FINAL
Work Plan Addendum for
Kuskokwim River
Off-Shore Sediment Sampling
Remedial Investigation/Feasibility Study
Red Devil Mine, Alaska

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Prepared for:

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List of Abbreviations and Acronyms

BLM	Bureau of Land Management
COPCs	contaminants of potential concern
DOI	U.S. Department of the Interior
DQO	Data Quality Objectives
E & E	Ecology and Environment, Inc.
EPA	U.S. Environmental Protection Agency
FS	Feasibility Study
FSP	Field Sampling Plan
GPS	global positioning system
RDM	Red Devil Mine
RI	Remedial Investigation
TAL	target analyte list
TOC	total organic carbon
USGS	U.S. Geological Survey

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1 Introduction

This document is an addendum to the final Remedial Investigation (RI)/Feasibility Study (FS) Work Plan for the Red Devil Mine (RDM) site, Red Devil, Alaska (E & E 2011). This addendum addresses off-shore sediment sampling in the Kuskokwim River to be used during the RI/FS process to characterize potential contaminant migration from the site into the Kuskokwim River.

The RDM consists of an abandoned mercury mine and ore processing facility located on public lands managed by the U.S. Department of the Interior (DOI) Bureau of Land Management (BLM) in the state of Alaska. Historical mining activities included underground and surface mining. Ore processing included crushing, retorting/furnacing, milling, and flotation. Ecology and Environment, Inc. (E & E), has prepared this Work Plan addendum on behalf of the BLM under Delivery Order Number L09PD02160 and General Services Administration Contract Number GS-10F-0160J.

The final RI/FS Work Plan provides detailed background information on the RDM and information on the regulatory framework for the RI/FS. This information is not repeated in this addendum.

1.1 Purpose and Objectives

The purpose of this Work Plan addendum is to present the RI/FS activities, procedures, and methods that will be conducted to characterize sediments in the Kuskokwim River. Specifically, the objectives of the Kuskokwim River sampling are to:

- Assess metals concentration trends in the Kuskokwim River sediment in the vicinity of Red Devil Mine..
- Assess the magnitude of potential human health and ecological risks from site-related contaminants.
- Support evaluation of mine site remedial alternatives in the Feasibility Study.

1.2 Background and Setting

The RI/FS Work Plan presents detailed background and site setting information for the Red Devil Mine area. Information specific to the Kuskokwim River is summarized below.

The Kuskokwim River drains an area of approximately 130,000 square kilometers, and flows approximately 1,130 kilometers (700 miles) from interior Alaska to the Bering Sea. At the RDM site, the Kuskokwim River is more channelized than in up-river locations as it bisects the Kuskokwim Mountains. Flow in the river near the RDM site has been reported at 1,102 cubic meters-per-second (38,916 cubic feet-per-second). Sediment samples collected from the Kuskokwim River near the RDM site contained percent fines (<62 micrometers) ranging from 15 to 22 percent (USGS 1999).

1.3 Document Organization

The Work Plan addendum is organized into the following chapters.

- **Chapter 1, Introduction –** Describes the purpose of the Work Plan addendum.
- **Chapter 2, Data Quality Objectives –** Identifies the major study questions related to the Kuskokwim River sediment sampling that need to be answered and outlines how the study questions will be addressed through RI/FS activities.
- **Chapter 3, Field Sampling Plan -** Presents a focused sampling plan for the Kuskokwim River off-shore sediment samples, including sample locations, types, rationale, collection procedures, and analytical methods.
- **Chapter 4, Vessel Operations and Positioning** – Describes the sampling vessel, operational considerations, and methods to be utilized to georeference sample locations.
- **Chapter 5, Field Sampling Change Procedures –** Presents how changes to the Field Sampling Plan will be documented in the field.

2 Data Quality Objectives

The Data Quality Objective (DQO) process specifies project decisions, the data quality required to support those decisions, specific data types needed, and data collection requirements. It also and ensures that analytical techniques used will generate the specified data quality (EPA 2000). The process also ensures that the resources required to generate the data are justified. The DQO process consists of seven steps. The output from each step influences the choices that will be made later in the process.

The DQO steps are as follows.

1. State the problem.
2. Identify the decision.
3. Identify the inputs to the decision.
4. Define the study boundaries.
5. Develop a decision rule.
6. Specify tolerable limits on decision errors.
7. Optimize the design.

During the first six steps of the process, the planning team develops decision performance criteria (that is, the DQOs) that will be used to develop the data collection design. The final step involves refining the data collection design based on the DQOs. A discussion of these steps and their application to the Kuskokwim River Off-Shore Sediment Sampling for the RDM RI/FS is provided below.

2.1 Step 1: State the Problem

The key problem statements for the RDM RI/FS are presented below.

- The nature and extent of contamination in Kuskokwim River sediments in the vicinity of Red Devil Mine has not been determined.
- The fate and transport of contaminants in the river sediments have not been evaluated.
- Risks to human health and ecological receptors from river sediments have not been assessed.
- Site specific remedial action alternatives that could affect river sediments have not been evaluated.

2.2 Step 2: Identify the Decision

To accomplish the objectives of the RI/FS, key study questions (data gaps) are as follows.

Nature and Extent of Contamination

1. What contaminants of potential concern (COPCs,) identified for the Red Devil Mine site exist in river sediments?
2. What is the extent of site-related sediment impacts by COPCs?
3. Is mercury present in organic forms in river sediments?
4. What are the background concentrations of COPCs in river sediment?

Fate and Transport of Contamination

5. Have tailings and/or other mine site sources impacted sediments in the Kuskokwim River downriver of the mouth of Red Devil Creek, Red Devil Creek delta, and the Rice and Dolly sluice deltas?

Human Health and Ecological Risk

6. What risks to human health under future residential, subsistence user, and industrial land use scenarios are posed by COPCs in river sediments?
7. What risks to ecological receptors at various trophic levels are posed by COPCs at and near the site?

Feasibility Study

8. What remedial action technologies for river sediments could be implemented at the site to reduce or eliminate potential risks to human health and ecological receptors exposed to COPCs in Kuskokwim River sediments?
9. What remedial action alternatives can be assembled from the identified technologies to provide long-term protectiveness at the site?

2.3 Step 3: Identify the Inputs to the Decision

Inputs to the decisions for the RDM include the following.

Nature and Extent of Contamination

- Historical aerial photographs and mine operations information.
- Data from previous investigations and cleanup actions at the site that meet data usability criteria (see RI/FS Work Plan Section 3.3).
- RI/FS off-shore sediment samples analyzed for a full range of the most likely COPCs in the Kuskokwim River upstream of the mine site, adjacent to mine-related deltas , and downstream of the mouth of Red Devil Creek.
- RI/FS sample collection and analyses to determine the natural background concentrations of COPCs in sediment.

Fate and Transport of Contaminants

- RI/FS sampling of the Kuskokwim River to assess whether tailings and other sources have impacted river sediments.

Human Health and Ecological Risk

- Assessment of human health risks related to exposures of river sediments via direct contact, incidental ingestion, and ingestion of fish.
- Assessment of ecological risks related to exposure via direct contact, ingestion, and food chain consumption with river sediment.

Feasibility Study

- RI/FS sampling to characterize the lateral extent of potentially contaminated sediment in the Kuskokwim River.
- RI/FS sampling to characterize grain size characteristics of river sediment.

2.4 Step 4: Define the Study Boundaries

The presently defined spatial boundary of the RDM site is depicted in Figure1-2 of the RI/FS Work Plan. RI/FS Work Plan Figure 1-3 illustrates the known areas of contaminant sources at the site. The RI/FS will confirm or modify these site and source boundaries.

2.5 Step 5: Develop a Decision Rule

The RI/FS will apply multiple decision rules for making risk management and cleanup decisions at the RDM site. These include:

- The significance of COPC concentrations will be decided using multiple lines of evidence, including comparison with:
  - Background media concentrations as characterized during the RI/FS.
  - Site-specific, risk-based concentrations above which excessive risk exists as appropriate in the context of background concentrations.
  - Probable effect level and threshold effect level for sediment (McDonald et al. 2000).
- Risk management decisions will need to consider future land use management, policies, agreements, and ownership exchanges.
- Applicability of possible applicable or relevant and appropriate requirements will need to be determined.

2.6 Step 6: Specify Tolerable Limits on Decision Errors

Tolerable limits on decision errors, which are established performance goals for the data collection design, are specified in this step. Because analytical data and other measurements can only estimate true values, decisions that are based on measurement data could be in error. These errors are as follows.

1. Concentrations may vary over time and space. Limited sampling may miss some features of this natural variation because it is usually impossible or impractical to measure every point of a population. Sampling design errors occur when the sampling design is unable to capture the complete extent of natural variability that exists in the true state of the environment.
2. Analytical methods and instruments are never perfect; hence, a measurement can only estimate the true value of an environmental sample. Measurement error refers to a combination of random and systematic errors that inevitably arise during the measurement process.

A sufficient number of samples will be collected to minimize the risks of decision errors. Decision errors will also be minimized through the appropriate selection of sample locations.

Quality control samples will be collected and analyzed with environmental samples to assure that data are of known precision and accuracy. Control limits on both precision and accuracy are addressed in Section 1.4.2 of the Quality Assurance Project Plan (QAPP), contained in Appendix C of the RI/FS Work Plan.

2.7 Step 7: Optimize the Design for Obtaining Data

Based on the DQO process, data gaps were identified for Kuskokwim River sediments. These data gaps are summarized in Table 2-1. Based on these data gaps and Steps 1 through 6 of this DQO process, a study design for the Kuskokwim River has been developed. Details of the study design are presented in Section 3.0 of this Work Plan addendum.

Table 2-1 Kuskokwim River Sediment Data Gaps, Data Uses, and Investigative Approach

General Geographic Area	Location Description	Data Gaps	Planned Investigation Approach	Data Uses	DQOs Study Questions Addressed (See Section 2.2)
Kuskokwim River	Up-river of Red Devil Creek delta	Presence and concentration of metals and methylmercury. Fate and transport of metals-impacted sediment. Sediment grain size distribution.	Sediment sampling up-river of Red Devil Creek delta. See Table 3-1 and Figure 3-1. Locations: Transect Samples 11KR18, 11KR19, 11KR20, 11KR21, 11KR22 Transect Samples 11KR23, 11KR24, 11KR25, 11KR26, 11KR27 Analysis for total TAL metals, methylmercury, TOC, and grain size distribution.	▪ Assess metals and methylmercury concentrations in up-river locations. ▪ Assess human health and ecological risk. ▪ Assess feasibility of Kuskokwim River sediment remediation technologies.	1, 3, 4, 7, 8
	Off-shore of Red Devil Creek delta	Presence and concentration of metals and methylmercury. Fate and transport of metals-impacted sediment. Sediment grain size distribution.	Sediment sampling adjacent to Red Devil Creek delta. See Table 3-1 and Figure 3-1. Locations: Transect Samples 11KR28, 11KR29 Transect Samples 11KR30, 11KR31, 11KR32, 11KR33 Transect Samples 11KR34, 11KR35 Analysis for total TAL metals, methylmercury, TOC, and grain size distribution.	▪ Assess metals and methylmercury concentrations adjacent to Red Devil Creek delta. ▪ Approximate area of tailings and impacted sediment in Kuskokwim River. ▪ Assess human health and ecological risk. ▪ Assess feasibility of Kuskokwim River sediment remediation technologies.	1, 3, 5, 6, 7, 8, 9
	Down-river of Red Devil Creek delta	Presence and concentration of metals and methylmercury. Fate and transport of metals-impacted sediment. Sediment grain size distribution.	Sediment sampling down-river of Red Devil Creek delta. See Table 3-1 and Figure 3-1. Locations: Transect Samples 11KR36, 11KR37, 11KR38, 11KR39 Transect Samples 11KR40, 11KR41, 11KR42, 11KR43 Transect Samples 11KR44, 11KR45, 11KR46, 11KR47 Analysis for total TAL metals, methylmercury, TOCs, and grain size distribution.	▪ Assess metals and methylmercury concentrations in down-river locations. ▪ Assess human health and ecological risk. ▪ Assess feasibility of Kuskokwim River sediment remediation technologies.	1, 3, 5, 6, 7, 8, 9

Key
TAL = Target Analyte List
TOC = Total Organic Carbon

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3 Field Sampling Plan

This section presents a focused Field Sampling Plan (FSP) for the Kuskokwim River off-shore sediment sampling effort. The FSP contained in Appendix A of the RI/FS Work Plan (E & E 2011) presents detailed information and procedures addressing sample handling, preservation, and shipping; these topics are not repeated in this addendum. In addition, the QAPP contained in Appendix C of the RI/FS Work Plan addresses the field and laboratory quality control requirements and data quality assurance and validation procedures that will be applied to the Kuskokwim River sediment sample data.

3.1 Sample Locations, Types, and Rationale

A total of 30 off-shore surface sediment samples will be collected from the Kuskokwim River (Figure 3-1). Data gaps and planned uses for the Kuskokwim River sediment data are presented in Section 2 of this addendum. In general, sample results will be used for:

- Characterization of the nature and extent of COPCs in river sediments;
- Provision of data for the human health risk assessment to assess potential exposure to COPCs through direct contact, incidental ingestion, and consumption of fish;
- Provision of data for the ecological risk assessment to assess potential exposure of river biota to COPCs through direct contact and food chain consumption;
- Development of estimate of the area and volume of tailings and/or contaminated sediment in the Kuskokwim River requiring remediation; and
- Evaluation of site remedial technologies on potentially-contaminated sediment in the river.

The off-shore sediment samples will be collected along transects perpendicular to the flow of the Kuskokwim River. Each transect will contain between two and five sample points. Table 3-1 summarizes the proposed numbers, locations, and analyses of the samples. A description of the samples is provided in the subsections below.

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Table 3-1 Summary of Kuskokwim River Off-Shore Sediment Samples

General Geographic Area	Location Description	Sample Location IDs	Number of Samples			
			Total TAL Metals	Methyl Mercury	Grain Size	Total Organic Carbon
Up-River of Red Devil Creek Delta	Transect at Shorline Sediment Station 11KR01	11KR18 - 11KR22	5	1 (11KR18)	5	5
	Transect at Shorline Sediment Station 11KR12	11KR23 - 11KR27	5	1 (11KR 24)	5	5
Adjacent to Red Devil Creek Delta	Transect at Shoreline Sediment Station 11KR15	11KR28 - 11KR29	2	1 (11KR28)	2	2
	Transect at Shoreline Sediment Station 11RD08	11KR30 - 11KR33	4	2 (11KR30 and 11KR31)	4	4
	Transect at Shoreline Sediment Station 11KR16	11KR34 - 11KR35	2	1 (11KR34)	2	2
Down-River of Red Devil Creek Delta	Transect at Shoreline Sediment Station 11KR05	11KR36 - 11KR39	4	1 (11KR37)	4	4
	Transect at Shoreline Sediment Station 11KR08	11KR40 - 11KR43	4	1 (11KR40)	4	4
	Transect at Shoreline Sediment Station 11KR09	11KR44 - 11KR47	4	1 (11KR45)	4	4
		Total	**30**	**9**	**30**	**30**

Key:

TAL = Target Analyte List

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3.1.1 Sample Transects Up-River of the Red Devil Creek Delta

Two transects will be established up-river of the Red Devil Creek delta at shoreline sediment sample stations 11KR01 and 11KR12 (Figure 3-1). Each transect will contain five sample points. The sample points will be located at the following distances outboard from the shoreline sediment sampling stations determined at the time of shoreline sediment sampling: 25 feet, 50 feet, 100 feet, 150 feet, and 200 feet. All of the sediment samples will be analyzed for total Target Analyte List (TAL) inorganic elements, total organic carbon (TOC), and grain size. Two of the samples will be analyzed for methyl mercury, as identified in Table 3-1, to provide spatial coverage in the nearest-to-shore sample locations. The objective of these samples is to characterize river sediments in locations unaffected by sediment loading to the Kuskokwim River from Red Devil Creek, Red Devil Creek delta, and the Rice and Dolly sluice deltas.

3.1.2 Sample Transects Adjacent to the Red Devil Creek Delta

Three transects will be established adjacent to the Red Devil Creek delta at shoreline sediment sample stations 11KR15, 10RD08, and 11KR16 (Figure 3-1). The transects at shoreline sediment stations 11KR15 and 11KR16 will contain two sample points located at 25 feet and 50 feet from the shoreline. The transect at shoreline sediment station 10RD08 will contain four sample points located at the following distances from the shoreline: 25 feet, 50 feet, 100 feet, and 150 feet. All of the sediment samples will be analyzed for total TAL inorganic elements, TOC, and grain size. Four of the samples will be analyzed for methyl mercury, as identified in Table 3-1, to provide spatial coverage in the nearest-to-shore sample locations. The objective of these samples is to characterize river sediments in locations potentially affected by sediment loading to the Kuskokwim River from Red Devil Creek.

3.1.3 Sample Transects Down-River of the Red Devil Creek Delta

Three transects will be established down river of the Red Devil Creek delta at shoreline sediment sample stations 11KR05, 11KR08, and 11KR09 (Figure 3-1). Each transect will contain four samples points. The sample points will be located at the following distances from the shoreline: 25 feet, 50 feet, 100 feet, and 150 feet. All of the sediment samples will be analyzed for total TAL inorganic elements, TOC, and grain size. Three of the samples will be analyzed for methylmercury, as identified in Table 3-1, to provide spatial coverage in the nearest-to-shore sample locations. The objective of these samples is to characterize the down-river migration of COPCs in river sediments from Red Devil Creek, and the potential contribution of COPCs in river sediments from the Red Devil Creek delta, the Rice delta, and the Dolly Sluice delta.

3.2 Sample Identification

Each sample collected from the Kuskokwim River will be assigned a unique alphanumeric code. Sample codes will be recorded in field logbooks, on sample containers, and on chain-of-custody forms. The field team leader will be responsible for maintaining a master database 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.

Table 3-2 describes the sample coding system for the Kuskokwim River off-shore sediment samples.

Table 3-2 Sample Identification Coding System

Characters	Purpose	Code	Description
1-2	Sample Date	11	Last two digits of year
3-4	Location	KR	Kuskokwim River
5-6	Location Number	01, 02, etc.	Consecutive numbers
7-8	Matrix	SD	Sediment

3.3 Sampling Procedures

Surface sediment will be collected using a stainless-steel van Veen (modified 0.1 square meters) (1.1 square feet), or similar grab device. Up to three grab attempts will be made at each proposed sampling location to achieve the minimum sediment volume needed to perform all necessary analyses specific to each station. If, after three grabs, the minimum sediment volume has not been met, the station will be moved to a new location at the discretion of the field team leader. This new location will be chosen based on similar location characteristics and using best professional judgment. If it is not possible to obtain a successful sample, the station will be abandoned, and the E & E project manager and BLM will be notified.

Surface sediment samples will be collected from the 0- to 10-centimeters (0- to 4-inches) interval. As detailed above, it may require multiple grabs to obtain an adequate sample volume for all analyses. Compositing and homogenization of samples is described below. Samples will be carefully collected as follows:

1) Make logbook and field form entries as necessary throughout the sampling process to ensure accurate and thorough record-keeping.

2) Position the sampling vessel at the targeted sampling location.

3) Set the sampler jaws in the open position, place the sampler over the edge of the boat, and lower the sampler to the bottom.

4) Trip the sampler to collect the sample.

5) Record the location using the global positioning system (GPS); measure and record the water depth.

6) Retrieve the sampler and place it securely in the sampling vessel.

7) Examine the sample for the following sample acceptance criteria; if criteria are not achieved, the sample will be rejected and another collection attempt will be made.

   - The sampler is not overfilled with sample to prevent the sediment surface from pressing against the top of the sampler.
   - The sample does not contain large foreign objects such as trash or debris. A sample that is predominately rock/gravel will be rejected in favor of depositional material (sand/silt/clay).
   - Overlying water is present in the sampler (indicates minimal leakage).
   - The overlying water is not excessively turbid (indicates minimal sample disturbance).
   - The sediment surface is relatively flat (indicates minimum of disturbance or winnowing).
   - The desired penetration depth is achieved (several centimeters more than the targeted sample depth).

8) Siphon off any overlying surface water.

9) Measure and collect the top 10 centimeters (4 inches) with a stainless steel spoon, avoiding any sediment that is in contact with the inside surface of the grab sampler, then place the sediment into a stainless steel bowl and cover with aluminum foil.

10) Record the following observations of sediment sample characteristics; if more sample volume is required repeat steps 3 through 11.

    - Texture (grain size distribution)
    - Color
    - Biological organisms or structures
    - Bedding or sedimentary structures
    - Presence of debris (natural or anthropogenic objects)
    - Presence of obvious tailings, waste rock, or gross contamination
    - Lithology of sediment particles
    - Mineralization, including metal sulfides and iron staining
    - Odor (for example, hydrogen sulfide or petroleum)

11) Wash excess sediment back into the water away from any areas remaining to be sampled.

12) Once sufficient sediment volume has been collected, homogenize the sample by mixing with a stainless steel spoon until a consistent color and texture are achieved. Place sample material in the appropriate, pre-cleaned, labeled sample containers, place in a cooler maintained at 4 ºCelsius, and prepare for shipment to the analytical laboratory.

13) Confirm all relevant documentation has been completed, entries are accurate, and paperwork has been signed.

14) Decontaminate all sampling equipment before proceeding to the next sampling location.

3.4 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 3-3 summarizes the sample analyses. The selected laboratory methods are detailed in the Quality Assurance Project Plan (Work Plan Appendix C) and include total TAL metals, methyl mercury, TOC, and grain size.

3.5 Equipment Decontamination

Following the collection of each sediment sample, the sampling device will be thoroughly rinsed with river water. Following this rinse, the device will be cleaned with non-phosphate detergent and rinsed with deionized water.

3.6 Investigation Derived Waste Management

Investigation derived waste that will be generated from the Kuskokwim River off-shore sediment sampling effort will include the following.

- Waste sediment
- Aqueous decontamination fluids
- Used disposable personal protective equipment

Waste sediment will be returned to the river by scooping unwanted sediment material from the sampling device into the river at the sample site. Aqueous decontamination fluids will be containerized and shipped off-site for disposal at a properly licensed facility in Anchorage. Used personal protective equipment, as needed based on site conditions, will principally consist of used gloves and will be bagged and shipped off-site for disposal in Anchorage.

Figure 3-1 2011 Kuskokwim River Sample Locations

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4 Vessel Operations and Positioning

A 20-foot length shallow-draft vessel will be used for grab sediment sample collection.

A GPS will be used for station positioning for all vessel sediment sampling stations. The vessel will have navigation equipment that provides accurate station positioning and assures that sample stations and water depths are accurately recorded. The GPS receiver will be capable of surveying positions accurate to within 3-5 meters. Horizontal coordinates will be referenced using the North American Datum of 1983 (NAD 83).

Before field work is initiated, a control check point will be established that can be accessed by the sampling vessel. At the beginning and end of each day, the check point will be surveyed from the vessel and compared to the known coordinates. The control check point position as recorded by the vessel should not differ by more than 2 meters from the land-surveyed coordinates.

The GPS receiver will be placed above the sampling device deployment boom to accurately record the position of the sampling device. At surface sediment grab stations, once the sampling device has been deployed, the actual position will be recorded when the device reaches the sediment floor and the deployment cable is in a vertical position. At these locations, water depths will be measured directly by lead-line.

Coordinates of the proposed sampling stations will be programmed as waypoints into the vessel's navigation system and used to guide the vessel to the appropriate locations.

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5 Field Sampling Changes

Deviations from the Field Sampling Plan 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 5-1. 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 5-1 FSP Deviation Documentation Form

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6 References

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