Quality Assurance Project Plan

Goosmus Creek
Metals and Conventional Parameters
Water Quality Monitoring

by
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Signatures are not available on the Internet version.
ERO – Eastern Regional Office
CRO – Central Regional Office
EAP - Environmental Assessment Program
EIM - Environmental Information Management system

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Abstract

Each study conducted by the Washington State Department of Ecology (Ecology) must have an approved Quality Assurance Project Plan. The plan describes the objectives of the study and the procedures to be followed to achieve those objectives.

This document describes Ecology's plan for obtaining water quality and stream sediment data for Goosmus Creek, Ferry County, Washington. Ecology's Water Quality Program has been notified of a new discharge of mine wastewater into the stream. They have asked Ecology's Environmental Assessment Program to assess the current (background) condition of the stream, then monitor for three years to determine if the discharge will adversely affect the stream.

The parameters tested for will include metals, nutrients, and conventional parameters in the stream water. Metals will also be tested for in stream sediments.

Background

Goosmus Creek is located in northwest Ferry County, Washington. The headwaters for Goosmus Creek originate in British Columbia (B.C.), Canada. Recently the Merit Mining Corporation (Merit) has reopened the Lexington-Grenoble gold and copper mine in B.C. They have a permit to discharge into a small stream that is a tributary to Goosmus Creek. The discharge point is approximately 1000 feet north of the international border.

The Department of Ecology (Ecology) Eastern Regional Office, Water Quality Program, has requested that Ecology's Environmental Assessment Program sample Goosmus Creek for three years to monitor effects of the discharge on the creek.

Mine Operation

During mine operations, water from the mine will be pumped into an underground fine particle settling pond.

After settling, the water will either be recycled for mine uses or pumped through a three-compartment settling pond before being discharged to the surface. According to the permit application, the volume of water will be significantly less than the receiving Goosmus Creek, which will dilute the mine discharge. Estimates of mine water discharge were not available, but water being generated varied from two to over 150 gallons per minute. Merit will ensure that its operations and impacts meet BC aquatic life guidelines and drinking water guidelines for Goosmus Creek before reaching the U.S. border. Canadian water quality criteria are generally not as stringent as Washington State's.

The pyrite tailings are expected to be acid generating. If not managed adequately, the tailings could result in acidic drainage with elevated concentrations of aluminum, arsenic, cadmium, chromium, cobalt, copper, iron, lead, nickel, selenium, and zinc.

Stormwater runoff will be directed to a sediment control pond. Water from this pond will be directed via a pipe and into a sediment control pond before being released along an overland flow path to Goosmus Creek.

Water Quality Data

Dewatering (the removal of groundwater that has infiltrated underground mine workings) commenced July 13, 2007 and was completed in late October 2007. This water was apparently discharged to Goosmus Creek.

Existing water quality from the mine portal indicates that the portal discharge can be slightly elevated with respect to B.C.'s *Water Quality Criteria for the Protection of Aquatic Life* for sulfate, cadmium, cobalt, nickel, and selenium. Upstream and downstream water quality in Goosmus Creek appears to be negligibly impacted, with only slight increases in nitrate, sulfate, magnesium, calcium, molybdenum, and selenium. Mine water quality data collected by Merit between July 2007 and September 21, 2007 indicate that only aluminum, antimony, arsenic, copper, iron, and selenium have exceeded guideline concentrations for total metals, with maximum concentrations of 37.9 mg/L, 0.41 mg/L, 0.14 mg/L, 2.63 mg/L, 48.7 mg/L, and 0.44 mg/L, respectively.

Approximately 43 samples were collected and analyzed for dissolved metals concentrations beginning in 1995. Of 43 samples, exceedances were observed for antimony (13), arsenic (24), copper (4), iron (1), nickel (2), and selenium (28).

The median arsenic concentration (0.0103 mg/L) was approximately ten times the guideline concentration of 0.005 mg/L, with a total of 24 out of 43 samples exceeding guideline concentrations. Since dewatering began in July 2007, arsenic concentrations have ranged from 0.00186 to 0.0254 mg/L, with 18 out of 21 samples collected between July 14, 2007 and September 21, 2007 exceeding guidelines. Arsenic concentrations appear to be naturally elevated in the vicinity of the Lexington-Grenoble mine. Arsenic is present in the dissolved phase with minor sediment-borne concentrations indicated by slightly higher total arsenic concentrations.

A median dissolved selenium concentration of 0.0087 mg/L was reported based on a total of 43 samples, with 28 samples exceeding the guideline concentration of 0.002 mg/L. Since dewatering began in July 2007, selenium concentrations have ranged from 0.0012 to 0.0119 mg/L, with 18 out of 21 samples collected between July 14, 2007 and September 21, 2007 exceeding guideline concentrations. Concentrations of dissolved selenium appear to be naturally elevated in the area surrounding the Lexington-Grenoble deposit. Selenium is primarily in the dissolved form, with a very small sediment-bound component.

The mine, mill, and tailings will be monitored by the mine operator for at least three years after mine operations cease. In the fourth year, if no reasons are observed to maintain the same frequency, site inspections will be reduced to once every two years undertaken in the mid to late spring. Site inspection frequency may be further reduced after ten years if all responsible parties agree that limited impacts or risks remain. At the end of the life of the mine, any waste rock which is potentially acid-generating will be covered.

Project Description

Since we have no historic monitoring data for the U.S. portion of the stream, we will sample both water and sediment in a branch that has not been impacted by the mine discharge.

The area is heavily patrolled by U.S. homeland security. They have requested advanced notice before our sampling trips. There is also evidence of bear, cougar, and moose in the area, so samplers have been advised to be alert while traversing from their vehicle to the sampling points.

The objective of this study is to assess the impact of the discharge of the Lexington-Grenoble mine in Canada on Goosmus Creek. The Environmental Assessment Program will monitor metals and conventional parameters in Goosmus Creek for three years. Sampling will be done during low-flow conditions (July-October). Three site visits will be made each year. Stream water will be sampled during each visit. Also, on one occasion each year, sediment in Goosmus Creek, and water and sediment on a non-impacted branch, will be sampled if possible. The samples from the non-impacted branch will be the background samples.

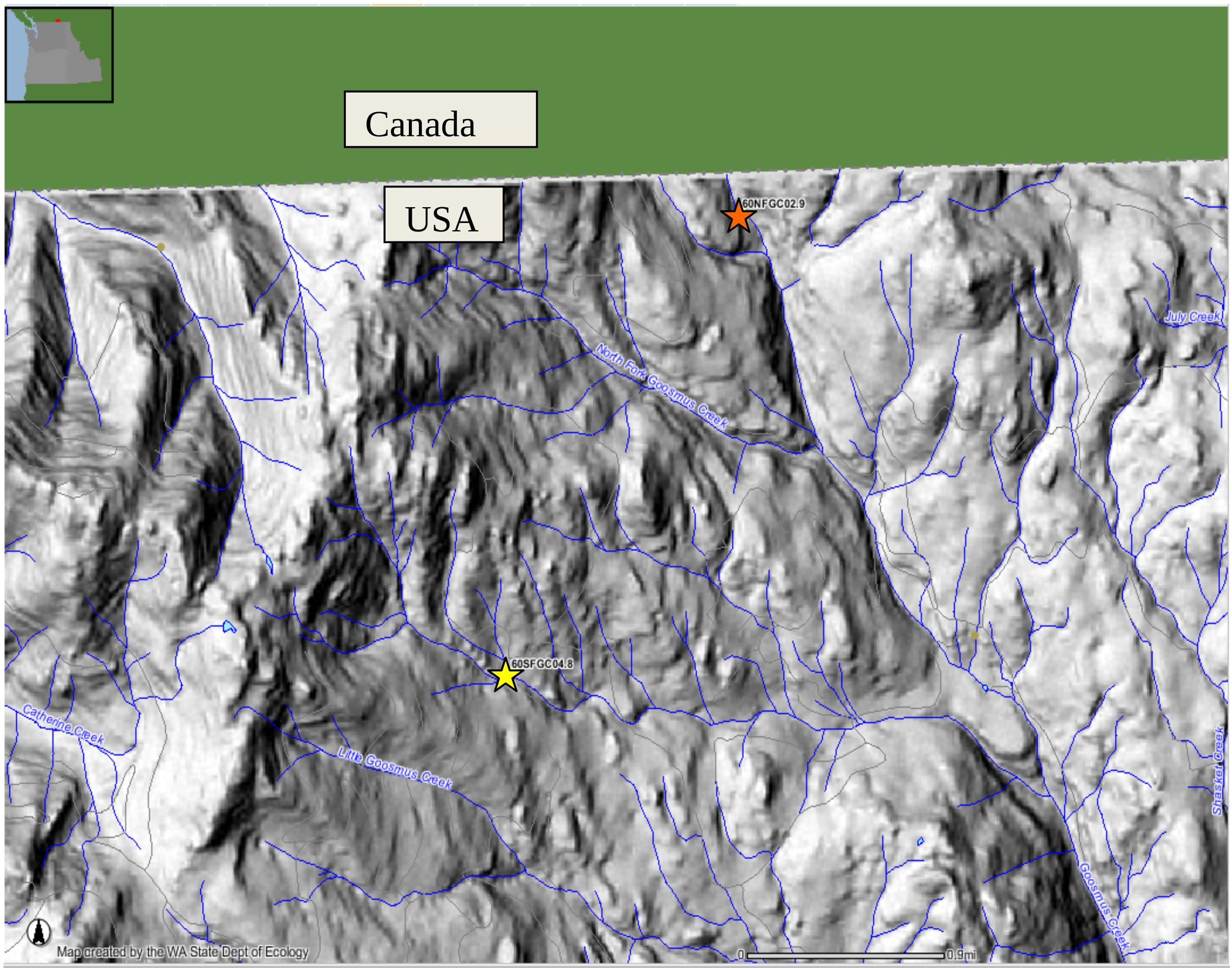
Metals to be analyzed are arsenic, cadmium, chromium, copper, lead, nickel, selenium, silver, zinc, mercury, iron, aluminum, sodium, calcium, magnesium, and potassium. Hardness will be calculated from the calcium and magnesium results.

Nutrients and conventional parameters analyzed are turbidity, total suspended solids (TSS), total dissolved solids (TDS), alkalinity, pH, dissolved oxygen (DO), conductivity, temperature, nitrate and nitrite nitrogen (NO_2/NO_3), total persulfate nitrogen (TPN), ammonia nitrogen (NH_3-N), total phosphorus (TP), dissolved ortho-phosphate (OP), sulfate (SO_4), and chloride (Cl).

Table 1 presents a summary of water and sediment collection for the three years. Sampling will be done at the sites indicated on Figures 1 – 3.

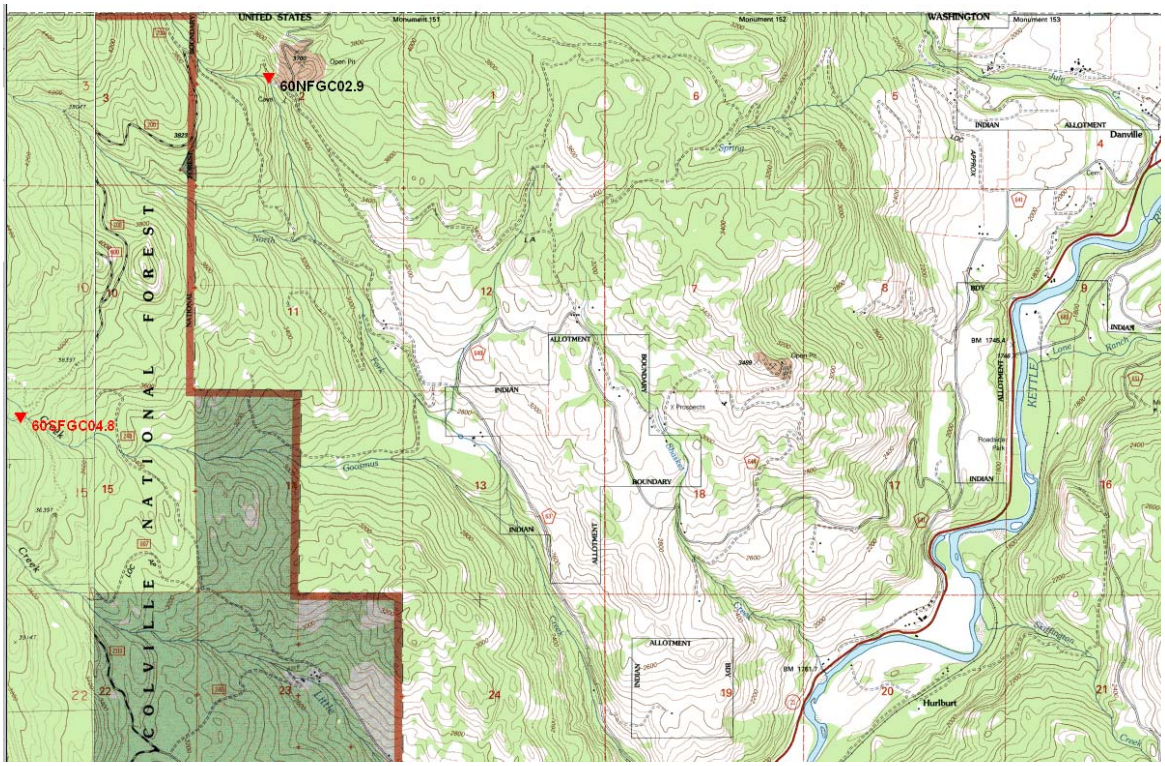
Table 1. Sample collection summary, July-October, 2008-2010.

Year	Water			Sediment	
	Goosmus	Background	Blank	Goosmus	Background
2008	3	1	1	1	1
2009	3	1	1	1	1
2010	3	1	1	1	1



★	Goosmus Creek sampling site	60NFGC02.9
☆	Background sampling site	60SFGC04.8

Figure 1. Site location map for Goosmus Creek.



Goosmus Creek sampling site   60NFGC02.9
Background sampling site   60SFGC04.8

Figure 2. Detailed sampling site map.

Organization, Schedule, and Cost

The following people are involved in this project. All are employees of the Washington State Department of Ecology.

Table 2. Organization of project staff and responsibilities.

Staff (all are EAP except client)	Title	Responsibilities
James Ross Eastern Operations Section ERO (509) 329-3425	Project Manager	Writes the QAPP, conducts QA review of data, analyzes and interprets data, and writes the data memo.
Dan Sherratt Eastern Operations Section ERO (509) 329-3420	Principal Investigator	Conducts field sampling and transportation of samples to the laboratory, conducts QA review of data, analyzes and interprets data, enters data into EIM.
Gary Arnold Eastern Operations Section CRO-ERO (509) 454-4244	Section Manager for the Project Manager	Reviews the project scope and budget, tracks progress, reviews the draft QAPP, and approves the final QAPP.
Pat Hallinan Water Quality Program ERO (509) 329-3500	EAP Client	Clarifies scopes of the project, provides internal review of the QAPP, and approves the final QAPP.
Stuart Magoon Manchester Environmental Laboratory (360) 871-8801	Director	Approves the final QAPP.
William R. Kammin (360) 407-6964	Ecology Quality Assurance Officer	Reviews the draft QAPP and approves the final QAPP.

EAP – Environmental Assessment Program (Washington State Department of Ecology)
EIM – Environmental Information Management system (Environmental Assessment Program)
QAPP – Quality Assurance Project Plan
ERO – Eastern Regional Office (Washington State Department of Ecology)
CRO – Central Regional Office (Washington State Department of Ecology)

Table 3. Proposed schedule for completing field and laboratory work, data entry into EIM, and reports.

Field and laboratory work	
Field work completed	October 31, 2010
Laboratory analyses completed	December 31, 2010
Environmental Information System (EIM) system	
EIM data engineer	Dan Sherratt
EIM user study ID	jros0001
EIM study name	Goosmus Creek
Data due in EIM	March 2011
Final report (memo only)	
Author lead	James Ross
Schedule	
Draft due to supervisor	March 31, 2011
Final due to client	May 31, 2011

Table 4. Laboratory cost estimate for the project.

Sample type	Parameter	Number of samples	Analytical cost	Misc. cost	Subtotal
Sediment	Total recoverable metals (As, Cd, Cr, Cu, Pb, Ni, Se, Ag, Zn)	8	154		1232
	Mercury		44		352
Water	Dissolved metals (As, Cd, Cr, Cu, Pb, Ni, Se, Ag, Zn)	19	147	54	3819
	Total recoverable metals (As, Cd, Cr, Cu, Pb, Ni, Se, Ag, Zn)		147	27	3306
	Fe, Al, Ca, Na, Mg, K (and hardness)		119		2261
	Mercury		37		703
	Nutrients NH3, NO2+NO3, TPN, OP, TP		76		1444
	Conventionals Alk, Turb, TSS, TDS		50		950
	Anions (Cl, SO_4)		26		494

Total - $14561

Costs include 50% discount for Manchester Laboratory

Quality Objectives

Measurement quality objectives are shown in Table 5. Table 6 presents methods and reporting limits for metals.

Table 5. Measurement quality objectives.

Analysis	Method	Accuracy	Precision RSD	Bias	Reporting Limits
Field Measurements					
pH	SM 4500-H^+	0.05 s.u.	0.05 s.u.	0.10 s.u.	1-14 s.u.
Temperature	SM 2550B	0.1°C	0.025°C	0.05°C	1°C to 40°C
Dissolved Oxygen	SM 4500-O C	15	<5%	±5%	0.1 to 15 mg/L
Specific Conductivity	SM 2510B	10	<10%	±5%	1 umhos/cm
Laboratory Analyses					
Total Suspended Solids	SM 2540D	20	<20%	N/A	1 mg/L
Total Dissolved Solids	SM 2540C	20	<20%	N/A	1 mg/L
Turbidity	SM 2130B	20	<20%	N/A	1 NTU
Chloride	EPA 300.0	20	<20%	±20%	0.1 mg/L
Sulfate	EPA 300.0	20	<20%	±20%	0.1 mg/L
Alkalinity	SM 2320B	20	<20%	±20%	1 mg/L
Total Persulfate Nitrogen	SM 4500-NO3 B	20	<20%	±20%	25 ug/L
Ammonia Nitrogen	SM 4500-NH3 H	20	<20%	±20%	10 ug/L
Nitrate & Nitrite Nitrogen	SM 4500-NO3 I	20	<20%	±20%	10 ug/L
Orthophosphate	SM 4500-P G	20	<20%	±20%	3 ug/L
Total Phosphorus	SM 4500-P F	20	<20%	±20%	5 ug/L
Trace Metals	See table 6	10	<15%	±10%	See Table 6
Ca, Mg, K, Na	See table 6	10	<15%	±10%	See Table 6
Hardness	SM 2340B	10	<15%	±10%	See Table 6

RSD – Relative standard deviation

Table 6. Metals methods and reporting limits.

Element	Method	Water (ug/L)		Sediment (mg/Kg)
		Diss	TR	
As	EPA 200.8	0.1	0.1	0.1
Cd	EPA 200.8	0.02	0.1	0.1
Cr	EPA 200.8	0.25	0.5	0.5
Cu	EPA 200.8	0.1	0.1	0.1
Pb	EPA 200.8	0.02	0.1	0.1
Ni	EPA 200.8	0.1	0.1	0.1
Se	EPA 200.8	0.5	0.5	0.5
Ag	EPA 200.8	0.02	0.1	0.1
Zn	EPA 200.8	1	5	5
Hg	EPA 245.7/EPA 245.5	N/A	0.05	0.005
Fe	EPA 200.7	20	N/A	N/A
Al	EPA 200.7	20	N/A	N/A
Ca	EPA 200.7	50	N/A	N/A
Mg	EPA 200.7	50	N/A	N/A
K	EPA 200.7	500	N/A	N/A
Na	EPA 200.7	50	N/A	N/A

Diss – dissolved
TR – total recoverable

Sampling Design (Experimental Design)

Ecology will sample Goosmus Creek (North Fork) three times a year for three years. The sampling will be done during low flow periods (July-October) to assess impacts during critical flow regimes, and due to access issues. A site off the main fork will be sampled once each season to establish baseline conditions. Stream water will be sampled for temperature, pH, conductivity, dissolved oxygen, TSS, alkalinity, turbidity, nutrients, metals, and anions.

Stream sediments will be sampled once a year for trace metals only.

Table 7. Sample collection summary for 2008-2010.

Sample location	Water		Sediment	
	sample	duplicate	sample	duplicate
Goosmus Creek	9	3	3	1
Background	3	1	3	1
Blank	3	N/A	N/A	

Sampling Procedures

Table 8 lists the sample size, containers, preservation, and holding time for each parameter in this study. Sample containers will be provided by Manchester Lab. Sampling procedures will follow the guidance in Ecology's stream sample collection SOP (Ward, 2007) and sediment collection SOP (Blakely, 2008). Care will be taken to collect only the topmost sediment in the streambed. A GPS will be used to record the coordinates of the sampling locations. Plastic flagging will mark the sites.

Table 8. Sample containers, preservation, and holding times.

Parameter	Container	Preservative	Holding time
TR Metals/Hg	500 mL Teflon	HNO_3 to pH < 2, 4^{o}C	6 months
Dissolved Metals	500 mL Teflon	HNO_3 to pH < 2, 4^{o}C	6 months
Ca, Mg, K, Na	125 poly	HNO_3 to pH < 2, 4^{o}C	6 months
TSS	1 L poly	Cool to 4^{o}C	7 days
Turbidity	500 mL poly	Cool to 4^{o}C	48 hours
Alkalinity	500 mL poly	Cool to 4^{o}C	14 days
Cl^-, $SO_4^=$	125 poly	Cool to 4^{o}C	28 days
TPN/NO_2NO_3-NH_3-N	125 poly	H_2SO_4 to pH < 2, 4^{o}C	28 days
Orthophosphate	125 poly	Filter, Cool to 4^{o}C	48 hours
Total Phosphorus	125 poly	HCl to pH < 2, 4^{o}C	28 days

Measurement Procedures

Temperature, pH, conductivity, and dissolved oxygen will be analyzed in the field. All parameters not analyzed in the field will be analyzed by Ecology's Manchester Laboratory according to their current standard operating procedures (SOPs).

Methods will be selected that will meet reporting limits in Tables 5 and 6.

Quality Control Procedures

Field

Table 9 lists the field quality control (QC) samples for this project. Field QC will consist of replicate samples and field blanks. Replicates will consist of two samples taken at the same location and at nearly the same time. Field blanks will consist of deionized water that is processed as a sample (filtered, preserved, cooled) and returned to Manchester Laboratory for analysis.

Laboratory

Manchester Laboratory will follow their standard operating procedures as described in their quality assurance manual (MEL, 2006). Laboratory QC will consist of laboratory control samples, method blanks, analytical duplicates, and matrix spikes where appropriate and using their standard practice. (See Table 9.)

Table 9. Quality control samples.

Parameter	Field		Laboratory			
	Blanks	Replicates	Check Standards	Method Blanks	Analytical Duplicates	Matrix Spikes
pH/conductivity	N/A	1/Season	In field	N/A	N/A	N/A
Nutrients, SO_4/Cl	1/Season	1/Season	1/Batch	1/Batch	1/Batch	1/Batch
Metals in Water/ Ca, Mg, K, Na	1/Season	1/Season	1/Batch	1/Batch	1/Batch	1/Batch
Metals in Sediment	N/A	1/Study	1/Batch	1/Batch	1/Batch	1/Batch
TSS/Alk/Turb/Hardness	1/Season	1/Season	1/Batch	1/Batch	1/Batch	N/A

Data Management Procedures

Case narratives included with the data package from Manchester Laboratory will discuss any problems encountered with the analysis, corrective action taken, changes to the requested analytical method, and a glossary for data qualifiers.

Laboratory data and quality control results, with any qualifiers noted, will be included in the data package. This information will be used to evaluate data quality and will act as acceptance criteria for the project data.

Field and laboratory data will be entered into Ecology's Information Management System (EIM). Laboratory data will be downloaded directly into EIM from Manchester's laboratory data management system (LIMS). Field data will be reviewed then entered into EIM by the project manager.

Data Verification and Validation

Verification of laboratory data is normally performed by a Manchester Laboratory unit supervisor or an analyst experienced with the particular method. It involves a detailed examination of the data package to determine whether method data quality objectives have been met. Manchester Laboratory's SOP and EPA functional guidelines will be used in the data assessment. Manchester Laboratory staff will provide a written report of their data review. This report will include a discussion verifying if (1) measurement quality objectives were met, (2) proper analytical methods and protocols were followed, (3) calibrations and control were within limits, and (4) data were consistent, correct, and complete.

The project manager is responsible for final acceptance of the project data. The project manager will assess the complete data package for completeness and reasonableness. Based on these assessments, the data will be accepted, accepted with qualifications, or rejected.

Data Quality (Usability) Assessment

After the project data have been reviewed and verified, the project lead will determine if the data are of sufficient quality to make decisions for which the study was conducted. The project memo will discuss data quality and whether project objectives were met. It will also note any limitations in the data.

Audits and Reports

Manchester Laboratory participates in performance and system audits of their routine procedures. Results of these audits are available on request.

A memo summarizing the findings of this study will be prepared and submitted to the client annually. A final memo is due to the client by May 31, 2011. This memo will contain at a minimum:

- Map and photos of sampling locations.
- Summary table of chemical and physical data, as well as pertinent field notes.
- Discussion of data quality and significance of problems encountered.
- Comparison of sample results with Washington State water quality standards.
- Evaluation of significant findings and recommendations for further action.

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Appendix. List of Acronyms and Abbreviations

Following are acronyms and abbreviations used frequently in this publication.

Ag	Silver
Al	Aluminum
Alk	Alkalinity
As	Arsenic
B.C.	British Columbia, Canada
Ca	Calcium
Cd	Cadmium
Cl	Chlorine
Cr	Chromium
Cu	Copper
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
Fe	Iron
Hg	Mercury
K	Potassium
Merit	Merit Mining Corporation
Mg	Magnesium
N/A	Not applicable
Na	Sodium
NH_3	Ammonia nitrogen
Ni	Nickel
NO_2+NO_3	Nitrate and nitrite nitrogen
OP	Orthophosphate
Pb	Lead
s.u.	Standard unit
Se	Selenium
SM	Standard method
SO_4	Sulfate
TDS	Total dissolved solids
TP	Total phosphorus
TPN	Total persulfate nitrogen
TR	Total recoverable
TSS	Total suspended solids
Turb	Turbidity
Zn	Zinc