2013 REPORT - FINAL

Environmental Monitoring at Sites LF005, ST001, LF010(SS014)
Big Mountain Long Radio Relay Station, Alaska

May 2014

Prepared for:

AFCEC/OLAR
JBER, ALASKA

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LIST OF ACRONYMS

611TH .... Air Force 611th Air Support Group
AAC............... Alaska Administrative Code
ADCCED....... Alaska Department of Commerce, Community and Economic Development
ADEC .... Alaska Department of Environmental Conservation
AFCEC/OLAR Civil Engineer Center, Operating Location Alaska Remote
ARAR .... Applicable or Relevant and Appropriate Requirements
ATV .... all-terrain vehicle
bgs .... below ground surface
BLM............... Bureau of Land Management
BTEX............. benzene, toluene, ethylbenzene, and xylenes
CERCLA........ Comprehensive Environmental Response and Compensation Liability Act
CES/CEAR.... Civil Engineer Squadron/Asset Management Flight Restoration Element
CFR............... Code of Federal Regulations
COPC............ Contaminant of Potential Concern
cy................... cubic yards
DO................. dissolved oxygen
DRO .... diesel range organics
Emerald......... Emerald Services, Inc.
EPA............... Environmental Protection Agency
F° .... Fahrenheit
FS.................. Feasibility Study
FSP .... Field Sampling Plan
GCL............... Groundwater Cleanup Level
GRO .... gasoline range organics
HCL .... Hydrochloric acid
HSP............... Health and Safety Plan
IDW .... Investigative derived waste
IRA .... Interim Remedial Activities
LOQ............... Limit of Quantitation
LTM............... Long Term Monitoring
LUC............... Land Use Controls
mg/Kg............ milligrams per kilogram
mg/L .... milligrams per liter
mL .... milliliters
mph .... miles per hour
MeOH............ Methanol
MNA .... Monitored Natural Attenuation
MS................. Matrix Spike

MSD .... Matrix Spike Duplicate
msl................. mean sea level
NCP............... National Contingency Plan
NOAA............ National Oceanographic and Atmospheric Administration
ORP .... Oxygen reduction potential
PAH............... Polycyclic aromatic hydrocarbons
PA/SI .... Preliminary Assessment/Site Investigation
PCB............... Polychlorinated Biphenyls
PEL .... Probable Effect Levels
POL............... Petroleum, oil and lubricants
PPE............... personal protective equipment
QA................. Quality Assurance
QAPP .... Quality Assurance Project Plan
QC................. Quality Control
RA .... Remedial Action
RI................... Remedial Investigation
ROD .... Record of Decision
RRS............... Radio Relay Station
SAP............... Sampling and Analysis Plan
SARA .... Superfund Amendment and Reauthorization Act
SCL .... Soil cleanup levels
SHPO............ Site Historic Preservation Officer
SQuiRT .... Screening Quick Reference Tables
SVOC............ Semi-volatile Organic Compounds
TAH............... Total Aromatic Hydrocarbons
TAqH............. Total Aqueous Hydrocarbons
TEL................ Threshold Effect Levels
USACE.......... United States Army Corps of Engineers
USAF............. Unites States Air Force
USF&WS....... United States Fish and Wildlife Service
VOC .... Volatile Organic Compound
WACS .... White Alice Communication System
WP .... Well point
WRCC........... Western Region Climate Center
YSI .... YSI 556 Water Quality Meter

1. INTRODUCTION

This report details the environmental services conducted in August 2013 in support of the Long Term Monitoring (LTM) program at the Big Mountain Radio Relay Station (RRS), Alaska. This report has been prepared for the Air Force Civil Engineer Center, Operating Location Alaska Remote (AFCEC/OLAR) under the U.S. Army Corps of Engineers (USACE), Alaska District Environmental Remediation Services Contract No. W911KB-13-C-0009 and in accordance with the requirements outlined in the Statement of Work.

The project field activities consisted of the inspection of two landfill caps and the collection of environmental analytical samples at two active monitoring sites within the installation. All field activities as well as handling and analysis of environmental samples were conducted in accordance with the procedures outlined in the project work plan, dated July 22, 2013.

1.1. Installation Location and Demographics

The Big Mountain RRS (herein also referred to as “the installation”) is located approximately 220 miles southwest of Anchorage on the south shore of the Iliamna Lake (Figure 1). The nearest community, the village of Kokhanok, is located approximately 16 miles to the east of Big Mountain. Additional communities in the region and situated along Iliamna Lake include the villages of Iliamna, New Halen, Pedro Bay, Nondalton and Igiugig.

The RRS installation was constructed by the United States Air Force (USAF) in 1956 as part of the White Alice Communication System (WACS). It was operated as a tropospheric scatter station for the WACS from 1957 until decommissioning in 1979. The installation originally consisted of approximately 402 acres separated into three distinct land parcels connected by gravel roads. The three parcels were referred to as the Lower Camp area (52 feet above mean seal level [msl]), located near the airstrip, the Upper Camp area (2,150 feet above msl) at the summit of Big Mountain and the Barge Landing site in Reindeer Bay on Iliamna Lake. Ownership of the Barge Landing site has since been transferred to the University of Alaska. The State of Alaska owns and maintains all lands surrounding the two camp areas.

The site is accessible by air via the 4,000-foot long airstrip at the Lower Camp area and by barge landing on Iliamna Lake. It can also be accessed via all-terrain vehicle (ATV) trails during the summer months and snow machines during the winter. A 2.5 mile gravel road, passable by four wheel drive vehicles connects the Upper and Lower Camp areas (Figure 2), (USAF, 2009).

During the facility operations, the Lower Camp installation consisted of the gravel airstrip, operation support facilities and living quarters for site personnel. The Upper Camp consisted of an antennae array for the WACS system, support facilities and personnel living quarters.

While in operation, various hazardous and potentially hazardous substances were used or stored on site. The substances stored and used at the installation included diesel fuel and gasoline, oils, antifreeze, solvents, lead-acid and nickel-cadmium batteries, asbestos and polychlorinated biphenyls (PCB) (in electrical transformers) (USAF, 2009). When the installation was decommissioned in 1979, the facility was closed down and abandoned (USAF, 2009).

During the operation of the RRS, releases of various contaminants are known to have occurred at the installation facilities. Several environmental investigations in the late 1990s and early 2000s were conducted to investigate the installation for the following environmental concerns:

- Petroleum, oil and lubricant (POL) releases from leaks and spills on storage tanks and transfer stations.
- Releases of oil containing PCBs and possibly solvents from electronic system maintenance operations.
- Potential releases of waste motor oil and cleaning solvents generated during power plant and vehicle maintenance activities.
- Potential leaching of hazardous substances from a former landfill (LF005) where various camp generated and construction waste was disposed.
- Potential releases from insufficient storage of paints used on buildings and equipment.
- Potential residual pesticide contamination from the use of insect sprays in the 1950s to mitigate populations of biting insects.
- Potential releases of various other liquids and powders utilized during the installation operations.

1.2. Project Objective

The LTM program was instituted at the facility to meet the requirements of the Comprehensive Environmental Restoration Compensation and Liability Act (CERCLA) and the National Contingency Plan (NCP). The objective of the program was to track the reduction of lingering contamination at the impacted sites, while also preventing any releases of contaminants to the undisturbed surrounding areas.

1.3. Scope of Work

The August 2013 field activities consisted of the inspection of two landfill caps and the collection of groundwater, surface water and sediment samples. The environmental monitoring effort was conducted to ensure that the institutional and engineering controls established in the LTM program remain effective and sufficient at meeting the project objective. The scope of work outlined in the project work plan and approved by the Alaska Department of Environmental Conservation (ADEC) was conducted as follows:

- Mobilize field personnel, monitoring equipment and sample containers to the site from Igiugig, Alaska across Iliamna Lake via a transport vessel;

- Transport equipment to the site from the Barge Landing area in Reindeer Bay on Iliamna Lake using gasoline powered ATVs and diesel powered pickup truck;
- Inspect the condition of the landfill caps at sites LF005 and LF010 to ensure the containment of the caps remain effective;
- Collect groundwater samples from monitoring wells at LF005 and ST001 to evaluate the extent of contamination in the groundwater at each site;
- Collect surface water and sediment samples from sites LF005 and ST001 to evaluate and track the contaminants of concern present within and beneath the surface water bodies at the sites;
- Demobilize from the site, removing all investigative derived waste (IDW) along with analytical samples and field equipment;
- Submit the samples to an ADEC-approved laboratory for analysis of the contaminants of concern;
- Draft an environmental monitoring report for review and approval by ADEC.

Deviations from the scope of work or other procedures described in the work plan are addressed in this project report.

1.4. Regulatory Framework

Cleanup of the installation is being conducted in accordance with the CERCLA as amended by the Superfund Amendment and Reauthorization Act (SARA) of 1986, the NCP and Alaska state law. In accordance with the CERCLA process, the USAF was identified as the responsible party and is the lead cleanup agency. ADEC oversees the cleanup effort on behalf of the State to ensure that remediation objectives are consistent with the State of Alaska cleanup standards for soil, groundwater and surface water.

The project work plan stated that the sediment sample results would be evaluated against the ADEC soil cleanup levels listed on Tables B1 and B2 of 18 AAC 75.340. However, additional review of the 2011 Final Record of Decision indicated that the screening criteria for the sediment samples was established using the National Oceanographic and Atmospheric Administration (NOAA) Screening Quick Reference Tables (SQuiRTs) threshold and probable effects levels (TEL and PEL) for freshwater sediments. Use of the SQuiRTs TELs and PELs provides a more conservative screening criterion for the installation.

Figure 1 – Site Location Map

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Figure 2 – Site Vicinity Map

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2. ENVIRONMENTAL SETTING

The Big Mountain RRS camp areas are situated at the top and along the western slope of Big Mountain. Big Mountain is an over 2,000 foot tall formation bordered to the north and west by Lake Iliamna at the north end of the Alaska Peninsula in western Alaska.

2.1. Geology

The majority of the bedrock in the Big Mountain area is of volcanic origin including formations of basalt, andesite, tuff and volcanic conglomerate. The terrain of the region consists of low elevation (generally <2500 feet amsl) mountains and rolling hills that were carved during the last Pleistocene glaciations.

At the upper elevations of Big Mountain, the bedrock extends to the surface or is overlain by a layer (generally less than 20 feet thick) of unconsolidated material, including poorly sorted glacial sediments and morainal deposits. Thin layers of unconsolidated volcanic gravel, created by glacial grating on the exposed bedrock, are common in the mountainous terrain of the area. The surface soil at the Upper Camp area, at the top of the mountain, is thin or non-existent with areas of exposed bedrock (USAF, 2011a).

In the lower elevations and drainage basins, glacial sediments have been reworked and distributed in broad alluvial outwash plains, which can cover many square miles. The alluvial stratigraphy consists of inter-stratified sand and gravel interspersed with silt and fine sand layers. Based on previous environmental investigations, soil data gathered at the Lower Camp area indicate that much of the native soils in this area consist of 5 percent to 50 percent silt with variable amounts of organic material. Some poorly drained lowland areas contain a dark loamy soil that is highly acidic with a high organic material content. The loamy soil also has been found to contain elevated levels of naturally occurring arsenic. Much of the surface material at the Lower Camp facilities is imported fill taken from local gravel pit sources (USAF, 2011a).

2.2. Groundwater Hydrology

Several groundwater monitoring points have been installed at the RRS installation for environmental investigation and monitoring. Permanent and temporary wells, as well as drive-point wells have been installed at both camp areas.

During a Remedial Investigation of the site in 1998, groundwater was encountered at the Lower Camp area at depths ranging from 1.5 to 11 feet below ground surface (bgs). Based on groundwater elevation data recorded during a recent monitoring effort in 2009, the groundwater at the Lower Camp area was reported to flow to the north, northwest. (USAF, 2009).

When the RRS installation was in operation, potable and firefighting water at the Upper Camp area was supplied by a well at the Water Supply Facility located in the former Building 1004 (USAF, 2009). The 232 foot deep well was abandoned in 2004 in conjunction with the Clean Sweep removal effort (USAF, 2011b). During previous characterizations at the Upper Camp area isolated pockets of a perched aquifer were encountered within depressions of the bedrock. Further investigation determined that the aquifer was limited and discontinuous and thus, not an adequate groundwater source. As a result, a 2008 Air Force Record of Decision (ROD) concluded that groundwater was not present at the Upper Camp area. Therefore, the migration to groundwater pathway at the Upper Camp was determined to be incomplete (USAF, 2011a).

2.3. Surface Water Hydrology

Surface water is abundant in the Big Mountain area. Several creeks and small rivers are present in valleys and basins on the mountain transporting precipitation runoff and snow melt towards the Iliamna Lake drainage. Discontinuous permafrost in low-lying areas creates poorly integrated stream patterns, isolated wetlands, and numerous tundra lakes, streams and bogs.

Iliamna Lake is 2 miles north and west of Big Mountain and is the regional discharge basin for area surface water drainage. Belinda Creek is the largest drainage in the Big Mountain RRS area. The creek passes approximately 3 miles southwest of the Lower Camp area and discharges into Iliamna Lake at Reindeer Bay.

A small unnamed drainage north of the airstrip at the Lower Camp area collects surface water from the Lower Camp area and part of the Upper Camp area. Beaver dams built on this drainage, near the land fill area LF005, have created impoundments restricting water flow, creating several large ponds and marshy areas.

The Upper Camp area is situated on the summit of Big Mountain. Surface water drainage at the camp flows intermittently and radially into one of several ephemeral streams draining down from the peak. Water draining from the north side of Big Mountain drains directly into Iliamna Lake at the base of the mountain. Surface water draining from the west and south of the Upper Camp area drains south and southeast toward the Belinda Creek drainage (USAF, 2011a).

2.4. Wetlands

The National Wetlands Inventory has not mapped the Big Mountain area. However, it is estimated that several wetlands of potentially high-value (i.e., provide wildlife habitat, flood control, water quality preservation) are located within a 4-mile radius of the RRS installation. Poorly integrated drainage due to the presence of discontinuous permafrost in low-lying areas and diverted water flows by beaver dams have created numerous isolated wetland areas on the mountain. No wetland areas have been observed in vicinity of the Upper Camp area at the summit of Big Mountain (USAF 2011a).

2.5. Climate

The Iliamna Lake region exhibits a continental climate typical of the interior of Alaska. The climate is characterized by extreme seasonal variations in temperature and low amounts of precipitation. The nearest location to the RRS installation with recorded historical weather data is the village of Iliamna, 30 miles northwest of the Big Mountain.

According to the climate history as reported by the Western Region Climate Center (WRCC) the average summer temperatures in the region range from 42 degrees Fahrenheit (°F) to 62 °F and average winter temperatures range from 10 °F to 29 °F. Temperature extremes for Iliamna are a maximum of 76 °F in the summer and a minimum of -18 °F in the winter (WRCC, 2013).

The highest periods of precipitation occurs between July and October with accumulation totals ranging between 2.5 to 4.5 inches per month. The wettest months are August and September with average precipitation rates of over 4 inches per month. The remainder of the year, from November through June, the precipitation totals average less than 2 inches per month. Snowfall and subfreezing temperatures typically occur between November and March. The total annual precipitation levels in Iliamna average 26 inches of precipitation and 60 inches of snow (WRCC, 2013).

Wind data gathered at Iliamna, which is situated with a similar exposure to Iliamna Lake as Big Mountain, shows average daily wind speeds recorded between June and September to exceed 30 miles per hour (mph) approximately 63 percent of the time. Similar wind conditions are expected at the Big Mountain RRS.

Fog may create low visibility conditions for the Upper Camp area at the summit of Big Mountain. Weather data recorded at the Upper Camp has indicated that fog is prevalent in the summer, occurring about 15 percent of the time between July and August, while only five percent of the time the rest of the year (USAF, 2009).

2.6. Ecology

2.6.1. Vegetation

The differing vegetation in vicinity of the two camp areas is mostly due to the topography and locations of each camp on the mountain. Big Mountain has an elevation of 2,160 feet above msl, which is above the tree line for the region. The rocky, windswept mountain slopes are dominated by mountain avens, heaths, low growing forbs, grasses, and sedges. In some areas, mosses from patchy to continuous mats on the rocky substrate.

On the well-drained mountain slopes, particularly along stream banks and drainages, taller scrub plant species have established at and above the tree line. Sitka alder and feltleaf willow grow to a height of about 6 feet and dominate these microhabitats. Low shrubs and understory herbaceous layers are common in the more open alder-willow strands.

Below the tree line, mixed alder and willow communities populate the Lower Camp area. South of the runway, the vegetation is primarily mixed forest communities dominated by white spruce, paper birch and balsam poplar. Dense strands of low shrubs and herbaceous ground cover characterize the understory growth in this area. Sedge-moss bog meadows can be found in depressions within the forest communities, and marshy wetland areas along impounded drainages.

2.6.2. Wildlife

Most wildlife common to interior or southwestern Alaska is found in the Big Mountain area. The Iliamna Lake drainage is important habitat for waterfowl and resident and migratory birds. The region is located on the migratory route of approximately 370,000 duck and geese species and 12,000 tundra swans.

Over 130 bird species have been observed in the Big Mountain RRS area. Bird species sighted during previous environmental work at the installation have included snow bunting, golden crowned sparrow, Wilson's warbler, orange-crowned warbler, hermit thrush, gray jay and raven. Game birds such as spruce grouse and ptarmigan have also been observed at the site.

Herbivorous mammals common in the Big Mountain area include moose, caribou, marmots, ground squirrels, voles and lemmings. Beavers have inhabited several ponds at the Lower Camp area. Mammalian predator species such as brown bear, foxes and wolves are also known to frequent the area.

The regional network of rivers, streams, and lakes in the Iliamna Lake drainage contribute to a vital subsistence and sport fishing resource to Alaska and the local economies. The Bristol Bay area is the largest producer of sockeye salmon in the world, and approximately two-thirds of the Bristol Bay harvest is produced from the Kvichak River drainage, which includes Iliamna Lake. The unnamed creek, which flows from the Lower Camp area into Belinda Creek, supports an anadromous Arctic char run that are harvested for subsistence at the lower portions of Belinda Creek (USAF, 2009).

The United States Fish and Wildlife Service (USFWS) haves identified 17 animal species in Alaska as threatened or endangered, and one plant species as endangered (USF&WS, 2009). During previous environmental investigations at the installation, none of these species have been observed in the area, nor are they known to inhabit the Iliamna Lake Region.

The Big Mountain area is not considered critical habitat for birds, mammals or fish due to lack of cover and preferred food sources for most of these animals. Nearby critical habitat areas include Iliamna Lake, the Katmai National Preserve (6 miles south of the airstrip at the Lower Camp area) and the Kvichak River (23 miles west of the installation and a major sockeye salmon route to Iliamna Lake) (USAF, 2011a).

2.7. Subsistence Activities

According to the Bureau of Land Management (BLM), subsistence can be defined as "hunting, fishing and gathering for the primary purpose of acquiring traditional food". Subsistence activities are a culture base and provide a sense of identity to the native people. Subsistence stores supply not only nutritional value, but are also used for clothing, tools and transportation. Cultural and family ties are preserved through obtaining, sharing and bartering such resources.

The Big Mountain RRS installation is not connected to any local communities by road. The nearest community is Kokhanok, located approximately 16 miles east of Big Mountain on the southern shore of Iliamna Lake. According to the Alaska Department of Commerce, Community and Economic Development (ADCCED) the community has a year round population of 170 (ADCCED, 2010). The village of Igiugig, with a population of 50, is located approximately 23 miles west of Big Mountain where the Kvichak River flows out of Iliamna Lake (ADCCED, 2010). The other communities in the region are Iliamna, (population 109), Pedro Bay (population 42), and Newhalen (population 190) (ADCCED, 2010).

Iliamna Lake community residents and outside sportsmen use the area around the lake and the Big Mountain RRS for occasional recreational and subsistence uses. Recreation activities include hunting, fishing, snow machining, and use of all-terrain vehicles (ATVs). Subsistence uses include hunting, fishing, berry picking, and other food harvest activities. About 3 miles down gradient from the installation, the lower portion of Belinda Creek is used for subsistence and sport fishing. Some Iliamna Lake community residents lived and herded reindeer at Reindeer Bay prior to the construction of the Big Mountain RRS (USAF, 2011a).

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3. SITE BACKGROUND

Since 1993, several environmental actions have been performed at the Big Mountain RRS installation. An administrative record for all of the work conducted at the site is maintained by AFCEC/OLAR. The previous studies and reports pertinent to the 2013 field effort are summarized below.

3.1. Previous Investigations

In 1993, a Preliminary Assessment/Site Investigation (PA/SI) was performed of the installation. Based on the investigation effort POL, lead and PCBs were identified as contaminants of concern at the site.

In 1996, an Environmental Assessment was performed of the installation (ENSR, 1996). The assessment was conducted to delineate known areas and investigate additional locations where PCB and POL concentrations in the soil exceeded ADEC Method Two cleanup levels established in Table B of 18 Alaska Administrative Code (AAC) Chapter 75 for Oil and Other Hazardous Substances Pollution Control (ADEC, 2012a).

In the late 1990s, the installation was selected for demolition as part of the Air Force's Clean Sweep Program. The Clean Sweep Program was initiated to identify facilities throughout Alaska, no longer deemed necessary, for removal and environmental cleanup. The program was instituted in accordance with a Memorandum of Agreement between the Air Force and the State Historic Preservation Officer (SHPO) in 1988 (USAF 2011).

In accordance with the Clean Sweep Program the installation's facilities and structures were surveyed, demolished and removed or placed in landfills from 2000 to 2005. Demolition debris was disposed of at a permitted construction and demolition (C&D) landfill located at the Lower Camp area east of the airstrip. All hazardous waste was shipped offsite for disposal.

In conjunction with the demolition effort, Remedial Investigations were conducted in 2001, 2003, and 2004 to characterize and define the remnant environmental contamination at the site. Based on the findings of the environmental investigations several sites were identified at the RRS installation. These sites are managed under the current LTM program, pertaining to the 2013 field effort are summarized below:

- **LF005; the former landfill**: The former landfill is located at the Lower Camp area adjacent to the unnamed creek. The landfill was reportedly closed when the installation was decommissioned in 1979. A total of nine monitoring wells have been installed at the site since 2004 to investigate groundwater conditions in the vicinity. In 2004, the landfill was capped with clean fill material and seeded with native vegetation. Based on reports of low levels of residual petroleum contamination following the 2004 investigation, a long term monitoring (LTM) program was approved for tracking the remnant contaminants in the groundwater, surface water and wetlands sediments at the site (USAF, 2009).

- **SS010a; the former Equipment and Power Building area**: The 7,200 square foot Equipment and Power Building at the Upper Camp area was used to store materials and equipment and four diesel generators for powering the facility. The building and associated structures were removed during the Clean Sweep activities in 2003 and 2004 (USAF, 2011).
- **SS010b: the former Septic Tank and Outfall area (Formerly SS009)**: The Upper Camp area septic system included the septic tank and an approximately 100 foot long 4-inch diameter outfall pipe located east of the camp access road (USAF, 2011).
- **SS014: the former Dual AST system**: The Dual AST system was located at the Upper Camp area west of the camp access road. The system was comprised of two 126,000-gallon ASTs and associated above- and below-ground piping within a bermed containment area. The ASTs reportedly were used for fuel oil storage while the installation was in operation (USAF, 2005).
- **ST001; the 42,400-Gallon Fuel Oil AST and Pipeline Service area**: The ST001 site, located in the Lower Camp area, consisted of a truck fill stand, a containment berm with an outflow pipe and a 600-foot long, 4-inch-diameter pipeline that extended east from an aboveground storage tank (AST) toward the camp access road. All of the structures and associated piping were removed from the installation by the 2004 Phase II Clean Sweep removal effort (USAF, 2011).

Several contaminated soil removal efforts were performed at the site during the mid to late-2000s. In 2005, the concrete pad at SS010a was removed and disposed of in the C&D landfill at the Lower Camp area, east of the airstrip. Following removal of the pad, PCB contaminated soil was excavated from the site as well as the SS010b area and shipped offsite for disposal. The excavation effort was intended to remove all of the PCB impacted soil from the two SS010 areas. However, confirmation samples collected following the removal, indicated that the PCB concentrations in the soil was still above ADEC soil cleanup levels (SCLs) at several locations; necessitating additional remediation of the two sites.

Also in 2005, soil impacted with POL contamination was excavated from several areas of concern, including ST001 and SS014, and placed in lined and bermed stockpiles. Following the excavation, confirmation sampling at SS014 indicated that the remedial objectives for that site had been accomplished and cleanup of that site was determined complete (USAF, 2005).

In 2006, the septic tank and associated aboveground piping at SS010b were removed and disposed of offsite (USAF 2011).

3.1.1. 2011 Feasibility Study

Following additional remedial efforts in the late 2000s, in 2011, the USAF completed a Feasibility Study (FS) addressing the status of the remnant contamination at the installation property. The findings of the study are summarized below:

- **LF005**: Previous investigations documented PCB contamination in the soil and sediment at the landfill. The groundwater in vicinity of the landfill was also found to be contaminated with benzene, toluene, ethylbenzene and total xylenes (BTEX) and polycyclic aromatic hydrocarbons (PAHs).
    1. The FS concluded that the BTEX and PAH concentrations in the groundwater were naturally attenuating. However, the continuation of the LTM program was determined necessary to ensure the contaminants were not migrating offsite.
    2. The FS also estimated approximately 350 cubic yards (cy) of PCB contaminated soil would need to be removed from the site. It was assumed that the remaining impacted soil and sediment would have low enough concentrations to manage onsite using Land Use Controls (LUC) and LTM (USAF 2011a).
- **SS010a**: Previous investigations documented the presence of PCB contamination in the soil at the SS010a area. The FS estimated that a total of approximately 2,150 cy of PCB contaminated soil would need to be excavated from the area (USAF 2011a).
- **SS010b**: The SS010b area had documented PCB contamination in the soil. The FS estimated that a total of approximately 420 cy of PCB contaminated soil would need to be excavated from the area (USAF 2011a).
- **ST001**: Previous investigations documented the presence of PCB contamination in the sediment and DRO contamination in the groundwater at the ST001 area. The 2011 FS reported that the DRO concentrations in the groundwater were naturally attenuating and that the remaining low level PCB contamination in the sediment would be addressed using LUC (USAF 2011a).

3.1.2. 2011/2012 Remedial Action

In 2011 and 2012, additional remedial actions were performed at LF005, SS010a/b, and ST001.The remedial efforts included

- The excavation and removal of PCB-contaminated soils from LF005 and SS010 sites a and b,
- The construction of an onsite ADEC-approved landfill
- The removal of PCB contaminated soil stockpiles constructed during previous environmental efforts
- The decommissioning of one groundwater monitoring well and three well points at the ST001 site, and
- The collection of confirmation samples to verify conditions following the excavation efforts.

Over 1,100 tons of soil with concentrations of PCB greater than 10.0 mg/Kg was excavated from LF005 and SS010a/b and transported offsite to the Waste Management Facility in Arlington, Oregon. Approximately 3,850 cubic yards of the soil excavated from the sites contained PCB concentrations between 1.0 mg/Kg and 10.0 mg/Kg. This soil was transferred to a newly designated landfill location (LF010) at the Upper Camp area. The new landfill, LF010, is located at the Upper Camp area (over the former SS014 site). The landfill was excavated to a depth of 10 feet bgs. The PCB-contaminated soil (transported in supersacks) was placed into the excavated area. The void spaces between the supersacks were filled in with clean fill material. The landfill was capped with a geosynthetic clay liner and approximately 2.5 feet of fill material. Signage was installed at the corners to alert visitors of the buried contaminated soil.

Following removal of the PCB-impacted soil from the sites, analytical samples were collected from each of the excavated areas to confirm the removal of the contamination. Analytical samples were also collected from various locations along the roadway between the Upper and Lower Camp areas to ensure that no further releases of contaminants occurred during the transportation efforts.

At the ST001 site, one monitoring well (MW-10) and three well points (well point [WP]-14, WP-15 and WP-16) were decommissioned during the 2011 field season. One well (MW-11) was left at the site for the purpose of continued long term monitoring. The decommissioned well materials were loaded in to supersacks for transportation to the Waste Management Facility in Arlington, Oregon. Signs were erected at the ST001 location to alert visitors of the residual PCB contamination in the area.

4. 2013 ENVIRONMENTAL MONITORING EFFORT

The project field crew mobilized to the RRS installation on August 12, 2013 to perform the environmental monitoring effort. A photograph log documenting site conditions and field efforts is included as Appendix A. Copies of the project field notes and groundwater monitoring forms are provided in Appendix B. All field data collection and monitoring was performed in accordance with the project Field Sampling Plan (FSP) in the work plan (USAF, 2013) and the DEC Draft Field Sampling Guidance (ADEC, 2010).

4.1. Site Mobilization and Reconnaissance

On August 12, the field crew departed from Igiugig, Alaska on board a chartered vessel for transportation across Lake Iliamna. The field team accessed the site from the Barge Landing area in Reindeer Bay to the west of the camp areas. Transportation along the gravel roads between the Barge Landing area and the installation sites was conducted using ATVs and a pickup truck. The ATV trails to the camp areas were noted to be in good condition. Other than minor brush clearing around some of the monitoring wells, all sample locations and investigation areas were easily accessible by field personnel. Various debris including pieces of metal, aluminum cans, drums and tires were observed in vicinity of several of the sample locations.

The field team demobilized from the site at the completion of the field effort on August 17, 2013. All field sampling equipment and generated waste were transported back to Igiugig or Anchorage for demobilization and proper disposal.

4.2. Landfill Cap Site Inspections

The landfill caps at the LF005 and LF010 sites (Figures 3 and 4 respectively) were inspected by the field crew to assess the condition of the containments and the engineering controls designed to restrict unauthorized access. Photographs taken during the landfill cap inspections are included in Appendix A. Field observations were documented in the field notes as shown in Appendix B.

4.3. Groundwater Monitoring

The field crew performed groundwater monitoring at the LF005 and ST001 sites as part of the ongoing LTM program at the installation. The monitoring well locations are shown on Figures 3 and 5 respectively.

4.3.1. LF005

Four groundwater wells; AP-01, MW-06, MW-09 and MW-10 were selected for sampling to monitor the condition of the contaminant plume at the landfill site (Figure 3). The groundwater samples collected at LF005 were analyzed for concentrations of volatile organic compounds (VOCs), PAHs, dissolved RCRA metals, and DRO.

Figure 3 - Area LF005 – Historical Groundwater, Surface water and Sediment Sampling Locations

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Figure 4 - Area LF010 (Former SS014) – Landfill Cap Inspection

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4.3.2. ST001

One groundwater well, MW-11, was left at the site (Figure 5) following the 2011/2012 effort to verify that contaminant concentrations continue to decline. The groundwater samples from the well were analyzed for VOCs, PAHs and DRO concentrations.

4.3.3. Water Quality Monitoring

Upon the commencement of the groundwater monitoring effort, the field team located the monitoring wells and documented the condition of the well casings and protective monuments. The wells were opened and inspected for indications of deterioration. In general, the monitoring wells were observed to be in good condition.

At the ST001 site, the casing at well MW-11 had been pushed upward by frost-jacking to the top of the well monument. The presence of the monument cover prevented further jacking of the casing. The raised well casing did not impact the purging of the well or the collection of analytical samples and no measurable drawdown was observed during the monitoring effort.

After locating the monitoring wells, the field team measured the depth to water in each well referenced to the north edge of the well casing using a water level indicator. Groundwater depth measurements were recorded on the individual well groundwater data sheets, which are included with the field notes in Appendix B.

The monitoring wells were purged in accordance with low-flow techniques outlined in the U.S. Environmental Protection Agency (EPA) guidance (EPA, 2010) and the ADEC *Draft Field Sampling Guidance* dated May 2010 (ADEC, 2010). With the exception of MW-09, the monitoring wells were purged using a peristaltic pump and dedicated polyethylene tubing. The groundwater was pumped from the wells through a flow-through cell connected to a YSI 556 meter (YSI) for measuring the water quality parameters. At well MW-09, the depth to groundwater, at 28.91 feet, was greater than the maximum pump lift limit of approximately 28 feet. As a result, the groundwater at MW-09 was purged and sampled using dedicated and disposable polyethylene bailers.

In accordance with low-flow sampling requirements, the wells were purged until four successive readings, collected 3-5 minutes apart, met the following stabilization criteria:

- ± 3% for temperature (minimum of ± 0.2 °C),
- ± 0.1 for pH,
- ± 3% for conductivity,
- ± 10 mv for redox potential, and
- ± 10% for DO

The groundwater quality measurements and field observations were documented on individual groundwater monitoring data sheets, included in Appendix B.

Figure 5 - Area ST001 – Historical Groundwater and Sediment Sampling Locations

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While purging the wells, the field team monitored the water level and adjusted the pumping rate in order to meet the drawdown requirement of less than 0.1 m. In general, the low flow purging was sufficient to minimize drawdown. The one exception was well MW-10, which purged dry due to poor recovery. After purging dry, the well was allowed sufficient time to recharge before analytical samples were collected.

4.3.4. Groundwater Sampling

Upon achieving stabilization of the water quality parameters, the field team collected analytical samples from the monitoring wells. Groundwater samples were collected into clean, laboratory-supplied jars, appropriately labeled, and immediately placed into coolers with gel ice. Groundwater samples collected from each area of concern were submitted for the following analyses:

- **LF005**
    1. VOCs using EPA Method SW 8260B,
    2. PAHs using EPA Method SW 8270D SIMs,
    3. DRO using Alaska (AK) Method AK102,
    4. RCRA Metals (dissolved) using EPA Method SW 6020, and
- **ST001**
    1. VOCs using EPA Method SW 8260B,
    2. PAHs using EPA Method SW 8270D SIMs,
    3. DRO using Alaska (AK) Method AK102, and

The analytical samples from each location were collected in the orders listed above to minimize the loss of volatiles for the VOC and semi-volatile organic compound (SVOC) analyses.

Samples collected for analysis of VOC compounds were collected into 40-milliliter (mL) VOA vials preserved with hydrochloric acid (HCL). The vials were filled completely to prevent volatilization. After filling, the containers were capped, turned over and tapped to verify no air bubbles were present. If air bubbles were observed, the containers were filled further and the inspection process repeated until no air was present.

Samples collected for PAHs, DRO and metals concentrations were collected into clean laboratory provided containers without preservative.

Field duplicates were collected at a frequency of 10% and matrix spike/matrix spike duplicates (MS/MSD) were collected at a frequency of 5%. Immediately following collection, the sample containers were placed into a cooler with sufficient gel ice to maintain a sample temperature of 4 degrees Celsius (°C) ± 2°C during transport to the laboratory under COC procedures.

4.4. Surface Water and Sediment Sampling

In accordance with the LTM program at the installation, the field team monitored the surface water at LF005 and the sediment at LF005 and ST001 to assess the condition of the remnant contamination at each site.

4.4.1. Surface Water Sampling

Five surface water samples were collected from locations at LF005 as shown on Figure 7. Samples were collected near the water's edge approximately 1 to 2 feet from the bank. Single use, dedicated polyethylene tubing was suspended into the water column with care taken to avoid disturbing the sediment and/or fouling the water. The tubing was deployed at approximately mid-depth of the surface water bodies to prevent intake of bottom sediments and ensure collection of samples representative of the water quality conditions. The surface water was drawn through the sample tubing using a peristaltic pump.

The surface water samples collected at the LF005 area were analyzed for the following analyses:

1. VOCs using EPA Method SW 8260B,
2. PAHs using EPA Method SW 8270D SIMs,
3. PCBs using EPA Method 8082A, and
4. Pesticides using EPA Method SW 8270D SIMs

The analytical samples from each location were collected in the order listed above to minimize the loss of volatiles for the VOC and SVOC analyses. The collection of the surface water samples was performed in accordance with the methods detailed above in the groundwater sampling section (4.3.4).

Field duplicates were collected at a frequency of 10% and matrix spike/matrix spike duplicates (MS/MSD) were collected at a frequency of 5%. Immediately following collection, the sample containers were placed into a cooler with sufficient gel ice to maintain a sample temperature of 4 degrees Celsius (°C) ± 2°C during transport to the laboratory under COC procedures.

4.4.2. Sediment Sampling

Sediment samples were collected at five locations at the LF005 area and two locations at the ST001 area. The sample locations for each area are shown in Figures 3 and 5 respectively. The field team collected the sediment samples, using a hand shovel and clean stainless steel sample scoops, from along the banks of the surface water. The field team collected the sediment samples from 0.5 to 1.0 feet bgs. The collected sediments were deposited into clean stainless steel bowls for field analysis and sample collection. Field personnel decontaminated the samplers, sampling spoons and bowls after each sample collection to prevent cross contamination between locations.

The sediment samples at each location were analyzed for the following analyses:

- **LF005**
    1. VOCs using EPA Method SW 8260B,
    2. PAHs using EPA Method SW 8270D SIMs,
    3. PCBs using EPA Method 8082A, and
    4. Pesticides using EPA Method SW 8270D SIMs
- **ST001**
    1. PCBs using EPA Method 8082A

For VOC samples, a minimum of 25 grams of soil was placed directly into tared 4-ounce (oz) jars with a Teflon®-lined septum fused to the lid. Immediately following collection, 25 milliliters (mL) of methanol preservative was added to the container to completely submerge (and preserve) the volatile soil sample. Soil collected for analysis of PAHs, PCBs and pesticides was placed into clean laboratory-provided sample jars without preservative.

Field duplicates were collected at a frequency of 10% and matrix spike/matrix spike duplicates (MS/MSD) were collected at a frequency of 5%. Immediately following collection, the sample containers were placed into a cooler with sufficient gel ice to maintain a sample temperature of 4 degrees Celsius (°C) ± 2°C during transport to the laboratory under COC procedures.

4.5. Deviations

As stated in the work plan, a total of 10 sediment and surface water samples at LF005 and 5 sediment samples were planned to be collected during the field effort. In addition, the work plan also called for the analysis of monitored natural attenuation (MNA) parameters in the groundwater samples from LF005 and ST001 to evaluate the natural attenuation conditions at the sites. However, due to budget limitations, the number of samples was reduced to 5 sediment and surface water samples at LF005 and 2 sediment samples at ST001 and the MNA parameters analysis was terminated.

The project work plan stated that the sediment sample results would be evaluated against the ADEC soil cleanup levels listed on Tables B1 and B2 of 18 AAC 75.340. However, additional review of the 2011 Final Record of Decision indicated that the screening criteria for the sediment samples was established using the National Oceanographic and Atmospheric Administration (NOAA) Screening Quick Reference Tables (SQuiRTs) threshold and probable effects levels (TEL and PEL) for freshwater sediments. Use of the SQuiRTs TELs and PELs provides a more conservative screening criterion for the installation.

4.6. Investigative Derived Waste

The investigative derived waste (IDW) generated during the field effort included purge water from groundwater sampling, field equipment decontamination water and spent sampling equipment.

An estimated 10 gallons of purge and decontamination water was generated during the field work. The purge and decontamination water was contained into 5-gallon buckets with lids and placed in secondary containment for transportation to Anchorage. The purge water was manifested as non-hazardous waste to Emerald Services, Inc. (Emerald) in Anchorage, Alaska for proper disposal. A copy of the non-hazardous waste manifest is included in Appendix C.

The remaining IDW, including personal protective equipment (PPE), disposable sampling equipment and various other solid wastes was bagged and transported offsite for disposal at the Igiugig municipal landfill.

5. APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

In accordance with the *2011 Final Record of Decision* (USAF, 2011a), chemical-specific applicable or relevant and appropriate requirements (ARARs) are used for comparison with the analytical monitoring results. ARARs are defined as follows (based on definitions provided in 40 Code of Federal Regulations [CFR] 300.5):

- *Applicable requirements* means those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at Big Mountain RRS.
- *Relevant and appropriate requirements* are cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting law that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at Big Mountain RRS, address problems or situations sufficiently similar to those found at Big Mountain RRS that their use is well suited.

ARARs can be in the form of regulations enforceable by law (federal, state, and/or local) or regulatory guidance. For the purposes of this work plan, ARARs are identified in terms of the specific media that will be sampled during planned field activities. Identified ARARs are explained in the following paragraphs. These identifications are considered formal as regulatory agency concurrence has been established through the Final Record of Decision document for this site (USAF, 2011a). It should be noted that Big Mountain RRS is not a "Superfund site" since it is not listed on the National Priorities List. Therefore, the formal identification of ARARs is not legally required. However, remediation of this site is being conducted using the Superfund program as a model.

5.1. Groundwater ARARs

Groundwater samples collected at the installation during the 2013 effort are compared to the groundwater cleanup levels presented in 18 AAC 75.345 - Table C (ADEC, 2012a). These regulations incorporate the ADEC Drinking Water Regulations in 18 AAC 80 (ADEC, 2012c).

5.2. Surface water and Sediment ARARs

Surface water samples collected during the 2013 effort are compared to the ADEC Water Quality Standards 18 AAC 70 (ADEC, 2012b) and the ADEC *Water Quality Criteria for Toxic and Other Deleterious Organic or Inorganic Substances* (ADEC, 2008). These water quality standards are dependent on the type of water and the use classification of the water body. Certain parameters are not addressed in 18 AAC 70 (e.g., GRO, DRO, and RRO); therefore, total aromatic hydrocarbons (TAH) and total aqueous hydrocarbons (TAqH) are used to assess surface water quality.

As stated in the Deviations Section, sediment samples collected during the 2013 field effort are compared against the NOAA SQuiRTs TELs and PELs for freshwater sediments.

6. RESULTS AND DISCUSSION

SGS Environmental Services, Inc., (SGS) in Anchorage, Alaska performed the analysis of the environmental samples collected at the site. The SGS laboratory meets all requirements for the ADEC and DOD Environmental Laboratory Accreditation Program (ELAP) as outlined in the project Quality Assurance Project Plan (QAPP). The SGS analytical report is included in Appendix D. The ADEC Laboratory Data Review Checklist for the analytical data package is included in Appendix D. Tables 6-1 through 6-10 below, present the results of the groundwater, surface water and sediment sampling along with the corresponding cleanup criteria for each analyzed media.

6.1. Landfill Inspection Results

At the time of the August field effort, nearly all of the signage marking the locations of the landfills at both sites was either damaged or missing. No signs were observed at the LF005 site. At LF010, two of the corner signs were missing, a third was disconnected and the fourth had been knocked over. The knocked over sign, at the northwest corner of the landfill, was repaired and the conditions of the remaining signs were documented in the field notes.

In general the landfill caps were observed to be in good condition. No indications of erosion, sink holes, debris or surface water ponding were observed at either site. In addition to the integrity inspections, the field team noted the progress of reestablishment of the native vegetation on the caps. At the time of the site visit, approximately 60 percent of the cap at LF005 had been revegetated by alders, willows, and grasses. The only area where the vegetation had not established was along the ATV trail traversing through the center of the landfill. No vegetation had yet established on the cap at the LF010 landfill, which had been constructed more recently following the 2011/2012 field efforts.

6.2. Groundwater Analytical Results

Analytical groundwater samples were collected from wells AP-01, MW-06, MW-09 and MW-10 at LF005 and from well MW-11 at ST001. The duplicate sample LF005-MW-20 was collected during the sampling of monitoring well MW-06. The following sections summarize the results of the sample analysis from the two sites.

6.2.1. Volatile Organic Compounds

A summary of the detected VOC concentrations is presented in Table 6-1. Complete VOC results are shown on Table 1 in the attached Tables section of this monitoring report.

Table 6-1. Groundwater Samples – Detected VOC Sample Results

Sample ID (13-BM-):		LF005-AP-01	LF005-MW-06	LF005-MW-20 (Dup)	LF005-MW-09	LF005-MW-10	ST001-MW-11
Location ID:		LF005-AP-01	LF005-MW-06		LF005-MW-09	LF005-MW-10	ST001-MW-11
Collect Date:		8/14/13	8/13/13	8/13/13	8/14/13	8/14/13	8/14/13
Collect Time:		14:35	14:20	14:30	12:05	15:16	11:10
Analytes	ADEC GW Cleanup Level	Results in ug/L					
1,1-Dichloroethene	7	**0.560J**	ND(0.620)	ND(0.620)	ND(0.620)	ND(0.620)	ND(0.620)
1,2,4-Trichlorobenzene	70	**1.23**	ND(0.620)	ND(0.620)	ND(0.620)	ND(0.620)	ND(0.620)
1,2,4-Trimethylbenzene	1800	**0.460J**	ND(0.620)	ND(0.620)	ND(0.620)	ND(0.620)	ND(0.620)
1,2-Dichlorobenzene	600	**5.96**	ND(0.620)	ND(0.620)	ND(0.620)	**2.38**	ND(0.620)
1,3-Dichlorobenzene	30 [1]	**120**	ND(0.620)	ND(0.620)	ND(0.620)	**11.6**	ND(0.620)
1,4-Dichlorobenzene	75	**108**	ND(0.300)	ND(0.300)	ND(0.300)	**21.6**	ND(0.300)
4-Isopropyltoluene		ND(0.620)	ND(0.620)	ND(0.620)	ND(0.620)	**0.570J**	ND(0.620)
Benzene	5	**1.51**	ND(0.240)	ND(0.240)	ND(0.240)	**0.260J**	ND(0.240)
Chlorobenzene	100	**64.7**	ND(0.300)	ND(0.300)	ND(0.300)	**17.3**	ND(0.300)
Chloromethane	66	**0.610J B**	**0.450J B**	**0.500J B**	**0.330J B**	**0.400J B**	**0.460J B**
cis-1,2-Dichloroethene	70	**156**	ND(0.620)	ND(0.620)	ND(0.620)	**12.8**	ND(0.620)
P & M -Xylene		**1.94J**	ND(1.24)	ND(1.24)	ND(1.24)	ND(1.24)	ND(1.24)
Toluene	1000	**0.370J**	ND(0.620)	ND(0.620)	ND(0.620)	ND(0.620)	ND(0.620)
trans-1,2-Dichloroethene	100	**1.06**	ND(0.620)	ND(0.620)	ND(0.620)	**0.460J**	ND(0.620)
Trichloroethene	5	ND(0.620)	ND(0.620)	ND(0.620)	ND(0.620)	**0.340J**	ND(0.620)
Xylenes (total)	10000	**1.94J**	ND(1.88)	ND(1.88)	ND(1.88)	ND(1.88)	ND(1.88)

Notes:
Bolded values indicated detected concentrations
Bolded, underlined and red values indicate concentrations exceed the ADEC Groundwater Cleanup Levels (GCLs) listed in Table C of 18 AAC 75.345.
ND(#) = Concentration not detected at the limit of detection (LOD)
ug/L = microgram per liter
J = Detected concentration is an estimated value because result is below the analytical limit of quantitation (LOQ)
[1] = Denotes more conservative cleanup level then the ADEC GCL in Table C of 18 AAC 75.345; established in the 2002 Decision Document.

LF005

Multiple VOC constituents were detected in two wells, AP-01 and MW-10 at the LF005 site. Well AP-01 was the only well where contaminant concentrations exceeded the ADEC groundwater cleanup levels (GCLs) listed in Table C of 18 AAC 75.345. Concentrations of 1,3-Dichlorobenzene (1,3-DCB), 1,4-Dichlorobenzene (1,4-DCB) and cis-1,2-Dichloroethene (cis-1,2-DCE) were reported above the respective GCLs at that location. The detected compounds have all been previously detected at the AP-01 well and are identified as contaminants of potential concern (COPC) at the LF005 site.

VOC impacts were not detected in wells MW-06 and MW-09.

ST001

VOC impacts were not detected in well MW-11. The VOC sample results for MW-11 are shown on Table 6-1.

6.2.2. Polynuclear Aromatic Hydrocarbons and Petroleum Hydrocarbons

A summary of the PAH analytical results for the monitoring wells at LF005 and ST001 is presented on Table 6-2. The DRO sample results are summarized below in Table 6-3.

Table 6-2: Groundwater Samples – PAH Sample Results

	Sample ID (13-BM-):	LF005-AP-01	LF005-MW-06	LF005-MW-20 (Dup)	LF005-MW-09	LF005-MW-10	ST001-MW-11
	Location ID:	LF005-AP-01	LF005-MW-06		LF005-MW-09	LF005-MW-10	ST001-MW-11
Analyte	ADEC GW Cleanup Level (ug/L)	Results in ug/L					
Acenaphthylene	2200	ND(0.0306)	ND(0.0352) UJ	ND(0.0352)	ND(0.0322)	ND(0.0330)	ND(0.0330)
Acenaphthene	2200	**0.0422J**	**0.0218 J**	**0.0298J**	ND(0.0322)	ND(0.0330)	ND(0.0330)
Fluorene	1500	ND(0.0306)	ND(0.0352) UJ	ND(0.0352)	ND(0.0322)	ND(0.0330)	ND(0.0330)
Phenanthrene	11000	ND(0.0306)	ND(0.0352) UJ	ND(0.0352)	ND(0.0322)	ND(0.0330)	ND(0.0330)
Anthracene	11000	ND(0.0306)	ND(0.0352) UJ	ND(0.0352)	ND(0.0322)	ND(0.0330)	ND(0.0330)
Fluoranthene	1500	ND(0.0306)	ND(0.0352) UJ	ND(0.0352)	ND(0.0322)	ND(0.0330)	ND(0.0330)
Pyrene	1100	ND(0.0306)	ND(0.0352) UJ	ND(0.0352)	ND(0.0322)	ND(0.0330)	ND(0.0330)
Benzo(a)Anthracene	1.2	ND(0.0306)	ND(0.0352) UJ	ND(0.0352)	ND(0.0322)	ND(0.0330)	ND(0.0330)
Chrysene	120	ND(0.0306)	ND(0.0352) UJ	ND(0.0352)	ND(0.0322)	ND(0.0330)	ND(0.0330)
Benzo[b]Fluoranthene	1.2	ND(0.0306)	ND(0.0352) UJ	ND(0.0352)	ND(0.0322)	ND(0.0330)	ND(0.0330)
Benzo[k]fluoranthene	12	ND(0.0306)	ND(0.0352) UJ	ND(0.0352)	ND(0.0322)	ND(0.0330)	ND(0.0330)
Benzo[a]pyrene	0.2	ND(0.0306)	ND(0.0352) UJ	ND(0.0352)	ND(0.0322)	ND(0.0330)	ND(0.0330)
Indeno[1,2,3-c,d] pyrene	1.2	ND(0.0306)	ND(0.0352) UJ	ND(0.0352)	ND(0.0322)	ND(0.0330)	ND(0.0330)
Naphthalene	730	**0.125**	**0.0752J M**	**0.101J**	ND(0.0666)	**0.0851J**	ND(0.0682)
1-Methylnaphthalene	150	**0.161**	**0.0359J M**	**0.0337J**	ND(0.0322)	**0.0430J**	**0.0218J**
Dibenzo[a,h]anthracene	0.12	ND(0.0306)	ND(0.0352) UJ	ND(0.0352)	ND(0.0322)	ND(0.0330)	ND(0.0330)
2-Methylnaphthalene	150	**0.0639**	**0.0249J M**	**0.0228J**	ND(0.0322)	**0.0288J**	ND(0.0330)
Benzo[g,h,i]perylene	1100	ND(0.0306)	ND(0.0352) UJ	ND(0.0352)	ND(0.0322)	ND(0.0330)	ND(0.0330)

Notes:

Bolded values indicated detected concentrations

Bolded, underlined and red values indicate concentrations exceed the ADEC Groundwater Cleanup Levels (GCLs) listed in Table C of 18 AAC 75.345.

ND(#) = Concentration not detected at the limit of detection (LOD)

ug/L = microgram per liter

J = Detected concentration is an estimated value because result is below the analytical limit of quantitation (LOQ)

UJ = Result is not detected and considered estimated due to quality control criteria not being met.

M = Result is an estimate because effects of the Matrix Spike were detected in the sample.

LF005

Concentrations of PAHs were detected in all wells at LF005, except for well MW-09 where all PAH compounds were non-detect. The PAH concentrations in wells AP-01, MW-06, and MW-10 were either several orders of magnitude below the respective ADEC GCLs (Acenapthene and Napthalene) or do not have an established cleanup criteria (1-Methlynapthalene and 2-Methylnapthalene).

DRO was detected in all four monitoring well locations. The results however, are considered estimates because the concentrations were reported above the detection limit, but below the limit of quantitation (LOQ). All DRO results were below the ADEC GCLs.

ST001

The compound 1-Methylnapthalene was the only PAH constituent detected in the sample from well MW-11. DRO was also detected in the well. However the results were reported as estimated values because the concentrations are below the analytical LOQs. All PAH and DRO results were below ADEC GCLs. DRO and PAH results are consistent with historical concentrations at MW-11.

Table 6-3: Groundwater Samples – DRO Sample Results

	Sample ID (13-BM-):	LF005-AP-01	LF005-MW-06	LF005-MW-20 (Dup)	LF005-MW-09	LF005-MW-10	ST001-MW-11
	Location ID:	LF005-AP-01	LF005-MW-06		LF005-MW-09	LF005-MW-10	ST001-MW-11
Analyte	ADEC GW Cleanup Level (mg/L)	Results (mg/L)					
Diesel Range Organics	1.5	**0.447J J**	**0.232J B**	**0.270J B**	**0.206J B**	**0.395J J**	**0.228J B**

Notes:

Bolded values indicated detected concentrations

Bolded, underlined and red values indicate concentrations exceed the ADEC Groundwater Cleanup Levels (GCLs) listed in Table C of 18 AAC 75.345.

ND(#) = Concentration not detected at the limit of detection (LOD)

ug/L = microgram per liter

J = Detected concentration is an estimated value because result is below the analytical limit of quantitation (LOQ)

6.2.3. Metals

The analytical results of the groundwater samples for metals concentrations are presented on Table 6-4.

LF005

The results of the metals analysis on the groundwater samples from LF005 are displayed on Table 6-4. All four wells contained detectable concentrations of metals in the groundwater. The detected metals included arsenic, barium, chromium and selenium. The arsenic concentration at AP-01 was the only reported result above the ADEC cleanup criteria. Arsenic was also detected in wells MW-06 and MW-10, but the reported results were below the ADEC GCL. Barium was reported in all four monitoring wells at LF005, but at concentrations at least two orders of magnitude below the cleanup level. Chromium and selenium were each only detected once and the concentrations were flagged as estimates because the results were reported below the LOQs.

ST001

The groundwater samples from MW-11 were not analyzed for metals concentrations.

Table 6-4: Groundwater Samples – Metals Sample Results

	Sample ID (13-BM-):	LF005-AP-01	LF005-MW-06	LF005-MW-20 (Dup)	LF005-MW-09	LF005-MW-10
	Location ID:	LF005-AP-01	LF005-MW-06		LF005-MW-09	LF005-MW-10
Analyte	ADEC GW Cleanup Level (ug/L)	Results in ug/L				
Arsenic	10	**<u>17.5</u>**	**3.11J**	**2.53J**	ND(3.00)	**8.22**
Barium	2000	**14.4**	**19.1**	**19.3**	**2.82J**	**25.9**
Cadmium	0.09	ND(1.20)	ND(1.20)	ND(1.20)	ND(1.20)	ND(1.20)
Chromium	100	ND(2.40)	ND(2.40)	ND(2.40)	**1.27J**	ND(2.40)
Lead	0.5	ND(0.620)	ND(0.620)	ND(0.620)	ND(0.620)	ND(0.620)
Selenium	5	ND(3.00)	**1.63J**	ND(3.00)	ND(3.00)	ND(3.00)
Silver	0.32	ND(1.24)	ND(1.24)	ND(1.24)	ND(1.24)	ND(1.24)
Mercury	0.5	ND(0.124)	ND(0.124)	ND(0.124)	ND(0.124)	ND(0.124)

Notes:
Bolded values indicated detected concentrations
<u>Bolded, underlined and red</u> values indicate concentrations exceed the ADEC Groundwater Cleanup Levels (GCLs) listed in Table C of 18 AAC 75.345.
ND(#) = Concentration not detected at the limit of detection (LOD)
ug/L = microgram per liter
J = Detected concentration is an estimated value because result is below the analytical limit of quantitation (LOQ)

6.2.4. Historical COPC Concentrations at LF005

Table 6-5 presents the historical monitoring results of the COPC concentrations in the wells at LF005. Based on the previous monitoring data, the results from the 2013 monitoring effort are generally consistent with historic levels. The AP-01 well has consistently reported the highest level of contamination at the site. Concentrations of arsenic, 1,3-DCB,1,4-DCB, cis-1,2-DCE and chlorobenzene have all been reported above cleanup levels at that location. Chlorobenzene was detected at AP-01 in 2013, but below the ADEC GCL. Of the remaining wells that were sampled at LF005, only MW-

06 had previously reported a COPC concentration (the detected arsenic concentration in 2009) above the cleanup criteria.

Table 6-5: Groundwater Samples – Historical Monitoring Well Results

Well	Analytes	Project Cleanup Level (µg/L)	1998 Analytical Results (µg/L)	2004 Analytical Results (µg/L)	2006 Analytical Results (µg/L)	2007 Analytical Results (µg/L)	2008 Analytical Results (µg/L)	2009 Analytical Results (µg/L)	2013 Analytical Results (µg/L)
AP-01	Arsenic	10	**42**	**13.8**	**22.6**	**17**	**15**	**17.6**	**17.5**
	1,3-DCB	30 [1]	ND	**33.7**	**65.7**	**121**	**85**	**140**	**120**
	1,4-DCB	75	ND	**35.5**	**67**	**201**	**100**	**190**	**108**
	Chlorobenzene	100	ND	**18.5**	**69.6**	**93.3**	**110**	**130**	**64.7**
	cis-1,2-DCE	5	ND	ND	**1.41**	**162**	**2.8**	**0.5**	**156**
MW-06	Arsenic	10	NS	2.80	ND	ND	**3.50**	**12.20**	**3.11J**
	1,3-DCB	3.0 [1]	NS	ND	ND	ND	**0.13**	**1**	ND
	1,4-DCB	75	NS	ND	ND	ND	**0.14**	**0.9**	ND
	Chlorobenzene	100	NS	ND	ND	ND	ND	**0.16**	ND
	cis-1,2-DCE	5	NS	ND	ND	ND	ND	**0.5**	ND
MW-09	Arsenic	10	NS	0.9	ND	ND	ND	NS	ND
	1,3-DCB	3.0 [1]	NS	ND	ND	ND	ND	NS	ND
	1,4-DCB	75	NS	ND	ND	ND	ND	NS	ND
	Chlorobenzene	100	NS	ND	ND	ND	ND	NS	ND
	cis-1,2-DCE	5	NS	ND	ND	ND	ND	NS	ND
MW-10	Arsenic	10	NS	NS	NS	NS	NS	NS	**8.22**
	1,3-DCB	3.0 [1]	NS	NS	NS	NS	NS	NS	**11.6**
	1,4-DCB	75	NS	NS	NS	NS	NS	NS	**21.6**
	Chlorobenzene	100	NS	NS	NS	NS	NS	NS	**17.3**
	cis-1,2-DCE	5	NS	NS	NS	NS	NS	NS	**12.8**

Notes:

Bolded values indicated detected concentrations

Bolded, underlined and red values indicate concentrations exceed the ADEC Groundwater Cleanup Levels (GCLs) listed in Table C of 18 AAC 75.345.

ND(#) = Concentration not detected at the limit of detection (LOD)

ug/L = microgram per liter

J = Detected concentration is an estimated value because result is below the analytical limit of quantitation (LOQ)

[1] = Denotes more conservative cleanup level then the ADEC GCL in Table C of 18 AAC 75.345; established in the 2002 Decision Document.

Figure 6 - Area LF005 – Results of Groundwater Monitoring for Contaminants of Potential Concern

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6.3. Surface Water Sample Results

LF005

Surface water samples were collected at five historical monitoring locations at the LF005 site. The sampling locations, as shown on Figure 3, consisted of SW-02, SW-03, SW-05, SW-09 and SW-10. The field duplicate sample LF005-SW-81 was collected from the SW-09 location.

The surface water samples from LF005 were analyzed for concentrations of VOCs, PAHs, PCBs and select pesticides (4,4'-DDD, 4,4'-DDT, and 4,4'-DDE). The surface water results were compared against the total aromatic hydrocarbons (TAH) and total aqueous hydrocarbons (TAqH) water quality standards listed in 18 AAC 70 and the ADEC *Water Quality Criteria for Toxic and Other Deleterious Organic or Inorganic Substances*. To compare the analytical results with the regulatory criteria, the BTEX results reported in the VOC analyses were totaled to calculate the TAH concentration for each location. Similarly, the detected BTEX and PAH concentrations were summed to calculate the TAqH concentration. The results of the TAH and TAqH analyses are presented in Table 6-6. The results for the complete VOC and PAH analyses are included in the Tables Section attached to this report.

As shown on Table 6-6, none of the analyzed constituents were detected in the groundwater samples. As a result, no monitoring location contained measurable TAH or TAqH concentrations.

Table 6-6: Surface Water Samples – TAH And TAqH Sample Results

Sample ID (13-BM-):		LF005-SW-02	LF005-SW-03	LF005-SW-05	LF005-SW-09	LF005-SW-081 (Dup)	LF005-SW-10
Location ID:		LF005-SW-02	LF005-SW-03	LF005-SW-05	LF005-SW-09		LF005-SW-10
Analytes	**ADEC Water Quality Standards**	**Results in (ug/L)**					
Benzene		ND(0.240)	ND(0.240)	ND(0.240)	ND(0.240)	ND(0.240)	ND(0.240)
Ethylbenzene		ND(0.620)	ND(0.620)	ND(0.620)	ND(0.620)	ND(0.620)	ND(0.620)
Toluene		ND(0.620)	ND(0.620)	ND(0.620)	ND(0.620)	ND(0.620)	ND(0.620)
Xylenes (total)		ND(1.88)	ND(1.88)	ND(1.88)	ND(1.88)	ND(1.88)	ND(1.88)
Total Aromatic Hydrocarbons	10	ND	ND	ND	ND	ND	ND
Acenaphthylene		ND(0.0316)	ND(0.0326)	ND(0.0326) UJ	ND(0.0326)	ND(0.0312)	ND(0.0306)
Acenaphthene		ND(0.0316)	ND(0.0326)	ND(0.0326) UJ	ND(0.0326)	ND(0.0312)	ND(0.0306)
Fluorene		ND(0.0316)	ND(0.0326)	ND(0.0326) UJ	ND(0.0326)	ND(0.0312)	ND(0.0306)
Phenanthrene		ND(0.0316)	ND(0.0326)	ND(0.0326) UJ	ND(0.0326)	ND(0.0312)	ND(0.0306)
Anthracene		ND(0.0316)	ND(0.0326)	ND(0.0326) UJ	ND(0.0326)	ND(0.0312)	ND(0.0306)
Fluoranthene		ND(0.0316)	ND(0.0326)	ND(0.0326) UJ	ND(0.0326)	ND(0.0312)	ND(0.0306)
Pyrene		ND(0.0316)	ND(0.0326)	ND(0.0326) UJ	ND(0.0326)	ND(0.0312)	ND(0.0306)
Benzo(a)Anthracene	.	ND(0.0316)	ND(0.0326)	ND(0.0326) UJ	ND(0.0326)	ND(0.0312)	ND(0.0306)
Chrysene		ND(0.0316)	ND(0.0326)	ND(0.0326) UJ	ND(0.0326)	ND(0.0312)	ND(0.0306)
Benzo[b]Fluoranthene		ND(0.0316)	ND(0.0326)	ND(0.0326) UJ	ND(0.0326)	ND(0.0312)	ND(0.0306)
Benzo[k]fluoranthene		ND(0.0316)	ND(0.0326)	ND(0.0326) UJ	ND(0.0326)	ND(0.0312)	ND(0.0306)
Benzo[a]pyrene		ND(0.0316)	ND(0.0326)	ND(0.0326) UJ	ND(0.0326)	ND(0.0312)	ND(0.0306)
Indeno[1,2,3-c,d] pyrene		ND(0.0316)	ND(0.0326)	ND(0.0326) UJ	ND(0.0326)	ND(0.0312)	ND(0.0306)
Naphthalene		ND(0.0652)	ND(0.0674)	ND(0.0674) UJ	ND(0.0674)	ND(0.0646)	ND(0.0632)
1-Methylnaphthalene		ND(0.0316)	ND(0.0326)	ND(0.0326) UJ	ND(0.0326)	ND(0.0312)	ND(0.0306)
Dibenzo[a,h]anthracene		ND(0.0316)	ND(0.0326)	ND(0.0326) UJ	ND(0.0326)	ND(0.0312)	ND(0.0306)
2-Methylnaphthalene		ND(0.0316)	ND(0.0326)	ND(0.0326) UJ	ND(0.0326)	ND(0.0312)	ND(0.0306)
Benzo[g,h,i]perylene		ND(0.0316)	ND(0.0326)	ND(0.0326) UJ	ND(0.0326)	ND(0.0312)	ND(0.0306)
Total Aqueous Hydrocarbons	15	ND	ND	ND	ND	ND	ND

Notes:

Bolded values indicated detected concentrations

Bolded, underlined and red values indicate concentrations exceed the ADEC Water Quality Standards for Petroleum Hydrocarbons, Oils, and Grease, for Fresh Water Bodies as outlined in 18 AAC 70.020.

ND(#) = Concentration not detected at the limit of detection (LOD)

ug/L = microgram per liter

J = Detected concentration is an estimated value because result is below the analytical limit of quantitation (LOQ)

UJ = Result is not detected and considered estimated due to quality control criteria not being met.

The PCBs and pesticides analytical results of the surface water samples are displayed on Table 6-7. Analysis of the samples collected in 2013 indicates that none of the contaminant compounds were present above detection limits at any of the surface water monitoring locations.

Table 6-7: Surface Water Samples – PCB And Pesticide Sample Results

	Sample ID (13-BM-):	LF005-SW-02	LF005-SW-03	LF005-SW-05	LF005-SW-09	LF005-SW-081 (Dup)	LF005-SW-10
	Location ID:	LF005-SW-02	LF005-SW-03	LF005-SW-05	LF005-SW-09		LF005-SW-10
Analyte	ADEC GW Cleanup Level (ug/L)	Results in ug/L					
PCBs							
Aroclor-1016		ND(0.0682)	ND(0.0666)	ND(0.0646)	ND(0.0674)	ND(0.0660)	ND(0.0656)
Aroclor-1221		ND(0.330)	ND(0.322)	ND(0.312)	ND(0.326)	ND(0.320)	ND(0.318)
Aroclor-1232		ND(0.0682)	ND(0.0666)	ND(0.0646)	ND(0.0674)	ND(0.0660)	ND(0.0656)
Aroclor-1242		ND(0.0682)	ND(0.0666)	ND(0.0646)	ND(0.0674)	ND(0.0660)	ND(0.0656)
Aroclor-1248		ND(0.0682)	ND(0.0666)	ND(0.0646)	ND(0.0674)	ND(0.0660)	ND(0.0656)
Aroclor-1254		ND(0.0682)	ND(0.0666)	ND(0.0646)	ND(0.0674)	ND(0.0660)	ND(0.0656)
Aroclor-1260		ND(0.0682)	ND(0.0666)	ND(0.0646)	ND(0.0674)	ND(0.0660)	ND(0.0656)
PCBs[1]	0.5	ND(0.3982)	ND(0.3886)	ND(0.3766)	ND(0.3934)	ND(0.386)	ND(0.3836)
Pesticides							
4,4'-DDE		ND(0.0208)	ND(0.0204)	ND(0.0202) UJ	ND(0.0202)	ND(0.0222)	ND(0.0188)
4,4'-DDD		ND(0.0208)	ND(0.0204)	ND(0.0202) UJ	ND(0.0202)	ND(0.0222)	ND(0.0188)
4,4'-DDT		ND(0.0208)	ND(0.0204)	ND(0.0202) UJ	ND(0.0202)	ND(0.0222)	ND(0.0188)

Notes:

Bolded values indicated detected concentrations

Bolded, underlined and red values indicate concentrations exceed the ADEC Water Quality Manual for Toxic and Other Deleterious Organic and Inorganic Substances.

ND(#) = Concentration not detected at the limit of detection (LOD)

ug/L = microgram per liter

J = Detected concentration is an estimated value because result is below the analytical limit of quantitation (LOQ)

UJ = Result is not detected and considered estimated due to quality control criteria not being met.

ST001

Surface water samples were not collected at the ST001 site.

6.4. Sediment Sample Results

The sediment samples were compared against the NOAA SQuiRTs for TELs and PELs. The sample results for VOC concentrations are displayed on Table 6-8. The ADEC soil cleanup levels listed in Tables B1 and B2 of 18 AAC 75.340 are included on Table 6-8 due to the limited established TEL and PEL screening criteria for VOCs in freshwater sediment. The PAH and pesticides results are presented on Table 6-9.

LF005

Sediment samples were collected at the same five historical monitoring locations as the surface water samples at the LF005 site (SD-02, SD-03, SD-05, SD-09 and SD-10). The sediment samples were analyzed for concentrations of VOCs, PAHs, PCBs and select pesticides (4,4’-DDD, 4,4’-DDT, and 4,4’-DDE). The duplicate sediment sample LF005-SD-20 was collected from the SD-09 sample location.

Concentrations of VOC compounds were not reported above the detection limits in any of the five samples from LF005.

Table 6-8: Sediment Samples – VOC Compounds Sample Results

		Sample ID (13-BM-):	LF005-SD-02	LF005-SD-03	LF005-SD-05	LF005-SD-09	LF005-SD-20 (Dup)	LF005-SD-10
		Location ID:	LF005-SD-02	LF005-SD-03	LF005-SD-05	LF005-SD-09		LF005-SD-10
Analyte	SQuiRTs TELs/PELs For Freshwater Sediment	ADEC Soil Migration to Groundwater Cleanup Level (mg/Kg)	Results in ug/Kg					
1,1,1,2-Tetrachloroethane		0.82	ND(70.8)	ND(78.4)	ND(33.8)	ND(66.0)	ND(48.0)	ND(18.1)
1,1,1-Trichloroethane			ND(70.8)	ND(78.4)	ND(33.8)	ND(66.0)	ND(48.0)	ND(18.1)
1,1,2,2-Tetrachloroethane		0.017	ND(136)	ND(151)	ND(64.8)	ND(127)	ND(92.4)	ND(34.8)
1,1,2-Trichloroethane		0.018	ND(70.8)	ND(78.4)	ND(33.8)	ND(66.0)	ND(48.0)	ND(18.1)
1,1-Dichloroethane		25	ND(70.8)	ND(78.4)	ND(33.8)	ND(66.0)	ND(48.0)	ND(18.1)
1,1-Dichloroethene		0.03	ND(70.8)	ND(78.4)	ND(33.8)	ND(66.0)	ND(48.0)	ND(18.1)
1,1-Dichloropropene			ND(70.8)	ND(78.4)	ND(33.8)	ND(66.0)	ND(48.0)	ND(18.1)
1,2,3-Trichlorobenzene			ND(136)	ND(151)	ND(64.8)	ND(127)	ND(92.4)	ND(34.8)
1,2,3-Trichloropropane		0.00053	ND(70.8)	ND(78.4)	ND(33.8)	ND(66.0)	ND(48.0)	ND(18.1)
1,2,4-Trichlorobenzene		0.85	ND(70.8)	ND(78.4)	ND(33.8)	ND(66.0)	ND(48.0)	ND(18.1)
1,2,4-Trimethylbenzene		23	ND(136)	ND(151)	ND(64.8)	ND(127)	ND(92.4)	ND(34.8)
1,2-Dibromo-3-chloropropane			ND(282)	ND(312)	ND(134)	ND(262)	ND(191)	ND(72.0)
1,2-Dibromoethane		0.00016	ND(70.8)	ND(78.4)	ND(33.8)	ND(66.0)	ND(48.0)	ND(18.1)
1,2-Dichlorobenzene		5.1	ND(70.8)	ND(78.4)	ND(33.8)	ND(66.0)	ND(48.0)	ND(18.1)
1,2-Dichloroethane		0.016	ND(70.8)	ND(78.4)	ND(33.8)	ND(66.0)	ND(48.0)	ND(18.1)
1,2-Dichloropropane		0.018	ND(70.8)	ND(78.4)	ND(33.8)	ND(66.0)	ND(48.0)	ND(18.1)
1,3-Dichloropropane			ND(70.8)	ND(78.4)	ND(33.8)	ND(66.0)	ND(48.0)	ND(18.1)
1,3,5-Trimethylbenzene		23	ND(70.8)	ND(78.4)	ND(33.8)	ND(66.0)	ND(48.0)	ND(18.1)
1,3-Dichlorobenzene		28	ND(70.8)	ND(78.4)	ND(33.8)	ND(66.0)	ND(48.0)	ND(18.1)
1,3-Dichloropropene		0.033	ND(70.8)	ND(78.4)	ND(33.8)	ND(66.0)	ND(48.0)	ND(18.1)
1,4-Dichlorobenzene		0.64	ND(70.8)	ND(78.4)	ND(33.8)	ND(66.0)	ND(48.0)	ND(18.1)
2,2-Dichloropropane			ND(70.8)	ND(78.4)	ND(33.8)	ND(66.0)	ND(48.0)	ND(18.1)
2-Butanone (MEK)		59	ND(708)	ND(784)	ND(338)	ND(660)	ND(480)	ND(181)
2-Chlorotoluene			ND(70.8)	ND(78.4)	ND(33.8)	ND(66.0)	ND(48.0)	ND(18.1)
2-Hexanone			ND(708)	ND(784)	ND(338)	ND(660)	ND(480)	ND(181)
4-Chlorotoluene			ND(70.8)	ND(78.4)	ND(33.8)	ND(66.0)	ND(48.0)	ND(18.1)
4-Isopropyltoluene			ND(70.8)	ND(78.4)	ND(33.8)	ND(66.0)	ND(48.0)	ND(18.1)
4-Methyl-2-pentanone (MIBK)			ND(708)	ND(784)	ND(338)	ND(660)	ND(480)	ND(181)
Benzene		0.025	ND(35.4)	ND(39.2)	ND(16.9)	ND(33.0)	ND(24.0)	ND(9.06)
Bromobenzene			ND(70.8)	ND(78.4)	ND(33.8)	ND(66.0)	ND(48.0)	ND(18.1)
Bromochloromethane			ND(70.8)	ND(78.4)	ND(33.8)	ND(66.0)	ND(48.0)	ND(18.1)
Bromodichloromethane		0.044	ND(70.8)	ND(78.4)	ND(33.8)	ND(66.0)	ND(48.0)	ND(18.1)
Bromoform		0.34	ND(70.8)	ND(78.4)	ND(33.8)	ND(66.0)	ND(48.0)	ND(18.1)
Bromomethane		0.16	ND(562)	ND(624)	ND(268)	ND(526)	ND(382)	ND(144)
Carbon disulfide		12	ND(282)	ND(312)	ND(134)	ND(262)	ND(191)	ND(72.0)
Carbon tetrachloride		0.023	ND(70.8)	ND(78.4)	ND(33.8)	ND(66.0)	ND(48.0)	ND(18.1)
Chlorobenzene		0.63	ND(70.8)	ND(78.4)	ND(33.8)	ND(66.0)	ND(48.0)	ND(18.1)

Chloroethane		580	ND(562)	ND(624)	ND(268)	ND(526)	ND(382)	ND(144)
Chloroform		0.46	ND(70.8)	ND(78.4)	ND(33.8)	ND(66.0)	ND(48.0)	ND(18.1)
Chloromethane		0.21	ND(70.8)	ND(78.4)	ND(33.8)	ND(66.0)	ND(48.0)	ND(18.1)
cis-1,2-Dichloroethene		0.24	ND(70.8)	ND(78.4)	ND(33.8)	ND(66.0)	ND(48.0)	ND(18.1)
cis-1,3-Dichloropropene			ND(70.8)	ND(78.4)	ND(33.8)	ND(66.0)	ND(48.0)	ND(18.1)
Dibromochloromethane			ND(70.8)	ND(78.4)	ND(33.8)	ND(66.0)	ND(48.0)	ND(18.1)
Dibromomethane		1.1	ND(70.8)	ND(78.4)	ND(33.8)	ND(66.0)	ND(48.0)	ND(18.1)
Dichlorodifluoromethane		0.032	ND(136)	ND(151)	ND(64.8)	ND(127)	ND(92.4)	ND(34.8)
Ethylbenzene		6.9	ND(70.8)	ND(78.4)	ND(33.8)	ND(66.0)	ND(48.0)	ND(18.1)
Hexachlorobutadiene		0.12	ND(136)	ND(151)	ND(64.8)	ND(127)	ND(92.4)	ND(34.8)
Isopropylbenzene (Cumene)		51	ND(70.8)	ND(78.4)	ND(33.8)	ND(66.0)	ND(48.0)	ND(18.1)
Methylene chloride		0.016	ND(282)	ND(312)	ND(134)	ND(262)	ND(191)	ND(72.0)
Methyl-t-butyl ether		1.3	ND(282)	ND(312)	ND(134)	ND(262)	ND(191)	ND(72.0)
Naphthalene	**34.6 /391**		ND(136)	ND(151)	ND(64.8)	ND(127)	ND(92.4)	ND(34.8)
n-Butylbenzene		15	ND(70.8)	ND(78.4)	ND(33.8)	ND(66.0)	ND(48.0)	ND(18.1)
n-Propylbenzene		15	ND(70.8)	ND(78.4)	ND(33.8)	ND(66.0)	ND(48.0)	ND(18.1)
o-Xylene			ND(70.8)	ND(78.4)	ND(33.8)	ND(66.0)	ND(48.0)	ND(18.1)
P & M –Xylene			ND(136)	ND(151)	ND(64.8)	ND(127)	ND(92.4)	ND(34.8)
sec-Butylbenzene		12	ND(70.8)	ND(78.4)	ND(33.8)	ND(66.0)	ND(48.0)	ND(18.1)
Styrene		0.96	ND(70.8)	ND(78.4)	ND(33.8)	ND(66.0)	ND(48.0)	ND(18.1)
tert-Butylbenzene		12	ND(70.8)	ND(78.4)	ND(33.8)	ND(66.0)	ND(48.0)	ND(18.1)
Tetrachloroethene		0.024	ND(35.4)	ND(39.2)	ND(16.9)	ND(33.0)	ND(24.0)	ND(9.06)
Toluene		6.5	ND(70.8)	ND(78.4)	ND(33.8)	ND(66.0)	ND(48.0)	ND(18.1)
trans-1,2-Dichloroethene		0.37	ND(70.8)	ND(78.4)	ND(33.8)	ND(66.0)	ND(48.0)	ND(18.1)
trans-1,3-Dichloropropene			ND(70.8)	ND(78.4)	ND(33.8)	ND(66.0)	ND(48.0)	ND(18.1)
Trichloroethene		0.020	ND(35.4)	ND(39.2)	ND(16.9)	ND(33.0)	ND(24.0)	ND(9.06)
Trichlorofluoromethane		86	ND(136)	ND(151)	ND(64.8)	ND(127)	ND(92.4)	ND(34.8)
Vinyl chloride		0.0085	ND(70.8)	ND(78.4)	ND(33.8)	ND(66.0)	ND(48.0)	ND(18.1)
Xylenes (total)		63	ND(282)	ND(312)	ND(134)	ND(262)	ND(191)	ND(72.0)

Notes:
Bolded values indicated detected concentrations
Bolded, underlined and red values indicate concentrations exceed the NOAA SQuiRTs TELs and/or PELs for freshwater sediments.
ND(#) = Concentration not detected at the limit of detection (LOD)
ug/L = microgram per liter
J = Detected concentration is an estimated value because result is below the analytical limit of quantitation (LOQ)
TEL – Threshold Effects Level
PEL – Probable Effects Level

The analytical results detected PAH concentrations at just one of the five sample locations. Concentrations of napthalene, 1-Methylnapthalene, and 2-Methylnapthalene were all detected at the SD-10 location. However, the concentrations, which were reported as estimated values, were all several orders of magnitude below the cleanup criteria. Pesticides concentrations were not detected in any of the sample locations at LF005.

The PCB results of the five samples at LF005 are presented below on Table 7-9. Only one PCB compound was detected in the sediment samples. Concentrations of the compound Aroclor-1260 were reported in each of the sample locations. The detected concentrations, which ranged from 27.2 µg/Kg to 372 µg/Kg, exceeded the SQuiRT TEL of 34.1 µg/Kg in all but two sample locations at the LF005 site (SD-05 and SD-10).

Table 6-9: Sediment Samples – PCB And Pesticide Compounds Sample Results

Sample ID (13-BM-):			LF005-SD-02	LF005-SD-03	LF005-SD-05	LF005-SD-09	LF005-SD-20 (Dup)	LF005-SD-10	ST001-SD-01	ST001-SD-02
Location ID:			LF005-SD-02	LF005-SD-03	LF005-SD-05	LF005-SD-09		LF005-SD-10	ST001-SD-01	ST001-SD-02
PCBs										
Analyte	TEL	PEL	Results in ug/Kg							
Aroclor-1016			ND(74.4)	ND(82.4)	ND(50.4)	ND(65.2)	ND(48.0)	ND(36.6)	ND(70.0)	ND(37.4)
Aroclor-1221			ND(74.4)	ND(82.4)	ND(50.4)	ND(65.2)	ND(48.0)	ND(36.6)	ND(70.0)	ND(37.4)
Aroclor-1232			ND(74.4)	ND(82.4)	ND(50.4)	ND(65.2)	ND(48.0)	ND(36.6)	ND(70.0)	ND(37.4)
Aroclor-1242			ND(74.4)	ND(82.4)	ND(50.4)	ND(65.2)	ND(48.0)	ND(36.6)	ND(70.0)	ND(37.4)
Aroclor-1248			ND(74.4)	ND(82.4)	ND(50.4)	ND(65.2)	ND(48.0)	ND(36.6)	ND(70.0)	ND(37.4)
Aroclor-1254			ND(74.4)	ND(82.4)	ND(50.4)	ND(65.2)	ND(48.0)	ND(36.6)	ND(70.0)	ND(37.4)
Aroclor-1260			**99.2J**	**202**	**29.8J**	**372 JD**	**139 JD**	**27.2J**	**46.7J**	**41.5J**
PCBs[1]	34.1	277	**99.2J**	**202**	**29.8J**	**372**	**139**	**27.2J**	**46.7J**	**41.5J**
Pesticides										
Analyte	TEL	PEL	Results in ug/Kg							
4,4'-DDE	1.42	6.75	ND(15.3)	ND(17.1)	ND(2.10)	ND(13.5)	ND(9.76)	ND(1.52)	NA	NA
4,4'-DDD	3.54	8.51	ND(15.3)	ND(17.1)	ND(2.10)	ND(13.5)	ND(9.76)	ND(1.52)	NA	NA
4,4'-DDT	1.19	4.77	ND(15.3)	ND(17.1)	ND(2.10)	ND(13.5)	ND(9.76)	ND(1.52)	NA	NA

Notes:

Bolded values indicated detected concentrations

Bolded, underlined and red values indicate concentrations exceed the NOAA SQuiRTs TELs and/or PELs for freshwater sediments

ND(#) = Concentration not detected at the limit of detection (LOD)

ug/L = microgram per liter

J = Detected concentration is an estimated value because result is below the analytical limit of quantitation (LOQ)

TEL – Threshold Effects Level

PEL – Probable Effects Level

Figure 7 displays the PCB concentrations at each of the sample locations at the LF005 site. The figures also show the approximate extent of the PCB impacted sediments at the site. The sample locations SD-05 and SD-10 delineate the extent of PCB impacted soil above the SQuiRTs TEL to the east and northwest of the landfill. However, as shown on Figure 7, additional investigation to the north of the LF005 landfill is necessary to define the extent of PCB impacted sediments in that area.

ST001

Sediment samples were collected from the historical monitoring locations SD-01 and SD-02 at the ST001 site for analysis of PCB concentrations. As shown on Table 6-9, the PCB compound Aroclor-1260 was detected at both locations. The detected PCB concentrations at ST001 are considered estimated values, because the results were reported below the laboratory limit of quantitation. However, the results were reported above the SQuiRTs TEL for PCBs. Therefore, it is considered that the sediment at the two locations remains impacted with PCBs above the cleanup criteria. Figure 8 displays the approximate extent of PCB impacted sediments in vicinity of the ST001 site. Due to the fact that both the sample results were reported above the cleanup levels, the extent of impacted sediments could not be defined at ST001.

6.5. Laboratory Quality Analytical Summary

The analytical data gathered during the 2013 LTM effort consisted of the collection of groundwater, surface water, sediment, trip blank, and matrix spike/matrix spike duplicate samples. The analytical data was reviewed in accordance with the project QAAP (USAF, 2013). A QA/QC Summary Report detailing the results of the analytical data review is provided in Appendix D. Based on review of the data in accordance with the QA/QC criteria, the analytical results, the field collection and the laboratory analysis methods were found to have been conducted in adherence to the project data quality objectives and are acceptable for use for this Environmental Monitoring report.

Figure 7 - Area LF005 – PCB Sediment Sample Results

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Figure 8 - Area ST001 – PCB Sediment Sample Results

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7. CONCLUSIONS AND RECOMMENDATIONS

The objective of the August 2013 field effort was to perform site investigations and environmental monitoring to ensure the current LTM and LUC programs are effective in preventing any future releases of contaminants at the installation. Field activities included the inspection of landfill caps at LF005 and LF010 and the collection of environmental samples at LF005 and ST001.

7.1. Landfill Inspections

The surface caps of the closed landfills at LF005 and LF010 were observed to be in good condition. The field team did not observe any indications of degradation, such as sink holes, debris, ponded water or erosion at either site. The successful establishment of native vegetation was noted on the majority of cap at LF005. No vegetation had yet to establish on the LF010 landfill cap, which was completed more recently then the LF005 landfill. At both sites the landfill marking signs were either missing or damaged beyond repair capabilities. Only one sign, at the northwest corner of LF010 was able to be repaired by field personnel.

Continuing the annual inspections of the landfills is necessary to ensure the integrity of the caps are maintained and to monitor the reestablishment of the native vegetation. Future field efforts to the site should include plans to fabricate and transport replacement signage for the landfills to ensure the LUC measures meet the notification requirements for site visitors.

7.2. Environmental Monitoring Analysis

Environmental samples were collected from the LF005 and ST001 sites at the Lower Camp area during the 2013 field effort. The findings and recommendations for each site are presented below.

7.2.1. LF005 Site

<u>Groundwater Monitoring</u>

Groundwater samples were collected from four monitoring well locations (AP-01, MW-06, MW-09 and MW-10) at LF005. The groundwater samples were analyzed for concentrations of VOCs, PAHs, DRO and metals. Of the five wells monitored, only AP-01 contained contaminant concentrations above the ADEC cleanup criteria. The arsenic, 1,3-DCB, 1,4-DCB and cis-1,2-DCE concentrations all exceeded their respective GCLs at the well. Review of the historical monitoring data for the site indicates that the results from the 2013 monitoring effort are consistent with previous monitoring efforts.

Annual groundwater monitoring at the LF005 site should continue until declining contaminant trends can be verified at the landfill. A total of nine monitoring wells have been installed at the LF005 site. As shown on Table 6-5, three of the wells (AP-01, AP-03 and MW-06) have in recent years reported contaminant concentrations above the

ADEC cleanup levels. Future monitoring events should include these wells to track the contaminant trends with greater confidence at the site. In addition, subsequent sampling efforts should include the MW-10 well, which was installed to monitor the groundwater down-gradient of AP-01. MW-10 was the only other well with detectable concentrations of VOCs in 2013. Monitoring of MW-10 is beneficial to provide evidence that the impacted groundwater at AP-01 continues to attenuate to concentrations below cleanup levels down-gradient of the source area.

Future sampling efforts at the site should also consist of the monitoring of MNA parameters in the groundwater. Measuring the MNA concentrations will enable an evaluation of the active natural attenuation processes occurring at the site. In order to evaluate the attenuation processes, a well that historically has reported low levels of contaminant concentrations, such as MW-09, should be sampled for comparison of background MNA parameter levels at the site.

Quantifying the degree of natural attenuation along with the delineation of the extent of contamination at MW-10 could provide sufficient justification for a stability determination for the groundwater contamination at the site.

Sediment Monitoring

Five sediment samples were collected at historical monitoring locations at the LF005 site for analysis of VOCs, PAHs, PCBs and pesticides concentrations. Concentrations of PCBs were detected in all five sample locations and exceeded the SQuiRTs TEL in three of the five locations. The remaining contaminant concentrations were either not detected or reported below the laboratory limit of quantitation.

The PCB concentrations at locations SD-05 and SD-10, which were reported below the TEL, delineate the extent of sediment contamination to the east and northwest of the landfill. Further monitoring could be performed at those locations to confirm the results as well as at additional locations to the north to define the extent of the impacted area. The results of subsequent sampling efforts can be used to evaluate whether the extent of impacted sediment below the landfill is stable.

Surface Water Monitoring

Surface water samples were collected from the same five locations at the LF005 site as the sediment samples. None of the sample results exceeded the ADEC surface water criteria for freshwater bodies. Some material debris, including scrap metal, cans, drums and tires were observed in vicinity of the monitoring locations. However, no sheen was noted at any of the locations during the 2013 monitoring event.

The collection of surface water samples should continue to monitor for the presence of contaminants detected in the sediment samples. Although, analysis of the surface water samples did not detect any contaminant concentrations, the presence of PCBs in the sediment above the screening criteria at several locations necessitates continued sampling to monitor the exposure risks to the surface water.

7.2.2. ST001 Site

The groundwater samples collected from the MW-11 well at ST001 were analyzed for concentrations of VOCs, PAHs and DRO. All concentrations were reported below the respective ADEC GCLs. The results of the DRO analysis support the findings of the 2011 FS that the diesel concentrations in the groundwater are naturally attenuating. Future monitoring at the well should be reduced to a biennial frequency based on the attenuating conditions in the groundwater until closure of the site is awarded.

The results of the sediment samples at the ST001 site indicate that the boundaries of PCB impact above the TEL screening levels are not defined. Additional sampling of the sediment could be performed at the site to delineate the extent of the impacted area down-gradient of the former ST001 site. In addition, surface water sampling could be performed in conjunction with the sediment sampling, similar to the LF005 site, to evaluate the exposure to the surface water from the impacted sediments. Upon delineating the extent of contamination, subsequent monitoring efforts can be conducted to determine if the impacted area is expanding or decreasing and to assess the effects on the surrounding surface water. Evidence from future monitoring events of decreasing contamination and negligible impacts to the surface water could provide justification for a closure determination of the ST001 site.

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APPENDIX A

Photographic Log

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APPENDIX B

Field Notes

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APPENDIX C

Non-Hazardous Waste Manifest Form

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APPENDIX D

Laboratory Analytical Report and Quality Assurance Review