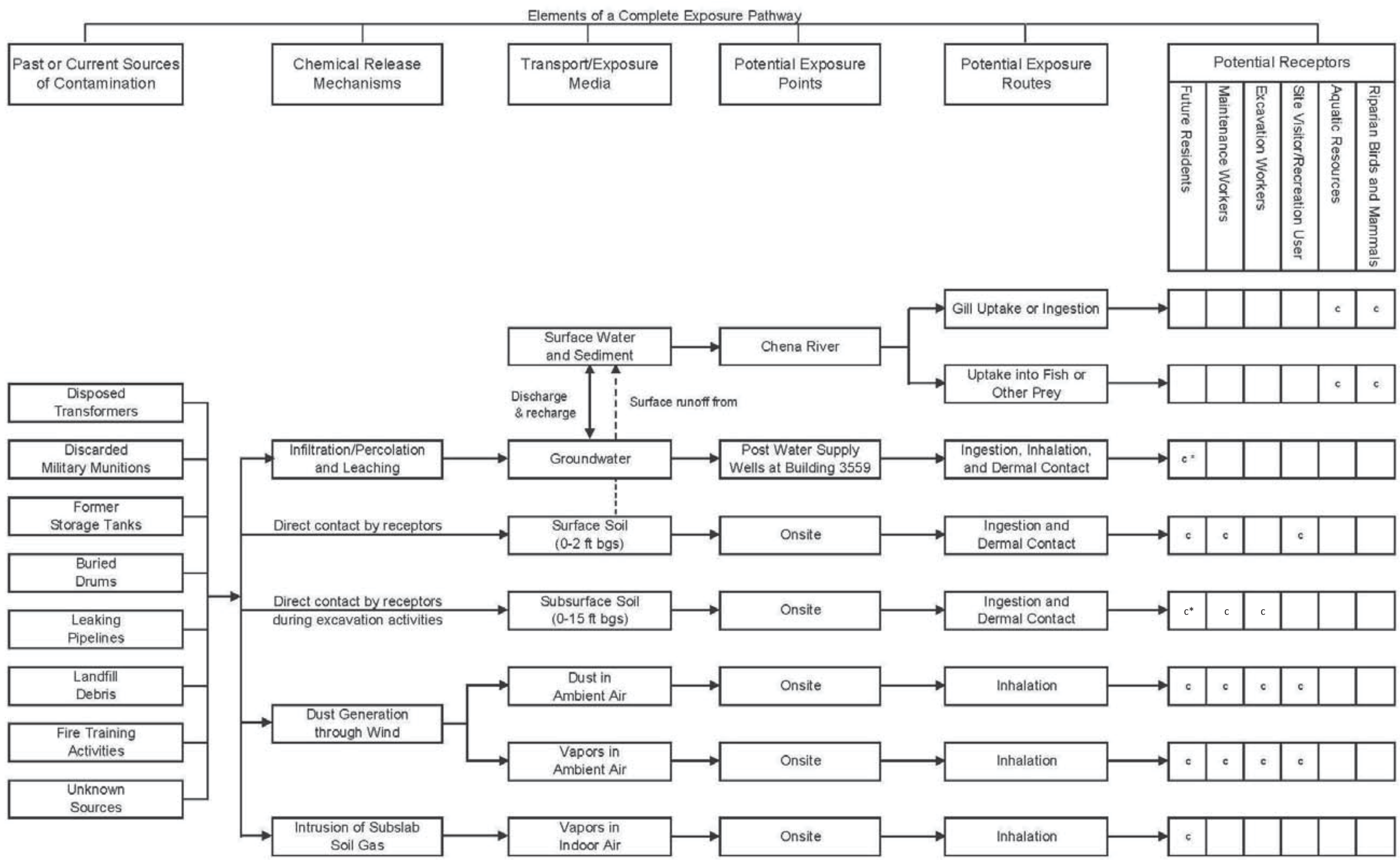
SOURCE: CH2M HILL, 2010 (DECEMBER)

FORMER COMMUNICATION SITE

CONCEPTUAL SITE MODEL FOR POTENTIAL HUMAN AND ECOLOGICAL EXPOSURES

FORT WAINWRIGHT, ALASKA

JACOBS	DATE: 22 FEB 2013	PROJECT MANAGER: T. HEIKKILA	FIGURE NUMBER: A-23



Notes:
c = Potentially complete pathway (addressed quantitatively)
Blank = incomplete pathway
* = Soil from 0-15 ft bgs and groundwater from wellpoints outside the potential capture zone of the Post Supply well were evaluated under the hypothetical unrestricted use exposure scenario.

SOURCE: CH2M HILL, 2010 (DECEMBER)

FORMER COMMUNICATION SITE CONCEPTUAL SITE MODEL FOR POTENTIAL HUMAN AND ECOLOGICAL EXPOSURES

FORT WAINWRIGHT, ALASKA

JACOBS®	DATE: 13 Feb 2013	PROJECT MANAGER: T. HEIKKILA	FIGURE NO.: A-24

Image Source: Fort Wainwright DPW - ENV, 2012

Fence
OU6 Institutional Control Boundary
Buildings 50-59 Not Built
Building
Paved Road
Unpaved Road

All Locations Are Approximate
0 100 200 300 400
Feet
Alaska State Plane Zone 3
Transverse Mercator

N

OPERABLE UNIT 6 SOIL AND GROUNDWATER
INSTITUTIONAL CONTROL BOUNDARY

FORT WAINWRIGHT, ALASKA

JACOBS	DATE: 31 DEC 2013	PROJECT MANAGER: T. HEIKKILA	FIGURE NO: A-25

P:\Taku_Gardens\2013_FCS_WorkPlan\2013_IC_Boundary.mxd beatycj

APPENDIX B

Applicable or Relevant and Appropriate Requirements

Table B-1
Chemical-Specific Applicable and Relevant and Appropriate Requirements
Former Communications Site, Fort Wainwright, Alaska

Standard, Requirement, Criterion, or Limitation		ARAR Status	Description
Alaska Oil and Other Hazardous Substances Pollution Control	18 AAC 75.345	Applicable	Table C establishes groundwater cleanup levels for the site (i.e., DRO, RRO, and 1,2,3-TCP).
National Primary Drinking Water MCLs	40 CFR 141	Relevant and Appropriate	Establishes primary drinking water standards (MCLs) pursuant to section 1412 of the Public Health Service Act, as amended by the Safe Drinking Water Act (Pub. L. 93-523) and establishes the MCL for TCE.

Notes:
AAC = Alaska Administrative Code
ARAR = Applicable or relevant and appropriate requirement
CFR = Code of Federal Regulations
MCLs = maximum contaminant levels
TCE = trichloroethene
U.S.C = United States Code
1,2,3-TCP = 1,2,3-trichloropropane

Table B-2
Action-Specific Applicable and Relevant and Appropriate Requirements
Former Communications Site, Fort Wainwright, Alaska

Standard, Requirement, Criterion, or Limitation		ARAR Status	Description
Alaska Oil and Other Hazardous Substances Pollution Control	18 AAC 75.355(b)	Applicable	ADEC requirement that sampling and analysis be conducted or supervised by a qualified, objective person.
	18 AAC 75.360	Applicable	ADEC requirement that the site cleanup be conducted or supervised by a qualified person .
	18 AAC 75.375(c)	Applicable	ADEC requirements for selection and implementation of institutional controls.
Implementation of Institutional Controls	SPAR Guidance 2011	TBC	Describes steps to create, remove, and track institutional controls.

Notes:
AAC = Alaska Administrative Code
ADEC = Alaska Department of Environmental Conservation
ARAR = Applicable or relevant and appropriate requirement
TBC = To be considered
1,2,3-TCP = 1,2,3-trichloropropane

APPENDIX C

Public Participation

PUBLIC NOTICE
THE UNITED STATES ARMY INVITES PUBLIC COMMENT ON THE PROPOSED PLAN AND AFTER ACTION MEMORANDUM FOR THE FORMER COMMUNICATIONS SITE (TAKU GARDENS), FORT WAINWRIGHT, ALASKA

PUBLIC MEETING ON JANUARY 15, 2013 AT THE FAIRBANKS PRINCESS HOTEL

The U.S. Army Garrison Fort Wainwright, as lead agency for environmental response actions on the installation, in partnership with the U.S. Environmental Protection Agency and the Alaska Department of Environmental Conservation, has developed a Proposed Plan and After Action Memorandum for the Former Communications Site (FCS). The U.S. Army is soliciting public review and comment on the recommendation to implement monitored natural attenuation and institutional controls for this site.

After January 2, 2013, copies of the Proposed Plan, After Action Memorandum, Remedial Investigation/Feasibility Study, subsequent reports and supporting documentation contained in the Administrative Record will be available for public review at the Fort Wainwright Public Library, Bldg 3700 Santiago Avenue, Fort Wainwright, Alaska, 99703, the Noel Wien Public Library, 1215 Cowles Street, Fairbanks, Alaska, 99701 and the U.S. Army Directorate of Public Works, Environmental Office, Building 3023, Engineer Place, Fort Wainwright, Alaska.

Individuals interested in reviewing the documents on post should allow additional waiting time in line to get the pass. Access to the Post requires non-residents/employees to get a pass at the Visitor's Center at the Main Gate on Gaffney Road. The U.S. Army encourages the public to participate in the decision-making process by offering comments on the Proposed Plan and After Action Memorandum.

The public comment period is January 14, 2013 through February 12, 2013. A public meeting will be held January 15, 2013 from 7:00 PM to 9:00 PM at the Fairbanks Princess Hotel, 4477 Pikes Landing Rd., Fairbanks, Alaska. Questions, comments, and responses on the Proposed Plan and After Action Memorandum will be recorded by a court reporter during the public meeting. Written comments will be accepted throughout the public comment period. Comments may also be submitted via a toll-free number (1-877-243-6974) or by sending an email to FCS-

Comments@jacobs.com. Individuals wishing to receive a response to their comments should indicate so in their message.

The FCS is located between Alder and Neely Roads, on Fort Wainwright, Alaska, and covers an area of approximately 54 acres. The site is the current location of the unoccupied Taku Gardens housing development, which the U.S. Army intends to open for residential occupation with EPA and ADEC concurrence. Soil and groundwater at the FCS were contaminated as a result of historical use and disposal activities during the 1950s. Soil at the site was contaminated with polychlorinated biphenyls (PCBs), petroleum, and volatile and semivolatile organic compounds. Groundwater was contaminated with petroleum and volatile organic compounds. Extensive site investigation and removal actions were conducted between 2005 and 2012. Potentially hazardous debris and contaminated soil above risk-based cleanup levels was removed to the greatest extent practicable. Diesel in subsurface soil is the only contaminant present above risk-based cleanup levels but does not pose an unacceptable risk to future residents provided they abide by the Institutional Controls.

The After Action Memorandum documents the removal of residual contaminated soil and debris encountered during earlier investigations and removal actions between 2005 and 2012. The Proposed Plan also documents all site investigation and removal actions of contaminated soil and buried munitions-related debris between 2005 and 2012, describes the remedial alternatives considered, and presents the Preferred Alternative. The Army, EPA, and ADEC evaluated the following remedial alternatives for addressing contaminated soil and groundwater at the site:

- Soil
- No Action
- Institutional Controls to Restrict Excavation
- Groundwater
- No Action
- Monitored Natural Attenuation and Institutional Controls to Prohibit Groundwater Use
- In Situ Chemical Oxidation and Institutional Controls to Prohibit Groundwater Use
- Permeable Reactive Barrier, Monitored Natural Attenuation, and Institutional Controls to Prohibit Groundwater Use.

Interested individuals should refer to the Remedial Investigation Report and other contents of the Administrative Record file for further information on all remedial alternatives considered. Electronic copies of these records will be available at the aforementioned locations after January 2, 2013.

The Preferred Alternative for the FCS is monitored natural attenuation and institutional controls for soil and groundwater. Groundwater monitoring will confirm that groundwater contaminant concentrations are naturally decreasing. Institutional controls limiting excavation of soil and prohibiting groundwater use at the FCS will continue to promote the ongoing protection of human health and the environment. Although this is the Preferred Alternative at the present time, the Army welcomes the public's comments on all of the remedial alternatives listed above. At the conclusion of the public comment period, the Army, in cooperation with the EPA and ADEC, will review all comments and select the best alternative based on the Evaluation Criteria and public input. The Final Remedy for the FCS will be chosen after the public comment period ends and after taking public comments into account.

The Army invites all residents of Fort Wainwright, the Fairbanks North Star Borough and other Stakeholders to attend a public meeting designed to provide attendees with a brief overview of the environmental cleanup and allow them the opportunity to ask questions and interact with representatives from the Army, the EPA and ADEC. Participants will have the opportunity to hear a briefing describing the work that has been accomplished at this site; look at static displays of the types of materials found during the remedial investigation; the types of sampling that were conducted on the site, and posters that chronicle the work completed at Taku Gardens. The doors will open at 6:00 PM. A short presentation will begin at 7:00 PM with questions and topics of discussion to follow immediately after the presentation.

For more information regarding this public meeting, the Proposed Plan, the After Action Memorandum, or the Administrative Record please contact Joe Malen at 907-361-4512 or Cliff Seibel at 907-361-6220.

UNITED STATES ARMY ALASKA
U.S. ARMY GARRISON, FORT WAINWRIGHT

PROPOSED PLAN FOR
FORMER COMMUNICATIONS SITE (TAKU GARDENS)
FORT WAINWRIGHT, ALASKA

BEFORE JOSEPH MALEN,
Remedial Project Manager

Fairbanks, Alaska
Princess Hotel, Jade Room
4477 Pikes Landing Road
Fairbanks, Alaska 99709
January 15, 2013
7:00 p.m.

P R O C E E D I N G S

JOSEPH MALEN: Good evening, everyone. Like I said, my name is Joe Malen and I'm the remedial project manager for the Operable Unit 6 Taku Gardens site out on Fort Wainwright. I'd like to thank you all for coming and I would like to recognize a few of our distinguished visitors or attendees at the moment, and I would like to leave opening remarks to Col. Johnson, who is the Garrison commander, to give opening stuff. If you want to do it from there or here, it's up to you, sir.

COL. JOHNSON: No, I can come up there. Okay. How are you doing? I'm Col. Johnson. So I'm the commander of Fort Wainwright. So how many folks here aren't part of either federal regulators, state regulators, or somebody that has something to do with Fort Wainwright? How many are just interested citizens? Okay. The reason I'm asking is so I'd rather spend my time focusing on you guys and have our guys focus on you because everyone else has been involved with this for a long time because of what's going on.

So what we're doing today and I -- this evening, and Joe will get into it -- is there anyone else presenting besides you?

JOSEPH MALEN: No, sir.

COL. JOHNSON: Okay. So Joe will run through a whole bunch of stuff for you, but what this is, is part of the process that we have to do. There's a thing called CERCLA, and it's a big acronym, but basically the CERCLA process is a process that is basically focused on law, but, you know, we are required to go through a process that talks about our remediation and there's a whole bunch of steps and things we have to do. But to make it simple, what we're doing tonight as part of that is the public comment process.

So the whole intent tonight is to kind of present, hey, here's what happened, here's what we found, here's what we did. These were some of the things that were required, this is the way ahead and what the future has for us. But as you go through all of this, we are required by law to give the public an opportunity to (1) get smart about what's going on and (2) have some comments and ask some questions.

So we've got -- there's federal regulators here. Jack is from EPA, there are folks from ADEC, Alaska state regulators; there's a whole bunch of environmental folks from the Garrison. So after Joe has gone through and given you all this information, if you haven't already, feel free to go around and look at these different boards, look at some of the stuff here and ask any questions that you have, because there's a lot of really smart people in the room that have been working on this since around 2005. And I just happened to be the commander at Fort Wainwright back in 2005 when this all started. In fact, it was like week into my command. I took command and like four days later we figured out what was going on; that we had an issue at Taku Gardens.

So I've got a lot of personal knowledge of what happened for three years, and then I was gone and I just came back about a year and a half ago and, you know, all this stuff was supposed to be taken care of by the time I got back, but here we are.

So, really, this is the one thing I want to say and then I'll get out of here, is to me this is a good-news story, Taku Gardens. And I don't know if Joe is going to get into that as far as the process of what we've done, but as far as the Army goes, and this is my own personal opinion, what I think is good about this whole process is that, you know, we were trying to build Army family housing on the installation and during that time we saw that we had environmental issues. So one of the things that could have happened is we could have just shut the project down, stop construction, and probably lost the project. What we did instead is we worked with federal regulators and state regulators and we found a way to figure out -- do site exploration and really find out, what do we have? While we're doing that, continue with the construction as we could.

So once we kind of searched and looked to see what was going on, in those areas where we didn't have problems, we kept the project going, and we also were allowed to do some remediation at the same time. So we'd find something -- find a mess, clean it up, keep building and keep going so that the process didn't just stop. It kept going and that allowed us to get where we're at today, which is an important part of that whole CERCLA process, and I'll let Joe talk more about that.

But this, to me, is a good news story that we're actually here today with the houses done, remediation done, and we're ready to transfer assets from -- the Corps of Engineers has already passed them back to us at Fort Wainwright; we're ready to pass them to our privatized housing partner, and we're ready to put families in those houses, in a safe environment and take advantage of great houses that we really need.

So thank you very much, and we'll hang out afterwards; if you've got questions, you can ask us.

JOSEPH MALEN: The other thing -- one of the things that the colonel brought up was that this is -- the public meeting is a requirement of public law. One of the other things that's a requirement is that we're supposed to take a verbatim transcript of the stuff that happens here. That's why we have our court reporter that's over to my right, your left, in the corner, and she's going to be taking the transcript of all that's said during this meeting.

The other thing is, if you would like to make an official public comment and you don't want to write it, you don't want to send an e-mail, you can come up and she will record you as a verbatim transcript. If you have a comment, if you have a question, if you have a request, that's the nice lady that you would go to and make that known.

As we are going along and as I will be answering questions, I would like to ask your indulgence that I could carry a little pocket recorder so that questions, answers, and responses can be recorded as well, and then I just turn them over to her and it becomes a part of the record. If you don't want to be recorded, we don't have to take your name, we don't have to take anything like that; it can be an anonymous comment, it can be an anonymous question, but please let me know so that, you know, we turn -- I don't take the recorder with me and, you know, stick it up under your nose. So if you have a question, you have a concern and you don't want to go on official record or be recorded, please just let us know and we can accommodate that need.

We will make the com -- we will record the comment as "someone asked," you know, and that will go in the record, but you don't have to be officially there.

So I'd also like to recognize the other RPMs that are part of this project. The colonel already spoke of Jacques Gusmano. Mr. Gusmano is from Region 10 EPA. He has been with the project since 2005 and is here currently with us. Ms. Deb Caillouet, which -- who is from the State of Alaska, is right there in the back of the room, making sure that she makes faces at me to make me laugh during the presentation. She's been with the program since 2008.

We had to switch RPMs for the state, in the middle, but Deb has caught herself up for everything that has happened in '05 all the way up to present day. So she is as knowledgeable as any of us to ask questions. We have regulators from the EPA and the State of Alaska as a requirement; it's part of our Federal Facility Agreement and it is part of the law of CERCLA. And CERCLA stands for the Comprehensive Environmental Response Compensation Liability Act. That's the great big thing, why we say CERCLA instead of the actual name of the act.

So if you have any questions, if you have any concerns, I'd like to ask if you could wait until after the presentation, but if something just jumps up and you've just got to ask a question, I'll entertain questions during the presentation. Just remember that the more questions you ask, the longer I blather on. So if you want to get me to sit down and shut up, you know, just wait till the end. But I will entertain, if you have something that you would really like to have.

Okay. The reason that we are here, we are talking about the former communication site, otherwise known as Taku Gardens, and we want to give you a brief history of everything that has happened, what was done there in the past, what we found out, what we encountered during our construction, during our investigations, tell you where we are today, and where we think we're going.

We also, again like we talked in the beginning, we want to give you, the public, the opportunity to have your comments known, ask your questions, and get the answers out to the public that we can. We have also -- in our public notices, we have put up a web site. Every piece of paperwork that we have attached to this is in what is called the Administrative Record, which is basically a record of every document, everything that we did that led to a decision for where we are today. And that is available online. It's part of the newspaper ad that we did. If you'd like to have it afterward, please let me know and we can get it to you so that you can download it.

Okay. Any questions about what we're here for, what we want to do before I jump into this? Okay. Here we go. Roller coaster ride.

This is Taku Gardens back in the forties and fifties. You can see that there's a lot going on in here. And what we did is we superimposed where the houses are today over what was there back in the forties and fifties. Up in the -- well, I have a pointer; I can do this. Up here in this upper area -- upper center area, this is what we call brigade and wing section. That's where the troops were living, it's where their company stuff was, their storage, their equipment was all stored in that area. We also had -- if I can get this thing to move, you know, another offshoot over here. No one is quite sure what that was, but, you know, they're there.

What we have in this area right here is what's called Hoppe's Slough. It was a slough that came off the Chena River at one time. It was basically filled over time as the troops were putting more and more things in the area. The antenna farm area is this area in here and we had what was called the Air Force Secret Security Service that was stationed in there. One of the unique things about all of the aerial photos that we have is this area right here in the bottom, and it's always obscured and we could never figure out how they always took a picture with a cloud over top of it. And it's kind of like, duh, they obscured it on purpose so that you couldn't see what was going on because it was a secret.

We also have a few other things that we care about today. There's an asphalt batch plant and a concrete batch plant up in that corner. We have a bunch of drums and what have you that are stored over here on the far right-hand side of the picture. And then, you know, down here is what we call a "cannibalization yard." It was a bunch of equipment, like a junkyard for the Army, and they would, you know, take pieces and parts from different equipment and would use it and return equipment to serviceable condition.

So there's a whole lot that we have going on around here. So, you know, we go back in history as best we can. You know, the problem is there's no absolute document as to what was happening out there in a specific spot. I mean, back then, they did what they were supposed to do and no one was expecting that we were going to be here today doing what we're doing. So we have to go and make our best guess as far as what we need to look for and where we need to look for it.

The area that started the whole thing is down here in the southwest corner. It is the old Building 52 site which is down here. That's where we found PCBs during the initial excavation of the foundation. We had several contractors working, a lot of heavy equipment going on, and one of the -- the operator of the piece of equipment smelled something funny, stopped his equipment, went through his chain and we ended up, after sampling, found that there was PCB contamination.

It's not that big an area as far as where the main PCBs were located, but what we did have, as the guy was pushing up dirt, making his foundation hole, the soil pile that was generated from that is where the PCB oils had gotten pushed up into. The environmental office folks at the time said, hey, we have this issue out here; we need to make it go away. And as -- and what normally the rule is, as you're loading stuff from the ground into a box to make it go away, you're supposed to use water -- you know, a water misting spray to keep the dust down. The contractor said, well, you know, if a couple gallons is good, a thousand gallons is better. And what he ended up doing was spraying a whole bunch of water over top of that and made a mess, and we'll talk more about that later.

What we end up doing is we have a whole bunch of metal that was found during the investigation and it was scrap metal mostly, crushed up drums, pieces of equipment, beds, lockers. Yes, we actually found a locomotive engine and, yes, we did find a forklift that was buried on site. They were there. It was a place where they were burying junk; we found it. There were tank treads, there was Marsden Matting, which is a hasty airfield material. All sorts of stuff that was out there.

Unfortunately, a couple of the drums had some petroleum in it; it was not a big deal. We had to go and segregate that stuff. There was a little bit of petroleum-contaminated soil. That was segregated off in separate piles and then everything that was not known to be contaminated was pushed off into other piles within the compound.

So after we go through all of this stuff of what's happening, and we decided that we needed to go and do further investigation, we went and ran EM61, Electromagnetic 61, is the name of the equipment that goes and generates this map that we're seeing right here. And everywhere that you see dark spots, that says that there's a lot of metal that's buried in that place and we care about that because metal equates possibly to drums and drums we cared about because if there was something in it, we wanted to make it go away.

So what we ended up doing as the RPMs, we sat down and said, okay, this is a big site. The contractor who was building the housing has already removed a whole bunch of stuff that was underneath and in and around the houses to get them out of his way so that he could build his utilities and put the houses up.

This is the stuff that was left afterward that we needed to go back and find. This was done in 2007 and what I'm going to lead you over to is my left, your right, we have yet the large posters over there that kind of give you an idea -- a better idea of the type of stuff that was looked at. When you look at the original housing, there were 88 borings that the Corps of Engineers did before we even started shovel 1. And all they found was junk and they found a little bit of petroleum. And Alaska, and especially up at Fort Wainwright, that's something that we find every day and we weren't really concerned. There was no contamination found other than the petroleum, with the exception of one PCB hit and when we went back to look to see if there was anything there, we couldn't replicate it, so we said we must have got it with the sample.

And we have over here on the far side, you know, you can actually see where the samples happened, where we stepped out, if you're interested.

And so with all the information that we had from our initial start in 2004 and we come out here to 2006 and we're at the point where we're saying, hey, we keep hitting this metal, there's a possibility for stuff in the drums, but we said we need to go and look at the places that had the most heavily -- you know, heavily concentrations -- heavy concentrations of metal, which are the areas that we see here and down in here, and look at see what's there.

Well, your normal CERCLA process is you go in and you do some borings and you say, okay, this is what we think is in the soil, groundwater based on the information we have. Well, it's a pretty big site and that's a lot -- you know, those are very big areas here that we're looking at when you look at how much metal is there. So what we said was, you know, you're not going to be able to do this with soil borings; let's get the excavators in. And so what we did is investigation by excavator, which, in our process, is probably the best way to do it because you're getting a whole lot of dirt, you're getting a great big picture instead of this very little, tiny thing that you normally deal with.

So, again, these areas here that you see, the heavier concentrations, that's where we focused our initial investigations on. It expanded from there, and I'll go into that a little bit later. Fine.

The EM61 map that you just saw, that's how we generate that thing. There's actually a guy that walked the entire compound, all 54 acres, just like that on a line. Some of it was towed when we had big open areas. And that's how the map was generated. The guys are looking like they're having all sorts of fun, don't they?

Okay. What was accomplished? You know, you start looking at stuff, you try and put words, you know, to all this stuff and you start thinking, oh, my gosh, we've really done a whole bunch of work. And, you know, when you start talking about 345,000 square feet, you're starting to talk eight acres of area that we actually went and put backhoe into it, dug it up, and made sure that there was nothing in the soil or, if there was something in the soil, it went away.

So we know that after we dug, we took samples at the bottoms of the holes and the side walls of the holes. If we found anything in the holes that was a contamination, we dug it out, put it in a box, made it go away. If it was clean, we'd cite it as clean and moved on to the next area. The munitions-related debris, that's the stuff that's on my right, your left; it's laying on the floor and I invite you to go and look at that after the presentation. We also have UXO technicians that are available, that can explain to you what it is that you're looking at, if you're interested.

Two rocket motors were found. We have a rocket motor sitting there, you know, of what we had found. In the tail end, in the rocket part of the motor, there was some residual propellent and it's called residual propellent because it was all water-logged and basically degraded. But because the propellant was there and it was still inside the cup for the rocket motor, those two things get classified as discarded military munitions, meaning that there was an energetic source within the device itself, which were taken to the range, blown up and made go away.

Of the other items that you will see over here on display, whenever they were found, they were treated as live munitions until we could prove that there was nothing in them. And the way that you find that there's nothing in them, either they're opened and you can see inside or we take them out to the range and we put what's called a small donor charge and we try and initiate an explosion. If all you do is make a hole in the thing or dent it up and mangle it up a little bit, it's not full of energetic material and is considered munitions debris, and that's what we have over here. And that was the majority of the stuff we found with the exception of the two rocket motors.

You know, lots of -- you know, 389 tons. We have pictures of it over there on the wall that you can see and I'll flip it up here in a second. But that's a lot of metal, you know, and what we have in the picture over there is basically from one investigation, not all of them.

Nonservicable material that was hauled off: basically, when you have sandy silt, you can't build on it, it's not good for your gardens or anything like that. So 11,000 cubic yards went over to our landfill to be used as landfill cover, which is about the best thing for it. 1,061 drums dug up; 608 empty, meaning there was absolutely nothing in it; 445 had detectible residue, meaning you could tell what was in it based on the residue there, mostly oil. Eight had measurable liquid that could be sampled. It came out mostly petroleum hydrocarbon and one of them had something else added into it that was kind of strange, but it was still mostly just fuel; nothing else was hazardous.

Okay. The PCB-contaminated soil: 3,300 cubic yards is a lot of soil and, again, the reason that that had to be dug up that way is after I told you about the water being splashed on the top of the pile, it made the soil run away from the pile and out into the area around it. So we had to clean all of that stuff up, which is why this number gets to be so huge. The 3,300 cubic yards of petroleum-contaminated soil, again, petroleum is something that we encounter all the time. We get it out of the way, we dig it up, we take it to OIT downtown, down in North Pole, and have them burn it, and then they bring that soil back and we put it in the landfill. The asbestos and solid waste, you know, again, it's just stuff that we normally encounter. It's not a big deal. Well, it's a big deal as far as we've got to make it go out of there, but it's now all gone, no longer an issue. We have none of that stuff left that we know of.

This is a picture -- this is building -- what are we doing? Oh, okay. That's right in the middle of 15, 17, and 19, which is in the northern side of the northeast corner of the compound. This is what we were dealing with and what you're looking -- right here at the bottom, those are the -- what the drums look like. Some of them actually look like they were intact; others were all crushed up and mangled like we have here and over in here. We dug the stuff out, had to unearth utilities, we came as close to the buildings as we could without compromising the foundations, and if we found, you know, drums or containers like this out there, when we were all done cleaning the solids out, we went and did lab samples to make sure that there was nothing from that drum and history left in the soil. If it was, it was dug up and made go away.

This is the same excavation that you just saw. They basically -- you know, what you were seeing was right along here and we had to go and do this backfill because, as you can see, we have utility poles that we had to go and replace. So this excavation actually went all the way against the house and, as you can see, this excavation down here, that's actually 18 feet deep. We were right over top of groundwater and when -- we have that picture over there on the -- your right-hand side there, you'll actually see orange pin flags and that's where we took our samples to prove that we were actually clean. So that is a huge hole and everybody gets excited when

I say this, but that hole is clean. We have sampled that hole. We have looked at that -- we've pulled everything out, we went down to groundwater, there's nothing in the groundwater over there and there's nothing in the soil. It's clean. You know, and that was the object of the drill; that when we got to those sort of things, we could actually go back and tell everybody who shows up, "That's clean."

I was telling you about the junk that was pulled out. That's part of that 296 tons that we pulled out. We actually -- this is just from building 15, 17, and 19, that area that you just saw exhumed. That's the stuff that we pulled out. That's an actual house behind it, so it'll give you an idea of the scale of just how big that pile of stuff was. And it's basically just a whole bunch -- a potpourri of Marsden Matting and commo wire and tank treads and drums and just metal, junk.

This here -- we actually only had one building that we observed drums underneath the building. This is building 49L, the left side of building 49. And as you can see here in this center part, those are the sidewalls of drums and they look like they're intact. So we said, you know, there are drums under the buildings, we are not leaving drums under the buildings, so we actually went and dug -- this thing right here that you see on the top, that's the underside of the garage. That's the garage floor that you see there. And the garage floor is held up. We had our eng -- or Jacobs Engineering consultants go through there and they engineered a way to keep everything in place while they dug underneath.

That'll kind of give you a better scale of what's going on, you know, and these little things that you see that are drums, every one of them came out. Nothing was left in place. And when they got them all dug out, they were all empty. So, a good news story that they're all gone. Nothing in them is even a better good news story. And then when we were all said and done, because there's no way to compact soil underneath that thing to keep the house from moving, they used an expanding concrete that they pumped underneath the thing and it -- so we had this great big hunk of concrete underneath that one particular house. So it's not going anywhere.

Again, this is the area of investigation. If you see a color on here, this is where we dug. The blue that we see right down in here, this is the PCB area. Right where the dot is now is the main area where we had to go down to groundwater to dig it all out. The rest of it was just because of where the water smeared and we had to go and go after it. Now, after the water smeared, we had some -- there's construction still going on. We had some little spots here, you know, little drabs, dibs over here, and then one little place right here on the side of the sound berm had PCBs in it and that was dug up and made go away.

So anything that we found that had PCBs in it, it's gone if it was over 1; 1 part per million is the requirement by state and EPA for residential housing. There is not one 1 part per million anywhere on that site that -- you know, that we know of. And we've looked pretty much everywhere you can imagine to go look. And, again, everything that's got color to it, that's where we dug. When you go compare that to the map over there on the far side, that's pretty much everywhere where we had heavy concentrations and then some. So eight acres -- you know, if you guys have an appreciation for size of an acre, here's eight of them that we went and dug up and at times down to 18 feet. We stopped when we didn't find anything anymore, and we checked, but we didn't stop until we were all done.

What you see down in here, this -- these were the 10 houses where the construction was stopped because we had the PCB in the one area and we were concerned about the rest. So after we were all done, all this stuff up here, we said, you know, we might as well go and dig out these foundations out here and check underneath the foundations just to make sure there was nothing under there. Good news is there was nothing under there. That whole area that was considered the PCB exclusion zone is clean based on our lab analyses. We even came over to the side of the sound berm over here. Again, it was just a place that we saw a lot of metal and we made the metal go away, and nothing extraordinary was found over here.

And we can talk about additional stuff after the thing -- after the briefing.

This little area here is just south of building 8. As they were digging one of the drainage swails, we found all sorts of diesel fuel in the soil and we tried digging out of it. We were not able to completely dig out of it, so we do have the diesel -- it's weathered diesel left in the soil, but it's five feet below the surface of where people are walking. So there's no way for people to come in contact with the stuff that was left behind.

Throughout this entire investigation, we have trace amounts of chemicals that exceed State of Alaska migration to groundwater levels. And what that basically says, if you exceed this level and yet you're still below an action level, that if you ever go to dig that out, you have to make sure that you don't put that dirt anywhere within 100 yards of a surface water body, a drinking water well, or a wetland. You know, so that's why we have to care about that and, again, that's considered contamination left in place

What do we know? We know that we moved all sorts of stuff out. We removed the drums, debris. All the contamination that we found, except for some diesel fuel, was put in a box or was treated or moved away from the site. It is not there today. Groundwater monitoring wells: there are 93 groundwater monitoring wells because, as we were going through our investigation, we said, well, you know, we don't know what's here; we don't know what's there. So we would put a well in, sample the soil as we went down, and sample the groundwater to make sure that we had a full characterization of the site and we knew what was left in place.

The soil samples, like I said before, we took them -- if we found drums, if we found indications, smelly soil, stained soil, anything didn't look right, we took a sample just to make sure there was nothing left behind. The -- we have some shallow groundwater contamination, which I'll talk about here in a little bit, but again no one is drinking the water, it is low-level stuff that we're talking about that I'll go into in a little bit more detail later.

The DRO is the diesel-range organic, and that's basically weathered diesel fuel, is what we're dealing with there. The whole -- what we're planning to do out there with putting residents back in is we've installed -- we have established institutional controls. Institutional controls are a means by which we are stopping people from becoming exposed to contamination. The rule that basically the institutional control says: you don't disturb the soil greater than six inches without getting a dig permit and without having a work plan to make sure that you're not digging in any place that we had something left behind. You're not going to be able to put a potable water well on site to use either for drinking or for irrigation. And then the other: we have to go and tell all the residents all the stuff that we have done out there so that they have an informed choice as to whether they want to live there or not.

Living in this compound is optional. If people decide they do not want to live on here based on the information that they receive, they do not get dropped to the bottom of the housing list that normally happens when you refuse a house somewhere else. You get -- you stay right where you are on the list and you get the next available house. So these houses were designed for three-, four-, and five-bedroom families. If you want one, they will be made available. If not, you get the next thing available that they have down within the installation.

The CERCLA actions, again, we had to -- we started this thing with an action memorandum that basically said we found contamination, we did a removal, now we need to do some further investigation. We established the ICs that said nobody lives here until we've gone through and evaluated everything that's out there; that we're also going to do monitoring the soil gas, groundwater, and -- yeah. And then the other thing that comes at the bottom, two preliminary source investigations. Before we started the remedial investigation, we basically had a contractor going out and taking samples all across the area. And in 2005, 2006, we went back through the history with a fine-toothed comb; we talked -- we went through all of the comments and stuff that was established by the contractors. Shannon & Wilson was the consultant, who is sitting right here. This is the young lady that got to be there throughout the entire construction as the houses were being built. She documented everything. If someone said, "I had a headache from standing here," we marked that down and we put that in our investigation. "It smelled funny over here." We put that down and we went and did an investigation based on that. So all the comments that we had, all the information we had was brought together in the PSE I and PSE II for our beginning evaluation for how to proceed with the investigation. The remedial investigation starts in 2007. I told you earlier, in 2005 we went and we dug the PCB soil that was on the surface. In 2007, we dug the rest of it. We went down to groundwater and we took it all out. So the first batch was 146 yards that was laying on the ground. The rest of the 3300-plus came out from '07 and '08.

The other part of the investigation -- the remedial investigation was a very dynamic thing, and over here to my left, your right, over in the front, you'll see a chart, and basically what that does, it takes -- you know, how did we develop the steps? How did we know to go from point A to point B? Where do we go look next? And that chart there kind of describes the whole thing and we can answer questions, if you have any, as you're looking at it.

After we finished doing our remedial investigation and we took everything out, the contractor who was doing the human health risk assessment made an assumption that was rather unusual, but because of the notoriety the site had and the fact that we were going to have people living here, they took every site where we had found something and assumed that we found everything in that one place. So of all the places that we found something, they were all considered that we had everything there, even though it wasn't, and they calculated the risk based on that. And even after they did that extreme kind of calculation, there is still no unacceptable risk to people living in these areas. And, again, based on the fact that you're not going to drink the groundwater and you're not going to dig a hole that's five feet deep in the back yard.

So the human health risk assessment says there is no unacceptable risk to human health or the environment, and then with -- based on that information, we proceed to say we're ready to go and start our final check to putting people in these houses.

Feasibility study basically says what do you need to do out there? And so we thought about it, we thought about it, and we said, you know, we do need to monitor the groundwater because there is some contamination left on site and we need to make sure we know what's happening with it at all times, and we need to make sure the institutional controls remain in place and are enforced and we need to meet on a regular basis, the RPMs, to go through all the information and figure out what, if anything, if there's a next step.

We are currently at the Proposed Plan Phase. The Proposed Plan -- I have copies over here on the table if anyone needs. Basically, what it says, it tells everything that we did. From 2005 to current, it says this is what we did. This is all the stuff that came out, this is where it went, this is what's left, and we say that we're ready to put people in here.

Again, we have -- there's three major institutional controls. We're going to monitor -- we have sampling ports in every single garage with the exception of 49L and basically what we do is we sampled the soil gas underneath the house. We're sampling to see if there are any vapors or fumes coming up, and we have found nothing that is out of the ordinary, nothing that would pose an unreasonable risk underneath the houses.

We have prepared the Proposed Plan for Public Comment. When public comment period is over on the 12th, basically, everybody who made comment, all those comments get put in what's called a Responsiveness Summary; that summary gets put into the Record of Decision. And basically what it says, if there is something that is brought up by the public that needs to be addressed, it's addressed before we can go any further with the RoD. Once we get everything addressed, we can move the Record of Decision forward and get it signed and we can -- we will complete the investigation process under CERCLA.

So, again, the Record of Decision goes up. The Army, EPA, and State of Alaska have to sign the document, depending on how much the final costs are for, the Record of Decision decides at what level these things get signed within each agency.

I told you about the soil gas sampling that we're talking about. There's a plan inside the Proposed Plan that says for five years -- up to five years, we are going to look at the sub-slab soil gas underneath the houses and we're going to monitor that to make sure that there is not something that we missed. There was a concern that there were some drums left underneath. We said the only way that we can check to see if there's something happening after we dug and didn't find anything was to go and sample the soil gas. And so that's basically a picture of what it looks like. The probe gets drilled into the concrete. You can see it happening here. We have another picture over off on the side, and we go and -- there's a whole elaborate operation as to how they go and sample that. We can talk about that later if you have questions.

Okay. I'm done, or at least half-baked. So is there anything that I can answer right now?

JULIE KEENER: It is true that debris remains under the structures except for four -- debris remains under some structures except for building 49?

JOSEPH MALEN: Correct. There are 12 buildings that we saw debris that was still on the side wall when we did our investigation, but it basically looks like, you know, bedposts or tank tracks or something like that that it's junk metal. And, again, junk metal has no risk. It doesn't do anything to anybody's health. It's just there. The fact that the contractor promised that after his compaction and his construction technique that the house would not move, you know, that's when the Army said, okay, you can leave stuff underneath the house provided it does not provide an opportunity for the house to shift later on.

Sir?

COL. JOHNSON: Joe, when you talked about making stuff go away, could you be a little more specific? Primarily, with the soil that contained PCBs, you know, once that was contained and identified, could you just talk about the process of what you did with it?

JOSEPH MALEN: Sure. You know, the colonel is asking me to go into a little more detail on the PCB removal operation. What happens is the excavators will come out to the site and they're -- hopefully with a light misting of water, the excavators will go into the dirt, they move the dirt from the pile into a 20-yard roll-on/roll-off metal container, a giant box, and there's a liner inside the box so that you can reuse the box afterward. And you basically fill the box up, you put a seal on it after you've sampled it and then the boxes get shipped down through the haz-waste process and goes to a toxic substance disposal facility, the closest of which is in Oregon. Columbia, Oregon.

And so everything that we dug up went to Columbia, Oregon, if you ever want to visit it. And that happened with everything that we found that had a hazardous nature. If it had to go and be disposed of Outside, it went in to a 20-yard roll-on/roll-off box that had a little burrito -- what we call a burrito inside; they fill the box up to the weight limit of the box itself, they get sampled, they get sealed and we put them out under a manifest to the hazardous waste facility. And then we get a piece of paper back that says it made it to the facility so that there's no chance that the stuff got lost in place -- you know, in transit and went somewhere else.

So we know where that stuff went to, we know that -- everything that we moved out of there, we know where it went to and we can -- we have the documentation to go and back up the stuff that went Outside.

So, again, it's a fairly simple process. The excavator comes in -- and the other thing with the excavators, the contractors who do that, they put down tarps all over the place so that as the bucket comes down and reaches up and you have the dirt going from here to there, anything that would normally drip, drips on top of the plastic and then when they're all said and done, they go and wrap the plastic up and throw it in the last box, and then they sample underneath the plastic to make sure that nothing got through the plastic.

So it's a very involved process as far as the contractor goes; fairly simple for me to say it. But it's a very long process. It's a very serious process. And all the time that the contractors are working this stuff, they're in Tyvek suits with respirators, they have gloves, and the reason that they do that -- you know, because of their career choice, they come in contact with contamination on a regular basis. All that is, is to make sure that there is no cumulative effect of them always going out and being in contact with contamination and them getting hurt.

This whole thing was done so that everybody was safe. The contractors were safe, who were doing it; the people are safe who are going to live there. So that's how that process went.

COL. JOHNSON: Thank you.

JOSEPH MALEN: Anything else? Sir?

GENE KUHN: I'm wondering if the dirt that's been dumped out by the landfill, is that part of your project?

JOSEPH MALEN: Right now? The stuff that's being dumped today or.....

GENE KUHN: Well, this summer -- last summer?

JOSEPH MALEN: No. That soil that got dumped off to the side came from other construction projects on post. We had -- I forget how many millions of dollars of construction. And so basically everything that was dug out of the hole to make room for foundations and what have you, had to go somewhere and we decided to go and build a clean soil cell that is just south of the landfill.

GENE KUHN: Okay. Well, that's -- I was wondering if I should be wearing my hazmat suit out there.

JOSEPH MALEN: No.

GENE KUHN: Since that's a wood-cutting area.

JOSEPH MALEN: That's correct.

GENE KUHN: And I thank Colonel Johnson for giving us that opportunity to cut wood. Thank you.

COL. JOHNSON: I'm not through with you. Yes, that's a good point, though, because it -- Joe mentioned a little bit of that during the brief, but deciding where anything that came off of that site, a lot of time and energy goes into where does it go, what's the proper disposition of it. So if it had any contamination, then it went -- as you said, it went down south.

JOSEPH MALEN: Went into a box and went somewhere else.

COL. JOHNSON: If it had fuel in it, then it went and got burned and then it got dumped in a dump. So it got treated before it got put in our landfill. And correct me if I'm wrong, but none of that dirt went off the installation to a landfill here in Alaska.

JOSEPH MALEN: That's correct.

COL. JOHNSON: Our -- it either went our landfill on post or it got sent down to the Lower 48 to be treated and.....

JOSEPH MALEN: That is correct.

COL. JOHNSON: .....do whatever they do with it in Oregon.

JOSEPH MALEN: Yep. Ma'am?

JULIE KEENER: Excuse me. And that soil was less than 10 parts per million PCB that went in -- or is to be used as cover on Fort Wainwright landfills.

JOSEPH MALEN: That is correct. We did.....

JULIE KEENER: It's between 1 and 10.

JOSEPH MALEN: Correct. The landfill -- the Fort Wainwright landfill allows less than 10 parts per million; it's considered clean soil or how -- how does it go? It is not contaminated soil if it's less than 10. And that's how -- and then we asked permission from the State of Alaska because we have a permit for our landfill. We said, it's less than 10 -- it's actually way less than 10 that we put it in, and we were able to get permission to move a significant portion of the soil there, thus saving the taxpayers a significant chunk of money.

Mr. Adams, who is sitting here at the computer, is our land -- well, still is for the moment, our landfill manager and I think he has something to add to that?

BRIAN ADAMS: No, I was just going to say the permit for the landfill at Fort Wainwright is such that we are not allowed to take contaminated soils into the landfill. So there's a limit. If you -- that's why we had to go to the state and ask the state if we could actually put that stuff into the landfill. It's the same with the diesel fuel contaminated soils. It gets burned. It automatically just comes back to the landfill and it's used as cover material.

JULIE KEENER: With limited exposure.

BRIAN ADAMS: Correct.

JULIE KEENER: I mean, it's obviously not a residential scenario.

BRIAN ADAMS: Correct.

JOSEPH MALEN: See, the other nice thing about the stuff that was moved to the landfill, as soon as we moved the soil that was not contaminated but could not be left on Taku, as soon as we moved it in there, we went and took cover soil and we covered that stuff back up. So there was no chance for dust to be blowing off of the landfill and outside it.

So, again, as many precautions as we could take, the installation took to make sure that everyone is safe and we have a good operation throughout the installation.

Yes, ma'am?

JULIE KEENER: The debris that we initially removed during construction, was that stockpiled somewhere and later inventoried and gone through, or.....

JOSEPH MALEN: In 2005, the contractor that was building the buildings, as they were digging up the waste material.....

JULIE KEENER: Excavation.

JOSEPH MALEN: .....the solid waste, the crushed drums, the tank treads, and all the other metal that they found, and some wood and some other items that were found, they would stockpile them in great big piles and then after they had a certain sized pile, then they would load everything into a truck and they would haul it out to the landfill.

Well, in 2006 as we were going through the stuff, one of the contractors that we had -- one of the environmental contractors said, you know, we really need to go through this metal and look for this kind of stuff, the discarded -- the munitions debris. And so what we ended up having -- what we ended up doing is we stopped the first contractor from hauling stuff just directly to the landfill and had UXO technicians actually go through each and every scrap pile and they pulled out anything that was considered munitions debris.

A couple of the items that we had, the contract folks were basically saying, hey, they never made a training device for this type of bomb or this piece of munitions, and so everybody was treating it as this is a live real-deal thing. As we took them to the range and we blew them up, we found out that that was not true; they actually did make training devices for darn near every piece of munitions that the Army used during World War I, II, and the Korean War.

So what you see over here is what we basically found. Some of the stuff was more intact when they dug it up; others are -- you know, they're obviously dismantled now to prove that there's nothing in it. So we did have a scare at first and then when we had, you know, the second contractor come through with their UXO techs and they took it over to the range, we found out that they were actually just training devices.

So with the exception of the two rocket motors that had the residual -- or the residue, the propellent residue, everything else was inert, had no energetic piece to it. There were no fuses, there were no hunks of explosive; just that propellant residue is the only thing that we had to be concerned about. And that was taken care of, too, at the range.

Anything else?

JULIE KEENER: Can you give us a quick rundown of the groundwater remediations?

JOSEPH MALEN: Okay. Within the Proposed Plan, we talk about that there are certain areas of groundwater contamination. The main -- the players that we have that are still -- that we are tracking is 1,2,3-trichloropropane which is a solvent; trichloroethane, which is another solvent; and diesel fuel. So those are the three main things that we really have to track.

When we first started doing the investigation in 2006, we detected elevated levels. Some of them were above the clean-up levels for EPA and so we kind of focused in those areas and we tried to make sure what was going on. We have sampled these wells in the areas of concern twice a year since 2006. And as we go through the years and as we're watching the samples, the levels of the contaminants are going down on a -- very significantly through what's called natural attenuation. You know, we're not doing any pumping, treating, or anything like that. The lab results are indicating the stuff is breaking down biologically or just through the dilution process of the groundwater moving through the aquifer.

We've made special effort to ensure that that water is not moving towards the drinking water wells, the production wells on Fort Wainwright. We have intercept wells or sentry wells between Taku and the drinking water source and those wells are still coming up as absolutely clean. There's nothing in them. So -- and we're going to continue monitoring, we're going to continue watching, you know, because we care about, you know, the drinking water on post.

JULIE KEENER: And can you point out the location of source for the supply wells.

JOSEPH MALEN: Well, from here, let's see.....

JULIE KEENER: Or a distance and a direction.

JOSEPH MALEN: Well, it's in the northeast corner -- it's outside the northeast corner of the compound. It's basically behind the PX gas station.

JULIE KEENER: Oh, so they're right there.

JOSEPH MALEN: Huh?

JULIE KEENER: If I may? They're there.

JOSEPH MALEN: Right there.

JULIE KEENER: Right there, yes.

JOSEPH MALEN: Is where the drinking water protection wells are. Right there.

JULIE KEENER: And groundwater flows?

JOSEPH MALEN: And groundwater flows to the northwest, which is basically from here to here. North to northwest. And the reason that -- the way that they find that out is they measure the water levels across all the wells, and the water -- you know, the high point is where the water starts, the low point is where the water is going, and so what they do is they take measurements to one-tenth or one-hundredth?

AUDIENCE MEMBER: Hundredth.

JOSEPH MALEN: One-hundredth of an inch to.....

JULIE KEENER: A foot.

JOSEPH MALEN: Or of a foot, rather. I'm sorry. You're right. One-hundredth of a foot to see which way the water is moving, and it was clearly moving north/northwest. More northwest than north. So -- and it's -- we're seeing that evidence based on where we have the known contamination that the -- the diesel fuel that we see here, it's actually moving to the northwest. The solvents that we saw here, they were moving to the northwest. The TCP that we saw that was right down in here is also moving to the northwest. And we see that based on, again, the water levels and which way the direction the water is going. Okay? Anything else?

AUDIENCE MEMBER: Looks like you did a good job. No one has got any questions.

JOSEPH MALEN: Well, thank you very much for coming, on behalf of the Garrison. The Garrison commander, Garrison Command Sergeant Major. Thank you very much for coming out. Again, if you would like to make public comment, if you have a question, you can come over here to the court reporter and she can go and take your questions, comments, whatever it is that you have. I'm going to be here. We also have, you know, Mr. Adams right here, we have Mr. Gusmano to the far back over there, Ms. Caillouet over here.

So if you want to get the answer from the agency and not from the Army, those are the two people that you go see. And if there's anything that I can answer, please come and see me. Thank you very much for being here.

(Off record)

(END OF PROCEEDINGS)

* * * *

C E R T I F I C A T E

UNITED STATES OF AMERICA)
) ss.
STATE OF ALASKA)

I, Elizabeth D'Amour, Notary Public in and for the State of Alaska, residing at Fairbanks, Alaska and court reporter for Liz D'Amour & Associates, do hereby certify:

That the annexed and foregoing PROPOSED PLAN FOR FORMER COMMUNICATIONS SITE (TAKU GARDENS) PUBLIC MEETING, held in Fairbanks, Alaska at the Princess Hotel, Jade Room, 4477 Pikes Landing Road, Fairbanks, Alaska, was digitally recorded and transcribed by me, pursuant to a request to do so;

That said transcript is a true and correct transcription contained on said digital recording;

That I am not a relative nor employee nor attorney nor counsel of any of the parties, nor am I financially interested in this action.

That the original of said transcript has been retained by me for the purpose of filing with Sarah Belway, Project Manager, Jacobs, 3437 Airport Way, Suite 201, Fairbanks, Alaska 99709.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed my seal this 4th day of February, 2013.

Elizabeth D'Amour

Notary Public in and for the
State of Alaska
My Commission Expires: 12/28/2014

(S E A L)

DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service

Agency for Toxic Substances
and Disease Registry
Atlanta GA 30333

February 6, 2013

Mr. Joseph Malen
Remedial Project Manager
US Army Garrison, Fort Wainwright
1060 Gaffney Road #4500
Fort Wainwright, Alaska 99703

Dear Mr. Malen,

The Agency for Toxic Substances and Disease Registry (ATSDR) has reviewed the *Proposed Plan for Former Communications Site (Taku Gardens) Fort Wainwright, Alaska* (dated December 2012) that was issued for public comment from January 14, 2013 to February 12, 2013. We are in the process of completing a Health Consultation evaluating the potential for vapor intrusion at the proposed housing complex. We have submitted a data validation version to the Army for review. The data validation version includes a number of recommendations to protect public health of residents who will occupy the property in the summer or fall of 2013. We wish to outline these recommendations during the public comment period, so that they may be considered during finalization of the proposed plan.

ATSDR has reviewed the environmental information gathered about the site and concluded that, while the probability of a health hazard occurring from vapor intrusion is low, the lines of evidence presented do not completely eliminate the vapor intrusion pathway. Subsurface containers that could contain volatile chemicals may remain undetected beneath homes on-site. Based on the conclusions in the data validation version of the Health Consultation, our recommendations to protect the future health of families residing at Taku Gardens concentrate on two areas:

(1) implementing measures to prevent possible exposures to hazardous air pollutants in homes that may be constructed over containers of hazardous materials in the subsurface, and,
(2) continued and additional precautionary sampling and monitoring of the properties.

Specifically, ATSDR recommends:

(1) that the Army consider implementing measures to prevent possible exposures to hazardous air pollutants in homes, such as installing sub-slab depressurization systems in the buildings identified as having observed and possible debris beneath them prior to occupancy as a precautionary measure. NOTE: The Proposed Post-construction Subslab Soil Gas Monitoring Program only considers installation of the system after vapor intrusion has been detected by quarterly or annual monitoring. However, the release of volatile or semi-volatile chemicals from a container could occur rapidly and migrate into homes at hazardous levels that are below olfactory detection. Subslab depressurization systems could prevent such exposures that may cause a health hazard and would likely go undetected during quarterly or annual monitoring.

(2) that the following additional sampling and monitoring is conducted, including:

a. monitoring at appropriate intervals following any changes to the site that may affect vapor flow, such as earthquake, building renovation, construction, or landscaping. This applies to future changes as long as contamination may remain onsite above screening or background levels.
b. monitoring semi-volatile organic compounds and 1,2-dibromo-3-chloropropane in all monitoring plans.
c. performing continued sub-slab gas and indoor air monitoring of units where screening levels were exceeded (i.e. a clean round of sampling shouldn't be used to eliminate the building from future study). NOTE: This would result in sampling more units than the 12 houses selected for monitoring in the Proposed Post-construction Subslab Soil Gas Monitoring Program.
d. sampling sub-slab gas in at least three locations, as advised in ADEC guidance, for a representative number of residences to characterize the spatial variability of contaminant vapors in the sub-slab space.
e. sampling during spring for all residences to capture conditions during the spring thaw and snow melt (the dates for future sampling plans are not specified in the proposed plan).
f. performing at least one of the comprehensive sub-slab soil gas sampling events after construction is complete (the dates for construction completion and future sampling plans are not specified in the proposed plan).
g. sampling of soil-gas collocated within a representative number of utility lines and sampling within utility line access ports (manholes) to provide evidence for or against this as an active vapor migration pathway.

We hope that you will find this information useful. We appreciate the opportunity to comment on the Proposed Plan and look forward to releasing our Health Consultation in the near future. If you have any questions please contact Dr. Tonia Burk, Environmental Health Scientist, at 770-488-0764 or email at TBurk@cdc.gov.

Sincerely,

Tina Forrester, PhD, M.S.
Acting Director
Division of Community Health Investigations
Agency for Toxic Substances and Disease Registry

cc:
Ms. Ronie Shackelford, US Army
Ms. Doris Anders, US Army

DEPARTMENT OF THE ARMY
INSTALLATION MANAGEMENT COMMAND
HEADQUARTERS, U.S. ARMY GARRISON FORT WAINWRIGHT
1060 GAFFNEY ROAD #6000
FORT WAINWRIGHT, ALASKA 99703-6000

REPLY TO
ATTENTION OF:

Directorate of Public Works

SUBJECT: Response to ATSDR Review of Taku Gardens Proposed Plan

Dr. Tina Forrester
Acting Director
Division of Community Health Investigations
Agency for Toxic Substances and Disease Registry
1600 Clifton Road (F-09)
Atlanta, GA 30333

Dear Dr Forrester:

The U.S. Army has received your letter dated February 6, 2013 outlining ATSDR's review comments for the *Proposed Plan for Former Communications Site (Taku Gardens) Fort Wainwright, Alaska,* dated December 2012, hereinafter referred to the Proposed Plan. The comments were received within the public review period of 14 January through 12 February 2013. This letter provides official response to your comments.

The U.S. Army Garrison Fort Wainwright Alaska appreciates the time and effort ATSDR expended on this review. The ATSDR review is very clear and concise. The review comments address the entire plan with particular emphasis on two main topics: 1) implementing measures to prevent possible exposures to hazardous air pollutants in homes that may be constructed over containers of hazardous materials in the subsurface and 2) continued and additional precautionary sampling and monitoring of sub-slab soil gas.

We agree with ATSDR's statement that "the probability of a health hazard occurring from vapor intrusion is low," but take exception as to how the statement that "Subsurface containers that could contain volatile chemicals may remain undetected beneath homes on-site" is used in the context of your letter. The weight of evidence gathered during the Remedial Investigation (RI) and subsequent construction support activities suggest that if intact drums exist, they most likely contain relatively small quantities of petroleum hydrocarbons or tar. This is based on the fact that of the 1,061 mostly crushed and empty drums found during the RI and subsequent construction support activities, only eight (less than 0.5 percent) had enough liquid to allow for sampling and analysis. Liquids in the 8 drums were characterized primarily as fuel and water mixtures, with few volatile organic compounds (VOCs). None of the drums contained chlorinated VOCs, which tend to be more of a concern in terms of volatility, migration, and toxicity. The remainder of the drums with contents contained tar, asphalt, and other non-hazardous solid and semi-solid materials. The types of material found in the subsurface at this site suggest that it is unlikely any debris that might be present under any structure contains intact drums with volatile liquids. As evidenced by the predominantly empty and crushed drums, and limited volume of contaminated soil recovered from areas where the few partially filled drums were encountered, the presence of buried metal and drums does not directly correlate with chemical contamination.

The Army has conducted extensive investigations and concurrent cleanup activities between 2004 (during preliminary investigations by the Alaska District Corps of Engineers for the pre-construction assessment) and 2011. The Army, in cooperation with the U.S. Environmental Protection Agency (EPA) and the Alaska Department of Environmental Conservation (ADEC) expended considerable time and resources to ensure that every reasonable method and approach was used to delineate the nature and extent of contamination at this site. The approach taken during the investigations and removal actions has been extremely conservative; all material suspected of presenting even a possible unacceptable risk has been removed to the greatest extent practicable.

Small, isolated areas of non-petroleum contamination were excavated to the point that there was no physical evidence of contamination and then, the floors and sidewalls of the excavated areas were sampled and analyzed. If additional contamination was detected by the laboratory analyses, the excavation continued until the contaminants of potential concern were not detected or concentrations were below conservative project screening levels. The only area where subsurface contamination is present at concentrations above health-based screening levels is in the north-central portion of the site. DRO in this area was removed to the greatest extent practicable without damaging structures or utilities but, due to its highly weathered nature, remaining DRO is not expected to pose a risk to indoor air quality, future site workers or visitors.

Following completion of the RI, only five structures are suspected to have debris beneath the building foundation. To investigate the unlikely possibility that debris remaining under structures might present an unacceptable risk, the Army tasked the Corps of Engineers to execute a highly complex engineered excavation project to remove debris from beneath Building 49L. Debris was encountered between 7 and 11 feet below ground surface and extended 15 feet beneath the garage foundation. Materials removed from the excavation included 42 crushed and empty drums; 3 drums containing water with a sheen, and 3 yd^3 of grease-affected soil. The excavation continued vertically and horizontally until the natural soil horizon or uncontaminated soil was reached. Results of this investigation provide additional support that metal debris at this site is not necessarily correlated with contamination.

The risk assessment was based on the location and amount of residual contamination remaining after the RI investigation. Risk calculations considered the toxicity of each contaminant, the current and potential future uses of the site, and the pathways by which people could be exposed to contaminants. The risk assessment used a highly conservative approach which calculated risk using the highest sample results of each contaminant from across the site and assumed that future residents would be regularly exposed to all of these contaminants over a 30-year period. The results indicate that, under the reasonably anticipated future use scenario, the cumulative multimedia hazard index for non-carcinogenic chemicals due to exposure to soil, vapor intrusion and use of the post water supply is 0.5, which is below EPA and ADEC threshold value of 1. Results of the cumulative excess lifetime cancer risk are within the EPA's acceptable risk of 1 in 10,000 to 1 in 100,000 and below the ADEC risk threshold of 1 in 100,000. This shows there is no unacceptable risk to residents who use the Post drinking water supply wells and do not come into contact with subsurface soil. It is important to note that potential risks due to vapor intrusion were negligible, and the primary contributors to calculated risk estimates were removed during post-RI construction support activities. Consequently, the risk estimates provided in the Proposed Plan (as taken from the risk assessment) actually overestimate risk.

The Risk Assessments and related data are available within the *December 2010 Final Remedial Investigation, FWA 102, Former Communications Site, Fort Wainwright, Alaska* report and the *Final Feasibility Study Former Communications Site, Fort Wainwright, Alaska, July 2011 Revision*. The Army also has all of the follow-on documentation and datasets available online if ATSDR would like to see them again.

The Army has carefully considered ATSDR's two major recommendations for the site: (1) measures to prevent possible exposures to hazardous air pollutants in homes that may be constructed over containers of hazardous materials in the subsurface; and (2) continued and additional precautionary sampling and monitoring. Specific responses area as follows:

Installation of sub-slab depressurization (1) was carefully considered during the Remedial Investigation/Feasibility Study (RI/FS) phase of the work, but based on the results of the RI/FS, the Army, EPA, and ADEC concluded that there is no unacceptable risk from sub-slab soil-gas and no additional remedies were necessary. Based on the results of all the investigations, there is no reason to install sub-slab depressurization units under each building duplex.

To address ATSDR's comment (2) a: the Army is statutorily required to periodically review the effectiveness of all implemented remedies. If site conditions change substantially, due to construction activities or natural disasters like earthquakes (as mentioned in the review) the Army will take appropriate action to ensure the safety of occupants in all of the housing areas on Post. Please note that construction and landscaping at this development is nearly complete. The only remaining task is installation of cable TV lines in the housing area. The installation contractor will use a special trenching tool to install these lines 3 to 4 inches below the existing surface, and the cable lines will be covered with the original surface material (i.e. gravel, concrete, or asphalt). This utility installation will not significantly alter site conditions.

In comment (2b), the ATSDR recommended that semi-volatile organic compounds (SVOCs) and 1,2-dibromo-3-chloropropane (DBCP) be added to the target analyte list. The method selected for indoor air and soil gas analysis at this site (EPA TO-15) includes analysis for DBCP. Although DBCP was detected at a low concentration in one sample collected during the October 2008 RI vapor intrusion evaluation, additional samples collected on March 9 and 10, 2009 were submitted to two different laboratories for analysis and DBCP was not detected in any of the samples. Given that this chemical was used for commercial agricultural and manufacturing purposes, it is highly unlikely that it was ever used at the Former Communications Site. Additionally, no SVOCs are present at this site above human health-based cleanup levels. The current list of analytes, and the analytical method selected for continued monitoring, was developed in consultation with the EPA and ADEC and the Army believes it is sufficient and capable of producing the necessary data to protect human health.

Comments (2)c through (2)f recommends a more aggressive sub-slab soil-gas sampling schedule than the schedule presented in the Proposed Plan. Please be assured that the current protocols and locations of the sampling ports were established in cooperation with the EPA and ADEC. The current plan will establish a post-construction baseline for the chemicals of potential concern at every unit (comment 2f), account for spatial variability (2d), account for seasonal variations (2e) and focus on the areas in close proximity to the ground water plumes, and where previous sampling results were greater than the project screening levels, but less than applicable clean-up levels. There are four sampling events scheduled in the first year, and the initial sampling event as stated in the Proposed Plan will include sample collection at (item 2 c) each of 109 residential units. Note that the void under Building 49L caused by the investigation was completely filled with expanding concrete so sub-slab sampling at this residential unit is not possible.

The Army appreciates the fact that utility lines may sometimes provide preferential flow-paths for vapor migration (ATSDR comment [2f]), however, the Garrison believes that the current strategy to sample sub-slab vapor provides the most conservative means to assess vapor intrusion into residential units. Additional sampling of utility lines will not provide the Army with information that can be directly applied to vapor intrusion within any single residential unit. As described in detail in the RI and post-RI reports, all contaminated soil has been removed to the greatest extent practicable. Concentrations of residual volatile contaminants remaining in the subsurface between 5 and 15 feet below ground surface do not exceed human health-based cleanup levels; instead, these chemicals of concern are identified as such only because they are present at concentrations that potentially threaten groundwater quality. DRO is the only COC that remains above human health-based cleanup levels.

Again, the Army sincerely appreciates ATSDR's thoughtful and helpful review of the Proposed Plan, and the recommendations provided. Should you wish further information or clarification of Fort Wainwright's comments, please contact my POC for this effort, Mr. Joe Malen, at 907-361-4512 or email him @ joseph.s.malen@mail.mil.

Sincerely,

Clifford A. Seibel
Chief, Environmental Resources Division
FWA Public Works