Final
Field Sampling Plan
2011 Sampling Event

Remedial Investigation/Feasibility Study
Red Devil Mine, Alaska

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List of Abbreviations and Acronyms

°C	degrees Celsius
ARARs	Applicable and Relevant or Appropriate Requirements
As	arsenic
ASTM	American Society for Testing and Materials
ATV	all-terrain vehicle
bgs	below ground surface
BLM	U.S Department of the Interior Bureau of Land Management
Br	bromine
BTEX	benzene, toluene, ethylbenzene, and xylenes
cfs	cubic feet per second
Cl	chlorine
COC	chain-of-custody
COPCs	contaminants of potential concern
DOT	U.S. Department of Transportation
DRO	diesel range organics
E & E	Ecology and Environment, Inc.
EPA	U.S. Environmental Protection Agency
FSP	Field Sampling Plan
GIS	Geographic Information System
GPS	global positioning system
HSA	hollow-stem auger
HCl	hydrochloric acid
Hg	mercury
HNO_3	nitric acid
IATA	International Air Transportation Association
IDW	investigation-derived waste
L	Liter
LSE	limited sampling event
mg/kg	milligrams per kilogram
mL	milliliter
MS/MSD	matrix spike/matrix spike duplicates
NSF	National Sanitation Foundation
PCBs	polychlorinated biphenyls
Pb	lead
QAPP	Quality Assurance Project Plan
QA/QC	quality assurance/quality control
QC	field quality control
RCRA	Resource Conservation and Recovery Act
RDM	Red Devil Mine
RI/FS	Remedial Investigation/Feasibility Study

List of Abbreviations and Acronyms (cont.)

RRO	residual range organics
Sb	antimony
SOPs	Standard Operating Procedures
SPLP	synthetic precipitation leaching procedure
SSE	selective sequential extraction
SVOCs	semi-volatile organic compounds
TAL	target analyte list
TCLP	toxicity characteristic leaching procedure
TDS	total dissolved solids
TSS	total suspended solids
USCS	United Soil Classification System
USGS	U.S. Geological Survey
XRF	X-ray fluorescence spectrometer

1 Introduction

This document is a Field Sampling Plan (FSP) to be used for a sampling event to be conducted during the 2011 summer field season at the Red Devil Mine (RDM) site. The RDM site is an abandoned mercury mine and ore-processing site on the southern bank of the Kuskokwim River in a remote area of Alaska, approximately 250 air miles west of Anchorage and 75 air miles northeast of the village of Aniak. The site is on public lands managed by the U.S Department of the Interior Bureau of Land Management (BLM).

The 2011 sampling event is being performed in support of a Remedial Investigation/Feasibility Study (RI/FS) at the RDM site. A limited sampling event (LSE) was conducted at the RDM site during the 2010 summer field season. Sampling activities and results of the 2010 limited sampling event are presented in the *2010 Limited Sampling Event* report (E & E 2010a). The tasks described in this FSP include planned field activities that were not completed during the 2010 LSE and additional activities to address data gaps identified subsequent to evaluation of the 2010 LSE results.

The RI/FS Work Plan details the site setting, site history, previous investigations, data quality objectives, and applicable and relevant or appropriate requirements (ARARs) for the site. Information in the RI/FS Work Plan is not repeated in the FSP. This FSP is intended to be used as a streamlined guide for the field investigation team.

The purpose of this FSP is to provide specific methodology for the sampling and analysis at the RDM site. The results of the activities performed under this FSP will be used in support of the RI/FS to characterize the nature and extent and fate and transport of contaminants of potential concern (COPCs) at and near the site, to provide data for human health and ecological risk assessments, and to provide data and information for use in the analysis of remedial alternatives.

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Sample Locations, Types, and Rationale

This section describes the study design for each component of the 2011 RI/FS sampling event at the RDM. The study area for the 2011 sampling event includes the Main Processing Area, where ore-processing operations were conducted and areas outside of the Main Processing Area where additional potential contaminant sources may exist and/or where site-related contamination may be present (see Figures 1-2 and 1-3 in the RI/FS Work Plan). The RI/FS Work Plan details the contaminant sources associated with the site and the COPCs associated with these sources.

The study design is biased to target locations that are potential and/or known sources of COPCs and locations and media potentially impacted by migration of COPCs at the site. Some sample locations have also been selected to verify historical sample results or to provide new data because site conditions have changed since previous sampling events (e.g., movement of soil, construction activities associated with mine operations or cleanup actions, and vehicle traffic).

The study design incorporates both field screening and fixed laboratory analyses. Field screening will provide real-time data to inform decisions about subsequent sample locations and selection of samples for laboratory analysis, as well as providing a large data set to delineate the areal distribution of tailings and waste rock. Tailings included thermally-processed ore, also variously referred to as calcines; burnt ore; retorted ore; and flotation tailings, which consist of the fraction of milled ore remaining after selected ore minerals are separated from the bulk ore slurry using water and flotation agents. For the remainder of this document, the term “tailings” will refer to the tailings derived by the thermal processing of ore, and “flotation tailings” will refer to tailings derived by processing ore using the flotation process.

As discussed in the RI/FS Work Plan, available information does not clearly indicate the locations at which the waste rock generated during all mining operations was disposed of. The waste rock is likely mixed with tailings locally, and waste rock may be difficult to distinguish from tailings. Therefore, the term “tailings/waste rock” is used throughout this document to refer to tailings and/or waste rock.

The historical and present channel and delta of Red Devil Creek likely consists of sluiced overburden, tailings/waste rock, and native alluvial material.

2.1 Surface Soil

Surface soils will be characterized using a combination of visual observations, field screening methods, and fixed laboratory analyses. To evaluate the presence and areal extent of tailings/waste rock at the RDM site, information regarding waste disposal during mine operations and subsequent construction activities and natural processes will be verified and supplemented in the field using a combination of visual observations (see Section 2.1.1) and in-situ field screening for total metals using a portable X-ray fluorescence spectrometer (XRF) (see Section 2.1.2). Visual inspection and XRF field screening will also be performed at locations where soil samples are collected for laboratory analysis. Sampling for laboratory analysis is covered in Section 2.1.3.

Determination of the extent of tailings/waste rock will be based on multiple lines of evidence, including historical reports and photographs, topography, and the lithological observations and XRF field screening results. Criteria for the determination of the extent of tailings/waste rock will be established following collection of additional data during the RI/FS. Visual inspection and XRF field screening to delineate the extent of tailings/waste rock during the RI/FS field activities will supplement the field screening data collected during the 2010 LSE.

2.1.1 Visual Inspection

Based on a review of historical descriptions of mine operations, historical aerial and other photographs, and topography, the extent of tailings/waste rock during the period of mining operations is expected to include much of the Main Processing Area and areas within the Red Devil Creek drainage downstream of the Main Processing Area. Tailings and waste rock were disposed of in the Red Devil Creek drainage, and piles of tailings/waste rock located along the banks of and beneath Red Devil Creek are subject to erosion by the creek. Early mining operations consisted of sluicing of overburden, apparently into Red Devil Creek. As such, tailings are expected to be mixed with waste rock, overburden, and native alluvial materials within the Red Devil Creek drainage and its delta into the Kuskokwim River. Based on review of existing information, at most locations, the expected edge of tailings/waste rock is located at a transition from generally flat areas within the Main Processing Area and Red Devil Creek valley to the steeper slopes of the surrounding valley walls. Tailings were reportedly used for some unknown building foundations and road ballast or surfacing material. The locations of the buildings and roads where tailings may have been used are not known. The expected extent of the areas where tailings/waste rock and flotation tailings were disposed of or subsequently transported to is illustrated in Figure 2-2 of the RI/FS Work Plan.

Review of recent photographs indicates that some of the areas where tailings/waste rock have historically been located still likely have tailings/waste rock at the surface. At other locations, tailings/waste rock may have been redistributed, covered by soil, and/or obscured by vegetation. Based on historical photographs and lithological descriptions of tailings/waste rock provided in soil boring logs (Wilder/HLA 2001), tailings/waste rock at the site are expected to consist of mixtures of gravel, sand, and silt-sized material, with at least some of the gravel comprising angular shale fragments. Some tailings/waste rock material is expected to be largely gray to black with some brown, and other tailings/waste rock material is expected to be rusty brown. Flotation tailings in the settling ponds are expected to consist predominantly of silt-sized and fine sand-sized particles.

During the 2010 LSE (E & E 2010a), a visual inspection was conducted in conjunction with XRF field screening over much of the area expected to contain tailings/waste rock. Field screening for the presence of tailings/waste rock was performed at 44 grid locations and along 33 transects in the area expected to contain tailings/waste rock based on existing information. At each field screening location, visual observations of soil characteristics and XRF field screening data were recorded.

Early in the 2010 LSE field event, visual observation and XRF field screening were performed in areas where historical information and visual observations indicated tailings/waste rock were likely present (see RI/FS Work Plan). Field screening commenced in the areas of the site where tailings/waste rock were at the surface (e.g., area between the Post-1955 Retort building and Red Devil Creek). Observations of visual soil characteristics and XRF concentrations of the key metals in these known tailings/waste rock materials were used as a guide to identify tailings/waste rock at other areas of the site where the presence of tailings/waste rock was not as readily observed. Such areas included locations where tailings/waste rock were suspected based on historical photographs, but where the surface has subsequently been vegetated and/or modified by construction activities (e.g., within the Red Devil Creek drainage downstream of the Main Processing Area). The possible presence of tailings/waste rock at these locations was assessed based on comparison of visual characteristics and XRF concentrations at these locations with those at locations where tailings/waste rock were documented (e.g., Main Processing Area).

Later in the 2010 LSE field event, in an effort to delineate the lateral limits of materials consisting of or containing tailings/waste rock, and to further characterize the nature of the tailings/waste rock materials, soil was field screened along transects established along the expected edge of materials containing tailings/waste rock. A total of 33 transects were field screened. Each transect initially consisted of two points—Stations A and B—on a line segment oriented perpendicular to and straddling the expected lateral limit of tailings/waste rock. Prior to mobilization to the site, horizontal coordinates of the transect stations were estimated using the project Geographic Information System (GIS) and uploaded into resource-grade global positioning system (GPS) units to use as waypoints to guide the field team to the transect stations in the field. Initially, Station A points were located approximately15 feet inside of the expected lateral limit and the Station B points were located approximately 25 feet outside of the expected lateral limit. At several locations, the initial transect station positions were adjusted by the field team based on site conditions (e.g., topography). The presence of tailings/waste rock was assessed at each initial transect station based on a combination of visual soil characteristics and XRF field screening results. Observations gathered during the previous grid-based field screening of known tailings/waste rock were used as a guide to identify materials containing tailings/waste rock. If tailings/waste rock materials were identified at the initial Station B location along any given transect, that transect was extended further outward by approximately 25 feet from the initial Station B to assess whether the soil materials at that location contained tailings/waste rock. Similarly, if it appeared that tailings/waste rock were not present at the Station A position along a given transect, the transect line was extended inward approximately 25 feet from Station A. This process was repeated until the apparent lateral extent of tailings/waste rock materials at that transect was preliminarily identified to the extent possible.

Results of the 2010 LSE visual inspection confirmed that three types of native soil are present at the site: alluvium associated with Red Devil Creek; soil derived from the Kuskokwim Group bedrock; and loess. The 2010 LSE results also indicated that the lithological characteristics of tailings/waste rock are similar in some respects to those of the Red Devil Creek alluvial soils and soils derived from the Kuskokwim Group bedrock. The reason for this is that tailings/waste rock are derived from materials mined from the Kuskokwim Group bedrock unit. Tailings/waste rock includes mixtures of gravel, sand, and silt, with at least some of the gravel comprising angular fragments of shale/argillite or greywacke (sandstone) of the Kuskokwim Group. The alluvial materials in Red Devil Creek valley are largely derived from the erosion and transport of Kuskokwim Group bedrock that underlies at least part of the Red Devil Creek drainage basin.

The 2010 LSE results suggest that tailings/waste rock are locally mixed with the native soils within the Red Devil Creek valley. As such, visually distinguishing tailings/waste rock from Red Devil Creek alluvial soils by visual observations alone is difficult. Similarly, visually distinguishing tailings/waste rock from colluvial soils derived from the Kuskokwim Group bedrock where such soils contain clasts of argillite/shale and greywacke is difficult. Preliminarily, the presence of red porous rock in field-screened materials is considered likely to indicate thermally-processed ore. Results of the 2010 LSE XRF field screening indicate that the presence of red porous rock is commonly associated with relatively high concentrations of arsenic, antimony, and mercury. Relatively high concentrations of arsenic, antimony, and mercury are also commonly associated with the presence of mineralized vein material in rock fragments contained in field-screened materials. Such mineralized vein material may be associated with waste rock or tailings.

However, such mineralized vein material may also be present in native soils derived from Kuskokwim Group bedrock; therefore, the presence of mineralized vein material may not be a reliable indicator of the presence of tailings/waste rock.

Additional field screening for the presence of tailings/waste rock during the 2011 RI/FS field event will incorporate the observations gathered during the 2010 LSE to further delineate the extent of tailings/waste rock at locations not fully addressed during the 2010 LSE. Additional visual inspection will be performed during the 2011 RI/FS field event at areas discussed in Section 2.1.2. Physical characteristics of soils at each field-screening location will be recorded during the visual inspection, as summarized in Section 4.1.1.

2.1.2 In-Situ XRF Field Screening

As indicated above, during the 2010 LSE, field screening for the presence of tailings/waste rock was performed at 44 grid locations and along 33 transects in the area expected to contain tailings/waste rock based on existing information. At each field-screening location, visual observations of soil characteristics and XRF field-screening data were recorded. As expected, the 2010 LSE XRF field screening indicated that concentrations of arsenic, antimony, and mercury in materials consisting or containing tailings/waste rock are generally higher than concentrations in materials that do not appear to contain tailings/waste rock. Therefore, XRF field screening and laboratory results are considered to be useful to delineate the extent of tailings/waste rock at the site. However, it is noted that comparably high concentrations of these COPCs are expected to be present in native materials locally at the site due to naturally occurring mineralization. Such native materials are expected to include Kuskokwim Group bedrock and colluvium and alluvial materials derived from that bedrock unit. Such native colluvial soils may be present locally at some locations adjacent to the expected edge of material consisting of or containing tailings/waste rock. Similarly, such native alluvial soils are expected to be present locally within Red Devil Creek valley, within which tailings/waste rock have been disposed of and subsequently redistributed. Therefore, elevated concentrations of arsenic, antimony, and mercury alone are not indicative of the presence of tailings/waste rock.

Based on data collected during the 2010 LSE, the concentrations of arsenic, antimony, and mercury in soils that appear to be unimpacted by tailings/waste rock are variable. The concentrations of these COPCs in soils consisting of or believed to contain tailings/waste rock are also variable. As such, no single concentration value for arsenic, antimony, or mercury is expected to be useful to define the extent of tailings/waste rock at all areas of the site. As indicated above, multiple lines of evidence will be used to attempt to delineate the extent of tailings/waste rock. In the field, XRF concentration data will be used in conjunction with other information, including aerial and land-based photographs, site topography, lithologic observations, and other field observations to attempt to delineate the extent of tailings/waste rock.

Results of the 2010 LSE (E & E 2010a) indicate that the extent of tailings/waste rock warranted further investigation at the following areas:

- The vicinity of the Post-1955 Retort,
- The Power Plant area,
- The Area West of Gravel Pad, and
- The roads at the RDM site.

Results of the 2010 LSE also indicate the presence of elevated concentrations of metal COPCs within portions of the following areas:

- The Surface Mined Area,
- The Dolly Sluice, and
- The Rice Sluice.

Other areas that will be field screened during the 2011 RI/FS field event are:

- An area of surface disturbance located south of the Power Plant identified during the 2010 LSE; and
- Foundations of former residential buildings.

Each of the areas listed above will be investigated during the 2011 RI/FS field activities. XRF field screening will be performed in conjunction with visual inspection during the 2011 RI/FS field event. In general, field screening will be performed at each field-screening location in-situ (on the soil surface) after removal of any surficial detritus that may exist. XRF in-situ field screening procedures are discussed further in Chapter 4. XRF field screening will target in-situ concentrations of arsenic, mercury, and antimony, but will also include other metals including lead and chromium. The lateral coordinates of each field screening location will be surveyed with GPS instrumentation, as described in Chapter 8. The specific field screening approach for each of the 2011 RI/FS field screening areas is discussed below.

Post-1955 Retort Area

The surface extent of elevated concentrations of COPCs in the vicinity of the Post-1955 Retort will be further evaluated using visual observations and XRF field screening at 2010 LSE Transects IT22 through IT27 (see FSP Figure 2-1). The concentrations of arsenic, antimony, and/or mercury at the 2010 LSE Station B locations at each of these transects were generally higher than concentrations elsewhere at the site outside of the expected extent of tailings/waste rock. Each of these existing transects will be extended further outward to assess whether concentrations decrease further outward and whether surface soils exhibit visual indications of tailings/waste rock and/or other mining-related materials (e.g., spilled ore, dust, etc.). Each existing transect will initially be extended approximately 25 feet outward along the transect line from the 2010 LSE Station B position. If tailings/waste rock or generally high concentrations of arsenic, antimony, and/or mercury are observed, the transect will be extended further outward by another 25 feet. This process will be repeated as necessary to delineate the apparent extent of tailings/waste rock and to gain additional information about concentrations of arsenic, antimony, and mercury in the area. The number of additional stations along each transect will be determined in the field based on the field team's observations and judgment. Prior to mobilization to the site, horizontal coordinates of the new transect stations will be estimated using the project GIS and uploaded into resource-grade GPS units to use as waypoints to guide the field team to the transect stations.

Power Plant Area

The 2010 LSE field screening (Transect IT21) and laboratory soil analytical results indicated comparatively high concentrations of arsenic, antimony, and mercury, suggesting that the surface of the Power Plant Area may contain tailings/waste rock. Grid and transect locations will be evaluated to assess the presence of tailings/waste rock and elevated concentrations of metal COPCs in the surface soil. Four grid locations and four transects are planned for field screening in the Power Plant Area (see FSP Figure 2-1). Each transect will initially consist of two points—Stations A and B—on a line segment oriented perpendicular to and straddling the expected lateral limit of tailings/waste rock. Prior to mobilization to the site, horizontal coordinates of the transect stations will be estimated using the project GIS and uploaded into resource-grade GPS units to use as waypoints to guide the field team to the transect stations in the field. Initially, Station A points will be located approximately 15 feet inside of the expected lateral limit of tailings/waste rock or other surface disturbance, and the Station B points will be located approximately 25 feet outside of the expected lateral limit. Initial transect station positions may be adjusted by the field team based on site conditions (e.g., topography). The presence of tailings/waste rock will be assessed at each initial transect station based on a combination of visual soil characteristics and XRF field-screening results. If tailings/waste rock are identified at the Station B location along any transect, the transect line will be extended further outward by approximately 25 feet from the initial Station B to assess whether the soil materials at that location contain tailings/waste rock. Similarly, if it appears that tailings/waste rock are not present at the Station A position along a given transect, the transect line will be extended inward approximately 25 feet from the initial Station A. This process will be repeated until the apparent lateral extent of tailings/waste rock is identified, to the extent possible.

Area West of Gravel Pad

The surface extent of elevated concentrations of COPCs in the area west of the Gravel Pad, along 2010 LSE Transects IT18 and IT19 will be further evaluated (see FSP Figure 2-1). The concentrations of arsenic, antimony, and/or mercury at the 2010 LSE Station B locations at each of these transects were generally higher than concentrations elsewhere at the site outside of the expected extent of tailings/waste rock. Each of these existing transects will be extended further outward to assess whether concentrations decrease further outward and whether surface soils exhibit visual indications of tailings/waste rock and/or other mining-related materials. Each existing transect will initially be extended approximately 25 feet outward along the transect line from the 2010 LSE Station B position. If tailings/waste rock or generally higher concentrations of arsenic, antimony, and/or mercury are observed, the transect will be extended further outward by 25 feet to assess soil conditions for changes in lithological characteristics or changes in XRF concentrations. This process will be repeated, as necessary, to delineate the apparent extent of tailings/waste rock and to gain additional information about concentrations of arsenic, antimony, and mercury in the area. The number of additional stations along each transect will be determined in the field based on the field team's observations and judgment. Prior to mobilization to the site, horizontal coordinates of the new transect stations will be estimated using the project GIS and uploaded into resource-grade GPS units to use as waypoints to guide the field team to the transect stations.

Area of Surface Disturbance South of Power Plant

An area of surface disturbance south of the Power Plant (FSP Figure 2-1) that was identified during the 2010 LSE will be inspected to attempt to determine the nature of the disturbance. It is possible that the surface disturbance is related to mining or mineral exploration. Surface soil at the area will be field screened to assess soil conditions, including lithological characteristics and concentrations of metal COPCs to attempt to determine the nature of the soil disturbance and the concentrations of metal COPCs within and outside of the perimeter of the disturbance. Surface soil will be field screened at grid locations and transects. A square grid will be established within the expected perimeter of the disturbance. One location within each grid square will be field screened. At each grid location, visual observations of soil characteristics and XRF field screening data will be recorded. Transects will be established along the expected perimeter of surface disturbance based on aerial photographs. The objectives of the transects are to delineate the edge of the surface disturbance and provide additional information regarding the nature of the soil disturbance. Each transect will initially consist of two points—Stations A and B—on a line segment oriented perpendicular to and straddling the expected lateral limit of the surface disturbance. Prior to mobilization to the site, horizontal coordinates of the transect stations will be estimated using the project GIS and uploaded into resource-grade GPS units to use as waypoints to guide the field team to the transect stations in the field. Initially, Station A points will be located approximately 15 feet inside of the expected lateral limit of the surface disturbance and the Station B points will be located approximately 25 feet outside of the expected lateral limit. Initial transect station positions may be adjusted by the field team based on site conditions (e.g., topography). The lithological characteristics and in-situ XRF concentrations of arsenic, antimony, and mercury will be assessed at each initial transect station. If the soil characteristics and XRF concentrations at the initial Station B location along any transect are similar to those observed at the Station A locations and grid locations, the transect line will be extended further outward by approximately 25 feet from the initial Station B. This process will be repeated until the apparent lateral extent of the soil disturbance is identified, to the extent possible.

Area of Surface Mining/Exploration or Other Soil Disturbance

This area includes a portion of the area of surface mining north of the Main Processing Area and the area between the surface mining area and Red Devil Creek where residential structures were formerly located. Laboratory analytical results for surface soil samples collected during the 2010 LSE indicate that concentrations of metal COPCs, particularly arsenic, are elevated at many of the surface soil sample locations within the southern portion of the Surface Mined Area (E & E 2010a). The extent of elevated concentrations of arsenic in the disturbed native soils of the Surface Mined Area is not known.

Although the area of the former residential structures is not believed to have been mined based on review of historical information and photographs, the soils in this area have been disturbed as part of the building and road construction. Historical reports of mine operations indicate the possibility that tailings were used as foundations for the buildings. This area will be field screened to assess the presence of tailings/waste rock as well as general soil characteristics, including concentrations of metal COPCs.

For the purposes of the 2011 field screening in this area, the portion of the Area of Surface Mining and the area of the former residential structures are grouped together into one area (Area of Surface Mining/Exploration or Other Soil Disturbance) as shown in FSP Figure 2-1. This area will be assessed by field screening at grid locations within the overall area, at targeted locations at former residential and other buildings, and at transects arranged along the overall perimeter of the area. These field screening areas and approaches are discussed further below.

A square grid with 200-foot spacing will be established within the overall area (see FSP Figure 2-1). One location within each grid square (Proposed Initial Field Screening Location, FSP Figure 2-1) will be field screened. At each location, visual observations of soil characteristics and XRF field screening data will be recorded.

At the locations of former buildings, the presence of tailings/waste rock field screening will be assessed by the performance of field screening. At each field screening location, visual observations of soil characteristics and XRF field screening data will be recorded. Some of the former buildings lie within the area of the petroleum-contaminated soil landspread treatment area constructed by Marsh Creek on behalf of the BLM in 2010 (FSP Figure 2-1). In Marsh Creek, six discrete soil samples were collected from the area of the landspread prior to construction of the landspread and analyzed for mercury, arsenic, antimony, and lead. Results of the sampling have not yet been reported. The foundations of such buildings are expected to have been altered as part of the landspread construction and/or to underlie the landspread soils. The landspread area will be visually inspected to assess the present conditions at the former building locations. Those former buildings that are located outside the footprint of the landspread will be field screened.

Within the Surface Mined Area, it is anticipated that the extent of comparatively high arsenic concentrations may coincide with the extent of soil disturbance. This will be assessed by field screening at transects that straddle the apparent extent of surface mining/exploration based on a review of historical aerial photos. Based on aerial photographs, transects will be established approximately every 200 feet along the expected perimeter of surface disturbance. Each transect will initially consist of two points—Stations A and B—on a line segment oriented perpendicular to and straddling the expected lateral limit of the surface mining/exploration. Prior to mobilization to the site, horizontal coordinates of the transect stations will be estimated using the project GIS and uploaded into resource-grade GPS units to use as waypoints to guide the field team to the transect stations in the field. Initially, Station A points will be located approximately 30 feet inside of the expected lateral limit of the surface mining/exploration and the Station B points will be located approximately 50 feet outside of the expected lateral limit. Initial transect station positions may be adjusted by the field team based on site conditions (e.g., topography). The lithological characteristics and in-situ XRF concentrations of arsenic, antimony, and mercury will be assessed at each initial transect station. If the soil characteristics and XRF concentrations at the initial Station B location along any transect are similar to those observed at the Station A locations and grid locations, the transect line will be extended further outward by approximately 50 feet from the initial Station B. Preliminarily, a concentration of 50 milligrams per kilogram (mg/kg) of arsenic will be used as a cutoff concentration to delineate the area of elevated arsenic concentrations. This process will be repeated until the apparent lateral extent of the area of surface mining/exploration and area of comparatively elevated arsenic concentration is identified, to the extent possible.

Transects will be established and assessed in a similar manner elsewhere along the perimeter of the Area of Surface Mining/Exploration or Other Soil Disturbance (FSP Figure 2-1) to assess for lateral changes in lithological characteristics and COPC concentrations across the expected extent of soil disturbance.

Roads

Based on the available information regarding site operational history, it is expected that tailings are locally present on roadways where these materials have been used as ballast or surface material. However, the identity of the roads on which tailings were used for such purposes is not known. The locations of roads developed during mining operations that have been identified based on review of historical information and photographs and the 2010 LSE (E & E 2010a) are shown in Figure 2-2 of the RI/FS Work Plan. Portions of these roads are illustrated in FSP Figure 2-1. These roads will be evaluated for the presence of tailings by performing visual observations and XRF field screening. Field XRF screening will be conducted approximately every 500 feet along the centerline of the former mine roads. To aid in the assessment of whether tailings/waste rock were emplaced for road surface or ballast at each centerline location, surface soil at locations outside of the roadway will be field screened and compared to the centerline locations. Surface soil will be field screened at locations approximately 25 feet from the road centerline on each side of the road at each of the road field screening locations. Proposed road centerline field screening locations are shown in FSP Figure 2-1. Additional road field screening locations may be identified in the field to refine the understanding of the distribution of tailings/waste rock along roadways based on field screening results.

It is possible that some of the roads have been maintained or modified since the end of mining operations. Such roads include the road between the Main Processing Area and the former above-ground storage tanks. Information on where such activities may have taken place will be gathered and used to guide the field screening. For any locations where the road may have been resurfaced based on reported information or observations made during the road field screening, the road surface will be assessed by excavating a small test hole up to six inches deep. Visual and XRF field screening will be performed on the materials from the base of the test hole. Upon completion of field screening, the test hole will be backfilled with the excavated material.

Dolly Sluice and Rice Sluice Gullies

The 2010 LSE laboratory soil analytical results indicated comparatively high concentrations of arsenic, antimony, and/or mercury at locations within the gullies of the Dolly Sluice and Rice Sluice. To better understand the distribution of metal COPCs in the sluice gullies, visual observations and XRF field screening will be conducted at 100-foot intervals along the centerline of each gully within the Dolly Sluice and Rice Sluice areas. To aid in the assessment of whether the arsenic, antimony, or mercury concentrations in the gullies are elevated relative to the surrounding areas, surface soil also will be field screened at locations outside of the sluice gullies and compared to gully locations. Surface soil will be field screened at locations approximately 25 feet from the gully centerline on each side of the gully at each of the sluice gully field screening locations. Proposed sluice gully centerline field screening locations are shown in FSP Figure 2-1.

2.1.3 Laboratory Analytical Sampling

Surface soil samples will be collected for laboratory analysis as part of the 2011 field event. Surface soil sample results will be used in conjunction with the 2010 LSE surface soil samples to meet the objectives and approach of the RI/FS surface soil investigation. Data gaps and the investigative approach for the 2011 surface soil investigation are presented in Chapter 4 of the RI/FS Work Plan. General data objectives of the soil investigation are summarized below:

- Determine the nature and extent of COPCs in surface soil;
- Delineate the areal extent of tailings/waste rock on the ground surface;
- Determine the presence and concentrations of polychlorinated biphenyls (PCBs) in the soil at the former transformer use and storage locations;

- Assess the presence and concentrations of COPCs in the surface soils at the location where the single abandoned drum was identified during the 2010 LSE;
- Assess the nature of surface soil disturbance and concentrations of metal COPCs in the surface soils at the area of surface disturbance south of the Power Plant identified during the 2010 LSE;
- Determine the bioavailability of arsenic in surface soil and tailings/waste rock;
- Determine the soil characteristics that may affect contaminant fate, transport, and bioavailability;
- Gather data for the human health risk assessment to assess potential exposure to COPCs through direct contact, inhalation, and incidental ingestion; and
- Gather data to be used in support of the ecological risk assessment to assess potential exposure of biota to COPCs through direct contact and ingestion.

Proposed surface soil sample locations are illustrated in FSP Figures 2-2, 2-3, and 2-4. Positions of these sample locations are approximate. Final sample locations will be refined during field sampling based on actual conditions encountered in the field.

Surface soil samples will be collected from 0 to 6 inches below ground surface following removal of any surficial detritus that may exist on the ground surface. Specific sampling methodologies are provided in Chapter 4 of this FSP.

Selected 2011 surface soil samples will be analyzed for target analyte list (TAL) inorganic elements, mercury selective sequential extraction (SSE), synthetic precipitation leaching procedure (SPLP) TAL metals, bioavailability of arsenic, semi-volatile organic compounds (SVOCs), PCBs, diesel range organics (DRO), and residual range organics (RRO).

Table 2-1 summarizes the planned surface soil samples by geographic area and/or source area to be evaluated, and the proposed numbers of samples to be collected for selected analyses.

Each surface soil sample collected for laboratory analysis for TAL metals will be field screened with an XRF, as described in Section 4 and in accordance with the XRF standard operating procedures (SOPs). Results of the XRF field screening will be correlated to laboratory total metals results to assess the effectiveness of the XRF field screening.

Table 2-1 Summary of Surface Soil Samples

General Geographic Area	Source Area / Other Area	Sub-Area	Location Description	Sample Location ID	Number of Samples / Selection Criteria						
					Total TAL Metals	Mercury SSE	SPLP TAL Metals	Arsenic Bioavailability	PCBs	SVOCs^{3}	DRO/RRO
Main Processing Area	East of Red Devil Creek	Gravel Pad	Gravel Pad	11MP76					1		
				11MP77					1		
				11MP78					1		
				11MP79					1		
				11MP25				1			
			Location where the single abandoned drum was identified during the 2010 limited sampling effort	11MP70	1					1	1
		General, Tailings/Waste Rock	Tailings Borrow Area	11MP17				1			
		Settling Pond Area	Flotation Tailings, Settling Pond #1	11MP32				1			
			Flotation Tailings, Settling Pond #2	11MP34				1			
			Flotation Tailings, Settling Pond #3	11MP36				1			
		Southwest of the Power Plant / Former Drum Storage Area	Area of Surface Disturbance	11MP71	1	1	1				
		Power Plant / Former Drum Storage Area	Power Plant / Former Drum Storage Area	11MP72					1		
				11MP73					1		
				11MP74					1		
				11MP75					1		
	Pre-1955 Rotary Furnace Buildings / Tailings/Waste Rock	Monofill #1 / Former Shop Buildings / Tailings/Waste Rock	Area near Monofill #1 / Shop Pad A / Tailings/Waste Rock	11MP83					1		
				11MP84					1		
				11MP85					1		
		Pre-1955 Retort	East of Pre-1955 Retort Building	11MP59				1			
		Pre-1955 Rotary Furnace Building / Tailings/Waste Rock	Area of Pre-1955 Rotary Furnace Building / Tailings/Waste Rock	11MP52				1			
				11MP86					1		
				11MP87					1		
		West of Gravel Pad	Along Red Devil Creek West of Gravel Pad	11MP80					1		
				11MP81					1		
				11MP82					1		
Area of Surface Mining / Exploration	Southern Surface-Mined Area	Bulldozed Area Away from Known Ore Trend	Bulldozed Area Away from Known Ore Trend	11SM13				1			
				11SM18				1			
	Trenches	Trenched Area West of Residential Structures	Trenched Area West of Residential Structures	11SM28				1			
Outside of Main Processing Area and Area of Surface Mining / Exploration	Nackground Upland Soils: Upland Area Apparently Outside of Mine Impacts	Soil Derived from bedrock (Kuskokwim Group)	West of Area of Surface Mining	11UP09				1			
	Background Alluvial Deposits: Red Devil Creek Alluvial Deposits Upstream of Main Processing Area	Red Devil Creek Alluvial Deposits Upstream of Dam	Red Devil Creek Alluvial Deposits Upstream of Dam	11RD18				1			
				Total	**2**	**1**	**1**	**12**	**16**	**1**	**1**

Key:

DRO = diesel range organics
PCBs = polychlorinated biphenyls
RCRA = Resource Conservation Recovery Act
RRO = residual range organics
SPLP = synthetic precipitation leaching procedure
SSE = selective sequential extraction
SVOC = semivolatile organic compound
TAL = Target Analyte List

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2.2 Subsurface Soil

Subsurface soil samples will be collected from soil borings installed during the RI/FS. Data gaps and the investigative approach for the subsurface soil investigation are presented in Chapter 4 of the RI/FS Work Plan. General data objectives of the soil investigation are summarized below:

- Determine the nature and extent of COPCs in subsurface soil, including tailings/waste rock and underlying native soil;
- Determine the depth of tailings/waste rock up to the total depth of the boring;
- Identify and characterize possible tailings/waste rock at the reservoir dam;
- Identify tailings/waste rock within alluvial deposits of Red Devil Creek, including its delta in the Kuskokwim River up to the total depth of the boring;
- Identify mining-related material (expected to consist of sluiced overburden) within alluvial deposits of the Dolly Sluice delta and possible Rice Sluice delta up to the total depth of the boring;
- Assess lithologic characterization of subsurface soils;
- Identify soil characteristics that may affect the fate and transport of COPCs;
- Provide data for the human health risk assessment to assess potential exposure to COPCs through direct contact;
- Characterize the geotechnical properties of tailings/waste rock and soils that may be subject to excavation; and
- Characterize the geotechnical properties of the subsurface for use in the FS.

Proposed soil boring locations are illustrated in Figures 2-5, 2-6, and 2-7. Positions of these boring locations are approximate. Final sample locations will be refined during RI/FS field sampling based on actual conditions encountered in the field.

Soil borings will be installed using either a hand auger operated by Ecology and Environment, Inc. (E & E) field staff or a drill rig operated by a subcontracted, Alaska-licensed, driller. It is anticipated that physical access to several planned boring locations, including the area within the Red Devil Creek valley upgradient of the Main Processing Area, the Dolly Sluice delta, and possible Rice Sluice delta, will be limited. Therefore, it is expected that subsurface soil sampling at these locations may need to be attempted with a hand auger. A drill rig will be used to install soil borings at the other locations.

Soil boring installation and subsurface soil sampling methodologies are discussed in Chapter 4. New monitoring wells will be installed within selected soil borings as specified in Section 2.3.

At each soil boring installed with a hollow-stem auger drill rig, split spoon samples will be collected continuously from the surface to the borehole total depth. The material recovered in each split spoon sample (tailings/waste rock, native soil/alluvium, rock) will be visually characterized and logged by the field geologist and field screened for total metals using an XRF. Specific field procedures are described in Chapter 4.

Available information on the geologic and hydrogeologic conditions at the site will be used to guide the installation of the soil borings, including target depth. Unconsolidated materials in the Main Processing Area range up to 30 feet, and consist of tailings/waste rock and soil. The thickness of unconsolidated materials elsewhere at the site is expected to range from 0 feet where bedrock is exposed to perhaps several dozen feet where alluvium or loess has formed thick deposits. Native bedrock-derived soil in the Surface Mined Area and upland areas north of the Main Processing Area is expected to be thin.

As discussed in Section 2.1 above, the 2010 LSE results indicated that the lithological characteristics of tailings/waste rock at the surface are similar to those of colluvial soils derived from the Kuskokwim Group bedrock and the Red Devil Creek alluvial soils, because they all are derived from the Kuskokwim Group bedrock unit. Furthermore, tailings/waste rock appears to be locally mixed with the native soils within the Red Devil Creek valley. This is supported by the results of the 2010 U.S. Geological Survey (USGS) geophysical investigation, which indicate that there is not a significant contrast in resistivity between the tailings, waste rock, and bedrock at the site. As such, distinguishing tailings/waste rock from Red Devil Creek alluvial soils and colluvium by visual observations alone is expected to be difficult. As discussed in Section 2.1, based on the preliminary results of the 2010 LSE, the presence of red porous rock in field screened materials is considered likely to indicate thermally-processed ore. Visual observations will be used in conjunction with XRF field-screening results for subsurface soil and the results of the geophysical survey to attempt to determine the depth of tailings/waste rock in soil borings.

Available information on groundwater levels in the existing monitoring wells at the site (MW01, MW03, MW04, MW06, and MW07) includes water depth measurements on the following dates: August 14, 2000; September 5, 2007; September 18, 2008; June 19, 2009; October 6 and 7, 2009; and September 20 and 21, 2010. Historically, measured depths to groundwater in these wells have ranged from approximately 18 to 28 feet below ground surface. Seasonally, depth to groundwater has varied by as much as 3.5 feet, with the highest recorded groundwater elevations occurring in June 2009 and the lowest recorded elevations occurring in October 2009 or August 2000. It is anticipated that thin accumulations of unconsolidated materials in upland areas are not saturated; however, no soil boring information outside of the Main Processing Area is presently available to confirm this. Results of the 2010 USGS geophysical investigation tentatively identified the water table at several locations in the Main Processing Area.

In general, if feasible, each soil boring will be advanced to a depth approximately three feet below the base of the tailings/waste rock where these materials are present and identified, or, to the depth of the water table. For those soil borings targeted for conversion into monitoring wells, the boring will be advanced deep enough to set a well with a 10-foot screen. If such a soil boring planned for monitoring well installation encounters bedrock at a depth shallower than groundwater, the boring will be advanced until groundwater is encountered or to a maximum depth based on the site geologist's judgment.

The soil borings planned in areas where tailings/waste rock are present are intended to determine the depth and characteristics of tailings/waste rock at those locations. A secondary objective is to characterize potential impacts to native materials underlying the tailings/waste rock. Therefore, at several boring locations to be selected based on the site geologist's judgment, split spoon samples from the native materials underlying will be collected for laboratory analysis.

Monitoring well pairs are planned for two locations to assess vertical groundwater gradients and other possible differences in groundwater conditions between shallow and deeper portions of the saturated zone or zones. The shallow well of each well pair will be installed only if saturated conditions are present in the overburden material at that location. The deep wells are intended to characterize underlying bedrock.

Up to three subsurface soil samples will be collected from each boring for fixed laboratory analysis. Each of these subsurface soil samples will be analyzed for total TAL metals. A subset of these subsurface soil samples will be selected for analysis for SPLP TAL metals, toxicity characteristic leaching procedure (TCLP) Resource Conservation and Recovery Act (RCRA) metals, mercury SSE, arsenic speciation, SVOCs, DRO, and RRO. Selected subsurface soil samples collected from the soil borings in tailings/waste rock will be analyzed for geotechnical parameters including grain size/Atterburg limits, moisture content, direct shear, compaction, and permeability. Table 2-3 summarizes the planned subsurface soil samples by geographic area and/or source area to be evaluated, the proposed numbers of samples to be collected for selected analyses, and the criteria for selecting the laboratory analyses. Data gaps and investigative approach, including planned uses for the subsurface soil investigation data, are presented in Chapter 4 of the RI/FS Work Plan. In general, samples will be selected for the various analyses to achieve the following:

- Provide broad areal distribution of data;
- Obtain data from multiple depth intervals within tailings/waste rock to assess vertical variability based on depth and/or lithologic characteristics;
- Obtain data for different tailings types (e.g., flotation tailings versus thermally processed tailings, including pre-1955 thermally processed tailings and post-1955 thermally processed tailings);

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Table 2-2 Summary of Subsurface Soil Samples

General Geographic Area	Source Area / Other Area	Sub-Area	Location Description	Soil Boring Location	Total TAL Metals[a]	Mercury SSE[a]	Arsenic Speciation[a]	SPLP TAL Metals[a]	TCLP RCRA Metals[a,b]	SVOCs	DRO/RRO	Particle Size / Atterberg Limits (ASTM D2487) and Moisture Content	Grain Size (ASTM D422)	Comment
						Number of Samples / Selection Criteria								
		Area of Monofill #2 / Post-1955 Retort Building	Road below Monofill #2 / Post-1955 Retort Building	11MP11	3	2	1	2	2					Select two discrete samples for Hg SSE from the borings/depth intervals that exhibit the highest and mid-range XRF concentrations for mercury. Select one discrete sample for arsenic speciation from the boring/depth interval that exhibits the highest XRF concentrations for arsenic. Select two discrete samples for SPLP TAL metals from borings/depths that exhibit the highest XRF concentrations for mercury and arsenic. Select two discrete samples for TCLP RCRA metals from borings/depths that exhibit the highest XRF concentrations for mercury and arsenic. Collect particle size / Atterberg Limits and moisture content samples from intervals above water table. Collect grain size samples from intervals below water table.
				11MP12	3							1	2	
				11MP13	3									
				11MP14	3							2	2	
				11MP15	3	2	1	2	2					Select two discrete samples for Hg SSE from the borings/depth intervals that exhibit the highest and mid-range XRF concentrations for mercury. Select one discrete sample for arsenic speciation from the boring/depth interval that exhibits the highest XRF concentrations for arsenic. Select two discrete samples for SPLP TAL metals from borings/depths that exhibit the highest XRF concentrations for mercury and arsenic. Select two discrete samples for TCLP RCRA metals from borings/depths that exhibit the highest XRF concentrations for mercury and arsenic. Collect particle size / Atterberg Limits and moisture content samples from intervals above water table. Collect grain size samples from intervals below water table.
				11MP16	3							1		
				11MP17	3								2	
				11MP18	3									
			North of Monofill #2 / Post-1955 Retort Building / Drum Storage Area	11MP10	3	2	1	2	2	1	1			Select two discrete samples for Hg SSE from the borings/depth intervals that exhibit the highest and mid-range XRF concentrations for mercury. Select one discrete sample for arsenic speciation from the boring/depth interval that exhibits the highest XRF concentrations for arsenic. Select two discrete samples for SPLP TAL metals from borings/depths that exhibit the highest XRF concentrations for mercury and arsenic. Select two discrete samples for TCLP RCRA metals from borings/depths that exhibit the highest XRF concentrations for mercury and arsenic. Select sample for SVOCs and DRO/RRO analysis from depth interval with highest field screening result for volatile organics on PID. If the PID results are negative, select sample from interval at the water table for laboratory analysis. Collect particle size / Atterberg Limits and moisture content samples from intervals above water table.
				11MP19	3					1	1	1		
		Area Upgradient of Monofill #2 / Post-1955 Retort Building	Upgradient Area	11MP01	3	1	1	1					2	Select one discrete sample for Hg SSE from the depth interval that exhibits the highest XRF concentration for mercury. Select one discrete sample for arsenic speciation from the depth interval that exhibits the highest XRF concentrations for arsenic. Select one discrete sample for SPLP TAL metals from the boring that exhibits the highest XRF concentrations for arsenic. Collect particle size / Atterberg Limits and moisture content samples from intervals above water table. Collect grain size samples from intervals below water table.
		Gravel Pad	Gravel Pad	11MP23	3	2	1	2	2	1	1			Select two discrete samples for Hg SSE from the borings/depth intervals that exhibit the highest and mid-range XRF concentrations for mercury. Select one discrete samples for arsenic speciation from the boring/depth interval that exhibits the highest XRF concentrations for arsenic. Select two discrete samples for SPLP TAL metals from borings/depths that exhibit the highest XRF concentrations for mercury and arsenic. Select two discrete samples for TCLP RCRA metals from borings/depths that exhibit the highest XRF concentrations for mercury and arsenic. Select sample for SVOCs and DRO/RRO analysis from depth interval with highest field screening result for volatile organics on PID. If the PID results are negative, select sample from interval at the water table for laboratory analysis. Collect grain size samples from intervals below water table.
				11MP24	3					1	1			
				11MP25	3					1	1		2	

Table 2-2 Summary of Subsurface Soil Samples

General Geographic Area	Source Area / Other Area	Sub-Area	Location Description	Soil Boring Location	Number of Samples / Selection Criteria									Comment
					Total TAL Metals[a]	Mercury SSE[a]	Arsenic Speciation[a]	SPLP TAL Metals[a]	TCLP RCRA Metals[a,b]	SVOCs	DRO/RRO	Particle Size / Atterberg Limits (ASTM D2487) and Moisture Content	Grain Size (ASTM D422)	
Main Processing Area	East of Red Devil Creek	Monofill #3 Area	Monofill #3 Area/ Tailings/Waste Rock	11MP22	3									
		Power Plant / Former Drum Storage Area	Power Plant / Former Drum Storage Area	11MP20	3					1	1		2	Select sample for SVOCs and DRO/RRO analysis from depth interval with highest field screening result for volatile organics on PID. If the PID results are negative, select sample from interval at the water table for laboratory analysis. Collect grain size samples from intervals below water table.
				11MP21	3					1	1			Select sample for SVOCs and DRO/RRO analysis from depth interval with highest field screening result for volatile organics on PID. If the PID results are negative, select sample from interval at the water table for laboratory analysis. Collect grain size samples from intervals below water table.
		Settling Pond Area	Upgradient of Settling Pond #1	11MP31	3								2	Collect grain size samples from intervals below water table.
			Flotation Tailings, Settling Pond #1	11MP32	3	1	1	1	1	2	1	1		Select one discrete sample for Hg SSE from the depth interval that exhibits the highest XRF concentration for mercury. Select one discrete sample for arsenic speciation from the depth interval that exhibits the highest XRF concentrations for arsenic. Select one discrete sample for SPLP TAL metals from depth interval that exhibits the highest XRF concentrations for arsenic. Select one discrete sample for TCLP RCRA metals from depth interval that exhibit the highest XRF concentrations for arsenic. Collect two SVOC samples from depths above and below the water table. Select sample for DRO/RRO laboratory analysis from depth interval with highest field screening result for volatile organics on PID. If the PID results are negative, select sample from interval at the water table for laboratory analysis. Collect particle size / Atterberg Limits and moisture content samples from intervals above water table.
			Upgradient of Settling Ponds #2 and #3	11MP33	3								2	Collect grain size samples from intervals below water table.
			Flotation Tailings, Settling Pond #2	11MP34	3	1	1	1	1	2	1	1		Select one discrete sample for Hg SSE from the depth interval that exhibits the highest XRF concentration for mercury. Select one discrete sample for arsenic speciation from the depth interval that exhibits the highest XRF concentrations for arsenic. Select one discrete sample for SPLP TAL metals from depth interval that exhibits the highest XRF concentrations for arsenic. Select one discrete sample for TCLP RCRA metals from depth interval that exhibit the highest XRF concentrations for arsenic. Collect two SVOC samples from depths above and below the water table. Select sample for DRO/RRO laboratory analysis from depth interval with highest field screening result for volatile organics on PID. If the PID results are negative, select sample from interval at the water table for laboratory analysis. Collect particle size / Atterberg Limits and moisture content samples from intervals above water table.
			Berm of Settling Pond #2	11MP35	3									
			Flotation Tailings, Settling Pond #3	11MP36	3	1	1	1	1	2	1	1		Select one discrete sample for Hg SSE from the depth interval that exhibits the highest XRF concentration for mercury. Select one discrete sample for arsenic speciation from the depth interval that exhibits the highest XRF concentrations for arsenic. Select one discrete sample for SPLP TAL metals from depth interval that exhibits the highest XRF concentrations for arsenic. Select one discrete sample for TCLP RCRA metals from depth interval that exhibit the highest XRF concentrations for arsenic. Collect two SVOC samples from depths above and below the water table. Collect one grain size and moisture content sample from interval above water table. Select sample for DRO/RRO laboratory analysis from depth interval with highest field screening result for volatile organics on PID. If the PID results are negative, select sample from interval at the water table for laboratory analysis. Collect particle size / Atterberg Limits and moisture content samples from intervals above water table.

Table 2-2 Summary of Subsurface Soil Samples

					Number of Samples / Selection Criteria									
General Geographic Area	**Source Area / Other Area**	**Sub-Area**	**Location Description**	**Soil Boring Location**	**Total TAL Metals[a]**	**Mercury SSE[a]**	**Arsenic Speciation[a]**	**SPLP TAL Metals[a]**	**TCLP RCRA Metals[a,b]**	**SVOCs**	**DRO/RRO**	**Particle Size / Atterberg Limits (ASTM D2487) and Moisture Content**	**Grain Size (ASTM D422)**	**Comment**
			Berm of Settling Pond #	11MP37	3									
			Between Settling Ponds #1 and Red Devil Creek	11MP38	3	1	1	1					2	Select one discrete sample for Hg SSE from the depth interval that exhibits the highest XRF concentration for mercury. Select one discrete sample for arsenic speciation from the depth interval that exhibits the highest XRF concentrations for arsenic. Select one discrete sample for SPLP TAL metals from depth interval that exhibits the highest XRF concentrations for arsenic. Collect grain size samples from intervals below water table.
			Between Settling Ponds #2 and Red Devil Creek	11MP39	3	1	1	1					2	Select one discrete sample for Hg SSE from the depth interval that exhibits the highest XRF concentration for mercury. Select one discrete sample for arsenic speciation from the depth interval that exhibits the highest XRF concentrations for arsenic. Select one discrete sample for SPLP TAL metals from depth interval that exhibits the highest XRF concentrations for arsenic. Collect grain size samples from intervals below water table.
			Between Settling Ponds #3 and Red Devil Creek	11MP40	3	1	1	1					2	Select one discrete sample for Hg SSE from the depth interval that exhibits the highest XRF concentration for mercury. Select one discrete sample for arsenic speciation from the depth interval that exhibits the highest XRF concentrations for arsenic. Select one discrete sample for SPLP TAL metals from depth interval that exhibits the highest XRF concentrations for arsenic. Collect grain size samples from intervals below water table.
Main Processing Area (continued)	West of Red Devil Creek	Area East of Pre-1955 Processing Facilities	Near spring in Red Devil Creek / Downgradient of former mine openings / Tailings/Waste Rock	11MP60 / 11MP88 (paired shallow and deep borings)	3	1	1	1	1				2	Select one discrete sample for Hg SSE from the depth interval that exhibits the highest XRF concentration for mercury. Select one discrete sample for arsenic speciation from the depth interval that exhibits the highest XRF concentrations for arsenic. Select one discrete sample for SPLP TAL metals from depth interval that exhibits the highest XRF concentrations for arsenic. Select one discrete sample for TCLP RCRA metals from depth interval that exhibit the highest XRF concentrations for arsenic. Collect grain size samples from intervals below water table.
		Area East of Pre-1955 Processing Facilities	Area between Pre-1955 Retort and Red Devil Creek	11MP63	3									
			Mine Access Road / Downgradient of Pre-1955 Processing Area	11MP66	3								2	Collect grain size samples from intervals below water table.
		Monofill #1 / Former Shop Buildings / Tailings/Waste Rock	Area near Monofill #1 / Former Shop Pad / Tailings/Waste Rock	11MP45	3					1	1			Select sample for SVOCs and DRO/RRO analysis from depth interval with highest field screening result for volatile organics on PID. If the PID results are negative, select sample from interval at the water table for laboratory analysis.
				11MP46	3					1	1			Select sample for SVOCs and DRO/RRO analysis from depth interval with highest field screening result for volatile organics on PID. If the PID results are negative, select sample from interval at the water table for laboratory analysis.
				11MP47	3					1	1			Select sample for SVOCs and DRO/RRO analysis from depth interval with highest field screening result for volatile organics on PID. If the PID results are negative, select sample from interval at the water table for laboratory analysis.
			Area near Monofill #1 / Shop Pad A / Tailings/Waste Rock	11MP49	3			1	1					Select one discrete sample for SPLP TAL metals from depth interval that exhibits the highest XRF concentrations for arsenic. Select one discrete sample for TCLP RCRA metals from borings/depth that exhibit the highest XRF concentrations for lead.
			Area near Monofill #1 / Shop Pad B / Tailings/Waste Rock	11MP89	3								2	Collect grain size samples from intervals below water table.
			Area of Pre-1955 Retort Building	11MP58	3	3	2	3	3			1		Select three discrete samples for Hg SSE from the borings/depth intervals that exhibit the highest, mid-range, and low XRF concentrations for mercury. Select two discrete samples for arsenic speciation from the borings/depth interval that exhibit the highest to mid-range XRF concentrations for arsenic. Select three discrete samples each for SPLP TAL metals and TCLP RCRA metals from borings/depths that exhibit the highest XRF concentrations for mercury, arsenic, and antimony. Collect particle size / Atterberg Limits and moisture content samples from intervals above water table.

Table 2-2 Summary of Subsurface Soil Samples

					Number of Samples / Selection Criteria									
General Geographic Area	Source Area / Other Area	Sub-Area	Location Description	Soil Boring Location	Total TAL Metals[a]	Mercury SSE[a]	Arsenic Speciation[a]	SPLP TAL Metals[a]	TCLP RCRA Metals[a,b]	SVOCs	DRO/RRO	Particle Size / Atterberg Limits (ASTM D2487) and Moisture Content	Grain Size (ASTM D422)	Comment
		Pre-1955 Retort	Burnt Ore near Pre-1955 Retort	11MP59	3	1	1	1	1			1		Select one discrete sample for Hg SSE from the depth interval that exhibits the highest XRF concentration for mercury. Select one discrete sample for arsenic speciation from the depth interval that exhibits the highest XRF concentrations for arsenic. Select one discrete sample for SPLP TAL metals and TCLP RCRA metals from location that exhibit the highest XRF concentrations for mercury. Collect particle size / Atterberg Limits and moisture content samples from intervals above water table.
			Area between Pre-1955 Retort and Red Devil Creek	11MP61	3								2	Collect grain size samples from intervals below water table.
			Area between Pre-1955 Retort and Red Devil Creek / Pre-1955 Rotary Furnace Burnt Ore Disposal	11MP62	3								2	Collect grain size samples from intervals below water table.
		Pre-1955 Rotary Furnace Building / Tailings/Waste Rock	Area of Pre-1955 Furnace Building / Tailings/Waste Rock	11MP50	3	3	2	3	3					Select three discrete samples for Hg SSE from the borings/depth intervals that exhibit the highest, mid-range, and low XRF concentrations for mercury. Select two discrete samples for arsenic speciation from the borings/depth interval that exhibit the highest to mid-range XRF concentrations for arsenic. Select three discrete samples each for SPLP TAL metals and TCLP RCRA metals from borings/depths that exhibit the highest XRF concentrations for mercury, arsenic, and antimony. Collect particle size / Atterberg Limits and moisture content samples from intervals above water table. Collect grain size samples from intervals below water table.
				11MP51	3									
				11MP52	3							1	2	
				11MP53	3									
				11MP54	3									
		Upslope of Pre-1955 processing facilities and Monofill #1	Upslope of Pre-1955 processing facilities and Monofill #1	11MP41 / 11MP89 (paired shallow and deep borings)	3	1	1	1					2	Select one discrete sample for Hg SSE from the boring/depth that exhibits the highest XRF concentration for mercury. Select one discrete sample for arsenic speciation from the boring/depth that exhibits the highest XRF concentrations for arsenic. Select one discrete sample for SPLP TAL metals from boring/depth that exhibits the highest XRF concentrations for arsenic. Collect grain size samples from intervals below water table.
Surface Mining / Exploration Area	Sluiced Areas	Dolly Sluice Area	Dolly Sluice Delta	11DS01	3	1	1	1				1		Select one discrete sample for Hg SSE from the boring/depth that exhibits the highest XRF concentration for mercury. Select one discrete sample for arsenic speciation from the boring/depth that exhibits the highest XRF concentrations for arsenic. Select one discrete sample for SPLP TAL metals from boring/depth that exhibits the highest XRF concentrations for mercury. Collect particle size / Atterberg Limits and moisture content samples from intervals above water table.
				11DS02	3									
		Possible Rice Sluice Area	Rice Sluice Delta	11RS01	3	1	1	1				1		Select one discrete sample for Hg SSE from the boring/depth that exhibits the highest XRF concentration for mercury. Select one discrete sample for arsenic speciation from the boring/depth that exhibits the highest XRF concentrations for arsenic. Select one discrete sample for SPLP TAL metals from boring/depth that exhibits the highest XRF concentrations for mercury. Collect particle size / Atterberg Limits and moisture content samples from intervals above water table.
				11RS02	3									
	Southern Surface-Mined Area	Bulldozed Area Away from Known Ore Trend	Potential Site of On-Site Repository / Bulldozed Area Away from Known Ore Trend	11SM11	3	1	1	1				3		Select one discrete sample for Hg SSE from the boring/depth that exhibits the highest XRF concentration for mercury. Select one discrete sample for arsenic speciation from the boring/depth that exhibits the highest XRF concentrations for arsenic. Select one discrete sample for SPLP TAL metals from boring/depth that exhibits the highest XRF concentrations for mercury. Collect particle size / Atterberg Limits and moisture content samples from intervals above water table.
		Bulldozed Area	Upslope of Pre-1955 processing facilities and Monofill #1	11SM31 / 11SM32 (paired shallow and deep borings)	3	1	1	1					2	Select one discrete sample for Hg SSE from the boring/depth that exhibits the highest XRF concentration for mercury. Select one discrete sample for arsenic speciation from the boring/depth that exhibits the highest XRF concentrations for arsenic. Select one discrete sample for SPLP TAL metals from boring/depth that exhibits the highest XRF concentrations for mercury. Collect grain size samples from intervals below water table.
	Upland Area West of Surface Mined Area	Upland Area West of Surface Mined Area	Upland Area West of Surface Mined Area	11UP11	3	1	1	1	1			1		Select one discrete sample for Hg SSE from the depth that exhibits the highest XRF concentration for mercury. Select one discrete sample for arsenic speciation from the depth that exhibits the highest XRF concentrations for arsenic. Select one discrete sample for SPLP TAL metals from boring/depth that exhibits the highest XRF concentrations for mercury. Collect particle size / Atterberg Limits and moisture content samples from intervals above water table.

Table 2-2 Summary of Subsurface Soil Samples

General Geographic Area	Source Area / Other Area	Sub-Area	Location Description	Soil Boring Location	Total TAL Metals[a]	Mercury SSE[a]	Arsenic Speciation[a]	SPLP TAL Metals[a]	TCLP RCRA Metals[a,b]	SVOCs	DRO/RRO	Particle Size / Atterberg Limits (ASTM D2487) and Moisture Content	Grain Size (ASTM D422)	Comment
					Number of Samples / Selection Criteria									
Outside of Main Processing Area and Area of Surface Mining / Exploration	Dam / Upgradient from Main Processing Area	Dam	Dam	11RD08	3	1	1	1						Select one discrete sample for Hg SSE from the boring/depth that exhibits the highest XRF concentration for mercury. Select one discrete sample for arsenic speciation from the boring/depth that exhibits the highest XRF concentrations for arsenic. Select one discrete sample for SPLP TAL metals from boring/depth that exhibits the highest XRF concentrations for mercury.
				11RD09	3									
	Red Devil Creek Alluvial Deposits and/or Soil Downstream of Main Processing Area	Red Devil Creek Alluvial Deposits Between Main Processing Area and delta	Red Devil Creek Alluvial Deposits and/or Soil	11RD05	3	3	2	2				3	2	Select three discrete samples for Hg SSE from the borings/depth intervals that exhibit the highest to mid-range XRF concentrations for mercury. Select two discrete samples for arsenic speciation from the borings/depth interval that exhibit the highest to mid-range XRF concentrations for arsenic. Select two discrete samples for SPLP TAL metals from borings/depths that exhibit the highest XRF concentrations for mercury and arsenic. Collect particle size / Atterberg Limits and moisture content samples from intervals above water table. Collect grain size samples from intervals below water table.
				11RD06	3									
				11RD07	3							3		
				11RD20	3								2	
		Red Devil Creek Delta	Red Devil Creek Delta	11RD01	3	3	2	2						Select three discrete samples for Hg SSE from the borings/depth intervals that exhibit the highest to mid-range XRF concentrations for mercury. Select two discrete samples for arsenic speciation from the borings/depth interval that exhibit the highest to mid-range XRF concentrations for arsenic. Select two discrete samples for SPLP TAL metals from borings/depths that exhibit the highest XRF concentrations for mercury and arsenic. Collect particle size / Atterberg Limits and moisture content samples from intervals above water table.
				11RD02	3									
				11RD03	3							3		
				11RD04	3									
	Red Devil Creek Alluvial Deposits Upstream of Main Processing Area	Red Devil Creek Alluvial Deposits Between Dam and Main Processing Area	Red Devil Creek Alluvial Deposits Between Dam and Main Processing Area	11RD10	3	3	3	3					2	Select three discrete samples for Hg SSE from the borings/depth intervals that exhibit the highest to mid-range XRF concentrations for mercury. Select three discrete samples for arsenic speciation from the borings/depth interval that exhibit the highest to mid-range XRF concentrations for arsenic. Select three discrete samples for SPLP TAL metals from borings/depths that exhibit the highest XRF concentrations for mercury and arsenic. Collect grain size samples from intervals below water table.
				Total	**219**	**42**	**33**	**41**	**23**	**16**	**13**	**31**	**48**	

Notes:

[a] - At each soil boring, split spoon samples will be collected continuously from the surface to the borehole total depth. The material recovered in each split spoon sample (tailings, fill, native soil/alluvium, rock) will be field screened with an XRF.

If possible, each soil boring will be advanced to a depth approximately 3 feet below the base of the tailings where tailings are present.

If possible, each soil boring will be advanced to the depth of the water table. For those soil borings to be converted to monitoring wells, the boring will be advanced to a depth deep enough to set a well with a 10-foot screen. If such a soil boring planned for monitoring well installation encounters bedrock at a depth shallower than groundwater, the boring will be advanced until groundwater is encountered or to a maximum depth based on the site geologist's judgment.

The soil borings installed in areas where tailings are present are intended to determine the depth and characteristics of tailings at those locations. A secondary objective is to characterize potential impacts to native materials underlying the tailings. Therefore, at several boring locations to be selected based on the site geologist's judgment, split spoon samples from the native materials underlying will be collected for laboratory analysis.

For all soil borings, material from approximately 3 sample intervals will be submitted for laboratory analysis. Total TAL metals will be analyzed for each of these samples. These samples may be analyzed for one or more other analyses in addition to total TAL metals as described elsewhere in this table. The sample intervals to be selected for laboratory analysis will be selected based on criteria identified in Chapter 2 of the FSP.

[b] - Aliquots for TCLP RCRA metals analysis will be collected as indicated and submitted to the laboratory. The laboratory will be directed to perform the analysis only if total metal concentrations exceed the theoretical TCLP RCRA limits.

Blue-shaded soil boring locations are targeted for installation of monitoring wells.

Key:

DRO = diesel range organics
RCRA = Resource Conservation Recovery Act
RRO = residual range organics
SPLP = synthetic precipitation leaching procedure
SSE = selective sequential extraction
SVOCs = semivolatile organic compounds
TAL = Target Analyte List
TCLP = toxicity characteristic leaching procedure

- Obtain data for underlying native soils or bedrock to evaluate the presence of elemental mercury in these materials (at locations where elemental mercury is suspected and based on historical information) or observed in overlying intervals; and
- Select samples of each chemical analysis from anticipated background or upgradient locations.

2.3 Groundwater

Groundwater samples will be collected for laboratory analyses from existing and new monitoring wells. FSP Figures 2-8 and 2-9 illustrates the locations of existing and new monitoring wells planned for sampling in 2011. Data gaps and investigative approach, including planned uses for the groundwater investigation data, are presented in Chapter 4 of the RI/FS Work Plan. In general, groundwater monitoring results will be used as follows:

- Characterization of the nature and extent of COPCs in groundwater;
- Characterization of the cation-anion signature of the groundwater to assess potential sources and migration patterns of groundwater and COPCs;
- Characterization of groundwater depth, flow direction, gradient, and migration patterns of COPCs;
- Assessment of groundwater-surface water interactions, including the potential for COPCs in groundwater to enter surface water; and
- Provision of data for the human health risk assessment to assess potential exposure to COPCs through ingestion of drinking water.

Table 2-2 summarizes the planned groundwater samples by geographic area and/or source area evaluated and the proposed numbers of samples to be collected for selected laboratory analyses. Groundwater samples will be analyzed for total TAL inorganic elements, dissolved TAL inorganic elements, total low-level mercury, dissolved low-level mercury, methyl mercury, inorganic ions, nitrate/nitrite, carbonate/bicarbonate, total dissolved solids (TDS), and total suspended solids (TSS). Several groundwater samples also will be analyzed for arsenic speciation, SVOCs, DRO, RRO, and gasoline range hydrocarbons and benzene, toluene, ethylbenzene, and xylenes (BTEX). The groundwater samples from existing monitoring well MW-1 will be analyzed for BTEX to evaluate the potential presence of benzene in groundwater based on historical sample results of benzene in soil at the Gravel Pad.

Newly installed monitoring wells will be developed and purged as described in Chapter 4. Groundwater samples will be collected from the newly installed and existing monitoring wells using a low-flow sampling technique, if feasible. If it is not possible to sample using the low-flow technique, alternative technique(s) will be employed. Specific sampling methodologies are described in Chapter 4 of this FSP.

At the beginning of the field event, a round of static water level measurement will be conducted at all existing wells. Following the completion of groundwater sampling near the end of the sampling event, another round of static water level gauging will be conducted at all new and previously existing monitoring wells.

The static water levels will be measured during each round within the shortest time period possible. Horizontal coordinates and elevations of all existing and newly installed monitoring wells will be surveyed by a subcontracted Alaska-registered land surveyor. Well elevations will be surveyed to within the nearest 0.1 foot.

Field measurements of pH, temperature, specific conductance, oxidation-reduction potential, dissolved oxygen, and turbidity will be collected for each groundwater sample.

2.4 Red Devil Creek Surface Water and Sediment

Surface water grab samples will be collected from 12 locations (11RD01 through 11RD12) along Red Devil Creek between the creek's mouth at the Kuskokwim River and a point upstream of the reservoir south of the Main Processing Area during the 2011 sampling event (FSP Figure 2-10). Nine of these locations (10RD01 through 10RD09) were sampled for surface water and sediment during the 2010 LSE. Only surface water will be sampled from these nine locations during the 2011 sampling event. Three additional surface water and sediment grab sample locations (11RD10 through 11RD12) will be sampled for the 2011 sampling event. Sediment sample locations are illustrated in FSP Figure 2-11. Location 11RD10 will be sampled to better define where concentrations of COPCs increase in the surface water and sediment on the upstream end of the Main Processing Area. Location 11RD12, located within Red Devil Creek surface adjacent to the spring in the Main Processing Area, will be sampled to assess surface water and sediment conditions in the creek immediately downstream of the spring. Location 11RD11, in Red Devil Creek downstream from where the single abandoned drum was identified during the 2010 LSE, will be sampled to assess potential impacts to the creek from the drum.

A visual survey will be conducted at the site to identify if additional springs or seeps are present. Surface water and sediment grab samples will be collected and discharge will be measured at any new springs identified during the 2011 sampling event.

Surface sediment and surface water sample locations between the Kuskokwim River and the reservoir are intended to assess the presence of tailings/waste rock in the creek and characterize the contribution of COPCs from overland runoff from tailings/waste rock and/or contaminated soil and from groundwater contribution. Data gaps and investigative approach, including planned uses for the groundwater investigation data, are presented in Chapter 4 of the RI/FS Work Plan. In general, sample results will be used for:

- Characterization of the nature and extent of COPCs in creek sediment and water;
- Assessment of changes in water chemical conditions along Red Devil Creek and contribution from groundwater sources using major ion data of the surface water;

- Characterization of chemical attributes affecting contaminant fate and transport of COPCs in surface water and sediment;
- Characterization of grain size distribution of sediment;
- Provision of data for the human health risk assessment to assess potential exposure to COPCs through direct contact and incidental ingestion; and
- Provision of data for the ecological risk assessment to assess potential exposure of creek biota to COPCs through direct contact and ingestion.

It is anticipated that the creek will be shallow at most sample locations. To the extent feasible, surface water samples will be collected from mid-depth water in the creek. Surface sediment samples will be collected from the top 10 centimeters of the sediment bed. Specific sampling methodologies are summarized in Chapter 4 of this FSP.

Red Devil Creek surface water samples will be analyzed for the parameters listed in Table 2-4, including total TAL inorganic elements, dissolved TAL inorganic elements, methyl mercury, low-level total mercury, low-level dissolved mercury, inorganic ions, nitrate/nitrite, carbonate/bicarbonate, TDS, and TSS. Selected surface water samples will also be analyzed for arsenic speciation and SVOCs. Field measurements for pH, temperature, specific conductance, oxidation-reduction potential, dissolved oxygen, and turbidity will be collected at each sample station.

Red Devil Creek sediment samples will be analyzed for the parameters identified in Table 2-5, including total TAL inorganic elements, methyl mercury, arsenic speciation, grain size, and total organic carbon. Selected sediment samples also will be analyzed for mercury by SSE.

Spot elevations of Red Devil Creek will be surveyed at locations along the creek adjacent to existing and planned monitoring wells to assess differences between water levels in the creek and water levels in groundwater on either side of the creek. Elevations will be measured to within the nearest 0.1 foot. The data will be used to assess gaining and losing conditions along the creek. The elevation survey will be performed by a subcontracted, Alaska-registered, land surveyor.

2.5 Surface Water Discharge Measurement

Surface water discharge will be measured at each surface water and spring sampling location (11RD01 through 11RD12) on Red Devil Creek (FSP Figure 2-10). This data will be used to:

- Evaluate mass transport of COPCs by surface water, and
- Assess gaining versus losing conditions.

Surface water discharge will be measured using the Mid-Section method or a portable weir plate. Specific methodologies are summarized in Chapter 4 of this FSP.

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Table 2-3 Summary of Groundwater Samples

General Geographic Area	Source Area / Other Area	Sub-Area	Location Description	Sample Location ID (Existing Monitoring Well or RI/FS Soil Boring[a])	Number of Samples														
					Total TAL Metals	Dissolved TAL Metals with Silicon	Total Low Level Mercury	Dissolved Low Level Mercury	Methyl Mercury	Arsenic Speciation	Inorganic Ions (Cl, F, SO4)	Total Dissolved Solids	Total Suspended Solids	Nitrate/Nitrite	Carbonate, Bicarbonate	SVOCs with TICs	DRO / RRO	GRO/ BTEX	PCBs
Main Processing Area	East of Red Devil Creek	Area of Monofill #2 / Post-1955 Retort Building	Downgradient from Monofill #2 / Post-1955 Retort Building	11MP12	1	1	1	1	1		1	1	1	1	1				
				11MP14	1	1	1	1	1	1	1	1	1	1	1				
				11MP17	1	1	1	1	1		1	1	1	1	1				
			Upgradient Area	11MP01	1	1	1	1	1	1	1	1	1	1	1				
		General, Tailings	Downgradient from Monofill #2 / Post-1955 Retort Building	11MP29	1	1	1	1	1	1	1	1	1	1	1				
				11MP30	1	1	1	1	1		1	1	1	1	1				
		Gravel Pad	Gravel Pad	11MP25	1	1	1	1	1		1	1	1	1	1		1	1	
		Gravel Pad / Monofill #3 Area	Gravel Pad / Downgradient from Monofill #3	MW-01 (Existing well previously refered to as MW-1)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
		Power Plant / Former Drum Storage Area	Downgradient from Power Plant / Former Drum Storage Area	11MP20	1	1	1	1	1		1	1	1	1	1	1	1		
				MW-07 (Existing well previously refered to as MW-7)	1	1	1	1	1		1	1	1	1	1				
		Settling Pond Area	Upgradient of Settling Pond #1	11MP31	1	1	1	1	1	1	1	1	1	1	1	1	1		
			Berm of Settling Pond #1	MW-03 (Existing well previously refered to as MW-3)	1	1	1	1	1		1	1	1	1	1				
			Upgradient of Settling Ponds #2 and #3	11MP33	1	1	1	1	1	1	1	1	1	1	1	1	1		
			Berm / Downgradient of Settling Pond #3	11MP40	1	1	1	1	1		1	1	1	1	1	1	1		
			Downgradient of Settling Pond #1	11MP38	1	1	1	1	1	1	1	1	1	1	1	1	1		
			Downgradient of Settling Pond #2	11MP39	1	1	1	1	1	1	1	1	1	1	1	1	1		
	West of Red Devil Creek	Mine Openings / Monofill #1 / Former Shop Buildings / Tailings	Well pair near spring in Red Devil Creek / Downgradient of former mine openings / Tailings	11MP60	1	1	1	1	1	1	1	1	1	1	1				
				11MP88	1	1	1	1	1	1	1	1	1	1	1				
			Near Shop Pad B	11MP89	1	1	1	1	1	1	1	1	1	1	1				
			Downgradient of Former Shop Pad	MW-04 (Existing well previously refered to as MW-4)	1	1	1	1	1		1	1	1	1	1	1	1		1
		Pre-1955 Retort Area	Possibly downdradient of Pre-1955 Retort Area	MW-06 (Existing well previously refered to as MW-6)	1	1	1	1	1		1	1	1	1	1				
			Possibly downdradient of Pre-1955 Retort Area	11MP66	1	1	1	1	1		1	1	1	1	1				
			Downgradient from Pre-1955 Retort and Pre-1955 Rotary Furnace Burnt Ore Disposal Pile	11MP62	1	1	1	1	1	1	1	1	1	1	1				
		Pre-1955 Rotary Furnace Building / Tailings	Area of Pre-1955 Furnace Building / Tailings	11MP52	1	1	1	1	1		1	1	1	1	1				
Outside of Main Processing Area and Area of Surface Mining / Exploration	Red Devil Creek Alluvial Deposits and/or Soil Downstream of Main Processing	Red Devil Creek Alluvial Deposits Between Main Processing Area and delta	Red Devil Creek Alluvial Deposits	11RD05	1	1	1	1	1	1	1	1	1	1	1	1	1		
				11RD20	1	1	1	1	1	1	1	1	1	1	1	1	1		
	Red Devil Creek Alluvial Deposits Upstream of Main Processing	Red Devil Creek Alluvial Deposits Between Dam and Main Processing Area	Red Devil Creek Alluvial Deposits Between Dam and Main Processing Area	11RD10	1	1	1	1	1	1	1	1	1	1	1	1	1		
	Upland Area West of Surface Mined Area	Upland Area West of Surface Mined Area	Upland Area West of Surface Mined Area	11UP11	1	1	1	1	1	1	1	1	1	1	1				
Surface Mining / Exploration Area	Bulldozed Area	Upslope of Pre-1955 processing facilities and Monofill #1	Well pair upgradient from Main Processing Area	11MP41	1	1	1	1	1	1	1	1	1	1	1				
				11MP89	1	1	1	1	1	1	1	1	1	1	1				
			Well pair upgradient from Main Processing Area	11SM31	1	1	1	1	1	1	1	1	1	1	1				
				11SM32	1	1	1	1	1	1	1	1	1	1	1				
				Total	**32**	**32**	**32**	**32**	**32**	**20**	**32**	**32**	**32**	**32**	**32**	**11**	**12**	**2**	**1**

Note:

[a] - New RI/FS monitoring wells will be assigned well identification numbers per FSP Table 3-3.

Key:

BTEX = benzene, toluene, ethylbenzene, and xylenes

DRO = diesel range organics

GRO = gasoline range organics

PCBs = polychlorinated biphenyls

RRO = residual range organics

SVOC = semivolatile organic compound

TAL = Target Analyte List

TIC - tentatively identified compound

Table 2-4 Summary of Surface Water Samples

				Number of Samples											
General Geographic Area	**Sub-Area**	**Location Description**	**Sample Location ID**	**Total TAL Metals**	**Dissolved TAL Metals**	**Methyl Mercury**	**Arsenic Speciation**	**Inorganic Ions (Cl, F, SO4)**	**Total Low-Level Hg**	**Dissolved Low-Level Hg**	**Total Dissolved Solids**	**Total Suspended Solids**	**Nitrate/Nitrite**	**SVOCs with TICs**	**Carbonate, Bicarbonate**
Red Devil Creek Area	Upstream from Main Processing Area	50 feet upstream from reservoir	11RD01	1	1	1	1	1	1	1	1	1	1		1
		50 feet downstream from reservoir dam	11RD02	1	1	1	1	1	1	1	1	1	1		1
		Approximately 300 feet upstream from the Main Processing Area	11RD03	1	1	1		1	1	1	1	1	1	1	1
		Downgradient from abondoned drum	11RD11	1										1	
	Main Processing Area	10 feet upstream from where the access road crosses Red Devil	11RD04	1	1	1	1	1	1	1	1	1	1	1	1
		Seep on Left Bank of Red Devil Creek	11RD05	1	1	1	1	1	1	1	1	1	1	1	1
		Near Settling Pond #2	11RD09	1	1	1		1	1	1	1	1	1	1	1
		Near Settling Pond #3	11RD06	1	1	1	1	1	1	1	1	1	1	1	1
		Upstream end of the Main Processing Area	11RD10	1	1	1	1	1	1	1	1	1	1	1	1
		Within Red Devil Creek, adjacent to Main Processing Area seep	11RD12	1	1	1	1	1	1	1	1	1	1	1	1
	Downstream from Main Processing Area	250 feet upstream from confluence with Kuskokwim River	11RD07	1	1	1		1	1	1	1	1	1	1	1
		Confluence of Red Devil Creek and Kuskokwim River	11RD08	1	1	1	1	1	1	1	1	1	1	1	1
Main Processing Area	Settling Pond Area	Settling Pond #1	11SP32	1	1	1	1	1	1	1	1	1	1	1	1
		Settling Pond #2	11SP34	1	1	1	1	1	1	1	1	1	1	1	1
		Settling Pond #3	11SP36	1	1	1	1	1	1	1	1	1	1	1	1
			Total	**15**	**14**	**14**	**11**	**14**	**14**	**14**	**14**	**14**	**14**	**13**	**14**

Key:

Hg = mercury
SVOC = semivolatile organic compound
TAL = Target Analyte List
TIC - tentatively identified compound

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2.6 Settling Pond Surface Water

One surface water grab sample will be collected from locations (11SP32, 11SP34, and 11SP36) in each of the settling ponds if surface water is present during the 2011 sampling event (FSP Figure 2-10). Data gaps and investigative approach, including planned uses for the surface water investigation data, are presented in Chapter 4 of the RI/FS Work Plan. In general, sample results will be used for:

- Characterization of the nature and extent of COPCs in pond water;
- Utilization of major ion data of the surface water to assess water chemical conditions in the settling ponds in relation to groundwater and Red Devil Creek to evaluate groundwater-surface water interaction;
- Characterization of chemical attributes affecting contaminant fate and transport of COPCs in surface water and sediment;
- Provision of data for the human health risk assessment to assess potential exposure to COPCs through direct contact and incidental ingestion;
- Provision of data for the ecological risk assessment to assess potential exposure of biota to COPCs through direct contact and ingestion; and
- Provision of data for the ecological risk assessment to assess potential exposure of creek biota to COPCs through direct contact and ingestion.

It is anticipated that the pond water will be shallow at each sample location. To the extent feasible, surface water samples will be collected from mid-depth water in the ponds. Specific sampling methodologies are summarized in Chapter 4 of this FSP.

All of the settling pond surface water samples will be analyzed for total TAL inorganic elements, dissolved TAL inorganic elements, methyl mercury, low-level total mercury, low-level dissolved mercury, inorganic ions, nitrate/nitrite, carbonate/bicarbonate, TDS, and TSS. Field measurements for pH, temperature, specific conductance, oxidation-reduction potential, dissolved oxygen, and turbidity will be collected at each sample station.

Table 2-4 summarizes the proposed numbers of surface water and sediment samples to be collected for selected laboratory analyses.

2.7 Kuskokwim River Sediment

Surface sediment grab samples will be collected from 10 locations along the shoreline of the Kuskokwim River (11KR01, 11KR05, 11KR06, 11KR08, 11KR09, 11KR12, 11KR14, 11KR15, 11KR16, and 11KR17) between a point approximately 900 feet up-river of the mouth of Red Devil Creek and a point approximately 800 feet down-river of the Dolly Sluice delta (FSP Figure 2-12). Six of these locations were proposed for the 2010 field season, but were not collected due to time constraints. Based on the 2010 LSE results, four additional locations have been added to better define the distribution of elevated concentrations of COPCs. The surface sediment sample locations down-river of the mouth of Red Devil Creek are intended to provide information regarding the migration of COPCs from site sources in the Kuskokwim River. The surface sediment samples up-river of the mouth of Red Devil Creek are intended as reference samples to be used to infer the contribution of COPCs from the site to the Kuskokwim River. Data gaps and investigative approach, including planned uses for the sediment investigation data, are presented in Chapter 4 of the RI/FS Work Plan. In general, ample results will be used for:

- Characterization of the nature and extent of COPCs in river sediment;
- Characterization of chemical attributes affecting fate and transport of COPCs;
- Provision of data for the human health risk assessment to assess potential exposure to COPCs through direct contact, incidental ingestion, and consumption of fish; and
- Provision of data for the ecological risk assessment to assess potential exposure of river biota to COPCs through direct contact and ingestion.

Surface sediment samples will be collected from the top 10 centimeters of the sediment bed. The sediment samples will be collected beneath moving river water within 1 meter of the wetted edge of the river and in water less than 2 feet deep. Specific sampling methodologies are summarized in Chapter 4 of this FSP.

All of the Kuskokwim River sediment samples will be analyzed for total TAL inorganic elements, methyl mercury, arsenic speciation, grain size, and total organic carbon. Selected sediment samples also will be analyzed for mercury SSE. Table 2-5 summarizes the proposed numbers of sediment samples to be collected for selected laboratory analyses.

2.8 Plant Tissue

Vegetation samples will be collected during the 2011 field event to provide data on COPC concentrations in selected plant types. The numbers of samples of the targeted plant species and tissue planned for collection are summarized below in Table 2-6.

Table 2-6 Planned Plant Samples

Target Species	Target Tissue	Number of Samples			
		Site	Background	Field Duplicate	Total
Green alder	Bark	8	8	1	17
White spruce	Needles	8	8	1	17
Blueberry	Fruit	8	8	1	17
	Leaves and stems	8	8	1	17
Pond Vegetation	Aquatic or Semi-aquatic plants, to be determined	4	3	1	8
	Total	36	35	5	76

A composite sample of each plant species/tissue will be collected. Plant tissues from two to five individual plants will be combined into a single sample until the minimum required sample mass (50 to 100 grams fresh weight) is reached.

Table 2-5 Summary of Sediment Samples

General Geographic Area	Sub-Area	Location Description	Sample Location ID	Number of Samples						
				Total TAL Metals	Methyl Mercury	Arsenic Speciation	Mercury SSE	Grain Size	SVOCs with TICs	Total Organic Carbon
Red Devil Creek Area	Upstream from Main Processing Area	Downgradient from abondoned drum identified during the 2010 limited sampling effort	11RD11	1				1	1	1
	Main Processing Area	Upstream end of the Main Processing Area	11RD10	1	1	1	1	1	1	1
		Within Red Devil Creek, in mixing zone adjacent to Main Processing Area spring	11RD12	1	1	1	1	1		1
Kuskokwim River Area	Upriver from Red Devil Creek	900 feet upriver from Red Devil Creek Delta	11KR01	1	1	1		1		1
		750 feet upriver from Red Devil Creek Delta	11KR12	1	1	1	1	1		1
		300 feet upriver from Red Devil Creek Mouth	11KR14	1	1	1	1	1		1
		100 feet upriver from Red Devil Creek Mouth	11KR15	1	1	1	1	1		1
	Downriver from Red Devil Creek	100 feet downriver from Red Devil Creek Mouth	11KR16	1	1	1	1	1		1
		800 feet downriver from Dolly Sluice Delta	11KR17	1	1	1	1	1		1
		200 feet downriver from "Rice Sluice" Delta	11KR05	1	1	1		1		1
		200 feet upriver from Dolly Sluice Delta	11KR06	1	1	1		1		1
		100 feet downriver from Dolly Sluice Delta	11KR08	1	1	1	1	1		1
		200 feet downriver from Dolly Sluice Delta	11KR09	1	1	1		1		1
			Total	**13**	**12**	**12**	**8**	**13**	**2**	**13**

Key:

SSE = selective sequential extraction
SVOC = semivolatile organic compound
TAL = Target Analyte List
TIC - tentatively identified compound

Plant samples will be co-located with surface soil samples. If possible, the plant samples will be collected at locations co-located with surface soil samples collected during the 2010 LSE. E & E will revisit the 2010 LSE surface soil sample locations and look for the target plant species within a 3-meter radius of these locations. If the target plant species is sufficiently plentiful, a sample will be collected. If the desired number of composite plant samples can be attained with this approach, then no new surface soil samples will be collected. If not, then the target plant species will be collected from where they are available, and a new co-located soil sample will be collected. This general approach will be used to collect plant samples from various locations across the site and background locations. The site is defined as the Main Processing Area, Red Devil Creek downstream from the Main Processing Area, and area of surface mining and exploration. Prospective plant sample locations are illustrated in FSP Figures 2-13 and 2-13a. The prospective background locations include locations where Kuskokwim Group bedrock-derived upland background soil samples were collected and where Red Devil Creek alluvium background soil samples were collected in 2010. The background pond plant samples will be collected from the reservoir along Red Devil Creek upgradient from the site.

All plant tissue samples will be analyzed for total TAL metals. In addition, 50 percent of the plant samples will be analyzed for methyl mercury, and 50 percent of the blueberry fruit samples will be analyzed for arsenic speciation. If additional surface soil samples are collected, they will be analyzed for the same parameters as the plant samples. A summary of plant sampling and analysis by plant species and tissue type is provided in Table 2-7.

2.9 Quality Control Samples

Following the requirements specified in the RI/FS Quality Assurance Project Plan (QAPP), included in the RI/FS Work Plan, field quality control (QC) samples will be collected for all matrices and analytes (except soil samples collected for XRF field screening, grain size, and geotechnical parameters). QC samples will be:

- **Field Duplicates**: A field duplicate sample is a second sample collected at the same time and location as the original sample. Field duplicate samples are collected simultaneously (an extra volume of one sample, which is then homogenized and split into equal aliquots) or in immediate succession, using identical recovery techniques, and treated in an identical manner during storage, transportation, and analysis. The sample containers are assigned an identification number in the field such that they cannot be identified (blind duplicate) as duplicate samples by laboratory personnel performing the analysis. Duplicate sample results are used to assess precision of the overall sample collection and analysis process. For soil, sediment, surface water, and groundwater, field duplicate samples will be collected at a minimum frequency of one field duplicate for every 10 regular samples for each matrix and sampling method and/or type of equipment used. For vegetation samples, field duplicate samples will be collected at a rate of one field duplicate for every 20 regular samples by plant type.

Table 2-7 Summary of Plant Tissue Samples

Analytical Parameter	Target Plant Species	Target Plant Tissue	Number of Samples/Analyses		
			Mining Impacted Areas Excluding Settling Ponds	Settling Ponds	Background Locations
TAL Metals	Green alder	Bark	8		8
	White spruce	Needles	8		8
	Blueberry	Fruit	8		8
		Leaves and stems	8		8
	Pond Vegetation	TBD		4	3
Percent Moisture	Green alder	Bark	8		8
	White spruce	Needles	8		8
	Blueberry	Fruit	8		8
		Leaves and stems	8		8
	Pond Vegetation	TBD		4	3
Methylmercury	Green alder	Bark	4		4
	White spruce	Needles	4		4
	Blueberry	Fruit	4		4
		Leaves and stems	4		4
	Pond Vegetation	TBD		1	1
Arsenic Speciation	Blueberry	Fruit	4		4

Key:
TAL = Target Analyte List

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- **Matrix Spike**: Matrix spikes (MS) are used to assess the effect of the sample matrix on analyte recovery. A MS consists of an aliquot of a field sample to which the laboratory adds a known concentration of the analyte(s) of interest. An unspiked aliquot is also analyzed, and the %R for the spiked sample is calculated. Analysis of MSs requires collection of a sufficient volume of sample to accommodate the number of aliquots to be analyzed. The sample(s) chosen for MSs should be representative of the sample matrix but should not contain excessive concentrations of analytes or interfering substances. MSs are analyzed at a frequency of one MS per 20 or fewer samples for each matrix and each sampling event.

- **Rinseate Blanks:** Rinseate blanks are used to assess the effectiveness of equipment decontamination procedures when non-dedicated sampling equipment is used. A rinseate blank is a sample of ASTM Type II reagent grade water or equivalent (i.e., deionized), poured into or over the sampling device or pumped through it, collected in a sample container, and transported to the laboratory for analysis. Rinseate blanks will be collected immediately after the equipment has been decontaminated. The blank will be analyzed for all laboratory analyses requested for the environmental samples collected at the site. A minimum frequency of one rinseate blank per 20 field samples is required for each collection/decontamination method, by matrix and by sample type.

- **Equipment Blanks**: Equipment blanks are used to demonstrate that dedicated sampling equipment is adequately clean if a certificate is not available to demonstrate cleanliness. Equipment blanks will be analyzed for all laboratory analyses requested for the environmental samples collected at the site. One equipment blank sample for dedicated equipment will be collected at a rate of one for each set of dedicated equipment (i.e., bailers and sample tubing) of identical manufacturer’s lot number.

- **Trip Blanks**: One trip blank will be collected for every shipment of samples collected for BTEX analysis.

- **Field Blanks**: Field blanks are laboratory-provided, mercury-free water samples that are processed and treated as a regular sample in all respects, including contact with sampling devices, equipment, sampling site conditions, and analytical procedures. Field blanks are used to determine whether mercury detected in a sample is from the site or can be attributed to contamination. Field blanks will be collected at a rate of one field blank for every 10 regular samples to be analyzed for low-level mercury.

3 Sample Identification

Each sample collected for during the 2011 sampling event will be assigned a unique alphanumeric code. Sample codes will be recorded in field logbooks, on sample containers, and on chain-of-custody (COC) forms. The field team leader will be responsible for maintaining a master database or spreadsheet of samples to be collected and samples obtained to ensure that all planned samples are collected during the field investigation, sample designation codes are not used twice for different locations, and the correct analytical parameters are identified on laboratory documentation.

Tables 3-1 through 3-5 describe the sample coding system.

Table 3-1 Location Identification Coding System: In-Situ Surface Soil Tailings/Waste Rock Delineation XRF Field Screening

Characters	Purpose	Code	Description
1–2	Sample year	11	Last two digits of year
3	XRF Unit ID	A or B	A = XRF Unit A B = XRF Unit B
4–7	Location ID or Transect/Station ID	**For Point Locations:** PXXX **For Transect Locations:** TXXY	**For Point Locations:** PXXX, where: P signifies "Location" and XXX = Consecutive numerical characters identifying location (e.g., 001, 002, etc.). **For Transect Locations:** TXXY, where: T signifies "Transect"; XX = Consecutive numerical characters identifying transect (e.g., 01, 02, etc.); and Y = alpha character identifying station on transect (e.g., A, B, C, AA).

Example sample code for XRF surface soil screening:

- 11AP002: The second point location screened with XRF unit A.
- 11BT03A: Station A along Transect 3, screened with XRF unit B.

Surface and subsurface soil samples collected for laboratory analysis will be assigned sample identifiers as specified in Table 3-2. Pre-assigned sample location identifiers for proposed surface and subsurface soil samples are presented in Tables 2-1 and 2-2 and illustrated in FSP Figures 2-2 through 2-7.

Table 3-2 Sample Identification Coding System: Surface Soil and Subsurface Soil Samples

Characters	Purpose	Code	Description
1–2	Sample date	11	Last two digits of year
3–4	Area/Location	MP	Main Processing Area
		RD	Red Devil Creek area (including area along creek and on delta in Kuskokwim River)
		SM	Surface-mined area
		DS	Dolly Sluice delta area
		RS	Possible Rice Sluice area
		UP	Upland area west of Main Processing Area and area of surface mining and exploration
5–6	Location number	01, 02, etc.	Consecutive number within area/location
7–8	Matrix	SS	Surface soil
		SB	Subsurface soil
9–10	Depth (subsurface soil samples only)	02, 04, 06, etc.	Depth in feet below ground surface as measured at the bottom of the subsurface soil sample interval

Surface and subsurface soil samples collected for laboratory analysis will be field screened using an XRF analyzer. The sample coding described in Table 3-2 for laboratory samples will be used to identify samples field screened with the XRF.

Field duplicate samples for surface and subsurface soil samples will be identified by selecting a unique location number not used for the regular sample or any subsequent samples. All surface and subsurface soil samples will be cross-referenced in the field logbooks and in the sample master database to sample locations.

Example sample codes for surface and subsurface soil:

- 11MP04SS: The regular surface soil sample collected from the fourth surface soil/subsurface soil sampling station in the Main Processing Area.
- 11MP80SS: The field duplicate surface soil sample collected from the fourth surface soil/subsurface soil sample location in the Main Processing Area.

- 11MP04SB06: The regular subsurface soil sample collected from the fourth surface soil/subsurface soil sample location in the Main Processing Area, collected from a depth interval of from 4 to 6 feet below ground surface (bgs).
- 11MP80SB06: The field duplicate subsurface soil sample collected from the fourth surface soil/subsurface soil sample location in the Main Processing Area, collected from a depth interval of from 4 to 6 feet bgs.

Groundwater samples will be collected for laboratory analyses from existing and new monitoring wells during the 2011 sampling event. Groundwater samples will be collected from the wells identified in Table 2-3 and shown in FSP Figures 2-8 and 2-9. Groundwater samples will be assigned sample identifiers as specified in Table 3-3.

Table 3-3 Sample Identification Coding System: Groundwater Samples

Characters	Purpose	Code	Description
1–2	Sample date	11	Last two digits of year
3–4	Monitoring Well	MW	Existing monitoring wells installed in 2001 (MW-1, MW-3, MW-4, and MW-6) and new monitoring wells installed during this RI/FS.
5–6	Monitoring Well Identification Number	01, 02, etc.	Consecutive number. For existing monitoring wells installed in 2001, MW01 corresponds to MW-1, MW02 corresponds to MW-2, etc. New RI/FS monitoring wells will be installed within soil borings identified in Table 2-3 and assigned well identification numbers following successful installation of monitoring wells at the boring locations. New RI/FS monitoring wells identification numbers will begin with MW-08.
7–8	Matrix	GW	Groundwater

Field duplicate samples for groundwater samples will be identified by selecting a unique monitoring well identification number not used for the regular sample or any subsequent samples. All groundwater samples will be cross-referenced in the field logbooks and in the sample master database to monitoring well designations.

Example sample codes for groundwater:

- 11MW03GW: The regular groundwater sample collected from existing monitoring well MW-3.

- 11MW50GW: The field duplicate groundwater sample collected from existing monitoring well MW-3.
- 11MW08GW: The regular groundwater sample collected from new RI/FS monitoring well MW08.

Surface water and sediment samples will be assigned sample identifiers as specified in Table 3-4. Pre-assigned sample location identifiers for proposed surface water and sediment samples are presented in Table 2-3 (surface water) and 2-4 (sediment) and FSP Figures 2-10 and 2-11.

Table 3-4 Sample Identification Coding System: Surface Water and Sediment Samples

Characters	Purpose	Code	Description
1–2	Sample date	11	Last two digits of year
3–4	Area/location	RD	Red Devil Creek area (including creek and delta in Kuskokwim River; surface water and sediment).
		KR	Kuskokwim River (locations along Kuskokwim river; sediment only).
		SP	Surface water sample location within settling ponds.
5–6	Location number	01, 02, etc.	Consecutive number within area/location.
7–8	Matrix	SD	Sediment
		SW	Surface water

Field duplicate samples for surface water and sediment samples will be identified by selecting a unique location number not used for the regular sample or any subsequent samples. All surface water and sediment samples will be cross-referenced in the field logbooks and in the sample master database to sample locations.

Example sample codes for surface water and sediment:

- 11RD10SW: The regular surface water sample collected from surface water sampling station RD10 in Red Devil Creek.
- 11RD10SD: The regular surface sediment sample collected from sediment sampling station RD10 in Red Devil Creek.
- 11RD20SW: The field duplicate surface water sample collected from surface water sampling station RD10 in Red Devil Creek.
- 11RD20SD: The field duplicate surface sediment sample collected from surface sediment sampling station RD10 in Red Devil Creek.

Plant tissue samples will be assigned sample identifiers as specified in Table 3-5. Plant samples will be targeted for existing 2010 LSE soil sample locations. Whether or not the targeted plant species tissues will be present at any given 2010 soil sample location will not be determined until the 2011 field activities. Therefore, no sample location identifiers are pre-assigned. Possible vegetation sample locations are illustrated in FSP Figures 2-13 and 2-13a.

Table 3-5 Sample Identification Coding System: Plant Tissue Samples

Characters	Purpose	Code	Description
1–2	Sample date	11	Last two digits of year
3–4	Area/Location	MP	Main Processing Area
		RD	Red Devil Creek area (including area along creek and on delta in Kuskokwim River).
		SM	Surface-mined area
		UP	Upland area west of Main Processing Area and area of surface mining and exploration.
		SP	Settling Pond
		RS	Reservoir
5–6	Location number	01, 02, etc.	Consecutive number within area/location.
7–8	Matrix	GA	Green alder bark
		WS	White spruce needles
		BF	Blueberry fruit
		BL	Blueberry leaves and stems
		PV	Pond vegetation

Field duplicate vegetation samples will be identified by selecting a unique location number not used for the regular sample or any subsequent samples. All vegetation samples will be cross-referenced in the field logbooks and in the sample master database to sample locations.

Example sample codes for vegetation:

- 11SM04GA: The regular green alder bark sample collected from soil sampling station SM04 in the Main Processing Area.
- 11SM80GA: The field duplicate green alder bark sample collected from soil sample location SM04 in the Main Processing Area.

4

Sampling and Other Field Procedures

This chapter describes the procedures and equipment to be used in the collection of samples and collection of observations during the 2011 field activities. E & E SOPs are referred to in this chapter and subsequent chapters. A copy of all applicable E & E SOPs will be onsite during the implementation of the 2011 field work.

All surface water and groundwater sampling conducted for the 2011 field event will be conducted using ultraclean sampling methods (EPA Method 1669). In summary, ultraclean sampling methods involve the following procedures:

- Sampling equipment and containers are obtained from the laboratory that have been cleaned using detergent, mineral acids, and reagent water, filled with weak acid solution, and individually double bagged for storage and shipment.
- Onsite, one member of the two-person sampling team is designated as “dirty hands”; the second member is designated as “clean hands.” All operations involving contact with the sample container and transfer of the sample from the sample collection device to the sample container are handled by the individual designated as “clean hands.”
- A new pair of 8-mile nitrile gloves will be worn during each sample collection.
- All sampling equipment and sample containers used will be non-metallic and free from any material that may contain metals.
- Sampling personnel will wear clean, non-talc gloves when handling sampling equipment and sample containers.
- Surface water samples will be collected facing upstream and upwind (when possible) to minimize introduction of contamination.
- Acid preservatives will be placed in sample containers in a clean area prior to sample collection.

4.1 Surface Soil Characterization

Surface soil samples will be collected for laboratory analysis at all soil boring locations and additional locations as described in Section 2. Field screening for total metals using an XRF will be performed at each of these locations in addition to the field screening locations to delineate the areal extent of tailings/waste rock. Specific procedures to perform these activities are described below.

4.1.1 Surface Visual Inspection

The areal extent of disturbed native soils and tailings/waste rock will be delineated using visual observations and field screening for total metals using a portable XRF. As detailed in Chapter 2, based on a review of topography and historical aerial and other photographs and reports, the extent of tailings/waste rock has historically included much of the Main Processing Area, the bed, banks, and adjacent alluvial deposits of Red Devil Creek, and the delta of Red Devil Creek in the Kuskokwim River.

Based on a review of historical aerial and other photographs and the 2010 LSE results, disturbed native soils potentially containing elevated COPCs are present in the Area of Surface Mining and potentially in other areas with similar disturbed native soils.

Review of recent photographs indicates that some of the areas where tailings/waste rock have historically been located still likely have tailings/waste rock at the surface. At other locations, tailings/waste rock may have been redistributed, covered by soil, and/or vegetated.

The visual inspection to delineate the areal extent of tailings/waste rock will be performed in conjunction with XFR field screening for total metals. At each inspection location, any vegetation and organic detritus will be removed with a trowel or shovel to expose underlying tailings/waste rock or mineral soil. Observations of the soil will be recorded in the field logbook, and will include:

- Soil type;
- United Soil Classification System (USCS) soil group classification;
- Color;
- Odor;
- Grain size range and distribution;
- Soil particle mineralogy and lithology (e.g., greywacke or argillite of Kuskokwim group);
- Stratigraphy;
- Plasticity;
- Moisture content;
- Observations of gross contamination, including sheen or staining and elemental mercury;
- Mineralization, including sulfides (e.g., cinnabar, stibnite, and realgar, orpiment) and iron staining; and

- Observations of non-native materials (e.g., brick, wood, metal or other debris).

4.1.2 In-Situ XRF Field Screening

At each field screening location that will be evaluated for the presence of disturbed native soils or tailings/waste rock, the XRF will be used to field screen surface soils in-situ. Samples will not be extracted from the sampling station or containerized. In-situ XRF readings will be collected at each field screening location by at three discrete points arranged at the points of an equilateral triangle approximately one meter on each side. The XRF readings of the key metals (mercury [Hg], arsenic [As], and antimony [Sb]) will be recorded in the field logbook. XRF concentrations of these and other metals analyzed also will be recorded digitally by the XRF units. Rented Innov-X Alpha 4000 units and/or a BLM-owned Niton XL3t XRF device will be used. Operation of the XRF units will be in accordance with manufacturer specifications and the XRF SOP. A copy of the XRF SOP is attached at the end of this plan. The lateral coordinates of the field screening location will be recorded using GPS instrumentation.

4.1.3 Surface Soil Sampling for Laboratory Analysis

Surface soil samples for laboratory analysis will be collected from 0 to 6 inches below ground surface at each sample location. Large rocks, cobbles, and organic detritus will be removed from the sampling site prior to sample collection.

The sample will be collected by excavating a hole to a depth of 6 inches below the ground surface after surficial detritus has been removed. The sampling team will excavate each hole with a dedicated durable plastic scoop, if possible. It is anticipated that, at some sample locations, the targeted soil material may be too coarse and/or compacted to effectively excavate the hole with a plastic scoop. In the event that it is not possible or practical to excavate a hole with the plastic scoop, a clean stainless steel trowel and/or rock hammer pick will be used to excavate a ‘pilot hole’ to 6 inches below the surface. Subsequently, a dedicated durable plastic scoop will be used to remove the soil from the surface of the sidewall of the ‘pilot hole’ (by prying and undermining) that may have been in contact with the trowel or rock hammer pick. This material will be discarded. A dedicated durable plastic scoop will then be used to collect sample material from the newly exposed sidewall of the ‘pilot hole’ (by prying and undermining) from 0 to 6 inches below the surface. Collection of sample material for various laboratory analyses will be performed as described below.

Sample material for other inorganic analyses will be placed into a clean dedicated re-sealable plastic bag. The bag will be sealed and the material will be homogenized by working the material manually within the sealed bag. This material will subsequently be field screened with an XRF by testing the soil material directly through the bag. XRF field screening will be performed in accordance with the XRF SOP.

XRF field screening results will be recorded and used for the selection of samples for additional laboratory analyses as indicated in Table 2-1. Material for these analyses will be transferred from the plastic bag into the appropriate pre-cleaned sample containers using a dedicated plastic scoop.

For those sample locations selected for analysis for DRO, RRO, PCBs, and SVOCs, following collection of material for all the inorganic analyses, sample material will be collected with a dedicated stainless steel spoon and placed into a dedicated stainless steel bowl and thoroughly homogenized. The homogenized material will be placed into the appropriate pre-cleaned sample containers.

Sample locations will be recorded with a GPS unit and marked with survey flagging.

4.2 Subsurface Soil Sampling

Subsurface soil samples will be collected at soil boring locations identified in Section 2.2. Soil borings will be installed using either a hand auger operated by E & E field staff or a drill rig operated by a subcontracted Alaska-licensed driller. It is anticipated that physical access to the reservoir dam, the Dolly Sluice delta, and the possible Rice Sluice delta will be limited; therefore, it is expected that subsurface soil sampling at these locations may be performed with a hand auger in accordance with E & E's SOPs. It is anticipated that a drill rig will be used to install soil borings at all other locations.

A high-torque hollow-stem auger (HSA) drill rig will be used to advance soil borings. If the HSA drilling method/equipment is not capable of advancing the soil boring to the necessary depth, air-rotary/down-the-hole hammer drilling techniques will be employed. It is anticipated that a single drill rig that is capable of converting from HSA to down-the-hole hammer techniques will be used. Alternatively, separate HSA and air rotary/down-the-hole hammer drill rigs may be used.

Soil cores will be collected from soil borings installed with the drill rig using 2 foot split-spoon samplers. Soil cores will be collected continuously from near the ground surface to the total depth of each borehole.

Drilling and soil coring will continue at each borehole to the targeted depth if possible. The target depth of each borehole will depend on the specific objective for that borehole and conditions encountered during drilling, as described below.

- Each borehole will be advanced to at least approximately 3 feet below the base of the tailings/waste rock to confirm the depth of tailings/waste rock and to identify potential contamination below the tailings/waste rock in native unconsolidated material or bedrock.

- For those boreholes planned for conversion to monitoring wells, the borehole will be advanced to a depth adequate to allow construction of a monitoring well with a 10-foot screen (see Section 4.3). If such a soil boring planned for monitoring well installation encounters bedrock at a depth shallower than groundwater, the boring will be advanced until groundwater is encountered or to a maximum depth based on the site geologist's judgment.

Each borehole will be logged by a project geologist. Observations of soil cores will include the following:

- Soil type;
- USCS soil group classification;
- Color;
- Odor;
- Grain size and distribution;
- Soil particle lithology;
- Gradation;
- Plasticity;
- Bedding or sedimentary structures;
- Moisture content;
- Observations of gross contamination, including sheen and elemental mercury; and
- Mineralization, including sulfides and iron staining.

Following initial visual observation of the cored material, an aliquot of the soil will be collected for possible laboratory analysis for mercury SSE by placing the material directly into the sample container without homogenizing, thereby reducing potential volatilization of any elemental mercury that could be present in the material. Soil collected for organic analysis (DRO, RRO, and SVOCs) and inorganic analyses will be placed in a dedicated stainless steel bowl, thoroughly homogenized, and placed into pre-cleaned sample containers. For those samples for which no organics analyses are to be performed, following collection of an aliquot for mercury SSE, sample material will be placed into a clean dedicated re-sealable plastic bag and the bag will be sealed. This material will be homogenized by working the material manually within the sealed bag. This material will then be field screened with an XRF to provide data for the selection of samples for additional analyses (see FSP Chapter 2, including Table 2-2).

A subset of subsurface soil samples collected will be selected for laboratory analysis for total TAL metals and selected additional analyses including SPLP TAL metals, TCLP RCRA metals, mercury SSE, arsenic speciation, SVOCs, DRO, RRO, and geotechnical parameters.

After boreholes have been successfully advanced, unless they are converted to monitoring wells they will be abandoned at the completion of sampling or the end of the day. Soil borings will be abandoned in accordance with State of Alaska regulations. Management of drill cuttings will be performed as specified in Chapter 7.

4.3 Monitoring Well Installation, Construction, and Development

New monitoring wells will be installed within selected soil borings at the locations identified in Section 2.3. Wells will be installed in accordance with State of Alaska regulations and as described below.

The monitoring wells will be constructed of 2-inch inside-diameter, Schedule 40, National Sanitation Foundation (NSF)-approved, PVC flush-threaded joints. The wells will be screened with one 10-foot section of 2-inch, 0.010-inch slot PVC screen, or equivalent. Sections of pre-constructed sand pack filter/screen ("pre-pack" screens) may be used for construction of some new monitoring wells.

A 1-foot, 2-inch diameter, Schedule 40, matching thread, NSF-approved sump will be attached to the base of the well screen. The monitoring wells will be completed to ground surface using Schedule 40 PVC riser. All PVC casing joints will be of matching flush-threaded design with Viton O-rings and will be screwed together without the use of glues, epoxies, or petroleum-based lubricants. All materials will be cleaned and placed in polyethylene bags at the factory; the bags will remain sealed until the time of installation.

A minimum annular space of 2 inches between the borehole and well casing will be maintained. The annular space between the well screen and borehole will be filled with a uniform sand pack (i.e., conforming to the selected screen size) to serve as a filter media. The top of the sand pack will extend to approximately 2 to 3 feet above the top of the well screen.

A minimum 2-foot-thick bentonite pellet seal will be installed directly above the sand pack. A measured volume of clean water will be added and a specified time period (minimum one hour) will be allotted for maximum hydration. The remaining annulus will be filled with high solids bentonite grout or hydrated bentonite pellets or chips. The bentonite grout will consist of a mixture of powdered bentonite with the recommended volume of water to achieve an optimal seal. The grout will contain at least 30 percent solids by weight and have a density of 11 pounds per gallon or greater. Grout will be emplaced to approximately 3 feet bgs using a tremie pipe from the bottom of the annual space upwards to the surface. A concrete or cement surface seal will be used to finish grouting the annular space during well completions as discussed below. The monitoring wells will be completed with a 2.5-foot steel riser with locking monument above the ground surface. A locking well cap will secure the well inside the monument.

Prior to well development, grout will be allowed to cure for a minimum of 24 to 72 hours to allow sufficient time for the bentonite seal to cure. For wells installed below the water table, grout will be allowed a minimum of 72 hours curing time prior to development. For wells in which the bentonite seal is above the water table, development may proceed after a minimum of 24 hours. Well development will be accomplished by a combination of mechanical surging, bailing, and pumping with a submersible pump. The wells will be mechanically surged, depending on the geologic characteristics of the screened interval, to remove fines from inside the screen and casing and to flush the formation around the filter pack throughout the entire screened interval. Fines will be removed from the borehole periodically during the surging process using a bailer to minimize the re-entry of fines into the formation. The monitoring wells will then be pumped with a submersible pump until the measured water quality parameters are stabilized. Water will be removed throughout the entire water column by periodically lowering and raising the pump intake. Development will be considered complete when all water introduced during drilling, if any, plus a minimum of 5 to 10 well-bore volumes have been removed from the well, and the water is chemically stable and as free of sediment as possible. Water produced from the well will be considered chemically stable when field parameters, measured by E & E (pH, temperature, specific conductance, and turbidity) remain within 10 percent of the previous measurement for at least three successive measurements. Water produced from the well will be considered free of sediment when it is clear or turbidity has stabilized for at least three successive borehole measurements. The pump, tubing, and all other equipment used during development will be decontaminated between each use. All development water generated will be collected in 55-gallon drums. The development water will be disposed of as described in Section 7.3.

4.4 Groundwater Sampling

During the 2011 sampling event, groundwater samples will be collected from all existing and new RI/FS monitoring wells. To the extent practicable, groundwater sampling will occur in a progression from the least to the most contaminated wells, based on existing groundwater sample data.

In general, each well will be sampled following United States Environmental Protection Agency's (EPA's) Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers, EPA 542-S-02-001 (EPA 2002).

Prior to sample collection, each well will be sounded with a decontaminated electronic water level meter to determine the static water level, measured to the nearest 0.01 feet. The water level measurements will be used to determine groundwater elevation and to estimate the standing water volume contained within the well. The measurement will also be used to determine the depth of the pump intake and to monitor water drawdown during low-flow purging and sampling, as described below.

If feasible, each well will be purged and sampled using a low-flow purging and sampling technique. A battery-operated peristaltic pump outfitted with dedicated Teflon-lined tubing will be used to purge and sample the monitoring wells. The tubing will be lowered into the well to the targeted sample point at the middle of the water column within the screen interval. The well will be purged at a target rate of less than 0.5 liter/minute. During purging, the water level will be monitored with the water level indicator to measure well drawdown and to guide the adjustment of purge rate to minimize drawdown while purging. The sampling team will attempt to maintain less than 0.1 meter of drawdown during purging.

During purging, field water quality parameters, including pH, temperature, specific conductance, oxidation-reduction potential, dissolved oxygen, and turbidity, will be measured to determine when stabilization of the groundwater is achieved. Water quality parameters will be measured using an in-line water quality meter (e.g., Horiba U50 or similar equipment) and recorded in the field logbook. Field parameters will be measured every 3 to 5 minutes during purging. Field parameters will be considered stabilized after all parameters have stabilized for three successive readings. Criteria for stabilization are three successive readings within the following limits include:

- pH: ±0.1 pH units;
- Temperature: ±1 degree Celsius (°C);
- Specific electrical conductance (conductivity): ±3%;
- Turbidity: ±10% (when turbidity is greater than 10 nephelometric turbidity units);
- Dissolved oxygen: ±0.3 milligrams per liter; and
- Oxidation Reduction Potential: ±10 millivolts.

Upon stabilization of field parameters, groundwater samples will be collected directly into the appropriate (pre-preserved, as applicable) sample containers. Dissolved metals aliquots will be collected following collection of the other aliquots using a dedicated in-line 0.45-micrometer filter. The filter will be inserted into the end of the sample tubing while the pump is still running in order to maintain a steady flow of water, minimizing potential disturbance of formation groundwater. Following installation of the filter, the dissolved water aliquot will be collected directly into the appropriate sample container.

The use of peristaltic pumps to collect groundwater samples is limited by the ability of peristaltic pumps to draw water from depths of greater than approximately 25 feet. If it is not possible to collect a groundwater sample from a given well using a peristaltic pump, the sampling team will attempt to use a decontaminated positive pressure pump (e.g., Grundfos Redi-Flo or similar pump) to purge and sample the well using low-flow techniques. If neither of these approaches is successful at a given well, the well will be purged and sampled with a clean, disposable Teflon-lined polyethylene bailer. For wells that are not sampled using low-flow techniques, each well will be purged of a minimum of three well volumes prior to sample collection. During purging, field water quality parameters will measured as described above. It may not be possible to achieve the stabilization criteria outlined above using a bailer to purge the well. In this case, sample collection will occur after six well volumes have been purged from the well. Samples collected by bailer will be poured directly into the appropriate pre-cleaned sample containers. Dissolved metals samples will be collected by pouring water from the bailer into a dedicated transfer container and pumping the water into the sample container using a peristaltic pump outfitted with dedicated tubing and in-line 0.45-micrometer filter.

For those wells sampled for BTEX, if a positive pressure pump is not used to purge and sample the well, the aliquot for BTEX will be collected with a bailer following collection of all other aliquots.

4.5 Surface Water Sampling

At each surface water and sediment sampling location, the surface water sample will be collected prior to the sediment sample. Surface water samples from Red Devil Creek will be collected first from near the confluence of Red Devil Creek and the Kuskokwim River. Sampling will proceed upstream to avoid disturbing sediments that could impact turbidity and contaminant concentrations in downstream locations.

Samples will be collected using a battery-operated peristaltic pump outfitted with dedicated silicone tubing. The water sample will be collected from a single location within the middle of the stream channel at the mid-depth water level. Dissolved metals aliquots will be collected following collection of the other aliquots using a dedicated in-line 0.45-micrometer filter.

In the event that it is not possible to collect the water samples using a peristaltic pump, the samples will be collected by hand-dipping the sample container directly into the creek water. For sample containers that have been pre-preserved, a separate dedicated bottle may be used as a transfer container.

Following sample collection at each location, field parameters for pH, temperature, specific conductance, oxidation-reduction potential, dissolved oxygen, and turbidity will be measured using a water quality meter and recorded in the field logbook.

4.6 Sediment Sampling

For those locations where both a surface water sample and a sediment sample are planned, following collection of the surface water sample, the sediment sample will be collected. Sediment samples will be collected from the most downstream locations first, with work progressing upstream to avoid disturbing sediments that could impact downstream sample locations. Accordingly, the following sequence for sediment samples will be followed:

- Collect most down-river sample on Kuskokwim River first;
- Collect Kuskokwim River samples sequentially, moving up-river to Red Devil Creek;
- Collect Kuskokwim River sample up-river of Red Devil Creek; and
- Collect Red Devil Creek samples sequentially, moving upstream to the background sample location.

Sediment sample locations illustrated in Figures 2-10 and 2-11 are approximate locations. Actual sample locations will be established in sediment depositional areas where fine-grained material is expected to accumulate. Areas containing a rocky substrate will be avoided. All sediment samples will be collected from below the water line.

Sediment samples will be collected from the top 10 centimeters (0 to 4 inches) of the bed sediments. Any organic debris that may be present will be removed from the sampling location prior to sample collection. Samples collected from Red Devil Creek will be collected from the middle of the stream channel, if possible. Samples collected from the shoreline of the Kuskokwim River will be collected from water less than 2 feet deep. The aliquot of sediment collected for laboratory analysis for mercury SSE will be placed directly into the sample container using a dedicated plastic scoop. This material will not be homogenized, thus reducing potential volatilization of any elemental mercury that could be present in the sediment material. Sediment to be analyzed for the other laboratory analyses will be placed into a dedicated plastic bowl using a dedicated plastic scoop. The collected sediment will be thoroughly homogenized, and placed into pre-cleaned sample containers.

At each sediment sample location, physical characteristics of the sediment material will be observed and recorded. Specific characteristics that will be documented are:

- Color;
- Odor;
- Grain size range and distribution;
- Sediment particle mineralogy and lithology (e.g., greywacke or argillite of Kuskokwim group);
- Stratigraphy;
- Observations of gross contamination, including sheen or staining and elemental mercury;
- Mineralization, including sulfides (e.g., cinnabar, stibnite, and realgar, orpiment) and iron staining; and
- Observations of non-native materials (e.g., brick, wood, metal or other debris).

4.7 Plant Tissue Sampling

Plant tissue samples will be collected by gloved hand with the aid of a stainless steel blade or scissors if necessary and placed into food-grade plastic bags with zip closures. New gloves will be used for each sample and sampling equipment will be decontaminated between samples. Composite samples will be collected. Plant tissues from multiple (two to five) individual plants will be combined into a single sample until the minimum required sample mass (50 to 100 grams fresh weight) is reached. The minimum required sample mass will be verified with the contract laboratory. One composite duplicate sample each of green alder bark, white spruce needles, blueberry fruit, and blueberry stems and leaves will be collected. The field duplicate sample will be taken from the sample plants that the routine sample is collected from.

The plant tissue samples will be stored and shipped on ice (approximately 4°C). Samples will be analyzed unwashed. Loosely adhering external contamination, if present, will be shaken off in the field. If the plant samples cannot be analyzed immediately after receipt by the laboratory, they will be stored frozen.

If collection of new surface soils samples becomes necessary (see Section 2.8), E & E will follow the soil sample collection methods presented in Section 4.1.3 to collect new so-located soil samples. The target depth range for any new surface soil samples will be 0 to 6 inches beneath any surface vegetation and/or leaf-litter layer.

4.8 Surface water and Spring Discharge Measurement

Surface water discharge will be measured using the Mid-Section method at each surface water sampling location where the estimated discharge is greater than 2.0 cubic feet per second (cfs) and a portable weir plate will be used for streams sections with smaller discharge rates. Discharge will be measured in accordance with Measurement and Computation of Streamflow: Volume 1, Measurement of Stage and Discharge (Rantz 1982) and Techniques of Water-Resources Investigations Reports (USGS 2011).

4.8.1 Measurement Methods

The following sections detail the methods to be used. Field staff will determine which of the two proposed methods will be applied based on the flow rate during the measurement event.

4.8.1.1 Mid-Section Method

The Mid-Section method involves measuring the channel area and water velocities at a stream cross section. This method will be used where sufficient stream flow is available to allow the channel to be divided into rectangular subsections. After dividing the stream into subsections, the depth, discharge, and distance from bank will be measured at the center of the stream subsection.

The preferred number of subsections across the width of the stream is 20 to 30, with a minimum of 10. If the stream width is less than 5 feet, the width of the sub sections should not be less than 0.5 feet. Not more than 5 percent of stream discharge should occur within a single subsection. Subsections do not have to be the same width. For water depths greater than 2.5 feet, velocity will be measured at two depths, 20 and 80 percent of the total subsection depth, and averaged. For water depths less than 2.5 feet, velocity only will be measured at 60 percent of the total subsection depth.

Appropriate locations for stream cross sections are straight reaches where the streambed is; uniform, free of boulders and aquatic vegetation, and where the stream flow is uniform.

4.8.2.1 Portable Weir Plates

Portable weir plates will be used where Red Devil Creek is too small or velocities too low to reliably use the above Mid-Section method. This is typically where stream widths are shallow and flows are less than 2.0 cfs. Weir plates are constructed with a staff gage on the upstream side, far enough away from the notch to not be impacted by the drawdown of flow through the notch. Once a steady-state discharge through the weir has been reached, the height behind the weir plate is recorded to determine the flow rate through the weir. These are intended to be short-term measurement devices and are removed after each use.

4.8.2 Discharge Calculation

The general equation for calculating discharge is:

Discharge (Q) = Velocity (v) x Cross sectional area of stream channel (A)

For the Mid-Section method, stream discharge will be calculated for each subsection (q) and then summed together to obtain total discharge (Q).

$q_{1,2,3,\text{etc.}} = V_{1,2,3,\text{etc.}} \times \text{Depth at Midpoint}_{1,2,3,\text{etc.}} \times \text{Width of Subsection}_{1,2,3,\text{etc.}}$

and,

$Q = q_1 + q_2 + q_3 + q_{\text{etc.}}$

For the Portable Weir Plate method, the following equation will be used:

Q = Ch^(5/2)

where,

Q = Discharge (cfs);

h = Static head above the bottom of the notch (mean gage height), in feet; and
C = Coefficient of discharge. A standard value of 2.47 will be used for C assuming a 90 degree notched V-weir.

4.8.3 Equipment

Stream discharge measurement will require the following equipment:

Mid-Section Method: a Marsh McBirney or similar flow meter, top-setting wading rod, long tape measure, waders, and calculator.

Portable Weir Plate: portable weir plate, constructed to USGS standard specifications, shovel, carpenter's level, rebar to stabilize the weir (as needed), and canvas or similar to prevent downstream undercutting.

4.8.4 Stream Measurements

4.8.4.1 Mid-Section Method

After identifying a suitable location for the stream cross section, select a reference point on one bank. Then stretch a tape measure across the stream, fixing it to the reference point on one bank and another point on the opposite bank, while ensuring that the tape is oriented perpendicular to the stream flow.

Using the measured channel width, determine the appropriate number of sub sections based on the guidelines in Section 3.8.2.1.

From the mid-point of each subsection measure the stream velocity at the depths provided in Section 3.8.2.1. When measuring the stream velocity the wading rod and flow meter should be located upstream from the field personnel to ensure that stream flow is not disrupted.

Discharge will then be calculated as described in Section 3.8.2.2 and the velocity of each subsection will be checked ensure that it is less than 5 percent of the total stream discharge. If any subsection contains more than 5 percent of the stream discharge, additional subsections will be measured.

4.8.4.2 Portable Weir Plate

The weir plate is pushed into the stream bed perpendicular to the flow, with an effort made to channel all of the stream flow through the weir by using stream bed material to pack around the weir and/or channelize the flow towards the opening of the weir plate. As needed, an estimation of flow around the weir will be made and noted. A carpenter’s level is then used to ensure that the weir is horizontal after insertion and that the weir is vertical. This is done to provide an accurate and consistent measurement relative to the water surface. Weir plates will not be submerged on either the up or downstream sides to also increase accurate readings.

Once the pool height has stabilized on the upstream side of the weir, gage readings will be recorded every 30 seconds for three minutes. The mean value of these readings will then be used to compute discharge.

5

Sample Analytical Methods

Sample analytical methods, including holding times and method detection limits, are presented in the QAPP (Appendix C of the RI/FS Work Plan). For reference, Table 5-1 summarizes the sample analytical methods. The selected laboratory methods include total and dissolved metals, methyl mercury, petroleum hydrocarbons, SVOCs, PCBs, geotechnical parameters, and various conventionals. In addition, several other analyses—mercury SSE, arsenic speciation, SPLP metals, and arsenic bioavailability—will be used to assess transport and fate of COPCs in the environment. These analyses are described briefly below.

5.1 Mercury Selective Sequential Extraction

The mercury SSE procedure will be used to inform the evaluation of the mobility and bioavailability of mercury in soils. Generally, mercury SSE fractions F1 through F3 are more mobile and bioavailable and fractions F4 through F6 are less mobile and bioavailable. When interpreting mercury SSE data, the proportions of the mineral bound forms are compared to the non-mineral bound forms. A summary of the selective extraction technique and typical mercury compounds identified by each extraction step is provided below.

Step	Extractant	Fraction Description	Typical Compounds
F0	De-ionized Water	Volatile	Hg_0
F1	De-ionized Water	Water soluble	$HgCl_2$, $HgSO_4$ (salts)
F2	pH 2 HCl/HOAc	Stomach acid soluble (weak acid)	HgO
F3	1 M KOH	Organo-complexed	Hg-humics, Hg_2Cl_2
F4	12 M HNO_3	Strong complexed	mineral lattice, Hg_2Cl_2, Hg_0
F5	Aqua Regia (concentrated HCl and HNO_3)	Mineral bound/cinnabar	HgS, m-HgS, HgSe, HgAu
F6	Hydrofluoric Acid	Mineral bound	Hg-silicates

Key:
HCL = Hydrochloric acid
HOAc = Acetic acid
M = Molar
KOH = Potassium hydrochloride
HNO_3 = Nitric acid
HgO = Mercuric Oxide
HgCl2 = Mercuric chloride
HgSO4 = Mercuric sulfate
Hg_O = Elemental mercury
Hg = Mercury
Hg2Cl2 = Mercurous chloride
HgS = Cinnabar
m-HgS = Metacinnabar
HgSe = Mercuric selenide
HgAu = Mercury-gold amalgam

5.2 Arsenic Speciation

Arsenic speciation analysis will be used along with other data to help inform the evaluation of the mobility of arsenic in the environment. The concentrations of arsenic III (arsenite), arsenic V (arsenate) and total arsenic will be analyzed.

5.3 SPLP and TCLP Metals

SPLP and TCLP metals analyses will be used along with other data to help inform the evaluation of the mobility of COPCs in the environment. TCLP results will also be compared to RCRA regulatory criteria.

5.4 Arsenic Bioavailability

Arsenic bioavailability analysis is being used along with other data to help inform the evaluation of the mobility and bioavailability of arsenic.

Table 5-1 Summary of Sample Analytical Methods

Subgroup	Analyte	Analytical Method
Matrix: Soil/Sediment		
Analytical Group: Metals		
Total Metals	▪ Mercury	▪ EPA 7471A
	▪ Mercury (low level)	▪ EPA 1631
	▪ Aluminum	▪ EPA 6010B
	▪ Antimony	▪ EPA 6020A (mass=121)
		▪ EPA 6020A (mass=123)
	▪ Arsenic	▪ EPA 6010B
	▪ Arsenic (low level)	▪ EPA 6020A
	▪ Barium	▪ EPA 6020A (mass=135)
		▪ EPA 6020A (mass=137)
	▪ Beryllium	▪ EPA 6020A
	▪ Cadmium	▪ EPA 6020A (mass=111)
		▪ EPA 6020A (mass=114)
	▪ Calcium	▪ EPA 6010B
	▪ Chromium	▪ EPA 6020A (mass=52)
		▪ EPA 6020A (mass=53)
	▪ Cobalt	▪ EPA 6020A
	▪ Copper	▪ EPA 6020A (mass=63)
		▪ EPA 6020A (mass=65)
	▪ Iron	▪ EPA 6010B (mass=54)
		▪ EPA 6010B (mass=57)
	▪ Lead	▪ EPA 6010B
	▪ Magnesium	▪ EPA 6010B
	▪ Manganese	▪ EPA 6020A
	▪ Nickel	▪ EPA 6020A (mass=60)
		▪ EPA 6020A (mass=62)
	▪ Potassium	▪ EPA 6010B
	▪ Selenium	▪ EPA 6020A (mass=82)
		▪ EPA 6020A (mass=78)
	▪ Silver	▪ EPA 6020A
	▪ Sodium	▪ EPA 6010B
	▪ Thallium	▪ EPA 6020A
	▪ Vanadium	▪ EPA 6020A
	▪ Zinc	▪ EPA 6020A (mass=66)
		▪ EPA 6020A (mass=67)
		▪ EPA 6020A (mass=68)
▪ **Methyl Mercury**	▪ Methyl Mercury	▪ EPA 1630, modified
▪ **Mercury Selective Sequential Extraction**	▪ Mercury	▪ BRL SOP #BR-0013; Hg 5-step SSE and (www.epa.gov/esd/pdf-ecb/542asd95.pdf)
▪ **Arsenic Species**	▪ Arsenic Species	▪ EPA 1632, modified As (inorganic)
		▪ EPA 1632, modified As (III)
		▪ EPA 1632, modified As (V)
▪ **SPLP Metals**	▪ TAL Metals	▪ EPA 1312/6020A/7470A
▪ **TCLP Metals**	▪ Arsenic, Barium, Cadmium, Chromium, Lead, Mercury, Selenium, Silver	▪ EPA 1311/6020A/7470A
▪ Arsenic bioavailability	▪ Arsenic	▪ EPA 9200.1-89, Per Drexler mod / EPA 6020

Table 5-1 Summary of Sample Analytical Methods

Subgroup	Analyte	Analytical Method
Analytical Group: Petroleum		
	▪ Diesel Range Organics	▪ AK 102
	▪ Residual Range Organics	▪ AK 103
Analytical Group: Conventionals and Geotechnical Parameters		
	▪ Particle Size/Atterberg Limits	▪ ASTM D2487
	▪ Grain Size Analysis	▪ ASTM D422
	▪ Total Organic Carbon (TOC) ▪ Moisture Content ▪ Permeability ▪ Compaction	▪ EPA 9060 modified ▪ ASTM D2216 ▪ ASTM D2434 ▪ ASTM D1557 ▪
Analytical Group: SVOCs and PCBs		
	▪ SVOCs + TICs	▪ EPA 8270D
	▪ PCBs	▪ EPA 8082
Matrix: Groundwater/Surface Water		
Analytical Group: Metals		
▪ **Total and Dissolved Metals**	▪ Total Mercury (low level)	▪ EPA 1631
	▪ Aluminum	▪ EPA 6010B
	▪ Antimony	▪ EPA 6020A (mass=121)
		▪ EPA 6020A (mass=123)
	▪ Arsenic	▪ EPA 6020A
	▪ Barium	▪ EPA 6020A (mass=135)
		▪ EPA 6020A (mass=137)
	▪ Beryllium	▪ EPA 6020A
	▪ Cadmium	▪ EPA 6020A (mass=111)
		▪ EPA 6020A (mass=114)
	▪ Calcium	▪ EPA 6010B
	▪ Chromium	▪ EPA 6020A (mass=52)
		▪ EPA 6020A (mass=53)
	▪ Cobalt	▪ EPA 6020A
	▪ Copper	▪ EPA 6020A (mass=63)
		▪ EPA 6020A (mass=65)
	▪ Iron	▪ EPA 6010B (mass=54)
		▪ EPA 6010B (mass=57)
	▪ Lead	▪ EPA 6020A
	▪ Magnesium	▪ EPA 6010B
	▪ Manganese	▪ EPA 6010B
	▪ Nickel	▪ EPA 6020A (mass=60)
		▪ EPA 6020A (mass=62)
	▪ Potassium	▪ EPA 6010B
	▪ Selenium	▪ EPA 6020A (mass=82)
		▪ EPA 6020A (mass=78)
	▪ Silver	▪ EPA 6020A
	▪ Sodium	▪ EPA 6010B
	▪ Thallium	▪ EPA 6020A
	▪ Vanadium	▪ EPA 6020A
	▪ Zinc	▪ EPA 6020A (mass=66)
		▪ EPA 6020A (mass=67)
		▪ EPA 6020A (mass=68)
▪ Methyl Mercury	▪ Methyl Mercury	▪ EPA 1630
▪ Arsenic Speciation	▪ Arsenic Species	▪ EPA 1632, modified As (inorganic)

Table 5-1 Summary of Sample Analytical Methods

Subgroup	Analyte	Analytical Method
		▪ EPA 1632, modified As (III)
		▪ EPA 1632, modified As (V)
Analytical Group: Petroleum		
	▪ Gasoline Range Organics	▪ AK 101
	▪ Diesel Range Organics	▪ AK 102
	▪ Residual Range Organics	▪ AK 103
	▪ Benzene	▪ EPA 8021B (15.0 mL)
		▪ EPA 8021B (5.0 mL)
	▪ Toluene	▪ EPA 8021B (15.0 mL)
		▪ EPA 8021B (5.0 mL)
	▪ Ethylbenzene	▪ EPA 8021B (15.0 mL)
		▪ EPA 8021B (5.0 mL)
	▪ m/p-Xylene	▪ EPA 8021B (15.0 mL)
		▪ EPA 8021B (5.0 mL)
	▪ o-Xylene	▪ EPA 8021B (15.0 mL)
		▪ EPA 8021B (5.0 mL)
Analytical Group: SVOCs		
	▪ SVOCs + TICs	▪ EPA 8270D
Analytical Group: Conventionals		
	▪ Sulfate	▪ EPA 300.0
	▪ Chloride	▪ EPA 300.0
	▪ Fluoride	▪ EPA 300.0
	▪ Nitrate/Nitrite	▪ EPA 353.2
	▪ Carbonate, Bicarbonate	▪ EPA 310.1
	▪ Total Suspended Solids	▪ EPA 160.1
	▪ Total Dissolved Solids	▪ EPA160.2
Matrix: Vegetation		
Analytical Group: Metals		
	▪ Mercury	▪ EPA 7471A
	▪ Mercury (low level)	▪ EPA 1631
	▪ Aluminum	▪ EPA 6010B
	▪ Antimony	▪ EPA 6020A (mass=121)
		▪ EPA 6020A (mass=123)
	▪ Arsenic	▪ EPA 6010B
	▪ Arsenic (low level)	▪ EPA 6020A
	▪ Barium	▪ EPA 6020A (mass=135)
		▪ EPA 6020A (mass=137)
	▪ Beryllium	▪ EPA 6020A
	▪ Cadmium	▪ EPA 6020A (mass=111)
		▪ EPA 6020A (mass=114)
	▪ Calcium	▪ EPA 6010B
	▪ Chromium	▪ EPA 6010B (mass=52)
		▪ EPA 6010B (mass=53)
	▪ Cobalt	▪ EPA 6020A
	▪ Copper	▪ EPA 6020A (mass=63)
		▪ EPA 6020A (mass=65)
	▪ Iron	▪ EPA 6010B (mass=54)
		▪ EPA 6010B (mass=57)
	▪ Lead	▪ EPA 6020A
	▪ Magnesium	▪ EPA 6010B

Table 5-1 Summary of Sample Analytical Methods

Subgroup	Analyte	Analytical Method
	▪ Manganese	▪ EPA 6020A
	▪ Nickel	▪ EPA 6020A (mass=60)
		▪ EPA 6020A (mass=62)
	▪ Potassium	▪ EPA 6010B
	▪ Selenium	▪ EPA 7742 (mass=82)
		▪ EPA 7742 (mass=78)
	▪ Silver	▪ EPA 6020A
	▪ Sodium	▪ EPA 6010B
	▪ Thallium	▪ EPA 6020A
	▪ Vanadium	▪ EPA 6020A
	▪ Zinc	▪ EPA 6020A (mass=66)
		▪ EPA 6020A (mass=67)
		▪ EPA 6020A (mass=68)
Methyl Mercury	▪ Methyl Mercury	▪ EPA 1630, modified
Arsenic Speciation	▪ Arsenic Species	▪ EPA 1632, modified As (inorganic)
		▪ EPA 1632, modified As (III)
		▪ EPA 1632, modified As (V)

Key:
EPA = Environmental Protection Agency
mL = milliliter
PCB = Polychlorinated Biphenyls
SVOCs = semivolatile organic compounds
SPLP = Synthetic Precipitation Leaching Procedure
TCLP = Toxicity Characteristic Leaching Procedure
TICs = Tentatively Identified Compounds

6

Sample Handling, Preservation, and Shipping

Transportation and handling of samples must be accomplished in a manner that not only protects their integrity but also prevents any detrimental unnecessary exposure to sample handlers due to the possibly hazardous nature of the samples.

6.1 Sample Documentation

6.1.1 Sample Labels

Sample labels attached to or fixed around the sample container will be used to identify all samples collected in the field. The sample labels will be placed on bottles so as not to obscure any quality assurance/quality control (QA/QC) lot numbers on the bottles, and sample information will be printed legibly. Field identification will be sufficient to enable cross-reference with the project logbook.

To minimize handling of sample containers, labels will be filled out before sample collection. Each sample label will be written in waterproof ink, attached firmly to the sample containers, and protected with Mylar tape. The sample label will contain the following information:

- Sample designation code,
- Date and time of collection,
- Analysis required, and
- pH and preservation (when applicable).

6.1.2 Custody Seals

Custody seals are preprinted, adhesive-backed seals with security slots designed to break if the seals are disturbed. Sample shipping containers (e.g., coolers) will be sealed in as many places as necessary to ensure security. Seals will be signed and dated before use. Upon the containers' arrival at the laboratory, the custodian will check (and certify by completing the package receipt log) that seals are intact.

6.1.3 Chain-of-Custody Records

The COC records will be completed fully, at least in duplicate, by the field technician designated by the site manager as responsible for sample shipment. Information in the COC record will contain the same level of detail found in the site logbook, except that the onsite measurement data will not be recorded. The custody record will include, among other things, the following information:

- Name and company or organization of person collecting the samples;
- Date of sample collected;
- Matrix of sample collected (soil/water);
- Location of sampling station (using the sample designation code system described in Chapter 3);
- Number and type of containers shipped;
- Analysis requested;
- Signature of the person relinquishing samples to the transporter, with the date and time of transfer noted, and signature of the designated sample custodian at the receiving facility.

If samples require rapid laboratory turnaround, the person completing the COC record will note these or similar requirements in the remarks section of the custody record.

The relinquishing individual will record pertinent shipping data (e.g., air-bill number, organization, time, and date) on the original custody record, which will be transported with the samples to the laboratory and retained in the laboratory’s file. Original and duplicate custody records with the air bill or delivery note constitute a complete custody record. The field team leader will ensure that all records are consistent and that they are made part of the permanent job file.

6.1.4 Field Logbooks and Data Forms

Field logbooks (or daily logs) and data forms are necessary to document daily activities and observations. Documentation will be sufficient to enable reconstruction of events that occurred during the project accurately and objectively at a later time. All daily logs will be kept in a bound notebook containing numbered pages, and all entries will be made in waterproof ink, dated, and signed. No pages will be removed for any reason.

Minimum logbook content requirements are described in E & E’s SOPs, *Preparation of Field Activities Logbooks*, a copy of which will be kept onsite during the field activities. If corrections are necessary, they will be made by drawing a single line through the original entry (so that the original entry is still legible) and writing the corrected entry alongside it. The correction will be initialed and dated. Corrected errors may require a footnote explaining the correction.

6.1.5 Photographs

Photographs will be taken as directed by the team leader. Documentation of a photograph is crucial to ensure its validity as a representation of an existing situation.

The following information on photographs will be noted in field logbooks:

- Date, time, and location photograph was taken;
- Weather conditions;
- Description of photograph;
- Reasons photograph was taken;
- Sequential number of photograph; and
- Direction.

After the photographs are processed, the information recorded in the field logbook will be summarized in captions in the digital photo log.

6.1.6 Custody Procedures

The primary objective of COC procedures is to provide an accurate written or computerized record that can be used to trace the possession and handling of a sample from collection to completion of all required analyses. A sample is considered to be in custody if it is:

- In someone’s physical possession,
- In someone’s view,
- Locked up, and
- Kept in a secured area that allows authorized personnel only.

6.1.6.1 Field Custody Procedures

The following guidance will be used to properly control samples during fieldwork:

- As few people as possible will handle samples.
- Coolers or boxes containing cleaned bottles will be sealed with custody tape during transport to the field or while in storage before use. Sample bottles from unsealed coolers or boxes, or bottles that appear to have been tampered with, will not be used.
- The sample collector will be responsible for the care and custody of samples until they are transferred to another person or dispatched properly under COC rules.
- The sample collector will record sample data in the field logbook.
- The site team leader will determine whether proper custody procedures were followed during the fieldwork and decide whether additional samples are required.

When custody is transferred (e.g., samples are released to a shipping agent), the following will apply:

- The coolers in which the samples are packed will be sealed and accompanied by two COC records. When transferring samples, the individuals relinquishing and receiving them must sign, date, and note the time on the COC record. This record documents sample custody transfer.
- Samples will be dispatched to the laboratory for analysis with separate COC records accompanying each shipment. Shipping containers will be sealed with custody seals for shipment to the laboratory. The method of shipment, name of courier, and other pertinent information will be entered in the COC record.
- All shipments will be accompanied by COC records identifying their contents. The original record will accompany the shipment. The other copies will be distributed appropriately to the site team leader and site manager.
- If samples are sent by common carrier, a bill of lading will be used. Freight bills and bills of lading will be retained as part of the permanent documentation.

6.1.6.2 Laboratory Custody Procedures

A designated sample custodian at the laboratory will accept custody of the shipped samples from the carrier and enter preliminary information about the package into a package or sample receipt log, including the initials of the person delivering the package and the status of the custody seals on the coolers (e.g., broken versus unbroken). Additional details on laboratory custody procedures are found in the QAPP.

6.2 Sample Containers and Preservation

Sample aliquots submitted to the analytical laboratories will be placed in commercial certified pre-cleaned sample containers and preserved as identified in Table 6-1.

6.3 Sample Shipping

Due to the remote location of the RDM site, sample shipment to the analytical laboratories will require careful logistical planning to ensure sample holding times are not exceeded and that samples arrive at the laboratories in good condition. In general, sample shipping logistics will involve the following:

- The field team leader will keep records of sample collection dates. Based on the dates of samples being held on site and the number of samples ready for shipment, the field team leader will contact E & E’s Anchorage-based sample custodian to notify an aircraft charter service that a sample shipment flight is needed.
- When the sample shipment aircraft arrives at the Red Devil airstrip, the field team leader will relinquish custody of the samples to the pilot.

- When the sample shipment aircraft arrives in Anchorage, E & E’s Anchorage-based sample custodian will assume custody of the samples. The custodian will re-pack all sample shipping containers with fresh ice and relinquish custody of the samples to an overnight delivery service that will ship the samples to the analytical laboratories.
- E & E’s Anchorage-based sample custodian will confirm with the laboratories that all shipped samples have been received.

Table 6-1 Sample Containers and Preservation

Matrix	Analysis	Maximum Holding Time	Preservation	Sample Containers
Soil/Sediment	TAL Inorganic Elements	6 months (28 days for Hg)	None, 0–4°C	4-oz glass jar
	Methyl Mercury	1 year (if aliquoted, weighed, and frozen ≤ –15°C at lab)	None, 0–4°C (shipment), ≤ –15°C (in lab)	4-oz glass jar
	Low-Level As, Sb, Pb, Hg	6 months (1 year for Low-Level Hg)	None, 0–4°C (None, 0–4°C (shipment), ≤ –15°C (in lab) for Low Level Hg)	4-oz glass jar
	SPLP Metals	6 months	None, 0–4°C	8-oz glass jar
	Mercury SSE	1 year	None, 0–4°C (shipment), ≤ –15°C (in lab)	4-oz glass jar
	Arsenic Speciation	1 year	None, 0–4°C (shipment), ≤ –15°C (in lab)	4-oz glass jar
	TCLP Metals	6 months (28 days for Hg)	None, 0–4°C	8-oz glass jar
	ASTM D2487, Particle Size and determination of Atterberg Limits	None	None	5-gallon bucket
	ASTM D422	None	None	16-oz glass or plastic jar or plastic bag.
	ASTM D2216 (Moisture Content)	10 days	None, 0–4°C	4-oz glass jar
	ASTM D3080 (Direct Shear Test)	None	None	5-gallon bucket
	ASTM D1557 (Compaction/Modified Proctor Test)	None	None	5-gallon bucket
	ASTM D2434 (Permeability)	None	None	5-gallon bucket
	Polychlorinated Biphenyls	14 days to extraction, 40 days from extraction to analysis	Cool to < 6°C	8 oz. glass jar with Teflon-lined lid
	Bioavailability of Arsenic	TBD	TBD	TBD
	DRO/RRO (AK102/103)	14 days to extraction, 40 days from extraction to analysis	Cool to < 6°C	8 oz. glass jar with Teflon-lined lid
	SVOCs with TICs	14 days to extraction, 40 days from extraction to analysis	Cool to < 6°C	8 oz. glass jar with Teflon-lined lid
Water	Total TAL Inorganic Elements	6 months (28 days for Hg)	HNO_3, pH<2, 0–4°C	500-mL plastic bottle

Table 6-1 Sample Containers and Preservation

Matrix	Analysis	Maximum Holding Time	Preservation	Sample Containers
	Dissolved TAL Inorganic Elements	6 months	HNO_3, pH<2, 0–4°C	500-mL plastic bottle
	Methyl Mercury	6 months	0–4°C and dark immediately; HCl, pH<2	250-mL pre-tested fluoropolymer or glass bottle w/fluoropolymer-lined lids (no extra volume needed for MS/MSD)
	Dissolved Low-Level As, Sb, Pb, Hg	6 months (90 days for Low-Level Hg)	HNO_3, pH<2, 0–4°C (BrCl in lab within 28 days of collection for low-level Hg)	500-mL (for MS/MSD sample) or 250-mL plastic bottle; pre-tested fluoropolymer or glass bottle w/fluoropolymer-lined lids
	Arsenic Speciation	28 days	0–4°C and dark immediately; HCl, pH<2	250-mL pre-tested fluoropolymer or glass bottle w/fluoropolymer-lined lids (no extra volume needed for MS/MSD)
	DRO/RRO	7 days for extraction, 40 days after extraction for analysis	None, 0–4°C	1-L amber bottle
	SVOCs with TICs	7 days for extraction, 40 days after extraction for analysis	None, 0–4°C	1-L amber bottle
	GRO and BTEX	14 days preserved, 7 days unpreserved.	HCl to pH <2, cool to 6°C	Four 40-mL amber glass vials, no headspace
	Total suspended solids	7 days	Cool to 6°C	1000 mL HDPE
	Total dissolved solids	7 days	Cool to 6°C	1000 mL HDPE
	Nitrate/Nitrite	28 days	2 mL H_2SO_4 per liter. Cool to 6°C	500 mL or 1-L HDPE
	Alkalinity	14 days	Cool to 6°C	500 mL HDPE

Table 6-1 Sample Containers and Preservation

Matrix	Analysis	Maximum Holding Time	Preservation	Sample Containers

Key:

As	arsenic
ASTM	American Society for Testing and Materials
BBr	bromine
°C	degrees Celsius
Cl	chlorine
RO/RRO	diesel range organics/residual range organics
HCl	hydrochloric acid
Hg	mercury
HDPE	high density polyethylene
$HHNO_3$	nitric acid
H_2SO_4	sulfuric acid
L	liter
mml	milliliter
MS/MSD	matrix spike/matrix spike duplicate
Pb	lead
Sb	antimony
SE	elective sequential extraction
SVOC	semivolatile organic compound
TAL	target analyte list
TCLP	toxicity characteristic leaching procedure
TBD	to be determined
TIC	tentatively identified compound

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6.3.1 Sample Packaging

Samples will be packaged carefully to avoid breakage or contamination and will be shipped to the laboratory at proper temperatures. The following sample package requirements will be followed:

- Sample bottle lids must never be mixed. All sample lids must stay with the original containers.
- The sample volume level may be marked by placing the edge of the label at the appropriate sample height or by using a grease pencil. This will help the laboratory determine whether any leakage occurred during shipment. The label should not cover any bottle preparation QA/QC lot numbers.
- All sample bottles will be placed in a plastic bag to minimize leakage in case a bottle breaks during shipment.
- The samples will be cooled by placing on ice in sealed plastic bags. Ice is not to be used as a substitute for packing materials.
- Any remaining space in the sample shipping container should be filled with inert packing material. Under no circumstances should material such as sawdust, newspaper, or sand be used.
- The custody record must be sealed in a plastic bag and placed in the shipping container. Custody seals must be affixed to the sample cooler.

6.3.2 Shipping Containers

The appropriate shipping container will be determined by U.S. Department of Transportation (DOT) or International Air Transportation Association (IATA) regulations for the anticipated level of suspected contaminants. For the RDM 2011 field event, it is anticipated that all sample shipping containers will be commercially available coolers.

Shipping containers will be custody-sealed for shipment as appropriate. The custody seals will be affixed so that access to the container can be gained only by breaking a seal.

Field personnel will arrange transportation of samples to the laboratory. When custody is relinquished to a shipper, field personnel will inform the laboratory sample custodian by telephone of the expected arrival time of the sample shipment and advise him or her of any time constraints on sample analysis.

Suggested guidelines for marking and labeling shipping containers are presented below. In all cases, DOT or IATA regulations will be consulted for appropriate marking and labeling requirements, which include the following:

- Use abbreviations only where specified.
- The words “This End Up” or “This Side Up” must be printed clearly on the top of the outer package. Upward-pointing arrows should be placed on the sides of the package.
- After a shipping container is sealed, two COC seals must be placed on the container, one on the front and one on the back. To protect the seals from accidental damage, clear strapping tape must be placed over them.

7

Decontamination and Management of Investigation-Derived Waste

7.1 Equipment Decontamination Procedures

Dedicated sampling equipment will be used to collect all surface soil, sediment, surface water, and groundwater samples. As indicated in Chapter 4, it may be necessary at some surface soil sample locations to use a stainless steel trowel and/or rock hammer pick to excavate a “pilot hole” as part of the surface soil sampling method. However, in such instances, none of the soil material that may come into contact with the trowel and/or rock hammer pick will be sampled or contacted with the dedicated scoop used to collect the sample. Any material that may be contacted by the trowel or rock hammer pick will be discarded. The sample will be collected using a dedicated plastic scoop or stainless steel spoon. The trowel and/or rock hammer will be cleaned between sample locations by removing visible dirt with a brush and/or wet paper towels.

Borehole drilling equipment (e.g., drill rods, cutting shoe, and sampler rods) and non-dedicated sampling equipment (e.g., spoons, bowls, hand augers) will be decontaminated between sampling locations.

Drilling equipment will be decontaminated using a high-pressure water washer before the start of work and between each borehole to minimize the potential for cross-contamination between sampling locations. Non-dedicated soil and sediment sampling equipment will be decontaminated using the following process.

- Phosphate-free detergent and water wash
- Potable water rinse
- 10% nitric acid/water solution rinse
- Distilled water final rinse
- Air dry

Detailed information on decontamination procedures is provided in E & E’s SOP, Sampling Equipment Decontamination.

7.2 Vehicle Decontamination Procedures

Vehicles will be used to facilitate completion of the field activities. During the 2011 field event, vehicle use at the site will include all-terrain vehicles (ATVs) used to transport staff and equipment between Red Devil and the site and drill rigs and associated support vehicles. It is not expected that the planned use of the vehicles will result in significant contamination of the ATVs. In the event that the ATVs are subjected to significant contamination, they will be decontaminated by scrubbing with a brush and will be rinsing with potable water.

Equipment will be decontaminated within the site Main Processing Area, away from Red Devil Creek. Gross contamination (e.g., soil, mud) will be removed by washing with potable water and phosphate-free detergent. Any equipment with loose paint chips or that is badly rusted will be scrubbed with a wire brush prior to steam cleaning. Once all visible contaminants are removed, the equipment will be rinsed with potable water.

7.3 Investigation-Derived Waste Management

Investigation-derived waste (IDW) that is expected to be generated during the 2011 sampling event includes the following:

- Used dedicated sampling equipment;
- Used personal protective equipment, including gloves and booties;
- Non-dedicated sampling equipment decontamination fluids and used paper towels;
- Equipment decontamination fluids;
- Soil cuttings from drilling operations; and
- Monitoring well development and purge water.

IDW will be managed in accordance with criteria established in the document, *Management of Investigation-Derived Wastes During Site Inspections* (EPA/540/G-91/009), and guidelines outlined in EPA guidance, *Guide to Management of Investigation-Derived Wastes* (OSWER Publication 9345.3-03FS).

Used dedicated sampling equipment, personal protective equipment, and paper towels will be grossly decontaminated if there is visible evidence of contamination (soil), placed in sturdy plastic bags, and shipped offsite at the conclusion of the field activities and disposed of at a sanitary landfill in Anchorage.

The decontamination fluids generated from non-dedicated sampling equipment and the drill rig and related equipment will be allowed to run onto the ground within the boundaries of the site. Disposal of the decontamination fluid will be conducted in such a way that the water fully infiltrates into the ground without ponding and does not enter surface water. Disposal will also be conducted in such a way that it does not transport sediment to surface water.

Soil cuttings from drilling operations will be handled as follows:

- For those soil borings installed in the vicinity of the former ore processing facilities—Pre-1955 Retort, Pre-1955 Furnace, and Post-1955 Retort (Monofill #2)—and the settling ponds, drill cuttings will be temporarily stockpiled in the Tailings Borrow Area.
- For any soil borings in which visible mercury is encountered, drill cuttings will be collected by the subcontractor in 55-gallon drums, sampled for TCLP TAL metals, and stored on-site pending laboratory analysis.
- For those soil borings installed at other locations where tailings/waste rock are expected, soil cuttings will be collected by the subcontractor and temporarily stockpiled in the Tailings Borrow Area.
- For those soil borings installed outside of the Main Processing Area and other locations where tailings/waste rock is not expected, drilling cuttings will be returned to the borehole. This is expected to include soil borings in the upland surface mined area and background locations. The soil cuttings will be emplaced starting from the bottom of the hole.

Monitoring well development and purge water will be managed in a manner based on which soil boring/monitoring well the development water and purge water originate from. Due to the potential for comparatively high concentrations of metal COPCs in the development water and purge water at some locations in the Main Processing Area, development water and purge water generated at the monitoring wells installed at soil boring locations 11MP12, 11MP14, 11MP17, 11MP25, 11MP29, and 11MP30 will be collected by the drilling subcontractor in 55-gallon drums. The drums will be shipped off-site for profile characterization and disposed of in accordance with appropriate requirements. Well development and purge water generated at the other new RI/FS wells and existing wells will be disposed of onto the ground at the time of sampling. Disposal of this purge water will be conducted in the area of the well following completion of sampling by pouring slowly onto the ground surface in such a way that the water fully infiltrates into the ground without ponding and does not enter surface water. Disposal will also be conducted in such a way that it does not transport sediment to surface water.

8

Surveying and Station Positioning

Horizontal coordinates of all tailings/waste rock field delineation locations, sample locations, and monitoring wells will be surveyed using a mapping grade GPS device. Coordinates of planned sample locations will be determined prior to mobilization and programmed into the GPS units as waypoints to facilitate the navigation to planned sample locations. Coordinates will be recorded using a Trimble GeoXT or GeoXH series or equivalent handheld GPS device. Anticipated horizontal accuracy will be contingent on conditions encountered in the field. GPS data will be differentially corrected as necessary to maximize accuracy. Post-processing of coordinate data may allow sub-meter horizontal accuracy to be achieved.

A subcontracted Alaska-registered land surveyor will survey the vertical coordinates of newly installed monitoring wells. Well elevations will be surveyed to within the nearest 0.1 foot. The land surveyor also will survey spot elevations along Red Devil Creek to within the nearest 0.1 foot.

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9

Deviations from the Field Sampling Plan

Deviations from the FSP are inevitable. Deviations may arise from changed field conditions, adjustment of sampling methods, inability to obtain samples from a planned location, and other circumstances. All deviations to the FSP will be carefully documented by the field team leader using the form presented in Figure 9-1. The nature and reason for FSP deviations will be documented in the RI report.

Red Devil Mine 2011 Sampling Event
FSP Deviation Documentation

Date:	**Name:**
Description of Problem:	
Location of Problem:	
Description of Deviation to Address Problem:	
Other Means Considered but Rejected to Address Problem:	

Figure 9-1 FSP Deviation Documentation Form

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10 References

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Figures

Attachment A 0013-004 5-Step Hg-Client-Redacted

The 5-Step SSE Procedure document is a secured document that cannot be reproduced. E & E has a physical copy of the document that can be shared upon request.

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