Appendix A

Quality Assurance Project Plan

Quality Assurance Project Plan

Phase II Sampling Program
DMTS Fugitive Dust Risk Assessment

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May 2004

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A copy of this quality assurance project plan will also be provided to all contractors hired by Teck Cominco to complete any phase of the sampling, including field sampling crews and testing laboratory.

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Acronyms and Abbreviations

COC/SAR	chain-of-custody/sample analysis request
CVAA	cold vapor atomic absorption spectrometry
DMTS	DeLong Mountain Regional Transportation System
DQI	data quality indicator
DQO	data quality objective
EPA	U.S. Environmental Protection Agency
FSP	field sampling plan
GC/PID	gas chromatography/photoionization detection
GFAA	graphite furnace atomic absorption spectrometry
GPS	global positioning system
ICP-AES	inductively coupled plasma-atomic emission spectrometry
ICP-MS	inductively coupled plasma-mass spectrometry
LCS	laboratory control sample
MDL	method detection limit
MRL	method reporting limit
MS/MSD	matrix spike/matrix spike duplicate
QA/QC	quality assurance and quality control
QAPP	quality assurance project plan
RPD	relative percent difference
SDG	sample delivery group
SOP	standard operating procedure
TSA	technical systems audit

Introduction

This quality assurance project plan (QAPP) describes the quality assurance and quality control (QA/QC) procedures that will be used to support the analytical data generated from various biota (small mammals, ptarmigan, terrestrial and aquatic invertebrates, fishes, and vegetation) tundra soil, and sediment sampling to be conducted for the DeLong Mountain Regional Transportation System (DMTS) fugitive dust risk assessment. The QA/QC procedures ensure the data generated are representative of actual field conditions and meet the project's data quality objectives (DQOs). This QAPP was developed using guidance provided by the U.S. Environmental Protection Agency (EPA) (U.S. EPA 1998, 2000, 2001).

A complete description of the project, including rationale for the current sampling specifications, tentative dates for the fieldwork, and the intended end use of the data acquired from this field effort, is provided in the field sampling plan (FSP).

This QAPP contains the following sections:

- Section 1. *Project Management*
- Section 2. *Measurement and Data Acquisition*
- Section 3. *Assessment and Oversight*
- Section 4. *Data Review, Verification, Validation, and Usability*
- Section 5. *References*.

Various elements of the field and laboratory procedures are addressed in each section, as applicable.

1 Project Management

Well-defined project management procedures, QA/QC procedures, and quality assessment checkpoints are instrumental in the execution of a successful field effort and the generation of well-documented, high-quality data. This section of the QAPP includes descriptions of the project structure and management procedures that relate to project quality assurance.

1.1 Project Organization

Exponent will be responsible for planning and managing the Phase II ecological risk assessment sampling program. Teck Cominco personnel will be responsible for planning and managing the marine assessment sampling program. Table A-1 identifies the personnel responsible for planning and implementing field and laboratory operations and QA/QC procedures for this project and describes each individual's tasks for project management and quality assurance. The laboratory quality assurance officer, also described in Table A-1, will ensure that appropriate procedures are followed during sample analysis and preparation of the data packages and electronic deliverables.

The testing laboratory may, at Exponent's request, be required to provide its quality assurance manual for review and approval by the project QA/QC coordinator. The quality assurance manual will include a description of the laboratory organization, personnel, and responsibilities; facilities and equipment; analytical methods and QA/QC protocols; and routine procedures for sample custody and data handling. The laboratory quality assurance manuals will be provided if requested.

No changes in the QAPP procedures will be permitted without written justification and a detailed explanation of the intended change. All changes are subject to approval by the Exponent QA/QC coordinator and project manager, and the Teck Cominco project manager. A description of all changes, with justification, will be included in applicable quality assurance or data reports generated for this project.

1.2 Project Description

The details of the design of the DMTS fugitive dust risk assessment sampling are presented in the FSP. A more complete description of the scope of work and field sampling procedures, including station locations and a tentative sampling schedule, is provided in the FSP.

1.3 Quality Objectives and Criteria for Measurement Data

Quality objectives for this investigation primarily include obtaining data that are of acceptable quality, are representative of the conditions at the site, and are sufficient to support the end uses of the data.

To meet the overall quality objectives of a project, the production of valid and acceptable data begins with establishing DQOs prior to the collection of field samples and measurement data. As outlined in guidance for preparing QAPPs (U.S. EPA 1998, 2001), the specific quality objectives and criteria for measurement data for this investigation are discussed below.

To meet the overall quality objectives of a project, the production of valid and acceptable data begins with the seven-step DQO process, as described in EPA QA/G-4 (U.S. EPA 2000), prior to the collection of field samples and measurement data. As outlined in guidance for preparing QAPPs (U.S. EPA 1998, 2001) and specified by the seven-step DQO process (U.S. EPA 2000), the specific quality objectives and criteria for measurement data for this investigation are discussed below.

Measurement performance criteria for data quality indicators (DQIs) have been established for this project to ensure that chemical data are of known and sufficiently high quality to support the project objectives. Quantitative DQIs for field quality control samples and laboratory analyses include indicators for precision, accuracy, completeness, and sensitivity. The DQI for completeness is 95 percent for all analyses for this project. Measurement performance criteria for the quantitative DQIs for laboratory analyses are provided in Table A-2 for matrix spike and laboratory control sample (LCS) recoveries, and Table A-3 for laboratory duplicate sample or matrix spike duplicate (MSD) sample analyses. Field duplicate samples will be collected to determine overall precision. Laboratory duplicates or MSDs will be analyzed to check for analytical precision. Matrix spike samples will be used to determine analytical accuracy. Field equipment rinsate blanks and laboratory method blanks will serve as additional quality control checks. Method-specific detection limits or method reporting limits will be determined as required by U.S. EPA (1994a, 1997) to quantify sensitivity of the system.

The qualitative goals of representativeness and comparability of the data will be met by the careful collection of samples according to protocols established in the FSP and the use of standard methodology for laboratory testing and analyses. These procedures are described or referenced in Section 3 of this QAPP.

1.4 Special Training and Certification

Procedures to be completed for this study are, for the most part, routine. Standard procedures will be used to collect the sediment, water, soil, and vegetation samples and to complete laboratory analyses. All Exponent field personnel will have completed the 40-hour Hazardous Waste Operations and Emergency Response training with annual refresher courses as required by the Occupational Safety and Health Administration. No other special personnel or requirements are identified in the FSP.

1.5 Required Data Records and Reports

Procedures, observations, and test results will be documented for all sample collection, laboratory analysis and reporting, and data validation activities. In addition to data reports provided by the laboratory, reports will be prepared that address data quality and usability and

that provide tabulated laboratory and field data. Internal and external reporting procedures for this study are described in this section.

The required records and reports for this site investigation include the following:

- A field logbook for recording daily sampling activities, field conditions, field measurements, and any deviations from sampling procedures specified in the FSP, this QAPP, and any other field observations
- Laboratory data reports that will include complete documentation of all analytical results, analytical methods, reporting limits, results of QA/QC measurements, and any problems that arise during analysis
- Electronic data deliverables provided by the laboratory for direct entry into the project database
- Quality assurance reports that detail the results of the data review and validation of the analytical results from the laboratory.

1.5.1 Field Records

Field records will be maintained during all stages of sample collection and preparation for shipment to the laboratory. Field records will include the following items:

- Field logbook to record daily sampling activities and conditions
- External sample labels on all sample jars and bags
- Internal sample labels (on waterproof paper) inside each invertebrate sample container for community analysis and each vegetation sample container
- Combined chain-of-custody/sample analysis request (COC/SAR) forms
- Custody seals to monitor cooler security during shipment
- Photographic documentation (if any).

Descriptions of the information that will be documented during the fieldwork are provided in the FSP.

In addition to the standard field records, the following reports may be completed if a deviation from the FSP or QAPP is encountered or to document an audit:

- Corrective action reports documenting any problems encountered during field activities and corrective actions taken
- System and performance audit reports completed during the investigation

- A summary of any changes made to documented procedures and the rationale for the changes.

1.5.2 Laboratory Data Reports

The laboratory will perform data reduction as described in each test method for this project (Table A-4) and submit a complete data package with full documentation for all analyses or other determinations. The laboratory quality assurance officer is responsible for reviewing the laboratory data packages and checking data reduction prior to submittal to Exponent. Any transcription or computation errors identified during this review will be corrected by the laboratory.

1.5.2.1 Chemical Analyses

The analytical laboratory will provide all information (as appropriate for the specific analyses) required for a complete quality assurance review, including the following:

- A cover letter discussing analytical procedures and any difficulties that were encountered
- A summary of analyte concentrations (to two significant figures, unless otherwise justified) and method reporting limits
- Laboratory data qualifier codes appended to analyte concentrations, as appropriate, and a summary of code definitions
- Instrument tuning, initial and continuing calibration data, including instrument printouts and quantification summaries for all analytes
- Results for method and calibration blanks
- Results for all QA/QC checks, including internal standards, LCSs, matrix spike/MSD (MS/MSD) samples, and laboratory duplicate or triplicate samples
- Results for all instrument-specific QA/QC checks (e.g., inductively coupled plasma interference check sample analyses and inductively coupled plasma serial dilution results) that are specified in the applicable analytical methods
- Original data quantification reports for all analyses and samples
- All laboratory worksheets and standards preparation logs (data include final dilution volumes, sample sizes, wet-to-dry ratios, and spiking and standards preparation procedures for all analyses).

1.5.2.2 Toxicity Tests

The following information will be reported by the toxicity testing laboratory to allow a complete quality assurance review of the sediment toxicity data:

- A cover letter discussing testing procedures and any difficulties that were encountered
- Results for all water quality measurements made during testing (i.e., dissolved oxygen, pH, temperature, and salinity)
- The test-specific endpoint value (e.g., survival) for each exposure chamber and the mean and standard deviation for the negative control (i.e., laboratory reference sediment)
- The 96-hour median lethal concentration values for the positive control tests
- Information on the source of test organisms (i.e., must be from the same source)
- Information on the type of test chambers used (must be identical), and information on the amount of sediment in each test chamber
- Paper copies of all laboratory data sheets
- Descriptions of any problems that may have influenced data quality and any corrective action taken by the laboratory (may only be taken with the project QA/QC officer's concurrence).

1.5.2.3 Taxonomic Identifications

The following information will be reported by the taxonomic laboratory to allow a complete quality assurance review of the invertebrate community data:

- A cover letter discussing laboratory procedures and any difficulties that were encountered.
- The number of individuals of each taxon found in each replicate sample. Data for each replicate sample will be reported as number of individuals per sample for each species (or lowest identifiable taxon).
- Data for each replicate sample reported as numbers of individuals per sample for each species and as biomass (nearest 0.1-g wet weight per sample) for each major taxonomic group.
- Information on the sample sorting efficiency reported by the laboratory (a minimum of 95 percent of the total number of individuals is required [i.e., no more than 5 percent of the organisms in a given sample can be missed by the original sorter]).

- Paper copies of all laboratory data sheets (original, re-sort, and verification) as well as an electronic file containing all data. The electronic file can be either an Excel spreadsheet or ASCII file containing three columns of information; sample number, taxon name, and number of individuals.

1.5.3 Data Quality and Usability Report

A data quality and usability report will be prepared in conjunction with a data report for each sampling event. The data quality report will summarize the results of the data validation and data quality review and will describe any significant quality assurance problems that were encountered. The report will include the following items:

- Executive summary of overall data quality and recommendations for data use and limitations
- Description of sample collection and shipping, including chain-of-custody and holding time documentation
- Description of analytical methods and detection limits (chemical data only)
- Description of data reporting
- Description of completeness relative to QAPP objectives
- Description of any contamination in field and laboratory blanks and implications for bias of the data (chemical data only)
- Description of accuracy relative to QAPP objectives, including results for matrix spikes and LCSs (chemical data only)
- Description of precision relative to QAPP objectives, including results for field and laboratory replicate analyses
- Identification of all cases where control limits or measurement performance criteria were not met and a discussion of the significance of these deviations
- Description of analyte identification and quantification (chemical data only).

All data and any qualifiers applied to the data as a result of the quality assurance review will be reported in the final data report.

1.5.4 Location of Records and Reports

The electronic and hard copy data generated for this study will be retained at Exponent's office in the custody of the project data manager. Field logs, sample records, and chain-of-custody records will be kept with the Exponent project files for reference purposes.

2 Measurement and Data Acquisition

The purpose of this section is to provide sufficient detail to evaluate whether the methods used for this project have been verified and documented.

2.1 Experimental Design

The overall goal of the field sampling efforts is to collect data that will support the intended uses of the data as described in the FSP.

2.2 Sampling Method Requirements

Detailed descriptions of field methods and related quality assurance procedures are provided in the FSP.

Requirements for sample containers, preservation, and holding times, as well as the sample mass required by the laboratory for each analysis, are summarized in Table A-5. New I-Chem® 300 series or equivalent sample containers, with certificates of analysis, will be provided by the laboratory. Procedures for labeling, processing, and shipping samples are described in the FSP.

2.3 Sample Handling and Custody Requirements

A continuous record of the possession and proper handling of samples must be documented so that sample custody and handling are traceable from the time of sample collection until the analytical data have been validated and accepted for use.

2.3.1 Field Sampling Operations

Sample custody documentation is initiated in the field as each sample is collected. The designated sampler assumes custody of the samples as soon as they are collected. A sample label is attached to each sample jar as it is filled in the field and assigned a sample number. The sample information is recorded by the field samplers into the field logbook at the time of collection. Details regarding sample custody documentation and an example COC/SAR form are provided in the FSP.

During sample collection or at the end of each day and prior to shipping or storage, COC/SAR forms will be completed for all samples by a designated sample custodian. The information on the sample labels will be rechecked and verified against field logbook entries and the COC/SAR forms. Any necessary changes to COC/SAR forms, sample container labels, or the field logbook will be made by striking out the error with one line and reentering the correct information. The new entries will be initialed and dated.

Samples with extra volume for laboratory quality control procedures (MS/MSD and laboratory duplicates) will be designated as such on the COC/SAR. The laboratory will decide how to batch samples within the constraint of a maximum of 20 samples per batch. Samples that arrive over a period of several days may be combined in a sample delivery group (SDG) provided the samples are processed together and holding times are not jeopardized. A separate LCS must be analyzed with each processing batch if the samples are not prepared together.

2.3.2 Shipping

All samples will be accompanied by COC/SAR forms during shipment. The custodial sampler provides the first signature on the COC/SAR form when relinquishing custody to another member of the field team for documentation or packing or to the shipping company or laboratory courier. Sample information from the COC/SAR forms will be transferred electronically into the database. Paper copies of completed COC/SAR forms will be provided by the laboratory with the data packages and will be stored with the data by the project data manager.

When samples are shipped, the sample containers will be securely packed inside the shipping coolers and placed on ice as specified in Standard Operating Procedure (SOP) GEN-3 *Sample Packaging and Shipping*, provided in Appendix B. Any glass containers will be wrapped in bubble wrap. The original COC/SAR forms will be enclosed in a plastic bag and taped to the inside lid of the cooler. The cooler will be taped closed by wrapping fiber tape completely around it. "This End Up" labels and "Fragile—Glass" labels (if glass containers are used), as well as any other required shipping labels, will be attached to the cooler, and the cooler will be sealed with two custody seals on adjacent sides of the lid. Packaging will conform to applicable U.S. Department of Transportation regulations.

The field personnel will be responsible for sample custody and appropriate sample storage prior to shipment, as well as for packing and shipping samples in a manner that allows the laboratory sufficient time to meet holding time requirements. The technical field personnel will also contact the laboratory project manager and Exponent's QA/QC chemical testing coordinator to notify them of the sample shipment.

2.3.3 Laboratory Operations

The laboratory project managers will verify receipt of each sample shipment and will contact the Exponent's QA/QC chemical testing coordinator to provide notification that all samples were received and to relay any concerns or observations regarding sample integrity or documentation. The laboratory project manager will also be responsible for ensuring that laboratory chain-of-custody forms and tracking records are completed upon receipt of the samples and maintained through all stages of laboratory analysis. Storage information must be maintained until disposal of the samples. The sample tracking records must show the date of sample extraction or preparation and the date of instrument analysis for each analytical procedure. These records will be used to determine compliance with holding time requirements.

The laboratory will maintain daily temperature logs for all refrigerators and freezers that contain samples for this project. These logs will be stored at the laboratory and copies will be provided to Teck Cominco if requested. The laboratory project manager will notify the project QA/QC coordinator if storage temperatures deviate from those specified in Table A-5.

2.4 Analytical Method Requirements

2.4.1 Chemical Analyses

Chemical and physical analyses that will be completed for the sampling will be performed using EPA-approved methods. The laboratory for this study will have established protocols and quality assurance procedures that meet or exceed any applicable EPA guidelines. Chemical analyses will be completed by Columbia Analytical Services, Inc. (CAS), located in Kelso, WA. The samples will be analyzed for the analytes listed in Table A-4.

Chemical analyses will be completed according to methods described in *Test Methods for Evaluating Solid Wastes*, EPA SW-846 (U.S. EPA 1997) or other EPA-approved methods when available, and will include all associated QA/QC procedures recommended in each method.

Laboratory procedures for chemical and physical analyses may be completed for the target analytes (Table A-4) by one or more of the following methods:

- Inductively coupled plasma-mass spectrometry (ICP-MS) in accordance with EPA Method 200.8 (U.S. EPA 1994a) for analysis of specific metals
- Inductively coupled plasma-atomic emission spectrometry (ICP-AES) in accordance with EPA SW-846 Method 6010B (U.S. EPA 1997) for analyses of specific metals
- Cold vapor atomic absorption (CVAA) in accordance with EPA SW-846 Methods 7470A and 7471A (U.S. EPA 1997) for analysis of mercury
- Graphite furnace atomic emission spectrometry (GFAA) in accordance with EPA Method 7740 (U.S. EPA 1997) for analyses of selenium (tissues samples only)
- Grain size in accordance with ATSM D422-63 (ASTM 2003)
- Desiccation and gravimetric determination in accordance with EPA Method 160.3 (modified) (U.S. EPA 1983) for total solids determination.

The project-specific target compounds, method detection limits (MDLs), and method reporting limits (MRLs) for the chemical analyses that will be completed are provided in Table A-4. These MDLs and MRLs reflect laboratory capabilities or reporting limits that can reasonably be expected from a competent laboratory. Analytical methods that yield MDLs and MRLs that are sufficiently low to support the objectives of this investigation were selected, whenever possible, to meet the

DQOs of the project. The MDLs and MRLs were selected to obtain reporting limits that are low enough to compare with human health and ecological risk-based benchmarks. The actual MRLs and MRLs attained during this site investigation may be elevated with respect to theoretical detection limits if interferences are encountered because of the sample matrices.

2.4.2 Toxicity Tests

The amphipod survival test, if required, will be completed using *Leptocheirus plumulosus*, according to the methods referenced in U.S. EPA (1994a). These analyses, if conducted, will be completed by Northwest Aquatic Sciences of Newport, Oregon.

2.4.3 Taxonomic Identifications

Samples for invertebrate assemblages will be sieved and preserved in the field prior to shipment. Taxonomic analyses will be completed by Steve Peek of Fairbanks, Alaska. Taxonomic analyses will be conducted on the organisms retained on the screen. At the laboratory, technicians will remove detritus from the samples. Benthic taxonomists will sort the invertebrates in each sample. After sorting has been completed, organisms will be identified to the lowest taxonomic level possible, the target being species level. All taxa will be identified in their entirety. All taxonomic identifications will be made by qualified taxonomists and will be based on published keys. For incomplete specimens, only the anterior or posterior ends will be enumerated, depending upon the taxon. All identifications will be made using a microscope (e.g., binocular-dissecting or compound). If possible, at least two pieces of literature will be used for each species identification.

The taxonomist will record initial identifications and counts on sample data sheets. Any pertinent notes and comments on the organisms in each sample will also be recorded. The taxonomist will then sign and date the sample data sheet.

2.5 Quality Control Requirements

Quality control samples and procedures are used to obtain quantitative information regarding the execution of field sampling and laboratory testing activities. Quality control results may be used to estimate the magnitude of bias and level of precision inherent in the test data. Various quality control samples will be collected in the field and initiated by the laboratory for every test. The sections presented below describe field and laboratory quality control samples and procedures in more detail.

2.5.1 Field Quality Control

Field quality control samples will include equipment rinsate blanks and field duplicate/replicate samples.

Equipment rinsate blanks and field duplicate/replicate samples will be collected or prepared by sampling personnel in the field and submitted to the laboratory as natural samples. Equipment rinsate blanks will be used to identify possible contamination from the sampling environment or from the sampling equipment. These blanks will be collected by pouring deionized and distilled water over the decontaminated sampling equipment and into a sample jar. One equipment rinsate blank will be collected during the sampling event for each kind of sampling equipment used.

Field duplicate/replicate samples will be collected to assess the homogeneity of the samples collected in the field and the precision of the sampling process. Field duplicates will be collected from the homogenized media (i.e., tundra soils and sediments). Field duplicates will be prepared by collecting two aliquots of sample from the homogenization bowl and submitting them for analysis as separate samples. Field replicates will be collected for each of the vegetation sample types (willow, sedge, lichen). Five field replicates will be collected for the community survey of aquatic invertebrates in the freshwater streams and coastal lagoons. Field duplicates/replicates for each matrix will be collected at frequencies specified in the FSP.

2.5.2 Laboratory Quality Control

Each analytical protocol used in this investigation (Table A-4) includes specific instructions for analysis of quality control samples and completion of quality control procedures during sample analysis. These quality control samples and procedures verify that the instrument is calibrated properly and remains in calibration throughout the analytical sequence and that the sample preparation procedures have been effective and have not introduced contaminants into the samples. Additional quality control samples are used to identify and quantify positive or negative interference caused by the sample matrix. Each method protocol provides control limits that indicate acceptable conditions for analysis of samples as well as unacceptable conditions that would necessitate reanalysis of samples.

The following laboratory quality control procedures are required for chemical and physical analyses:

- **Holding Times—**Holding time constraints for each method will be met to ensure the validity of the results reported.
- **Instrument Tuning—**Instrument tuning for analyses by ICP-MS will be completed to ensure that mass resolution, identification, and, to some degree, sensitivity of the analyses are acceptable. Instrument tuning will be completed in accordance with the requirements stated in the analytical method during which samples or standards are analyzed. In the event that an instrument tuning does not meet control limits, analysis of project samples will be suspended until the source of the control failure is either eliminated or reduced to within control specifications. Any project samples analyzed while the instrument is out of tune will be reanalyzed.
- **Initial and Continuing Calibration—**Initial calibration of instruments will be performed at the start of the project and when any ongoing calibration

does not meet control criteria. The number of points used in the initial calibration is defined in each analytical method. Continuing calibration will be performed as specified in the analytical methods to track instrument performance. In the event that a continuing calibration does not meet control limits, analysis of project samples will be suspended until the source of the control failure is either eliminated or reduced to within control specifications. Any project samples analyzed while the instrument was out of calibration will be reanalyzed.

- **Method Blanks—**Method blanks are used to assess possible laboratory contamination of samples during all stages of preparation and analysis. Blank corrections will not be applied by the laboratory to the original data. A minimum of 1 method blank will be analyzed for every sample preparation group or 1 for every 20 samples, whichever is more frequent.

- **Laboratory Control Samples—**LCSs (reference material or spiked blanks) will be used as a check on overall method performance. An LCS (and possibly a duplicate LCS) will be analyzed for every SDG or for every 20 samples, whichever is more frequent.

- **Matrix Spike and Matrix Spike Duplicates—**MS/MSD samples are used to assess the effects of the sample matrix on the accuracy of analytical measurements. For organic compound analyses, an MS and MSD will be analyzed for every SDG or for every 20 samples, whichever is more frequent. For metals, a minimum of 1 matrix spike (and possibly an MSD) will be analyzed for each SDG or for every 20 samples, whichever is more frequent.

- **Laboratory Duplicates—**Replicate laboratory analyses are indicators of laboratory precision. For all organic compound analyses, an MS and MSD will be analyzed for every SDG or for every 20 samples, whichever is more frequent. For metals and physical analyses, 1 laboratory duplicate will be analyzed for every SDG or for every 20 samples, whichever is more frequent. An MSD for metals may also be analyzed with every SDG or for every 20 samples.

- **Internal Standards—**Internal standards are added to all field and quality control samples for analyses completed by ICP-MS. The internal standards are used for quantification of target compounds and to ensure that the instrument is stable and functioning as calibrated.

No special quality control procedures will be required for this project. Laboratory-established control limits for , MS/MSD, and LCS recoveries, and laboratory duplicate sample analyses, as may be applicable, are provided in Tables A-2 and A-3.

2.5.3 Laboratory Quality Control for Toxicity Tests

Laboratory QA/QC procedures for the toxicity tests include the use of positive and negative controls and daily measurements of water quality conditions (i.e., dissolved oxygen, temperature, salinity, and pH). Appropriate ranges of water quality variables are stipulated in the test-specific method (U.S. EPA 1994b) and are as follows:

- Temperature: 15 ± 1°C
- pH: 8 ± 1 pH units (desirable)
- Salinity: 28 ± 1 ppt
- Dissolved oxygen: >5 mg/L (desirable).

In addition, ammonia and sulfide will be monitored in the pore water for the amphipod survival test. Ammonia and sulfide concentrations will be monitored throughout the exposure period (at test initiation, every fifth day during the exposure period, and at test termination). The ammonia and sulfide concentrations measured at test initiation provide a baseline of the exposure conditions present in the test chambers. Ammonia and sulfide are monitored to assess whether they may be contributing to toxicity, and not for the purpose of eliminating them. Therefore, if the ammonia or sulfide concentrations at test initiation exceed published threshold values, no corrective action will be taken.

Only healthy organisms will be used for testing. Positive and negative controls will be tested concurrently with each toxicity test series. Reference toxicants (i.e., positive controls) will be used to provide insight into mortalities or increased sensitivity that may have occurred as a result of disease or the potential stresses related to handling, acclimation, and testing (e.g., loading density). An invalid reference toxicant test will not invalidate the test data, but will provide an indication of the suitability of the organisms for testing. Negative controls will be used to confirm the viability of the test organisms in the absence of stressors introduced with the test sediment. One set of negative controls (with the appropriate number of replicates) will be run per toxicity test. Mean mortality of amphipods in negative controls must not exceed 10 percent for the test results to be considered valid.

2.5.4 Laboratory Quality Control for Taxonomic Identifications

After the sorting is complete for the five replicate samples at a given station, one of replicates will be selected for laboratory QC. At least 25 percent of that replicate will be re-sorted. Re-sorting is the examination of a sample or subsample that has been sorted once and is considered free of organisms. It is critical that the re-sorted aliquot be a representative subsample of the total sample. Care should be taken to examine the preservative in each sample for any organisms that may be floating in the preservative. Re-sorting should be conducted using a microscope (e.g., dissection microscope) capable of magnification to 25X. A partial re-sorting of every sample ensures that any gross sorting errors are detected. Re-sorting may be conducted by an individual other than the one who sorted the original sample.

Each sample aliquot that is selected for re-sorting will be checked for removal of ≥95 percent of total organisms. Thus, each sample elicits a decision concerning a possible re-sort. If a sample is found that does not meet the recommended 95-percent removal criterion, the entire sample will be re-sorted.

When taxonomic error or inconsistency is found, all previous results should be evaluated to identify those samples that may be affected. This process, which should be carefully documented by the laboratory, can be very time-consuming. However, upon completion of all taxonomic work, few (if any) taxonomic errors or inconsistencies should remain in the data set.

When all identification and QA/AC procedures are completed, the jars containing the vials of identified species will be topped off with a solution of 5 percent glycerine/70 percent isopropyl alcohol (the glycerine is added to keep invertebrate exoskeletons supple to facilitate any subsequent taxonomic identification). The lids will then be sealed tightly with black electrical tape to prevent evaporation. Each container will be labeled clearly with the survey name, date of collection, and number and type of samples within.

2.6 Instrument and Equipment Testing, Inspection, and Maintenance

Preventive maintenance of field equipment and laboratory instruments is essential if project resources are to be used in a cost-effective manner. Preventive maintenance will take two forms: 1) a schedule of preventive maintenance activities to minimize downtime and ensure the accuracy of measurement systems and 2) availability of critical spare parts and backup systems and equipment. The performance of these maintenance procedures will be documented in field and laboratory notebooks.

Teck Cominco will be responsible for ensuring that routine preventive maintenance is performed and documented for their field instrumentation and equipment (e.g., global positioning system [GPS] and water quality monitoring probe). Exponent will be responsible for all other instrumentation and equipment used during this field program.

The laboratory quality assurance officer will be responsible for ensuring that routine preventive maintenance is performed and documented for each analytical instrument and that spare parts or additional instruments are available in case of instrument breakdown or failure. Instrument quality control procedures (e.g., initial and continuing calibration, LCSs, calibration blanks) will be used to verify the continuing acceptable performance of each instrument. Details are provided in the referenced method descriptions (Table A-4), the laboratory SOPs, the laboratory quality assurance manuals, and the SOPs for field procedures (contained in the FSP).

2.7 Instrument and Equipment Calibration

Initial and continuing calibration procedures for laboratory instruments will be performed in accordance with the cited analytical method for each analysis (Table A-4). The method

descriptions for each analysis specify acceptance criteria for initial and continuing calibration and state the conditions where recalibration is necessary.

All primary chemical standards and standard solutions used in this project will be traceable to the National Institute of Standards and Technology or other documented, reliable, commercial sources. At the laboratory, standards are validated prior to use to verify their accuracy by comparison with an independent standard. Reagents are examined for purity by performing method blank analyses.

Field instruments (e.g., GPS) will be calibrated according to and at the frequency specified in the manufacturers' instructions.

2.8 Inspection and Acceptance of Supplies and Consumables

Supplies and consumables are required for sample collection and laboratory activities. During sample collection, the most critical supplies affecting data quality are those used for decontamination of the sampling equipment. Supplies of appropriate, documented purity will be used for sample collection and decontamination. Acceptance for all supplies will require an intact seal upon receipt, maintenance at appropriate temperature, and use only prior to the expiration date. This method of documentation allows any contamination problem to be traced to its source and will enable identification of related samples that may have been affected. Acceptance requirements will include a basic inspection of all containers received and rejection of unacceptable supplies.

Reagents of appropriate purity and suitably cleaned equipment must be used for all stages of laboratory analyses. In addition, the laboratory must ensure that the concentrations of calibration and spiking standard are accurate and that instrumentation is functioning properly. The lot numbers of all standards are routinely tracked by the laboratory, from purchase of stock standards to preparation of secondary and working calibration standards. All calibration and spiking standards are checked against standards from another source. LCS results provide an additional check for accuracy. Details for acceptance requirements for supplies and consumables at the laboratory are provided in the laboratory SOPs and quality assurance manuals.

2.9 Data Acquisition Requirements for Non-direct Measurements

In addition to the direct site measurement data that will be collected, other data and information may be used in data assessment and evaluation. Although not specified at this time, additional analyses and data collection may be required to meet the project objectives. These data (if collected), which constitute non-direct measurements, will be carefully evaluated to determine quality and usability. Data characteristics that may be evaluated can include the following:

- Technical basis
- Experimental bias
- Relevance to site conditions
- Natural variability
- Uncertainty
- Validation processes applied to the data (if applicable).

2.10 Data Management

Computerized systems will be used to record, store, and sort the technical data that will be generated to support the monitoring program. Automated data handling increases data integrity by reducing errors, omissions, and ambiguities that can be introduced by manual procedures. In addition, automated procedures will be used by the laboratory to capture and summarize analytical results. In this case, electronic data files can be imported directly from the laboratory to the project database, minimizing both data entry effort and opportunities for error. Sampling location coordinates will be entered into the database to enable the generation of maps and figures using appropriate software.

Field logbooks and COC/SAR forms are prepared by the field team while sample collection activities are in progress. Sample information from the field is entered manually into the database in Exponent's office. Each data record will include a unique sample code, station ID, sample type (matrix), analyte, analyte concentration, and concentration units. Data from the laboratory are entered directly from the electronic disk deliverables. A small portion of the laboratory data may be entered manually if electronic data cannot be supplied. Electronic data summaries are produced to support data validation procedures. Data qualifiers are entered into the database when validation is completed and verified, and the data set is approved as final. All manual and electronic entries are verified by the data manager or validation personnel.

Project data tables and reports are prepared using customized retrievals that filter and sort the data according to criteria specified by the user. The data are automatically formatted for direct use with statistics software packages and various geographic information system software. The maintenance of a single authoritative database prevents the proliferation of multiple versions of data and the introduction and proliferation of errors.

3 Assessment and Oversight

The sections below describe the internal and external checks used to ensure that the elements specified in this QAPP are correctly implemented as prescribed, the quality of the field and laboratory data is adequate to support their intended purpose, and corrective actions, if required, are implemented efficiently and effectively.

No changes in the QAPP procedures will be permitted without written justification and a detailed explanation of the intended change. All changes are subject to approval by the Exponent QA/QC coordinator and the project manager. A description of all changes, with justification, will be included in applicable quality assurance or data reports generated for this project. Any major deviations from the QAPP will be discussed with the applicable project managers.

3.1 Assessment Activities

Various types of assessment activities will be implemented during the course of the investigation to determine compliance with the planning documents and ensure efficiency in completing the project tasks. Assessment activities for each sampling event will include readiness reviews prior to commencement of each phase of project work and surveillance while work is in progress. In addition, a technical systems audit (TSA) may be conducted if problems are encountered during sample collection or analysis.

Readiness reviews are completed to ensure that the components of a project are in place so that work can be completed efficiently. Generally, two readiness reviews are conducted, one prior to the initiation of fieldwork and the other prior to data interpretation activities for each monitoring event.

The field team leader will verify that the following conditions are met prior to field sampling:

- All of the field equipment is ready and available, and shipment to the sampling site has been arranged
- The field sampling team has been scheduled, and transportation has been arranged
- Subcontractors have been contracted and scheduled.

The data manager, at the project manager's direction, will finalize the project data after all results have been received from the laboratory, data validation has been completed, and data qualifiers have been entered into the database. This process constitutes the readiness review for data use. The project manager will be responsible for addressing any deficiencies in the readiness review. No report will be prepared.

Project surveillance may be conducted throughout the course of each monitoring event to ensure that every phase of work (fieldwork, laboratory analysis, data review/validation, data interpretation, and report preparation) follows the quality assurance procedures outlined in this QAPP. The project manager will be responsible for conducting surveillance with the assistance of the field sampling director, data validation manager, laboratory quality assurance officer, and lead technical personnel. Technical problems will be noted in the field sampling or quality assurance report if appropriate. Any noncompliance issues will be addressed as described below in Section 3.2.

TSAs may be conducted if problems are encountered during sampling and analysis operations. If completed, these audits will be conducted by the project QA/QC coordinator or designee or by the laboratory quality assurance officer. These audits may consist of onsite reviews of field activities or laboratory analyses. TSAs may include, but are not limited to, the following components:

- Field and laboratory personnel, facilities, and equipment
- Chain-of-custody procedures and records
- Instrument calibration and maintenance procedures and records
- Standards preparation and verification procedures and records
- Documentation of analytical methods
- Sample storage conditions
- Data reduction, processing, and reporting procedures
- Documentation of control procedures.

All personnel engaged in sampling and analysis tasks will have appropriate training and required certifications. The laboratory is required to have written procedures addressing internal QA/QC; if requested, these procedures must be submitted to Exponent and will be reviewed by the project QA/QC coordinator to ensure compliance with this QAPP. The QA/QC coordinator will discuss any serious problems with the project manager and the Teck Cominco project manager will be notified of the situation. Any problems identified during the course of the project that affect data quality will be discussed in the quality assurance report.

3.2 Response Actions

While the entire quality assurance program is designed and implemented to avoid problems, it also serves to identify unexpected or unavoidable problems that may be encountered during sample collection and analysis. An important part of any quality assurance program is a well-defined policy that can effectively correct these problems after they have been identified.

3.2.1 Short-Term Corrective Action

Short-term corrective actions fall into two categories: 1) analytical instrument or field equipment malfunctions, and 2) nonconformance or noncompliance with the quality assurance requirements that have been established for the project.

During field operations and sampling procedures, the field team leader will be responsible for correcting equipment malfunctions. Acceptable equipment operating parameters and control limits are specified in the operating instructions and SOPs. If any piece of equipment fails to meet established quality control criteria or cannot be properly repaired, it will be replaced. All equipment malfunctions and subsequent corrective measures will be documented in the field logbook.

The laboratory quality assurance officer is responsible for ensuring that laboratory results comply with project, method, and laboratory quality control requirements and that all analytical instruments and laboratory equipment are properly maintained. Acceptable instrument operating parameters, control limits for quality control results, and required corrective actions are specified in the laboratory SOPs, method protocols, and manufacturers' instructions provided with laboratory instruments. Control limit specifications are designed to help analysts detect the need for corrective action. Often an analyst's experience will be most valuable in identifying suspicious data or malfunctioning equipment. Immediate corrective action must be taken by the laboratory if any phase of the sample preparation and analysis process is considered suspect. Any corrective actions will be noted in the laboratory notebooks and, if appropriate, discussed in the case narratives for all affected sample sets.

3.2.2 Long-Term Corrective Action

In addition to short-term corrective actions taken by field and laboratory personnel, a mechanism is required to address long-term, systemic corrective actions. The need for long-term corrective action may be identified by an overview of compliance with standard quality control procedures, control charts, and performance or system audits. Any quality control problem that cannot be solved by immediate corrective action falls into this long-term category. The long-term system will be used to ensure that the condition is reported to the person responsible for the corrective action and follow-up plan.

The required corrective actions will vary, depending on the nature of the problem; however, the essential steps in the closed-loop, long-term corrective action system are as follows:

- Identify the problem
- Assign responsibility for investigating the problem
- Investigate and determine the cause of the problem
- Determine a corrective action to eliminate the problem
- Establish responsibility for implementing the corrective action and implement the corrective action

- Verify that the corrective action has eliminated the problem
- Document the complete process of establishing and implementing the corrective action in a project memorandum that specifies the problem areas requiring corrective action and how they were detected, the individual initiating corrective action, the samples concerned, the acceptable data range, the measures taken to correct the problems, and the individual approving the corrective action.

The QA/QC coordinator, who has the authority to enforce necessary corrective measures, will routinely review the documentation of corrective actions.

3.3 Reports to Management

Reports will be prepared for any condition that requires corrective action and for TSAs (if conducted). The reports will be prepared by the individual who conducted the audit, approved by the project QA/QC coordinator, and provided to Teck Cominco and Exponent.

Prior to inclusion or presentation of any of the data in a report, a data quality report will be prepared that will include the following items:

- A discussion of sampling procedures and any anomalies encountered during sample collection
- A discussion of laboratory procedures
- A discussion of quality control procedures and data validation results
- A description and discussion of any other conditions that may have affected the quality of the data
- A summary of the quality of the project data
- A description of the data usability and limitations for the project.

The data quality report will be prepared by or under the direction of the field activities manager (for discussions related to fieldwork) and the QA/QC coordinator (for data quality evaluation).

4 Data Review, Verification, Validation, and Usability

Data review, verification and validation are conducted to establish the data quality and usability for the project. Data verification is the process of determining whether samples have been collected and analyzed according to procedures prescribed in the FSP, field and laboratory SOPs, and this QAPP. Data verification includes checking for compliance of procedures with the project plan, correctness of protocols used in the field and at the laboratory, comparability of the data collection and analysis procedures, and completeness of the data set and supporting documentation. Data validation is the process of evaluating the technical quality of the verified data with respect to the project DQOs. The implementation of these procedures will ensure that the data conform to the project requirements and DQOs and that limitations are specified when DQOs are not met.

Verification of sampling information and chemical data occurs at several levels throughout the course of sample collection and analysis. The project data are validated after the field activities are completed, the results reported by the laboratory are available, and all data have been verified, and prior to use of the data for interpretive activities. The purpose of the verification and validation procedures is to assess whether the data conform to the project requirements and DQOs, and to identify data limitations when data do not conform to the project requirements and DQOs. Data review, verification, and validation criteria and procedures are described below.

4.1 Data Review, Verification, and Validation Requirements

Data verification is the process of determining whether data have been collected or generated according to the FSP and the respective SOPs or method descriptions. Data verification consists of the following categories: 1) verifying compliance with SOPs, QAPP, and contractual agreements; 2) verifying correctness to determine that the data collection plans and protocols were followed; and 3) verifying completeness to establish that all data necessary to meet project objectives have been collected.

Data validation is the process of evaluating the technical usability of the verified data with respect to the planned objectives of the project. Data validation consists of the following objectives: 1) verifies that measurements (field and laboratory) meet the user's needs, 2) provides information to the data user regarding data quality by assignment of individual data qualifiers based on the associated degree of variability, and 3) determines whether DQOs were met.

4.1.1 Sampling Design and Sample Collection Procedures

The conformance of the field activities to specifications in the sampling plan will be evaluated on an ongoing basis while field activities are in progress. Additional verification will be provided through oversight of the field activities by the field team leader and by contacts with the project manager. If a sample cannot be collected as planned, the project manager will be

notified and an alternate location or sampling method may be selected if possible. The review process will include immediate evaluation of any change to the sampling plan so that an alternate field procedure may be established quickly, if necessary.

Additional verification procedures may be completed for information generated in the field. Field information recorded in the sample logs will be verified when these data are entered into the database and station location information will be verified when station coordinates are used to generate project maps. A final verification review of field activities will be made when the field effort is complete. The verification results will be included in the data quality and usability report.

4.1.2 Sample Handling

Standard procedures for sample collection and shipping will be followed to ensure that samples are preserved and stored as required (Table A-5). Any sample handling difficulties that are encountered in the field will be described in the field log. The field log will be reviewed and sample integrity verified as part of the data validation procedures.

Samples will be checked by laboratory personnel upon receipt and the cooler temperature will be determined. The temperature and condition of the samples will be recorded at the laboratory and any problems will be described in the case narrative for the data report. The field log and case narrative will be reviewed during the quality assurance review, and data will be flagged if the sample integrity was compromised. Data may be rejected as unusable if severe handling problems are encountered.

4.1.3 Analytical Procedures, Calibration, and Quality Control

Review and verification of testing procedures, including instrument calibration and analysis of all field samples and quality control samples, will initially be completed at the laboratory during and after sample analyses. The laboratory will complete quality control procedures as specified in the method descriptions and in the laboratory's SOPs and quality assurance manual. The laboratory will perform internal quality assurance checks on the reported data to verify data quality prior to submitting the data packages to Exponent. Any nonconformance issues identified during this quality assurance check will be corrected and noted by the laboratory. Close contact will be maintained between the QA/QC coordinator and laboratory project chemist so that all quality issues can be resolved in a timely manner.

Teck Cominco and Exponent may complete additional data verification and validation when data are received from the laboratory. All data will be reviewed as described below in Section 4.2.2.

4.1.4 Data Reduction and Processing

Review procedures for laboratory data are described in the previous section and in Section 4.2.2. These procedures include the verification of correct transcription and reduction procedures at

the laboratory. Data verification procedures also include verification of the field information and laboratory data in the project database, as described in Sections 4.2.1 and 4.2.2. Data integrity during data processing will be maintained through the exclusive use of electronic data transfer and manipulation.

4.2 Verification and Validation Methods

Verification procedures will be completed in the field during sample collection and in the laboratory during sample analysis and testing. In addition, verification and validation of all field and laboratory documentation and reports will be conducted after the analyses and tests are completed. The data will be released for interpretation only after validation has been completed and all qualifiers have been correctly entered into the database.

4.2.1 Field Procedures

The conformance of field activities to specifications in the FSP will be verified by the field team leader on an ongoing basis while field activities are in progress. Additional verification will be provided through oversight of the field activities by the project manager. Verification procedures will include the review of any deviation from prescribed sampling procedures described in the field logbook.

Planned sampling locations are described in the FSP. If a sample cannot be collected as planned, the project manager will be notified and an alternate location or sampling method will be selected, if possible. The review process will include immediate evaluation of any sampling difficulties so that an alternate field procedure or location may be established quickly, if necessary.

Sample completeness will be verified at the end of each sampling day and again when samples are packed for shipment to the laboratory. Laboratory personnel will provide an additional completeness check when the samples are received and logged in and checked against the COC/SAR forms.

Sample identification information in the sample logs and COC/SAR forms will be verified by the data manager or sampling personnel when the field data are entered into the database. Station location information will be verified by the project manager or designee when station coordinates are used to generate project maps. Any discrepancies will be brought to the attention of the field team leader, who will be responsible for resolving the issue. Any deviations that affect data quality or completeness will be discussed in the data quality report, and data will be qualified or rejected, as appropriate.

4.2.2 Verification and Validation of Chemical Data

Verification of chemical data will be completed at the laboratory and by Exponent. The laboratory will be responsible for the review and verification of all bench sheets, manual entry or transcriptions of data, and any professional judgments made by a chemist during sample

preparation, analysis, and calculation and reporting of the final concentrations. The laboratory will also be responsible for the review of quality control results to determine whether data are of usable quality or reanalyses are required. Any nonconformance issues identified during the laboratory's quality assurance checks will be corrected and noted by the laboratory. Close contact will be maintained between the project QA/QC coordinator and the laboratory project manager so that any quality issues can be resolved in a timely manner. Any data quality deviations will be discussed in the laboratory case narrative, including the direction or magnitude of any bias to the data, if possible.

Data validation and verification will be completed by Exponent prior to finalization of the data and release of the data set for interpretation. All data will be verified and validated in accordance with U.S. EPA (2002) for inorganic analyses and in the context of method-specific quality control requirements and laboratory-established control limits as they are applicable to the methods being used. Data will be qualified when quality control procedures are not completed as required, when measurement performance criteria established in the applicable method (e.g., criteria for acceptable calibration) are not met, or when specific DQIs established for this project (e.g., control limits for bias and precision) are not achieved.

4.2.3 Algorithms to Assess Quality Control Results

Data verification includes checking that quality control procedures were included at the required frequencies and that the quality control results meet control limits defined in the method descriptions or by the project DQIs. The equations that will be used to determine whether measurement targets for project DQIs were met for each quality control procedure are provided below.

Duplicate Analyses—Precision for duplicate chemical analyses will be calculated as the relative percent difference (RPD), expressed as an absolute value, between the duplicate samples. The formula that will be used to assess precision for both laboratory and field duplicate samples is as follows:

$$\text{RPD} = \left| \frac{D_1 - D_2}{(D_1 + D_2)/2} \right| \times 100$$

where:

D1 = sample value

D2 = duplicate sample value.

Matrix Spikes Recoveries—Spiked samples provide an indication of the bias of the analysis system. The recovery of matrix spikes will be calculated as the ratio of the recovered spike concentration to the known spiked quantity:

$$\%R = \frac{A - B}{C} \times 100$$

where:

A = the analyte concentration determined experimentally from spiked sample

B = the background level determined by a separate analysis of the unspiked sample

C = the amount of the spike added.

Completeness—Completeness will be calculated for each sample type by dividing the number of valid measurements (all measurements except rejected data) actually obtained by the number of valid measurements that were planned:

$$\%\text{Completeness} = \frac{\text{Valid Data Obtained}}{\text{Total Data Planned}} \times 100$$

To be considered complete, the data sets must also contain all quality control check analyses that verify the precision and accuracy of the results.

4.2.3.1 Sensitivity

The detection limit of the sample preparation and analysis process is defined as "the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte is greater than zero" (40 CFR 136B). In other words, it is the point at which qualitative, not quantitative, identification can be made. In practice, the limit of detection is defined as three times the standard deviation of the blank or background response adjusted for the amount of sample typically extracted and the final extract volume of the method.

Best professional judgment is used to adjust the limit of detection upward in cases where high instrument precision (i.e., low variability) results in a calculated limit of detection and equivalent instrument response less than the absolute sensitivity of the analytical instrument. The actual reporting limit for environmental samples is generally higher than the instrument detection limit because the sample matrix tends to contribute to fluctuations in the instrument's background signal. Laboratory personnel will determine reporting limits based on their experience with samples of similar matrix to those collected for this study and on the response of each instrument to samples for this study. The method reporting limits will be verified during data validation.

4.2.3.2 Toxicity Tests

The following procedures and results will be verified for toxicity test data:

- Use of the correct test procedures
- Identity and source of the test organisms
- Results for positive and negative controls
- Results for measurements for salinity, pH, temperature, and dissolved oxygen.

Results from a toxicity test will not be accepted if the QA/QC criteria stipulated in each toxicity test protocol (U.S. EPA 1994b) are not met. Results for the positive controls (tests using reference toxicants) will be reviewed to evaluate mortalities or increased sensitivity that may have occurred as a result of disease or the potential stresses related to handling, acclimation, and testing.

4.2.3.3 Invertebrate Identification

The data validation process for the taxonomic identification of invertebrates includes reviewing the reported data; checking for completeness, consistency of the results, and transcription errors; and recalculating results when feasible. The following information will be reviewed, and verified and validated when feasible:

- Assemblages of species, as determined by visually surveying and mapping the species composition and distribution (i.e., qualitative estimates)
- The results of the taxonomic verification for each taxon as part of the distribution survey
- The number of individuals of each taxon found in each sample.

4.3 Reconciliation with Data Quality Objectives

The goal of data validation is to determine the quality of each data point and to identify data that do not meet the project DQOs. Nonconforming data may be qualified as estimated (*J*) or rejected as unusable (*R*) during data validation if criteria for data quality are not met. Rejected data will be flagged as unreportable in the project database and will not be used for any purpose. An explanation of the rejected data will be included in the data validation report. If the rejected data are needed to make a decision, then it may be necessary to resample. Any decision to resample will be based on discussions among the project management team (Teck Cominco and Exponent).

Data qualified as estimated (*J*) are less precise or less accurate than unqualified data but are still acceptable for use. The data users and the Exponent project manager are responsible for

assessing the effect of the inaccuracy or imprecision of the qualified data on statistical procedures and other data uses. The data quality report will include all available information regarding the direction or magnitude of bias or the degree of imprecision for qualified data to facilitate the assessment of data usability. The data reporting will include a discussion of data limitations and their effect on data interpretation activities.

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Tables

Table A-1. Project personnel and responsibilities

Personnel	Responsibilities
Jim Kulas Teck Cominco Project Manager	Overall responsibility for Teck Cominco activities. Oversee all program activities to ensure compliance; perform technical oversight and consultation on major quality assurance problems; provide final approval of all necessary actions and adjustments for activities to accomplish project objectives.
Scott Shock Exponent Project Manager	Oversee all investigation activities under Teck Cominco's direction to ensure appropriate quality control review; provide technical oversight; implement necessary actions and adjustments for activities to accomplish project objectives.
James McAteer Exponent QA/QC Coordinator	Provide technical quality assurance assistance; oversee quality assurance activities to ensure compliance with QAPP; coordinate and supervise data validation and data quality report preparation; review and submit quality assurance reports.
Jane Sexton Exponent Field Team Coordinator	Coordinate and supervise field activities; ensure field procedures are completed in accordance with the FSP and QAPP; authorize and document minor adjustments to the sampling plan in response to field conditions, as necessary, and notify project manager and QA/QC coordinator; track submittal and receipt of samples at the laboratory; verify chain-of-custody/sample analysis request forms.
Database Administrator	Organize and maintain project database. Ensure that the data are stored in accordance with the QAPP. Supervise data management personnel.
Lee Wolf CAS Quality Assurance Officer	Ensure that sample receipt and custody records are properly handled and data are reported within specified turnaround times: calibrate and maintain instruments as specified; perform internal quality control measures and analytical methods as required; take appropriate corrective action as necessary; notify the QA/QC coordinator when problems occur; report data and supporting quality assurance information as specified in this QAPP.

Note: FSP - field sampling plan
QA/QC - quality assurance and quality control
QAPP - quality assurance project plan

Table A-2. Summary of data quality indicators for matrix spike and laboratory control sample recoveries[a,b]

Analyte	Soil/Sediment	Tissue	Water
Metals by ICP-MS			
Aluminum	70–130[d]	70–130[d]	70–130[d]
Antimony	70–130[d]	70–130[d]	70–130[d]
Arsenic	70–130[d]	70–130[d]	70–130[d]
Barium	70–130[d]	70–130[d]	70–130[d]
Cadmium	70–130[d]	70–130[d]	70–130[d]
Chromium	70–130[d]	70–130[d]	70–130[d]
Cobalt	70–130[d]	70–130[d]	70–130[d]
Copper	70–130[d]	70–130[d]	70–130[d]
Lead	70–130[d]	70–130[d]	70–130[d]
Manganese	70–130[d]	70–130[d]	70–130[d]
Molybdenum	70–130[d]	70–130[d]	70–130[d]
Selenium	70–130[d]	70–130[d]	70–130[d]
Silver	70–130[d]	70–130[d]	70–130[d]
Thallium	70–130[d]	70–130[d]	70–130[d]
Vanadium	70–130[d]	70–130[d]	70–130[d]
Zinc	70–130[d]	70–130[d]	70–130[d]
Metals by ICP-AES			
Chromium	75-125[c]	75-125[c]	75-125[c]
Vanadium	75-125[c]	75-125[c]	75-125[c]
Metals by CVAA			
Mercury	60–130[d]	70–130[d]	70–130[d]
Metals by GFAA			
Selenium	70–130[d]	70–130[d]	70–130[d]
Conventionals			
Total solids	NA	NA	NA
Grain size	NA	NA	NA

Note: CVAA - cold vapor atomic absorption spectrometry
GFAA - graphite furnace atomic absorption spectrometry
ICP-MS - inductively coupled plasma-mass spectrometry
NA - not applicable

[a] Control limits provided by Columbia Analytical Services are as listed in the laboratory quality assurance manual. Control limits are continually updated; therefore, the control limits listed above may be different when data are reported.

[b] In-house limits, unless footnoted.

[c] Matrix spike control limits.

[d] Method specified control limits.

Table A-3. Summary of data quality indicators for duplicate analyses

Analyte	Precision[a]		
	Soil/Sediment	Tissue	Water
Metals by ICP-MS			
Aluminum	30	30	20
Antimony	30	30	20
Arsenic	30	30	20
Barium	30	30	20
Cadmium	30	NA	20
Chromium	30	30	20
Cobalt	30	30	20
Copper	30	30	20
Lead	30	30	20
Manganese	30	30	20
Molybdenum	30	30	20
Selenium	30	30	20
Silver	30	30	20
Thallium	30	30	20
Vanadium	30	NA	20
Zinc	30	30	20
Metals by ICP-AES			
Chromium	30	30	20
Vanadium	30	30	20
Metals by CVAA			
Mercury	30	30	20
Metals by GFAA			
Selenium	30	30	20
Conventionals			
Total solids	30	30	20
Grain Size	30	NA	20

Note: CVAA - cold vapor atomic absorption spectrometry
GFAA - graphite furnace atomic absorption spectrometry
ICP-AES - inductively coupled plasma-atomic emission spectrometry
ICP-MS - inductively coupled plasma-mass spectrometry
NA - not applicable
TBD - to be determined by laboratory

[a] Control limits provided by Columbia Analytical Services are as listed in the laboratory quality assurance manual. Control limits are continually updated; therefore, the control limits listed above may be different when data are reported.

Table A-4. Target analyte list, methods, method detection limits, and method reporting limits[a]

Analyte	Method	Tundra Soil/Sediment (mg/kg) Method Detection Limit	Tundra Soil/Sediment (mg/kg) Method Reporting Limit	Tissue (mg/kg) Method Detection Limit	Tissue (mg/kg) Method Reporting Limit	Water (μg/L) Method Detection Limit	Water (μg/L) Method Reporting Limit
Metals							
Aluminum	EPA 200.8 by ICP-MS	2	2	0.3	2	0.9	2
Antimony	EPA 200.8 by ICP-MS	0.02	0.05	0.005	0.05	0.006	0.05
Arsenic	EPA 200.8 by ICP-MS	0.2	0.5	0.03	0.5	0.09	0.5
Barium	EPA 200.8 by ICP-MS	0.02	0.05	0.006	0.05	0.03	0.5
Cadmium	EPA 200.8 by ICP-MS	0.005	0.05	0.005	0.02	0.007	0.02
Chromium	EPA 200.8 by ICP-MS	0.03	0.2	NA	NA	0.06	0.2
Chromium	EPA 6010B by ICP-AES	NA	NA	0.5	0.5	5	3
Cobalt	EPA 200.8 by ICP-MS	0.002	0.02	0.002	0.02	0.004	0.02
Copper	EPA 200.8 by ICP-MS	0.01	0.1	0.07	0.1	0.02	0.05
Lead	EPA 200.8 by ICP-MS	0.02	0.05	0.007	0.02	0.008	0.02
Manganese	EPA 200.8 by ICP-MS	0.04	0.1	0.005	0.05	0.02	0.05
Molybdenum	EPA 200.8 by ICP-MS	0.006	0.05	0.003	0.05	0.006	0.05
Selenium	EPA 200.8 by ICP-MS	0.2	1	NA	NA	0.2	1
Silver	EPA 200.8 by ICP-MS	0.003	0.02	0.004	0.02	0.002	0.02
Thallium	EPA 200.8 by ICP-MS	0.002	0.02	0.002	0.02	0.003	0.02
Vanadium	EPA 200.8 by ICP-MS	0.02	0.2	NA	NA	0.03	0.02
Vanadium	EPA 6010B by ICP-AES	NA	NA	0.7	1	5	10
Zinc	EPA 200.8 by ICP-MS	0.2	0.5	0.06	0.5	0.3	0.5
Selenium	EPA 7740 by GFAA	NA	NA	1	1	5	1
Mercury	SW-846 7470A/7471A by CVAA	0.008	0.02	0.002	0.02	0.04	0.2
Conventionals							
Total solids	EPA 160.3	0.1	0.1	0.1	0.1	NA	NA
Grain Size	ASTM D422-M	NA	NA	NA	NA	NA	NA

Note: CVAA - cold vapor atomic absorption spectrometry
EPA - U.S. Environmental Protection Agency
GFAA - graphite furnace atomic absorption spectrometry
ICP-MS - inductively coupled plasma-mass spectrometry
NA - not applicable
ICP-MS - inductively coupled plasma-atomic emission spectrometry
SM - Standard Method

[a] Control limits provided by Columbia Analytical Services are as listed in the laboratory quality assurance manual. Control limits are continually updated; therefore, the control limits listed above may be different when data are reported.

Table A-5. Sample preservation, handling procedures, and holding time requirements

Analyte	Approximate Laboratory Subsample[a]	Container	Preservation and Handling	Maximum Holding Time[b]
Sediment/Soil				
Physical Analytes				
Total solids	10 g	125-mL wide-mouth HDPE jar	Cool (4°C)	180 days
Grain Size	100 g	125-mL wide-mouth HDPE jar	Cool (4°C)	180 days
Toxicity tests (sediment only)				
Leptocheirus survival	2 L	1 L wide mouth glass jar; Teflon-lined lid	Keep in dark; cool (4°C)	14 days
Metals				
Metals	10 g	125-mL wide-mouth HDPE jar	Cool (4°C)	180 days
Mercury	10 g	125-mL wide-mouth HDPE jar	Cool (4°C)	28 days
Tissue				
Conventional Analytes				
Solids	1–2[d] g	Double plastic self-sealing bags; minimize air space[c]	Cool (4°C)	180 days
Metals				
Metals	1–2[d] g	Double plastic self-sealing bags; minimize air space[c]	Cool (4°C)	1 year
Mercury	2–5[d] g	Double plastic self-sealing bags; minimize air space[c]	Cool (4°C)	1 year
Water				
Metals	200 mL	1-L HDPE bottle	HNO_3 to pH <2	6 months
Mercury	100 mL	250-mL HDPE bottle	0.5% HCl	28 days

Note: HDPE - high density polyethylene

[a] Sample volumes listed are the optimum amounts that should be used to conduct the target analyses to achieve the detection limit goals. However, the sample volume that will be used at the laboratory may vary if a limited amount of sample is collected or if concentrations of target analytes are elevated.

[b] Sample collection to preparation holding time/sample preparation to analysis holding time.

[c] Wide-mouth glass jars with Teflon®-lined lids will be used by the laboratory to store tissue samples.

[d] Sample volumes listed are the minimum amounts that should be used to conduct the target analyses to achieve the detection limit goals (due to limited sample size).