UPPER COLUMBIA RIVER

FINAL
Quality Assurance Project Plan for the 2019 Phase 3 Sediment Study

Prepared for

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SECTION A: PROJECT MANAGEMENT

A1 TITLE AND APPROVAL SHEET

QUALITY ASSURANCE PROJECT PLAN FOR THE 2019 PHASE 3 SEDIMENT STUDY

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BMI Laboratory QA Manager (EcoAnalysts)	Rob Bodle		Date	8/23/19
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Chemistry Laboratory QA Manager (ALS)	Carl Dagner		Date	8/23/19
BSEM Laboratory Project Manager (R.J.G)	Keith Rickabaugh		Date	
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Bioassay Laboratory QA Manager (PER)	Stephen L. Clark		Date	8/23/19
Database Administrator	Randy O'Boyle		Date	Aug 23, 2019

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ACRONYMS AND ABBREVIATIONS

AA	atomic absorption
Agreement	June 2, 2006, Settlement Agreement
ACG	analytical concentration goal
AIC	Aikaike's Information Criterion
ALS	ALS Environmental
AOI	area of interest
AREMP	Aquatic Receiving Environment Monitoring Program
ASTM	American Society of Testing and Materials
AVS	acid volatile sulfide
AWQC	ambient water quality criteria
BERA	baseline ecological risk assessment
BLM	biotic ligand model
BMI	benthic macroinvertebrate
BSEM	back scatter electron microscopy
BTAG	Biological Technical Assistance Group
$CaCO_3$	calcium carbonate
CCT	Confederated Tribes of the Colville Reservation
CERC	Columbia Environmental Research Center
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
CMA	Coastal Monitoring Associates
COC	chain-of-custody
COPC	chemical of potential concern
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyltrichloroethane
DEA	David Evans & Associates
DMP	data management plan
DO	dissolved oxygen
DOC	dissolved organic carbon
DQI	data quality indicator
DQO	data quality objective
Ecology	Washington State Department of Ecology
EDD	electronic data deliverable

EPA	U.S. Environmental Protection Agency
ESI	Environmental Standards, Inc.
Exponent	Exponent, Inc.
f_{oc}	fraction of organic carbon
FSP	field sampling plan
GC/ECD	gas chromatography/ electron capture detector
GC/MS	gas chromatography/mass spectrometry
GIS	geographic information system
GPS	global positioning system
GRTS	Generalized Random Tessellation Stratified
ICP/AES	inductively coupled plasma/atomic emission spectrometry
ICP/MS	inductively coupled plasma/mass spectrometry
ID	identification
LAET	lowest apparent effects threshold
LCS	laboratory control sample
LOE	level of effort
mBLM	mixtures biotic ligand model
MDL	method detection limit
MQO	measurement quality objective
MRL	method reporting limit
MS	matrix spike
MSD	matrix spike duplicate
ORP	oxidation-reduction potential
OU	Operable Unit
PAH	polycyclic aromatic hydrocarbon
PARCCS	precision, accuracy or bias, representativeness, completeness, comparability, and analytical sensitivity
PCB	polychlorinated biphenyl
PEC	probable effects concentration
PER	Pacific EcoRisk
QA	quality assurance
QA/QC	quality assurance and quality control
QAPP	quality assurance project plan
QC	quality control
RI/FS	remedial investigation and feasibility study
RJLG	RJ Lee Group, Inc.

RM	river mile
RPD	relative percent difference
RSD	relative standard deviation
S2BVM	Stage 2B data validation
S4VM	Stage 4 data validation
SEM	simultaneously extracted metals
SEM-AVS	simultaneously extracted metals minus acid volatile sulfide
SHSP	site health and safety plan
SIM	selective ion monitoring
Site	Upper Columbia River site
SM	Standard Methods for the Examination of Water and Wastewater
SOP	standard operating procedure
SQS	sediment quality standards
SQT	sediment quality triad
SRM	standard reference material
STI	Spokane Tribe of Indians
TAI	Teck American Incorporated
TAL	target analyte list
TEC	threshold effect concentration
TIE	toxicity identification evaluation
TOC	total organic carbon
TRV	toxicity reference value
UCL	upper confidence limit
USGS	U.S. Geological Survey
WQS	water quality standard
Windward	Windward Environmental, Inc.

UNITS OF MEASURE

amsl	above mean sea level
°C	degree(s) Celsius
cm	centimeter(s)
dw	dry weight
ft	foot/feet
g	gram(s)
gal	gallon(s)
in.	inch(es)
km	kilometer(s)
lux	unit of illumination
L	liter
L:D	light to dark ratio (photoperiod)
m	meter(s)
m^2	square meter(s)
mg	milligram(s)
mg/kg	milligram(s) per kilogram
mg/L	milligram(s) per liter
mL	milliliter(s)
mm	millimeter(s)
oz	ounce(s)
µm	micrometer(s)
mV	millivolts
sqkm	square kilometer
µS/cm	microSiemens/centimeter
µg/L	microgram(s) per liter
µmol/g	micromoles per gram
µmol/gd	micromoles per gram (dry weight)
µmol/goc	micromoles per gram organic carbon
v/v	volume to volume
wwt/wwt	wet weight to wet weight

A3 DISTRIBUTION LIST

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Senior Technical Advisor/Task Manager (Porewater)	Robert Santore
Senior Technical Advisor/Task Manager (Bioassays/TIE) and Bioassay Coordinator	Karen Tobiason
Senior Technical Advisor/Task Manager (BMI)	Chad Wiseman
QAPP Coordinator	Kevin Lundmark
Field Supervisor (AECOM)	Jennifer Pretare
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BSEM Laboratory Project Manager (RJLG)	Keith Rickabaugh
BSEM Laboratory QA Manager (RJLG)	TBD
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A4 INTRODUCTION AND TASK ORGANIZATION

A4.1 Introduction

This document presents the quality assurance project plan (QAPP) for the 2019 Phase 3 sediment study (hereafter, the "study") of the Upper Columbia River (UCR; hereafter, the Site[1]), which extends from the U.S.-Canada border (river mile [RM] 745) to Grand Coulee Dam (RM 596). This study is one of the tasks being completed as part of the remedial investigation and feasibility study (RI/FS) and baseline ecological risk assessment (BERA) being completed for the Site under an agreement between Teck American Incorporated (TAI) and the U.S. Environmental Protection Agency (EPA). The overall objective of the RI/FS is to investigate the nature and extent of contamination and risk to humans and the environment at the Site. TAI is conducting the RI/FS and current sediment study with EPA oversight.

This QAPP describes the organization, data quality objectives (DQOs), study design, analytical procedures, and quality assurance and quality control (QA/QC) procedures upon which the study will be based. The field sampling plan (FSP) describes field procedures and protocols that will be followed and is presented in Appendix A. This QAPP is formatted consistent with EPA QAPP Guidance (USEPA 2002a).

The objective of the Phase 3 sediment study is to characterize sediment and porewater conditions in three areas of interest (AOIs)[2] in the Upper Reach Operable Unit (OU) such that an overall understanding of risk to benthic organisms and the nature and extent of contamination in this portion of the Site can be assessed. A sediment quality triad (SQT) approach incorporating multiple lines of evidence will be used. These lines of evidence consist of sediment and sediment porewater chemistry, whole sediment laboratory toxicity tests, and in situ benthic macroinvertebrate community structure and are largely affiliated with the concepts in DQOs 2, 3, 4, and 5 as defined by TAI and commented on by EPA over the past few months. The chronology of EPA and TAI interaction on the scope and details of the study is summarized in Table A4-1.

[1] The Site as defined within the June 2, 2006 Settlement Agreement is the areal extent of hazardous substances contamination within the United States in or adjacent to the Upper Columbia River, including the Franklin D. Roosevelt Lake, from the U.S.-Canada border to the Grand Coulee Dam, and those areas in proximity to the contamination that are suitable and necessary for implementation of response actions.

[2] The three AOIs are 1) Deadman's Eddy, 2) China Bend, and 3) Evans (see Map A4-1).

A4.2 Task Organization

This section presents the organizational structure for activities associated with the study, including task management and oversight, fieldwork, sample analysis, and data management. Contact information for team task members is provided in Table A4-2.

A4.2.1 EPA Organization and Responsibilities

EPA will oversee TAI activities associated with the study and will coordinate the comments and review of the following parties: U.S. Department of the Interior, Washington State Department of Ecology (Ecology), and local tribes (i.e., the Confederated Tribes of the Colville Reservation [CCT] and the Spokane Tribe of Indians [STI]). In addition, EPA, under Section 106 of the National Historic Preservation Act, has the primary responsibility for consulting with interested parties. EPA's project manager, Kathryn Cerise, will be responsible for ensuring that the work performed is consistent with all applicable EPA guidance. The EPA Region 10 quality assurance (QA) manager is Donald Brown. The responsibilities of the QA manager or QA designee will include review and approval of the QAPP and any subsequent addenda, as well as laboratory oversight as requested or necessary (i.e., data validation or laboratory observation).

A4.2.2 TAI Organization and Responsibilities

Kris McCaig will serve as TAI's project coordinator and will have the primary responsibility for ensuring that TAI meets all the requirements and associated deliverables specified within the June 2, 2006 Settlement Agreement (Agreement) (USEPA 2006a). Denise Mills will serve as TAI's assistant project coordinator working closely with Ms. McCaig to ensure the above.

A4.2.3 Key Task Personnel

TAI technical team members for the study and their respective responsibilities are identified below.

Principal Investigator and Technical Coordinator—Jennifer Holder (ERM) will serve as principal investigator and will oversee and approve all project activities, review QA reports, approve final project QA needs, and authorize necessary actions and adjustments needed to accomplish program QA objectives.

Senior Technical Advisors/Task Managers—There are four senior technical advisors responsible for their respective study elements as follows:

- David Abranovic (ERM) is responsible for providing technical oversight in the design, implementation, and data interpretation for the characterization of chemical and physical properties in surface sediment.

- Robert Santore (Windward Environmental, Inc. [Windward]) is responsible for providing technical oversight in the design, implementation, and data interpretation for characterization of in situ porewater chemistry.
- Karen Tobiason (Windward) is responsible for providing technical oversight in the design, implementation, and data interpretation for the characterization of toxicity in surface sediment. As the bioassay coordinator, she is responsible for ensuring that bioassays are completed satisfactorily and conducted according to standard protocols and the project-specific standard operating procedures (SOPs); coordinating receipt of samples by the test laboratory and tracking the laboratory's progress; addressing QA issues related to the bioassays; and addressing any scheduling issues. Ms. Tobiason will report to the principal investigator, and will work closely with the database administrator. Ms. Tobiason will also coordinate the identification of samples for performing toxicity identification evaluations (TIEs). If TIEs are performed, she will be the technical lead for the development of a TIE study plan to be prepared as an addendum to this QAPP in collaboration with EPA. Ms. Tobiason will also facilitate the exchange of Pacific EcoRisk (PER) and Columbia Environmental Research Center (CERC) lab personnel prior to the commencement of bioassays to ensure that the same methods will be implemented by both laboratories and comments and questions regarding method implementation may be addressed.
- Chad Wiseman (HDR) is responsible for providing technical oversight in the design, implementation, and data interpretation for the characterization of benthic macroinvertebrate (BMI) communities.

Each senior technical advisor will serve as the task manager for their respective study. Each task manager will lead technical design and data interpretation. The task manager (or their designee) will also provide on-site and/or laboratory supervision as needed and ensure that proper sample collection, preservation, storage, transport, and chain-of-custody (COC) procedures are followed. He or she will inform the principal investigator when problems occur, and will communicate and document corrective actions taken.

QAPP Coordinator—Kevin Lundmark (ERM) will serve as QAPP coordinator and will assist the TAI project coordinator, principal investigator, senior technical advisors, and field supervisor as questions arise during the implementation of this QAPP, as corrective actions are identified, or if potential deviations from the QAPP are identified.

Task QA Coordinator—Rock Vitale (Environmental Standards, Inc. [ESI]) is the task QA coordinator and is responsible for providing overall QA support for the study. Mr. Vitale will coordinate validation of laboratory data; communicate data quality issues

to the laboratory coordinator; and will work with the database administrator to address potential data limitations. Mr. Vitale will report directly to the laboratory coordinator, and will work closely with the database administrator to ensure that the data are of the highest quality.

Laboratory Coordinator—Cristy Kessel (TAI) is the laboratory coordinator for the analytical chemistry, BMI, and back scatter electron microscopy (BSEM) laboratories. Ms. Kessel will report directly to TAI's project coordinator and will work closely with the principal investigator. She will work closely with the task QA coordinator and the database administrator.

- **Analytical Chemistry Laboratory**—Ms. Kessel is responsible for ensuring that laboratory method selection and/or development is satisfactorily completed prior to the analysis of samples; coordinating with the testing laboratory and tracking the laboratory's progress; verifying that the laboratory has implemented the requirements of this QAPP; addressing QA issues related to the laboratory's analyses; ensuring that the laboratory's capacities are sufficient to undertake the required analyses in a timely manner; and addressing scheduling issues related to the laboratory's analyses.
- **BMI Laboratory**—Ms. Kessel is responsible for coordinating with the BMI laboratory and tracking the laboratory's progress; verifying that the laboratory has implemented the requirements of this QAPP; addressing QA issues related to the laboratory's analyses; ensuring that the laboratory's capacities are sufficient to undertake the required analyses in a timely manner; and addressing scheduling issues related to the laboratory's analyses.
- **BSEM Laboratory**—Ms. Kessel is responsible for coordinating receipt of samples by the test laboratory and tracking the laboratory's progress; addressing QA issues related to the BSEM analysis; and addressing any scheduling issues.

Database Administrator—Randy O'Boyle (Exponent) is the database administrator and will have primary responsibility for data management and database maintenance and development. Mr. O'Boyle is responsible for overseeing and/or conducting the following activities: establishing storage formats and procedures appropriate for data collected; ensuring all data packages are complete and delivered in the correct format; maintaining the integrity and completeness of the database; and providing data summaries to data users for interpretation and reporting. Mr. O'Boyle will report directly to the TAI project coordinator and will work closely with the task QA coordinator and the laboratory.

Field Supervisor—The field supervisor, Jennifer Pretare (AECOM), is responsible for overseeing the planning and coordination of the field sampling efforts and for all aspects of sample collection activities to ensure that appropriate sampling, QA, and documentation procedures are used. If changes in the QAPP or FSP (Appendix A) are needed, the field supervisor will ensure that proposed changes are coordinated with EPA's project coordinators, its staff, and its authorized representative in the field, and with TAI's project coordinator according to the established lines of communication among the TAI technical team, TAI, and EPA.

A4.2.4 Laboratories

The following responsibilities apply to respective project and QA managers at the analytical, bioassay, BMI identification, and BSEM laboratories. The analytical laboratory will be ALS Environmental (ALS) while the bioassay laboratory will be PER, the BMI laboratory will be EcoAnalysts, Inc., and the BSEM laboratory will be RJ Lee Group, Inc. (RJLG). ALS will perform the sample processing and analyses for metals, general chemistry, and conventional parameters for sediment and porewater samples. PER will perform the sample processing and bioassay analysis of sediment samples. EcoAnalysts will perform BMI identification and enumeration for the BMI survey. RJLG will conduct BSEM analysis of sediment samples to determine percent slag content. ALS will also prepare and ship samples to PER and RJLG for the bioassay and BSEM analyses. BMI samples will be shipped from the field directly to EcoAnalysts. The following responsibilities apply to project and QA managers at ALS, PER, EcoAnalysts, and RJLG who will be available for this project.

TIE testing, if performed, will be described in a QAPP addendum that identifies the testing laboratory. The TIE testing laboratory proposed by TAI will be subject to review by EPA as described in the Settlement Agreement.

Analytical Chemistry Laboratory Project Manager—Mark Harris (ALS) is responsible for the successful and timely completion of sample analyses at their laboratory, as well as the following:

- Ensuring that samples are received and logged correctly, analyzed within specified holding times, correct methods and modifications are used, and data are reported within specified turnaround times
- Reviewing analytical data to ensure that procedures were followed as required in this QAPP, the cited methods, and laboratory SOPs

- Apprising the TAI analytical chemistry laboratory coordinator of the schedule and status of sample analyses and data package preparation
- Notifying the TAI analytical chemistry laboratory coordinator if problems occur in sample receiving, analysis, or scheduling, or if control limits cannot be met
- Taking appropriate corrective action as necessary
- Reporting data and supporting QA information as specified in this QAPP
- Providing electronic data deliverables (EDDs) in a format consistent and compatible with the UCR electronic database.

Analytical Chemistry Laboratory QA Manager—Carl Degner (ALS) is responsible for overseeing QA activities in the analytical chemistry laboratory and ensuring the quality of the data for this task. Specific responsibilities include the following:

- Overseeing and implementing the laboratory's QA program
- Maintaining QA records for the laboratory production unit
- Ensuring that QA/QC procedures are implemented as required for each method and providing oversight of QA/QC practices and procedures
- Reviewing and addressing or approving nonconformity and corrective action reports
- Coordinating responses to any quality control (QC) issues that affect this task with the analytical chemistry laboratory project manager.

Roles and responsibilities outlined above for ALS will also apply to PER, EcoAnalysts, and RJLG, as appropriate to the types of analyses to be performed. Jeffrey Cotsifas and Stephen Clark will serve as the project manager and QA manager, respectively, for PER; Jay Word and Rob Bobier will serve as the project manager and QA manager, respectively, for EcoAnalysts; and Keith Rickabaugh and TBD will serve as the project manager and QA manager, respectively, for RJLG.

A5 PROBLEM DEFINITION AND BACKGROUND

This section presents the overall risk question, specific study questions, and analytical approaches to be used in the Phase 3 Sediment Study. The format of this section is different from the individual DQO format used by TAI in preliminary Phase 3 study DQO documents. Instead, the basis for the Phase 3 study is presented as a series of study questions and analytical approaches intended to characterize sediment and porewater in the three AOIs in the Upper Reach OU to answer overall questions about risk to benthic organisms and the nature and extent of contamination in the Upper Reach OU[3].

An SQT approach incorporating multiple lines of evidence will be used. These lines of evidence are largely affiliated with the concepts in DQOs 2, 3, 4, and 5 (see Section A.5.3 below) as defined by TAI and commented on by EPA in 2018 and 2019. Figure A5-1 shows the link between the TAI's previously defined DQOs 2, 3, 4, and 5 (see Section A.5.3 below) and the overall problem statement.

A5.1 Summary of Conceptual Site Model for the Upper Reach OU

Review of existing data indicates a strong relationship between the presence of sand-sized material and potentially toxic concentrations of metals in samples collected from depositional features in the OU. However, the quantity and spatial coverage of existing data are not sufficient to characterize the nature and magnitude of risks posed to benthic organisms through exposure to contaminated sediment and porewater.

A5.2 Overall Risk Question

Do elevated metals concentrations associated with slag deposits pose unacceptable risk to benthic organisms in the UCR Upper Reach OU?

A5.3 Approach and Specific Study Questions

The SQT approach will be used to address the overarching question by evaluating correlations or concordance among the elements of the triad: co-located sediment and porewater chemistry, toxicity in laboratory bioassays, and BMI community metrics (i.e., measures of BMI community structure, function, and/or stress/metals tolerance scores).

[3]The Upper Reach OU encompasses the UCR from upstream of Marcus Flats at RM 708 to the U.S.-Canada border north of RM 744

Specific questions:

1. The SQT will answer the following specific questions about the Upper Reach OU:
    a) Do metals concentrations in UCR Upper Reach OU sediment and porewater exceed aquatic toxicity benchmarks for sediment and porewater?
    b) Do bioassay test organisms exposed to UCR Upper Reach OU sediment show responses indicative of sediment toxicity relative to laboratory control sediment?
    c) Do BMI community metrics indicate reduced species diversity and richness, or increase pollution tolerance in some UCR Upper Reach OU locations?
    d) Do elevated metals associated with slag in depositional sediments cause toxicity in laboratory bioassays?
    e) Do elevated metals associated with slag in depositional sediments adversely affect BMI communities?
    f) Do sediment sample locations having elevated bioassay toxicity also have altered BMI metrics indicative of metals-related stress?
2. Additional secondary study questions include comparisons of central tendency and distribution between Site and reference areas:
    a) Are bioassay results and BMI metrics at individual locations within the AOIs outside their respective reference envelopes?
    b) Do measures of central tendency in sediment and porewater metals chemistry, bioassay results, and BMI metrics differ from those of the reference areas?
3. Because the above questions will not directly assess causation of the observed effects, the TIE will be used to experimentally assess the cause of observed toxicity. The question addressed by the TIE is: Are elevated metals concentrations in sediment and porewater the cause of the observed toxicity to aquatic invertebrates?

The elements of the Phase 3 study, previously expressed as DQOs 1 through 5, are summarized below:

- DQO 1—Sediment Facies Mapping: The UCR riverbed is composed of substrates that include mixtures of unconsolidated fine-grained sediments (i.e., sediments <2 mm), gravels, cobbles, and bedrock. Sediment organisms utilize these substrates differentially and chemical of potential concern (COPC) concentrations may differ as a function of sediment composition and bed characteristics, with finer-grained

deposits potentially containing granulated slag, which may be a source of elevated concentrations of COPCs. Detailed maps showing the distribution of different sediment facies within the Upper Reach OU were needed to plan for and implement Phase 3 sediment and porewater sampling in the three AOIs during 2019. The sediment facies mapping effort was completed throughout the OU in 2018[4].

- DQO 2—Characterize Chemical/Physical Properties in Surface Sediment: The concentration and distribution of metals identified as COPCs in surface sediment (0 to 6 in.) are needed to characterize the distribution of metals and slag in sediments and to refine assessments of potential toxicity to aquatic receptors in three AOIs within the Upper Reach OU.
- DQO 3—Characterize In Situ Sediment Porewater Chemistry: Sampling in situ sediment porewater is needed to decrease uncertainty and provide a line of evidence for assessing potential sediment toxicity. Characterization of the physical and chemical properties of surficial sediment porewater is needed to provide additional data for the BERA and to support the site characterization components of the RI.
- DQO 4—Characterization of Toxicity in Surface Sediment: To reduce uncertainties and refine assessments of potential toxicity, additional bioassay data will be collected in the Phase 3 sediment study from the three AOIs and reference areas. TIEs may be conducted on a subset of samples (both Site and reference) that show a reduction in performance relative to the laboratory control to understand the causes of biological effects. The TIE would address whether the effects were due to one or more classes of metal COPCs or to some other sediment property.
- DQO 5—Characterization of Benthic Macroinvertebrate Communities: The BERA Work Plan (TAI 2011) specifies that additional measures will be used to assess the potential for adverse impacts on the BMI community if the bioassay test results collected in the Phase 2 sediment study do not lead to a definitive conclusion about the presence or absence of adverse biological effects, or if there are conflicting lines of evidence. The additional measures specified include a biological survey of the BMI community that would consider the potential effects of sediment toxicity, as well as the potential confounding effects of reservoir drawdown and other factors that can influence BMI communities.

[4] A small portion of the OU near the U.S.-Canada border was mapped in 2019.

A6 DATA NEEDS

As noted in Section A5, additional data are needed from the Upper Reach OU AOIs to characterize chemical and physical properties in surface sediment, characterize in situ sediment porewater chemistry, characterize toxicity in surface sediment, and characterize BMI communities. The DQOs associated with these data needs are detailed in Section A7.

A7 UCR PHASE 3 SEDIMENT STUDY DATA QUALITY OBJECTIVES

EPA's seven-step DQO process (USEPA 2006b) was used to guide the design rationale for the Phase 3 sediment study in the Upper Reach OU within the UCR Site.

A7.1 DQO Step 1 – State the Problem

Review of existing data indicates a strong relationship between the presence of sand-sized material and potentially toxic concentrations of metals in samples collected from depositional features in the Upper Reach OU. However, the quantity and spatial coverage of existing data are not sufficient to characterize the nature and magnitude of risks posed to benthic organisms through exposure to contaminated sediment and porewater.

A7.2 DQO Step 2 – Identify the Goals of the Study

A7.2.1 Primary Goal and Study Questions

The primary goal of the Phase 3 sediment study is to gather enough data to characterize the nature and magnitude of risks posed to benthic organisms through exposure to contaminated sediment and porewater in the Upper Reach OU. An SQT approach (see Figure A5-1) will be used to address the overarching question by independently evaluating each element of the triad and by evaluating correlations or concordance among the elements of the triad: co-located sediment and porewater chemistry, toxicity in laboratory bioassays, and BMI community metrics (i.e., measures of [BMI] community structure, function, and/or stress or metals tolerance scores) in three pre-selected AOIs within the Upper Reach OU.

Specific questions to be answered by the primary study goal include:

1. The SQT will answer the following specific questions about the Upper Reach OU:
    a) Do metals concentrations in UCR Upper Reach OU sediment and porewater exceed aquatic toxicity benchmarks for sediment and porewater?
    b) Do bioassay test organisms exposed to UCR Upper Reach OU sediment show responses indicative of sediment toxicity relative to laboratory control sediment?

c) Do BMI community metrics indicate reduced species diversity and richness, or increase pollution tolerance in some UCR Upper Reach OU locations?

d) Do elevated metals associated with slag in depositional sediments cause toxicity in laboratory bioassays?

e) Do elevated metals associated with slag in depositional sediments adversely affect BMI communities?

f) Do sediment sample locations having elevated bioassay toxicity also have altered BMI metrics indicative of metals-related stress?

2. Additional secondary study questions include comparisons of central tendency and distribution between Site and reference areas:

   a) Are bioassay results and BMI metrics at individual locations within the AOIs outside their respective reference envelopes?

   b) Do measures of central tendency in sediment and porewater metals chemistry, bioassay results, and BMI metrics differ from those of the reference areas?

3. Because the above questions will not directly assess causation of the observed effects, the TIE will be used to experimentally assess the cause of observed toxicity. The question addressed by the TIE is: Are elevated metals concentrations in sediment and porewater the cause of the observed toxicity to aquatic invertebrates?

A7.2.2 Secondary Goals

- Estimate the proportion of sediment facies in each AOI containing sampleable sand that exceeds an effects concentration or other benchmarks.
- Map physical and chemical properties of surficial riverbed substrates and porewater in the three AOIs.
- Verify the results of the sediment facies mapping completed in 2018 in the three AOIs.

A7.2.3 Integration of Phase 3 Results with Historical Results

The Phase 3 results are intended to supplement and possibly take precedence over or receive greater weight-of-evidence than historical sample and evaluation results for the Upper Reach OU in the BERA. The rationale for potentially giving more emphasis to these results is that they will include 1) BMI samples, 2) more samples of likely slag-containing sands, 3) more thorough reference site chemistry, and 4) refined field and laboratory porewater sampling approaches. However, data quality and acceptability evaluations must be completed before any weight-of-evidence analysis can be completed.

A7.3 DQO Step 3 – Identify Information Inputs

A7.3.1 Needed Information

- Sediment facies, bathymetry, and backscatter maps for each AOI
- Historical river channel geometry and bathymetry
- Analytical data for surface sediment and field-collected porewater samples from each AOI and from reference locations
  - Surface sediment sample analytical data:
    - Total target analyte list (TAL) metals [5]
    - Percent slag by BSEM
    - Grain size
    - Total organic carbon (TOC)
    - Simultaneously extracted metals (SEM)
    - Acid volatile sulfide (AVS)
    - Polychlorinated biphenyls (PCBs)
    - Polycyclic aromatic hydrocarbons (PAHs)
    - Pesticides
  - Porewater chemistry data analyzed at the laboratory or in the field during sampling:
    - Dissolved metals, including major cations
    - Major anions (chloride, sulfate)
    - Alkalinity
    - TOC and dissolved organic carbon (DOC)
    - Sulfide at select locations
    - pH
- Coordinates, imagery, and sediment descriptions at each sediment and field-collected porewater sample location
- Sediment and porewater toxicity benchmarks (generic or site-specific)
- 42-day sediment bioassay data for AOI and reference area samples using the freshwater amphipod *Hyalella azteca* with the following endpoints:
  - 28-day survival, weight, and biomass
  - 42-day survival, weight, biomass, and reproduction
- Validated analytical data from sediment and porewater collected synoptically with the bioassays

[5] TAL metals include aluminum (Al), antimony (Sb), arsenic (As), barium (Ba), beryllium (Be), cadmium (Cd), calcium (Ca), chromium (Cr), cobalt (Co), copper (Cu), iron (Fe), lead (Pb), magnesium (Mg), manganese (Mn), mercury (Hg), nickel (Ni), potassium (K), selenium (Se), silver (Ag), sodium (Na), thallium (Tl), vanadium (V), and zinc (Zn). Validated total zinc data will used to estimate percent slag in Phase 3 sediment samples using a total zinc regression model developed from Phase 2 and U.S. Geological Survey (USGS) 2016 data. Regression model estimates will be confirmed with results from the samples analyzed for percent slag using BSEM.

  - Sediment
    - SEM
    - AVS
    - TOC
  - Porewater
    - Anions (chloride, sulfate)
    - Alkalinity
    - pH
    - DOC
    - Sulfide
    - Dissolved metals, including major cations
- Data from TIE studies, if performed. Details on bioassay and chemistry data to be collected during the TIE will be provided in the TIE study plan prepared as an addendum to the QAPP in collaboration with EPA before starting the TIE.
- BMI survey data at each sampling location:
  - BMI species
  - BMI abundance, by species
  - Calculated BMI density (per unit area)
  - Community metrics (e.g., diversity indices)
  - Physical location attributes
    - Position in river (river channel, seasonally flooded historical channel, seasonally flooded backwater)
    - Coordinates
    - Grain size data
    - Near sediment bed water quality parameters (temperature, pH), collected during porewater sampling.

A7.3.2 Sources of Information

- EPA RI/FS, ecological risk assessment, and sediment quality triad guidance (USEPA 1988; USEPA 1997; USEPA 1998; Chapman 1990)
- Existing data from previous studies (CH2M HILL 2012; Ingersoll et al. 2016; USEPA 2006d; Windward 2017), including the 2018 sediment facies mapping program (TAI 2019a) and BMI community reconnaissance (TAI 2018)
- New data to be collected as described in Step 7.

A7.3.3 Action Levels

The action levels are conservative ecological screening levels for sediment and water, which provide a general (not site-specific) understanding of risk to benthic organisms to ensure that analytical detection limits are appropriate for data to be used in the Phase 3 study evaluations and in the BERA. These values are listed in Table A7-1.

A7.3.4 Methods

Appropriate methods for sediment and porewater analyses are listed in Table A7-2.

A7.4 DQO Step 4 – Define Boundaries of Study

A7.4.1 Spatial Limits

Sampling will be conducted within the three AOIs (Deadman's Eddy, China Bend, and Evans) and at select reference locations (Map A7-1). Sediment samples will be limited to surface sediments (0 to 6 inches below riverbed surface). All proposed sediment and porewater sampling locations will be underwater at the time of sampling[6]. Sample locations and methods may be modified to accommodate personnel safety, logistical concerns, and cultural resources.

A7.4.2 Temporal Limits

For improved safety and access conditions, sampling will be timed to occur when the reservoir is at or near high pool and low flow (approximately late August through October). Because of safety concerns regarding weather and freezing conditions, all sampling activities will be completed by November 1, 2019.

The data collected will be most representative of the time of year in which sampling occurs. Contaminants and properties of interest in sediment are generally persistent in this environment and unlikely to be impacted by the timing of sample collection. However, the persistence of contaminants and properties of interest in porewater are unknown; potential temporal fluctuations in porewater chemistry will not be captured by the study.

[6] Repeat sampling locations proposed at Deadman's Eddy are outside of the sediment facies map coverage and therefore may be dry or in very shallow water (< 1-m depth). Sampling at these select locations may require use of wading or ground-based methods, as described in the FSP (see Appendix A).

A7.5 DQO Step 5 – Develop the Analytical Approach

The primary study questions stated in Step 2 are repeated below, each with a general description of the analytical approach that will be used to address the question.

A7.5.1 Sediment Quality Triad

The SQT uses a multiple-lines-of-evidence approach developed to combine analysis of sediment chemistry, toxicity, and the BMI community to address risk to aquatic communities at contaminated sites (Chapman 1990). Data within each element of the triad (chemistry, toxicity, and BMI community) should be evaluated separately (questions a through c below) and as pairwise relationships among the SQT elements (questions d through f below) (Figure A5-1).

Integration of the SQT lines of evidence is typically done using a deductive reasoning approach, rather than being a quantitative or mathematical integration of the lines of evidence. For example, if the following six conditions exist, it is reasonable to deduce that contaminant X is likely the cause of toxicity and poor BMI community condition.

- Contaminant X exceeds toxicity benchmarks in some locations.
- Some locations have reduced bioassay performance relative to controls suggesting toxicity.
- Some locations have poor BMI metrics suggesting toxicity.
- Contaminant X is correlated with reduced bioassay performance.
- Contaminant X is correlated with poor BMI metrics.
- Sites with reduced bioassay performance have poor BMI metrics.

The above example is an ideal condition and likely an oversimplification relative to most sites. It is conceivable that in some cases not all six elements above will align, necessitating careful consideration and potential qualitative evaluation or weighting of evidence for interpretation.

The analytical approach to each of the questions from Step 2 are discussed below.

a) Do metals concentrations in UCR Upper Reach OU sediment and porewater exceed aquatic toxicity benchmarks for sediment and porewater?
   - Site and reference sediment metals concentrations will be compared to sediment screening benchmarks, including the threshold effect concentrations (TECs), probable effects concentrations (PECs) (MacDonald et al. 2000), and the lowest apparent effects thresholds (LAETs) (Ecology 2003).
   - Acid volatile sulfides and simultaneously extracted metals (USEPA 2005) will be used as a refined approach for estimating potential toxicity due to bioavailable divalent metals in sediment. This approach will include both non-

organic carbon-normalized (SEM-AVS) and organic carbon-normalized values ([SEM-AVS]/f_{oc}), where f_{oc} is the fraction of organic carbon.

- Concentrations of metals measured in porewater will be compared to National Recommended Ambient Water Quality Criteria (AWQC) to determine if toxicity to benthic organisms is predicted. The single metals biotic ligand model (BLM) for copper (and potentially other metals) and metals mixture BLM (mBLM) will also be used to evaluate potential aquatic toxicity. TAI and EPA have discussed the application of the BLM and mBLM extensively; use of the BLMs will be in accordance with the outcome of ongoing discussions.
- For reference area samples, PAH, PCB, and pesticide concentrations will be compared to equilibrium partitioning benchmarks (EPA 2012), PECs, and other potentially applicable benchmarks.

b) Do bioassay test organisms exposed to UCR Upper Reach OU sediment show responses indicative of sediment toxicity relative to laboratory control sediment?
   - Laboratory bioassays using field-collected sediment will be to assess amphipod (*Hyalella azteca*) survival and growth at 28 days, and survival, growth, and reproduction at 42 days. Sediment and porewater chemistry and sediment physical characteristics will be measured for each sample tested.
   - Each bioassay endpoint, including reference sample results, will be evaluated relative to batch-specific results for control sediment using pairwise t-tests or a nonparametric pairwise approach. It may be useful to consider multiple criteria or multiple levels of toxicity. For example, toxicity samples should be categorized as 1) statistically significantly different from controls, and 2) more than 20 percent lower response than control, or 3) more than 40 percent lower response than control.

c) Do BMI community metrics indicate reduced species diversity and richness, or increased pollution tolerance in some UCR Upper Reach OU locations?
   - Commonly used BMI metrics (e.g., species richness and species diversity) will be calculated for the BMI communities in each sampling location. The applicability of tolerance values or indices (e.g., Carlisle et al. 2007) may also be useful for comparing species composition with respect to general or specific stressor tolerance. However, the availability of suitable tolerance values or indices has not been determined. The answers to this study question may necessarily be qualitative in nature due to the complexity in making determinations about whether a BMI community in a specific sample does or does not exhibit signs of degradation or stress.

d) Do elevated metals associated with slag in depositional sediments cause toxicity in laboratory bioassays?
   - Data analyses will include:
     - Bivariate concentration-response models will be developed for each bioassay endpoint (i.e., survival, growth, and reproduction) and each sediment and porewater chemistry measurement. Chemistry measurements used as predictors of effects will include at least the following:
       - Concentrations of metals in sediment and porewater
       - Percent slag
       - Probable effects quotients (single and multiple metals) for metals in sediment
       - Simultaneously extracted metals minus acid volatile sulfides (SEM-AVS and SEM-AVS/$_{foc}$)
       - Outputs from metals bioavailability models (e.g., single and multiple metals BLMs)
     - Multivariate models may be developed to evaluate association between bioassay endpoints and groups of chemicals and physical variables with similar spatial distributions. This will include regressing univariate bioassay endpoints on principal component or factor scores derived from the chemical and physical measurements.

e) Do elevated metals associated with slag in depositional sediments adversely affect BMI communities in the UCR Upper Reach OU?
   - Co-located BMI community data, sediment and porewater metals chemistry, and sediment physical characteristics (e.g., grain size) will be sampled and measured from multiple Upper Reach OU AOI locations. BMI community metrics will be summarized and compared. Comparisons will include:
     - Descriptive statistics and among-group comparisons (ANOVA[7] and boxplots or similar) will be used to compare BMI metrics, metals concentrations, and physical characteristics among AOIs and potentially among strata (e.g., sediments with no slag and sediments with slag). Comparisons will be stratified as necessary (e.g., by grain-size strata).
     - Bivariate relationships of BMI metrics with sediment and porewater chemistry and sediment physical characteristics will be assessed (e.g., correlations, scatterplots, concentration-response models).

[7] Analysis of variance

- Where statistically significant bivariate relationships are identified, multivariate regression relationships may be used to refine relationships and account for the influence of multiple variables on the BMI metrics.
- If multivariate relationships are evident, other multivariate approaches (clustering, nonmetric multidimensional scaling, etc.) may also be useful in understanding relationships among variables, but the statistical power of these relationships may be limited by sample size.

f) Do sediment sample locations having elevated bioassay toxicity also have altered BMI metrics indicative of metals-related stress?

- Pairwise correlations among bioassay results and BMI metrics will be developed. In addition, analyses will be conducted relating multivariate measures of the BMI metrics to multivariate summaries of chemistry and physical data.

A7.5.2 Reference Area Comparisons

a) Are bioassay results and BMI metrics at individual locations within the AOIs outside their respective reference envelopes?

- Although the use of a reference envelope approach was put forth in the UCR BERA Work Plan (TAI 2011), the approach has some limitations, particularly when applied to BMI metrics. It is possible that there will be considerable variability of the BMI communities among the reference locations due to the large distance among reference areas and potential habitat heterogeneity, which may occur due to, for example, differences among lake and riverine locations or differences in sediment composition. Because there is potential for substantial BMI community variation, it is not reasonable to assume that BMI metrics for a contaminant-affected site community will necessarily be outside of a reference envelope for those same metrics (e.g., less than the 5th percentile of reference area species diversity). Nonetheless, individual sample comparisons to reference distributions may be informative, as long as they are treated as one of multiple lines of evidence (not as a screening to eliminate further evaluation of a metric), and with sufficient attention to the nature of the differences. Group comparisons (e.g., sediment strata) (Question b, below) should be used as well as individual comparisons.

- To support the use of the reference envelope, chemical analyses on reference samples must be thorough and include at least PAHs, PCBs, metals, and pesticides in sediment.
    - The first step in reference envelope analysis will be to identify and exclude any reference area samples that have both elevated chemistry and elevated toxicity in bioassays. TAI will work with EPA to develop technically sound decisions about the level of elevated chemistry and bioassay results that will be cause for exclusion from the reference envelope after the chemical analyses and bioassays have been completed.
    - Each Site sample will be categorized based on bioassay results and BMI metrics relative to reference area results (e.g., less than 80th and less than 50th centiles of bioassay reference sample results, and/or less than 50th and 5th centiles of BMI reference sample results (specific percentiles or other thresholds to be determined in discussion with EPA).

b) Do measures of central tendency in sediment and porewater metals chemistry, bioassay results, and BMI metrics differ from those of the reference areas?

- Group means comparisons will be used. Because it has been previously determined (EPA preliminary analyses, May 2017) that bioassay results in the Upper Reach OU are less (i.e., more toxic) than bioassay results in the reference locations, and there is known contamination within the Site, these comparisons will be based on the null hypothesis that Site samples have lower average (e.g., mean, median, etc.) biological response than reference samples. The alternative hypothesis will be that the central tendency of Site bioassay endpoints are within an agreed to level of equivalence with the central tendency of measurement endpoints at the reference sites. For example, Site equivalence with the reference area could be established by showing that the lower confidence limit for the ratio of Site to reference central tendency measures is no less than a specified constant (for example 0.8). Selection of an equivalence constant should be based on what would be considered an important level of impairment of biological performance.

A7.5.3 Toxicity Identification Evaluation

a) Are elevated metals concentrations in sediment and porewater the cause of the observed toxicity to aquatic invertebrates?

- The SQT approach can be powerful if data are available to address each of the six questions with minimal uncertainty, and if all answers point to similar conclusions. However, while this evidence may support or refute conclusions

about causation, the SQT is not an approach that can directly address causation. The TIE is a tool designed to experimentally determine the cause of sediment toxicity. Assuming the pilot TIE study indicates that TIE methods are usable and applicable to UCR sediments, then the TIE will be performed on toxic samples from the Phase 3 study, potentially including reference samples as well as Upper Reach OU samples, and will be used to identify potential classes of toxicants associated with adverse responses.

A7.5.4 Secondary Goals

- Sediment and porewater chemistry data from the Phase 3 study, as well as historical data of appropriate quality, will be used to estimate the proportion of sediment facies in each AOI containing sampleable sand that exceed an effects concentration or other benchmarks.
- Refusals, imagery, and data from the Phase 3 study, as well as results from historical sampling events will be used, as appropriate, to map the physical and chemical properties of surficial riverbed substrates.
- Refusals, imagery, and grain size data from the Phase 3 study, as well as similar results from historical events, will be used as appropriate to verify and refine the results of the preliminary sediment composition maps developed to support the Phase 3 sampling design.

A7.6 DQO Step 6 – Specify Performance or Acceptance Criteria

The sampling design for Phase 3 will provide sufficient representative data to answer the primary study questions as described below. A stratified random sampling approach, detailed in Step 7, will be employed to provide the majority of these data. Biased sample locations (resampled Phase 2 locations) will be used to better understand possible relationships between historical and Phase 3 results.

A7.6.1 Sediment, Porewater, and BMI Sampling Locations

- Must meet study design collection location (especially strata) completeness requirements[8].
- Must meet sediment volume requirements based on analyses to be performed at each location.

[8] Actual completeness might vary depending on the intrinsic nature of the samples and the ability to assess sample locations and collect field samples. The sample design includes sufficient alternate sample locations from all strata to meet these completeness goals. The EPA will be notified during field implementation if such goals cannot be achieved because of conditions encountered at primary and alternate sample locations.

A7.6.2 Sediment Chemistry

- Data quality indicators (DQIs) must meet precision, accuracy or bias, representativeness, completeness, comparability, and analytical sensitivity (PARCCS) requirements[9].
- Analyses must meet required quantitation limits per Table A7-1. Failure to meet quantitation limits will limit the usability of the data.

A7.6.3 Porewater Chemistry

Field-Collected (Trident probe) Porewater

- DQIs must meet PARCCS requirements.
- Analyses must meet required quantitation limits per Table A7-1. Failure to meet quantitation limits will limit the usability of the data.
- Confirm that excessive surface water was not drawn in during sampling (dissolved oxygen [DO], conductivity, oxidation-reduction potential [ORP], pH)

Laboratory Bioassay Porewater (Centrifuge)

- DQIs must meet PARCCS requirements.
- Method detection and reporting limits.
- Additional requirements may be needed based on the outcome of the porewater sampling study[10].

Laboratory Bioassay Porewater (Peeper)

- DQIs must meet PARCCS requirements.
- Additional requirements may be needed based on the outcome of the porewater sampling study.

BLM

- Use of single metals and multiple metals BLMs may be useful as estimates of dissolved, bioavailable metals.

[9] DQIs of precision, accuracy, bias, representativeness, completeness, comparability, and analytical sensitivity (PARCCS) will be used to assess the conformance of sediment, field porewater, and laboratory porewater analytical results with specific QC criteria. QC samples will include equipment rinsate blanks; field duplicates; standard reference materials (SRMs), if available and analyzed; and laboratory analytical QC samples. Field duplicate QC samples will be collected at a frequency of 10 percent for sediment and 5 percent for field-collected porewater. Data quality and conformance will be evaluated by third-party data validation of DQIs and laboratory QC procedures.

[10] The porewater extraction method study that is being conducted by TAI in collaboration with USGS and initiated July 30, 2019 is intended to resolve questions related to the measurement of metals concentrations and toxicity mitigating factors.

- The use and interpretation of the BLM and mBLM are subject to ongoing discussions between TAI and EPA. Use of the BLM and mBLM must be in accordance with agreed-upon methods.
- Any information developed in the porewater sampling study must be incorporated. Specifically, the porewater sampling study is intended to resolve questions related to the measurement of metals concentrations and toxicity mitigating factors.

Hyalella Bioassay

- Bioassays must be conducted in accordance with laboratory SOPs and quality procedures.
- Bioassays must meet test acceptability criteria established in the EPA bioassay guidance document.
  - Control performance (per EPA test guidance)
  - Starting size and minimum growth of controls (per EPA test guidance).
- If control performance for a bioassay endpoint is acceptable, but is variable among batches, an evaluation of batch normalization approaches will be implemented. Multiple normalization approaches may need to be explored (e.g., normalization to controls, median of clean samples, or batch percentile responses). In general, the optimal approach will reduce the variation among batches, limit variation among samples replicated across batches, and yield better-fitting concentration response models. All statistical tests will be run on batch-normalized data.
- Regression model comparisons, if required, will be based on Aikaike's Information Criterion (AIC), with the lower AIC value indicating a better-fitting model.
- Significance of regression analysis (i.e., concentration response analyses) will be based on alpha = 0.05 (i.e., p-value less than 0.05).
- Reference samples must not have PAH, PCB, or pesticide concentrations that exceed ecological screening values. TIEs may be required on reference samples that show poor performance relative to controls and other reference samples.

BMI

- The volume of sediment collected must be in accordance with the SOP for the type of sampler used to obtain the sample. BMI data collected with the freeze grab sampler will not be compared with BMI results for samples collected using other devices.
- Minimum taxonomic resolution must be at least to genus, but to species where practicable.
- Sample analysis must be conducted in accordance with BMI laboratory SOP and QC procedures.

A7.7 DQO Step 7 – Develop the Plan for Obtaining Data

Data for the Phase 3 study will be obtained using an integrated stratified random sampling design, which can accommodate the multiple data needs and analyses for the study. The components of the sampling design are described below and summarized in Table A7-3.

A7.7.1 Areas of Interest

- Deadman's Eddy
- China Bend
- Evans
- Reference Areas[11]

A7.7.2 Media of Interest

- Surface sediment
- Porewater
- BMI community

A7.7.3 Strata of Interest

- Sampleable Sand—sediment containing more than 50 percent finer-grained sediments, and includes sand and mixed fines, predominantly sand facies classes (S, and mFs) identified by the sediment facies mapping program (TAI 2019a) [12]
- Mixed Coarse—sediment containing 50 percent to 20 percent finer-grained sediment, and includes mixed coarse with sand facies (mCs) identified by the sediment facies mapping program (TAI 2019a)

[11] Reference areas are included in this list of AOIs for sampling; AOIs for the Phase 3 sediment study include Deadman's Eddy, china Bend, and Evans.

[12] A project-specific texture triangle (Figure A7-1) was developed and used to map sediment facies based on sediment composition (TAI 2019a).

- Mud—sediment containing greater than 80 percent silt and clay (M) identified by the sediment facies mapping program (TAI 2019a)
- Coarse—sediment containing greater than 50 percent cobbles and boulders (mBs) and/or contains less than 20 percent fine-grained (< 2 mm) sediment (B, C, and G) identified by the sediment facies mapping program (TAI 2019a). Due to anticipated difficulties in obtaining bulk samples from this material, only porewater samples will be collected from this stratum.

A7.7.4 Number of Samples

The statistically based sample size determination for this study only considered the primary goal and study questions. Sample size determinations to support the secondary goals are based on professional judgement. A post hoc data adequacy assessment will be carried out for each secondary goal to assess the degree to which the collected data support each secondary goal.

A7.7.5 AOI Samples

To answer the primary study questions, a target of 21 statistically based collocated sediment, porewater, and BMI community sample locations is proposed for the sampleable sand strata at Deadman's Eddy and Evans AOIs, and 12 locations are proposed at China Bend AOI (54 total samples). To confirm that this is an appropriate sample size, a simulation study using existing total zinc, copper, and lead concentrations in samples collected at the China Bend and Evans AOIs was completed by EPA to assess the uncertainty (UCL-mean/mean, where the UCL is the upper confidence limit) in central tendency estimates of chemical concentrations within a given stratum across the three AOIs. Relative error determined using bias-corrected and accelerated bootstrap samples from the historical Site data estimated a relative error of less than 50 percent for sample sizes of 40 or greater. Based on these simulation results, it is expected that the sample size of 54, pooled across the three AOIs, is sufficient to characterize the distribution of metals and slag (e.g., range and mean concentrations) in the sampleable sand strata.

In addition, the China Bend AOI also includes two judgmental samples as requested by EPA.

Sample size determinations for the other three strata in the AOIs were made based on professional judgement to support the secondary goals of this study. These sample sizes include six samples for each AOI for mixed coarse with sand (mCs), and porewater-only coarse sediment types (B, mBs, C). Five samples each at China Bend and Evans AOIs are proposed for the mud strata; there was no mud mapped at Deadman's Eddy AOI.

Bioassay samples will come from a subset of the collocated samples in the AOIs. Sufficient volumes of sediment for bioassay testing will be obtained from all sampleable sand and mud strata sample locations within each AOI (as applicable). Preliminary analytical data for these samples will be used to identify up to 14 samples for bioassay testing at each AOI[13]. The bioassay samples will represent the range of metals concentrations and factors affecting bioavailability and be spatially distributed across each stratum in the AOI. The lists of samples will be developed in consultation with EPA. If it is necessary to run bioassays in multiple batches, samples selected for each batch should be stratified such that a full range (to the extent practicable) of chemistry and grain sizes are included in each batch, and at least two samples should be selected to be run in each batch (such that comparisons of results can be made among batches).

A7.7.6 Reference of Samples

Sampling will also be performed at a total of 18 reference locations in Canada. Twelve samples will be collected from the riverine reaches of Genelle and Birchbank eddies. Six samples will be collected in the lacustrine zone in Lower Arrow Lake. Samples for bioassays and BMI community analyses will be collected and analyses conducted on all 18 reference area samples.

A7.7.7 Distribution of Samples

Sampling locations for all strata[14] within the AOIs were determined statistically by choosing randomly from within polygons created during the segmentation step of sediment facies mapping and are characterized as having similar terrain and texture statistics (TAI 2019a). The contiguous area of each facies type was calculated; only polygons greater than 0.5 acre in area or falling in a contiguous facies area of at least 0.5 acre were retained for sampling.

To ensure spatial balance, a Generalized Random Tessellation Stratified (GRTS) sampling approach was used (Stevens and Olsen 2004) for identifying proposed sampling locations for all target strata. Backup (or alternate) sampling locations were also chosen for each AOI using the oversampling technique available within GRTS[15]. Maps A7-2, A7-3, and A7-4 present proposed sampling locations for Deadman's Eddy, China Bend, and Evans AOIs, respectively. In addition, the China Bend AOI also includes two judgmental samples as requested by EPA.

[13] Sediment samples selected for bioassay testing will include the locations pre-determined by EPA for analysis as bioassay split samples as part of their QA/QC program.

[14] Two judgmental samples were added at China Bend AOI as requested by EPA. These locations were not statistically-determined.

[15] Two, judgmental specific, alternate locations have been identified at China Bend AOI, these alternate locations are were assigned to be in the same sediment feature, and sediment facies class as the primary judgmental sample locations.

Based on discussions with EPA, sampling locations for the sampleable sand stratum at China Bend and Evans AOIs were intended to be distributed evenly between the historical river channel and areas outside the historical channel, including flooded terraces and adjacent steep shorelines or mapped landslide areas. However, the presence of cultural resources prohibit collection of samples in most areas outside of the historical channel. Therefore, the numbers of samples within and outside of the historical channel at China Bend and Evans cannot be evenly distributed. The historical river channel at China Bend and Evans can be approximated by the 1,250-ft and 1,220-ft bathymetric contours, respectively. The distributions of the GRTS-generated proposed sampleable sand sampling locations falling above and below these contours are as follows:

- Sampleable Sand at China Bend AOI—10 locations below 1,250 ft; 2 locations above 1,250 ft
- Sampleable Sand at Evans AOI—18 locations below 1,220 ft; 3 locations above 1,220 ft.

The proposed sediment sampling locations within the AOIs have been cleared by tribal and federal/state cultural resources coordinators in consultation with the UCR RI/FS Cultural Resources Working Group. An archaeological or a tribal cultural resources monitor will be present during all sampling activities, and any adjustments to sampling locations in the field will be reviewed and approved by the on-site archaeologist or cultural resources monitor before ground disturbance occurs.

Additionally, repeat sampling is proposed at locations previously sampled by TAI in 2013 during the Phase 2 sediment study in the China Bend AOI and Evans AOI, including two locations previously sampled by the Natural Resource Trustees in 2013 in the Deadman's Eddy AOI.

Reference samples will be collected from targeted areas at Birchbank and Genelle eddies between Trail and Castlegar, British Columbia, where the sand and mixed sediment facies are expected to occur (Maps A7-5 through A7-7). Mud sediment is expected to be rare in this portion of the river. The riverine reference areas were defined based on previous grab sample sediment characteristics (Aquatic Receiving Environment Monitoring Program [AREMP] 2013; Golder 2007; Windward 2017), visual field reconnaissance (TAI 2018), and best professional judgement. Reference samples will also be collected at the Phase 2 sediment study external reference site locations in Lower Arrow Lake (Map A7-8). These samples had the greatest mud (silt and clay) content among all the samples collected at the Phase 2 sediment study external reference site locations and represent the lacustrine end of the hydraulic condition (similar to samples on the seasonally flooded and backwater zones at China Bend and Evans AOIs). Within these target areas, locations

likely to have the mud, sand, and mixed sediment facies will be sampled. The locations will be a combination of previously sampled and new locations.

A7.7.8 Target Analytes, Tests, and Measurement

- Surface sediment samples:
  - TAL metals
  - Percent slag by BSEM (10 percent of sampleable sand sample locations)
  - Grain size
  - TOC
  - SEM
  - AVS
  - 42-day sediment bioassays using the freshwater amphipod *H. Azteca*
  - Organic chemicals (PCBs, PAHs, pesticides) [16]
  - TIE studies. [17]
- Field-collected porewater samples:
  - Dissolved metals, including major cations
  - Major anions (chloride, sulfate)
  - Alkalinity
  - Sulfide (if field data indicate need)
  - TOC and DOC
  - pH.
- BMI survey data:
  - BMI species
  - BMI abundance, by species
  - Physical location attributes
    - Water depth
    - Presence of macrophytes
    - Position in river (river channel, seasonally flooded historical channel, seasonally flooded backwater)
    - Near sediment bed water quality parameters (temperature, pH), collected during porewater sampling.

[16] Initially, only reference area samples will be analyzed. However, aliquots from potential bioassay sample locations (sampleable sand and mud strata samples) will be archived frozen and may be analyzed for organic chemicals at a later date if needed.

[17] Details on bioassay and chemistry data to be collected during the TIE will be provided in the TIE study plan prepared in collaboration with EPA as an addendum to the QAPP.

- Sediment and porewater collected synoptically with the bioassays: [18]
  - Sediment (collected at Day 0 and Day 21):
    - SEM
    - AVS
    - TOC.
  - Centrifuged porewater (collected at Day 0):
    - Anions (chloride, sulfate)
    - Cations
    - Alkalinity
    - pH
    - DOC
    - Sulfide
    - Dissolved metals
  - Diffusion chamber (peeper) porewater (collected at Day 7 and Day 21)
    - Dissolved metals.

A7.7.9 Sampling Methods

Sediment

Needed sample volumes for sediment chemistry, bioassays, and BMI community surveys in mud- and sand-dominated sediment facies are expected to be easily obtained using a mechanical sample method (i.e., power Van Veen or modified[19] Hamon grab sampler), because these facies are predominantly composed of finer-grained sediments with < 20 percent coarse (i.e., gravel and boulder/cobble) content. A sampling methods hierarchy for the sampleable sand stratum is provided in Figure A7-2. Adequate sample volumes may also be obtained from mixed fines, predominantly sand facies (mFs) using a mechanical sample method if the coarse sediment content is on the low end of this range. Mixed coarse with sand (mCs) facies, are expected to be sampleable using a freeze grab sample method (ERM 2019). Select locations may also be sampled using a manual collection method if river conditions are deemed safe.

Field-Collected Porewater

Porewater will be collected using the Trident probe, to be operated by Coastal Monitoring Associates (CMA) of San Diego, California. CMA has previously used the Trident probe

[18] Porewater collection methods and timing for this study will be finalized after a porewater collection study has been completed and the results have been reviewed and discussed by TAI and EPA.

[19] A typical Hamon grab sampler is activated by release of tension in the cable (e.g., winch line) when the sampler contacts the sediment bed, and closed by tension on the cable during inhauling (Brown et al. 2002). The modified Hamon grab sampler being developed for use at the UCR is being constructed with a pneumatic arm to drive the sampler's bucket through the sediment.

for porewater sampling in the Columbia River within the Hanford Reach, adjacent to Hanford, Washington. A pilot study conducted in September 2018 demonstrated that porewater samples can be collected with the Trident probe under various depth, flow, and substrate conditions in the Deadman's Eddy portion of Upper Reach OU. Adequate porewater volumes were collected during the pilot study and sample integrity was maintained (Windward 2019). Sample containers for chemical analyses will be filled in an anaerobic glovebox to reduce porewater oxidation, as done for the pilot study and described in Windward (2019).

Conductivity, total dissolved solids, ORP, and pH will be measured continuously or at frequent intervals in the field using a handheld water quality meter to help determine in real time whether porewater, and not overlying water or groundwater, is being sampled. In addition, DO will be measured in the field using a handheld DO meter. ORP and DO measurements at each sampling location will be used to determine if a sample bottle will be filled for sulfide analysis.

Sediment-Water Interface

Conductivity, temperature, and pH at the sediment-water interface will be measured in the field using a Sonde or a portable meter to support the BMI community survey.

A8 SPECIAL TRAINING AND CERTIFICATES

TAI has assembled a technical team with the requisite experience and technical skills to successfully complete all aspects of the study described in Section A7. Minimum training and certification requirements for laboratory personnel are provided in the laboratory QA manuals (Appendices B, C, and D).

Sampling personnel will be familiar with the Site Cultural Resources Coordination Plan (Appendix E). Sampling personnel will report any materials that might be considered a cultural resource to the cultural resources monitors participating in the field sampling program.

A9 DOCUMENTATION AND RECORDS

This section identifies onsite and laboratory records to be maintained for this project, information to be included in project reports, data reporting format for data report packages, and document control procedures to be used. Critical records required for this study are identified below with descriptive or supporting information as appropriate. Records will include documents and electronic deliverables related to field sampling (field logbook, field forms, COC forms, etc.), as well as chemistry, bioassay, BMI, and BSEM laboratory documentation (laboratory records, data packages, project reports,

electronic deliverables, etc.), data validation, and data reports. Data reports will be made available through integration into the project database web tool. Briefly, this is an electronic data management system that is accessible via an external website. The QAPP, FSP (Appendix A), site health and safety plan (SHSP) (TCAI 2007), and the general SHSP addendum (Attachment A1 to Appendix A) will be provided to each person listed in Section A3 (distribution list). Any revisions or amendments to any of the documents that comprise the FSP will also be provided to these individuals.

A9.1 Field Documentation

The TAI technical team field supervisor will ensure that the field team receives the final approved version of the QAPP prior to the initiation of field activities. Minimum field records that will be maintained include the following:

- Field logbooks
- Photo/video documentation
- Field forms
- Global positioning system (GPS) location information for sample attempts
- Sample tracking/COC forms.

Additional content, information, and use of the above-listed documents are further described in the FSP (Appendix A).

A9.2 Chemistry Laboratory

Analyses for metals, general chemistry, conventional parameters, and organics will be conducted by ALS. Full laboratory data reports will be provided in electronic format to the task QA coordinator, who will oversee data verification and validation, as well as archiving the final data and data quality reports in the project file. EDDs will be prepared in an MS Access database format and will be compatible with the project database.

The laboratory will provide a data package for each sample delivery group or analysis batch that is comparable in content to a full Contract Laboratory Program (CLP) package. Documentation requirements are detailed in the analytical laboratory QA manual (Appendix B) and will, at a minimum, include the following:

- A cover letter discussing analytical procedures and any difficulties that were encountered
- A case narrative referencing or describing the procedures used and discussing any analytical problems and deviations from SOPs and this QAPP
- Sample receipt and analysis dates

- COC and cooler receipt forms
- Copies of sample processing documentation, including supporting documentation for sample extraction, digestion, and analysis of percent moisture
- Final analyte concentrations, detection limits, and reporting limits
- Laboratory data qualifier codes appended to analyte concentrations, as appropriate, and a summary of code definitions
- Sample preparation, digestion, extraction, dilution, and cleanup logs
- Instrument run logs
- Initial and continuing calibration data, including instrument printouts and quantification summaries, for all analytes
- Results for method and calibration blanks
- Results and control limits for all applicable method QC checks, including laboratory control samples (LCSs; including blank spikes and SRMs, if analyzed), matrix spike (MS)/matrix spike duplicates (MSDs), serial dilutions, interference checks, internal standards, recovery standards, surrogates, and any other QC procedures required by applicable method protocols and laboratory SOPs
- Original data quantification reports, printouts of chromatograms and mass spectra, and manual integration identification and reason codes for all analyses and samples, as applicable
- All laboratory worksheets and standards preparation logs
- A page of example calculations for each analytical method included in the data package
- A documented data deliverable for each analytical method performed and reported.

The analytical chemistry laboratory coordinator will oversee data verification and validation, and the data validator will be automatically notified via the web tool database (http://teck-ucr.exponent.com) that the data set is available and ready for review. Further details of data handling are in Section D.

A9.3 Bioassay Laboratory

The bioassay laboratory, PER, will provide a data package for each sample delivery group or analysis batch that will contain all information required for a complete QA review, including the following:

- A cover letter discussing bioassay procedures and any difficulties encountered
- A case narrative referencing or describing procedures used and any analytical problems and deviations from SOPs and this QAPP

- COC and cooler receipt forms
- A summary of the bioassay results
- Results for all QA/QC checks, including serial dilutions, LCS and reference toxicant tests, and any other QC procedures required by applicable method protocols and laboratory SOPs
- Test acceptability requirements (i.e., test acceptability criteria and performance goals) will be documented; deviations from these requirements will be explained within the provided data package
- The laboratory toxicity report will document the source of control sediment and associated measurements
- The laboratory toxicity report will document how organisms of known age were obtained for testing
- The weight of a representative subsample of organisms at the start of sediment exposures will be documented
- The laboratory toxicity report will document the measured light intensity during testing
- Original data reports and laboratory worksheets as applicable.

A9.4 Benthic Macroinvertebrate Enumeration Laboratory

Benthic macroinvertebrate enumeration will be conducted by EcoAnalysts. Full laboratory data reports will be provided in electronic format to the task QA coordinator, who will oversee data verification and validation, as well as archiving the final data and data quality reports in the project file. EDDs will be prepared in spreadsheet format.

EcoAnalysts will provide a data package for each sample delivery group or analysis batch that will contain all information required for a complete QA review, including the following:

- A cover letter discussing BMI enumeration procedures and any difficulties encountered
- A case narrative referencing or describing procedures used and any problems and deviations from SOPs and this QAPP
- COC and cooler receipt forms
- A summary of the BMI enumeration results to include at a minimum
  - Scientific name of taxa
  - Total abundance
  - Total taxa

  - Richness
  - Evenness
  - Dominance
  - Abundance
  - Presence or absence of pollution-tolerant and sensitive species
- Results for all QA/QC checks and procedures required by applicable method protocols and laboratory SOPs
- Original data reports and laboratory worksheets as applicable.

A9.5 Backscatter Electron Microscopy Laboratory

The BSEM laboratory documentation requirements will be provided in a QAPP addendum.

A9.6 Data Quality Documentation

Data verification (i.e., confirming the accuracy and completeness of field and laboratory data) will be performed by the TAI technical team for data generated in the field, and by each laboratory for the analytical data that they generate. Data validation and data quality assessment for this task will be completed and results provided to the laboratory coordinator.

Accuracy of the laboratory EDDs will be verified by, or under the direction of, the database administrator. All changes to data stored in the database will be recorded in the database change log. Any data tables prepared from the database for data users will include all qualifiers that were applied by the laboratory and during data validation.

Data validation reports will be prepared and provided to the laboratory coordinator. Any limitation to the usability of the data will be discussed in this report. Completed data validation checklists will also be included in the data validation reports.

SECTION B: DATA GENERATION AND ACQUISITION

B1 SAMPLING PROCESS DESIGN AND RATIONALE

This section presents the detailed design and rationale for the sediment study to meet the data needs as described in Section A6. The sampling approach was developed based on sediment bed maps developed under the sediment facies mapping element of the Phase 3 study, information from pilot studies completed during 2018 and 2019, previous investigations, and scoping discussions between TAI and EPA as summarized in Table A4-1.

B1.1 Target Sampling Areas and Rationale

Sampling will be performed for three AOIs in the Upper Reach OU and at upstream reference areas in the Columbia River in British Columbia (Map A7-1). Sampling locations are listed in Table B1-1 and shown on Maps A7-2 through A7-8.

B1.1.1 Upper Reach OU Areas of Interest

The three AOIs were identified and agreed to by EPA and TAI during the informal dispute of the January 4, 2018 level of effort (LOE). The LOE originally required characterization of 19 depositional features. Through the informal dispute, the LOE was modified to include sampling of shallow sediment in three AOIs: Deadman's Eddy, China Bend, and Evans (Map A4-1). TAI and EPA also agreed on additional data collection in the three AOIs to support the BERA, including porewater sampling, sediment toxicity evaluations, and a BMI study. The chronology of EPA and TAI interaction on the scope and details of the study is summarized in Table A4-1.

Sediment, porewater, and BMI samples will be collected from the three AOIs as indicated on Maps A7-1 through A7-4. Sampling locations within the AOIs were developed using a statistical approach as described in Section A7.7. This approach relied on sediment bed (facies) maps to define the target strata included in the sample designs (TAI 2019a). The sediment facies maps were then used to define the areal extent of the four target strata included in the sample design as follows:

1. **Sampleable sand**. Sediment containing more than 50 percent finer-grained sediments, including sand and mixed fine, predominantly sand facies classes (S and mFs). The sampleable sand stratum will be sampled for sediment chemical/physical properties, in situ porewater, and BMI. Bioassay tests will also be performed on select samples from this stratum.

2. **Mixed coarse**. Sediment containing 50 percent to 20 percent finer-grained sediment, including mixed coarse with sand facies class (mCs). The mixed-coarse stratum will be sampled for sediment chemical/physical properties, in situ porewater, and BMI. Bioassay tests will not be performed on samples from the mixed-coarse stratum due to the freeze grab sampling method to be employed for this stratum.
3. **Mud**. Sediment containing sediment with more than 80 percent silt and clay (M). The mud stratum will be sampled for sediment chemical/physical properties, in situ porewater, and BMI. Bioassay tests will also be performed on select samples from this stratum.
4. **Coarse**. Coarse sediment having more than 50 percent boulder/cobble or more than 80 percent combined gravel plus boulder/cobble, including mixed boulder/cobble, and coarse facies classes (mBs, B, C, and G). The coarse stratum will be sampled for porewater only due to the low fine-grained sediment content and prevalence of coarse sediments (gravel and cobble), which would pose significant challenges for collecting sediment samples.

As described in Section A7. 7, the target number of sampling locations for the sampleable sand stratum is either 12 or 21 for each AOI. This number of samples is expected to be sufficient to characterize the distribution of metals and slag (e.g., range and mean concentrations) in the sampleable sand strata based on results from a simulation study completed by EPA using existing total zinc, copper, and lead concentrations in samples collected at the China Bend and Evans AOIs.

The target numbers of sampling locations for the other strata are six for mixed coarse, five for mud, and six for coarse. These sample size determinations were made based on professional judgement to support the secondary goals.

In addition, the China Bend AOI also includes two judgmental samples as requested by EPA.

B1.1.2 Reference Areas

Reference areas are needed to establish a reference envelope for bioassay testing and to define a reference distribution for the BMI community to compare with information collected in the AOIs. Reference samples will be collected from targeted areas on the Columbia River upstream of the UCR in British Columbia (Birchbank, Genelle, upstream of Genelle, and Lower Arrow Lake eddies) (Maps A7-5 through A7-8). These locations are intended to be representative of the surficial riverbed substrates where finer-grained sediment (< 2 mm) is predominant and have been selected to capture the range of percent

fines and TOC representative of available data from Site samples within the three AOIs. They also are intended to be representative of the flow conditions (riverine; lacustrine) found in the AOIs and to have some similar BMI habitat characteristics (e.g., presence of macrophytes; backeddies).

Reference samples will be collected from targeted riverine reference areas at Genelle and Birchbank eddies between Trail and Castlegar, British Columbia, where the sand and mixed-fines sediment facies are expected to occur (Maps A7-5 through A7-7). Mud sediment is expected to be very rare in this portion of the river. The riverine reference areas were defined based on previous grab sample sediment characteristics (AREMP 2013; Golder 2007; Windward 2017), visual field reconnaissance (TAI 2018), and best professional judgement. The locations will be a combination of previously sampled and new locations.

Lacustrine reference area samples will be collected at the Phase 2 sediment study external reference site locations in Lower Arrow Lake (Map A7-8). These samples had the greatest mud (silt and clay) content among all the samples collected at Phase 2 sediment study external reference site locations and represent the lacustrine end of the hydraulic condition (similar to samples on the seasonally flooded and backwater zones at the Evans and China Bend AOIs).

The number of reference area sampling locations was selected to support the comparison of BMI samples to a reference condition that is predominantly sand. The predominantly sand stratum will be characterized by six riverine sand locations, six riverine mixed-fines (facies mFs) locations, and six lacustrine sand locations. Each of these facies should have six replicates in the reference distribution to be adequate for statistical inference testing, if post hoc reference site analysis determines these more detailed facies provide better reference comparisons than the combined predominantly sand stratum. All reference samples will be collected with mechanical grab samplers. Mud and facies mCs external reference samples will not be collected.

B2 SAMPLING METHODS

Field sampling methods for collection of sediment, porewater, and BMI are described in the FSP (Appendix A). The FSP includes the following topics:

- Task schedule (Section 2.2.1)
- Sampling location positioning (Section 2.2.2)
- Refusal and alternate locations (Section 2.2.3)

- Field equipment and supplies (Section 2.2.4)
- Sample collection methods (Section 2.2.5)
- Sampling contingencies (Section 2.2.6)
- Quality control samples (Section 2.2.7)
- Individual sample numbering (Section 2.2.8)
- Equipment decontamination (Section 2.2.9)
- Sample handling (Section 2.3)
- Cultural resources (Section 2.4)
- Sample packaging and transport (Section 2.5)
- Study-derived waste (Section 2.6)
- Vessel procedures for aquatic invasive species control (Section 2.7)
- Field documentation and procedures (field logbooks, photo documentation, COC forms) (Section 3).

SOPs for each sampling method are provided in Attachment A2 of the FSP (Appendix A). Specific field sampling methods to be employed during the study include the following:

- Bulk Sediment—Sediment samples will be collected from vessels using mechanical grab samplers (Van Veen power grab, modified Hamon grab) or a freeze grab device. For safely accessible wadeable or dry locations that cannot be sampled using equipment deployed from the vessel, manual collection methods may be used. Manual sediment collection devices include a handheld Eckman grab sampler, a "cookie cutter" barrel sampler, and a scoop. Sediment sampling methods are described in SOP-3 through SOP-6 included in Attachment A2 of the FSP (Appendix A). BMI samples for taxonomic enumeration will be obtained from sediment samples, as described in SOP-8 included in Attachment A2 of the FSP (Appendix A).
- In situ Porewater—In situ porewater will be collected using a Trident probe. This sampling method is described in SOP-7 included in Attachment A2 of the FSP (Appendix A).

The FSP also describes the collection of field split samples that will be provided to EPA for analysis as part of their QA/QC program. These will include sediment split samples for chemical analysis from 5 percent of sediment sampling locations, porewater samples from 15 percent of porewater sampling locations, and sediment splits for bioassay testing

from 15 pre-determined locations. Pending approval and agreement from the government of Canada, EPA may collect sediment and/or porewater split samples from upstream reference locations. Field QC samples are described in Section 2.2.7 of the FSP.

If unanticipated or changed circumstances occur in the field, the field supervisor, in consultation with EPA or its representatives in the field, will institute the necessary corrective actions, complete a corrective action record, and ensure that the appropriate procedures are followed. If corrective actions require a departure from the FSP, these changes will be documented on a field change request form (refer to Attachment A3 of Appendix A for examples of these and other forms) and submitted to the TAI and EPA project coordinators for review and approval. In any other circumstances where sampling conditions are unexpected, the appropriate sampling actions consistent with this task's objectives will be conducted. This change will be noted by the field supervisor in the field log, and a change request form will be completed for the project files and submitted to EPA. Any problems that cannot be easily resolved or that affect the final quality of the work product will be brought to the attention of the principal investigator, TAI project coordinator, and EPA (and EPA's representatives in the field). EPA will be notified of any problems that may affect the final outcome of this task. Additional information regarding corrective actions and related documentation is provided in Section C1.

B3 SAMPLE HANDLING AND CUSTODY

Principal documents used to identify samples and to document possession will be field logbooks, field forms, and COC records. Custody will be documented for all samples at all stages of the collection and transfer process. COC procedures for sample handling prior to delivery to the laboratory are outlined in the FSP (Appendix A).

All sediment and porewater samples will be shipped from the field to the analytical chemistry laboratory (ALS); BMI samples will be shipped the BMI taxonomic enumeration laboratory (EcoAnalysts). Sediment volume archived for potential bioassay testing and/or percent slag determination by BSEM will be stored refrigerated at ALS, and sediment volume archived for potential organic chemical analysis will be stored frozen at ALS. Sediment samples identified for future bioassay testing or BSEM analysis will be shipped under COC from ALS to the appropriate laboratory (PER or RJLG, respectively).

Requirements for storage temperature and holding times are summarized in Table B3-1 and detailed in the FSP (Appendix A). Upon receipt of analytical samples at the laboratories, the physical integrity of coolers and custody seals will be checked, the internal cooler temperature recorded, and samples will be inventoried by comparing sample labels to those on the COC forms. The laboratories will include the COC and

shipping container receipt forms in the data package. Any breaks in the COC or non-conformances will be noted and reported in writing to the analytical chemistry laboratory coordinator within 24 hours of receipt of samples. Laboratory-specific QA plans are provided in Appendices B through D. The laboratory project managers will ensure that a sample-tracking record is maintained that follows each sample through all stages of sample processing at the laboratories. Samples will be stored in accordance with protocols listed in Table B3-1. The laboratories will maintain COC records and documentation of proper storage conditions for the entire time that the samples are in their possession. The laboratories will not dispose of samples from this task until receiving written authorization to do so by EPA. After authorization is obtained, the laboratories will dispose of samples, as appropriate, based on matrix, analytical results, and information received from the client.

B4 SAMPLE PROCESSING AND ANALYTICAL METHODS

Sediment will be collected for chemical analysis and bioassay for toxicity. Porewater samples will be collected for chemical analysis. The total number of samples for analytical chemistry, bioassay measurements, and BMI enumeration are listed in Table B4-1.

B4.1 Chemical Analyses

Sediment and porewater samples collected for this study will be analyzed for chemical parameters shown in Table A7-2 and as summarized below. Sample preservatives to be used are included in Table B3-1. Analytical methods are listed in Table A7-2 and analyte detection limits and reporting limits are provided in Table A7-1. All surface sediment samples will be analyzed for grain size, TOC, AVS, SEM, and total TAL metals. Sediment samples from reference locations will be analyzed for organic chemicals, including pesticides, PAHs, and PCBs. Field porewater will be collected using a Trident probe (refer to Section A7.7.9.2 and Appendix A for method) and preserved for the following analyses (volume permitting): dissolved metals (including cations), DOC, TOC, hardness, alkalinity, and major anions (chloride, sulfate). Porewater samples will be collected for sulfide analysis only if the field-measured DO and ORP indicate a reduced condition where sulfide could be present. Table B3-1 includes order of priority for these analyses.

Sediment and porewater samples will also be generated by the bioassay laboratory (PER) during the bioassay tests. These samples will be generated and preserved by PER then shipped under COC to ALS for chemical analyses. Bioassay laboratory-generated sediment and porewater samples will be analyzed following the methods listed in Table A7-2, which are the same methods to be used for field sediment and porewater samples.

Procedures for generating sediment and porewater samples during the bioassay testing are described in Section B4.3.

B4.2 Estimation of Percent Slag

Validated total zinc data will used to estimate percent slag in Phase 3 sediment samples using a total zinc regression model developed from the Phase 2 sediment study (Windward 2017) and USGS 2016 data. Regression model estimates will be confirmed with results from the samples analyzed for percent slag using BSEM. Regression model estimates will be confirmed by analysis of 10 percent of the samples from the sampleable sand stratum for percent slag by BSEM.

Using data from the Phase 2 and USGS studies, TAI has identified that slag content (i.e., percent slag) of UCR sediments can be predicted using various sediment chemistry characteristics, including total zinc concentration, total copper concentration, zinc:vanadium (Zn:V) ratio, and/or copper:aluminum (Cu:Al) ratio. Evaluation of model performance based on normality of model residuals and amount of variability explained identified total zinc as the best predictor of slag content in UCR sediments. For all predictors, power transformations (i.e., generally square root) were necessary to achieve normality of model residuals. The best performing model for predicting slag content was a three-segment linear regression with total zinc as an independent variable (Figure B4-1). This segmented linear regression is highly predictive of percent slag, with an adjusted r^2 value of 0.984.

The segmented linear regression has the following form:

Segment 1: $\%\,Slag = 0.223 \times \sqrt{\log_{10} Zn}$ when $\sqrt{\log_{10} Zn} < 1.72$

Segment 2: $\%\,Slag = 16.2 \times \sqrt{\log_{10} Zn} - 27.4$ when $1.72 < \sqrt{\log_{10} Zn} < 1.95$

Segment 3: $\%\,Slag = 29.7 \times \sqrt{\log_{10} Zn} - 53.7$ when $1.95 < \sqrt{\log_{10} Zn}$

Sediment samples from the AOIs for BSEM will be selected based on the results of analysis of bulk sediment samples for total zinc to ensure that the confirmation samples span a range of zinc concentrations, and therefore span the range of estimated percent slag content. After analytical results for bulk sediment chemistry are available, the 12 samples proposed for BSEM analysis will be documented in a memorandum for review and approval by EPA. Other factors that may be considered when selecting samples for BSEM include the AOI (to ensure some samples are from each AOI), the mapped sediment facies, and results from grain size analysis.

Slag determination by BSEM will be performed by RJLG—the same laboratory that performed BSEM analysis for sediment samples during the Phase 2 Sediment Study. The methods used for BSEM analysis for the Phase 3 Sediment Study will be comparable to methods used during the Phase 2 study, as described in Appendix F of the *Phase 2 Sediment Study Data Summary Report* (Windward 2017). A description of the BSEM method, including sample preparation, sample analysis, data interpretation, and QC procedures will be included as an attachment to the BSEM sample selection memorandum.

B4.3 Bioassays

Sediment bioassays will be performed using the freshwater amphipod *H. azteca*. The bioassays will be conducted using the 42-day survival, growth, and reproduction test and will measure 28-day survival, weight, and biomass, 35-day survival and reproduction, and 42-day survival, weight, biomass, and reproduction endpoints. Bioassay protocols are described in Appendix C and will follow the standard protocols outlined below with modifications as noted. Additional details are described in EPA (USEPA 2000) and ASTM (2019). During the tests, water quality will be measured in the overlying water of representative replicate chambers for each sample according to EPA guidance. Lighting, room temperature, and other environmental operations of the exposure system will be monitored daily. As required in USEPA (2000) and ASTM (2019) (and listed in Table B4-2), hardness, alkalinity, conductivity, and ammonia will be measured in the overlying water of test chambers at the beginning and end of the sediment exposure (i.e., Day 0 and Day 28) and pH will be measured three times per week. Hardness, alkalinity, and ammonia will also be measured at Day 35 and Day 42, and conductivity will be measured on a weekly basis. Dissolved oxygen will be measured daily and maintained above 2.5 mg/L; water temperature will be measured daily in at least one test replicate per treatment to ensure that the daily average temperature is within ± 1°C of 23°C.

Bioassay endpoints will be evaluated using a minimum of 12 replicates for biological endpoints for each 42-day *H. azteca* bioassay. Additional replicate bioassay chambers will be run on each sediment sample to obtain analytical measurements in porewater and sediment samples from exposure chambers. Chemistry replicates will not be used to evaluate biological endpoints (i.e., survival, growth, or reproduction). Thus, the 42-day *H. azteca* bioassay will have a total of 18 replicates (12 for biological endpoints and 3 each for porewater chemistry analysis at Day 7 and porewater and sediment at Day 21). These chambers are not true test replicates and will not be assessed for biological endpoints. A schematic illustrating the above-mentioned anticipated number of bioassay and chemistry-only replicates are presented in Figure B4-2.

Sediment samples identified for bioassay testing will be shipped under COC from ALS to PER. The entire bucket of archived sediment will be shipped to PER. Prior to bioassay testing, sediment samples will be homogenized, and 100 mL of the sediment will be distributed into each replicate and covered with laboratory water. Homogenization procedures are provided in Appendix C, SOP-17. Test chambers will be allowed to stabilize for 7 days prior to the introduction of test organisms. From the laboratory culture population, 10 test organisms will be randomly distributed to each replicate and allowed to burrow into the sediment.

Standard responses (endpoints) of test organisms to be measured include the following:

- Survival—number of surviving organisms divided by the initial number of organisms
- Weight—dw of surviving organisms divided by the number of surviving organisms
- Biomass—dw of surviving organisms divided by the initial number of organisms
- Reproduction—number of young divided by the number of surviving females, and number of surviving adult males and females.

Standard bioassay test conditions for the above-referenced tests are described in Table B4-2 (USEPA 2000). Test acceptability requirements (i.e., test acceptability criteria and performance goals) are listed in Table B4-3.[20] If the test acceptability criteria of 80 percent mean survival in the laboratory control sediment on Day 28 is not met, the test will be repeated. Standard bioassay endpoints will be reported in accordance with applicable guidance (USEPA 2000; ASTM 2019). As described in SOP-17 (Appendix C), equipment rinsate blanks will be prepared for equipment used to homogenize sediment samples for bioassay testing. These rinsate blanks will be analyzed for total metals as QC samples to evaluate whether the homogenization equipment was effectively cleaned between samples

B4.3.1 Physico-Chemical Data in Overlying Water

A variety of physico-chemical properties will be measured in the test chamber water column (overlying water) to document water quality during bioassay tests as specified by

[20] EPA (2000) guidance uses the term test acceptability requirements, which includes criteria that must be met for a test to be considered acceptable and other criteria that should be met as a goal for conducting a good test. For the purposes of providing clear language for the Phase 3 Sediment Study and as was used in the Phase 2 sediment study, the two types of requirements are distinguished as follows: test acceptability criteria that must be met are referred to as criteria and those that should be met are referred to as performance goals.

USEPA (2000); see Table B4-2. Analysis of overlying water is described in the PER SOP included in Appendix C.

The following water quality properties will be documented in each of the test chambers:

- Hardness (mg/L as calcium carbonate)
- Alkalinity (mg/L as calcium carbonate)
- Conductivity (µS/cm)
- pH (standard units)
- Ammonia (mg/L)
- Temperature (°C)
- Dissolved oxygen (mg/L).

B4.3.2 Laboratory Bioassay-Generated Porewater and Sediment Measurements

Table B4-4 provides the estimated number of laboratory bioassay-generated porewater samples that are expected to be analyzed during the study. Laboratory porewater data will be used in concert with the biological endpoint data to evaluate concentration-response relationships. Primary laboratory porewater measurements measured in bioassay porewater (volume permitting) will include the following[21]:

- Anions (chloride, sulfate)
- Alkalinity
- pH
- DOC
- Sulfide
- Dissolved metals, including major cations.

Anions, alkalinity, pH, DOC, sulfide, and dissolved metals will be measured in centrifuged porewater collected from homogenized bulk sediment at start of the test (Day 0). Dissolved metals will be measured in porewater collected using diffusion chambers fitted with 0.45-µm membranes (i.e., peepers) and placed in chemistry replicate chambers at the start of the test. Porewater from peepers will be collected at Day 7 and Day 21 to be comparable with measurements during the Phase 2 sediment study.

[21] The methods to be used for bioassay porewater collection are uncertain and will be informed based on the outcome of the porewater extraction method study that is being conducted by TAI in collaboration with USGS and initiated July 30, 2019.

Laboratory bioassay-generated sediment samples (Table B4-4) will be collected from the homogenized bulk sediment at the start of the test (Day 0) and from chemistry-only replicate chambers at Day 21. These sediment samples will be analyzed for SEM, AVS, and TOC.

Procedures for the collection of laboratory-generated bioassay porewater and sediment samples are included in the PER SOPs that are provided in Appendix C. The additional chambers setup for chemistry analysis of each sediment sample will contain test organisms to allow for bioturbation, but will only be used for sediment and porewater chemistry measurements. Sample containers containing the appropriate preservative and filters for collecting porewater samples for DOC analysis will be provided to PER by ALS. Analytical methods for laboratory bioassay-generated porewater and sediment samples are provided in Table A7-2; sample containers, preservation, and holding times are provided in Table B3-1.

Laboratory bioassay-generated porewater and sediment samples will be identified using the following nomenclature:

Laboratory Bioassay-Generated Sediment

Laboratory bioassay-generated sediment samples for analysis by the analytical chemistry laboratory will be labeled using the following nomenclature:

Sediment matrix code = SE

Location ID = see Table B1-1 for individual location identification (ID)

Organism code = HA42 for *H. azteca* 42-day test

Time code (days) = Day 21; for the test day the sample is generated

Bioassay batch code = Bi; where *i* is the sequential batch number

Below is an example of a laboratory bioassay-generated sediment sample ID for a *H. azteca* 42-day bioassay sediment sample on Day 21 from batch 1 from hypothetical field location CB081

SE-CB081-HA42-T21-B1

Laboratory Bioassay-Generated Porewater

Laboratory bioassay-generated porewater samples for analysis by the analytical chemistry laboratory will be labeled using the following nomenclature:

Porewater matrix code = PW

Location ID = see Table B1-1 for individual location IDs

Organism code = HA42 for *H. azteca* 42-day test

Time code (days) = Ti; where *i* is 0, 7, 21, or 28 for the test day the sample is generated

Bioassay batch code = Bi; where *i* is the sequential batch number

Below is an example of a bioassay laboratory-generated porewater sample ID for a *H. azteca* 42-day bioassay porewater sample on Day 7 from batch 3 from hypothetical field location EV092

PW-EV092-HA42-T7-B3

B4.4 Benthic Macroinvertebrate Enumeration

Benthic macroinvertebrate enumeration will be performed as described in Appendix D and will follow the standard protocols outlined below. The processing of BMI community samples requires two main steps:

- Sample sorting of the BMI community to remove all organisms from the sediment sample
- Identification of the organisms to the lowest practical taxonomic level by a qualified taxonomist.

B4.4.1 BMI Community Sample Sorting

To conduct a BMI community sample sorting, the sorting technician checks out a sample and prints a sorting bench sheet that contains the EcoAnalysts' sample identification information and sorting protocols. The sorting technician records the primary matrix type and approximates the volume of detritus prior to sieving. The standard descriptors for the types of sample matrix are Inorganic, Coarse Organic, Fine Organic, Vegetation, and Filamentous Algae.

The sample is elutriated entirely (no subsampling) by emptying the matrix into a sieve (250 µm) to remove preservative and fine sediment. If the sample matrix is composed of a significant percentage of inorganic material, the organic material will be elutriated from the inorganic material prior to sorting. For elutriation, the whole sample is washed into a shallow pan of water. At this time, any large pieces of organic material can be rinsed and inspected thoroughly by the original technician and a secondary technician for attached and burrowing aquatic invertebrates. If large organic matter is deemed removable from the sample, it is retained separately as sample residues. The sample is agitated with water to separate any organic matter from inorganic sediments. After agitating the sample in water, the lighter organic material is poured back into the sieve. The inorganic portion of

the sample remaining in the pan is repeatedly washed and decanted into the sieve until no more organic matter remains in the pan with the inorganic material. Once the elutriate process is completed, the remaining material will be sieved through a stack sieve (500 and 250 μm) to separate into size fractions.

The remaining inorganic sediments are inspected under a magnifying lamp (3X) to look for any invertebrates too heavy to have been elutriated (e.g., mollusks, snails, etc.). If there are significant numbers of heavy invertebrates in the inorganic material—too many to easily remove under the magnifying lamp—the inorganic and organic matrix is recombined into the sieve and the entire sample matrix is prepared for a subsample. If there are not significant numbers of heavy invertebrates in the inorganic material, they are removed under the magnifying lamp and placed with the organic matrix. A second technician inspects the inorganic material for organisms until it is determined there are no more invertebrates in the inorganic fraction of the sample.

The organic material and other contents of the sieve are then evenly distributed into the bottom of a Caton-style tray. These are trays of various sizes consisting of uniform grids; each grid is 2 in. per side and the bottom is constructed of 250-μm mesh. A grid (or a standardized portion of a grid) is randomly selected and its contents transferred to a Petri dish. The material in the Petri dish is sorted under a dissecting microscope (minimum magnification = 10X). The individual organisms are counted as they are placed into vials containing 70 percent ethanol. Each size fraction will have a 500 count minimum sort. Since there are two size fractions, over 1,000 individuals may be identified if each fraction is in excess of 500 individuals.

Sorting technicians are trained to pick and count only BMI, with heads, that were alive during sampling and contain the attributes required for taxonomic identification. Organisms picked are placed in one of five vials corresponding either to crustacea, polychaeta, mollusca, generals (miscellaneous taxa), and special organisms (copepods and ostracods). Specimens rejected according to EcoAnalysts' standard include nematodes, zooplankton, exuviae, and any organism without a head. When the target count of organisms has been reached or the target percentage of the sample has been sorted but not fully sorted, a special large and rare protocol may be followed on any remaining unsorted material. Organisms deemed relatively large or rare to the sample (in comparison with the target taxa enumerated in the final count) are found by a naked eye scan in the unsorted sample remnants and are not counted but picked and placed in a separate vial.

B4.4.2 Taxonomic Identification of BMI

Under a dissecting and/or compound microscope, the organisms are identified to the lowest practicable taxonomic resolution. The taxonomist enters the data listed below directly into the laboratory database:

- Sample identifier
- Each taxon using a unique taxonomic code
- Number of individuals of each taxon and user interface.

A synoptic reference collection will be prepared, where at least one specimen (preferably three to five specimens) of each taxon encountered is placed into a vial containing 70 percent ethanol and is properly labeled with identity and sample number. Depending on the requirements of the project, one or several reference collections can be made. Also, organisms can be vouchered by a specified taxonomic level, i.e., vouchered by each taxon per sample. If a synoptic reference collection is made, a second taxonomist examines the reference collection specimens to verify the accuracy of all taxa identified in the project.

B4.4.3 QA/QC Procedures

Procedures to ensure efficacy of the sorting process and accurate taxonomic identification of the BMI community are described below.

Sorting Efficacy Check

At least 10 percent of each sample will be re-sorted by a QC technician, who did not originally sort the sample, to ensure at least 90 percent of the organisms have been removed. The QC checks are performed by technicians who have shown to achieve 90 percent efficacy on a minimum of 90 percent of samples they process. The estimated percent efficacy is calculated, using the following equation:

$$Sorting\ Efficacy = \left(\frac{Original\ Count}{Original\ Count\ + \left(\frac{QC\ Count}{QC'd\ Grids} \right) * QC\ Total\ Grids} \right) * 100$$

Where: Original Count = the number of organisms picked by the first sorter
QC Count = the number of organisms found in the QC sort
QC'd grids = the number of grids sorted during the QC process
QC Total Grids = the total number of grids in the QC Caton

Sorting efficacy is measured as the estimated percent of the total organisms found during the original sorting process. If the estimated percent sorting efficacy is 90 percent or greater, the sample passes the QC check. If the estimate is less than 90 percent, the sample

is re-sorted and undergoes the QC process again until it passes the 90 percent efficacy requirement.

Taxonomic Accuracy Check

Taxonomic accuracy is evaluated by having individual specimens of selected taxa identified by recognized experts. Samples will be identified using the most appropriate technical literature that is accepted by the taxonomic discipline and reflects the accepted nomenclature. All taxonomists will be certified for the group that they will identify by the Society for Freshwater Science. A reference collection will be compiled as the samples are identified, flagged and/or excluded from use. Unusual data are rechecked to verify their accuracy.

B5 QUALITY CONTROL

This section describes the analytical laboratory QC procedures and the DQIs that will be used to assess the conformance of data with QC criteria. Measurement quality objectives for sediment samples and porewater samples are provided in Table B5-1 and Table B5-2, respectively. QC procedures for bioassay testing are provided in Appendix C and summarized in Table B4-3. QC procedures for laboratory enumeration of BMI samples are provided in Appendix D and measurement quality objectives for BMI samples are summarized in Table B5-3.

B5.1 Analytical Laboratory Quality Control

Extensive and detailed requirements for laboratory QC procedures are provided in the EPA methods that will be used for this study (see Table A7-2). Every method protocol includes descriptions of QC procedures, and many incorporate additional QC requirements by reference to separate QC sections. QC requirements include control limits and requirements for corrective action in many cases. QC procedures will be completed by the laboratory, as required in each protocol and their internal SOPs, and as indicated in this QAPP.

The frequency of the preparation and analysis of LCSs (i.e., blank spikes), MS samples, and method blanks will be 1 for every 20 samples or 1 per extraction or analysis batch, whichever is more frequent. Calibration procedures will be completed at the frequency specified in each method description.

As required for EPA SW-846 methods (USEPA 2008), performance-based control limits have been established by the laboratory. These and all other control limits specified in the method descriptions will be used by the laboratory to establish the acceptability of the

data or the need for reanalysis of the samples. Laboratory control limits for recoveries of QC samples applicable to each method (e.g., LCSs, MS/MSDs, laboratory replicate samples, serial dilutions, interference checks, internal standards, recovery standards, surrogates, and any other QC required by applicable method protocols and laboratory SOPs), and for relative percent differences (RPDs) of MS/MSDs, are reviewed by the laboratory QA manager regularly and updated, when appropriate, as described in the analytical laboratory's QA manual (Appendix B). Current values will be provided in each laboratory report.

B5.2 Data Quality Indicators

The overall quality objective for this task is to develop and implement procedures that will ensure the collection of representative data of known and acceptable quality. QA procedures and measurements that will be used for this task are based on EPA guidance. Data quality indicators such as the PARCCS parameters will be used to assess the conformance of data with QC criteria (USEPA 2002b). Measurement quality objectives (MQOs) for the quantitative PARCCS parameters are provided in Tables A7-1 and B5-1 to B5-3. Data quality indicators and QC objectives are described in this section.

Precision reflects the reproducibility between individual measurements of the same property. Precision will be evaluated using the results of laboratory replicates. Precision is expressed in terms of the RPD for two measurements. The following equation is used to calculate the RPD between measurements:

$$RPD = \frac{|C_1 - C_2|}{(C_1 + C_2)/2} \times 100$$

Where: RPD = relative percent difference
C_1 = first measurement
C_2 = second measurement

For three or more measurements, the relative standard deviation (RSD) is used to evaluate precision. The RSD is calculated as the ratio of the standard deviation of three or more measurements to the average of the measurements, expressed as a percentage.

Accuracy or bias represent the degree to which a measured concentration conforms to a reference value. Results for matrix spikes, LCSs, equipment rinsate blanks, and method blanks will be reviewed to evaluate accuracy or bias of the data. The following calculation is used to determine percent recovery for a matrix spike sample:

$$\%R = \frac{M - U}{C} \times 100$$

Where: %R = percent recovery
M = measured concentration in spiked sample
U = measured concentration in unspiked sample
C = concentration of added spike

Percent recovery for an LCS is calculated as follows:

$$\%R = \frac{M}{C} \times 100$$

Where: %R = percent recovery
M = measured concentration in reference sample
C = established reference concentration

Results for equipment rinsate and method blanks can reflect systematic bias that results from contamination of samples during processing or analysis. Detection of any target analytes at concentrations greater than the method reporting limits (MRLs) in field or method blanks will be evaluated as potential indicators of bias.

QC samples and procedures are specified in each method protocol (analytical methods are presented in Table A7-2). All QC requirements will be completed by the analytical laboratory as described in the protocols, including the following (as applicable to each analysis):

- Initial calibration
- Initial calibration verification
- Continuing calibration
- Calibration or instrument blanks
- Method blanks
- Equipment rinsate blanks
- LCSs, including blank spikes and SRMs, if analyzed
- MS/MSDs
- Serial dilutions
- Interference checks
- Internal standards

- Recovery standards
- Surrogates.

To alert data users of possible bias or imprecision, data qualifiers will be applied to reported analyte concentrations when associated QC samples or procedures do not meet laboratory internal control limits (Appendix B).

Analytical concentration goals (ACGs) provide the target concentration required for the chemical analysis. Methods selected for this study are expected to provide sufficient sensitivity to yield ACGs that are below the lowest reference value for this study (Table A7-1).

ALS has determined an MDL for each analyte, based on the procedure in 40 Code of Federal Regulations (CFR) Part 136, Appendix B, and as described in their Quality Assurance Manual (Appendix B). Method detection limits (MDLs) are statistically derived and reflect the concentration at which an analyte can be detected in a clean matrix with 99 percent confidence that a false positive result has not been reported. ALS established MRLs at levels above the MDLs. The MRLs are based on the laboratory's experience analyzing environmental samples and reflect the typical sensitivity obtained by the analytical system; they represent the level of analyte above which concentrations are accurately quantified. MDLs and MRLs for each analyte are summarized in Table A7-1.

ALS will quantify analytes at concentrations above the MRL. Analytes detected at concentrations between the MDL and MRL will be flagged with a "J" qualifier to indicate that the value is an estimate (i.e., the analyte concentration is greater than or equal to the MDL and less than the MRL). Analytes that are not detected will be reported as the MDL and will be flagged with a "U" qualifier. MDLs and MRLs will be adjusted by ALS as necessary to reflect sample dilution or matrix interference. All results will be reported on a dry weight basis (with percent moisture reported for all samples).

Representativeness is the degree to which data represent a characteristic of an environmental condition. In the field, representativeness will be addressed primarily in the sampling design by the selection of sampling sites and sample collection procedures. In the laboratory, representativeness will be ensured by the proper handling and storage of samples, the use of standard performance-based methods, and initiation of analyses within holding times.

Comparability is the qualitative similarity of one data set to another (i.e., the extent to which different data sets can be combined for use). Comparability will be addressed through the use of field and laboratory methods that are consistent with methods and procedures recommended by EPA. Where appropriate, field and laboratory methods

have also been identified to be comparable with methods using during previous studies completed under the Agreement.

Completeness is a measure of the amount of valid data obtained from the analytical measurement system and the complete implementation of defined field procedures. The target completeness objective will be 90 percent; the actual completeness may vary depending on the intrinsic nature of the samples. Completeness of the data will be assessed during QC reviews.

Completeness is defined as follows for all measurements:

$$\%C = \frac{V}{T} \times 100$$

Where: %C = percent completeness
V = number of measurements judged valid
T = total number of measurements

B6 INSTRUMENT AND EQUIPMENT TESTING, INSPECTION, AND MAINTENANCE

Analytical instrument testing, inspection, maintenance, setup, and calibration will be conducted by the laboratory in accordance with requirements identified in the laboratory SOPs and manufacturer instructions. In addition, each of the specified analytical methods provides protocols for proper instrument setup, tuning, and critical operating parameters. Instrument maintenance and repair will be documented in the laboratory's maintenance logs or record books.

B7 INSTRUMENT AND EQUIPMENT CALIBRATION AND FREQUENCY

Before beginning each analysis, laboratory instruments will be properly calibrated, and the calibration will be verified with appropriate check standards and calibration blanks for each parameter. Instrument calibration procedures and schedules will conform to analytical protocol requirements and descriptions provided in the laboratory's QA plan.

Calibration standards will be obtained from a commercial vendor, and the laboratory will maintain traceability back to the National Institute of Standards and Technology. Stock standards will be used to establish intermediate standards and calibration standards. Special attention will be given to expiration dating, proper labeling, proper refrigeration, and prevention of contamination. Documentation relating to the receipt, mixing, and use of standards will be recorded in a laboratory logbook. All calibration and spiking

standards will be checked against standards from another source, as specified in the analytical methods and the laboratory QA manual.

B8 INSPECTION/ACCEPTANCE OF SUPPLIES AND CONSUMABLES

The quality of supplies and consumables used during sample collection and laboratory analysis can affect the quality of the data. All equipment that comes into contact with the samples and extracts must be sufficiently clean to prevent detectable contamination, and the analyte concentrations must be accurate in all standards used for calibration and QC purposes. Filters for use in collecting porewater samples for DOC analysis will be lot-tested at the laboratory before use in the field. Plastic buckets (e.g., 2-gal and 5-gal capacity) used for sediment samples for bioassay testing will be decontaminated by the analytical laboratory before use in the field. The decontamination level of plastic buckets for bioassay sediment samples will be documented by the laboratory via a certificate of analysis or similar documentation and based on the preparation and analysis of bucket blank QC samples. Bucket blank QC samples will be prepared by the analytical laboratory at a minimum frequency of one per batch of buckets that are decontaminated and will be analyzed for total metals.

The quality of laboratory water used will be documented at the analytical laboratory, and the quality of deionized water prepared locally for use in the field (e.g., from a deionization system installed at the field warehouse) will be verified by laboratory analysis. All containers will be visually inspected prior to use, and any suspect containers will be discarded.

Reagents of appropriate purity and suitably cleaned laboratory equipment will also be used for all stages of laboratory analyses. Details of acceptance requirements for supplies and consumables at the laboratory are provided in the laboratory SOPs and QA plan (Appendices B through D). All supplies will be obtained from reputable suppliers with appropriate documentation or certification. Supplies will be inspected to confirm that they meet use requirements, and certification records will be retained by the field supervisor (i.e., for supplies used in the field) or the laboratory QA manager (i.e., for supplies used in the laboratory).

B9 DATA MANAGEMENT

Data for this study will be generated both in the field and at the analytical laboratory. The final repository for sample information will be the relational database housed at http://teck-ucr.exponent.com. Procedures used to transfer data from the point of generation to the database are described in this section.

The data management plan (DMP) and its amendment (TAI 2019b) establish standard procedures for the management of all documents and environmental data (field and laboratory) generated during the RI/FS. The DMP describes data management procedures relating to the creation, acquisition, handling, storage, and distribution of task-related data. Data management systems and procedures described below are intended to establish and maintain an efficient organization of large volumes of complex environmental information for a diverse combination of data types. To accomplish this task, the following four management systems will be used to provide organized and efficient data management and retrieval:

- **Project database**. Stores environmental sampling and analysis data, information pertaining to geographic information system (GIS) files, and citations of documents related to collection, analysis, or interpretation of environmental data stored in the database. Both current and historical data are stored in the project database. Access to the data is password controlled, with various levels of access available to users on a "need to know" basis, as determined by the project manager.
- **GIS**. Stores spatial data and enables the cartographic presentation of data trends and patterns.
- **Hard copy files**. Maintains a record and archive of documents from field studies and resulting reports.
- **Website** (http://www.ucr-rifs.com). Makes available draft documents and other project information via the secure domain. Users with appropriate privileges are able to download documents.

Study activities will use spatial data sets and analyses for planning, data interpretation, decision support, and data presentation. Links between data in the project database and GIS files will be established via common identifiers for sampling locations and other geographic features.

B9.1 Field Data

Data that are generated during the study will be manually entered into the field logbook, field data forms, and COC forms. Data from these sources will be entered into the project database directly from the field logbook and field data forms. These data include sample collection coordinates (World Geodetic System of 1984), station identification numbers, sampling dates, sample identifiers and numbers, and additional station and sample information. All entries will be reviewed for accuracy and completeness by a second

individual, and any errors will be corrected before the data are approved for release to data users.

B9.2 Analytical Laboratory Data

A variety of manually entered and electronic instrument data will be generated at the laboratory. Data will be manually entered into the following:

- Standard logbooks
- Storage temperature logs
- Balance calibration logs
- Instrument logs
- Sample preparation and analysis worksheets
- Maintenance logs
- Individual laboratory notebooks.

All manual data entry into the laboratory information management system will be proofed at the analytical laboratory. Data collected from each laboratory instrument, either manually or electronically, will be reviewed and confirmed by analysts before reporting. A detailed description of procedures for laboratory data management and data review and verification is provided in the laboratory QA plan (Appendices B through D). Analytical data packages will be comprehensive Tier 4 CLP-comparable packages that will allow for a full Stage 4 (S4VM) data validation (see Section D2 below for data verification and validation methods for this study).

SECTION C: ASSESSMENT AND OVERSIGHT

This task will rely on the knowledge and expertise of the TAI technical team. The field team and laboratory will stay in close verbal contact with the principal investigator and the task QA coordinator during all phases of this task. This level of communication will serve to keep the management team apprised of activities and events, and will allow for informal but continuous task oversight. In the following sections, the term "laboratory" refers to the analytical, BMI, and bioassay laboratories.

C1 ASSESSMENTS AND RESPONSE ACTIONS

Assessment activities will include readiness reviews prior to sampling and prior to release of the final data to the data users, as well as internal review while work is in progress. A technical systems audit may be conducted by either EPA or TAI if problems are encountered during any phase of this task.

Readiness reviews typically are conducted to ensure that all necessary preparations have been made for efficient and effective completion of each critical phase of work. The first readiness review will be conducted prior to field sampling. The field supervisor will verify that all field equipment is ready for transfer to the Site. The field supervisor will also verify that the field team and subcontractor, as required, have been scheduled and briefed (including review of the SHSP and the cultural resources coordination plan), and that the contract for the subcontractor has been signed by both parties. Any deficiencies noted during this readiness review will be corrected prior to initiation of sampling activities.

The second readiness review will be completed before final data are released for use. The database administrator will verify that all results have been received from the laboratory, data validation and data quality assessment have been completed for all the data, and data qualifiers have been entered into the database and verified. Any deficiencies noted during this review will be corrected by the database administrator, the task QA coordinator, or their designees. Data will not be released for final use until all data have been verified, validated, and approved by EPA. No written report will be prepared in conjunction with the readiness reviews.

Technical review of intermediate and final work products generated for this task will be completed throughout the course of all sampling and laboratory activities, data validation, data management, and data interpretation to ensure that every phase of work is accurate and complete and follows the QA procedures outlined in this QAPP. Any problems that are encountered will be resolved between the reviewer and the person completing the work. Any problems that cannot be easily resolved or that affect the final

quality of the work product will be brought to the attention of the TAI technical team coordinator and TAI project coordinator. EPA will be notified of any problems that may affect the final outcome of this task, according to the Agreement. EPA assessment and/or oversight of sampling and laboratory processing or analysis will be conducted as directed by the EPA project coordinator.

The laboratory will be required to have implemented a review system that serves as a formal surveillance mechanism for all laboratory activities. Each phase of work will be reviewed by a supervisor before it is approved for release. Details are provided in the laboratory QA plans (Appendices B through D).

Technical system audits may be conducted if serious problems are encountered during sampling or analysis operations. If completed, these audits will be conducted by the task QA coordinator or designee, or by the laboratory, as appropriate. These audits may consist of onsite reviews of any phase of field or laboratory activities or data management. Results of any technical systems audits will be provided in the data summary report and verbally to the project manager.

Any task team member who discovers or suspects a nonconformance is responsible for reporting the nonconformance to the principal investigator, the task QA coordinator, or the laboratory project or QA manager, as applicable. The task QA coordinator will ensure that no additional work dependent on the nonconforming activity is performed until a confirmed nonconformance is corrected. Any confirmed nonconformance issues will be communicated to the TAI technical team coordinator and to EPA. In addition, during corrective actions, communication among the field personnel and the laboratory relative to the accuracy and completeness of the COC documents will follow the procedures for corrective action.

C2 REPORTS TO MANAGEMENT

Each laboratory will keep the appropriate technical team coordinator and QA manager apprised of their progress on a regular basis. The laboratory will provide the following information:

- Inventory and status of samples held at the laboratory in spreadsheet format by sample delivery group
- Summaries of out-of-control laboratory QC data that resulted in a requirement for corrective action and a description of the corrective actions implemented
- Descriptions and justification for any significant changes in methodology or QA/QC procedures.

The laboratory coordinator and QA manager will provide this information to the task QA coordinator who, in turn, will provide this information to the TAI technical team coordinator.

The laboratory will be required to have implemented routine systems of reporting nonconformance issues and their resolutions. These procedures are described in the laboratory QA manuals (Appendices B through D). Laboratory nonconformance issues will also be described in the data summary report if the data validator determines that they affect any of the DQIs discussed in Section B5.2 of this QAPP.

Data packages and EDDs will be prepared by the laboratory upon completion of analyses for each sample delivery group. The case narrative will include a description of any problems encountered, control limit exceedances (if applicable), and a description and rationale for any deviations from protocol. Copies of corrective action reports generated at the laboratory will also be included with the data package.

Validated data will be provided electronically to EPA. These data will also be provided with the data summary report containing an overview of the field event, a sampling location map, sample collection methods, and rationale for any deviations from the FSP and/or QAPP according to the Agreement.

SECTION D: DATA VALIDATION AND USABILITY

Data generated in the field and at the laboratory will be verified and validated according to criteria and procedures described in this section. Data quality and usability will be evaluated, and a discussion will be included in the data validation report. In the following sections, the term "laboratory" refers to the analytical, bioassay, and BMI laboratories.

D1 DATA REVIEW, VERIFICATION, AND VALIDATION

Field and laboratory data for this task will undergo a formal verification and validation process. All entries into the database will be verified. All errors found during the verification of field data, laboratory data, and the database will be corrected and documented prior to release of the final data.

Data verification and validation will be completed according to methods described in the following EPA guidance documents for data validation and criteria in this QAPP.

- Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use (EPA 540-R-08-005, January 2009) (USEPA 2009)
- USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Superfund Methods Data Review (USEPA 2017a)
- USEPA Contract Laboratory Program National Functional Guidelines for Organic Superfund Methods Data Review (USEPA 2017b).

Data will be qualified as estimated, as necessary, if results for applicable method QC (e.g., LCSs, MS/MSDs, serial dilutions, interference checks, internal standards, recovery standards, surrogates, or any other QC required by applicable method protocols and laboratory SOPs) do not meet method-specified control limits, including performance-based control limits. Results for other QC procedures will be qualified if they do not meet control limits outlined in EPA's guidance and functional guidelines for data validation (USEPA 2009, 2017a, 2017b). Data will be qualified as undetected based on concentrations of target analytes detected in laboratory or equipment rinsate blanks, according to EPA's guidance and functional guidelines for data validation. The data summary report will include a list of definitions of qualifiers applied by the laboratory and the data validator.

Performance-based control limits are established periodically by the laboratory as required for the selected methods. Current values will be provided in each laboratory report and the laboratory QA manual, as applicable.

No guidelines are available for validation of data for AVS, TOC, and DOC. These data will be validated using procedures described in the functional guidelines for inorganic

data review (USEPA 2017a), as applicable. Data will be qualified as estimated, as necessary, if results for QC samples do not meet performance-based control limits.

Data qualifiers will be applied for equipment rinsate blanks in the same manner as method blanks, as described in the functional guidelines for data review (USEPA 2017a, 2017b). Data will be rejected if control limits for acceptance of data are not met, as described in the functional guidelines for inorganic data review (USEPA 2017a) and organic data review (EPA 2017b).

The bioassay procedure described in this QAPP incorporates standard QA/QC procedures for evaluating the validity of the test results according to EPA (USEPA 2000) and ASTM (2010) guidelines. Standard QA/QC procedures include the use of negative controls, positive controls (to assess the sensitivity of test organisms to toxic stress), and the periodic measurement of water quality during testing. Test acceptability requirements (i.e., test acceptability criteria and performance goals) for bioassays are summarized in Table B4-3. Test acceptability criteria specified in Table B4-3 must be met in order for a test to be considered acceptable; all other test acceptability requirements are considered performance goals.

Criteria for verifying and validating BMI data are included in the project-specific SOPs included in Appendix D and summarized in Table B5-3. These criteria include sorting efficacy and taxonomic accuracy.

D2 VERIFICATION AND VALIDATION METHODS

Field data will be verified during preparation of samples and COC forms. Field notebook entries (including field taxonomy), field data forms, and COC forms will be reviewed daily by the field supervisor or designee. After field data are entered into the project database, 100 percent verification of the entries will be completed to ensure the accuracy and completeness of the database. Any discrepancies will be resolved before the final study data are released for use.

Approximately 10 percent of the chemistry data will undergo Stage 4 (S4VM) validation. The remaining data will undergo Stage 2B (S2BVM) validation with the understanding that more detailed validation will be performed on the S2BVM data if issues are identified in the S4VM validation. If problems or questions are encountered during validation, the laboratory will be contacted for resolution. An additional full validation will be completed, if required, to fully assess the quality of the data or to verify that laboratory errors have been addressed.

Procedures for verification and validation of laboratory data and field QC samples will be completed as described in the functional guidelines for data validation (USEPA 2017a, 2017b) and summarized in Section D1 above. Accuracy and completeness of each data set will be verified at the laboratory when EDDs are prepared and again as part of data validation. Ten percent of entries to the database from the laboratory EDDs will be checked against the hard-copy data packages. Data validation will be completed by ESI.

ESI will provide definitions of qualifiers applied by the laboratory and validator. In addition to verification of field and laboratory data and information, data qualifier entries into the database will be verified. Any discrepancies will be resolved before the final database is released for use.

MRL goals for this task are provided in Table A7-1. Reporting limits for nondetected values will be compared to the MRL goals to evaluate method sensitivity for each sample. Any exceedance of actual MRLs over the target MRLs will be discussed in the data validation report.

A full discussion of the QA/QC procedures and results will be included in the PER bioassay laboratory report. Bioassay data will be evaluated by TAI against the test acceptability criteria provided in Table B4-3 to determine if test acceptability criteria were met and if the data are usable. The bioassay acceptability evaluation will be presented in the data summary report. If any bioassay results do not meet test acceptability criteria, they will not be presented (i.e., included in data summary tables) in the data summary report but will be included in the bioassay laboratory report.

The BMI laboratory project manager will verify all BMI results and confirm that test criteria are met. Data packages for BMI analyses will provide complete documentation of QA/QC procedures and results. Data qualifiers are not assigned to BMI results, as samples not meeting criteria are re-sorted, and the reanalyzed sample data would be usable provided the next sort passes QC criteria and any taxonomic identification variability is resolved. In addition to the review by the BMI laboratory, a validation of BMI identification data will be performed by ESI using criteria provided in this QAPP.

D3 RECONCILIATION WITH USER REQUIREMENTS

The goal of data validation is to determine the quality of each data result and to identify those that do not meet the task MQOs. Nonconforming data may be qualified as estimated (i.e., a "J" qualifier will be applied to the result) or rejected as unusable (i.e., an "R" qualifier will be applied to the result) during data validation if criteria for data quality are not met. Data may also be qualified as undetected during validation based on laboratory

and equipment rinsate blank results. Rejected data will not be used for any purpose. A summary of the qualified data and the reasons for qualification will be included in the data validation report.

Data qualified as estimated will be used for all intended purposes and will be appropriately qualified in the final project database. However, these data are less precise or less accurate than unqualified data. Data users, in coordination with the principal investigator and task QA coordinator, 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 discussion in the data validation report will include information regarding the direction or magnitude of bias or the degree of imprecision for qualified data to facilitate the assessment of data usability. Data validation reports will also include a discussion of data limitations and their effect on data interpretation activities.

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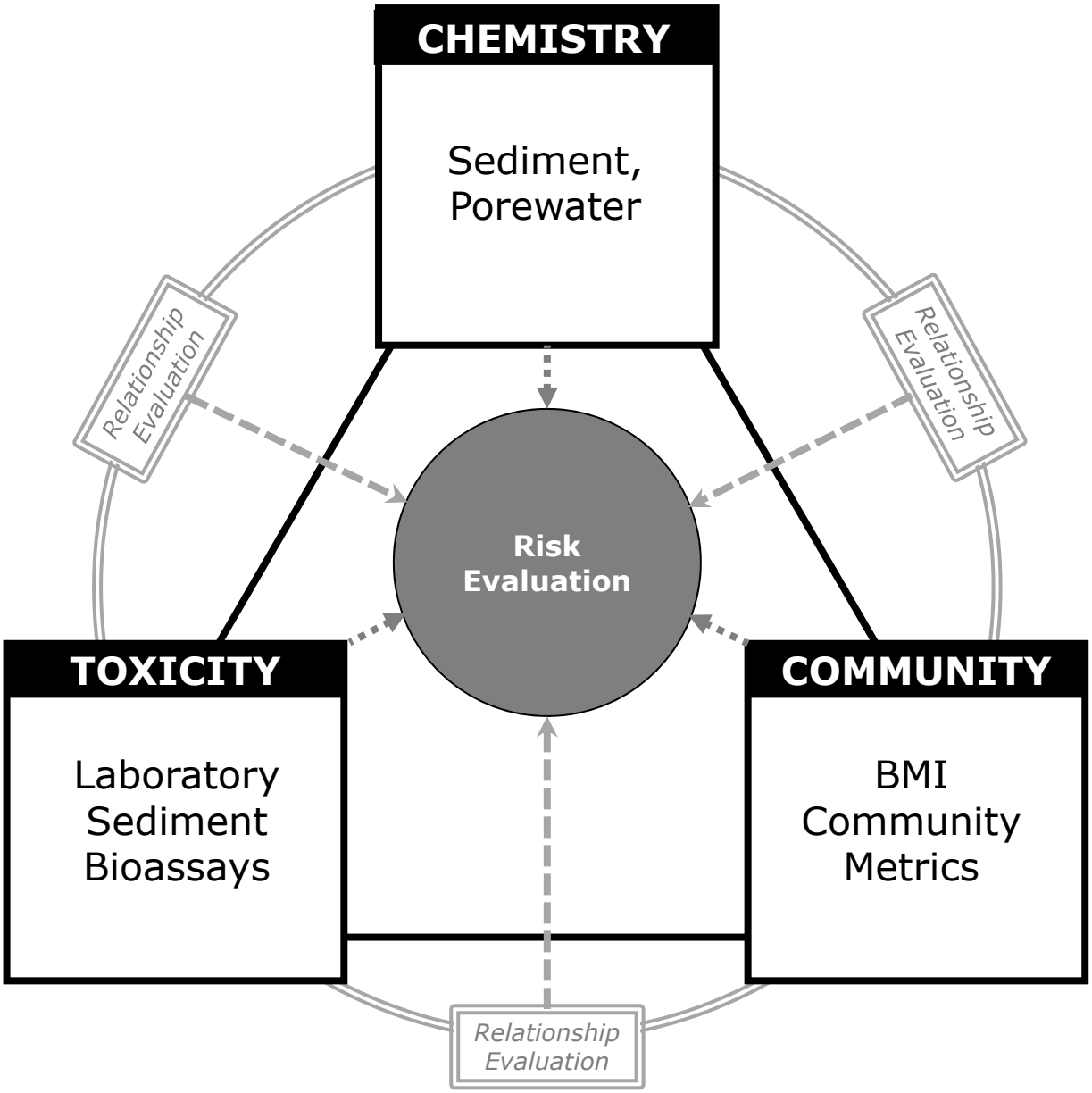
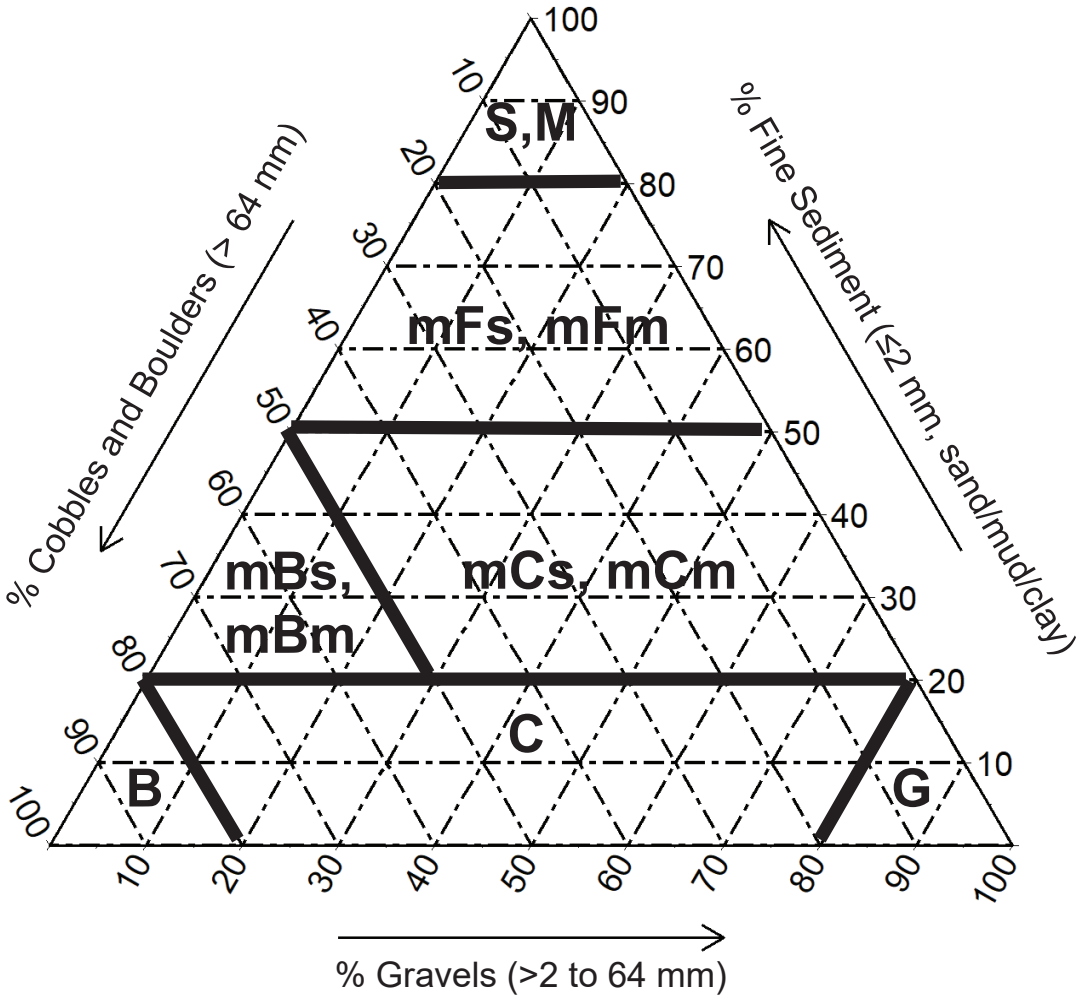
FIGURES



Source: EPA

Figure A5-1. Sediment Quality Triad Concept



Sediment Bed Surface Facies

M = mud (silt and clay, < 0.063 mm)

S = sand (0.063 mm – 2 mm)

G = gravel (2 mm – 64 mm)

B = boulder/cobble (> 64 mm)

mFm = mixed finer-grained, predominantly mud

mFs = mixed finer-grained, predominantly sand

mCm = mixed coarse, with mud

mCs = mixed coarse, with sand

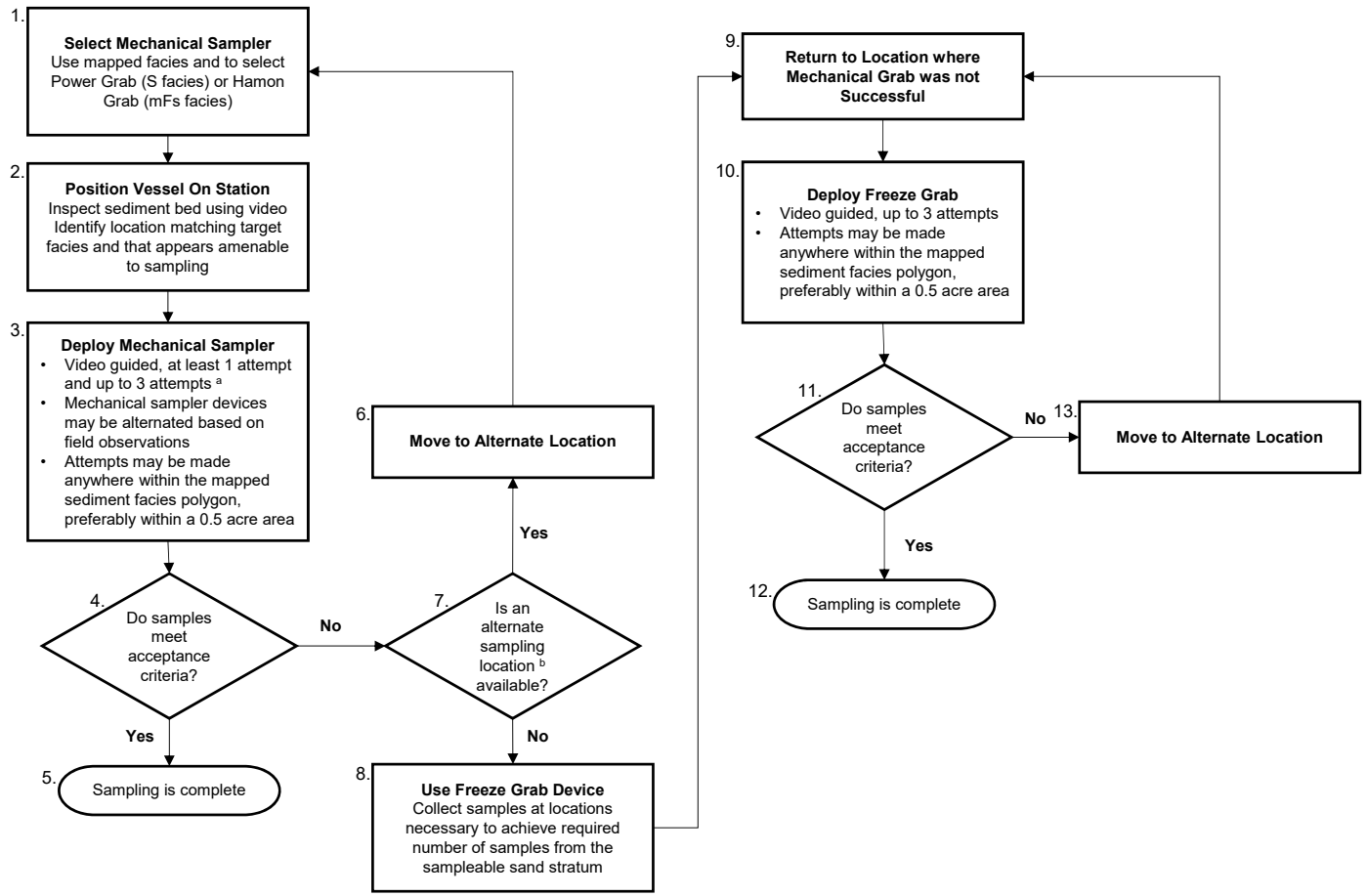
mBm = mixed boulder/cobble, with mud

mBs = mixed boulder/cobble, with sand

C = coarse

Note:
Bedrock is included as a sediment bed type in facies maps but is not shown in texture triangle.

Figure A7-1. Texture Triangle for Sediment Bed Surface Facies



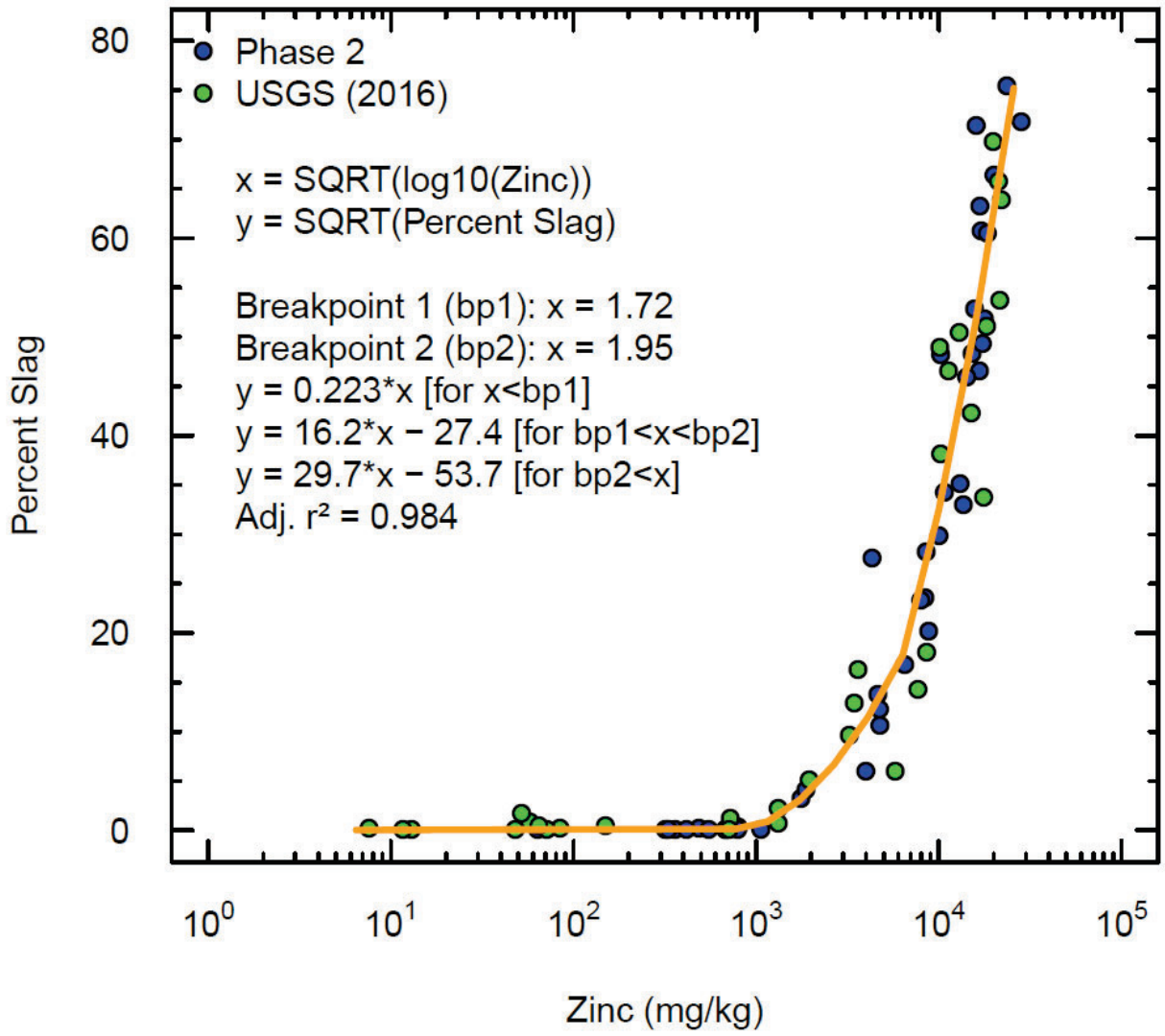
Notes:

[a] Number of attempts at a location will be based on video imagery and best professional judgement to minimize number of attempts in locations that are not sampleable using mechanical samplers.

[b] There are 21 available alternate sampling locations in this stratum at Deadman's Eddy and Evans AOIs; at China Bend AOI, there are 12 alternate sampling locations. In addition, two alternate judgmental sample locations are present at the China Bend AOI as requested by EPA. A maximum of 10 alternate locations will be used at statistically derived and repeat sample locations. If refusals are encountered at judgmental locations, both alternate locations may be attempted.

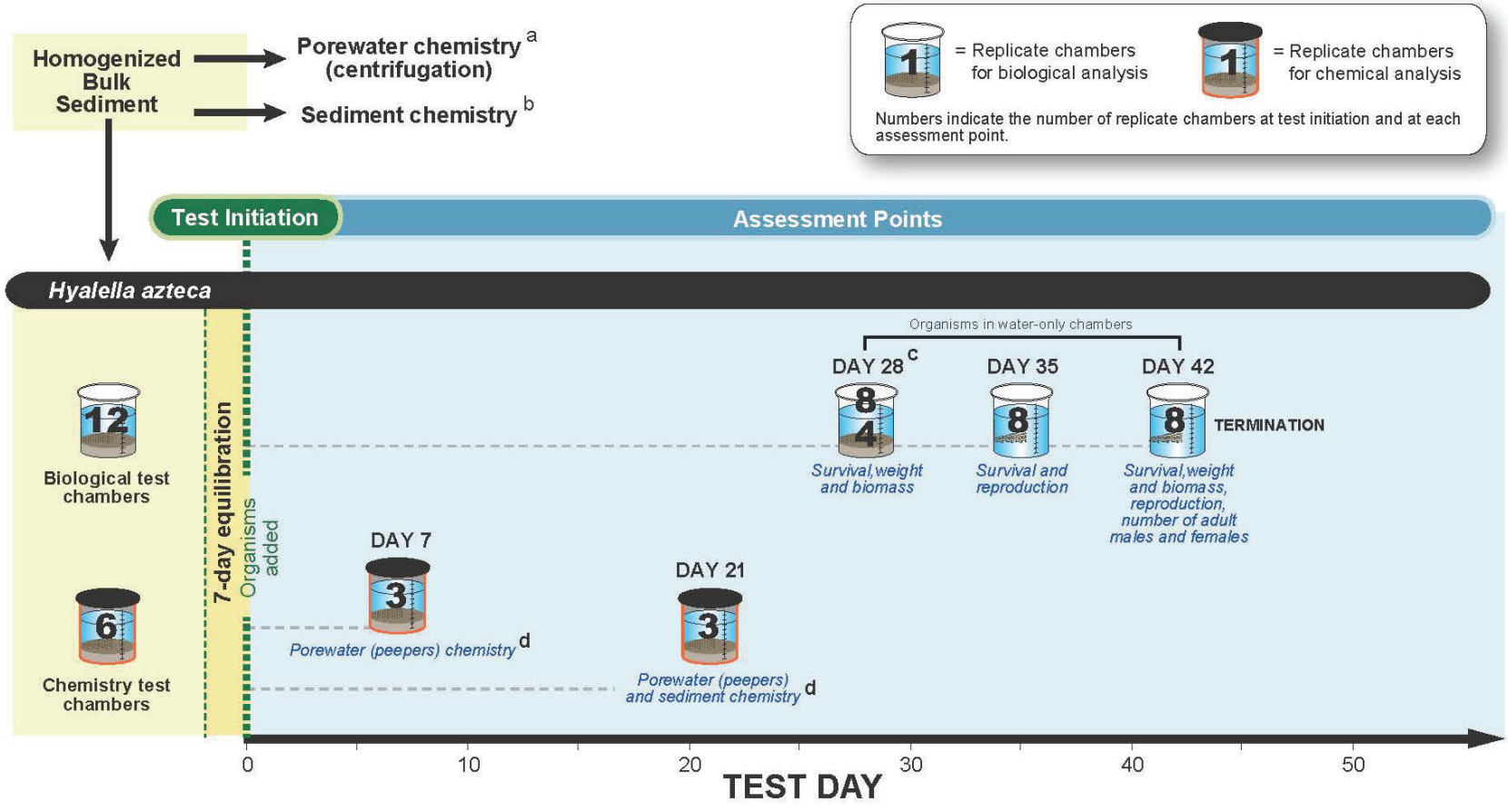
Numbers outside of shapes are provided purely for identification purposes, and should not be construed as a prescribe order of operations.

Figure A7-2. Sediment Sampling Hierarchy for Sampleable Sand Stratum



SQRT - square root

Figure B4-1. Segmented Regression Model for Zinc as a Predictor for Percent Slag in UCR Sediment



a Porewater collected by centrifugation and analyzed for dissolved metals, chloride, sulfate, alkalinity, pH, sulfide, and dissolved organic carbon (DOC).

b Sediment analyzed for acid volatile sulfide (AVS), simultaneously extracted metals (SEM), and total organic carbon (TOC)

c On Day 28, survival evaluated in all 12 replicates; 4 replicates sacrificed to obtain dry weight and biomass, surviving amphipods in 8 replicates transferred to water-only chambers and continued to Day 42

d Porewater from peepers analyzed for dissolved metals, sediment from chemistry test chambers analyzed for AVS, SEM, and TOC

Figure B4-2. Bioassay Timeline for Sediment Samples

MAPS

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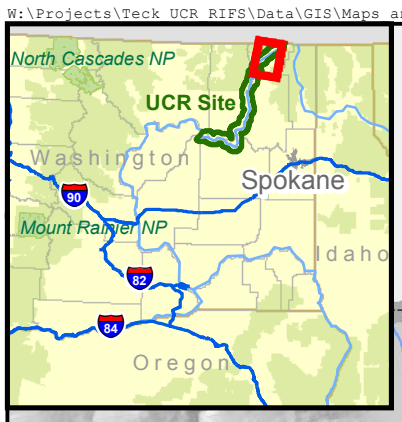

U.S. - Canada Border

RM 744

RM 740

Deadman's Eddy

Big Sheep Creek

Deadman's Eddy

North Fork Deep Creek

251

Northport

RM 730

Deep Creek

25

China Bend

China Bend

RM 720

South Fork Deep Creek

Cable Ferry Landing

Bossburg Flat Beach

Evans Campground

RM 710

Evans

South Fork Deep Creek

Legend

- Upper Reach OU AOI
- Upper Columbia River
- Stream
- Populated Places
- State Highway
- Railroad
- River Mile (USGS)

Windward environmental LLC

0 2 4 Km

0 1 2 Miles

N

Map A4-1. **Upper Reach Operable Unit and Phase 3 Sediment Study AOIs**
Upper Columbia River, WA

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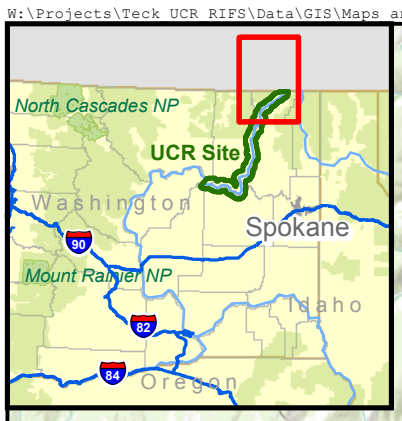

Lower Arrow Lake

Lower Arrow Lake

Upstream of Genelle

Genelle

Birchbank

China Bend

Evans

Deadman's Eddy

U.S. - Canada Border

UNITED STATES

CANADA

UNITED STATES

CHRISTINA RANGE

ROSSLAND RANGE

NORNS RANGE

BONNINGTO

Renata

Deer Park

Syringa Provincial Park

Gladstone Provincial Park

Nancy Greene Provincial Park

Blueberry Creek

Champion Lakes Provincial Park

Genelle

Kinnaird

Ootischenia

Robson

Raspberry

Castlegar

Brilliant

Krestova

Shoreacres

Glade

Burrington Falls

Taghum

Park Siding

Fruitvale

Glenmerry

Trail

Sunningdale

Warfield

Rossland

Montrose

Beaver Creek Provincial Park

Christina Lake

Gilpin Grasslands Provincial Park

Cascade

Laurier

King George VI Provincial Park

Crowsnest Hwy

Blueberry Creek

Columbia River

Highway 25 N

RM 740

RM 730

RM 720

RM 710

Northport

Orient

Boyds

Evans

Marcus

Colville National Forest

Lake Roosevelt National Recreation Area

Deadman Creek

North Fork Boulder Creek

LIME CREEK MOUNTAIN

KELLY HILL

GILLETTE MOUNTAIN

ALADDIN MOUNTAIN

Onion Creek

Deep Creek

South Fork Deep Creek

STEVENS

PEND OREILLE

FERRY

7303 ft

6379 ft

1630m

2375m

Lone

Metalin

Legend

- Upper Reach OU AOI
- Upstream Reference Area
- River Mile (USGS)

Windward environmental LLC

Kilometers 0 4 8

Miles 0 2 4

N

Map A7-1. **Sampling Area Overview**

Upper Columbia River, WA

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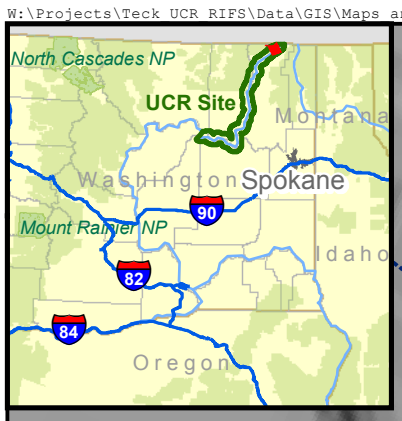

RM 738

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251

1-B5-NRT-2019
1-B6-NRT-2019

RM 737

Legend

Proposed Sampling Locations
- Sampleable Sand – Primary
- Sampleable Sand – Alternate
- Mixed Coarse – Primary
- Mixed Coarse – Alternate
- Coarse (Porewater Only) – Primary
- Coarse (Porewater Only) – Alternate
- Repeat Sampling Location

Sediment Facies (Area/Relative Abundance)
- Bedrock (0.04 sqkm/5.7%)
- Sand (S)(0.07 sqkm/10.5%)
- Mixed Fines, Predominantly Sand (mFs) (0.05 sqkm/8.6%)
- Mixed Coarse with Sand (mCs) (0.03 sqkm/4.7%)
- Mixed Boulder/Cobble with Sand (mBs) (0.03 sqkm/4.0%)
- Coarse (C)(0.42 sqkm/65.8%)
- Boulder/Cobble (B)(<0.01 sqkm/0.7%)

- Upper Reach OU AOI

UCR Riverbed Elevation
- 1,290 ft
- Historical Thalweg
- Major Road
- Railroad
- River Mile (USGS)

Windward environmental LLC

0 0.1 0.2 Km

0 0.05 0.1 Miles

Map A7-2. **Proposed Sampling Locations at Deadman's Eddy AOI**
Upper Columbia River, WA

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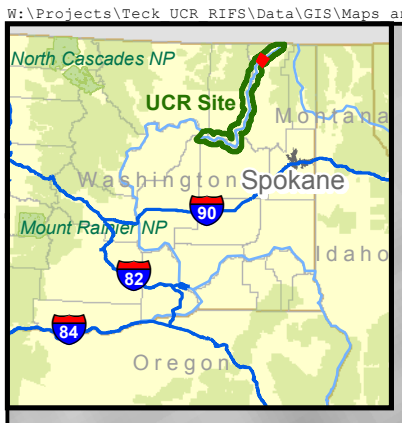

RM 724

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CB024
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CB032
CB034
CB033

Legend

Proposed Sampling Locations
- Sampleable Sand – Primary
- Sampleable Sand – Alternate
- Mixed Coarse – Primary
- Mixed Coarse – Alternate
- Mud – Primary
- Mud – Alternate
- Coarse (Porewater Only) – Primary
- Coarse (Porewater Only) – Alternate
- Judgmental Sampling Location - Primary
- Judgmental Sampling Location - Alternate
- Repeat Sampling Location

Sediment Facies (Area/Relative Abundance)
- Bedrock (0.05 sqkm/3.3%)
- Dense Vegetation (0.10 sqkm/6.8%)
- Gravel (G)(<0.01 sqkm/0.1%)
- Sand (S)(0.09 sqkm/6.3%)
- Mixed Fines, Predominantly Sand (mFs) (0.11 sqkm/7.7%)
- Mixed Coarse with Sand (mCs) (0.30 sqkm/21.1%)
- Mixed Boulder/Cobble with Sand (mBs) (0.17 sqkm/11.9%)
- Mud (M)(0.08 sqkm/5.9%)
- Mixed Fines, predominantly Mud (mFm) (0.02 sqkm/1.4%)
- Mixed Coarse with Mud (mCm) (0.01 sqkm/0.5%)
- Mixed Boulder/Cobble with Mud (mBm) (<0.01 sqkm/0.2%)
- Coarse (C)(0.45 sqkm/31.7%)
- Boulder/Cobble (B)(0.04 sqkm/3.2%)

- Upper Reach OU AOI

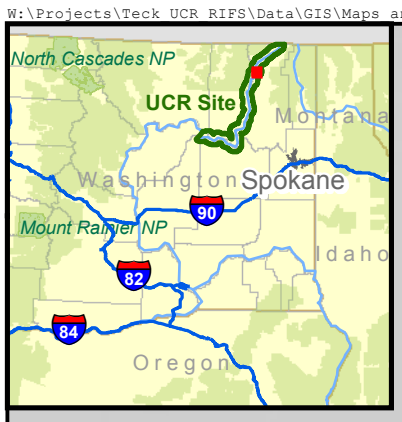
UCR Riverbed Elevation
- 1,220 ft
- 1,250 ft
- Historical Thalweg
- Major Road
- Railroad
- River Mile (USGS)

Windward environmental LLC

Km 0 0.2 0.4
Miles 0 0.1 0.2
N

Map A7-3. **Proposed Sampling Locations at China Bend AOI**
Upper Columbia River, WA

W:\Projects\Teck UCR RIFS\Data\GIS\Maps and Analyses\Phase 3 Support\Sediment QAPP\Map A7-4 7033 Sed facies and proposed smp locs - Evans.mxd @ 08/19/2019



RM 711
Powell
EV076
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RM 708
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EV015
EV009
EV012
EV001
EV010
EV003
EV011
25

Legend

Proposed Sampling Locations
- Sampleable Sand – Primary
- Sampleable Sand – Alternate
- Mixed Coarse – Primary
- Mixed Coarse – Alternate
- Mud – Primary
- Mud – Alternate
- Coarse (Porewater Only) – Primary
- Coarse (Porewater Only) – Alternate
- Repeat Sampling Location

Sediment Facies (Area/Relative Abundance)
- Bedrock (0.19 sqkm/5.2%)
- Dense Vegetation (0.27 sqkm/7.5%)
- Sand (S)(0.81 sqkm/22.2%)
- Mixed Fines, Predominantly Sand (mFs) (0.40 sqkm/11.1%)
- Mixed Coarse with Sand (mCs) (0.32 sqkm/8.9%)
- Mixed Boulder/Cobble with Sand (mBs) (0.31 sqkm/8.5%)
- Mud (M)(1.09 sqkm/30.0%)
- Mixed Fines, predominantly Mud (mFm) (0.06 sqkm/1.7%)
- Mixed Coarse with Mud (mCm) (0.02 sqkm/0.6%)
- Mixed Boulder/Cobble with Mud (mBm) (0.03 sqkm/0.8%)
- Coarse (C)(0.12 sqkm/3.4%)
- Boulder/Cobble (B)(0.01 sqkm/0.2%)

- Upper Reach OU AOI

UCR Riverbed Elevation
- 1,220 ft
- 1,250 ft
- Historical Thalweg
- Populated Places
- Major Road
- Railroad
- River Mile (USGS)

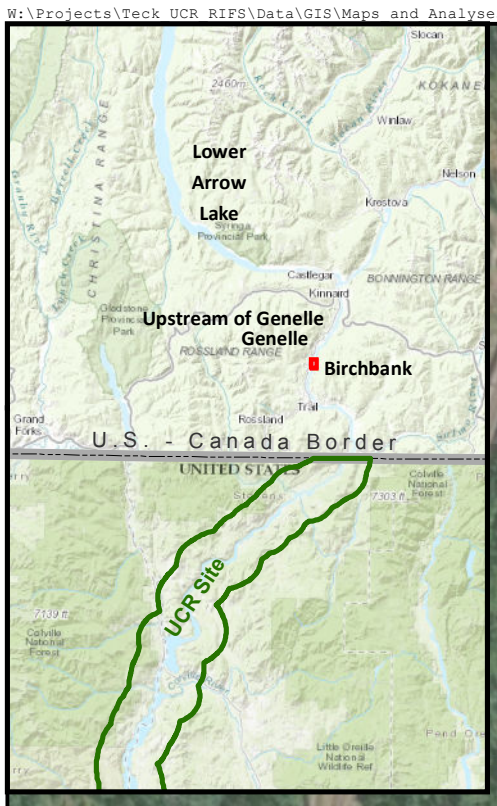
Windward environmental LLC

Km 0 0.2 0.4
Miles 0 0.1 0.2

N

Map A7-4. **Proposed Sampling Locations at Evans AOI**
Upper Columbia River, WA

W:\Projects\Teck UCR RIFS\Data\GIS\Maps and Analyses\Phase 3 Support\Sediment QAPP\Map A7-5 7024 Target Reference Locations - Birchbank.mxd @ 08/19/2019



REF004

Golder (2007) REF003

AREMP (2013) REF002

REF001

Photo source: Esri/Vivid DigitalGlobe, 0.5 m resolution. Photo date 06/06/2015.

Legend

Target Reference Locations

- Sand
- Mixed
- Previously Sampled Location

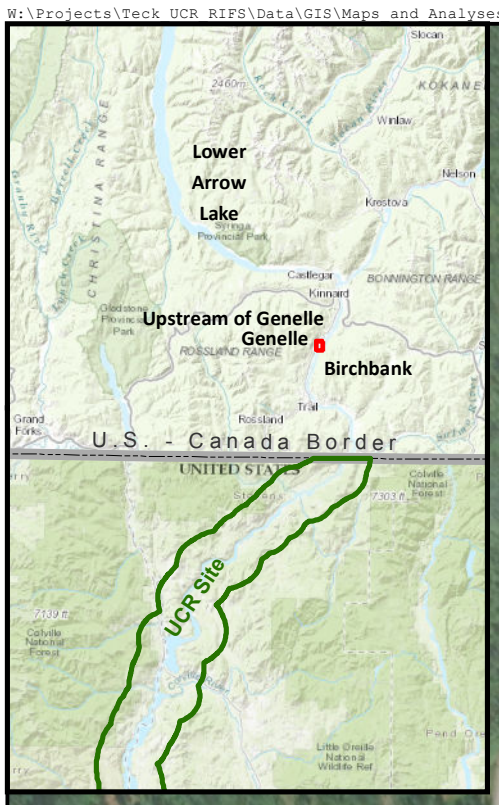
Windward environmental LLC

Meters
0 50 100
Yards
0 50 100

N

Map A7-5. **Target Reference Locations at Birchbank**
Columbia River, BC

W:\Projects\Teck UCR RIFS\Data\GIS\Maps and Analyses\Phase 3 Support\Sediment QAPP\Map A7-6 7024 Target Reference Locations - Genelle.mxd @ 08/19/2019



REF010

Phase 2: G-1

Phase 2: G-2 REF009

Phase 2: G-3 REF008

Phase 2: G-4 REF007

AREMP (2013)

Golder (2007)

REF005

REF006

Photo source: Esri/Vivid DigitalGlobe, 0.5 m resolution. Photo date 06/06/2015.

Legend

Target Reference Locations

- Sand
- Mixed
- Previously Sampled Location

Windward environmental LLC

0 100 200 Meters

0 100 200 Yards

N

Map A7-6. **Target Reference Locations at Genelle**
Columbia River, BC

W:\Projects\Teck UCR RIFS\Data\GIS\Maps and Analyses\Phase 3 Support\Sediment QAPP\Map A7-7 7024 Target Reference Locations - Upstream of Genelle.mxd @ 08/19/2019

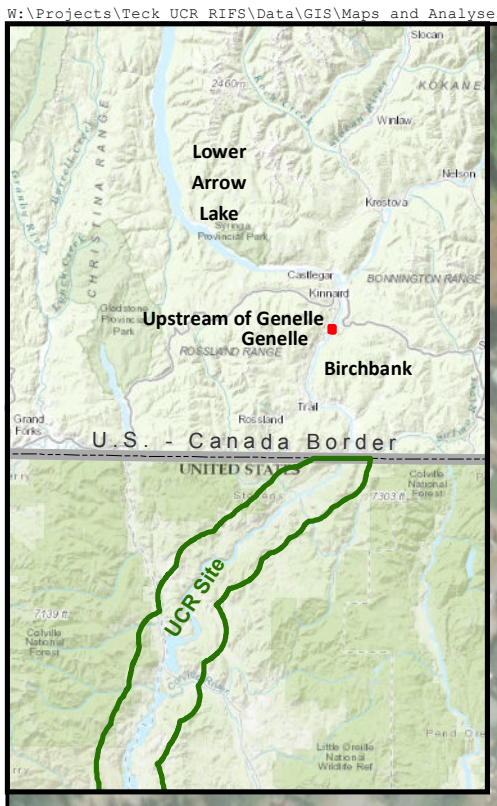


Photo source: Esri/Vivid DigitalGlobe, 0.5 m resolution. Photo date 06/06/2015.

Legend

Target Reference Locations

Sand

Mixed

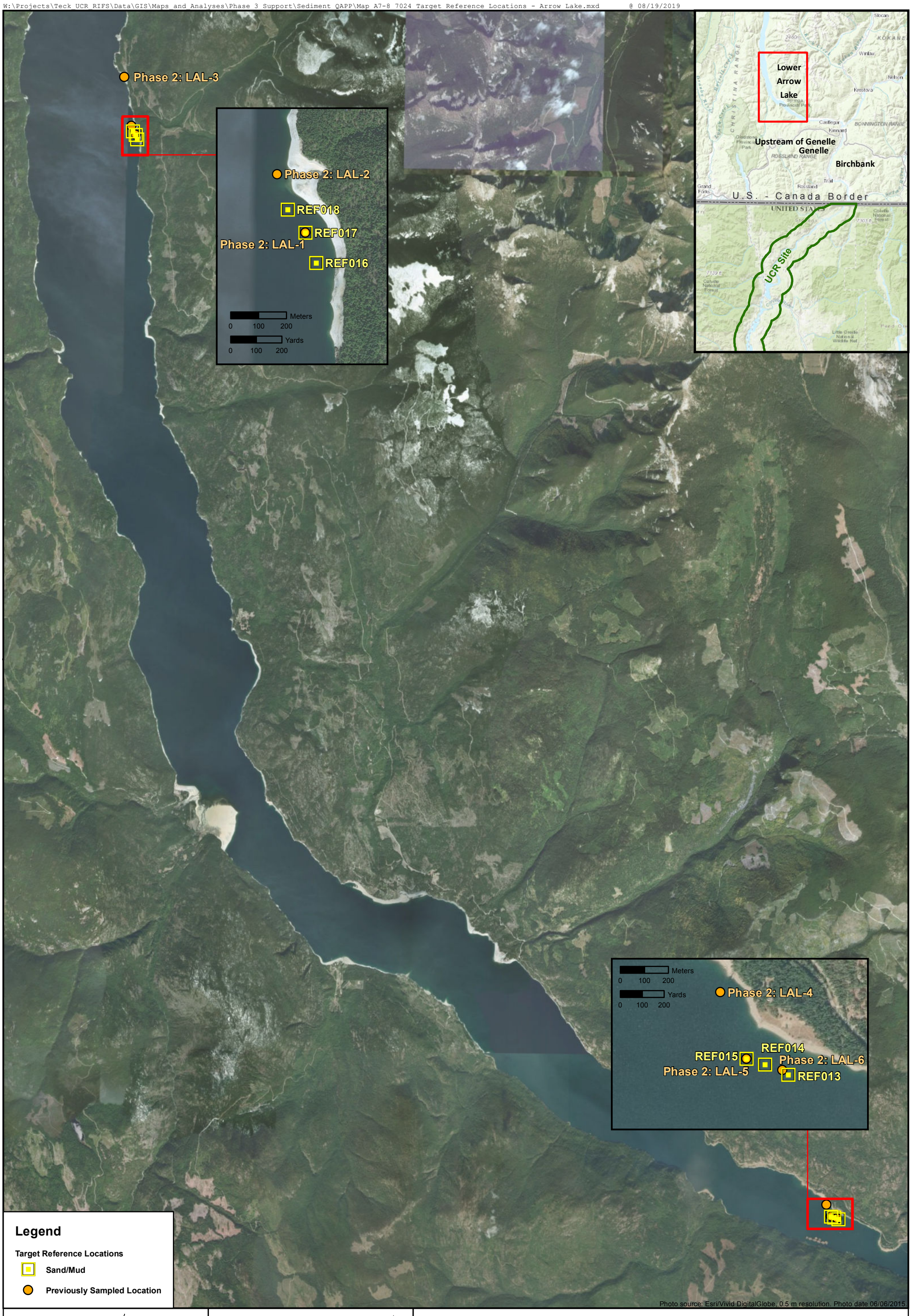
Windward environmental LLC

Meters
0 50 100
Yards
0 50 100

N

Map A7-7. **Target Reference Locations Upstream of Genelle**
Columbia River, BC

W:\Projects\Teck_UCR_RIFS\Data\GIS\Maps_and_Analyses\Phase 3 Support\Sediment QAPP\Map A7-8 7024 Target Reference Locations - Arrow Lake.mxd @ 08/19/2019



Legend

Target Reference Locations

- Sand/Mud
- Previously Sampled Location

Photo source: Esri/Vivid DigitalGlobe, 0.5 m resolution. Photo date 06/06/2015.

Windward environmental LLC

Kilometers 0 1 2

Miles 0 0.75 1.5

N

Map A7-8. **Target Reference Locations at Lower Arrow Lake**
Columbia River, BC

TABLES

Table A4-1. Phase 3 Sediment Study Scoping Chronology

Date	From	To	Description
1/8/2018	EPA (K. Cerise)	TAI (K. McCaig)	Letter identifying the upper reaches of the riverine portion of the UCR Site as an operable unit (OU); identifying data gaps in an level of effort (LOE) dated January 4, 2018 for the Upper Reach OU that include sediment facies mapping and 19 unsampled depositional features requiring surface sediment samples and sediment cores; and requiring TAI to submit a draft QAPP to fill the site characterization data gaps identified in the LOE. Specifically, the January 4, 2018 LOE required the following: *Additional characterization is needed to determine the spatial extent of potentially toxic sediments in the OU in order to complete the baseline ecological risk assessment (BERA) as outlined in the approved BERA Work Plan. The BERA Work Plan discusses the importance of 'investigating nature and extent of contamination at the Site, to provide information to support the baseline risk assessment' and speaks specifically to spatial refinements to 'define and delineate the nature and extent of sediment contamination'. Data gaps identified in the LOE for the Upper Reach OU include sediment facies mapping, and 19 unsampled depositional features requiring surface sediment samples and sediment cores.*
1/23/2018	TAI (K. McCaig)	EPA (K. Cerise)	Letter notifying EPA of TAI's dispute of the January 8, 2018, LOE letter
2/13/2018	TAI (K. McCaig)	EPA (K. Cerise)	Letter providing TAI's proposed guiding principles and a conceptual proposal for another sediments field program to facilitate negotiation during the informal dispute resolution period. The proposal was prefaced by a series of guiding principles and included two elements: bed mapping (Part 1) and a sediment program (Part 2). The proposed sediment program included implementation of four elements at two areas (Deadman's Eddy and Northport). The four sediments program elements included: a) chemistry, b) toxicity identification evaluation (TIE), c) in situ porewater sampling and analysis, and d) biological survey of aquatic invertebrate community.

Table A4-1. Phase 3 Sediment Study Scoping Chronology

Date	From	To	Description
2/14/2018	EPA (K. Cerise)	TAI (K. McCaig)	Letter acknowledging TAI's proposal and agreeing to modify the requirements of the LOE under conditions stipulated by EPA. EPA agreed "to modify the LOE to include Deadman's Eddy and Northport as locations for characterization sampling, but also requires focused characterization at the border, China Bend, and the historical river channel just upstream of Marcus (total of 5 study areas)." EPA also noted that: *TAI proposed higher-resolution nature and extent samples in shallow sediment, but did not describe the number of samples to be collected. EPA will agree to defer details, such as the number of samples to be collected, to the QAPP, but requires the number of samples be sufficient to statistically evaluate sediment variability within each feature and any reference areas (20 to 30 samples per area).*
2/15/2018	TAI (K. McCaig)	EPA (K. Cerise)	Letter providing TAI's response to EPA's February 14, 2018, letter and requesting a study design process to include development and agreement on data quality objectives (DQOs) prior to preparation of a QAPP
2/16/2018	EPA (K. Cerise)	TAI (K. McCaig)	Letter providing EPA's final proposal and identifying the three areas of interest (AOIs) as a further compromise from the initial LOE, and that the study design would be based on a statistical design. The AOIs were identified as follows: *For the initial 2018/2019 effort, a minimum of three depositional areas would need to be assessed to provide useful and comparable data for different conditions observed in the OU. These areas are China Bend, Deadman's Eddy, and a location just upstream of Marcus. The requirements for sampling at each depositional feature would need to be based on a robust statistical design discussed in a detailed* [sic] *in the data quality objectives section of the quality assurance project plan (QAPP).*
2/16/2018	EPA (K. Cerise)	TAI (K. McCaig)	Letter acknowledging that EPA and TAI have come to an agreement on the terms of resolution of the informal dispute and agreeing that the timing for the Phase 3 sediment QAPP will be determined after finalizing the DQOs
3/22/2018	TAI	EPA	A packet containing draft DQOs 1 through 5 prepared by TAI and provided to EPA on March 22, 2018

Table A4-1. Phase 3 Sediment Study Scoping Chronology

Date	From	To	Description
3/22 – 3/23/2018			A scoping meeting held in Seattle, Washington, on March 22 and 23, 2018, during which TAI, EPA, and agency representatives discussed the draft DQOs and modifications that may be required to address EPA's concerns
4/12/2018	Prepared by TAI	Approved by EPA	A summary of scoping meeting outcomes, prepared by TAI and approved by EPA on April 12, 2018, to document the agreements and action items from the March 22 and 23, 2018 scoping meeting
4/13/2018	EPA (K. Cerise)	TAI (K. McCaig)	A table of comments from EPA and the Parties on the March 22, 2018, draft DQOs 1 through 5
4/20/2018			A technical conference call between TAI and EPA on April 20, 2018, to clarify EPA comments on draft DQOs
5/8/2018	TAI (K. McCaig)	EPA (K. Cerise)	TAI responses to comments from EPA/Parties and revised draft Phase 3 sediment DQOs 1, 3, 4, and 5; responses to comments on DQO 2 were deferred to "later date"
5/17/2018			Teleconference between EPA and TAI to discuss status of draft final DQO review, DQO 1 mapping methods, DQO 2 sampling methods, and DQO schedule
5/17/2018	EPA (K. Cerise)	TAI (K. McCaig)	EPA expectations for DQOs 2 and 5 (email)
5/18/2018	EPA (K. Cerise)	TAI (K. McCaig)	A table of comments from EPA and the Parties on the May 8, 2018, revised draft DQOs 1 and 3 through 5 and additional comments on DQO 2
			Hiatus - work on pilot studies and sediment facies mapping (identified in EPA's May 23, 2019 letter to TAI in Attachment 1 Chronology)
5/18/2018 – 8/31/2018			Finalization of DQO 1 and preparation, review, and approval of the *Final Quality Assurance Project Plan for the Phase 3 Sediment Study—Sediment Facies Mapping*
8/22/2018	TAI	EPA	A freeze grab sediment sampler pilot study was completed on September 24 to 28, 2018 in support of DQO 2. The pilot study was performed as described in the *Final Technical Memorandum—Sediment Freeze Grab Sampling Pilot Study* submitted by TAI to EPA on August 22, 2018.

Table A4-1. Phase 3 Sediment Study Scoping Chronology

Date	From	To	Description
8/22/2018	TAI	EPA	A porewater sampling pilot study was conducted on September 24 to 27, 2018 to support DQO 3. The porewater pilot study was performed as described in the *Final Technical Memorandum—Porewater Sampling Pilot Study* submitted by TAI to EPA on August 22, 2018.
8/22/2018	TAI	EPA	A toxicity identification evaluation (TIE) pilot study to support DQO 4 is ongoing. This study is being conducted as described in the *Final Technical Memorandum—Toxicity Identification Evaluation Pilot Study* submitted by TAI to EPA on August 22, 2018.
9/7/2018	TAI (K. McCaig)	EPA (K. Cerise)	A field study reconnaissance survey was performed on September 17 to 20, 2018 to support a proposed benthic macroinvertebrate (BMI) field study under DQO 5. The objectives of the field study reconnaissance survey were detailed in the memorandum *Phase 3 Sediment Study—Benthic Macroinvertebrate Field Study Reconnaissance Survey* submitted to EPA by TAI on September 7, 2018.
9/25/2018 – 11/10/2018			Field data collection for sediment facies mapping in the Upper Reach OU, including the three AOIs
12/12/2018	TAI (K. McCaig)	EPA (K. Cerise)	Draft schedule for sediment facies mapping and Phase 3 sediment study DOQs 2 through 5 and QAPP

Deliverable / Meeting	Target Submittal / Meeting Date
Sediment Composition Maps and Sediment Facies Maps for AOIs	Early February 2019
Draft Phase 3 Sediment Facies Mapping Data Summary Report	Early March 2019
Draft Final DQOs 2 through 5 and TAI responses to EPA comments on Draft DQOs	Mid-March 2019
Workshop / meeting to discuss Draft Final DQOs	Late March or Early April 2019
Draft 2019 Phase 3 Sediment Study QAPP	Early June 2019

Table A4-1. Phase 3 Sediment Study Scoping Chronology

Date	From	To	Description
12/21/2018	TAI	EPA	Final trip report from the September 2018 benthic macroinvertebrate field study reconnaissance survey, which was submitted as a draft to EPA by TAI on November 21, 2018 and approved as final by EPA on December 21, 2018.
1/17/2019	TAI (K. McCaig)	EPA (M. Gauthier)	Deliverables schedule presented at 1/17/2019 bi-weekly meeting
1/28/2019	TAI (K. McCaig)	EPA (K. Cerise)	Updates, proposed dates, and deliverable schedule
2/1/2019	TAI	EPA	The *Final Technical Memorandum—Sediment Freeze Grab Sampling Pilot Study* (ERM 2019) was submitted to EPA by TAI on February 1, 2019. A draft technical memorandum was submitted to EPA by TAI on November 25, 2018 and EPA comments were received by TAI on December 21, 2018. A draft final technical memorandum was submitted to EPA by TAI on January 25, 2019 and approved by EPA on January 30, 2019.
2/1/2019	TAI (K. McCaig)	EPA (K. Cerise)	Email clarifying schedule for delivery of draft final DQOs by TAI to EPA and DQO workshop meeting notice
2/8/2019	TAI (K. McCaig)	EPA (K. Cerise)	The preliminary *Technical Memorandum Draft Sediment Facies Maps for Upper Reach Operable Unit Areas of Interests, Upper Columbia River, Phase 3 Sediment Study* (hereafter the sediment facies maps technical memorandum)
2/14/2019	TAI (K. McCaig)	EPA (K. Cerise)	Email confirming agreement that *Sediment Facies Mapping Draft Data Summary Report* will be submitted within 150 days following completion of remaining data acquisition in 2019
2/15/2019			Technical meeting on February 15, 2019 with Jennifer Holder (ERM), Tim McClinton (David Evans & Associates [DEA]), Marilyn Gauthier (Jacobs), and Shaun Roark (Jacobs) regarding preliminary sediment facies maps transmitted February 8, 2019
2/19/2019	EPA (K. Cerise)	TAI (K. McCaig)	EPA comments on draft sediment facies map technical memorandum
2/26/2019	TAI (K. McCaig)	EPA (K. Cerise)	Revised sediment facies maps for AOIs, revised according to EPA comments received February 19, 2019
2/26/2019	TAI (K. McCaig)	EPA (K. Cerise)	GIS data (shapefiles) for revised sediment facies maps
2/27/2019	TAI (K. McCaig)	EPA (K. Cerise)	Agenda for 2/28/2019 bi-weekly call, including schedule of deliverables
3/1/2019	TAI (K. McCaig)	EPA (K. Cerise)	Revised draft final sediment facies map technical memorandum and responses to EPA comments received February 19, 2019

Table A4-1. Phase 3 Sediment Study Scoping Chronology

Date	From	To	Description
3/6/2019	TAI (K. McCaig)	EPA (K. Cerise)	Draft agenda for DQO workshop
3/13/2019	TAI (K. McCaig)	EPA (K. Cerise)	Draft final DQOs 2 through 5 and responses to EPA comments on draft DQOs received in 2018
3/13 – 3/14/2019			A DQO workshop at TAI's office in Spokane, Washington on March 13 and 14, 2019 to discuss draft final DQOs 2 through 5, which would provide the basis for the 2019 Phase 3 sediment study QAPP.
3/14/2019	TAI (K. McCaig)	EPA (K. Cerise)	Updated deliverable schedule, showing EPA comments on draft final DQOs by 4/15/2019
3/18/2019	EPA (K. Cerise)	TAI (K. McCaig)	EPA comments on draft final sediment facies map technical memorandum (second set)
3/22/2019	TAI (K. McCaig)	EPA (K. Cerise)	Transmittal of BMI data from Golder 2007 Aquatic Receiving Environment Monitoring Program (AREMP) survey in British Columbia, Canada (followup from DQO workshop)
3/25/2019	TAI (K. McCaig)	EPA (K. Cerise)	Revised draft final sediment facies map technical memorandum and responses to EPA comments received March 18, 2019
3/26/2019	TAI (K. McCaig)	EPA (K. Cerise)	Agenda for 3/27/2019 bi-weekly call, including schedule
3/26/2019	TAI (K. McCaig)	EPA (K. Cerise)	Draft DQO workshop outcomes summary
3/27/2019			A presentation of TAI's revised proposal for the DQO 2 study design on March 27, 2019 during a standing biweekly coordination call between EPA and TAI.
4/2/2019	TAI (D. Mills)	EPA (K. Cerise)	Slides presenting TAI's revised proposal for the DQO 2 study design (for presentation to EPA on April 3, 2019)
4/3/2019			WebEx for TAI presentation of revised DQO 2 proposal (updated from 3/27/2019)
4/10/2019	EPA (K. Cerise)	TAI (K. McCaig)	EPA comments on Draft DQO workshop outcomes
4/11/2019	EPA (K. Cerise)	TAI (K. McCaig)	EPA draft comments on DQO 2 (and partial DQO 3)
4/11/2019	EPA (K. Cerise)	TAI (K. McCaig)	EPA comments on revised draft final sediment facies map technical memorandum (third set)
4/12/2019	EPA (K. Cerise)	TAI (K. McCaig)	EPA questions and comments for discussion on DQOs 2, 4, and 5
4/12/2019			Teleconference between EPA and TAI to discuss schedule, sample size statistics, and back scatter electron microscopy (BSEM)

Table A4-1. Phase 3 Sediment Study Scoping Chronology

Date	From	To	Description
4/15/2019	TAI (K. McCaig)	EPA (K. Cerise)	Transmittal of the sediment metals concentration data that were used for the various statistical analyses performed in support of the DQO 2 sample design from
4/17/2019			Call to discuss EPA draft comments on DQOs 2 through 5
4/17/2019	TAI (K. McCaig)	EPA (K. Cerise)	Transmittal of a table generated by TAI to organize the draft comments received from EPA on April 11, 2019 and April 12, 2019
4/18/2019	EPA (S. Roark)	TAI (K. McCaig)	EPA analysis of sample size for DQO 2
4/18/2019			Call about DQO 2 to discuss EPA's sample size proposal
4/18/2019	TAI (K. McCaig)	EPA (S. Roark)	Confirmation of EPA action items from April 18, 2019 DQO 2 call
4/22/2019	TAI (K. McCaig)	EPA (K. Cerise)	Revised DQO workshop outcomes
4/23/2019	TAI (K. McCaig)	EPA (K. Cerise)	Additional information regarding organics analyses at reference locations (follow-up from April 17, 2019 call concerning DQOs 3 through 5)
4/23/2019	TAI (K. McCaig)	EPA (K. Cerise)	Proposed BMI data analysis overview (follow-up from April 17, 2019 call regarding DQOs 3 through 5).
4/23/2019			Technical call with Tim McClinton (DEA), Kevin Lundmark (ERM), and Marilyn Gauthier (Jacobs) regarding EPA comments on revised draft final sediment facies map technical memorandum received April 11, 2019 and responded
4/24/2019	EPA (K. Cerise)	TAI (K. McCaig)	EPA's Statement of Objective for DQOs 2 and 3 Sampling
4/24/2019	EPA (K. Cerise)	TAI (K. McCaig)	EPA's proposal for sand sample selection
4/24/2019	TAI	EPA	*Final Phase 3 Sediment Study Porewater Sampling Pilot Study Report* (Windward 2019) submitted by TAI to EPA on April 24, 2019. A draft report was submitted by TAI to EPA on November 30, 2018, and EPA comments on the draft report were received on December 31, 2018. A draft final report was submitted to EPA by TAI on February 15, 2019, and EPA comments on the draft final report were received on March 18, 2019. A revised draft final report was submitted to EPA by TAI on March 27, 2019 and approved by EPA on April 24, 2019.
4/24/2019	EPA	TAI	Additional comments on the porewater sampling pilot study received by TAI from EPA on April 24, 2019, after the porewater pilot study technical memorandum had been approved by EPA as final

Table A4-1. Phase 3 Sediment Study Scoping Chronology

Date	From	To	Description
4/25/2019	TAI (K. McCaig)	EPA (K. Cerise)	Agenda for bi-weekly EPA call, including schedule
4/25/2019			Bi-weekly call between EPA and TAI, including discussion of EPA's objectives and sample selection process for DQO 2
4/25/2019	TAI (K. McCaig)	EPA (K. Cerise)	A table summarizing comparison between EPA sampling approach (received April 24, 2019) and TAI revised proposal (April 3, 2019)
4/26/2019	TAI (K. McCaig)	EPA (K. Cerise)	Supplemental information (maps) and copy of TAI DQO 2 proposal dated April 3, 2019
4/26/2019	TAI (K. McCaig)	EPA (K. Cerise)	Second revised draft final sediment facies map technical memorandum and responses to EPA comments received April 11, 2019 from TAI (Kris McCaig) and submitted to EPA (Kathryn Cerise) on April 26, 2019.
4/29/2019	EPA (K. Cerise)	TAI (K. McCaig)	Memorandum clarifying EPA's proposed sampling design
4/30/19	EPA (S. Roark)	TAI (K. McCaig)	EPA's Revised Statement of Objective for DQOs 2 and 3 Sampling
4/30/2019			Teleconference between EPA and TAI to discuss DQO 2 objectives and process
5/1/2019	EPA (K. Cerise)	TAI (K. McCaig)	A letter dated May 1, 2019, from Kathryn Cerise, EPA, to Kris McCaig, TAI, providing EPA's comments on *UCR Draft Final Phase 3 Sediment Data Quality Objectives*
5/2/2019	EPA (K. Cerise)	TAI (K. McCaig)	Clarification from EPA that mixed coarse (mCs) sediment facies should be evaluated separately from sampleable sand (email)
5/3/2019	TAI (K. McCaig)	EPA (K. Cerise)	Final TAI technical memorandum titled *Final Sediment Facies Maps for Upper Reach Operable Unit Areas of Interest, Upper Columbia River, Phase 3 Sediment Study*
5/6/2019	TAI (K. McCaig)	EPA (K. Cerise)	Email requesting clarification of EPA's expectations for porewater sampling in different strata
5/8/2019	EPA (K. Cerise)	TAI (K. McCaig)	Response from EPA to TAI's May 6, 2019 emailed request for clarification on porewater sampling expectations (email)
5/8/2019	TAI (K. McCaig)	EPA (K. Cerise)	Letter notifying EPA of TAI's intent to provide the draft QAPP in June 2019, which would include responses to EPA's comments on the draft final DQOs.
5/9/2019			Bi-weekly call between EPA and TAI, including discussion of select comments on draft final DQOs and presentation of sampling design for DQOs 2 and 3

Table A4-1. Phase 3 Sediment Study Scoping Chronology

Date	From	To	Description
5/20/2019	TAI (K. McCaig)	EPA (K. Cerise)	Transmittal of slides that were presented by TAI during May 9, 2019 call (sampling design for DQOs 2 and 3)
5/23/2019	EPA (C. Grandinetti)	TAI (K. McCaig)	Letter with EPA's response to TAI's May 8, 2019 letter and EPA's expectations for DQOs and sampling design. In an attachment to this letter, EPA introduced a partial DQO for a holistic, sediment quality triad (SQT)-focused study design that departed from the DQOs 2 through 5 that had been discussed and commented on since the LOE was modified in February 2018.
6/6/2019			Bi-weekly call between EPA and TAI, including presentation of TAI's proposal for incorporating EPA's May 23, 2019 letter Attachment 2 into QAPP. From the agenda, sent by K. McCaig to K. Cerise on June 6, 2019: "Discuss EPA's May 23, 2019 letter and incorporating analysis portions of Attachment 2 into the QAPP"
6/15/2019	EPA (K. Cerise)	TAI (K. McCaig)	Email providing EPA's framework for bioassay spilt sample collection
6/17/2019	TAI (K. McCaig)	EPA (K. Cerise)	*Draft Phase 3 Sediment Study QAPP*
6/17/2019	TAI (K. McCaig)	EPA (K. Cerise)	TAI responses to EPA's comments on the draft final Phase 3 sediment study DQOs 2 through 5
6/18/2019	TAI (K. McCaig)	EPA (M. Gauthier)	GIS files for maps included in the draft Phase 3 sediment study QAPP
6/20/2019	TAI (K. McCaig)	EPA (K. Cerise)	TAI preliminary questions on EPA bioassay slit sample framework
6/20/2019			Bi-weekly call between EPA and TAI, agenda sent by K. McCaig June 18, 2019
7/10/2019	EPA (K. Cerise)	TAI (K. McCaig)	EPA comments on draft Phase 3 sediment study QAPP
7/11/2019	TAI (K. McCaig)	EPA (K. Cerise)	Email requesting call to discuss EPA comments and for TAI to voice concerns with the comments in light of our collective ability to get out in the field this year
7/11/2019	EPA (K. Cerise)	TAI (K. McCaig)	Email response "We will try to set up something for tomorrow but I know Marilyn is in the field. I do not see a concern with getting in the field in August since the issues are regarding how the data will be evaluated. I think we have been very clear on our expectations of what needs to be in the QAPP and we are not flexible on the expectations for content in regard to the analytical approach."
7/12/2019	EPA (K. Cerise)	TAI (K. McCaig)	Email requiring that any questions on EPA comments must be submitted in writing and be resolved on July 12, 2019

Table A4-1. Phase 3 Sediment Study Scoping Chronology

Date	From	To	Description
7/12/2019	TAI (K. McCaig)	EPA (K. Cerise)	Email stating "It is not practicable to resolve this today. I will follow up with you early next week."
7/15/2019	EPA (D. Einan)	TAI (K. McCaig)	Letter informing TAI that EPA will prepare final DQOs for QAPP section A7
7/16/2019	EPA (K. Cerise)	TAI (K. McCaig)	EPA responses to questions on bioassay split sample framework from 6/20/2019 biweekly call
7/18/2019	EPA (K. Cerise)	TAI (K. McCaig)	EPA's UCR Phase 3 sediment study DQOs for use in preparing the draft final QAPP
7/25/2019	TAI (K. McCaig)	EPA (K. Cerise)	Email providing TAI's review of adjustments required for proposed sampling locations at AOIs based on review by the cultural resources working group and TAI's proposal for making the required adjustments
7/29/2019	EPA (K. Cerise)	TAI (K. McCaig)	Email stating EPA's agreement with sampling location adjustments at Deadman's Eddy and Evans AOIs proposed by TAI on 7/25/2019
7/30/2019	EPA (K. Cerise)	TAI (K. McCaig)	Email confirming EPA's agreement with sampling location adjustments at Deadman's Eddy and Evans AOIs proposed by TAI on 7/25/2019, and providing questions and considerations for the adjustments proposed at China Bend AOI
7/31/2019	TAI (K. McCaig)	EPA (K. Cerise)	Email providing TAI's responses to 7/30/2019 questions from EPA on proposed sampling location adjustments at China Bend AOI, and requesting a call with the objective of understanding the EPA's communication about adjusted sampling locations at China Bend AOI so that TAI can make appropriate revisions for the draft final QAPP
7/31/2019			Technical call between TAI and Marilyn Gauthier (Jacobs) to discuss TAI's proposed adjustments to sampling locations at China Bend AOI and EPA's concerns and preferences for sampling locations at this AOI, including EPA's desire to add one or more judgmental sampling locations pending approval by the cultural resources working group
8/1/2019	EPA (K. Cerise)	TAI (K. McCaig)	Email confirming EPA's acceptance of TAI's 7/25/2019 proposal for sampling location adjustments at China Bend AOI, and indicating that EPA is waiting to hear back from the cultural resources working group regarding EPA's proposed judgmental sampling location(s) at this AOI
8/2/2019	TAI (K. McCaig)	EPA (K. Cerise)	*Draft Final Phase 3 Sediment Study QAPP*
8/14/2019	EPA (K. Cerise)	TAI (K. McCaig)	Email providing EPA's requested judgmental sampling locations at China Bend AOI

Table A4-1. Phase 3 Sediment Study Scoping Chronology

Date	From	To	Description
8/15/2019	EPA (K. Cerise)	TAI (K. McCaig)	EPA comments on the draft final QAPP submitted 8/2/2019
8/15/2019	EPA (K. Cerise)	TAI (K. McCaig)	EPA's *Draft Quality Assurance Project Plan - Upper Columbia River Phase 3 Sediment Study Split Sample Analysis*, including list of sampling locations for sediment and porewater EPA split samples.
8/16/2019	TAI (K. McCaig)	EPA (K. Cerise)	Map depicting proposed alternate judgmental sampling locations at China Bend AOI
8/19/2019	EPA (K. Cerise)	TAI (K. McCaig)	Email approving proposed alternate judgmental sampling locations at China Bend AOI
8/20/2019	EPA (M. Gauthier)	TAI (K. McCaig)	Revised list of sampling locations for EPA sediment and porewater split samples
8/20/2019	TAI (K. McCaig)	EPA (K. Cerise)	Responses to EPA comments on the draft final QAPP received 8/15/2019 and summary of proposed changes to be made for the final QAPP based on 8/15/2019 EPA comments and the addition of judgmental sampling locations at China Bend AOI
8/21/2019	EPA (S. Roark)	TAI (K. McCaig)	List of sediment sampling locations for EPA split samples for bioassay testing
8/22/2019	EPA (K. Cerise)	TAI (K. McCaig)	Letter providing one edit to proposed QAPP revisions submitted by TAI on 8/20/2019 and providing EPA approval for TAI to proceed finalizing the QAPP

Table A4-2. Technical Team Task Member Information

Name	Task Role	Phone	Email
Teck American Incorporated			
Kris McCaig	TAI Project Coordinator	(509) 434-8542	Kris.McCaig@teck.com
Denise Mills	TAI Assistant Project Coordinator	(509) 904-9375	Denise.Mills@teck.com
Cristy Kessel	Laboratory Coordinator	(509) 496-1160	Cristy.Kessel@teck.com
U.S. Environmental Protection Agency			
Kathryn Cerise	EPA Remedial Project Manager	(206) 553-2589	Cerise.Kathryn@epa.gov
Donald Brown	EPA QA Manager	(206) 553-0717	Brown.Donaldm@epa.gov
Consultant Team			
Jennifer Holder	TAI Technical Team Coordinator/Principal Investigator (ERM)	(805) 684-2801	Jennifer.Holder@erm.com
Kevin Lundmark	QAPP Coordinator (ERM)	(801) 204-4313	Kevin.Lundmark@erm.com
David Abranovic	Senior Technical Advisor/Task Manager - Sediment (ERM)	(602) 284-4917	David.Abranovic@erm.com
Robert Santore	Senior Technical Advisor/Task Manager – Porewater (Windward)	(206) 812-5450	Roberts@windwardenv.com
Karen Tobiason	Senior Technical Advisor/Task Manager – Bioassays and TIE (Windward)	(206) 446-6337	Karent@windwardenv.com
Chad Wiseman	Senior Technical Advisor/Task Manager – Benthic Macroinvertebrates (HDR)	(360) 570-4427	Chad.Wiseman@hdrinc.com
Jenny Pretare	Field Supervisor (AECOM)	(510) 681-6401	Jennifer.Pretare@aecom.com
Rock Vitale	Task QA Supervisor (Environmental Standards, Inc.)	(610) 935-5577	rvitale@envstd.com
Randy O'Boyle	Database Administrator (Exponent)	(425) 519-8727	roboyle@exponent.com
Laboratories			
Mark Harris	Chemistry Laboratory Project Manager (ALS)	(360) 501-3376	Mark.harris@alsglobal.com
Carl Degner	Chemistry Laboratory QA Manager (ALS)	(360) 501-3270	Carl.degner@alsglobal.com
Jeffrey Cotsifas	Bioassay Laboratory Project Manager (Pacific EcoRisk)	(707) 207-7761	cotsifas@pacificecorisk.com
Stephen L. Clark	Bioassay Laboratory QA Manager (Pacific EcoRisk)	(707) 207-7766	slclark@pacficiecorisk.com
Jay Word	BMI Laboratory Project Manager (EcoAnalysts)	(360) 296-6040, ext. 6048	jword@ecoanalysts.com
Rob Bobier	BMI Laboratory QA Manager (EcoAnalysts)	(208) 882-2588	rbobier@ecoanalysts.com
Keith Rickabaugh	BSEM Laboratory Project Manager (RJLG)	(724) 386-1841	KRickabaugh@rjleegroup.com
TBD	BSEM Laboratory QA Manager (RJLG)	Place Holder	Place Holder

Notes:

BMI - benthic macroinvertebrate

BSEM - back scatter electron microscopy

TIE - toxicity identification evaluation

Table A7-1. Analyte Detection Limits, Reporting Limits, and Criteria

	Porewater						Sediment				
	Ecological Screening Criteria for Water										
Analyte	Chronic EPA AWQC (µg/L)	Ecology Chronic WQS (µg/L)	CCT Aquatic Life Chronic Criteria (µg/L)[a]	STI Aquatic Life Chronic Criteria (µg/L)[b]	MDL (µg/L)[c]	MRL (µg/L)[c]	Toxicity Benchmark Value (mg/kg dw)	Toxicity Benchmark Value Source	MDL (mg/kg dw)[c]	MRL (mg/kg dw)[c]	SEM-AVS MDL (µmol/g dw)
Physical Properties											
Grain Size	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Slag	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Conventional Parameters											
Alkalinity	NA	NA	NA	NA	3,000	15,000	NA	NA	NA	NA	NA
DOC	NA	NA	NA	NA	70	500	NA	NA	NA	NA	NA
TOC	NA	NA	NA	NA	70	500	NA	NA	0.02%	0.05%	NA
Sulfide	NA	NA	NA	NA	20	50	NA	NA	NA	NA	NA
Hardness	NA	NA	NA	NA	800	2,000	NA	NA	NA	NA	NA
Cations/Anions											
Calcium	NA	NA	NA	NA	0.9	20	NA	NA	1	4	NA
Chloride	230,000	230,000	230,000	230,000	7	100	NA	NA	NA	NA	NA
Magnesium	NA	NA	NA	NA	0.3	5	NA	NA	0.2	2	NA
Potassium	NA	NA	NA	NA	60	200	NA	NA	10	40	NA
Sodium	NA	NA	NA	NA	20	200	NA	NA	5	40	NA
Sulfate	NA	NA	NA	NA	4	200	NA	NA	NA	NA	NA
Metals/Metalloids[d]											
Aluminum	1200[e]	NA	87	87	0.2	4	NA	NA	0.6	2	NA
Antimony	NA	NA	NA	NA	0.02	0.05	2	EPA BTAG	0.02	0.05	0.0008
Arsenic	150	190	150	150	0.09	0.5	9.79	EPA BTAG	0.06	0.5	0.002
Barium	NA	NA	NA	NA	0.002	0.05	NA	NA	0.02	0.05	NA
Beryllium	NA	NA	NA	NA	0.005	0.02	NA	NA	0.006	0.02	NA
Cadmium	0.53[e]	0.77[e]	0.19[e]	0.77[e]	0.008	0.02	0.99	EPA BTAG	0.007	0.02	0.00007
Chromium	53[e]	128[e]	53[e]	53[e]	0.03	0.2	43.4	EPA BTAG	0.06	0.2	0.0004
Cobalt	NA	NA	NA	NA	0.006	0.02	50	EPA BTAG	0.006	0.02	NA
Copper	6.4[e]	8.1[e]	6.4[e]	6.4[e]	0.05	0.1	31.6	EPA BTAG	0.04	0.1	0.0005
Iron	1,000	NA	1,000	1,000	0.3	1	20000	EPA BTAG	2	8	NA
Lead	1.6[e]	1.6[e]	1.6[e]	1.6[e]	0.006	0.02	35.8	EPA BTAG	0.02	0.05	0.0005
Manganese	NA	NA	NA	NA	0.006	0.2	460	EPA BTAG	0.02	0.05	NA
Mercury	NA	NA	NA	NA	NA	NA	0.18	EPA BTAG	0.002	0.02	NA
Nickel	37[e]	112[e]	37[e]	37[e]	0.04	0.2	22.7	EPA BTAG	0.03	0.2	0.0003
Selenium	1.5-3.1	5	5	5	0.2	1	2	EPA BTAG	0.09	1	NA
Silver	NA	NA	NA	NA	0.009	0.02	1	EPA BTAG	0.004	0.02	NA
Thallium	NA	NA	NA	NA	0.008	0.02	NA	NA	0.004	0.02	NA
Vanadium	NA	NA	NA	NA	0.05	0.2	NA	NA	0.03	0.2	NA
Zinc	84[e]	74[e]	84[e]	74[e]	0.5	2	121	EPA BTAG	0.2	0.5	0.0003

Table A7-1. Analyte Detection Limits, Reporting Limits, and Criteria

	Porewater						Sediment				
	Ecological Screening Criteria for Water										
Analyte	Chronic EPA AWQC (µg/L)	Ecology Chronic WQS (µg/L)	CCT Aquatic Life Chronic Criteria (µg/L)[a]	STI Aquatic Life Chronic Criteria (µg/L)[b]	MDL (µg/L)[c]	MRL (µg/L)[c]	Toxicity Benchmark Value (mg/kg dw)	Toxicity Benchmark Value Source	MDL (mg/kg dw)[c]	MRL (mg/kg dw)[c]	SEM-AVS MDL (µmol/g dw)
PCBs[f]											
PCB 1 (2-Chlorobiphenyl)	NA	NA	NA	NA	NA	NA	NA	NA	0.0021	0.005	NA
PCB 101 (2,2',4,5,5'-Pentachlorobiphenyl)	NA	NA	NA	NA	NA	NA	NA	NA	0.00026	0.0005	NA
PCB 105 (2,3,3',4,4'-Pentachlorobiphenyl)	NA	NA	NA	NA	NA	NA	NA	NA	0.00012	0.0005	NA
PCB 110 (2,3,3',4',6-Pentachlorobiphenyl)	NA	NA	NA	NA	NA	NA	NA	NA	0.00016	0.0005	NA
PCB 114 (2,3,4,4',5-Pentachlorobiphenyl)	NA	NA	NA	NA	NA	NA	NA	NA	0.00012	0.0005	NA
PCB 118 (2,3',4,4',5-Pentachlorobiphenyl)	NA	NA	NA	NA	NA	NA	NA	NA	0.000095	0.0005	NA
PCB 119 (2,3',4,4',6-Pentachlorobiphenyl)	NA	NA	NA	NA	NA	NA	NA	NA	0.00016	0.0005	NA
PCB 123 (2',3,4,4',5-Pentachlorobiphenyl)	NA	NA	NA	NA	NA	NA	NA	NA	0.00012	0.0005	NA
PCB 126 (3,3',4,4',5-Pentachlorobiphenyl)	NA	NA	NA	NA	NA	NA	NA	NA	0.00017	0.0005	NA
PCB 128 (2,2',3,3',4,4'-Hexachlorobiphenyl)	NA	NA	NA	NA	NA	NA	NA	NA	0.00009	0.0005	NA
PCB 132 (2,2',3,3',4,6'-Hexachlorobiphenyl)	NA	NA	NA	NA	NA	NA	NA	NA	0.00012	0.0005	NA
PCB 138 (2,2',3,4,4',5'-Hexachlorobiphenyl)	NA	NA	NA	NA	NA	NA	NA	NA	0.00018	0.0005	NA
PCB 141 (2,2',3,4,5,5'-Hexachlorobiphenyl)	NA	NA	NA	NA	NA	NA	NA	NA	0.000096	0.0005	NA
PCB 149 (2,2',3,4',5',6-Hexachlorobiphenyl)	NA	NA	NA	NA	NA	NA	NA	NA	0.00014	0.0005	NA
PCB 151 (2,2',3,5,5',6-Hexachlorobiphenyl)	NA	NA	NA	NA	NA	NA	NA	NA	0.00012	0.0005	NA
PCB 153 (2,2',4,4',5,5'-Hexachlorobiphenyl)	NA	NA	NA	NA	NA	NA	NA	NA	0.00013	0.0005	NA
PCB 156 (2,3,3',4,4',5-Hexachlorobiphenyl)	NA	NA	NA	NA	NA	NA	NA	NA	0.00012	0.0005	NA
PCB 157 (2,3,3',4,4',5'-Hexachlorobiphenyl)	NA	NA	NA	NA	NA	NA	NA	NA	0.00013	0.0005	NA
PCB 158 (2,3,3',4,4',6-Hexachlorobiphenyl)	NA	NA	NA	NA	NA	NA	NA	NA	0.000073	0.0005	NA
PCB 166 (2,3,4,4',5,6-Hexachlorobiphenyl)	NA	NA	NA	NA	NA	NA	NA	NA	0.00014	0.0005	NA
PCB 167 (2,3',4,4',5,5'-Hexachlorobiphenyl)	NA	NA	NA	NA	NA	NA	NA	NA	0.00016	0.0005	NA
PCB 168 (2,3',4,4',5',6-Hexachlorobiphenyl)	NA	NA	NA	NA	NA	NA	NA	NA	0.00014	0.0005	NA
PCB 169 (3,3',4,4',5,5'-Hexachlorobiphenyl)	NA	NA	NA	NA	NA	NA	NA	NA	0.0002	0.0005	NA
PCB 170 (2,2',3,3',4,4',5-Heptachlorobiphenyl)	NA	NA	NA	NA	NA	NA	NA	NA	0.00014	0.0005	NA
PCB 174 (2,2',3,3',4,5,6'-Heptachlorobiphenyl)	NA	NA	NA	NA	NA	NA	NA	NA	0.00011	0.0005	NA
PCB 177 (2,2',3,3',4',5,6-Heptachlorobiphenyl)	NA	NA	NA	NA	NA	NA	NA	NA	0.00016	0.0005	NA
PCB 18 (2,2',5-Trichlorobiphenyl)	NA	NA	NA	NA	NA	NA	NA	NA	0.00022	0.0005	NA
PCB 180 (2,2',3,4,4',5,5'-Heptachlorobiphenyl)	NA	NA	NA	NA	NA	NA	NA	NA	0.00011	0.0005	NA
PCB 183 (2,2',3,4,4',5',6-Heptachlorobiphenyl)	NA	NA	NA	NA	NA	NA	NA	NA	0.00014	0.0005	NA
PCB 184 (2,2',3,4,4',6,6'-Heptachlorobiphenyl)	NA	NA	NA	NA	NA	NA	NA	NA	0.00015	0.0005	NA
PCB 187 (2,2',3,4',5,5',6-Heptachlorobiphenyl)	NA	NA	NA	NA	NA	NA	NA	NA	0.00016	0.0005	NA
PCB 189 (2,3,3',4,4',5,5'-Heptachlorobiphenyl)	NA	NA	NA	NA	NA	NA	NA	NA	0.000095	0.0005	NA
PCB 194 (2,2',3,3',4,4',5,5'-Octachlorobiphenyl)	NA	NA	NA	NA	NA	NA	NA	NA	0.00018	0.0005	NA
PCB 195 (2,2',3,3',4,4',5,6-Octachlorobiphenyl)	NA	NA	NA	NA	NA	NA	NA	NA	0.00011	0.0005	NA

Table A7-1. Analyte Detection Limits, Reporting Limits, and Criteria

	Porewater						Sediment				
	Ecological Screening Criteria for Water										
Analyte	Chronic EPA AWQC (µg/L)	Ecology Chronic WQS (µg/L)	CCT Aquatic Life Chronic Criteria (µg/L)[a]	STI Aquatic Life Chronic Criteria (µg/L)[b]	MDL (µg/L)[c]	MRL (µg/L)[c]	Toxicity Benchmark Value (mg/kg dw)	Toxicity Benchmark Value Source	MDL (mg/kg dw)[c]	MRL (mg/kg dw)[c]	SEM-AVS MDL (µmol/g dw)
PCBs (continued)[f]											
PCB 201 (2,2',3,3',4,5',6,6'-Octachlorobiphenyl)	NA	NA	NA	NA	NA	NA	NA	NA	0.00016	0.0005	NA
PCB 203 (2,2',3,4,4',5,5',6-Octachlorobiphenyl)	NA	NA	NA	NA	NA	NA	NA	NA	0.00013	0.0005	NA
PCB 206 (2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl)	NA	NA	NA	NA	NA	NA	NA	NA	0.00014	0.0005	NA
PCB 209 (Decachlorobiphenyl)	NA	NA	NA	NA	NA	NA	NA	NA	0.00022	0.0005	NA
PCB 28 (2,4,4'-Trichlorobiphenyl)	NA	NA	NA	NA	NA	NA	NA	NA	0.00022	0.0005	NA
PCB 31 (2,4',5-Trichlorobiphenyl)	NA	NA	NA	NA	NA	NA	NA	NA	0.000098	0.0005	NA
PCB 33 (2',3,4-Trichlorobiphenyl)	NA	NA	NA	NA	NA	NA	NA	NA	0.00026	0.0005	NA
PCB 37 (3,4,4'-Trichlorobiphenyl)	NA	NA	NA	NA	NA	NA	NA	NA	0.00017	0.0005	NA
PCB 44 (2,2',3,5'-Tetrachlorobiphenyl)	NA	NA	NA	NA	NA	NA	NA	NA	0.00017	0.0005	NA
PCB 49 (2,2',4,5'-Tetrachlorobiphenyl)	NA	NA	NA	NA	NA	NA	NA	NA	0.00013	0.0005	NA
PCB 5 (2,3-Dichlorobiphenyl)	NA	NA	NA	NA	NA	NA	NA	NA	0.000092	0.0005	NA
PCB 52 (2,2',5,5'-Tetrachlorobiphenyl)	NA	NA	NA	NA	NA	NA	NA	NA	0.0002	0.0005	NA
PCB 56 (2,3,3',4'-Tetrachlorobiphenyl)	NA	NA	NA	NA	NA	NA	NA	NA	0.00012	0.0005	NA
PCB 60 (2,3,4,4'-Tetrachlorobiphenyl)	NA	NA	NA	NA	NA	NA	NA	NA	0.00013	0.0005	NA
PCB 66 (2,3',4,4'-Tetrachlorobiphenyl)	NA	NA	NA	NA	NA	NA	NA	NA	0.00019	0.0005	NA
PCB 70 (2,3',4',5-Tetrachlorobiphenyl)	NA	NA	NA	NA	NA	NA	NA	NA	0.00014	0.0005	NA
PCB 74 (2,4,4',5-Tetrachlorobiphenyl)	NA	NA	NA	NA	NA	NA	NA	NA	0.00018	0.0005	NA
PCB 77 (3,3',4,4'-Tetrachlorobiphenyl)	NA	NA	NA	NA	NA	NA	NA	NA	0.0002	0.0005	NA
PCB 8 (2,4'-Dichlorobiphenyl)	NA	NA	NA	NA	NA	NA	NA	NA	0.00029	0.0005	NA
PCB 81 (3,4,4',5-Tetrachlorobiphenyl)	NA	NA	NA	NA	NA	NA	NA	NA	0.00018	0.0005	NA
PCB 87 (2,2',3,4,5'-Pentachlorobiphenyl)	NA	NA	NA	NA	NA	NA	NA	NA	0.00011	0.0005	NA
PCB 90 (2,2',3,4',5-Pentachlorobiphenyl)	NA	NA	NA	NA	NA	NA	NA	NA	0.00018	0.0005	NA
PCB 95 (2,2',3,5',6-Pentachlorobiphenyl)	NA	NA	NA	NA	NA	NA	NA	NA	0.00014	0.0005	NA
PCB 97 (2,2',3',4,5-Pentachlorobiphenyl)	NA	NA	NA	NA	NA	NA	NA	NA	0.000093	0.0005	NA
PCB 99 (2,2',4,4',5-Pentachlorobiphenyl)	NA	NA	NA	NA	NA	NA	NA	NA	0.00028	0.0005	NA
Aroclor 1016	NA	NA	NA	NA	NA	NA	NA	NA	0.0021	0.01	NA
Aroclor 1221	NA	NA	NA	NA	NA	NA	NA	NA	0.0021	0.02	NA
Aroclor 1232	NA	NA	NA	NA	NA	NA	NA	NA	0.0021	0.01	NA
Aroclor 1242	NA	NA	NA	NA	NA	NA	NA	NA	0.0021	0.01	NA
Aroclor 1248	NA	NA	NA	NA	NA	NA	NA	NA	0.0021	0.01	NA
Aroclor 1254	NA	NA	NA	NA	NA	NA	0.23	LAET	0.0021	0.01	NA
Aroclor 1260	NA	NA	NA	NA	NA	NA	0.138	LAET	0.0021	0.01	NA
Total PCBs	NA	NA	NA	NA	NA	NA	0.0598	TEC	NA	NA	NA

Table A7-1. Analyte Detection Limits, Reporting Limits, and Criteria

	Porewater						Sediment				
	Ecological Screening Criteria for Water										
Analyte	Chronic EPA AWQC (µg/L)	Ecology Chronic WQS (µg/L)	CCT Aquatic Life Chronic Criteria (µg/L)[a]	STI Aquatic Life Chronic Criteria (µg/L)[b]	MDL (µg/L)[c]	MRL (µg/L)[c]	Toxicity Benchmark Value (mg/kg dw)	Toxicity Benchmark Value Source	MDL (mg/kg dw)[c]	MRL (mg/kg dw)[c]	SEM-AVS MDL (µmol/g dw)
PAHs[f]											
2-Methylnaphthalene	NA	NA	NA	NA	NA	NA	0.469	LAET	0.00039	0.005	NA
Acenaphthene	NA	NA	NA	NA	NA	NA	1.06	SQS	0.00076	0.005	NA
Acenaphthylene	NA	NA	NA	NA	NA	NA	0.47	SQS	0.00059	0.005	NA
Anthracene	NA	NA	NA	NA	NA	NA	0.0572	TEC	0.00058	0.005	NA
Benzo(a)anthracene	NA	NA	NA	NA	NA	NA	0.108	TEC	0.00072	0.005	NA
Benzo(a)pyrene	NA	NA	NA	NA	NA	NA	0.15	TEC	0.00076	0.005	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA	11	SQS	0.00092	0.005	NA
Benzo(ghi)perylene	NA	NA	NA	NA	NA	NA	4.02	SQS	0.00085	0.005	NA
Benzo(k)fluoranthene	NA	NA	NA	NA	NA	NA	11	SQS	0.00087	0.005	NA
Chrysene	NA	NA	NA	NA	NA	NA	0.166	TEC	0.0008	0.005	NA
Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA	NA	0.033	TEC	0.0008	0.005	NA
Fluoranthene	NA	NA	NA	NA	NA	NA	0.423	TEC	0.00098	0.005	NA
Fluorene	NA	NA	NA	NA	NA	NA	0.0774	TEC	0.00061	0.005	NA
Indeno[1,2,3-cd]pyrene	NA	NA	NA	NA	NA	NA	4.12	SQS	0.00087	0.005	NA
Naphthalene	NA	NA	NA	NA	NA	NA	0.176	TEC	0.0006	0.005	NA
Phenanthrene	NA	NA	NA	NA	NA	NA	0.204	TEC	0.0014	0.005	NA
Pyrene	NA	NA	NA	NA	NA	NA	0.195	TEC	0.00076	0.005	NA
Total PAHs	NA	NA	NA	NA	NA	NA	1.61	TEC	0.00039	0.005	NA
Pesticides[f]											
2,4'-DDD	NA	NA	NA	NA	NA	NA	NA	NA	0.00011	0.001	NA
2,4'-DDE	NA	NA	NA	NA	NA	NA	NA	NA	0.00011	0.001	NA
2,4'-DDT	NA	NA	NA	NA	NA	NA	NA	NA	0.00014	0.001	NA
4,4'-DDD	NA	NA	NA	NA	NA	NA	0.096	LAET	0.0001	0.001	NA
4,4'-DDE	NA	NA	NA	NA	NA	NA	0.021	LAET	0.000085	0.001	NA
4,4'-DDT	NA	NA	NA	NA	NA	NA	0.019	LAET	0.000078	0.001	NA
Aldrin	NA	NA	NA	NA	NA	NA	NA	NA	0.000056	0.001	NA
alpha-BHC	NA	NA	NA	NA	NA	NA	NA	NA	0.000064	0.001	NA
alpha-Chlordane (cis-)	NA	NA	NA	NA	NA	NA	NA	NA	0.000063	0.001	NA
beta-BHC	NA	NA	NA	NA	NA	NA	NA	NA	0.00018	0.001	NA
cis-Nonachlor	NA	NA	NA	NA	NA	NA	NA	NA	0.00049	0.001	NA
delta-BHC	NA	NA	NA	NA	NA	NA	0.091	Tier 2 ESG	0.00007	0.001	NA
Dieldrin	NA	NA	NA	NA	NA	NA	0.0019	TEC	0.000083	0.001	NA
Endosulfan I	NA	NA	NA	NA	NA	NA	0.00203	Tier 2 ESG	0.00006	0.001	NA
Endosulfan II	NA	NA	NA	NA	NA	NA	0.0098	Tier 2 ESG	0.000091	0.001	NA
Endosulfan sulfate	NA	NA	NA	NA	NA	NA	NA	NA	0.000051	0.001	NA

Table A7-1. Analyte Detection Limits, Reporting Limits, and Criteria

	Porewater						Sediment				
	Ecological Screening Criteria for Water										
Analyte	Chronic EPA AWQC (µg/L)	Ecology Chronic WQS (µg/L)	CCT Aquatic Life Chronic Criteria (µg/L)[a]	STI Aquatic Life Chronic Criteria (µg/L)[b]	MDL (µg/L)[c]	MRL (µg/L)[c]	Toxicity Benchmark Value (mg/kg dw)	Toxicity Benchmark Value Source	MDL (mg/kg dw)[c]	MRL (mg/kg dw)[c]	SEM-AVS MDL (µmol/g dw)
Pesticides[f] (continued)											
Endrin	NA	NA	NA	NA	NA	NA	0.00222	TEC	0.000057	0.001	NA
Endrin aldehyde	NA	NA	NA	NA	NA	NA	NA	NA	0.000061	0.001	NA
Endrin ketone	NA	NA	NA	NA	NA	NA	NA	NA	0.000076	0.001	NA
gamma-BHC (Lindane)	NA	NA	NA	NA	NA	NA	0.00237	TEC	0.000051	0.001	NA
gamma-Chlordane (trans-)	NA	NA	NA	NA	NA	NA	NA	NA	0.000072	0.001	NA
Heptachlor	NA	NA	NA	NA	NA	NA	NA	NA	0.000055	0.001	NA
Heptachlor epoxide	NA	NA	NA	NA	NA	NA	0.00247	TEC	0.00023	0.001	NA
Hexachlorobenzene	NA	NA	NA	NA	NA	NA	NA	NA	0.00018	0.001	NA
Hexachlorobutadiene	NA	NA	NA	NA	NA	NA	NA	NA	0.00053	0.001	NA
Methoxychlor	NA	NA	NA	NA	NA	NA	0.0133	Tier 2 ESG	0.00015	0.001	NA
Oxychlordane	NA	NA	NA	NA	NA	NA	NA	NA	0.00068	0.001	NA
Total Chlordane	NA	NA	NA	NA	NA	NA	0.00324	TEC	NA	NA	NA
Total DDD	NA	NA	NA	NA	NA	NA	0.00488	TEC	NA	NA	NA
Total DDE	NA	NA	NA	NA	NA	NA	0.00316	TEC	NA	NA	NA
Total DDT	NA	NA	NA	NA	NA	NA	0.00416	TEC	NA	NA	NA
Total DDDx	NA	NA	NA	NA	NA	NA	0.00528	TEC	NA	NA	NA
Toxaphene	NA	NA	NA	NA	NA	NA	0.07	Tier 2 ESG	0.014	0.05	NA
trans-Nonachlor	NA	NA	NA	NA	NA	NA	NA	NA	0.00053	0.001	NA

Notes:

[a] Water Quality Standards Regulations: Confederated Tribes of the Colville Reservation (CCT) (USEPA 1989)

[b] Water Quality Standards Regulations: Spokane Tribe of Indians (STI) (USEPA 2013)

[c] Nondetected values will be reported to the method detection limit (MDL). Results between the MDL and the method reporting limit (MRL) will be reported as estimated values (i.e., "J" qualified). MDLs and MRLs for porewater and sediment provided by ALS Environmental in Kelso, Washington.

[d] Water samples are analyzed for dissolved metals and sediment samples are analyzed for total metals.

[e] Criteria are hardness dependent and are calculated using the mean values from the Ecology (2006) surface water data; mean hardness = 66.89 mg/L (range 58.3 to 77.3 mg/L). Criterion for aluminum (USEPA 2018) is hardness, pH, and dissolved organic carbon (DOC) dependent; value shown assumes pH = 8.11 and DOC = 1 mg/L.

[f] Analyte lists for organic chemical analyses are from the 2010 Upper Columbia River screening-level ecological risk assessment (TAI 2010).

AWQC - Ambient Water Quality Criteria

BHC - Beta-hexachlorocyclohexane

DDD - dichlorodiphenyldichloroethane

DDE - dichlorodiphenyldichloroethylene

DDT - dichlorodiphenyltrichloroethane

DDDx - sum of 2,4′-DDD, 4,4′-DDD, 2,4′-DDE, 4,4′-DDE, 2,4′-DDT, and 4,4′-DDT

EPA BTAG - EPA Region III Biological Technical Assistance Group (BTAG) freshwater sediment screening benchmarks (USEPA 2006c)

LAET - lowest apparent effects threshold, developed by the Washington Department of Ecology (Ecology 2003)

Table A7-1. Analyte Detection Limits, Reporting Limits, and Criteria

	Porewater						Sediment				
	Ecological Screening Criteria for Water										
Analyte	Chronic EPA AWQC (µg/L)	Ecology Chronic WQS (µg/L)	CCT Aquatic Life Chronic Criteria (µg/L)[a]	STI Aquatic Life Chronic Criteria (µg/L)[b]	MDL (µg/L)[c]	MRL (µg/L)[c]	Toxicity Benchmark Value (mg/kg dw)	Toxicity Benchmark Value Source	MDL (mg/kg dw)[c]	MRL (mg/kg dw)[c]	SEM-AVS MDL (µmol/g dw)

NA - not applicable

PAH - polycyclic aromatic hydrocarbon

PCB - polychlorinated biphenyl

SEM-AVS - simulatneously extracted metal minus acid volatile sulfide

SQS - sediment quality standards developed by the Washington Department of Ecology (Ecology 2003).

TEC - threshold effect concentration (MacDonald et al. 2000). Adopted by CCT and STI.

Tier 2 ESG - equilibrium partitioning sediment guidelines (ESG) for the protection of aquatic life, developed by the EPA for the National Sediment Quality Survey (USEPA 2004). ESGs were derived using the equilibrium partition coefficient method and the chronic ambient water quality criteria (AWQC). The ESGs were developed for nonionic organic chemicals and are dependent on the total organic carbon content (TOC). Using a site-specific organic carbon fraction (TOC% = 0.7%, mean of USEPA [2006d] sediment TOC data) the draft ESGoc can be expressed as a dry-weight sediment-specific value: ESG = (ESGoc)x(TOC).

WQS - water quality standard

Table A7-2. Analytes and Methods for Sediment and Porewater Samples

Analyte	Sample Preparation		Quantitative Analysis	
	Protocol	Procedure	Protocol	Procedure
Sediment Samples				
Total metals: aluminum (Al), antimony (Sb), arsenic (As), barium (Ba), beryllium (Be), cadmium (Cd), chromium (Cr), cobalt (Co), copper (Cu), lead (Pb), manganese (Mn), nickel (Ni), selenium (Se), silver (Ag), thallium (Tl), vanadium (V), and zinc (Zn)	EPA 3050B	acid digestion	EPA 6020A [a]	ICP/MS
Total metals: calcium (Ca), iron (Fe), magnesium (Mg), potassium (K), and sodium (Na)	EPA 3050B	acid digestion	EPA 6010C	ICP/AES
Mercury (total)	EPA 7471B	acid digestion	EPA 7471B	cold vapor AA
SEM-AVS [b]	NA	NA	EPA 6010C/SEM-AVS	ICP/AES
TOC	NA	NA	ASTM D4129-05	coulometric
Grain Size	NA	NA	ASTM D422	gravimetric
Pesticides	EPA 3546	microwave extraction	EPA 8081B LL	GC/ECD
PAHs	EPA 3546	microwave extraction	EPA 8270D SIM	GC/MS
PCB congeners	EPA 3546	microwave extraction	8082A-Cong	GC/ECD
PCB aroclors	EPA 3546	microwave extraction	8082A-LL	GC/ECD
Porewater Samples				
Dissolved metals: aluminum (Al), antimony (Sb), arsenic (As), barium (Ba), beryllium (Be), cadmium (Cd), chromium (Cr), cobalt (Co), copper (Cu), iron (Fe)[c], lead (Pb), manganese (Mn), nickel (Ni), selenium (Se), silver (Ag), thallium (Tl), vanadium (V), and zinc (Zn)	EPA CLP MET-DIG	acid digestion	EPA 6020A	ICP/MS
Dissolved metals: calcium (Ca), iron (Fe)[c], magnesium (Mg), potassium (K), and sodium (Na)	EPA CLP MET-DIG	acid digestion	EPA 6010C	ICP/AES
TOC and DOC	NA	NA	EPA 9060A	coulometric
Alkalinity as $CaCO_3$	NA	NA	SM 2320 B	titration
Hardness as $CaCO_3$	NA	NA	SM 2340C	calculated
Chloride, sulfate	NA	NA	EPA 300.0	ion chromatography
Sulfide			SM 4500-S2 D	coulometric

Notes:

42-day *H. azteca* bioassay tests will be performed on select sediment samples; bioassay testing is not listed in this table. Sediment and porewater samples generated from replicate chambers during bioassay tests will be analyzed following the methods listed above, as appropriate.

[a] If a metal concentration exceeds linear range of the inductively coupled plasma/mass spectrometry (ICP/MS) instrument, then that metal may be analyzed using inductively coupled plasma/atomic emission spectrometry (ICP/AES), if appropriate.

[b] Simultaneously extracted metals (SEM) analyses will be conducted for eight metals: Sb, As, Cd, Cr, Cu, Pb, Ni, and Zn.

[c] Dissolved iron will be analyzed using ICP/AES (EPA 6010C) for porewater samples collected from in-situ sediment via Trident probe and for bioassay laboratory-generated porewater samples that are prepared using centrifugation. Dissolved iron will be analyzed using ICP/MS (EPA 6020A) for bioassay laboratory-generated porewater samples that are prepared using peepers.

AA - atomic absorption
$CaCO_3$ - calcium carbonate
DOC - dissolved organic carbon
GC/ECD - gas chromatography/electron capture detector
GC/MS - gas chromatography/mass spectrometry
NA - not applicable
PAH - polycyclic aromatic hydrocarbon
PCB - polychlorinated biphenyl
SEM-AVS - simulatneously extracted metal minus acid volatile sulfide
SM - Standard Methods for the Examination of Water and Wastewater
TOC - total organic carbon

Table A7-3. Summary of Phase 3 Sampling Design

Location	Primary Data Use	Secondary Data Uses	Sample Design	Target Strata	Primary Sample Locations	Alternate Sample Locations	Media Sed	Media PW	Media BMI	Comments
Deadman's Eddy AOI	Characterize nature and magnitude of risks posed to benthic organisms through exposure to contaminated sediment and porewater using sediment quality triad (SQT)	- Characterize chemical and physical properties of surface sediment and porewater - Estimate proportion of sediment facies that exceed effects concentration or other benchmark - Refine sediment composition maps	Stratified random	Sampleable sand	21	21	X	X	X	Bioassay testing performed on select samples
				Mixed coarse	6	6	X	X	X	
				Mud	0	0				No mud mapped in area of interest (AOI)
				Coarse	6	6		X		
		- Evaluate relationship between historical and Phase 3 results	Biased	Resample	2	NA	X	X	X	Bioassay testing performed on both samples
China Bend AOI	Characterize nature and magnitude of risks posed to benthic organisms through exposure to contaminated sediment and porewater using SQT	- Characterize chemical and physical properties of surface sediment and porewater - Estimate proportion of sediment facies that exceed effects concentration or other benchmark - Refine sediment composition maps	Stratified random	Sampleable sand	12	12	X	X	X	Bioassay testing performed on select samples
				Mixed coarse	6	6	X	X	X	
				Mud	5	5	X	X	X	Bioassay testing performed on select samples
				Coarse	6	6		X		
		TBD	Judgmental	Sampleable sand	2	2	X	X	X	Two primary judgmental and two alternate judgmental sample locations were added at China Bend AOI as requested by EPA. These locations are not statistically determined.
		- Evaluate relationship between historical and Phase 3 results	Biased	Resample	2	0	X	X	X	Bioassay testing performed on both samples
Evans AOI	Characterize nature and magnitude of risks posed to benthic organisms through exposure to contaminated sediment and porewater using SQT	- Characterize chemical and physical properties of surface sediment and porewater - Estimate proportion of sediment facies that exceed effects concentration or other benchmark - Refine sediment composition maps	Stratified random	Sampleable sand	21	21	X	X	X	Bioassay testing performed on select samples
				Mixed coarse	6	6	X	X	X	
				Mud	5	5	X	X	X	Bioassay testing performed on select samples
				Coarse	6	6		X		
		- Evaluate relationship between historical and Phase 3 results	Biased	Resample	2	0	X	X	X	Bioassay testing performed on both samples
Reference	Reference comparisons		Random - Genelle and Birchbank	Sampleable sand	18	0	X	X	X	Bioassay testing performed on all samples
			Biased (resample) - Lower Arrow Lake							

Notes:

BMI - benthic macroinvertebrate community
NA - not applicable
PW - porewater
Sed - surface sediment
TBD - to be determined

Sediment Target Analytes, Tests, and Measurements:

- Target analysis list (TAL) metals
- Percent slag by back scatter electron microscopy (BSEM) (10% sampleable sand sample locations)
- Grain size
- Total organic carbon (TOC)
- Simultaneously extracted metals (SEM)
- Acid volatile sulfides (AVS)
- 42-day sediment bioassays using the freshwater amphipod H. azteca (select samples)
- Organic chemicals (polychlorinated biphenyls [PCBs], polycyclic aromatic hydrocarbons [PAHs], pesticides) [1]

Porewater Target Analytes, Tests, and Measurements:

- Dissolved metals, including major cations
- Major anions (chloride, sulfate)
- Alkalinity
- Sulfide (if field data indicate need)
- TOC and dissolved organic carbon (DOC)
- pH

BMI Community Measurements:

- BMI species
- BMI abundance, by species
- Physical location attributes

[1] Initially, only reference area samples will be analyzed. However, aliquots from potential bioassay sample locations (sampleable sand and mud strata samples) will be archived frozen and may be analyzed for organic chemicals at a later date if needed

Table B1-1. Sampling Locations

Area	Location ID	Primary, Alternate, or Repeat	Sample Type(s)	EPA Split Sample Type(s)	Target Stratum	Target Facies	Facies Elevation (ft amsl)	Elevation Class	X_UTM_11N (meters)	Y_UTM_11N (meters)
China Bend	CB001	A	PW	NS	coarse	B	1,209.6	< 1220	429350	5407271
China Bend	CB002	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,245.0	1220 to 1250	429476	5407452
China Bend	CB003	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,244.6	1220 to 1250	429512	5407456
China Bend	CB004	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,218.3	< 1220	429499	5407408
China Bend	CB005	P	SE, PW, BMI	SE, PW	mixed coarse	mCs	1,154.8	< 1220	429458	5407331
China Bend	CB006	P	SE, PW, TX, BMI	NS	sampleable sand	S	1,230.1	1220 to 1250	429540	5407412
China Bend	CB007	P	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,262.4	> 1250	429567	5407464
China Bend	CB008	P	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,241.3	1220 to 1250	429571	5407441
China Bend	CB009	P	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,259.0	> 1250	429612	5407449
China Bend	CB010	A	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,236.0	1220 to 1250	429625	5407436
China Bend	CB011	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,216.0	< 1220	429626	5407406
China Bend	CB012	P	SE, PW, TX, BMI	PW	sampleable sand	S	1,211.9	< 1220	429602	5407385
China Bend	CB013	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,167.6	< 1220	429563	5407352
China Bend	CB014	P	SE, PW, TX, BMI	TX	sampleable sand	S	1,165.0	< 1220	429614	5407338
China Bend	CB015	A	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,238.1	1220 to 1250	429682	5407421
China Bend	CB016	P	SE, PW, TX, BMI	PW	sampleable sand	mFs	1,218.9	< 1220	429676	5407402
China Bend	CB017	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,169.3	< 1220	429667	5407336
China Bend	CB018	P	SE, PW, TX, BMI	NS	sampleable sand	S	1,220.1	1220 to 1250	429706	5407381
China Bend	CB019	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,176.8	< 1220	429705	5407323
China Bend	CB020	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,219.2	< 1220	429734	5407361
China Bend	CB021	P	SE, PW, TX, BMI	NS	mud	M	1,243.9	1220 to 1250	429793	5407363
China Bend	CB022	P	SE, PW, TX, BMI	NS	sampleable sand	S	1,210.2	< 1220	429779	5407320
China Bend	CB023	A	SE, PW, TX, BMI	NS	mud	M	1,250.5	> 1250	429802	5407350
China Bend	CB024	P	SE, PW, TX, BMI	NS	mud	M	1,224.9	1220 to 1250	429796	5407334
China Bend	CB025	A	SE, PW, TX, BMI	NS	mud	M	1,261.7	> 1250	429813	5407352
China Bend	CB026	A	SE, PW, TX, BMI	NS	mud	M	1,228.8	1220 to 1250	429808	5407329
China Bend	CB027	P	SE, PW, TX, BMI	NS	mud	M	1,211.9	< 1220	429798	5407317
China Bend	CB028	A	SE, PW, TX, BMI	NS	mud	M	1,228.8	1220 to 1250	429805	5407315
China Bend	CB029	P	SE, PW, TX, BMI	TX	mud	M	1,252.5	> 1250	429831	5407316
China Bend	CB030	A	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,216.1	< 1220	429847	5407267
China Bend	CB031	P	SE, PW, TX, BMI	TX	sampleable sand	mFs	1,210.2	< 1220	429858	5407245
China Bend	CB032	P	SE, PW, BMI	NS	mixed coarse	mCs	1,230.9	1220 to 1250	430023	5407204
China Bend	CB033	A	PW	NS	coarse	B	1,198.8	< 1220	430005	5407105
China Bend	CB034	A	SE, PW, BMI	NS	mixed coarse	mCs	1,208.2	< 1220	430149	5407087
China Bend	CB035	P	SE, PW, BMI	NS	mixed coarse	mCs	1,219.8	< 1220	430354	5407156
China Bend	CB036	A	SE, PW, BMI	NS	mixed coarse	mCs	1,217.7	< 1220	430428	5407112

Table B1-1. Sampling Locations

Area	Location ID	Primary, Alternate, or Repeat	Sample Type(s)	EPA Split Sample Type(s)	Target Stratum	Target Facies	Facies Elevation (ft amsl)	Elevation Class	X_UTM_11N (meters)	Y_UTM_11N (meters)
China Bend	CB037	A	SE, PW, BMI	NS	mixed coarse	mCs	1,221.2	1220 to 1250	430494	5407113
China Bend	CB038	P	SE, PW, BMI	NS	mixed coarse	mCs	1,222.0	1220 to 1250	430548	5407140
China Bend	CB039	P	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,223.1	1220 to 1250	430647	5407204
China Bend	CB040	A	SE, PW, BMI	NS	mixed coarse	mCs	1,217.4	< 1220	430614	5407244
China Bend	CB041	P	PW	PW	coarse	C	1,226.2	1220 to 1250	430770	5407127
China Bend	CB042	A	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,225.6	1220 to 1250	430687	5407216
China Bend	CB043	P	PW	NS	coarse	C	1,223.1	1220 to 1250	430661	5407260
China Bend	CB044	P	SE, PW, TX, BMI	NS	mud	M	1,260.0	> 1250	430625	5407342
China Bend	CB045	A	SE, PW, TX, BMI	NS	mud	M	1,260.0	> 1250	430633	5407349
China Bend	CB046	P	SE, PW, BMI	NS	mixed coarse	mCs	1,225.8	1220 to 1250	430802	5407336
China Bend	CB047	P	SE, PW, TX, BMI	SE, PW, TX	sampleable sand	mFs	1,234.5	1220 to 1250	431007	5407422
China Bend	CB048	P	PW	NS	coarse	C	1,232.4	1220 to 1250	431088	5407419
China Bend	CB049	P	PW	NS	coarse	C	1,229.9	1220 to 1250	431255	5407342
China Bend	CB050	P	SE, PW, BMI	NS	mixed coarse	mCs	1,219.1	< 1220	431274	5407406
China Bend	CB051	A	PW	NS	coarse	C	1,230.3	1220 to 1250	431430	5407509
China Bend	CB052	P	PW	NS	coarse	C	1,220.5	1220 to 1250	431601	5407515
China Bend	CB053	A	PW	NS	coarse	mBs	1,246.5	1220 to 1250	431803	5407542
China Bend	CB054	A	SE, PW, BMI	NS	mixed coarse	mCs	1,213.3	< 1220	431812	5407633
China Bend	CB055	P	PW	NS	coarse	C	1,226.8	1220 to 1250	431792	5407692
China Bend	CB056	A	SE, PW, BMI	NS	mixed coarse	mCs	1,226.2	1220 to 1250	432089	5407732
China Bend	CB057	A	PW	NS	coarse	mBs	1,224.2	1220 to 1250	432092	5407831
China Bend	CB058	A	PW	NS	coarse	C	1,232.7	1220 to 1250	432202	5408183
China Bend	JS001	P	SE, PW, BMI	NS	sampleable sand	S	1,238.7	1220 to 1250	430966	5407512
China Bend	JS002	P	SE, PW, BMI	NS	sampleable sand	S	1,248.1	1220 to 1250	431069	5407578
China Bend	JS003	A	SE, PW, BMI	NS	sampleable sand	S	1,245.2	1220 to 1250	431014	5407540
China Bend	JS004	A	SE, PW, BMI	NS	sampleable sand	S	1,242.3	1220 to 1250	430969	5407554
Deadman's Eddy	DM001	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,261.1	NA	445961	5421205
Deadman's Eddy	DM002	P	SE, PW, TX, BMI	NS	sampleable sand	S	1,261.1	NA	445978	5421211
Deadman's Eddy	DM004	A	SE, PW, BMI	NS	mixed coarse	mCs	1,259.7	NA	445998	5421196
Deadman's Eddy	DM005	A	SE, PW, BMI	NS	mixed coarse	mCs	1,257.9	NA	446028	5421170
Deadman's Eddy	DM006	A	SE, PW, BMI	NS	mixed coarse	mCs	1,257.1	NA	446038	5421153
Deadman's Eddy	DM007	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,257.9	NA	446069	5421183
Deadman's Eddy	DM008	P	SE, PW, TX, BMI	TX	sampleable sand	S	1,263.0	NA	446070	5421205
Deadman's Eddy	DM009	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,270.1	NA	446207	5421191
Deadman's Eddy	DM010	P	SE, PW, TX, BMI	SE, PW	sampleable sand	S	1,281.9	NA	446108	5421208
Deadman's Eddy	DM011	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,272.1	NA	446107	5421183

Table B1-1. Sampling Locations

Area	Location ID	Primary, Alternate, or Repeat	Sample Type(s)	EPA Split Sample Type(s)	Target Stratum	Target Facies	Facies Elevation (ft amsl)	Elevation Class	X_UTM_11N (meters)	Y_UTM_11N (meters)
Deadman's Eddy	DM012	A	SE, PW, BMI	NS	mixed coarse	mCs	1,255.8	NA	446097	5421153
Deadman's Eddy	DM013	P	SE, PW, BMI	NS	mixed coarse	mCs	1,254.1	NA	446086	5421137
Deadman's Eddy	DM014	P	SE, PW, BMI	NS	mixed coarse	mCs	1,254.1	NA	446099	5421135
Deadman's Eddy	DM015	P	SE, PW, TX, BMI	NS	sampleable sand	S	1,280.4	NA	446155	5421228
Deadman's Eddy	DM016	P	SE, PW, TX, BMI	NS	sampleable sand	S	1,278.4	NA	446172	5421158
Deadman's Eddy	DM017	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,248.1	NA	446183	5421064
Deadman's Eddy	DM018	P	SE, PW, TX, BMI	NS	sampleable sand	S	1,276.7	NA	446198	5421144
Deadman's Eddy	DM019	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,277.1	NA	446207	5421191
Deadman's Eddy	DM020	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,277.1	NA	446222	5421213
Deadman's Eddy	DM021	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,270.9	NA	446243	5421224
Deadman's Eddy	DM022	P	SE, PW, TX, BMI	NS	sampleable sand	S	1,280.7	NA	446234	5421155
Deadman's Eddy	DM023	P	SE, PW, TX, BMI	NS	sampleable sand	S	1,279.4	NA	446259	5421166
Deadman's Eddy	DM024	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,279.5	NA	446251	5421110
Deadman's Eddy	DM025	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,276.7	NA	446314	5421101
Deadman's Eddy	DM026	P	SE, PW, TX, BMI	PW, TX	sampleable sand	S	1,280.4	NA	446283	5421071
Deadman's Eddy	DM027	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,271.4	NA	446313	5421058
Deadman's Eddy	DM028	P	PW	PW	coarse	C	1,268.9	NA	446224	5420934
Deadman's Eddy	DM029	P	PW	NS	coarse	C	1,256.3	NA	446384	5420813
Deadman's Eddy	DM030	A	PW	NS	coarse	C	1,280.2	NA	446701	5420788
Deadman's Eddy	DM031	A	SE, PW, BMI	NS	mixed coarse	mCs	1,249.4	NA	446661	5420526
Deadman's Eddy	DM032	P	SE, PW, BMI	NS	mixed coarse	mCs	1,249.7	NA	446682	5420529
Deadman's Eddy	DM033	P	SE, PW, TX, BMI	NS	sampleable sand	S	1,254.1	NA	446708	5420531
Deadman's Eddy	DM034	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,254.4	NA	446666	5420469
Deadman's Eddy	DM035	P	SE, PW, TX, BMI	TX	sampleable sand	S	1,253.3	NA	446680	5420451
Deadman's Eddy	DM036	P	SE, PW, BMI	SE, PW	mixed coarse	mCs	1,250.2	NA	446699	5420445
Deadman's Eddy	DM037	A	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,268.5	NA	446729	5420368
Deadman's Eddy	DM038	A	SE, PW, BMI	NS	mixed coarse	mCs	1,261.5	NA	446761	5420448
Deadman's Eddy	DM039	P	SE, PW, BMI	NS	mixed coarse	mCs	1,266.3	NA	446769	5420444
Deadman's Eddy	DM040	P	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,274.9	NA	446779	5420425
Deadman's Eddy	DM041	A	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,272.8	NA	446770	5420396
Deadman's Eddy	DM042	P	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,270.7	NA	446791	5420341
Deadman's Eddy	DM043	A	PW	NS	coarse	C	1,268.3	NA	446770	5420319
Deadman's Eddy	DM044	P	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,271.0	NA	446790	5420320
Deadman's Eddy	DM045	A	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,271.9	NA	446842	5420282
Deadman's Eddy	DM046	A	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,275.6	NA	446852	5420275
Deadman's Eddy	DM047	P	SE, PW, BMI	NS	mixed coarse	mCs	1,271.4	NA	446818	5420448

Table B1-1. Sampling Locations

Area	Location ID	Primary, Alternate, or Repeat	Sample Type(s)	EPA Split Sample Type(s)	Target Stratum	Target Facies	Facies Elevation (ft amsl)	Elevation Class	X_UTM_11N (meters)	Y_UTM_11N (meters)
Deadman's Eddy	DM048	P	SE, PW, TX, BMI	TX	sampleable sand	mFs	1,271.1	NA	446869	5420366
Deadman's Eddy	DM049	A	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,263.6	NA	446884	5420360
Deadman's Eddy	DM050	P	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,265.3	NA	446892	5420322
Deadman's Eddy	DM051	P	SE, PW, TX, BMI	PW	sampleable sand	mFs	1,277.4	NA	446875	5420405
Deadman's Eddy	DM052	P	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,277.4	NA	446900	5420400
Deadman's Eddy	DM053	A	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,265.1	NA	446934	5420386
Deadman's Eddy	DM054	A	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,272.0	NA	446847	5420524
Deadman's Eddy	DM055	A	PW	NS	coarse	C	1,276.7	NA	446921	5420705
Deadman's Eddy	DM056	P	PW	NS	coarse	C	1,277.0	NA	446944	5420805
Deadman's Eddy	DM057	P	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,267.4	NA	447027	5420499
Deadman's Eddy	DM058	A	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,268.5	NA	447048	5420521
Deadman's Eddy	DM059	P	PW	NS	coarse	C	1,271.3	NA	447036	5420591
Deadman's Eddy	DM060	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,271.9	NA	447064	5420571
Deadman's Eddy	DM061	P	SE, PW, TX, BMI	NS	sampleable sand	S	1,276.4	NA	447098	5420650
Deadman's Eddy	DM062	P	PW	NS	coarse	C	1,279.8	NA	447178	5420949
Deadman's Eddy	DM063	P	PW	NS	coarse	C	1,280.6	NA	447314	5420971
Deadman's Eddy	DM064	A	PW	NS	coarse	C	1,264.6	NA	447310	5421145
Deadman's Eddy	DM065	A	PW	NS	coarse	C	1,254.0	NA	447367	5421140
Deadman's Eddy	DM066	P	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,256.2	NA	447409	5421290
Evans	EV001	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,202.5	< 1220	422463	5391534
Evans	EV002	P	SE, PW, TX, BMI	TX	sampleable sand	S	1,204.0	< 1220	422495	5391672
Evans	EV003	A	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,201.3	< 1220	422509	5391491
Evans	EV004	A	SE, PW, TX, BMI	NS	mud	M	1,255.9	> 1250	422575	5391868
Evans	EV005	P	SE, PW, TX, BMI	NS	sampleable sand	S	1,202.1	< 1220	422603	5391705
Evans	EV006	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,200.2	< 1220	422660	5391744
Evans	EV007	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,195.2	< 1220	422728	5391709
Evans	EV008	P	SE, PW, TX, BMI	NS	sampleable sand	S	1,198.4	< 1220	422708	5391653
Evans	EV009	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,201.7	< 1220	422679	5391573
Evans	EV010	P	SE, PW, TX, BMI	PW	sampleable sand	mFs	1,201.2	< 1220	422660	5391528
Evans	EV011	A	SE, PW, BMI	NS	mixed coarse	mCs	1,217.4	< 1220	422776	5391453
Evans	EV012	P	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,199.8	< 1220	422815	5391576
Evans	EV013	P	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,200.8	< 1220	422910	5391593
Evans	EV014	P	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,216.0	< 1220	422857	5391808
Evans	EV015	P	SE, PW, BMI	SE, PW	mixed coarse	mCs	1,201.2	< 1220	423086	5391612
Evans	EV016	A	SE, PW, BMI	NS	mixed coarse	mCs	1,203.4	< 1220	423197	5391663
Evans	EV017	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,201.4	< 1220	423187	5391741

Table B1-1. Sampling Locations

Area	Location ID	Primary, Alternate, or Repeat	Sample Type(s)	EPA Split Sample Type(s)	Target Stratum	Target Facies	Facies Elevation (ft amsl)	Elevation Class	X_UTM_11N (meters)	Y_UTM_11N (meters)
Evans	EV018	P	PW	NS	coarse	mBs	1,205.9	< 1220	423341	5391692
Evans	EV019	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,199.7	< 1220	423420	5391883
Evans	EV020	A	SE, PW, BMI	NS	mixed coarse	mCs	1,207.3	< 1220	423492	5391761
Evans	EV021	P	PW	NS	coarse	mBs	1,208.0	< 1220	423640	5391827
Evans	EV022	P	SE, PW, BMI	NS	mixed coarse	mCs	1,208.0	< 1220	423655	5391802
Evans	EV023	P	PW	NS	coarse	mBs	1,238.0	1220 to 1250	423866	5391829
Evans	EV024	P	PW	NS	coarse	C	1,257.0	> 1250	423911	5391844
Evans	EV025	A	PW	NS	coarse	mBs	1,203.0	< 1220	423743	5392072
Evans	EV026	P	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,206.7	< 1220	423832	5392159
Evans	EV027	P	SE, PW, TX, BMI	TX	sampleable sand	mFs	1,201.6	< 1220	423866	5392028
Evans	EV028	A	SE, PW, BMI	NS	mixed coarse	mCs	1,200.9	< 1220	423968	5392005
Evans	EV029	P	PW	NS	coarse	mBs	1,197.4	< 1220	424041	5392086
Evans	EV030	A	PW	NS	coarse	mBs	1,195.7	< 1220	424077	5392080
Evans	EV031	A	SE, PW, BMI	NS	mixed coarse	mCs	1,201.9	< 1220	424127	5392055
Evans	EV032	A	PW	NS	coarse	C	1,253.1	> 1250	424207	5391990
Evans	EV033	A	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,192.3	< 1220	424117	5392138
Evans	EV034	P	SE, PW, BMI	NS	mixed coarse	mCs	1,232.0	1220 to 1250	424297	5392053
Evans	EV035	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,196.2	< 1220	424189	5392225
Evans	EV036	P	SE, PW, BMI	NS	mixed coarse	mCs	1,232.7	1220 to 1250	424415	5392111
Evans	EV037	P	SE, PW, TX, BMI	SE, PW	sampleable sand	S	1,204.9	< 1220	424273	5392314
Evans	EV038	A	PW	NS	coarse	C	1,232.8	1220 to 1250	424510	5392190
Evans	EV039	A	SE, PW, BMI	NS	mixed coarse	mCs	1,201.4	< 1220	424508	5392336
Evans	EV040	A	PW	NS	coarse	mBs	1,211.4	< 1220	424602	5392305
Evans	EV041	P	PW	NS	coarse	mBs	1,209.0	< 1220	424691	5392415
Evans	EV042	P	SE, PW, BMI	NS	mixed coarse	mCs	1,201.5	< 1220	424768	5392626
Evans	EV043	A	PW	NS	coarse	mBs	1,204.4	< 1220	424735	5392717
Evans	EV044	P	SE, PW, TX, BMI	TX	mud	M	1,258.0	> 1250	424998	5392740
Evans	EV045	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,199.0	< 1220	424714	5392805
Evans	EV046	P	SE, PW, TX, BMI	NS	sampleable sand	S	1,269.9	> 1250	425232	5392896
Evans	EV047	A	SE, PW, TX, BMI	NS	mud	M	1,257.2	> 1250	425146	5392954
Evans	EV048	P	SE, PW, TX, BMI	NS	sampleable sand	S	1,182.5	< 1220	424638	5392930
Evans	EV049	P	SE, PW, BMI	NS	mixed coarse	mCs	1,210.6	< 1220	424694	5392956
Evans	EV050	A	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,214.3	< 1220	424726	5393028
Evans	EV051	P	SE, PW, TX, BMI	NS	sampleable sand	S	1,205.3	< 1220	424659	5393066
Evans	EV052	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,207.1	< 1220	424623	5393169
Evans	EV053	P	SE, PW, TX, BMI	NS	sampleable sand	S	1,206.5	< 1220	424702	5393228

Table B1-1. Sampling Locations

Area	Location ID	Primary, Alternate, or Repeat	Sample Type(s)	EPA Split Sample Type(s)	Target Stratum	Target Facies	Facies Elevation (ft amsl)	Elevation Class	X_UTM_11N (meters)	Y_UTM_11N (meters)
Evans	EV054	P	SE, PW, TX, BMI	NS	mud	M	1,259.9	> 1250	425060	5393189
Evans	EV055	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,203.0	< 1220	424633	5393349
Evans	EV056	A	SE, PW, TX, BMI	NS	mud	M	1,255.5	> 1250	424977	5393465
Evans	EV057	P	SE, PW, TX, BMI	NS	mud	M	1,258.0	> 1250	424823	5393493
Evans	EV058	P	SE, PW, TX, BMI	NS	sampleable sand	S	1,223.9	1220 to 1250	424681	5393481
Evans	EV059	P	SE, PW, TX, BMI	NS	sampleable sand	S	1,207.5	< 1220	424554	5393581
Evans	EV060	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,205.2	< 1220	424566	5393697
Evans	EV061	A	SE, PW, TX, BMI	NS	mud	M	1,256.6	> 1250	424911	5393737
Evans	EV062	P	SE, PW, TX, BMI	PW	sampleable sand	S	1,260.6	> 1250	425015	5393767
Evans	EV063	P	SE, PW, TX, BMI	PW	mud	M	1,256.1	> 1250	424892	5393901
Evans	EV064	P	SE, PW, TX, BMI	NS	mud	M	1,260.8	> 1250	424645	5393930
Evans	EV065	P	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,206.3	< 1220	424462	5393916
Evans	EV066	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,205.6	< 1220	424474	5393994
Evans	EV067	P	SE, PW, TX, BMI	NS	sampleable sand	S	1,211.6	< 1220	424537	5394017
Evans	EV068	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,216.5	< 1220	424557	5394086
Evans	EV069	P	SE, PW, TX, BMI	TX	sampleable sand	S	1,204.2	< 1220	424427	5394120
Evans	EV070	A	SE, PW, TX, BMI	NS	mud	M	1,260.2	> 1250	424984	5394215
Evans	EV071	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,197.3	< 1220	424445	5394262
Evans	EV072	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,204.7	< 1220	424378	5394308
Evans	EV073	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,204.4	< 1220	424343	5394388
Evans	EV074	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,224.5	1220 to 1250	424476	5394396
Evans	EV075	P	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,204.6	< 1220	424385	5394453
Evans	EV076	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,205.2	< 1220	424290	5394457
Birchbank - Lower	REF001	NA	SE, PW, TX, BMI	NS	mixed	na	NA	NA	447485	5445991
Birchbank - Lower	REF002	NA	SE, PW, TX, BMI	NS	sand	na	NA	NA	447480	5446078
Birchbank - Upper	REF003	NA	SE, PW, TX, BMI	PW	sand	na	NA	NA	447868	5446883
Birchbank - Upper	REF004	NA	SE, PW, TX, BMI	TX	mixed	na	NA	NA	447835	5446938
Genelle - Upper	REF005	NA	SE, PW, TX, BMI	NS	mixed	na	NA	NA	448553	5450152
Genelle - Upper	REF006	NA	SE, PW, TX, BMI	NS	mixed	na	NA	NA	448703	5450052
Genelle - Upper	REF007	NA	SE, PW, TX, BMI	TX	sand	na	NA	NA	448724	5450204
Genelle - Upper	REF008	NA	SE, PW, TX, BMI	NS	sand	na	NA	NA	448597	5450270
Genelle - Upper	REF009	NA	SE, PW, TX, BMI	NS	sand	na	NA	NA	448711	5450339
Genelle - Upper	REF010	NA	SE, PW, TX, BMI	NS	mixed	na	NA	NA	449186	5450484
Upstream of Genelle	REF011	NA	SE, PW, TX, BMI	SE, PW	sand	na	NA	NA	451247	5453302
Upstream of Genelle	REF012	NA	SE, PW, TX, BMI	NS	mixed	na	NA	NA	451453	5453402
Arrow Lake	REF013	NA	SE, PW, TX, BMI	NS	sand/mud	na	NA	NA	435361	5466488

Table B1-1. Sampling Locations

Area	Location ID	Primary, Alternate, or Repeat	Sample Type(s)	EPA Split Sample Type(s)	Target Stratum	Target Facies	Facies Elevation (ft amsl)	Elevation Class	X_UTM_11N (meters)	Y_UTM_11N (meters)
Arrow Lake	REF014	NA	SE, PW, TX, BMI	NS	sand/mud	na	NA	NA	435264	5466533
Arrow Lake	REF015	NA	SE, PW, TX, BMI	TX	sand/mud	na	NA	NA	435187	5466555
Arrow Lake	REF016	NA	SE, PW, TX, BMI	NS	sand/mud	na	NA	NA	418677	5492191
Arrow Lake	REF017	NA	SE, PW, TX, BMI	NS	sand/mud	na	NA	NA	418638	5492298
Arrow Lake	REF018	NA	SE, PW, TX, BMI	PW	sand/mud	na	NA	NA	418575	5492381
Deadman's Eddy	1-B5-NRT	R	SE, PW, TX, BMI	NS	NA	NA	NA	NA	446376	5421101
Deadman's Eddy	1-B6-NRT	R	SE, PW, TX, BMI	NS	NA	NA	NA	NA	446353	5421016
China Bend	3-R7-2019	R	SE, PW, TX, BMI	NS	NA	C	NA	NA	430299	5407152
China Bend	3-R8-2019	R	SE, PW, TX, BMI	NS	NA	B	NA	NA	429442	5407277
Evans	4-B1-2019	R	SE, PW, TX, BMI	NS	NA	S	NA	NA	424499	5393517
Evans	4-B6-2019	R	SE, PW, TX, BMI	NS	NA	bedrock	NA	NA	423102	5391739

Notes:

Primary judgmental (JS001 and JS002) and alternate judgmental (JS003 and JS004) sample locations were added to the China Bend area of interest (AOI) as requested by EPA.

A - alternate

BMI - benthic macroinvertebrate

na - not available

NA - not applicable

NS - not specified as an EPA split location by EPA

P - primary

PW - porewater

R - repeat

SE - sediment

TX - potential toxicity testing

Facies

M - mud (silt and clay, < 0.063 mm)

S - sand (0.063 mm – 2 mm)

B - boulder/cobble (> 64 mm)

mFs - mixed finer-grained, predominantly sand

mCs - mixed coarse, with sand

mBs - mixed boulder/cobble, with sand

C - coarse

Table B3-1. Sample Containers, Holding Times, Preservation, and Sample Quantity

Priority	Analysis	Container Type	Container Size	Filtered	Field Preservation	Holding Time	Minimum Laboratory Sample Size	Total Minimum Sample Size Needed [a, b, c]	Target Sample Size[d]
Part A. Bulk Sediment Analysis									
1	Total metals, percent moisture	WMG	8 oz	NA	4±2ºC			312 g	
1	EPA 6020A metals	WMG	8 oz	NA	4±2ºC	6 months	10 g	312 g	30 g
1	EPA 6010C metals	WMG	8 oz	NA	4±2ºC	6 months	10 g	312 g	30 g
2	Total mercury	WMG	8 oz	NA	4±2ºC	28 days	5 g	312 g	15 g
2	TOC	WMG	8 oz	NA	4±2ºC	28 days	1 g	312 g	3 g
2	SEM-AVS	WMG	8 oz	NA	no headspace; 4±2ºC	14 days	25 g	312 g	75g
3	Grain size	WMG	8 oz	NA	4±2ºC	6 months	100 g	312 g	300 g
3	Backscatter electron microscopy	WMG	16 oz	NA	4±2ºC	NA	TBD	312 g	TBD
4	Organic chemicals	WMG	8 oz (2x)	NA	4±2ºC	14 days or 1 year if frozen	161 g	312 g	483 g
Total sediment volumes for chemical/physical analysis			56 oz (1.4 L)				312 g		936 g
Part B. Benthic Macroinvertebrate Analysis									
1	Taxonomic enumeration and identification	HDPE	1.0 L or 5 gal bucket	NA	90% ethanol	1 month, transfer to 70% ethanol after 1 month for longer holding time	500 sort count	0.1 m^2 sediment area (10 L or 2.7 gal)	0.1 m^2 sediment area (10 L or 2.7 gal)
Part C. Sediment Bioassays									
1	42-day *H. azteca* bioassay	plastic	2 gal	NA	4±2ºC	ASAP[e]	2.5 L (0.7 gal)	20 L	5 L (1.4 gal)
2	TIE	plastic	5 gal	NA	4±2ºC	NA	19 L (5 gal)	20 L	19 L (5 gal)
Total sediment volumes for sediment bioassays							21.5 L (5.7 gal)		24 L (6.3 gal)
Part D. In situ Sediment Porewater									
Dissolved Metals									
1	EPA 6020A metals	HDPE	125 mL	field filtered	HNO_3 to pH<2; 4±2ºC	6 months	20 mL	190 mL	60 mL
1	EPA 6010C metals	HDPE	125 mL	field filtered	HNO_3 to pH<2; 4±2ºC	6 months	20 mL	190 mL	60 mL
1	Hardness[f]	NA	NA	NA	NA	NA	NA	190 mL	NA
Organic Carbon									
2	DOC	amber glass	125 mL	field filtered	4±2ºC; H_2SO_4 to pH < 2	28 days	40 mL	190 mL	80 mL
2	TOC	amber glass	125 mL	not filtered	4±2ºC; H_2SO_4 to pH < 2	28 days	40 mL	190 mL	80 mL
Conventional Parameters									
3	Alkalinity as $CaCO_3$	HDPE	125 mL	not filtered	4±2ºC	14 days	35 mL	190 mL	100 mL
3	Chloride, sulfate	HDPE	125 mL	not filtered	4±2ºC	28 days	10 mL	190 mL	100 mL
3	Sulfide (select locations only)[g]	HDPE	250 mL (holds up to 270 mL[g])	not filtered	No headspace, ZnAc, NaOH to pH>9; 4±2ºC	7 days	25 mL	190 mL	270 mL[g]
Total porewater volumes for analysis							190 mL		320 mL or 570 mL[h]

Table B3-1. Sample Containers, Holding Times, Preservation, and Sample Quantity

Priority	Analysis	Container Type	Container Size	Filtered	Field Preservation	Holding Time	Minimum Laboratory Sample Size	Total Minimum Sample Size Needed [a, b, c]	Target Sample Size[d]
Part E: Bioassay Laboratory-generated Sediment and Porewater									
Sediment									
1	SEM-AVS	WMG	4 oz	NA	< 80% full; nitrogen headspace; frozen[i]	14 days	25 g	26 g	75 g
	TOC					28 days	1 g		3 g
Centrifuge Porewater									
1	EPA 6020A metals	HDPE	125 mL	filtered	1 mL of 20% HNO_3, pH<2; 4±2ºC	6 months	20 mL	150 mL	60 mL
	EPA 6010 metals								
	Hardness	NA	NA	NA	NA	NA	NA		NA
2	DOC	amber glass	125 mL	filtered	4±2ºC; H_2SO_4 to pH < 2	28 days	40 mL		80 mL
3	Alkalinity as $CaCO_3$	HDPE	125 mL	not filtered	4±2ºC	14 days	35 mL	150 mL	100 mL
	Chloride, sulfate					28 days	10 mL		
	Sulfide	HDPE	40 mL		no headspace, ZnAc, NaOH to pH>9; 4±2ºC	7 days	25 mL		40 mL
Peeper Porewater									
1	EPA 6020A metals	HDPE	125 mL	filtered	See Pacific EcoRisk SOP (Appendix C)	6 months	20 mL[j]	20 mL	20 mL

Notes:

[a] Total sample size does not include additional sample volumes needed for laboratory quality control or field duplicate samples. If sufficient sample volume is available, attempt to fill all sample containers provided. If insufficient sample volume is available, fill containers to laboratory minimums in order of priority and then fill the priority containers with any remaining sample.

[b] Project field duplicate samples should be collected for 10 percent of all analytical sediment samples and 5 percent of porewater samples and submitted blind to the analytical laboratory. Due to potential limitations on availability of porewater, field duplicates for porewater will be by bottle (or by analysis), not by sample location. If required, EPA split sediment samples will also be collected.

[c] EPA split samples will be collected for sediment chemistry locations (5 percent), bioassay locations (4 L at 15 selected locations), and porewater locations (15 percent). Locations for sediment, bioassay, and porewater splits for metal analysis are identified in Table B1-1. EPA split sediment samples will be taken directly after collection of the primary sample for metal analysis and require a minimum of 20 g in an 8 oz glass jar (fill completely when possible). EPA split porewater samples will be taken directly after collection of the primary porewater sample for metal analysis and require a minimum of 30 ml in a 125 ml high density polyethylene (HDPE) container. In addition, at one sediment and one porewater EPA split location, aditional sample is required for laboratory analytical QA/QC purposes. The EPA split QA/QC sediment sample requires a full 8 oz jar of sediment while the EPA split QA/QC porewater sample requires a minimum of 50 ml porewater. Finally, one EPA split field duplicate sample will be taken for sediment and porewater at a location determined based on the ability to collect aliquots for both an EPA split and EPA split field duplicate.

[d] If target volume exceeds container size listed, additional containers will be filled.

[e] After review of preliminary data and TAI and EPA agree on samples for bioassays.

[f] Hardness will be calculated from dissolved metals results for calcium (Ca) and magnesium (Mg) per: equivalent calcium carbonate ($CaCO_3$) = 2.5 (mg Ca2+/L) + 4.1(mg Mg2+/L).

[g] At locations where sulfide analysis is deemed necessary based on field measurements, a 250-mL HDPE bottle will be filled with no headspace. The approximate volume of sample required to fill a 250-mL bottle with no headspace is 270 mL. See SOP-7 in Attachment A2 to the Field Sampling Plan. (QAPP Appendix A) for field measurement criteria for collecting samples for sulfide analysis.

[h] The total porewater volume required is either 320 mL or 590 mL, depending on necessity for sulfide analysis.

i In anticipation that the sediment sample volume may not always be sufficient to completely fill the 4 oz jar (as occurred during the Phase 2 Sediment Study [Windward 2017]), samples will be covered with nitrogen and frozen. Place the 4 oz sample jar in an 8 oz wide-mouth glass (WMG) jar and add nitrogen to the headspace before freezing the sample to provide secondary containment in case the 4 oz sample jar cracks.

[j] The volume of porewater prepared from peepers will be less than 20 mL See Pacific EcoRisk SOP (QAPP Appendix C) for details.

ASAP - as soon as possible
DOC - dissolved organic carbon
H_2SO_4 - sulfuric acid
HNO_3 - nitric acid
NA - not applicable
NaOH - sodium hydroxide
SEM-AVS - simulatneously extracted metal minus acid volatile sulfide
TBD - to be determined
TIE - Toxicity Identification Evaluation
TOC - total organic carbon
ZnAc - zinc acetate

Table B4-1. Number of Field-Collected Samples for Analytical Chemistry, Bioassay Measurements, and BMI

Sample Analysis	Media	Target Number of Field-Collected Samples [a]	Testing Laboratory
Analytical Chemistry			
Sediment	sediment	108	ALS
In situ porewater	porewater	126	ALS
Bioassay			
42-day *H. azteca*	sediment	74	PER
BMI			
Taxonomic ID	sediment	108	EcoAnalysts

Notes:

[a] Total number of samples does not include field duplicates or EPA split samples.

ALS - ALS Environmental

BMI - benthic macroinvertebrate

PER - Pacific EcoRisk

Table B4-2. Test Conditions for Conducting a 42-day Sediment Toxicity Test with *Hyalella azteca*

Parameter	Conditions
Test type	Whole-sediment toxicity test with renewal of overlying water
Temperature	23 ± 1°C
Test duration	42 days
Light quality	Wide-spectrum fluorescent lights
Illuminance	About 100 to 1,000 lux
Photoperiod	16L:8D
Test chamber	300-mL high-form lipless beaker
Sediment volume	100 mL
Overlying water	SAM-5S reconstituted water (Borgmann 1996) modified to contain 0.4 mg bromine/L
Overlying water volume	175 mL in the sediment exposure from Day 0 to Day 28
	270 mL for the water-only exposure from Day 28 to Day 42
Renewal of overlying water	2 intermittent volume additions/day (e.g., 1 volume addition every 12 hour)
Age of organisms[a]	7-to-8 days old at the start of the test with a goal of achieving starting weights in the range of 0.02 to 0.035 mg/organism. The weight of a representative sample of organisms at the start of sediment exposures will be documented.
Number of organisms/chamber	10
Number of replicate chambers/treatment	18 replicates: 12 for biological endpoints and 6 for chemistry only. Of the 12 replicates for biological endpoints, 4 replicates will be sacrificed for 28-day growth measurements and 8 replicates will be continued on with the water-only exposure for 35-day survival and reproduction and 42-day survival, growth, and reproduction.
Feeding[a]	YCT and fish flake food (e.g., Tetramin) according to the following schedule:
	YCT: 1.0 mL/beaker-day
	Flake fish food suspension:
	Week 1 – 0.25 mg/beaker-day Week 2 – 0.5 mg/beaker-day Week 3 – 1.0 mg/beaker-day Week 4 – 1.5 mg/beaker-day Week 5 – 2.0 mg/beaker-day Week 6 – 2.5 mg/beaker-day
Aeration	None, unless DO in overlying water drops below 2.5 mg/L.
Test chamber cleaning	If screens become clogged during a test, gently brush the *outside* of the screen.
Overlying water quality	Hardness, alkalinity, and ammonia at Day 0, 28, 35, and 42; temperature and DO daily; conductivity weekly; pH three times/week. Concentrations of DO should be measured more often if DO drops more than 1 mg/L since the previous measurement.
Endpoints	28-day survival, weight, and biomass; 35-day survival and reproduction; and 42-day survival, weight, biomass reproduction, and number of adult males and females on Day 42.
Test acceptability	Minimum mean control survival of 80% on Day 28.

Source: USEPA (2000)

Notes:

[a] The specified parameter is a project-specific condition that has been modified from EPA guidance USEPA (2000) based on discussions with EPA in advance of the Phase 2 sediment study (Windward 2017) and during bioassay webinars conducted to prepare for the Phase 3 sediment study (McCaig 2019).

DO = dissolved oxygen

YCT = yeast, cereal leaves, and Tetramin

Table B4-3. Test Acceptability Requirements for a 42-day Sediment Toxicity Test with *Hyalella azteca*

A.	**Test acceptability criteria**	
	1	Mean survival of *H. azteca* in the control sediment on Day 28 must be greater than or equal to 80%. The test will be repeated if this criterion is not met.
	2	Age of *H. azteca* at the start of the test should be 7-to-8 days old.
	3	All organisms in a test must be from the same source. If organisms are purchased, vendor information must be reported.
B.	**Performance goals**	
	1	Mean survival of *H. azteca* in the control sediment on Day 42 should be greater than or equal to 80%.
	2	Mean weight of *H. azteca* in the control sediment should be greater than or equal to 0.35 mg dry/individual on Day 28, and greater than or equal to 0.5 mg dry/individual on Day 42.
	3	Mean reproduction of *H. azteca* in the control sediment by Day 42 should be greater than or equal to 6.0 young per female.
	4	Hardness, alkalinity, and ammonia in the overlying water typically should not vary by more than 50% during the sediment exposure, and DO should be maintained above 2.5 mg/L in the overlying water.
	5	The daily mean test temperature should be within ±1°C of 23°C. The instantaneous temperature should be within ±3°C of 23°C.
C.	**Additional requirements**	
	1	Data from 96-hour water-only reference toxiciity tests will be used to assess genetic strain or life-stage sensitivity of test organisms to select chemicals.
	2	Initial dry weights of organisms should be determined and reported.
	3	All test chambers (and compartments) should be identical and should contain the same amount of sediment and overlying water.
	4	Standard negative-control sediment, quartz sand negative control sediment, and appropriate treatment controls (in toxicity identification evaluations) must be included in a test.
	5	Test organisms must be cultured and tested at 23°C (±1°C).
	6	Natural physio-chemical characteristics of test sediment collected from the field should be within the tolerance limits of the test organisms. (See USEPA [2000] for standard tolerance limits.)
	7	Source of overlying water and control sediments must be documented and reported.

Source: USEPA (2000) and ASTM (2019)

Notes:

EPA (2000) guidance uses the term test acceptability requirements, which includes criteria that must be met for a test to be considered acceptable and other criteria that should be met as a goal for conducting a good test. For the purposes of providing clear language for the Phase 3 sediment study and as was used in the Phase 2 sediment study, the two types of requirements are distinguished as follows: test acceptability criteria that must be met are referred to as criteria and those that should be met are referred to as performance goals.

DO - dissolved oxygen

Table B4-4. Estimated Number of Bioassay-Generated Samples for Analytical Chemistry

Media	Analyses	Number of Sediment Samples Tested	Number of Analytical Samples Generated at Different Times During Bioassays		
			Day 0	Day 7	Day 21
Sediment	AVS, SEM, TOC	70	70	0	70
Centrifuged Porewater	Anions (chloride, sulfate), alkalinity, DOC, dissolved metals [a] (including major cations), sulfide	70	70	0	0
Peeper Porewater	Dissolved metals [b]	70	0	70	70
			Sediment total		140
			Porewater total		210

Notes:

The estimated number of analytical samples does not include samples collected from laboratory control samples or from samples repeated in multiple test batches. TAI and EPA will decide on the batching design using preliminary data from the field-collected sediment and porewater samples. The actual number of bioassay-generated samples will be updated at that time.

[a] Dissolved metals include aluminum (Al), antimony (Sb), arsenic (As), barium (Ba), beryllium (Be), cadmium (Cd), chromium (Cr), cobalt (Co), copper (Cu), lead (Pb), manganese (Mn), nickel (Ni), selenium (Se), silver (Ag), thallium (Tl), vanadium (V), and zinc (Zn) by ICP/MS and calcium (Ca), iron (Fe), magnesium (Mg), potassium (K), and sodium (Na) by inductively coupled plasma/atomic emission spectrometry (ICP/AES).

[b] Dissolved metals include aluminum (Al), antimony (Sb), arsenic (As), barium (Ba), beryllium (Be), cadmium (Cd), chromium (Cr), cobalt (Co), copper (Cu), iron (Fe), lead (Pb), manganese (Mn), nickel (Ni), selenium (Se), silver (Ag), thallium (Tl), vanadium (V), and zinc (Zn) by inductively coupled plasma/mass spectrometry (ICP/MS).

AVS - acid volatile sulfide

DOC - dissolved organic carbon

SEM - simultaneously extracted metals

TOC - total organic carbon

Table B5-1. Measurement Quality Objectives for Sediment Samples

Parameter	Analytical Accuracy (% Recovery)	Analytical Precision (Relative % Difference)	Overall Completeness (%)
Metals	by analyte [a]	20	90
Mercury	72-128	20	90
TOC	70-125	20	90
AVS	60 - 115	45	90
SEM	75-125	30	90
Grain Size	NA	NA	90
PCBs	by analyte [a]	40	90
PAH	by analyte [a]	40	90
Pesticides	by analyte [a]	40	90

Notes:

Sample results will be evaluate using the current criteria at the time of analysis, which will be reported in the analytical data package.

[a] Acceptance limits for accuracy vary by compound/element and are subject to change as control limits are updated.

AVS - acid volatile sulfide

NA - not applicable

PAH - polycyclic aromatic hydrocarbons

PCB - polychlorinated biphenyl

SEM - simultaneously extracted metals

TOC - total organic carbon

Table B5-2. Measurement Quality Objectives for Porewater Samples

Parameter	Analytical Accuracy (percent recovery)	Analytical Precision (relative percent deviation)	Overall Completeness (percent)
TOC and DOC	83-117	17	90
Alkalinity as $CaCO_3$	90-110	20	90
Hardness as $CaCO_3$	NA	NA	90
Anions (chloride, sulfate)	90-110	20	90
Sulfide	85-106	20	90
Dissolved Metals, including cations	80-120	20	90

Notes:

CaCO3 - calcium carbonate

TOC - total organic carbon

DOC - dissolved organic carbon

NA - not applicable

Table B5-3. Measurement Quality Objectives for BMI Samples

Parameter	Accuracy	Precision	Completeness
Sampling	NA	record relative percent difference of total richness for field duplicate samples	≥80% successful collection for target number of grab samples
Sorting	• ≥90% of organisms removed from sorted material (100% of primary samples)	NA	sort all collected samples (minimum 500 individuals or all individuals in sample)
Taxonomic ID	• taxa count accuracy ≥90%. (10% of primary samples) • taxa ID accuracy ≥90%. (10% of primary samples) • individual ID accuracy ≥90%. (10% of primary samples)	NA	identify sorted individuals from all samples

Notes:

BMI - benthic macroinvertebrate

NA - not applicable

APPENDIX A

FIELD SAMPLING PLAN FOR THE 2019 PHASE 3 SEDIMENT STUDY

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ACRONYMS AND ABBREVIATIONS

ALS	ALS Environmental
AOI	area of interest
AVS	acid volatile sulfide
BERA	baseline ecological risk assessment
BMI	benthic macroinvertebrate
$CaCO_3$	calcium carbonate
CMA	Coastal Monitoring Associates
COC	chain-of-custody
DGPS	differential global positioning system
DI	deionoized
DO	dissolved oxygen
DOC	dissolved organic carbon
EPA	U.S. Environmental Protection Agency
FSP	field sampling plan
GIS	geographic information system
GPS	global positioning system
H_2SO_4	sulfuric acid
HDPE	high-density polyethylene
HNO3	nitric acid
ID	identification (number)
NAD83	North American Datum of 1983
NaOH	sodium hydroxide
NOAA	National Oceanic and Atmospheric Administration
ORP	oxidation reduction potential
OU	Operable Unit
PVDF	polyvinylidene fluoride
QA/QC	quality assurance and quality control
QAPP	quality assurance project plan
QC	quality control
RI/FS	remedial investigation and feasibility study
RM	river mile
SEM	simultaneously extracted metals
SEM-AVS	simultaneously extracted metals minus acid volatile sulfide

SHSP	site health and safety plan
Site	Upper Columbia River site
SOP	standard operating procedure
SQT	sediment quality triad
Study	2019 Phase 3 sediment study
TAI	Teck American Incorporated
TDS	total dissolved solids
TIE	toxicity identification evaluation
TOC	total organic carbon
UCR	Upper Columbia River
USCG	U.S. Coast Guard
USGS	U.S. Geological Survey
UTM	Universal Transverse Mercator
WMG	wide-mouth glass
ZnAc	zinc acetate

UNITS OF MEASURE

cm	centimeter(s)
cm/sec	centimeter(s) per second
°C	degree(s) Celsius
in.	inch(es)
ft	foot(feet)
ft^3	cubic foot(feet)
ft/sec	foot(feet) per second
g	gram(s)
gal	gallon(s)
kg	kilogram(s)
L	liter(s)
lb	pound
m	meter(s)
m^2	square meter(s)
m/sec	meter(s) per second
mg/L	milligram(s) per liter
mL	milliliter(s)
mm	millimeter(s)
mV	millivolts
oz	ounce(s)
µm	micrometer(s)

1 INTRODUCTION

This document presents the field sampling plan (FSP) for the 2019 Phase 3 sediment study (hereafter referred to as the "study") for the Upper Columbia River (UCR, hereafter the Site[1]). Information collected in this study will be used to support the remedial investigation and feasibility study (RI/FS) and baseline ecological risk assessment (BERA) being completed by Teck American Incorporated (TAI) under U.S. Environmental Protection Agency (EPA) oversight under an agreement between TAI and the EPA. EPA has designated the UCR from upstream of Marcus Flats at river mile (RM) 708 to the international border north of RM 744 as the Upper Reach Operable Unit (OU) (Map A1).

The objective of the Phase 3 sediment study is to characterize sediment and porewater conditions in three areas of interest (AOIs) in the Upper Reach OU such that an overall understanding of risk to benthic organisms and the nature and extent of contamination in this portion of the Site can be assessed. The three AOIs for this study are Deadman's Eddy, China Bend, and Evans[2] (Map A1).

Sampling activities will be completed at the three AOIs and at three upstream reference areas on the Columbia River in British Columbia. Field sampling activities include the collection of sediment, porewater, and benthic macroinvertebrate (BMI) samples. Sediment and BMI samples will be collected from vessels using mechanical grab samplers (Van Veen power grab and/or a device similar to a Hamon grab sampler, referred to herein as a modified Hamon grab sampler) or a freeze grab device. In situ sediment porewater samples will be collected in the field using a Trident probe.

The requirements for data collection activities presented in this FSP were developed in consultation with EPA.

1.1 OVERVIEW

This FSP describes field methods that will be used to collect sediment, porewater, and BMI[3] samples for the Phase 3 sediment study. The objective of the Phase 3 sediment study is to characterize sediment and porewater conditions in three AOIs in the Upper Reach OU such

[1] The UCR Site as defined within the June 2, 2006 Settlement Agreement is the areal extent of hazardous substances contamination within the United States in or adjacent to the Upper Columbia River, including the Franklin D. Roosevelt Lake, from the U.S.-Canada border to the Grand Coulee Dam, and those areas in proximity to the contamination that are suitable and necessary for implementation of response actions.

[2] The Evans AOI was originally identified as "Upstream of Marcus Flats."

[3] BMI samples will be obtained from sediment samples.

that an overall understanding of risk to benthic organisms and the nature and extent of contamination in this portion of the Site can be assessed. A sediment quality triad (SQT) approach incorporating multiple lines of evidence will be used. These lines of evidence consist of sediment and sediment porewater chemistry, whole sediment laboratory toxicity tests, and in situ BMI community.

Section 2 of this FSP describes field sampling procedures that will be followed. Section 3 describes procedures for field documentation. References cited in this document are listed in Section 4.

Attachments to this FSP are:

- **Attachment A1—General Site Health and Safety Plan (SHSP) Addendum.** Describes site-specific requirements and procedures to minimize the safety risk to personnel who carry out the field study program.[4]
- **Attachment A2—Standard Operating Procedures (SOPs).** Detailed field procedures to be used include
  - SOP-1 – Positioning at Below-Water Stations
  - SOP-2 – Positioning for Wadeable Sample Locations
  - SOP-3 – Van Veen Power Grab Sediment Sample Collection
  - SOP-4 – Modified Hamon Grab Sediment Sample Collection
  - SOP-5 – Freeze Grab Sediment Sample Collection
  - SOP-6 – Eckman, Cookie Cutter, or Scoop Grab Sediment Sample Collection
  - SOP-7 – Sediment Porewater Sampling
  - SOP-8 – Collecting and Preserving Benthic Macroinvertebrate Samples from Sediment
  - SOP-9 – Sample Labeling
  - SOP-10 – Field Documentation
  - SOP-11 – Sample Custody
  - SOP-12 – Sample Packaging and Shipping
  - SOP-13 – Digital Camera Use and Documentation Procedures
  - SOP-14 – Decontamination of Sediment Sampling Equipment

[4] Subcontractors that are contracted to perform field work associated with the RI/FS may adopt the general SHSP and this Addendum or develop and follow their own SHSPs; however, subcontractor SHSPs must be consistent with the provisions outlined in the Addendum and the general SHSP, and any discrepancies should follow the most protective practices.

  - SOP-15 – Boat Inspection and Cleaning for Aquatic Invasive Species
  - SOP-16 – Handling and Reporting of Cultural Resources.

- **Attachment A3—Examples of Various Field Forms.** Contains examples of various forms that will be used during field sampling; a chain-of-custody (COC) form; and sample labeling forms.
- **Attachment A4—Archaeological Monitoring Protocol.** Provides study-specific procedures to be followed if any archaeological objects or resources are discovered during sampling activities.

2 SAMPLE COLLECTION AND PROCESSING

This section describes procedures and methods that will be used during the field portion of the study, including sampling procedures, record keeping, sample handling, storage, and field quality control (QC) procedures. Sample collection and processing will be conducted in accordance with the SOPs, provided in Attachment A2. Depending on field conditions, procedures specified in the referenced SOPs may be modified if necessary, in consultation with EPA and documented in a Protocol Modification Form or Field Change Request Form (Attachment A3).

2.1 SAMPLING LOCATIONS

Sampling locations are within the three Upper Reach OU AOIs and at five upstream reference areas on the Columbia River in British Columbia (Map A1). BMI samples will be co-located with sediment samples but will be obtained from separate sediment grab sample attempts. Unless a location is designated as a porewater-only location, porewater sampling locations will be co-located with sediment sampling locations to the extent possible.

A list of AOI and reference sampling locations identified for this study is provided in Table A1, and station locations are illustrated on Maps A2 through A8. As designated within Table A1, sampling locations have been assigned a station-specific identification (ID) number, geographic coordinates (northing/easting), and sample type (sediment, porewater, BMI, and/or potential toxicity) for tests to be performed.

2.1.1 Upper Reach OU Areas of Interest

Sediment, porewater, and BMI samples will be collected from the three AOIs as indicated on Maps A2 through A4. Co-location of porewater samples with sediment and BMI samples is discussed within Section 2.2.2 of the FSP. Sampling locations are either random (statistically based), repeat (i.e., locations that were sampled during a previous investigation that are being sampled again for this study), or judgmental sampling locations (i.e., non-statistically based sampling locations at China Bend requested by EPA). Statistically based sampling locations within the AOIs were developed using sediment bed (facies) maps to define target strata for sampling. The four target strata are described below.

I. **Sampleable Sand**—Sediment containing more than 50 percent finer-grained sediments, and includes sand and mixed-fine facies classes (S and mFs). The sampleable sand stratum will be sampled for sediment chemical/physical properties, in situ porewater, and BMI. Sufficient volume for potential bioassay

testing will be obtained from sampling locations in this stratum, if possible. There are 21 primary sampling locations and up to 21 available alternate sampling locations in this stratum at Deadman's Eddy and Evans AOIs; at China Bend AOI, there are 12 primary and 12 alternate sampling locations. In addition, two primary judgmental and two alternate judgmental sample locations are present at the China Bend AOI as requested by EPA. A maximum of 10 alternate locations will be used at statistically derived and repeat sample locations. If refusals are encountered at judgmental locations, both alternate locations may be attempted. The excess number of alternate locations were identified to help ensure that a suitable alternate location could be identified in proximity to, and in the same elevation class as, the primary location where refusal is recorded. At China Bend and Evans AOIs, proposed sampling locations for this stratum are classified based on the riverbed elevation as either within the historical river channel (elevation less than 1,250 ft at China Bend AOI and elevation less than 1,220 ft at Evans AOI) or outside the historical river channel (elevation greater than 1,250 ft at China Bend AOI and elevation greater than 1,220 ft at Evans AOI).

II. **Mixed Coarse**—Sediment containing 50 percent to 20 percent finer-grained sediment and includes mixed-coarse facies classes (mCs). The mixed-coarse stratum will be sampled for sediment chemical/physical properties, in situ porewater, and BMI. There are six primary sampling locations and six alternate sampling locations in this stratum at each AOI.

III. **Mud**—Sediment containing sediment with more than 80 percent silt and clay (M). The mud stratum will be sampled for sediment chemical/physical properties, in situ porewater, and BMI. Sufficient volume for potential bioassay testing will be obtained from sampling locations in this stratum, if possible. There are five primary sampling locations and five alternate sampling locations in this stratum at China Bend and Evans AOIs. No mud was mapped at Deadman's Eddy AOI; therefore, this stratum is not targeted for sampling at Deadman's Eddy.

IV. **Coarse**—Coarse sediment having more than 50 percent boulder/cobble or more than 80 percent combined gravel plus boulder/cobble, and includes mixed boulder/cobble, and coarse facies classes (mBs, B, C, and G). The coarse stratum will be sampled for porewater only due to the low fine-grained sediment content and prevalence of coarse sediments (gravel and cobble), which would pose significant challenges for collecting sediment samples. There are six primary sampling locations and six alternate sampling locations in this stratum at each AOI.

In addition to the statistically based sampling locations in the four strata listed above, there are a total of six repeat sampling locations, with two at each AOI. Finally, the China Bend AOI also includes two judgmental samples as requested by EPA.

The total number of primary and repeat sampling locations at each AOI is as follows:

Deadman's Eddy AOI – 29 sediment and BMI locations, 35 porewater locations

China Bend AOI[5] – 25 sediment and BMI locations, 31 porewater locations

Evans AOI – 34 sediment and BMI locations, 40 porewater locations

All three AOIs – 88 sediment and BMI locations, 106 porewater locations.

Specific information on each sample location is provided in Table A1.

Previous studies conducted within the UCR have reported difficulty sampling sediment at below-water locations due to the mix of fine-grained sediment within larger sediment facies (gravel and cobble). Sediment facies maps for the AOIs indicate the presence of coarse material (i.e., gravel and boulder/cobble) throughout much of the AOIs, making refusal with a mechanical sampling method possible. Therefore, the sampleable sand stratum was established to preferentially focus sample collection on areas where mapped bed textures indicate a predominance of fine-grained (< 2 mm) material in surficial sediments. This will increase the likelihood of collecting samples in sand-dominated depositional features using mechanical sampling methods that can obtain sufficient sediment volume to support the required chemical and physical analyses and provide adequate volume for potential toxicity testing and BMI enumeration.

However, because the sampleable sand strata contains areas with up to 50 percent coarse material, refusal is still possible. Reasonable effort will be expended at each location (see Figure A1 for the sediment sampling protocol) to collect sediment, as needed, from the sampleable sand stratum. Mud and sand sediment facies are expected to be easily sampleable using a mechanical sample method, because these facies are predominantly composed of finer-grained sediments with < 20 percent coarse (i.e., gravel and boulder/cobble) content. Mixed-fines facies (mF), with 50 percent to 80 percent fine-grained sediment, may be sampleable using a mechanical sample method (i.e., Van Veen power or modified Hamon grab sampler) if the coarse sediment content is on the low end of this

[5] Two primary judgmental and two alternate judgmental sample locations were added at the China Bend AOI as requested by EPA and are not included in this sample count. These locations are not statistically-determined.

range. Mixed-coarse (mC) facies, with 20 to 50 percent fine-grained sediment, are expected to be sampleable using a freeze grab sample method (ERM 2019).

If individual sampling attempts at a location do not recover sufficient volume for planned physical or chemical analyses, those locations will be recorded as refusals, and sampling will be repeated at a suitable alternate (i.e., backup) location to ensure that the planned number of samples are collected in each AOI[6]. Up to 10 alternate locations for the sampleable sand stratum may be visited at each AOI[7]. If, after attempting mechanical grab samples at all primary and alternate locations, less than 21 successful sampleable sand samples have been obtained at Deadman's Eddy or Evans AOIs or less than 12 successful sampleable sand samples have been obtained at China Bend AOI, sampling locations will be revisited and a freeze grab sampler will be used to obtain enough sampleable sand samples to achieve a total of 21 (Deadman's Eddy and Evans AOIs) or 12 (Chain Bend AOI) successful sampleable sand samples at each AOI[8]. Six alternate locations are available at each AOI for the mixed-coarse stratum, and five alternate locations are available each at China Bend and Evans AOIs for the mud stratum.

2.1.2 Reference Areas

Eighteen reference sampling locations are proposed in three targeted areas on the Columbia River upstream of the UCR in British Columbia (Lower Arrow Lake and Genelle and Birchbank eddies) (Maps A5 through A8). These 18 locations are intended to be representative of the surficial riverbed substrates where fine sediment (< 2 mm) is predominant or mixed with coarse substrate. They were selected to capture the range of percent fines and total organic carbon (TOC) representative of available data from Site samples within the three AOIs to support both sediment bioassays and BMI community characterization. Reference samples will be collected from targeted riverine reference areas at Genelle and Birchbank Eddies between Trail and Castlegar, British Columbia, where the

[6] The two judgmental locations at China Bend AOI have their own alternate locations identified (Table A1). These alternate locations will only be attempted if refusals at primary judgmental locations occur. Attempts at judgmental alternate locations can occur regardless of the number attempted for statistically based and repeat sample locations.

[7] There are up to 21 alternate locations for sampleable sand at each AOI; however, only up to 10 alternate locations will be used. The excess number of alternate locations were identified to help ensure that a suitable alternate location could be identified in proximity to, and in same elevation class as, the primary location where refusal is recorded.

[8] Sediment samples obtained from freeze grab attempts will not be used for bioassay testing.

sand and mixed sediment facies are expected to occur (Maps A5 through A7). Mud sediment is expected to be very rare in this portion of the river.

Within these target areas, locations likely to have the sand and mixed-fine facies will be sampled. The locations will be a combination of previously sampled and new locations. Lacustrine reference area samples will also be collected near the Phase 2 sediment study external reference site locations in Lower Arrow Lake (Map A8). These samples had the greatest mud (silt and clay) content among all the samples collected at Phase 2 sediment study external reference site locations, and represent the lacustrine end of the hydraulic condition (similar to samples on the seasonally flooded and backwater zones at the Evans and China Bend AOIs).

The number of reference area sampling locations was selected to support the comparison of groups of BMI samples to a reference condition that includes sand and mixed-fine facies. Each of these facies should have six replicates in the reference distribution to be adequate for statistical inference testing. In addition, six sand samples will be collected from Lower Arrow Lake. Sampleable sand and mixed-fine stratum locations will be sampled using a mechanical grab device (Van Veen power grab or modified Hamon grab sampler).

2.2 FIELD SAMPLING METHODS

It is anticipated that at least four sampling teams and one shore-based team (for sample transport and logistics support) will be used to complete field sampling activities. Two sample vessels will be outfitted to collect sediment and two vessels will be outfitted to sample porewater. Sampling vessels will have a deck large enough to accommodate a minimum of three crew members in addition to the vessel's captain, one EPA oversight individual, and archaeological monitor (when required). In addition, it will have enough deck space to accommodate the sampling gear required to sample their respective medium (e.g., Van Veen power grab sampler, modified Hamon grab sampler, freeze grab sampler, Trident porewater sampler, glove box, Lexan tub, hand tools, decontamination materials, coolers, and multiple sampling boxes containing ancillary equipment). Vessels will include navigational lights, anchors, global positioning system (GPS) software, and a depth finder. Vessel operators will be familiar with the area and will have the capability to make headway and maneuver in the potentially turbulent, high-velocity waters of the UCR.

If very shallow water (e.g., < 1 m) or dry conditions are encountered at a sample location, and river conditions are favorable, sediment samples may be collected by wading or on land instead of from the sampling vessel (Attachment A2, SOPs 2 and 6).

2.2.1 Task Schedule

For improved safety and access conditions, sampling will be timed to occur when the reservoir is at or near high pool and low flow (approximately late August through October). Subject to EPA approval, field sampling is expected to begin in September 2019 (August if possible) and take approximately 5 weeks. Because of safety concerns regarding weather and freezing conditions, all sampling activities will be completed by November 1, 2019. Thirty days prior to field sampling activities, a detailed schedule will be prepared by the field sampling crew to facilitate planning and scheduling of EPA technical and cultural oversight.

2.2.2 Sampling Location Positioning

A differential global positioning system (DGPS)[9] and associated navigation system (e.g., Hypack marine navigation software or similar navigation software) will be used to locate and navigate to sampling locations listed in Table A1, whenever possible. Vessel navigation software will include uploaded geographic information system (GIS)-formatted point locations for all proposed sampling locations plus sediment facies map polygons for real-time display during navigation and sampling. The procedure for locating each sediment sample location by Universal Transverse Mercator (UTM) coordinates is detailed in SOP-1 (Attachment A2). The standard projection method to be used during field activities will be the horizontal datum of North American datum of 1983 (NAD83) and UTM Zone 11.

Upon arrival at a designated sampling location, the field sampling team leader will inspect the sediment bed composition using video and verify that the observed sediment bed appears consistent with the target strata (for locations at AOIs) or facies (for locations at reference areas) specified in the quality assurance project plan (QAPP) and in Table A1. If the sediment bed does not match the target stratum or facies, or if the location does not appear amenable to sample collection (e.g., due to presence of bedrock or large woody debris), then a suitable location will be identified using video. Field adjustments for AOI sampling locations can be moved anywhere within the contiguous target sediment facies; vessel position relative to sediment facies polygon will be monitored in real time using the navigation software, which will display DGPS position on a GIS-based sediment facies map. Reference area sampling locations should be moved no more than 50 m if possible; however, locations can be adjusted within the river reach, if necessary, based on field conditions. For sediment sampling, using mechanical grab methods, the sampling device

[9] If sampling is not performed from the vessel, a handheld GPS unit will be used to locate proposed sampling locations.

may be altered between attempts based on field observations as indicated in the sediment sampling hierarchy flowchart (Figure A1).

If very shallow water (e.g., < 1 m) is encountered at a sample location, and river conditions are favorable, the sample location may be accessed by wading instead of from the sampling vessel. Coordinates for wadeable sample locations will be uploaded onto handheld GPS units and the position of each sediment or porewater sample recorded using the GPS units. The procedure for locating each sampling location by foot using UTM coordinates is detailed in SOP-2 (Attachment A2).

It is important to note that the Cultural Resources Working Group in association with EPA must approve all UCR sampling locations prior to initiation of sampling activities, including the allowable distance for sample location adjustments away from the proposed sampling location. The proposed sediment sampling locations within the AOIs listed in Table A1 have been cleared by tribal and federal/state cultural resources coordinators in consultation with the UCR RI/FS Cultural Resources Working Group.

Co-Location of Porewater Samples

To the extent practicable, porewater samples from sampleable sand, mixed coarse, and mud strata at AOIs and at all reference area locations should be collected prior to the sediment sample or from an undisturbed sediment bed in proximity to the associated sediment sample collection location. Porewater samples will be collected at all primary sediment sampling locations at each AOI, regardless of whether sediment sampling is successful. Porewater samples will also be collected at any alternate locations where sediment samples are collected. For porewater, after three attempts, the field team leader will consult with the EPA oversight personnel to determine whether to move to an alternate location or perform additional sampling attempts.

2.2.3 Refusal and Alternate Locations

For sediment sample collection, at least one video-guided attempt must be made; up to three attempts may be necessary to obtain the required samples. As described in Section 2.1.1, if the attempts at an AOI sampling location is not possible or does not recover sufficient sediment volume for planned analyses, that location will be recorded as a refusal, and sampling will be repeated at a suitable alternate (i.e., backup) location to ensure that the planned number of samples are collected in each AOI. Up to 10 (out of the 21 available locations at Deadman's Eddy and Evans AOIs and 12 available locations at China Bend AOI) alternate locations for the sampleable sand stratum may be visited at each AOI. If, after attempting mechanical grab samples at all primary and 10 alternate locations, less than

21 successful sampleable sand samples have been obtained at Deadman's Eddy and Evans AOIs or less than 12 successful sampleable sand samples have been obtained at China Bend AOI, sampling locations will be revisited and a freeze grab sampler will be used to obtain enough sampleable sand samples to achieve a total of 21 (Deadman's Eddy and Evans AOIs) or 12 (China Bend AOI) successful sampleable sand samples at each AOI. A sampling methods hierarchy for the sampleable sand stratum is provided in Figure A1.

2.2.4 Field Equipment and Supplies

Minimum field equipment and supplies anticipated for this study include sampling equipment (e.g., Van Veen power grab/modified Hamon grab/freeze grab/Trident sampler), hand tools (e.g., mechanical stainless-steel paddle wheel mixer, scoops, shovel, sieve), scale or analytic balance, decontamination supplies, sample containers, coolers, shipping containers, cameras, field logs and forms (or electronic tablet), personal protective equipment (e.g., gloves, hard hat, and lifejacket), and personal gear. If personnel will be sampling at one of the designated handheld sampling stations, waders, handheld sampler, and portable first aid supplies will also be required (see SOPs 3 through 8 in Attachment A2 for details). Lists of field equipment necessary for each procedure are found in each SOP.

Sample containers, preservatives, filters, coolers, and packaging material for samples will be supplied by the analytical laboratory. Details on required sample volumes for sediment and field porewater are provided in Table A2 and discussed further in Section 2.2.5. Filters for use in collecting porewater samples for dissolved organic carbon (DOC) analysis will be lot-tested at the laboratory before use in the field (see Section 2.2.7). Deionized water for use in equipment decontamination and for collecting rinsate blank QC samples from equipment will either be provided by the laboratory or will be produced locally using a water deionization system.

2.2.5 Sample Collection Methods

This section describes sediment, porewater, and BMI sampling methods that will be implemented in the field. These methods are supported by SOPs and summarized in the following subsections. An example of a field form used to enter data is shown in Attachment A3.

Sediment and BMI Sample Collection

Sediment sample collection is described in SOPs 3 through 6. BMI sample collection will be performed concurrently with sediment sampling and is described in SOP-8. Because of different sample processing steps, BMI samples will be collected from sediment grabs that

are separate from grabs collected for sediment chemistry and bioassays (i.e., BMI samples cannot be collected from the same grab as sediment samples for analysis).

The general steps for sediment and BMI sample collection are as follows:

1. Deploy the decontaminated sampler at sampling station and record the GPS location.
2. Retrieve sampler and check grab sampler for sample acceptability. Photograph sediment in the sampler.
3. Measure penetration using method appropriate for the sampling device. Each method is described in detail in the applicable SOP.
    a. Van Veen power grab: measure from the top of the sample to the sediment surface and subtract this value from the total inside depth of sampler.
    b. Modified Hamon grab: observe penetration visually as the scoop passes through vertical using the underwater camera. Subtract the length of scoop above the sediment from the total scoop length below the frame to determine penetration.
    c. Freeze grab: Measure the average depth of the frozen sediment sample to determine penetration.
    d. Handheld sediment samplers: Measure the distance from the top of the sampler to the sediment interface and subtract this from the inside depth of the sampler. Estimate or measure the depth of scoop penetration for scoop sampling.
4. Confirm sample acceptance criteria are met. If acceptance criteria listed below and in the applicable SOP are not met, classify this sediment as rejected. Rejected sediment should be processed as described below and temporarily stored during attempts to collect accepted sediment.
5. Siphon water from sampler (if applicable), using care to not remove any BMI that may be present.
6. Collect sediment sample for acid volatile sulfide (AVS) and simultaneously extracted metals (SEM) testing. The sample jar for AVS and SEM analyses should be filled to minimize sediment exposure to air as follows:
    a. Place an excess of fine grained sediment into a re-sealable plastic bag using a decontaminated stainless steel spoon or other tool.

b. Squeeze out any air remaining from the bag and seal it.

c. Allow the archaeological monitor to inspect the sample.

d. If the sample passes cultural resources review, place the sediment into SEM-AVS sample jar by cutting a corner of the bag. The jar should be filled completely to minimize headspace and sealed tightly. Continue to the next sample collection step.

e. If the sample fails cultural resource review, proceed as described in Step 8 below at the direction of the archaeological monitor.

7. Deposit sediment into Lexan tub. For freeze grab samples, this will require thawing the sediment sample. For sediment samples used for collecting BMI samples, rinse the sampler using filtered river water pumped through a hose assembly to remove all material from the sampler.

8. Examine sediment for the presence of cultural resources. If the recovered sediment contains cultural resources, follow instructions from the archaeological monitor regarding what to do with the recovered sediment and cultural artifacts as well as whether to abandon the sampling station.

9. Characterize the sediment. A qualified person[10] will characterize the sediment, recording the following on the field data form:
   a. Sediment type and texture
   b. Color
   c. Presence/absence of black silica glass particles (based on vitreous, conchoidal fractures, and a translucent appearance); if present, estimate relative percent composition
   d. Presence/location/thickness of the redox potential boundaries (a visual indication of black is often adequate for documenting anoxia)
   e. Presence of biological structures (e.g., amphipods, tubes, macrophytes)
   f. Presence of debris (e.g., twigs, leaves)
   g. Presence of shells
   h. Stratification, if any

[10] A qualified person is either a Washington State Licensed Geologist (LG) or an engineer/scientist who has received Site-specific training in the following: 1) identification of sedimentary deposits of the Upper Columbia River basin, 2) recognition of amorphous silica-rich glass, 3) particle size and percentage estimation, 4) soil/sediment classification systems, and 5) recording of observations.

i. Presence of a sheen

j. Odor (e.g., hydrogen sulfide, oil, creosote).

Procedure for sediment samples for physical/chemical analysis and potential bioassay analysis

10. Evaluate and document sediment particle size. [11]
    a. Remove by hand large rocks and debris from sediments containing mostly fine particles.
    b. Press sediment through a 5-mm sieve if sediments contain large fractions of particles > 2 mm. Do not use river water to wash sediments through the sieve.
    c. Assess the sediment grain size (at least 25 percent must be ≤ 2 mm).
11. Homogenize sediment and photograph homogenized sediments.
12. Fill sediment sample containers.
    a. Fill all sediment containers for analytical chemistry, minimizing headspace.
    b. Fill appropriate decontaminated bioassay containers (e.g., 5-gal buckets with lids) with sediment.
    c. Add river water to bioassay sediment samples to create a thin water layer. This layer will minimize oxygenation during transit.

Procedure for BMI samples

13. Transfer sample material (scoop and pour) to a Lexan tub and rinse residual material from the inside of the grab sampler into the tub with pumped and filtered river water.
14. Pick out large gravel, cobble, and debris by hand, and carefully rinse with pumped and filtered river water so the attached BMI stays in the tub. Discard the rinsed large gravel and debris.
15. Fill BMI sample containers. After as much coarse gravel, cobble, and debris as possible is removed from the sample, carefully transfer all material retained in the tub into a pre-labeled 5-gal plastic sample container.

[11] If there is sufficient volume to perform analyses indicated in Table A2, sediment samples should be evaluated and homogenized as laid out in the steps 10 and 11, and retained for future analyses. The collection of these rejected sediments will allow some evaluation of the area, in case similar sampling difficulties are encountered at alternate locations.

16. Remove the water from the sample by pouring through a 250-µm sieve, and use a small amount of water to return any material retained on the sieve back into the sample container.
17. Preserve the sample with 90 percent ethanol. Do not fill containers more than two-thirds full. The volume of ethanol should be equal to the volume of sediment.

Procedures for sediment and BMI samples

18. Store all analytical chemistry samples in a cooler with ice.
19. Store BMI samples in a sturdy, waterproof container (such as a cooler).
20. Return any excess sediment to the river, decontaminate equipment (e.g., grab sampler, Lexan tub, mechanical stainless-steel paddle wheel mixer, sieves), and move to next sample station.
21. Store BMI samples. Upon arriving at the dock, transfer all sample containers into a refrigerated area where they can be stored until shipped.

Sediment Sampling Device Selection

Surface sediment samples will be collected from vessels using one of three decontaminated grab samplers (Van Veen power grab, modified Hamon grab, or freeze grab) see SOPs 3, 4, and 5 (Attachment A2). The Van Veen power grab and modified Hamon grab samplers are collectively referred to as "mechanical grab" samplers based on their method of operation. Mechanical grab samplers are preferable for use because they can provide a larger sediment volume per attempt than a freeze grab sampler; also, samples collected by mechanical grab samplers may be used for bioassay testing.

Van Veen Power Grab

The grab sampler has two doors on top to allow easy access to the sample for visual characterization and subsampling of undisturbed surface sediments. The interiors of the doors have screens to minimize disturbance of the sediment surface when the grab sampler is lowered to the bottom. Rubber flaps cover each screen as the grab sampler is retrieved to prevent disturbing the sediment sample as it is raised through the water column. The arms of the sampler are lengthened and arced to provide a stronger seal when the grab sampler is closed, thereby minimizing sample leakage when the grab sample is retrieved.

Modified Hamon Grab

The rectangular frame of the modified Hamon grab sampler provides support to a sampling bucket attached to a pivoted arm. Upon landing on sediment, the bucket will be driven through the sediment by a pneumatic arm that drives the sample bucket through the

sediment and onto an inclined rubber-covered steel plate, sealing the sample completely. While this device is known for its reliability, ease of use, and effectiveness in coarse substrates, potential drawbacks exist:

- Insufficient weight or refusal due to larger materials can cause the grab to "walk" by sliding the frame in the opposite direction of the bucket movement. The weight of the device (between 300 to 600 kg) helps to alleviate this issue but additional weight is sometimes added.
- Sample foreshortening (reduced penetration) occurs if the grab raises itself/walks during closure.
- Cobble is difficult to sample.
- The sampling bucket can collect a maximum of 0.1 m^2, providing between 10 to 12 L of sediment, which is a small sample size.

Freeze Grab

The freeze grab sampling device consists of a 12 in.-diameter metal pan with multiple 5-in.-long hollow rods protruding from the bottom to extract heat from the sediment. This pan will either penetrate the sediment under its own mass or due to mechanical force. A dry ice and methanol slurry will be used as the cooling agent. The dry ice is placed into the pan and the methanol is contained in a reservoir above the pan. The device is sealed and lowered to the sediment surface. Once the device penetrates the sediment, the methanol is released to initiate cooling and after approximately 5 to 10 minutes the device is retrieved with sediment frozen to the hollow rods and the bottom of the pan.

There are three targeted strata for sediment sample locations (sampleable sand, mixed coarse, and mud), which are composed of four sediment facies: S, mFs, mCs, and M (Figure A2). S and mFs facies comprise the "sampleable sand" stratum. Sampleable sand and mud (facies M) strata will be sampled using a mechanical sampler. Sediment samples in the mixed-coarse stratum (facies mCs) will only be sampled using a freeze grab device. However, as described in Section 2.2.3 and shown in Figure A1, use of a freeze grab device may be required to collect samples from the sampleable sand strata if the target number of 21 samples at Deadman's Eddy or Evans AOIs or 12 samples at China Bend AOI cannot be obtained using mechanical grab samplers.

All three samplers will be deployed using a hydraulic winch and an overhead davit or boom at a controlled rate of speed. The position of the grab samplers relative to the riverbed will be shown on the vessel's depth sounder, or alternatively will be determined by rigging the winch line to a meter wheel or using pre-marked meter lengths on the winch line itself.

Anticipated water depths at AOIs during the planned 2019 sampling event are shown in Maps A9 through A11. The preferred mechanical device (Van Veen power grab and modified Hamon grab sampler) for sampleable sand locations will be identified in advance by the field sampling crew leader based on the mapped sediment facies class (S or mFs). Underwater video will be used to help guide the sampling equipment to the intended sample location as well as to confirm that the sediment facies present at each location is consistent with the targeted sampling stratum (Table A1). Along with the sediment facies maps, observations of sediment facies type using the underwater video can be used to help determine the appropriate grab sampler and the specific locations at which to deploy samplers.

Sediment Sampling Devices used at Wadeable Locations

If very shallow water (e.g., < 1 m) or dry conditions are encountered at a sample location, a handheld sediment sampling device may be deployed by wading. Several handheld sampling methods are available (Eckman grab, cookie cutter grab, scoop grab). The field team leader, in consultation with the designated EPA advisor, will select a handheld sampling device, using professional judgement, which is expected to be the most successful for the observed substrate. Descriptions of each sampler are provided below.

Eckman Grab

The Eckman grab is ideal for sampling in soft non-cohesive sediment (i.e., silt and clay). The sampler consists of a steel box with hinging flaps on one end and spring-loaded jaws on another end. The device is lowered to the sediment surface on a rope, or could be mounted on a pole or placed by hand in shallow water. Once it is settled on the bottom, a messenger is sent down the rope and triggers the jaws to close, or if pole-mounted, the jaws are manually triggered to close.

Cookie Cutter Grab

This device is designed to be used by divers, but can also be deployed manually in shallow water. It consists of a steel box and a plate that can be used to close the bottom of the box manually. The box is driven into the sediment manually and then the sediment adjacent to one side of the box is excavated. Once excavated, the steel plate is inserted into slots on the bottom of the box and a sample is retained upon retrieval.

Scoop Grab

This technique consists of scooping sediment into a covered scoop on the end of a handle. The sediment is then put into a container and the operation repeated until sufficient sediment is retained. Care must be taken during this process to ensure that fine sediment does not escape from the scoop during retrieval. This method is suitable for collecting sediments at locations that are dry at the time of sampling.

Sample Acceptance Criteria

Each sediment sample attempt will be evaluated for acceptance criteria. Acceptance criteria for each potential sampling method are provided below.

Grab samples not meeting the acceptance criteria listed below will be 'rejected,' but will be temporarily held onboard while subsequent sampling drops attempt to obtain an 'accepted' sample (i.e., a sample meeting all the acceptance criteria). At the discretion of the field team leader, rejected sample materials may be temporarily placed in a decontaminated, transparent Lexan tub for cultural inspection, and the sampling steps repeated until an accepted sample has been obtained or until a decision is made that sampling using this equipment would not work at this location. Should subsequent sampling attempts also fail to meet the acceptance criteria, additional rejected samples will be placed in the same or separate Lexan tub. Field personnel will use their experience and professional judgement applying the acceptance criteria to identify accepted and rejected samples.

As acknowledged in Section 2.2.2 and illustrated in Maps A2 through A4, uncertainties such as the presence of unacceptably large grain sizes (> 2 mm) may adversely affect meeting the sample acceptance criteria. If all sampling attempts fail to meet the acceptance criteria, but prior to discarding all rejected sediments from this location, field personnel will (following inspection for cultural resources) assess the overall grain size distribution of rejected materials temporarily stored in the Lexan tub and photograph the collected materials. Field personnel will use their experience and professional judgement to evaluate the relative volume of fine-grained sediments (i.e., ≤ 2 mm). If there is sufficient volume to perform sediment chemistry and potential biological analyses as indicated in Table A2, sediment samples should be evaluated and homogenized, as described in the applicable SOPs, and collected for future laboratory analyses. The collection of these rejected sediments will allow some evaluation of the area if similar sampling difficulties are encountered at alternate locations.

Van Veen Power Grab Acceptance Criteria

Van Veen samples will be retrieved aboard the vessel and evaluated for the following acceptance criteria:

- The sampler is not overfilled with the sample to the point that the sediment surface presses against the top of the sampler or is extruded through the top of the sampler.
- Overlying water is present (indicating minimal leakage).
- The overlying water is not excessively turbid (indicating minimal disturbance of the interface or winnowing). Excessive turbidity is determined based upon observation of other samples and best professional judgement. Turbidity will vary in water overlying different matrices (i.e., water overlying fine silt will naturally be more turbid than water overlying coarse sand).
- The sediment surface is relatively undisturbed; the sediment-water interface is intact and relatively flat with no sign of channeling or sample washout.
- Adequate penetration depth (4 to 6 in.) is achieved.
- There is no sign of sediment loss (incomplete closure of the sampler, penetration at an angle, or tilting upon retrieval).
- The sample contains ≥ 20 percent fines (i.e., ≤ 2 mm).

Modified Hamon Grab Acceptance Criteria

As soon as the grab sampler is secured, open the doors on the top of the grab sampler, and inspect the sample for acceptability. The following acceptability criteria should be satisfied:

- The sampler is closed so that material cannot escape during retrieval.
- The sampler is not overfilled with the sample to the point that the sediment surface presses against the top of the sampler or is extruded through the top of the sampler.
- Overlying water is present (indicating minimal leakage).
- The desired penetration depth (4 to 6 in.) is achieved.
- There is no sign of sediment loss (incomplete closure of the sampler, penetration at an angle, or tilting upon retrieval).
- The sample contains ≥ 20 percent fines (i.e., ≤ 2 mm).

Freeze Grab Acceptance Criteria

After the freeze grab attempts a sediment sampling event, it will be lifted slowly off the bottom and then steadily raised to the surface at a speed of about 30 cm/sec. As soon as the grab sampler is secured, inspect the sample for acceptability. The following acceptability criteria should be satisfied:

- The sample surface is smooth or reflects the material collected and does not indicate that material was lost during retrieval.
- The desired penetration depth (4 to 6 in.) is achieved.

Wadeable Methods Acceptance Criteria

Wadeable methods include the Eckman grab, cookie cutter, and scoop. During collection, inspect each sample for acceptability as described below. Ideally, the following acceptability criteria should be satisfied (note that most of these criteria are not applicable to scoop sampling):

- The sampler is not overfilled with the sample to the point that the sediment surface presses against the top of the sampler or is extruded through the top of the sampler.
- Overlying water is present (indicating minimal leakage).
- The overlying water is not excessively turbid (indicating minimal disturbance of the interface or winnowing). Excessive turbidity is determined based upon observation of other samples and best professional judgement. Turbidity will vary in water overlying different matrices (i.e., water overlying fine silt will naturally be more turbid than water overlying coarse sand).
- The sediment surface is relatively undisturbed; the sediment-water interface is intact and relatively flat with no sign of channeling or sample washout.
- The desired penetration depth (4 to 6 in.) is achieved.
- There is no sign of sediment loss (incomplete closure of the sampler, penetration at an angle, or tilting upon retrieval).
- The sample contains ≥ 20 percent fines (i.e., ≤ 2 mm).

Sediment Sample Allocation

Homogenized sediment samples will be placed into labeled (Attachment A2, SOP-9), laboratory-provided, sample containers as described in Table A2. Sample containers for a field duplicate sample (if needed) will be filled from the same homogenized sediment as the primary sample. The container for the AVS and SEM analysis should be filled first

because the results of these analyses are affected by excess oxygen exposure. The AVS and SEM container should be filled using a subsample of sediment collected before manipulation of the sediment sample and with no headspace. All remaining sediment samples for analytical chemistry should be filled after homogenization of the sediment. Sediment samples for the analytical laboratory will be stored in a cooler with ice until they are transferred from the sampling vessel.

As outlined in Table A2, 1.4 L of sediment will be collected for chemical/physical analysis and up to 6.3 gal (24 L) of sediment will be collected for bioassays at sample locations where bioassay analyses will be conducted[12]. Sediment allocated for bioassays can be stored in appropriate, decontaminated containers (e.g., a 2-gal and a 5-gal bucket). A thin layer of river water should be added to the sediment to prevent excess oxygenation during transport to the bioassay laboratory. It is acknowledged that at designated bioassay sampling stations, field sampling personnel will strive to collect the 25.4 L of sediment necessary to complete all planned analyses. However, the potential lack of attaining the desired 25.4 L of sediment will not be cause to reject or dismiss the sediment sampling location. Rather, the retained sediment volume will be evaluated relative to the analytical priorities outlined in Table A2 (i.e., 1.4 L for chemical analysis; 3.9 L for chemical analysis and bioassays; and 22.9 L for chemical analysis, bioassays, and toxicity identification evaluations [TIEs]). Bioassay samples may be stored at ambient temperature until they are transferred from the sampling vessel. After being transferred from the sampling vessel, chemical and bioassay samples will be stored in a refrigerated area while awaiting shipping.

If BMI samples will be collected at a location, an additional 2.7 gal (10 L) will be required. This sediment sample must be collected independently of sediment collected for sediment chemistry and bioassays (i.e., from a separate sampling event). Following sediment collection, screening for cultural resources, and rinsing to remove large grain sizes, excess water will be removed, and sediment placed in a 5-gal container and filled with 90 percent ethanol. See Table A2 and SOP-8 (Attachment A2) for additional information.

[12] An additional 4 L of sediment is required at locations where EPA requests split samples for chemical analysis and bioassay testing.

Porewater Sampling

Sample Collection

Procedures for collection of porewater samples are provided in SOP-7 (Attachment A2). Sediment porewater will be sampled from the top 0 to 6 in. of sediment from an anchored boat using the Trident probe developed by Coastal Monitoring Associates (CMA). The Trident probe is a direct-push sampler with integrated temperature and conductivity sensors. The decontaminated probe will be inserted into the sediment, and porewater will be collected by low-flow peristaltic pump extraction through a small-diameter Teflon™ sampling tube. The sampling tube will be routed into a glovebox on the vessel. Porewater will be collected into sampling containers inside a glovebox that has been purged with nitrogen to minimize oxidation. Chemical analyses will take place at the analytical laboratory.

During sampling, water quality parameters will be measured in porewater and in near-bottom surface water. Procedures and water quality parameters to be monitored are described in SOP-7. Near-bottom surface water quality parameters of temperature, conductivity, and pH measured during porewater sampling will be used for evaluations of BMI data at sampling locations.

The Trident probe will be deployed in one of several ways, depending on the water depth, current velocity, and substrate type at each sample location. CMA will determine which Trident configuration to use based on the conditions. For example, a pole-mounted Trident probe may be used in shallow areas with low water velocity and soft substrate, while a Trident probe with a weighted frame and pneumatic hammer may be used in deeper areas with higher flow and coarser substrate.

The Trident probe will usually be deployed from an anchored boat. A camera can be mounted to the sampler frame to allow for real-time viewing of the sediment surface and probe position in deeper water locations. If very shallow water (e.g., < 1 m) is encountered at a sample location, the pole-mounted Trident probe may be deployed by wading instead of from the sampling vessel.

Sample Allocation

Porewater allocation will be performed as described in Table A2. Once the glovebox has been purged of oxygen and approximately 300 mL of porewater has been purged from the sampling tube, porewater will be collected directly into the sampling containers provided by the analytical laboratory. Fill sample containers in the following order: metals, DOC, TOC, sulfide, and sulfate/chloride/alkalinity according to volumes specified in Table A2.

2.2.6 Sampling Contingencies

During the surface sediment sampling program conducted during the Phase 3 sediment study, the sediment bed will be inspected using video or direct observation to confirm that the sediment texture at a proposed sampling location appears consistent with the target stratum or sediment facies from the sampling design. If the actual sediment texture appears different than the target stratum or facies type, the location will be adjusted or sampling will be performed at an alternate location.

Field conditions or circumstances may adversely affect sampling success during the course of sampling. Such conditions or circumstances may include, but are not necessarily limited to, the presence of cultural resources (refer to the cultural resources coordination plan in Appendix E of the QAPP), the presence of coarse substrates (e.g., gravels, cobbles, boulders, bedrock), above-average river flow conditions, sample area access issues, and extreme heat or cold. To accommodate such circumstances, alternate sample locations have been identified for this sampling effort (Table A1). If acceptable samples cannot be successfully collected from a proposed primary sampling station location, the field sampling crew will attempt to collect a sample from alternate locations as described in Section 2.2.3[13]. Special contingencies for collecting sediment samples from the sampleable sand stratum at AOIs are shown in Figure A1. If attempts to collect sediment from the target stations and all designated alternate stations are unsuccessful, samples will be collected using the freeze grab device.

2.2.7 Quality Control Samples

Field QC samples will be used to assess sample variability and evaluate potential sources of contamination. Types of QC samples that will be collected for this study are described below and in the attached SOPs. Detailed information on quality assurance/quality control (QA/QC) procedures, limits, and reporting are provided in the QAPP.

Field QC samples will include field duplicate samples (both internal and those collected by EPA in support of their QA/QC program) and equipment blanks. The following QC samples will be collected in the field and analyzed by the analytical laboratory.

[13] Porewater samples will be collected at all primary sediment sampling locations at each AOI, regardless of whether sediment sampling is successful. Porewater samples will also be collected at any alternate locations where sediment samples are collected.

Sediment

- **Field Duplicate Samples (Internal).** Field duplicate samples for chemical and physical analyses will be collected and analyzed to assess variability associated with sample processing and laboratory variability at the analytical laboratory. Field duplicates will be collected from no less than 10 percent of the sediment samples, pending availability of sufficient sediment volume. These duplicates will be collected at approximately even intervals throughout the sampling period. No field duplicate sample volume will be collected for potential bioassay testing.
- **Field Split Samples (EPA).** EPA field split samples from AOIs will be collected by EPA representatives from 5 percent of sediment samples for chemical analysis and from 15 pre-determined locations for bioassay testing as part of EPA's QA/QC program. EPA field split samples for chemical analysis are listed in Table A1. There will be a total of 8 sediment samples from 7 locations (the 8th sample will be a field duplicate collected at one of the AOI sampleable sand sediment locations). Additional volumes of sediment will also be obtained at one of the AOI sampleable sand sediment locations for QA/QC purposes. EPA splits for bioassay testing will require 4 L and will be collected as splits of homogenized sediments. Specific sampling locations for bioassay splits are listed in Table A1. Prior approval and agreement is required from the government of Canada for the three EPA-requested field bioassay split samples from upstream reference locations. Field split samples for chemical analysis will be provide to EPA in the field at the time of sampling. Split samples for bioassay testing will be prepared in the field and stored at the analytical laboratory and shipped to the EPA's bioassay testing laboratory at the same time that selected sediment samples for bioassay testing are shipped to TAI's contracted bioassay testing laboratory.
- **Equipment Rinsate Blanks.** Equipment rinsate blanks will be collected to identify possible contamination from the sampling environment or from the sampling equipment (e.g., mechanical stainless-steel paddle wheel mixer, scoops, bowls). Equipment rinsate blanks will be generated once a week for each sampling crew. Equipment rinsate blanks will consist of running distilled/deionized water over the sampling equipment after decontamination. Equipment rinsate blanks will be collected a minimum of one time for each type of sampling equipment used during the field event (i.e., at least one blank for the sampler, one for the bowl, and one for the scoop). The blank-to-sample association information for each equipment blank sample (e.g., the sampling crew, equipment types, sampling week dates, and associated sediment samples) will be documented in the field logbook and

tabulated by the Field Supervisor at the completion of the study for reference during data validation.

Benthic Macroinvertebrates

- **Field Duplicate Samples (Internal).** For BMI, field duplicate samples must be collected from a sampling grab independent from that used for the primary BMI sample. Therefore, to obtain a field duplicate sample, at least three successful grabs must occur at a sampling location: 1 for chemistry/bioassay, 1 for BMI, and 1 for the field duplicate BMI sample. Field duplicates will be collected from 5 percent of the sediment locations, contingent on the ability to obtain enough acceptable grabs at sufficient locations. These duplicates will be collected at approximately even intervals throughout the sampling period.

Porewater

- **Equipment Blanks.** One equipment blank for each AOI will be generated for each Trident sampler used in the AOI. Equipment blanks will be collected by flushing deionized water through the sampler and sample tubing after conducting the decontamination procedure between sample collections. The specific Trident sampler used to collect each porewater sample will be documented on field forms, allowing the data validator to associate each equipment blank with a specific group of porewater samples. Filters will be not be included as part of the equipment blanks; separate filter blanks will be collected to evaluate filter cleanliness.
- **Filter Blanks.** One filter blank will be generated for each lot and filter type used for the duration of the study. Filter blanks will be collected by flushing ASTM Type 1 deionized water through a filter of each type (i.e., one capsule filter per lot and one disc filter per lot). The disc filters will be precleaned with a 10-mL flush of ASTM Type 1 deionized water prior to collecting filter blanks. The capsule filter blanks will be analyzed for metals, and the disc filter blanks will be analyzed for DOC.
- **Field Duplicates (Internal).** Field duplicates will be collected at the rate of 1 per 20 samples. In order to reduce the potential for porewater drawdown, the total volume of porewater collected at any one location will be minimized by collecting only one duplicate bottle at a given sample location (i.e., because up to 5 bottles will be filled at each sample location to analyze for the required parameters, and 1 duplicate sample bottle will be filled at up to 5 of every 20 sample locations). Duplicate bottles will be filled immediately after filling the first bottle for the same analyte.

- **Field Splits (EPA).** EPA field split samples will be collected by EPA representatives from 15 percent of porewater samples for analysis for dissolved metals as part of EPA's QA/QC program. Table A1 lists the sampling locations at which EPA porewater splits will be taken. There will be a total of 19 porewater samples from 18 locations. The 19th sample will be a field duplicate collected at one of the AOI coarse porewater sample locations (location to be determined based on ability to collect additional aliquots for split and split field duplicate sample). Additional volume of porewater will also be obtained at one of the AOI sampleable sand sediment locations for laboratory analytical QA/QC purposes. Prior approval and agreement is required from the government of Canada for the three EPA-requested field split samples from upstream reference locations.

2.2.8 Individual Sample Numbering

Each distinct sediment, porewater, and BMI sample will be assigned a unique identifier. Sample IDs will be formatted to indicate sample location identification, matrix, sample type, and date, as shown below.

- Location Identification = AOI code (EV for Evans, CB for China Bend, DM for Deadman's Eddy, or "REF" for reference areas) and the station number (Table A1).
- Matrix Codes = SE for sediment, PW for porewater, or BMI for benthic macroinvertebrates. QC samples should be assigned the same matrix codes for which they are associated. For example, an equipment blank for sediment sampling should be assigned matrix code "SE" even though the QC sample itself will be aqueous.
- Sample Type = primary (1), field duplicate (2), field split (3), and equipment rinsate blank (4).
- Date = month/day/year as MMDDYY.

Examples

Format—Sample ID = Location ID-Matrix-Sample Type-Date

CB025-SE-1-091919 = Primary sediment sample collected from the China Bend AOI station 025, on September 19, 2019

CB025-PW-2-091919 = A duplicate porewater sample collected from the China Bend AOI station 025 on September 19, 2019

EV031-SE-3-090819 = A field split sediment sample collected from the Evans AOI station 031 on September 8, 2019

EV031-SE-4-090819 = An equipment rinsate blank collected on September 8, 2019 at the Evans AOI station 031.

The identification of field replicate sample status will be withheld from the analytical laboratory. Samples designated as potential EPA splits will be identified as such and submitted to the laboratory for further processing and splitting.

2.2.9 Equipment Decontamination Procedures

All sampling equipment coming into direct contact with samples will be decontaminated prior to beginning field work, between sampling stations, and at the conclusion of the field effort. Specific decontamination procedures are outlined in SOP-14 as well as in SOPs 3 through 7 (Attachment A2). Clean nitrile gloves will be worn at each sampling station and when handling samples to reduce the potential for cross contamination. Gloves will be changed and discarded in between sampling stations to avoid transfer of potential contaminants.

2.3 SAMPLE HANDLING

Records will be maintained to document all activities and data associated with field sampling, chemical analyses, bioassays, and BMI. Results of data verification and validation activities will also be documented. Procedures for documenting field activities are described herein (see SOP-10, Attachment A2); laboratory procedures are presented in Appendices B (analytical laboratory), C (bioassay laboratory), and D (taxonomic laboratory) of the QAPP.

Planning and documentation of all activities are emphasized to ensure that sample identity and integrity are preserved during all stages of the field operation (SOP-10). The following documentation will be provided with samples:

- A field form that contains information about each sampling location and sampling event
- Sample coordinates (recorded on the field form and/or recorded electronically)
- Photographic documentation (SOP-13)
- A sample identification label that accompanies and identifies each individual sample
- A COC form that provides continuous tracking information for all samples (SOP-11)
- A COC label that seals each shipping container.

The following information will be handwritten on the sample label at the time of collection with an indelible marker (or preprinted sample labels may be used):

- Sample ID
- Sampler's initials
- Date
- Time.

If necessary, corrections will be made on the sample labels by drawing a single line through the error and entering the correct information with an indelible marker. All corrections will be initialed and dated by the person performing the correction. If possible, the individual who made the error will correct it.

Sample labels will be placed either on the sample container or with the sample container inside resealable plastic bags. When individual samples are prepared for shipment, this sample label will remain with the packaging.

2.4 CULTURAL RESOURCES

A cultural resources coordination plan has been prepared for the RI/FS to provide relevant background information about Site-related cultural resources, define measures for protecting resources, and define procedures for consulting with the appropriate state, federal, and tribal parties with interests in the cultural resources of the Site. Because field sampling methods associated with this investigation involve ground disturbance, TAI and its technical team will work with the Cultural Resources Working Group and EPA to assess the effects of the planned work and seek ways to avoid, minimize, or mitigate any adverse effects on historic properties. SOPs for each sampling method are provided in Attachment A2 to this FSP. Handling and reporting of cultural resources are described in Attachment A2, SOP-16.

In accordance with the cultural resources coordination plan, an archaeological monitor and/or tribal representative will be present on the Site when sampling or sampling-related activity occurs. The archaeological monitor and/or tribal representative will visually examine the area prior to collection of each sample. The archaeological monitor and/or tribal representative will not make physical contact with the sample unless artifacts or other cultural deposits are present. If artifacts or potential archaeological deposits are present, the archaeological monitor or tribal representative will record the location of the materials and photograph the materials in place in such a manner to provide information on provenience. The artifacts and other archaeological materials will then be re-deposited at

their original location. At the discretion of the archaeological monitor or tribal representative, a specific sample location may be relocated from the location of the discovery. Such relocation will be coordinated with the field supervisor and documented in the field logbook. These procedures, collectively referred to as the Archaeological Monitoring Protocol, are summarized in the cultural resources coordination plan and also reproduced in Attachment A4 to this FSP.

2.5 SAMPLE PACKAGING AND TRANSPORT

After completing each day of sampling, the sampling vessel will return to the boat launch and the field crew will deliver the samples, held in coolers with ice where possible and appropriate, to the onshore sample processing team. The onshore sample processing team will have at their disposal a secure area for processing and preparing samples for shipment to the processing laboratory (Attachment A2, SOP-12). At the onshore sample processing facility, the following procedures will be employed:

1) Review field logs regarding sample characteristics
2) Leave the original sample label with the appropriate sample
3) Ensure that appropriate SOPs have been followed regarding sample identification
4) Further prepare sample for shipment to the analytical laboratory (as needed) and complete the COC forms.

All samples will be stored in an onshore refrigerated area while they are awaiting shipping. Prior to shipping to the analytical laboratory, analytical samples will be packed on ice (in sufficient quantity to keep the samples at 4°C for up to 48 hours) and shipped via priority overnight delivery service or courier service to ensure arrival at the processing laboratory within 48 hours from the time of sample shipment.

Clean, sturdy, plastic coolers will be used as shipping containers for analytical samples. The cooler will be lined with bubble wrap. A large opened plastic bag (e.g., sturdy garbage bag or drum liner) will be placed inside the bubble wrap-lined cooler before placing any samples inside the cooler. Samples will be individually wrapped with bubble wrap and placed inside the bag-lined cooler. The bag will be tied closed and sealed at the tied area with a custody seal to ensure that custody is maintained if the cooler is opened for inspection during shipment. Completed COC forms will be placed in resealable plastic bags and included in each cooler. After the cooler is sufficiently packed to prevent shifting of the

containers, it will be secured at both ends with nylon strapping tape and the following items will be attached:

- Address label for processing laboratory
- Two custody seals
- Overnight shipping airbill
- Perishable goods label
- At least one of the following labels: "This End Up," "Fragile," or "Handle With Care."

2.6 STUDY-DERIVED WASTE

All study-derived wastes will be disposed of at appropriate facilities (USEPA 2008). All disposable materials and supplies used for sample collection and processing (e.g., paper towels, gloves, tubing, porewater collection materials) will be placed in heavyweight garbage bags or other appropriate containers. This waste will be placed in a normal refuse container for disposal at a solid waste landfill.

2.7 VESSEL PROCEDURES FOR AQUATIC INVASIVE SPECIES CONTROL

Aquatic invasive species are a serious ecological and economic threat, and sediment sampling with research vessels and equipment has the potential to spread non-native noxious weeds, pathogens, and exotic flora and fauna among water bodies. The sampler vessel captain and crew will be familiar with the risks of invasive species and trained on inspection and decontamination procedures. The sampler vessel will be thoroughly inspected and cleaned before the field effort to prevent transport of exotic species (e.g., New Zealand mudsnail, quagga and zebra mussels, and milfoil) in accordance with SOP-15 (Attachment A2). Because the UCR is not an Area of Extreme or Moderate Concern, the sampling vessels do not need to be decontaminated between sampling stations within the UCR or after the sampling effort is complete.

3 FIELD DOCUMENTATION

The integrity of each sample from the time of collection to the point of data reporting must be maintained. Proper record-keeping and COC procedures will be implemented to allow samples to be traced from collection to final disposition. Representative photographs will be taken of each type of sampling activity performed during the study. Site photographs from various angles and views of the specific sampling locations within the AOIs will be collected.

3.1 FIELD LOGBOOK

All field activities and observations will be noted in a field log (SOP-10). The field log will be a bound document containing individual field and sample log forms. Information will include personnel, date, time, sampling area, sampler, types of sample collected, and general observations. Any changes that occur during sampling (e.g., personnel, responsibilities, deviations from the FSP) and the reasons for these changes will be documented in the field log. The log will identify onsite visitors (if any). The field supervisor is responsible for ensuring that the field log and all field data forms are correct. Photocopies of field notebooks should be made daily, or as often as practical, and stored in a secure location (field laboratory, hotel room, or the like). If electronic records are kept, it is advisable to make a backup copy (preferably daily), which can then be kept at a secure location. Upon completion of the field sampling effort, the field supervisor will be responsible for ensuring that all electronic data are compiled and submitted to TAI.

Requirements for keeping logbooks include the following:

- If paper logbooks are used
  - They will be bound all-weather paper, with consecutively numbered pages.
  - Removal of any pages, even if illegible, will be prohibited.
  - Entries will be made legibly with black (or dark) waterproof ink.
  - Corrections will be made by drawing a single line through the original entry, with the corrected entry written alongside the original. Corrections will be initialed and dated and may require a footnote for explanation.
- Each day's first entry will be made on a new, blank page.
- Easy to understand, descriptive language will be used.
- Entries will be made while activities are in progress or as soon afterward as possible (the date and time that the notation is made should be noted, as well as the time of the observation itself).

- Blank lines on a page or blank pages in the logbook will be lined out to indicate that they were intentionally left blank.
- The date and time, based on a 24-hour clock (e.g., 0900 for 9:00 am and 2100 for 9:00 pm), will appear on each page.

In addition to the preceding requirements, if a paper logbook is used, the person recording the information must initial and date each page of the field logbook. If more than one individual makes entries on the same page, each recorder must initial and date each entry. The bottom of the page must be signed and dated by the individual who makes the last entry. The field supervisor, after reading the day's entries, also must sign and date the last page of each daily entry in the field logbook.

The type of information that may be included in the field logbook and/or field forms includes the following:

- Task name, sampling locations, and task number
- Task start date and end date
- Weather conditions
- Name of person making entries and other field staff (including EPA oversight)
- Onsite visitors, if any
- Date and collection time of each sample
- The sampling location names
- Water depth, and sampling location coordinates derived from GPS for each drop of the sampler[14]
- Specific information on each type of sampling activity
- Observations made during sample collection
- Number of photographs and/or videos taken at each sampling location
- A record of site health and safety meetings, updates, and related monitoring
- Any deviation from the sampling plan and reasons for deviation.

[14] In the case of wadeable sampling locations, coordinates will be determined from a handheld GPS unit at the position of the handheld sampling device.

All logs must be completed at the time any observations are made. Copies of all logs and forms will be retained by TAI and its technical team in hardcopy and/or pdf files. It is advisable to photocopy each day's entries to provide a backup copy that can be kept at a secure location (field laboratory, hotel room, or the like).

3.2 CHAIN-OF-CUSTODY PROCEDURES

Samples are in custody if they are in the custodian's view, stored in a secure place with restricted access, or placed in a container secured with custody seals. Samples will not be outside of designated personnel's custody unless the samples have been transferred to a secure area (i.e., locked up and custody sealed) or transferred to the laboratory. If the samples cannot be placed in a secure area, then a field team member must physically remain with the samples at all times (e.g., at meal times). A COC record will be signed by each person who has custody of the samples and will accompany the samples at all times. Copies of the COC form will be included in laboratory and QA/QC reports. Attachment A3 contains an example of the COC form that will be used during the study, with directions for how to fill out the form in SOP-11 (Attachment A2).

The COC form will be either paper or electronic and, at a minimum, will include the following information:

- Site name
- Field supervisor's name and team members responsible for collection of the listed samples
- Sample identification number
- Collection date and time for each sample
- Sample type (e.g., sediment, porewater, or BMI)
- Number of sample containers (e.g., coolers) shipped
- Requested analyses for each sample (as shown in Table A2)
- Name, date, time, and signature of the relinquishing and receiving personnel (this does not include commercial shipment carriers).

The field supervisor, as the designated field sample custodian, will be responsible for all sample tracking and COC procedures for samples in the field. The field sample custodian will be responsible for final sample inventory and will maintain sample custody documentation. The field sample custodian will complete the COC form prior to removing samples from the field. Upon transferring the samples to the laboratory sample custodian

or shipping courier, the field supervisor will sign, date, and note the time of transfer on the COC form. The original COC form will be transported with the samples to the laboratories. All samples will be shipped to the testing laboratories in coolers sealed with custody seals.

Each laboratory will designate a sample custodian who will be responsible for receiving samples and documenting their progress through the laboratory analytical process. The sample custodian for each laboratory will confirm the integrity of the custody seals upon sample arrival at the laboratory. The laboratory sample custodian will also ensure that the COC and sample tracking forms are properly completed, signed, dated, and initialed upon receipt of the samples.

Upon receipt of the samples by the laboratory, the laboratory sample custodian will inventory the samples by comparing sample labels (numbers and tags) to those on the COC document. The internal cooler temperature will be taken by the laboratory sample custodian; if sample temperatures fall outside the acceptable range, the field supervisor should be alerted immediately. The custodian will enter sample numbers into a laboratory tracking system by task code and sample designation. The custodian will assign a unique laboratory sample identifier to each sample number and will be responsible for distributing the samples to the appropriate analyst or for storing samples at the correct temperature in an appropriate and secure area.

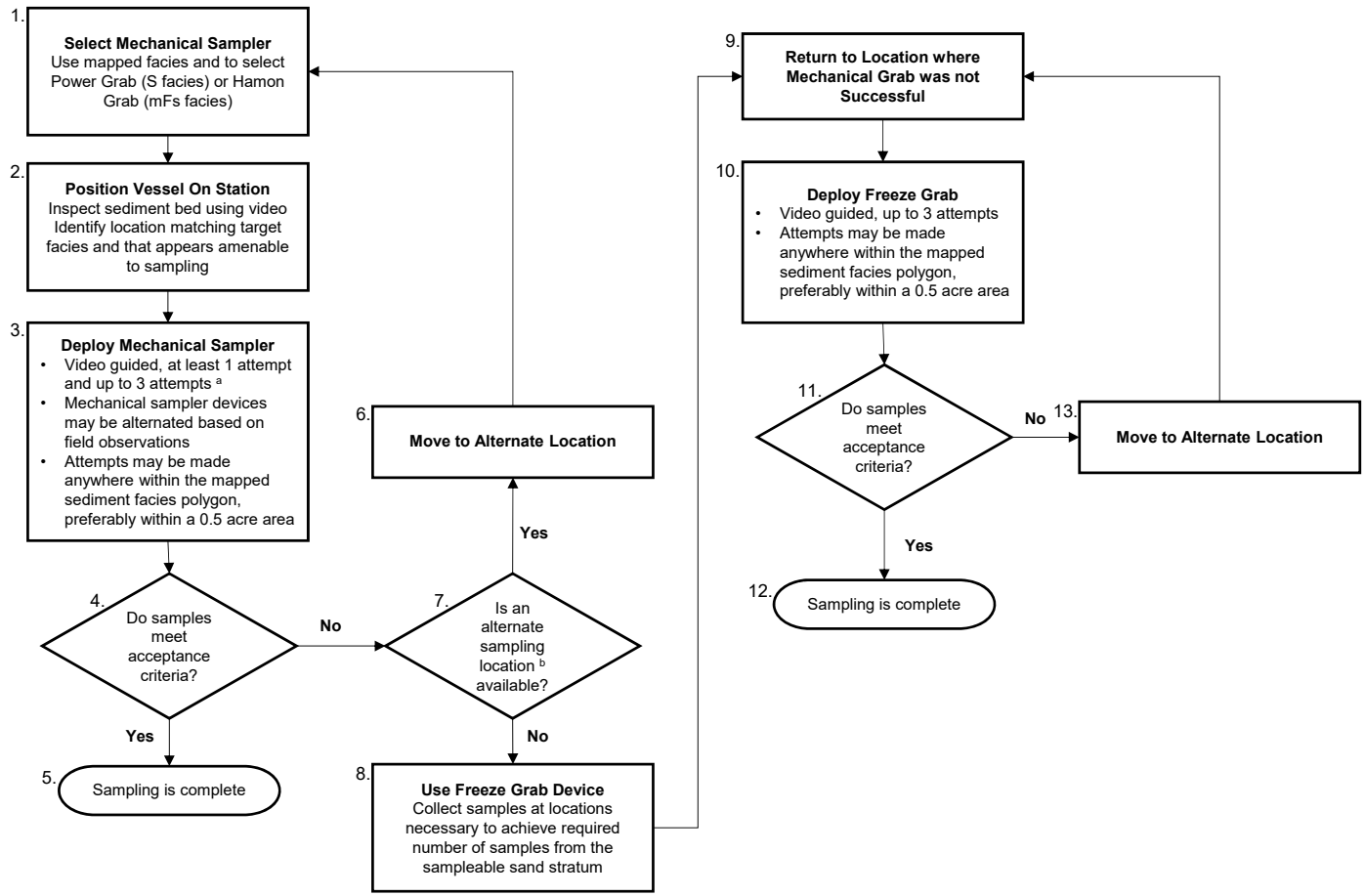
4 REFERENCES

ERM. 2019. Final technical memorandum—Sediment freeze grab sampling pilot study. Prepared for Teck American Incorporated. 31 January 2019.

USEPA. 2008. Green remediation: incorporating sustainable environmental practices into remediation of contaminated sites. Office of Solid Waste and Emergency Response, USEPA Washington, D.C. EPA542-R-08-002. Pp. 12-13.

Windward. 2017. Final Phase 2 sediment study data summary and data gap report. Prepared for Teck American Incorporated in Association and Consultation with Exponent, Parametrix, Inc., and HDR, Inc. May 2017.

FIGURES



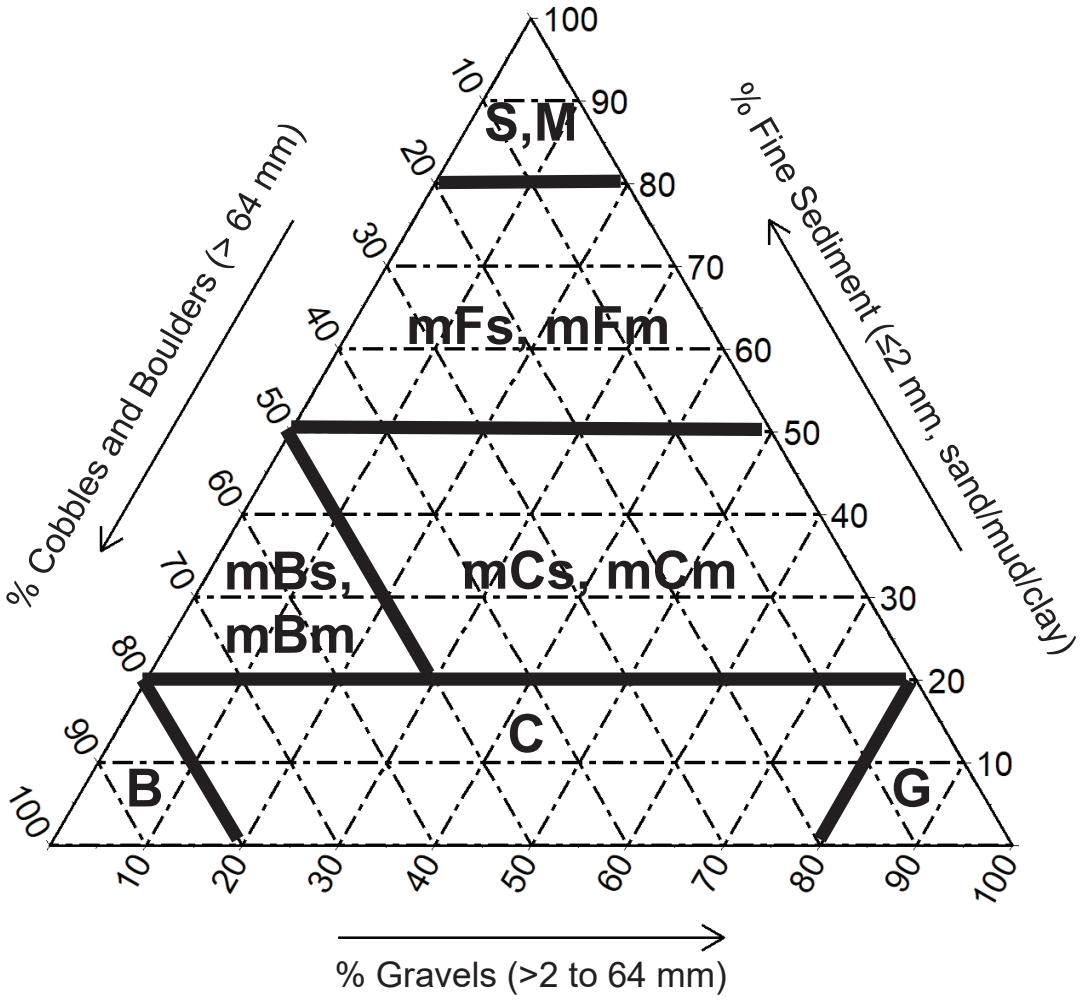
Notes:

[a] Number of attempts at a location will be based on video imagery and best professional judgement to minimize number of attempts in locations that are not sampleable using mechanical samplers.

[b] There are 21 available alternate sampling locations in this stratum at Deadman's Eddy and Evans AOIs; at China Bend AOI, there are 12 alternate sampling locations. In addition, two alternate judgmental sample locations are present at the China Bend AOI as requested by EPA. A maximum of 10 alternate locations will be used at statistically derived and repeat sample locations. If refusals are encountered at judgmental locations, both alternate locations may be attempted.

Numbers outside of shapes are provided purely for identification purposes, and should not be construed as a prescribe order of operations.

Figure A1. Sediment Sampling Hierarchy for Sampleable Sand Stratum



Sediment Bed Surface Facies

M = mud (silt and clay, < 0.063 mm)

S = sand (0.063 mm – 2 mm)

G = gravel (2 mm – 64 mm)

B = boulder/cobble (> 64 mm)

mFm = mixed finer-grained, predominantly mud

mFs = mixed finer-grained, predominantly sand

mCm = mixed coarse, with mud

mCs = mixed coarse, with sand

mBm = mixed boulder/cobble, with mud

mBs = mixed boulder/cobble, with sand

C = coarse

Note:
Bedrock is included as a sediment bed type in facies maps but is not shown in texture triangle.

Figure A2. Texture Triangle for Sediment Bed Surface Facies

Maps

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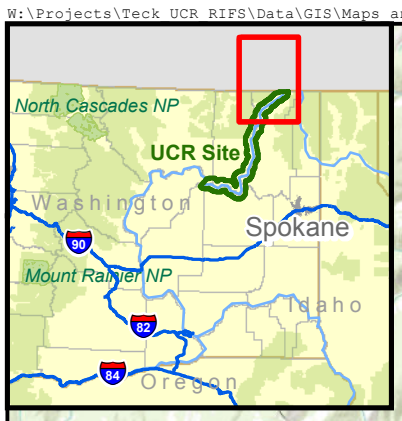

Lower Arrow Lake

Lower Arrow Lake

Upstream of Genelle

Genelle

Birchbank

Deadman's Eddy

China Bend

Evans

U.S. - Canada Border

UNITED STATES

CANADA

UNITED STATES

CHRISTINA RANGE

ROSSLAND RANGE

NORNS RANGE

LIME CREEK MOUNTAIN

KELLY HILL

ALADDIN MOUNTAIN

GILLETTE MOUNTAIN

Renata

Deer Park

Syringa Provincial Park

Gladstone Provincial Park

Nancy Greene Provincial Park

Blueberry Creek

Genelle

Champion Lakes Provincial Park

Christina Lake

Gilpin Grasslands Provincial Park

Cascade

King George VI Provincial Park

Rossland

Warfield

Trail

Glenmerry

Sunningdale

Fruitvale

Montrose

Beaver Creek Provincial Park

Park Siding

Glade

Shoreacres

Krestova

Borrington Falls

Taghum

Robson

Raspberry

Castlegar

Brilliant

Kinnaird

Ootischenia

Crowsnest Hwy

Blueberry Creek

Champion

Beaver Creek

Columbia River

Slocan River

Lardo Creek

Goose Creek

Norris Creek

Canadian Pacific

Lynch Creek

Dog Creek

Sheep Creek

Sawtooth Creek

Pend d'Oreille River

Kootenay Central Railway Co

Santa Fe Railway

1630m

2375m

Highway 25 N

Columbia River

Northport

Orient

Boyds

Evans

Marcus

Colville National Forest

Lake Roosevelt National Recreation Area

Deadman Creek

North Fork Boulder Creek

South Fork Deep Creek

Deep Creek

Onion Creek

Metaline

Ione

7303 ft

6379 ft

FERRY

STEVENS

PEND OREILLE

RM 740

RM 730

RM 720

RM 710

Legend

Upper Reach OU AOI

Upstream Reference Area

River Mile (USGS)

Windward environmental LLC

0 4 8 Kilometers

0 2 4 Miles

N

Map A1. **Sampling Area Overview**

Upper Columbia River, WA

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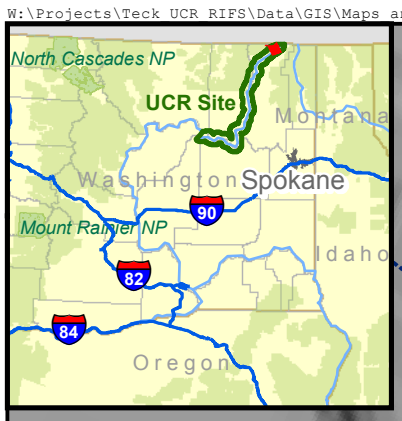

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Legend

Proposed Sampling Locations
- Sampleable Sand – Primary
- Sampleable Sand – Alternate
- Mixed Coarse – Primary
- Mixed Coarse – Alternate
- Coarse (Porewater Only) – Primary
- Coarse (Porewater Only) – Alternate
- Repeat Sampling Location

Sediment Facies (Area/Relative Abundance)
- Bedrock (0.04 sqkm/5.7%)
- Sand (S)(0.07 sqkm/10.5%)
- Mixed Fines, Predominantly Sand (mFs) (0.05 sqkm/8.6%)
- Mixed Coarse with Sand (mCs) (0.03 sqkm/4.7%)
- Mixed Boulder/Cobble with Sand (mBs) (0.03 sqkm/4.0%)
- Coarse (C)(0.42 sqkm/65.8%)
- Boulder/Cobble (B)(<0.01 sqkm/0.7%)

- Upper Reach OU AOI

UCR Riverbed Elevation
- 1,290 ft
- Historical Thalweg
- Major Road
- Railroad
- River Mile (USGS)

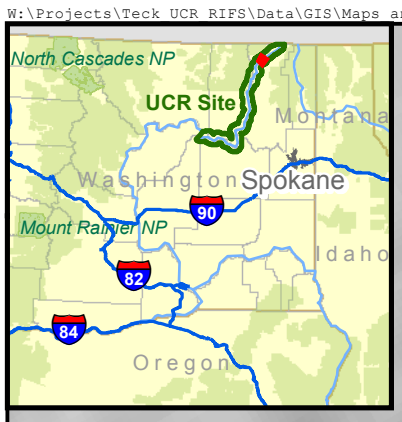
Windward environmental LLC

0 0.1 0.2 Km

0 0.05 0.1 Miles

Map A2. **Proposed Sampling Locations at Deadman's Eddy AOI**
Upper Columbia River, WA

W:\Projects\Teck UCR RIFS\Data\GIS\Maps and Analyses\Phase 3 Support\Sediment QAPP\Field Sampling Plan\Map A03 7033 Sed facies and proposed smp locs - China Bend.mxd @ 08/19/2019



RM 724

CB058
CB057
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CB055
RM 723
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CB053
CB052
CB051
JS002
CB050
JS004
JS003
CB048
CB049
JS001
CB047
25
CB046
CB045
CB044
CB043
CB040
CB042
CB039
CB041
CB038
CB037
CB035
3-R7-2019
CB036
RM 722
CB023
CB021
CB020
CB018
CB016
CB015
CB011
CB010
CB009
CB008
CB007
CB003
CB002
CB004
CB006
CB013
CB005
3-R8-2019
CB001
CB025
CB026
CB029
CB030
CB031
CB032
CB034
CB033
CB028
CB027
CB022
CB024
CB019
CB017
CB014
CB012

Legend

Proposed Sampling Locations

- Sampleable Sand – Primary
- Sampleable Sand – Alternate
- Mixed Coarse – Primary
- Mixed Coarse – Alternate
- Mud – Primary
- Mud – Alternate
- Coarse (Porewater Only) – Primary
- Coarse (Porewater Only) – Alternate
- Judgmental Sampling Location - Primary
- Judgmental Sampling Location - Alternate
- Repeat Sampling Location

Sediment Facies (Area/Relative Abundance)

- Bedrock (0.05 sqkm/3.3%)
- Dense Vegetation (0.10 sqkm/6.8%)
- Gravel (G)(<0.01 sqkm/0.1%)
- Sand (S)(0.09 sqkm/6.3%)
- Mixed Fines, Predominantly Sand (mFs) (0.11 sqkm/7.7%)
- Mixed Coarse with Sand (mCs) (0.30 sqkm/21.1%)
- Mixed Boulder/Cobble with Sand (mBs) (0.17 sqkm/11.9%)
- Mud (M)(0.08 sqkm/5.9%)
- Mixed Fines, predominantly Mud (mFm) (0.02 sqkm/1.4%)
- Mixed Coarse with Mud (mCm) (0.01 sqkm/0.5%)
- Mixed Boulder/Cobble with Mud (mBm) (<0.01 sqkm/0.2%)
- Coarse (C)(0.45 sqkm/31.7%)
- Boulder/Cobble (B)(0.04 sqkm/3.2%)

- Upper Reach OU AOI

UCR Riverbed Elevation

- 1,220 ft
- 1,250 ft
- Historical Thalweg
- Major Road
- Railroad
- River Mile (USGS)

Windward environmental LLC

Km 0 0.2 0.4

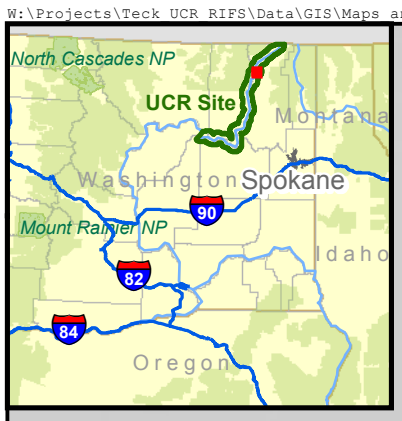
Miles 0 0.1 0.2

N

Map A3. **Proposed Sampling Locations at China Bend AOI**

Upper Columbia River, WA

W:\Projects\Teck UCR RIFS\Data\GIS\Maps and Analyses\Phase 3 Support\Sediment QAPP\Field Sampling Plan\Map A04 7033 Sed facies and proposed smp locs - Evans.mxd @ 08/19/2019



RM 711
Powell
EV076
EV075
EV073
EV074
EV072
EV071
EV070
EV069
EV068
EV067
EV066
EV065
EV064
EV063
EV062
EV061
EV060
RM 710
EV059
4-B1-2019
EV058
EV057
EV056
EV055
EV053
EV054
EV052
EV051
EV050
EV049
EV048
EV047
EV046
EV045
EV044
EV043
EV042
EV041
EV039
EV037
EV040
EV035
EV038
RM 709
EV026
EV033
EV029
EV030
EV036
EV025
EV031
EV034
EV027
EV028
EV032
EV004
EV019
EV021
EV024
EV014
EV022
EV023
EV020
EV006
EV017
EV005
4-B6-2019
EV007
EV018
EV002
EV016
EV008
RM 708
EV013
EV015
EV009
EV012
EV001
EV010
EV003
EV011
25

Legend

Proposed Sampling Locations

- Sampleable Sand – Primary
- Sampleable Sand – Alternate
- Mixed Coarse – Primary
- Mixed Coarse – Alternate
- Mud – Primary
- Mud – Alternate
- Coarse (Porewater Only) – Primary
- Coarse (Porewater Only) – Alternate
- Repeat Sampling Location

Sediment Facies (Area/Relative Abundance)

- Bedrock (0.19 sqkm/5.2%)
- Dense Vegetation (0.27 sqkm/7.5%)
- Sand (S)(0.81 sqkm/22.2%)
- Mixed Fines, Predominantly Sand (mFs) (0.40 sqkm/11.1%)
- Mixed Coarse with Sand (mCs) (0.32 sqkm/8.9%)
- Mixed Boulder/Cobble with Sand (mBs) (0.31 sqkm/8.5%)
- Mud (M)(1.09 sqkm/30.0%)
- Mixed Fines, predominantly Mud (mFm) (0.06 sqkm/1.7%)
- Mixed Coarse with Mud (mCm) (0.02 sqkm/0.6%)
- Mixed Boulder/Cobble with Mud (mBm) (0.03 sqkm/0.8%)
- Coarse (C)(0.12 sqkm/3.4%)
- Boulder/Cobble (B)(0.01 sqkm/0.2%)

- Upper Reach OU AOI

UCR Riverbed Elevation

- 1,220 ft
- 1,250 ft
- Historical Thalweg
- Populated Places
- Major Road
- Railroad
- River Mile (USGS)

Windward environmental LLC

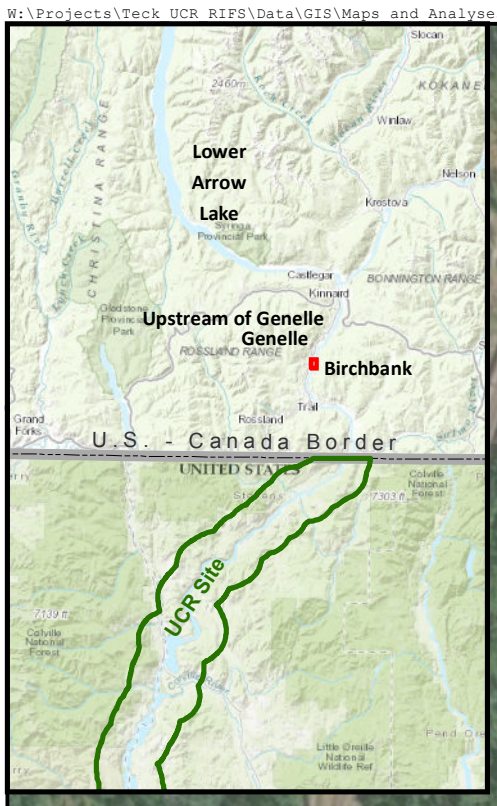
0 0.2 0.4 Km

0 0.1 0.2 Miles

N

Map A4. **Proposed Sampling Locations at Evans AOI**
Upper Columbia River, WA

W:\Projects\Teck UCR RIFS\Data\GIS\Maps and Analyses\Phase 3 Support\Sediment QAPP\Field Sampling Plan\Map A05 7024 Target Reference Locations - Birchbank.mxd @ 08/19/2019



REF004

Golder (2007) REF003

AREMP (2013) REF002

REF001

Photo source: Esri/Vivid DigitalGlobe, 0.5 m resolution. Photo date 06/06/2015.

Legend

Target Reference Locations

- Sand
- Mixed
- Previously Sampled Location

Windward environmental LLC

Meters 0 50 100

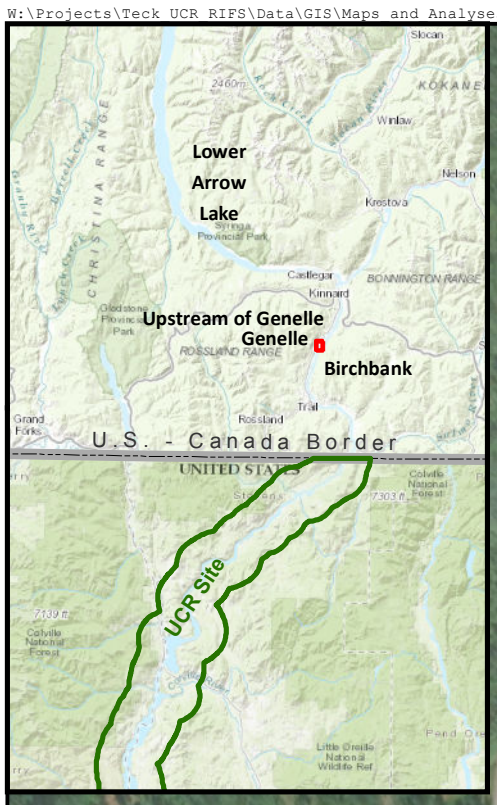
Yards 0 50 100

N

Map A5. **Target Reference Locations at Birchbank**

Columbia River, BC

W:\Projects\Teck UCR RIFS\Data\GIS\Maps and Analyses\Phase 3 Support\Sediment QAPP\Field Sampling Plan\Map A06 7024 Target Reference Locations - Genelle.mxd @ 08/19/2019



REF010

Phase 2: G-1

Phase 2: G-2 REF009

Phase 2: G-3 REF008

Phase 2: G-4 REF007

AREMP (2013)

Golder (2007)

REF005

REF006

Photo source: Esri/Vivid DigitalGlobe, 0.5 m resolution. Photo date 06/06/2015.

Legend

Target Reference Locations

- **Sand**
- **Mixed**
- **Previously Sampled Location**

Windward environmental LLC

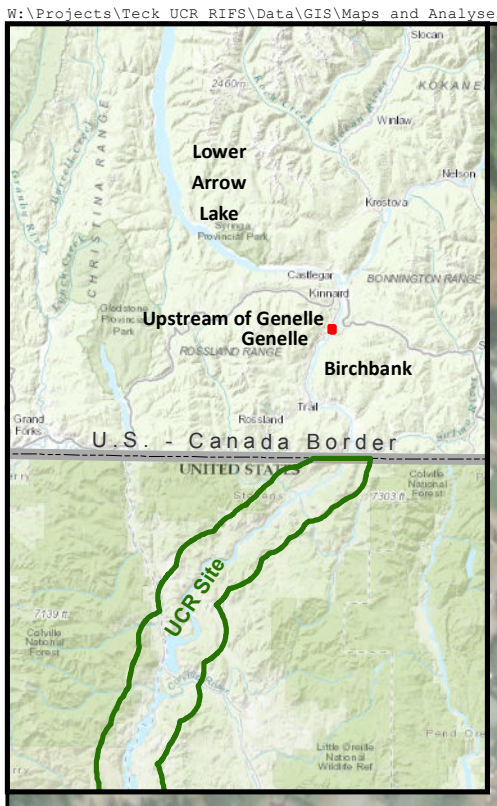
0 100 200 Meters

0 100 200 Yards

N

Map A6. **Target Reference Locations at Genelle**
Columbia River, BC

W:\Projects\Teck UCR RIFS\Data\GIS\Maps and Analyses\Phase 3 Support\Sediment QAPP\Field Sampling Plan\Map A07 7024 Target Reference Locations - Upstream of Genelle.mxd @ 08/19/2019



REF012

REF011

Photo source: Esri/Vivid DigitalGlobe, 0.5 m resolution. Photo date 06/06/2015.

Legend

Target Reference Locations

Sand

Mixed

Windward environmental LLC

Meters
0 50 100

Yards
0 50 100

N

Map A7. **Target Reference Locations Upstream of Genelle**
Columbia River, BC

W:\Projects\Teck_UCR_RIFS\Data\GIS\Maps_and_Analyses\Phase 3 Support\Sediment QAPP\Field Sampling Plan\Map A08 7024 Target Reference Locations - Arrow Lake.mxd @ 08/19/2019

Phase 2: LAL-3

Phase 2: LAL-2

REF018

REF017

Phase 2: LAL-1

REF016

Meters
0 100 200

Yards
0 100 200

Lower Arrow Lake

Upstream of Genelle

Genelle

Birchbank

U.S. - Canada Border

UCR Site

Phase 2: LAL-4

REF015

REF014

Phase 2: LAL-6

Phase 2: LAL-5

REF013

Legend

Target Reference Locations

- Sand/Mud
- Previously Sampled Location

Photo source: Esri/Vivid DigitalGlobe, 0.5 m resolution. Photo date 06/06/2015.

Windward environmental LLC

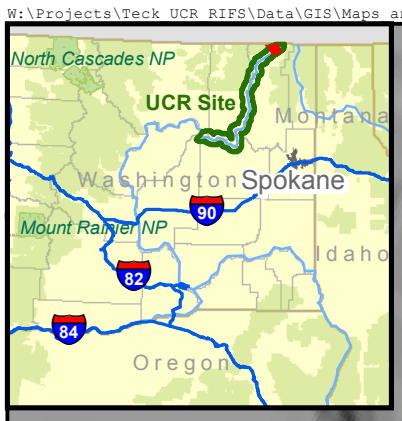
Kilometers
0 1 2

Miles
0 0.75 1.5

N

Map A8. **Target Reference Locations at Lower Arrow Lake**
Columbia River, BC

W:\Projects\Teck UCR RIFS\Data\GIS\Maps and Analyses\Phase 3 Support\Sediment QAPP\Field Sampling Plan\Map A09 7064 Approx water depth - Deadmans Eddy.mxd @ 08/19/2019



RM 738

RM 737

251

[a] Estimated depth calculated using mean water surface elevation of 1,291.4 feet during dates of multibeam data acquisition in Oct-Nov 2018.

Legend

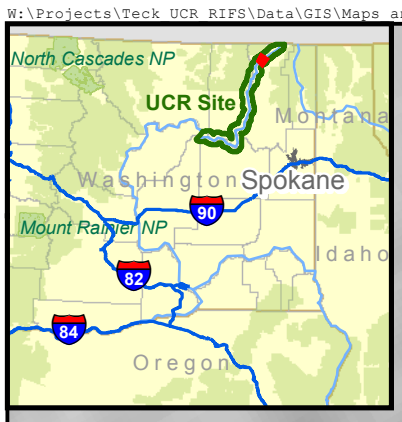
Multibeam Bathymetry Estimated Depth[a]
1.5 ft
95 ft
5 Ft Contour
EPA AOI
Historical Thalweg
Major Road
Railroad
River Mile (USGS)

Windward environmental LLC

0 0.1 0.2 Km
0 0.05 0.1 Miles

Map A9. **Approximate October Water Depth at Deadman's Eddy AOI**
Upper Columbia River, WA

W:\Projects\Teck UCR RIFS\Data\GIS\Maps and Analyses\Phase 3 Support\Sediment QAPP\Field Sampling Plan\Map A10 7064 Approx water depth - China Bend.mxd @ 08/19/2019



RM 724

RM 723

RM 722

25

Legend

Multibeam Bathymetry Estimated Depth[a]

5.5 ft

152.5

5 Ft Contour

EPA AOI

Historical Thalweg

Major Road

Railroad

River Mile (USGS)

[a] Estimated depth calculated using mean water surface elevation of 1,286.3 feet during dates of multibeam data acquisition in Oct 2018.

Windward environmental LLC

0 0.2 0.4 Km

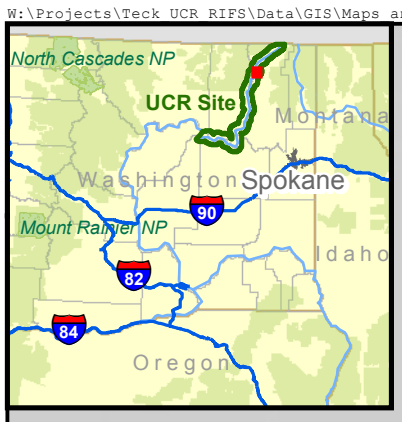
0 0.1 0.2 Miles

N

Map A10. **Approximate October Water Depth at China Bend AOI**

Upper Columbia River, WA

W:\Projects\Teck UCR RIFS\Data\GIS\Maps and Analyses\Phase 3 Support\Sediment QAPP\Field Sampling Plan\Map A11 7064 Approx water depth - Evans.mxd @ 08/19/2019



RM 711

Powell

RM 710

RM 709

RM 708

East Marcus

25

Legend

Multibeam Bathymetry Estimated Depth[a]

1.5 ft

95 ft

5 Ft Contour

EPA AOI

Historical Thalweg

Populated Places

Major Road

Railroad

River Mile (USGS)

[a] Estimated depth calculated using mean water surface elevation of 1,286.3 feet during dates of multibeam data acquisition in Oct 2018.

Windward environmental LLC

0 0.2 0.4 Km

0 0.1 0.2 Miles

N

Map A11. **Approximate October Water Depth at Evans AOI**

Upper Columbia River, WA

TABLES

Table A1. Sampling Locations

Area	Location ID	Primary, Alternate, or Repeat	Sample Type(s)	EPA Split Sample Type(s)	Target Stratum	Target Facies	Facies Elevation (ft amsl)	Elevation Class	X_UTM_11N (meters)	Y_UTM_11N (meters)
China Bend	CB001	A	PW	NS	coarse	B	1,209.6	< 1220	429350	5407271
China Bend	CB002	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,245.0	1220 to 1250	429476	5407452
China Bend	CB003	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,244.6	1220 to 1250	429512	5407456
China Bend	CB004	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,218.3	< 1220	429499	5407408
China Bend	CB005	P	SE, PW, BMI	SE, PW	mixed coarse	mCs	1,154.8	< 1220	429458	5407331
China Bend	CB006	P	SE, PW, TX, BMI	NS	sampleable sand	S	1,230.1	1220 to 1250	429540	5407412
China Bend	CB007	P	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,262.4	> 1250	429567	5407464
China Bend	CB008	P	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,241.3	1220 to 1250	429571	5407441
China Bend	CB009	P	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,259.0	> 1250	429612	5407449
China Bend	CB010	A	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,236.0	1220 to 1250	429625	5407436
China Bend	CB011	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,216.0	< 1220	429626	5407406
China Bend	CB012	P	SE, PW, TX, BMI	PW	sampleable sand	S	1,211.9	< 1220	429602	5407385
China Bend	CB013	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,167.6	< 1220	429563	5407352
China Bend	CB014	P	SE, PW, TX, BMI	TX	sampleable sand	S	1,165.0	< 1220	429614	5407338
China Bend	CB015	A	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,238.1	1220 to 1250	429682	5407421
China Bend	CB016	P	SE, PW, TX, BMI	PW	sampleable sand	mFs	1,218.9	< 1220	429676	5407402
China Bend	CB017	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,169.3	< 1220	429667	5407336
China Bend	CB018	P	SE, PW, TX, BMI	NS	sampleable sand	S	1,220.1	1220 to 1250	429706	5407381
China Bend	CB019	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,176.8	< 1220	429705	5407323
China Bend	CB020	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,219.2	< 1220	429734	5407361
China Bend	CB021	P	SE, PW, TX, BMI	NS	mud	M	1,243.9	1220 to 1250	429793	5407363
China Bend	CB022	P	SE, PW, TX, BMI	NS	sampleable sand	S	1,210.2	< 1220	429779	5407320
China Bend	CB023	A	SE, PW, TX, BMI	NS	mud	M	1,250.5	> 1250	429802	5407350
China Bend	CB024	P	SE, PW, TX, BMI	NS	mud	M	1,224.9	1220 to 1250	429796	5407334
China Bend	CB025	A	SE, PW, TX, BMI	NS	mud	M	1,261.7	> 1250	429813	5407352
China Bend	CB026	A	SE, PW, TX, BMI	NS	mud	M	1,228.8	1220 to 1250	429808	5407329
China Bend	CB027	P	SE, PW, TX, BMI	NS	mud	M	1,211.9	< 1220	429798	5407317
China Bend	CB028	A	SE, PW, TX, BMI	NS	mud	M	1,228.8	1220 to 1250	429805	5407315
China Bend	CB029	P	SE, PW, TX, BMI	TX	mud	M	1,252.5	> 1250	429831	5407316
China Bend	CB030	A	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,216.1	< 1220	429847	5407267
China Bend	CB031	P	SE, PW, TX, BMI	TX	sampleable sand	mFs	1,210.2	< 1220	429858	5407245
China Bend	CB032	P	SE, PW, BMI	NS	mixed coarse	mCs	1,230.9	1220 to 1250	430023	5407204
China Bend	CB033	A	PW	NS	coarse	B	1,198.8	< 1220	430005	5407105
China Bend	CB034	A	SE, PW, BMI	NS	mixed coarse	mCs	1,208.2	< 1220	430149	5407087
China Bend	CB035	P	SE, PW, BMI	NS	mixed coarse	mCs	1,219.8	< 1220	430354	5407156
China Bend	CB036	A	SE, PW, BMI	NS	mixed coarse	mCs	1,217.7	< 1220	430428	5407112

Table A1. Sampling Locations

Area	Location ID	Primary, Alternate, or Repeat	Sample Type(s)	EPA Split Sample Type(s)	Target Stratum	Target Facies	Facies Elevation (ft amsl)	Elevation Class	X_UTM_11N (meters)	Y_UTM_11N (meters)
China Bend	CB037	A	SE, PW, BMI	NS	mixed coarse	mCs	1,221.2	1220 to 1250	430494	5407113
China Bend	CB038	P	SE, PW, BMI	NS	mixed coarse	mCs	1,222.0	1220 to 1250	430548	5407140
China Bend	CB039	P	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,223.1	1220 to 1250	430647	5407204
China Bend	CB040	A	SE, PW, BMI	NS	mixed coarse	mCs	1,217.4	< 1220	430614	5407244
China Bend	CB041	P	PW	PW	coarse	C	1,226.2	1220 to 1250	430770	5407127
China Bend	CB042	A	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,225.6	1220 to 1250	430687	5407216
China Bend	CB043	P	PW	NS	coarse	C	1,223.1	1220 to 1250	430661	5407260
China Bend	CB044	P	SE, PW, TX, BMI	NS	mud	M	1,260.0	> 1250	430625	5407342
China Bend	CB045	A	SE, PW, TX, BMI	NS	mud	M	1,260.0	> 1250	430633	5407349
China Bend	CB046	P	SE, PW, BMI	NS	mixed coarse	mCs	1,225.8	1220 to 1250	430802	5407336
China Bend	CB047	P	SE, PW, TX, BMI	SE, PW, TX	sampleable sand	mFs	1,234.5	1220 to 1250	431007	5407422
China Bend	CB048	P	PW	NS	coarse	C	1,232.4	1220 to 1250	431088	5407419
China Bend	CB049	P	PW	NS	coarse	C	1,229.9	1220 to 1250	431255	5407342
China Bend	CB050	P	SE, PW, BMI	NS	mixed coarse	mCs	1,219.1	< 1220	431274	5407406
China Bend	CB051	A	PW	NS	coarse	C	1,230.3	1220 to 1250	431430	5407509
China Bend	CB052	P	PW	NS	coarse	C	1,220.5	1220 to 1250	431601	5407515
China Bend	CB053	A	PW	NS	coarse	mBs	1,246.5	1220 to 1250	431803	5407542
China Bend	CB054	A	SE, PW, BMI	NS	mixed coarse	mCs	1,213.3	< 1220	431812	5407633
China Bend	CB055	P	PW	NS	coarse	C	1,226.8	1220 to 1250	431792	5407692
China Bend	CB056	A	SE, PW, BMI	NS	mixed coarse	mCs	1,226.2	1220 to 1250	432089	5407732
China Bend	CB057	A	PW	NS	coarse	mBs	1,224.2	1220 to 1250	432092	5407831
China Bend	CB058	A	PW	NS	coarse	C	1,232.7	1220 to 1250	432202	5408183
China Bend	JS001	P	SE, PW, BMI	NS	sampleable sand	S	1,238.7	1220 to 1250	430966	5407512
China Bend	JS002	P	SE, PW, BMI	NS	sampleable sand	S	1,248.1	1220 to 1250	431069	5407578
China Bend	JS003	A	SE, PW, BMI	NS	sampleable sand	S	1,245.2	1220 to 1250	431014	5407540
China Bend	JS004	A	SE, PW, BMI	NS	sampleable sand	S	1,242.3	1220 to 1250	430969	5407554
Deadman's Eddy	DM001	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,261.1	NA	445961	5421205
Deadman's Eddy	DM002	P	SE, PW, TX, BMI	NS	sampleable sand	S	1,261.1	NA	445978	5421211
Deadman's Eddy	DM004	A	SE, PW, BMI	NS	mixed coarse	mCs	1,259.7	NA	445998	5421196
Deadman's Eddy	DM005	A	SE, PW, BMI	NS	mixed coarse	mCs	1,257.9	NA	446028	5421170
Deadman's Eddy	DM006	A	SE, PW, BMI	NS	mixed coarse	mCs	1,257.1	NA	446038	5421153
Deadman's Eddy	DM007	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,257.9	NA	446069	5421183
Deadman's Eddy	DM008	P	SE, PW, TX, BMI	TX	sampleable sand	S	1,263.0	NA	446070	5421205
Deadman's Eddy	DM009	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,270.1	NA	446207	5421191
Deadman's Eddy	DM010	P	SE, PW, TX, BMI	SE, PW	sampleable sand	S	1,281.9	NA	446108	5421208
Deadman's Eddy	DM011	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,272.1	NA	446107	5421183

Table A1. Sampling Locations

Area	Location ID	Primary, Alternate, or Repeat	Sample Type(s)	EPA Split Sample Type(s)	Target Stratum	Target Facies	Facies Elevation (ft amsl)	Elevation Class	X_UTM_11N (meters)	Y_UTM_11N (meters)
Deadman's Eddy	DM012	A	SE, PW, BMI	NS	mixed coarse	mCs	1,255.8	NA	446097	5421153
Deadman's Eddy	DM013	P	SE, PW, BMI	NS	mixed coarse	mCs	1,254.1	NA	446086	5421137
Deadman's Eddy	DM014	P	SE, PW, BMI	NS	mixed coarse	mCs	1,254.1	NA	446099	5421135
Deadman's Eddy	DM015	P	SE, PW, TX, BMI	NS	sampleable sand	S	1,280.4	NA	446155	5421228
Deadman's Eddy	DM016	P	SE, PW, TX, BMI	NS	sampleable sand	S	1,278.4	NA	446172	5421158
Deadman's Eddy	DM017	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,248.1	NA	446183	5421064
Deadman's Eddy	DM018	P	SE, PW, TX, BMI	NS	sampleable sand	S	1,276.7	NA	446198	5421144
Deadman's Eddy	DM019	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,277.1	NA	446207	5421191
Deadman's Eddy	DM020	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,277.1	NA	446222	5421213
Deadman's Eddy	DM021	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,270.9	NA	446243	5421224
Deadman's Eddy	DM022	P	SE, PW, TX, BMI	NS	sampleable sand	S	1,280.7	NA	446234	5421155
Deadman's Eddy	DM023	P	SE, PW, TX, BMI	NS	sampleable sand	S	1,279.4	NA	446259	5421166
Deadman's Eddy	DM024	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,279.5	NA	446251	5421110
Deadman's Eddy	DM025	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,276.7	NA	446314	5421101
Deadman's Eddy	DM026	P	SE, PW, TX, BMI	PW, TX	sampleable sand	S	1,280.4	NA	446283	5421071
Deadman's Eddy	DM027	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,271.4	NA	446313	5421058
Deadman's Eddy	DM028	P	PW	PW	coarse	C	1,268.9	NA	446224	5420934
Deadman's Eddy	DM029	P	PW	NS	coarse	C	1,256.3	NA	446384	5420813
Deadman's Eddy	DM030	A	PW	NS	coarse	C	1,280.2	NA	446701	5420788
Deadman's Eddy	DM031	A	SE, PW, BMI	NS	mixed coarse	mCs	1,249.4	NA	446661	5420526
Deadman's Eddy	DM032	P	SE, PW, BMI	NS	mixed coarse	mCs	1,249.7	NA	446682	5420529
Deadman's Eddy	DM033	P	SE, PW, TX, BMI	NS	sampleable sand	S	1,254.1	NA	446708	5420531
Deadman's Eddy	DM034	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,254.4	NA	446666	5420469
Deadman's Eddy	DM035	P	SE, PW, TX, BMI	TX	sampleable sand	S	1,253.3	NA	446680	5420451
Deadman's Eddy	DM036	P	SE, PW, BMI	SE, PW	mixed coarse	mCs	1,250.2	NA	446699	5420445
Deadman's Eddy	DM037	A	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,268.5	NA	446729	5420368
Deadman's Eddy	DM038	A	SE, PW, BMI	NS	mixed coarse	mCs	1,261.5	NA	446761	5420448
Deadman's Eddy	DM039	P	SE, PW, BMI	NS	mixed coarse	mCs	1,266.3	NA	446769	5420444
Deadman's Eddy	DM040	P	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,274.9	NA	446779	5420425
Deadman's Eddy	DM041	A	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,272.8	NA	446770	5420396
Deadman's Eddy	DM042	P	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,270.7	NA	446791	5420341
Deadman's Eddy	DM043	A	PW	NS	coarse	C	1,268.3	NA	446770	5420319
Deadman's Eddy	DM044	P	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,271.0	NA	446790	5420320
Deadman's Eddy	DM045	A	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,271.9	NA	446842	5420282
Deadman's Eddy	DM046	A	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,275.6	NA	446852	5420275
Deadman's Eddy	DM047	P	SE, PW, BMI	NS	mixed coarse	mCs	1,271.4	NA	446818	5420448

Table A1. Sampling Locations

Area	Location ID	Primary, Alternate, or Repeat	Sample Type(s)	EPA Split Sample Type(s)	Target Stratum	Target Facies	Facies Elevation (ft amsl)	Elevation Class	X_UTM_11N (meters)	Y_UTM_11N (meters)
Deadman's Eddy	DM048	P	SE, PW, TX, BMI	TX	sampleable sand	mFs	1,271.1	NA	446869	5420366
Deadman's Eddy	DM049	A	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,263.6	NA	446884	5420360
Deadman's Eddy	DM050	P	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,265.3	NA	446892	5420322
Deadman's Eddy	DM051	P	SE, PW, TX, BMI	PW	sampleable sand	mFs	1,277.4	NA	446875	5420405
Deadman's Eddy	DM052	P	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,277.4	NA	446900	5420400
Deadman's Eddy	DM053	A	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,265.1	NA	446934	5420386
Deadman's Eddy	DM054	A	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,272.0	NA	446847	5420524
Deadman's Eddy	DM055	A	PW	NS	coarse	C	1,276.7	NA	446921	5420705
Deadman's Eddy	DM056	P	PW	NS	coarse	C	1,277.0	NA	446944	5420805
Deadman's Eddy	DM057	P	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,267.4	NA	447027	5420499
Deadman's Eddy	DM058	A	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,268.5	NA	447048	5420521
Deadman's Eddy	DM059	P	PW	NS	coarse	C	1,271.3	NA	447036	5420591
Deadman's Eddy	DM060	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,271.9	NA	447064	5420571
Deadman's Eddy	DM061	P	SE, PW, TX, BMI	NS	sampleable sand	S	1,276.4	NA	447098	5420650
Deadman's Eddy	DM062	P	PW	NS	coarse	C	1,279.8	NA	447178	5420949
Deadman's Eddy	DM063	P	PW	NS	coarse	C	1,280.6	NA	447314	5420971
Deadman's Eddy	DM064	A	PW	NS	coarse	C	1,264.6	NA	447310	5421145
Deadman's Eddy	DM065	A	PW	NS	coarse	C	1,254.0	NA	447367	5421140
Deadman's Eddy	DM066	P	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,256.2	NA	447409	5421290
Evans	EV001	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,202.5	< 1220	422463	5391534
Evans	EV002	P	SE, PW, TX, BMI	TX	sampleable sand	S	1,204.0	< 1220	422495	5391672
Evans	EV003	A	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,201.3	< 1220	422509	5391491
Evans	EV004	A	SE, PW, TX, BMI	NS	mud	M	1,255.9	> 1250	422575	5391868
Evans	EV005	P	SE, PW, TX, BMI	NS	sampleable sand	S	1,202.1	< 1220	422603	5391705
Evans	EV006	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,200.2	< 1220	422660	5391744
Evans	EV007	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,195.2	< 1220	422728	5391709
Evans	EV008	P	SE, PW, TX, BMI	NS	sampleable sand	S	1,198.4	< 1220	422708	5391653
Evans	EV009	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,201.7	< 1220	422679	5391573
Evans	EV010	P	SE, PW, TX, BMI	PW	sampleable sand	mFs	1,201.2	< 1220	422660	5391528
Evans	EV011	A	SE, PW, BMI	NS	mixed coarse	mCs	1,217.4	< 1220	422776	5391453
Evans	EV012	P	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,199.8	< 1220	422815	5391576
Evans	EV013	P	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,200.8	< 1220	422910	5391593
Evans	EV014	P	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,216.0	< 1220	422857	5391808
Evans	EV015	P	SE, PW, BMI	SE, PW	mixed coarse	mCs	1,201.2	< 1220	423086	5391612
Evans	EV016	A	SE, PW, BMI	NS	mixed coarse	mCs	1,203.4	< 1220	423197	5391663
Evans	EV017	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,201.4	< 1220	423187	5391741

Table A1. Sampling Locations

Area	Location ID	Primary, Alternate, or Repeat	Sample Type(s)	EPA Split Sample Type(s)	Target Stratum	Target Facies	Facies Elevation (ft amsl)	Elevation Class	X_UTM_11N (meters)	Y_UTM_11N (meters)
Evans	EV018	P	PW	NS	coarse	mBs	1,205.9	< 1220	423341	5391692
Evans	EV019	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,199.7	< 1220	423420	5391883
Evans	EV020	A	SE, PW, BMI	NS	mixed coarse	mCs	1,207.3	< 1220	423492	5391761
Evans	EV021	P	PW	NS	coarse	mBs	1,208.0	< 1220	423640	5391827
Evans	EV022	P	SE, PW, BMI	NS	mixed coarse	mCs	1,208.0	< 1220	423655	5391802
Evans	EV023	P	PW	NS	coarse	mBs	1,238.0	1220 to 1250	423866	5391829
Evans	EV024	P	PW	NS	coarse	C	1,257.0	> 1250	423911	5391844
Evans	EV025	A	PW	NS	coarse	mBs	1,203.0	< 1220	423743	5392072
Evans	EV026	P	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,206.7	< 1220	423832	5392159
Evans	EV027	P	SE, PW, TX, BMI	TX	sampleable sand	mFs	1,201.6	< 1220	423866	5392028
Evans	EV028	A	SE, PW, BMI	NS	mixed coarse	mCs	1,200.9	< 1220	423968	5392005
Evans	EV029	P	PW	NS	coarse	mBs	1,197.4	< 1220	424041	5392086
Evans	EV030	A	PW	NS	coarse	mBs	1,195.7	< 1220	424077	5392080
Evans	EV031	A	SE, PW, BMI	NS	mixed coarse	mCs	1,201.9	< 1220	424127	5392055
Evans	EV032	A	PW	NS	coarse	C	1,253.1	> 1250	424207	5391990
Evans	EV033	A	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,192.3	< 1220	424117	5392138
Evans	EV034	P	SE, PW, BMI	NS	mixed coarse	mCs	1,232.0	1220 to 1250	424297	5392053
Evans	EV035	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,196.2	< 1220	424189	5392225
Evans	EV036	P	SE, PW, BMI	NS	mixed coarse	mCs	1,232.7	1220 to 1250	424415	5392111
Evans	EV037	P	SE, PW, TX, BMI	SE, PW	sampleable sand	S	1,204.9	< 1220	424273	5392314
Evans	EV038	A	PW	NS	coarse	C	1,232.8	1220 to 1250	424510	5392190
Evans	EV039	A	SE, PW, BMI	NS	mixed coarse	mCs	1,201.4	< 1220	424508	5392336
Evans	EV040	A	PW	NS	coarse	mBs	1,211.4	< 1220	424602	5392305
Evans	EV041	P	PW	NS	coarse	mBs	1,209.0	< 1220	424691	5392415
Evans	EV042	P	SE, PW, BMI	NS	mixed coarse	mCs	1,201.5	< 1220	424768	5392626
Evans	EV043	A	PW	NS	coarse	mBs	1,204.4	< 1220	424735	5392717
Evans	EV044	P	SE, PW, TX, BMI	TX	mud	M	1,258.0	> 1250	424998	5392740
Evans	EV045	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,199.0	< 1220	424714	5392805
Evans	EV046	P	SE, PW, TX, BMI	NS	sampleable sand	S	1,269.9	> 1250	425232	5392896
Evans	EV047	A	SE, PW, TX, BMI	NS	mud	M	1,257.2	> 1250	425146	5392954
Evans	EV048	P	SE, PW, TX, BMI	NS	sampleable sand	S	1,182.5	< 1220	424638	5392930
Evans	EV049	P	SE, PW, BMI	NS	mixed coarse	mCs	1,210.6	< 1220	424694	5392956
Evans	EV050	A	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,214.3	< 1220	424726	5393028
Evans	EV051	P	SE, PW, TX, BMI	NS	sampleable sand	S	1,205.3	< 1220	424659	5393066
Evans	EV052	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,207.1	< 1220	424623	5393169
Evans	EV053	P	SE, PW, TX, BMI	NS	sampleable sand	S	1,206.5	< 1220	424702	5393228

Table A1. Sampling Locations

Area	Location ID	Primary, Alternate, or Repeat	Sample Type(s)	EPA Split Sample Type(s)	Target Stratum	Target Facies	Facies Elevation (ft amsl)	Elevation Class	X_UTM_11N (meters)	Y_UTM_11N (meters)
Evans	EV054	P	SE, PW, TX, BMI	NS	mud	M	1,259.9	> 1250	425060	5393189
Evans	EV055	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,203.0	< 1220	424633	5393349
Evans	EV056	A	SE, PW, TX, BMI	NS	mud	M	1,255.5	> 1250	424977	5393465
Evans	EV057	P	SE, PW, TX, BMI	NS	mud	M	1,258.0	> 1250	424823	5393493
Evans	EV058	P	SE, PW, TX, BMI	NS	sampleable sand	S	1,223.9	1220 to 1250	424681	5393481
Evans	EV059	P	SE, PW, TX, BMI	NS	sampleable sand	S	1,207.5	< 1220	424554	5393581
Evans	EV060	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,205.2	< 1220	424566	5393697
Evans	EV061	A	SE, PW, TX, BMI	NS	mud	M	1,256.6	> 1250	424911	5393737
Evans	EV062	P	SE, PW, TX, BMI	PW	sampleable sand	S	1,260.6	> 1250	425015	5393767
Evans	EV063	P	SE, PW, TX, BMI	PW	mud	M	1,256.1	> 1250	424892	5393901
Evans	EV064	P	SE, PW, TX, BMI	NS	mud	M	1,260.8	> 1250	424645	5393930
Evans	EV065	P	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,206.3	< 1220	424462	5393916
Evans	EV066	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,205.6	< 1220	424474	5393994
Evans	EV067	P	SE, PW, TX, BMI	NS	sampleable sand	S	1,211.6	< 1220	424537	5394017
Evans	EV068	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,216.5	< 1220	424557	5394086
Evans	EV069	P	SE, PW, TX, BMI	TX	sampleable sand	S	1,204.2	< 1220	424427	5394120
Evans	EV070	A	SE, PW, TX, BMI	NS	mud	M	1,260.2	> 1250	424984	5394215
Evans	EV071	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,197.3	< 1220	424445	5394262
Evans	EV072	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,204.7	< 1220	424378	5394308
Evans	EV073	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,204.4	< 1220	424343	5394388
Evans	EV074	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,224.5	1220 to 1250	424476	5394396
Evans	EV075	P	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,204.6	< 1220	424385	5394453
Evans	EV076	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,205.2	< 1220	424290	5394457
Birchbank - Lower	REF001	NA	SE, PW, TX, BMI	NS	mixed	na	NA	NA	447485	5445991
Birchbank - Lower	REF002	NA	SE, PW, TX, BMI	NS	sand	na	NA	NA	447480	5446078
Birchbank - Upper	REF003	NA	SE, PW, TX, BMI	PW	sand	na	NA	NA	447868	5446883
Birchbank - Upper	REF004	NA	SE, PW, TX, BMI	TX	mixed	na	NA	NA	447835	5446938
Genelle - Upper	REF005	NA	SE, PW, TX, BMI	NS	mixed	na	NA	NA	448553	5450152
Genelle - Upper	REF006	NA	SE, PW, TX, BMI	NS	mixed	na	NA	NA	448703	5450052
Genelle - Upper	REF007	NA	SE, PW, TX, BMI	TX	sand	na	NA	NA	448724	5450204
Genelle - Upper	REF008	NA	SE, PW, TX, BMI	NS	sand	na	NA	NA	448597	5450270
Genelle - Upper	REF009	NA	SE, PW, TX, BMI	NS	sand	na	NA	NA	448711	5450339
Genelle - Upper	REF010	NA	SE, PW, TX, BMI	NS	mixed	na	NA	NA	449186	5450484
Upstream of Genelle	REF011	NA	SE, PW, TX, BMI	SE, PW	sand	na	NA	NA	451247	5453302
Upstream of Genelle	REF012	NA	SE, PW, TX, BMI	NS	mixed	na	NA	NA	451453	5453402
Arrow Lake	REF013	NA	SE, PW, TX, BMI	NS	sand/mud	na	NA	NA	435361	5466488

Table A1. Sampling Locations

Area	Location ID	Primary, Alternate, or Repeat	Sample Type(s)	EPA Split Sample Type(s)	Target Stratum	Target Facies	Facies Elevation (ft amsl)	Elevation Class	X_UTM_11N (meters)	Y_UTM_11N (meters)
Arrow Lake	REF014	NA	SE, PW, TX, BMI	NS	sand/mud	na	NA	NA	435264	5466533
Arrow Lake	REF015	NA	SE, PW, TX, BMI	TX	sand/mud	na	NA	NA	435187	5466555
Arrow Lake	REF016	NA	SE, PW, TX, BMI	NS	sand/mud	na	NA	NA	418677	5492191
Arrow Lake	REF017	NA	SE, PW, TX, BMI	NS	sand/mud	na	NA	NA	418638	5492298
Arrow Lake	REF018	NA	SE, PW, TX, BMI	PW	sand/mud	na	NA	NA	418575	5492381
Deadman's Eddy	1-B5-NRT	R	SE, PW, TX, BMI	NS	NA	NA	NA	NA	446376	5421101
Deadman's Eddy	1-B6-NRT	R	SE, PW, TX, BMI	NS	NA	NA	NA	NA	446353	5421016
China Bend	3-R7-2019	R	SE, PW, TX, BMI	NS	NA	C	NA	NA	430299	5407152
China Bend	3-R8-2019	R	SE, PW, TX, BMI	NS	NA	B	NA	NA	429442	5407277
Evans	4-B1-2019	R	SE, PW, TX, BMI	NS	NA	S	NA	NA	424499	5393517
Evans	4-B6-2019	R	SE, PW, TX, BMI	NS	NA	bedrock	NA	NA	423102	5391739

Notes:

Primary judgmental (JS001 and JS002) and alternate judgmental (JS003 and JS004) sample locations were added to the China Bend area of interest (AOI) as requested by EPA.

A - alternate

BMI - benthic macroinvertebrate

na - not available

NA - not applicable

NS - not specified as an EPA split location by EPA

P - primary

PW - porewater

R - repeat

SE - sediment

TX - potential toxicity testing

Facies

M - mud (silt and clay, < 0.063 mm)

S - sand (0.063 mm – 2 mm)

B - boulder/cobble (> 64 mm)

mFs - mixed finer-grained, predominantly sand

mCs - mixed coarse, with sand

mBs - mixed boulder/cobble, with sand

C - coarse

Table A2. Sample Containers, Holding Times, Preservation, and Sample Quantity

Priority	Analysis	Container Type	Container Size	Filtered	Field Preservation	Holding Time	Minimum Laboratory Sample Size	Total Minimum Sample Size Needed [a, b, c]	Target Sample Size[d]
Part A. Bulk Sediment Analysis									
1	Total metals, percent moisture	WMG	8 oz	NA	4±2ºC	6 months	10 g	312 g	30 g
	EPA 6020A metals								
	EPA 6010C metals								
2	Total mercury					28 days	5 g		15 g
2	TOC						1 g		3 g
2	SEM-AVS		8 oz		no headspace; 4±2ºC	14 days	25 g		75g
3	Grain size		8 oz		4±2ºC	6 months	100 g		300 g
3	Backscatter electron microscopy		16 oz			NA	TBD		TBD
4	Organic chemicals		8 oz (2x)			14 days or 1 year if frozen	161 g		483 g
Total sediment volumes for chemical/physical analysis			56 oz (1.4 L)				312 g		936 g
Part B. Benthic Macroinvertebrate Analysis									
1	Taxonomic enumeration and identification	HDPE	1.0 L or 5 gal bucket	NA	90% ethanol	1 month, transfer to 70% ethanol after 1 month for longer holding time	500 sort count	0.1 m^2 sediment area (10 L or 2.7 gal)	0.1 m^2 sediment area (10 L or 2.7 gal)
Part C. Sediment Bioassays									
1	42-day *H. azteca* bioassay	plastic	2 gal	NA	4±2ºC	ASAP[e]	2.5 L (0.7 gal)	20 L	5 L (1.4 gal)
2	TIE		5 gal			NA	19 L (5 gal)		19 L (5 gal)
Total sediment volumes for sediment bioassays							21.5 L (5.7 gal)		24 L (6.3 gal)
Part D. In situ Sediment Porewater									
Dissolved Metals									
1	EPA 6020A metals	HDPE	125 mL	field filtered	HNO_3 to pH<2; 4±2ºC	6 months	20 mL	190 mL	60 mL
	EPA 6010C metals								
	Hardness[f]	NA	NA	NA	NA	NA	NA		NA
Organic Carbon									
2	DOC	amber glass	125 mL	field filtered	4±2ºC; H_2SO_4 to pH < 2	28 days	40 mL	190 mL	80 mL
	TOC	amber glass	125 mL	not filtered					
Conventional Parameters									
3	Alkalinity as $CaCO_3$	HDPE	125 mL	not filtered	4±2ºC	14 days	35 mL	190 mL	100 mL
	Chloride, sulfate					28 days	10 mL		
3	Sulfide (select locations only)[g]		250 mL (holds up to 270 mL[g])		No headspace, ZnAc, NaOH to pH>9; 4±2ºC	7 days	25 mL		270 mL[g]
Total porewater volumes for analysis							190 mL		320 mL or 570 mL[h]

Table A2. Sample Containers, Holding Times, Preservation, and Sample Quantity

Priority	Analysis	Container Type	Container Size	Filtered	Field Preservation	Holding Time	Minimum Laboratory Sample Size	Total Minimum Sample Size Needed [a, b, c]	Target Sample Size[d]
Part E: Bioassay Laboratory-generated Sediment and Porewater									
Sediment									
1	SEM-AVS	WMG	4 oz	NA	< 80% full; nitrogen headspace; frozen[i]	14 days	25 g	26 g	75 g
	TOC					28 days	1 g		3 g
Centrifuge Porewater									
1	EPA 6020A metals	HDPE	125 mL	filtered	1 mL of 20% HNO_3, pH<2; 4±2ºC	6 months	20 mL	150 mL	60 mL
	EPA 6010 metals								
	Hardness	NA	NA	NA	NA	NA	NA		NA
2	DOC	amber glass	125 mL	filtered	4±2ºC; H_2SO_4 to pH < 2	28 days	40 mL		80 mL
3	Alkalinity as $CaCO_3$	HDPE	125 mL	not filtered	4±2ºC	14 days	35 mL	150 mL	100 mL
	Chloride, sulfate					28 days	10 mL		
	Sulfide	HDPE	40 mL		no headspace, ZnAc, NaOH to pH>9; 4±2ºC	7 days	25 mL		40 mL
Peeper Porewater									
1	EPA 6020A metals	HDPE	125 mL	filtered	See Pacific EcoRisk SOP (Appendix C)	6 months	20 mL[j]	20 mL	20 mL

Notes:

[a] Total sample size does not include additional sample volumes needed for laboratory quality control or field duplicate samples. If sufficient sample volume is available, attempt to fill all sample containers provided. If insufficient sample volume is available, fill containers to laboratory minimums in order of priority and then fill the priority containers with any remaining sample.

[b] Project field duplicate samples should be collected for 10 percent of all analytical sediment samples and 5 percent of porewater samples and submitted blind to the analytical laboratory. Due to potential limitations on availability of porewater, field duplicates for porewater will be by bottle (or by analysis), not by sample location. If required, EPA split sediment samples will also be collected.

[c] EPA split samples will be collected for sediment chemistry locations (5 percent), bioassay locations (4 L at 15 selected locations), and porewater locations (15 percent). Locations for sediment, bioassay, and porewater splits for metal analysis are identified in Table A1. EPA split sediment samples will be taken directly after collection of the primary sample for metal analysis and require a minimum of 20 g in an 8 oz glass jar (fill completely when possible). EPA split porewater samples will be taken directly after collection of the primary porewater sample for metal analysis and require a minimum of 30 ml in a 125 ml high density polyethylene (HDPE) container. In addition, at one sediment and one porewater EPA split location, aditional sample is required for laboratory analytical QA/QC purposes. The EPA split QA/QC sediment sample requires a full 8 oz jar of sediment while the EPA split QA/QC porewater sample requires a minimum of 50 ml porewater. Finally, one EPA split field duplicate sample will be taken for sediment and porewater at a location determined based on the ability to collect aliquots for both an EPA split and EPA split field duplicate.

[d] If target volume exceeds container size listed, additional containers will be filled.

[e] After review of preliminary data and TAI and EPA agree on samples for bioassays.

[f] Hardness will be calculated from dissolved metals results for calcium (Ca) and magnesium (Mg) per: equivalent calcium carbonate ($CaCO_3$) = 2.5 (mg Ca2+/L) + 4.1(mg Mg2+/L).

[g] At locations where sulfide analysis is deemed necessary based on field measurements, a 250-mL HDPE bottle will be filled with no headspace. The approximate volume of sample required to fill a 250-mL bottle with no headspace is 270 mL. See SOP-7 in Attachment A2 to the Field Sampling Plan. (QAPP Appendix A) for field measurement criteria for collecting samples for sulfide analysis.

[h] The total porewater volume required is either 320 mL or 590 mL, depending on necessity for sulfide analysis.

i In anticipation that the sediment sample volume may not always be sufficient to completely fill the 4 oz jar (as occurred during the Phase 2 Sediment Study [Windward 2017]), samples will be covered with nitrogen and frozen. Place the 4 oz sample jar in an 8 oz wide-mouth glass (WMG) jar and add nitrogen to the headspace before freezing the sample to provide secondary containment in case the 4 oz sample jar cracks.

[j] The volume of porewater prepared from peepers will be less than 20 mL See Pacific EcoRisk SOP (QAPP Appendix C) for details.

ASAP - as soon as possible
DOC - dissolved organic carbon
H_2SO_4 - sulfuric acid
HNO_3 - nitric acid
NA - not applicable
NaOH - sodium hydroxide
SEM-AVS - simulatneously extracted metal minus acid volatile sulfide
TBD - to be determined
TIE - Toxicity Identification Evaluation
TOC - total organic carbon
ZnAc - zinc acetate

ATTACHMENT A1

GENERAL SITE HEALTH AND SAFETY PLAN
ADDENDUM
PHASE 3 SEDIMENT STUDY

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ACRONYMS AND ABBREVIATIONS

AOI	area of interest
CFR	Code of Federal Regulations
COPC	chemical of potential concern
DEET	diethyl-m-toluamide
ERM	Environmental Resources Management
FSP	field sampling plan
HAZWOPER	hazardous waste operations and emergency response
IDLH	immediately dangerous to life and health
OSHA	Occupational Safety and Health Administration
OU	Operable Unit
PEL	permissible exposure limit
PFD	personal flotation device
PPE	personal protective equipment
QAPP	quality assurance project plan
RI/FS	remedial investigation and feasibility study
SHSP	site health and safety plan
Site	Upper Columbia River site
STEL	short-term exposure limit
TAI	Teck American Incorporated
UCR	Upper Columbia River
WISHA	Washington Industrial Safety and Health Act

UNITS OF MEASURE

ft	foot/feet
m	meter(s)
L	liter(s)

SITE HEALTH AND SAFETY PLAN ADDENDUM APPROVAL

This Addendum to the general site health and safety plan (SHSP) has been reviewed and approved by Teck American Incorporated's (TAI) lead technical consultant (Environmental Resources Management [ERM]) for the Phase 3 Sediment Study at the Upper Columbia River (UCR) site (Site) in support of the remedial investigation and feasibility study (RI/FS) for the Site.

ERM Task Manager Date

ERM Project Health and Safety Officer Date

SITE HEALTH AND SAFETY PLAN ADDENDUM ACKNOWLEDGEMENT

This Addendum to the general SHSP (TCAI 2009) is approved by TAI for use at the Site. The general SHSP and Addendum are the minimum health and safety standards for the Site and will be strictly enforced for all personnel conducting field activities associated with the Phase 3 sediment study at the Site. Subcontracted personnel may request to adopt a subcontractor-specific plan in lieu of this Addendum to the general SHSP, but must obtain prior written approval from TAI and provide written concurrence from the subcontractor that the subcontractor will assume direct responsibility and liability for administering the plan to its employees.

I have reviewed this Addendum to the general SHSP for the study. I have had an opportunity to ask any questions I may have and have been provided with satisfactory responses. I understand the purpose of the plan, and I consent to adhere to its policies, procedures, and guidelines.

Employee signature	Company	Date
Employee signature	Company	Date
Employee signature	Company	Date
Employee signature	Company	Date
Employee signature	Company	Date
Employee signature	Company	Date
Employee signature	Company	Date

1 INTRODUCTION

This Addendum to the Upper Columbia River (UCR) remedial investigation and feasibility study (RI/FS) general site health and safety plan (SHSP) provides specific Upper Columbia River site (Site) information and health and safety provisions to protect workers from potential hazards during sediment and porewater collection activities at locations along the UCR.

Site background information and general health and safety provisions to protect workers from potential hazards during work at the Site are presented in the general SHSP (TCAI 2009).

Subcontractors that are contracted to perform field work associated with the RI/FS may adopt the general SHSP and this Addendum or develop and follow their own SHSPs. However, subcontractor SHSPs must be consistent with the provisions outlined in the Addendum and the general SHSP, and any discrepancies will follow the most protective practices.

It is Environmental Resources Management's (ERM's) policy to provide a safe and healthful work environment. No aspect of the work is more important than protecting the health and safety of all workers.

ERM cannot guarantee the health or safety of any person entering the Site. Because of the potentially hazardous nature of the Site and the activity occurring thereon, it is not possible to regulate personal diligence or to discover, evaluate, and provide protection for all possible hazards that may be encountered. Strict adherence to the health and safety guidelines set forth herein will reduce, but not eliminate, the potential for injury and illness at the Site. The health and safety guidelines in this plan were prepared specifically for the Site and should not be used on any other site without prior evaluation by trained health and safety personnel.

A copy of this Addendum and the general SHSP must be in the custody of the field crew during field activities. All individuals performing field work must read, understand, and comply with this plan before undertaking field activities. Once the information has been read and understood, the individual must sign the Site Health and Safety Acknowledgment Form provided with this Addendum to the general plan. Any changes to the plan will be written in the plan and initialed by all potentially affected field personnel. The signed form and any initialed changes will become part of ERM's project file. A copy of the form will be provided to Teck American Incorporated (TAI).

This Addendum may be modified at any time based on the judgement of the site safety officer in consultation with the corporate health and safety officer and project manager or designee. Any modification will be presented to the onsite team during a safety briefing and will be recorded in the field notebook.

1.1 ORGANIZATION

Task-specific safety procedures associated with sediment and porewater sample collection activities are presented in this Addendum to the general SHSP. In addition, this Addendum provides detailed field study area and hospital location maps, air monitoring requirements, specific requirements for personal protective equipment (PPE), work zone definitions, and key emergency contact information.

The general SHSP (TCAI 2009) provides background site information and general health and safety provisions to protect workers from potential hazards during field activities. The information includes general safety guidelines for physical hazards, a chemical hazard evaluation, health and safety training requirements, general PPE requirements, emergency planning, general decontamination procedures, vehicle safety, and spill containment.

1.2 SCOPE OF WORK

Surface sediment and porewater sample collection activities will be conducted by a TAI field contractor during late-summer, early-fall 2019. As indicated in the quality assurance project plan (QAPP), sample collection locations are within three areas of interest (AOIs) within the Upper Reach Operable Unit (OU), which encompasses the UCR from the U.S.-Canada border to an area just north of Marcus Flats within the Site (Attachment A1-1). In addition, reference samples will also be collected from the Columbia River at five locations upstream of the U.S.-Canada border. Sediment samples will be collected using a Van Veen grab, modified Hamon grab, freeze grab, or appropriate handheld grab. Porewater samples will be collected using the Trident porewater sampler. Details on these samplers are provided with the Phase 3 sediment study field sampling plan (FSP). The coordinates of each sampling location are specified in the FSP.

1.3 DEFINITIONS

Contamination reduction zone	Area between the exclusion and support zones that provides a transition between contaminated and clean zones
Exclusion zone	Any area of the Site where hazardous substances are present, or are reasonably suspected to be present, and pose an exposure hazard to personnel
HAZWOPER	Hazardous Waste Operations and Emergency Response standard, as described in 29 Code of Federal Regulations (CFR) Part 1910.120
OSHA	Occupational Safety and Health Administration
Support zone	Any area of the Site, so designated, that is outside the exclusion and contamination reduction zones
WISHA	Washington Industrial Safety and Health Act, as described in Chapter 49.17 Revised Code of Washington

2 SAFETY GUIDELINES FOR PHYSICAL HAZARDS

2.1 GENERAL PROJECT HAZARDS

All work will be done using the buddy system. Depending upon the time of year and the location of work, biting insects, venomous snakes, and other wildlife may be an issue when accessing any of the sampling locations during the sampling events. Table 2-1 summarizes potential physical hazards posed by proposed Site activities. Table 2-2 presents potential physical hazards that are expected to be present during sampling activities.

Table 2-1. Summary of Activities and Potential Hazards

Activity	Potential Hazard
Sediment and porewater sampling	Boating and water hazards, slippery walking surfaces, cold/hypothermia (depending on sampling event), heat stress (depending on sampling event), material handling, adverse weather, work in remote areas

Table 2-2. Potential Physical Hazards and Proposed Safety Procedures

Potential Hazard	Yes	No	Proposed Safety Procedure
Uneven terrain/tripping, slippery walking surfaces	X		Use caution; wear properly fitting shoes or boots with good gripping capacity and ankle support; keep work area orderly.
Cold/hypothermia	X		Keep warm and dry, bring changes of clothes; do not work in extreme conditions without proper equipment and training; follow cold stress information (Attachment A1-2); potential for cold/hypothermia will depend on season.
Heat stress	X		Drink water frequently in hot weather; take work breaks; follow the heat-related illness policy (Attachment A1-3); potential for heat stress will depend on season.
Material handling	X		Lift properly; seek assistance if necessary; do not overfill coolers or boxes.
Hot water	X		Wear appropriate clothing, safety goggles, and use insulated container/handle; keep work area orderly to minimize trip hazards.
Compressed gas	X		Store nitrogen tank upright, in a secure location; a locking cylinder cap will be installed when transferring compressed gas cylinders. See Attachment A1-4 for Safety Data Sheet.
Dry ice	X		Store dry ice within a secure, insulated container. Proper PPE will be worn when transferring dry ice. See Attachment A1-4 for Safety Data Sheet.
Adverse weather	X		Seek shelter during storms; work in adverse weather conditions only with proper training, clothing, and equipment.

Table 2-2. Potential Physical Hazards and Proposed Safety Procedures (continued)

Potential Hazard	Yes	No	Proposed Safety Procedure
Drowning	X		All employees, when working in or near water (i.e., within 10 ft/3 m) where there is a potential to voluntarily, or involuntarily, enter the water must wear a Type III personal flotation device (PFD), Type V work vest, or better. All water work (including work near water) must be performed during daylight hours. Maintain good housekeeping during all activities to prevent slips, trips, and falls. Inspect the PFDs prior to use and do not use defective PFDs. Keep sampling equipment on the shore organized at all times.
Work in remote areas	X		Use the buddy system; carry radio and/or cellular telephone; carry satellite telephone, bring sufficient equipment in case of accident or injury (first aid kit, shelter if appropriate). A satellite telephone is necessary due to the unpredictable cellular network.
Biting insects, ticks, and mosquitos	X		**Biting insects.** Use repellents, as needed. **Ticks.** Wear long-sleeved clothing and ankle-length boots and try to avoid excessive contact with tall brush or grass. Personnel should change clothes and inspect their skin and scalps for ticks after every day of field work. If individuals discover a tick embedded in their skin, it should be removed as soon as possible. Grasp the tick with a blunt pair of tweezers as close to the skin as possible and remove it using slow even pressure. Do not break off the head or release fluids from the tick. Gently scrub the area with soap and water after removal. Note the date of the bite and watch for symptoms such as fever, chills, aches, and rashes for a month after the bite. If these symptoms occur, consult a doctor. **Mosquitos.** Use an insect repellent containing N, N-diethyl-m-toluamide (DEET). Wear long-sleeved shirts, pants, and hat; spray clothing with insect repellent containing DEET. Avoid handling dead animals. The risk of getting West Nile Virus is very low. Symptoms include fever, headache, neck stiffness, stupor, disorientation, tremors, convulsions, muscle weakness, paralysis, and body aches. If you develop any of these symptoms, contact your health care provider.
Stinging insects, bees/wasps (allergic reaction)	X		Avoiding wearing bright colors or scents. Use an appropriate insect repellent. Wear long-sleeved shirt, hat, and gloves. Employees must notify supervisor if they have allergies to bee/wasp stings prior to engaging in field activities. Employees with allergies may be required to carry an appropriate antidote kit.
Poisonous plants, poison ivy, poison sumac	X		Poison ivy generally has three green leaves on each stem. The color and appearance can vary throughout the year. Poison sumac generally occurs as a woody shrub or small tree with 7 to 13 leaflets as pairs along a central midrib and a single leaf at the end. The color and appearance can vary throughout the year. It has a smooth texture and is bright orange (spring) or glossy dark green with red midribs (summer). Avoid contact with all parts of the poison ivy or sumac plants. Contact with the oily resins on the plant may cause a skin rash. The rash usually appears within 24 to 48 hours and can last for weeks. If poison ivy or sumac is contacted, remove the affected clothing and wash the skin with soap and water to remove the oil resins as soon as possible.

Table 2-2. Potential Physical Hazards and Proposed Safety Procedures (continued)

Potential Hazard	Yes	No	Proposed Safety Procedure
Wildlife encounter	X		See individual animals listed below.
Poisonous snakes (rattlesnakes)	X		Wear appropriate PPE such as ankle-high leather boots, long pants, snake chaps, long sleeves when possible, a hat, and gloves if cutting brush or handling and moving vegetation. Do not reach into burrows or dens, under rocks, or logs. Walk heavily through brush. Back away if a snake is encountered. Take snake bite kit with a complete set of instructions. In case of a snake bite, seek prompt medical assistance. The injured employee should rest while awaiting (or being transported to) medical assistance. Workers should seek medical attention if bitten.
Black bear (potential attack)	X		If you come in contact with a black bear, stay calm and avoid eye contact. Try to stay upwind and identify yourself as a human being by standing up, talking, and waving your hands above your head. If you cannot safely move away from the bear and the animal does not flee, try to scare it away by clapping your hands or yelling. If the bear attacks, fight back aggressively. As a last resort if the attack continues, protect yourself by curling into a ball or lie on the ground on your stomach playing dead. Do not stand between mother and cub. Take bear mace with a complete set of instructions. All employees must be trained in the proper use of bear spray, which includes reading the manufacturer's instructions and listening to discussions during project planning and daily health and safety meetings.
Grizzly bear/ brown bear (potential attack)	X		If you are attacked by a grizzly bear, play dead. Lie flat on your stomach or curl up in a ball with your hands behind your head. Remain motionless as long as possible. Do not run. Do not stand between mother and cub. Take bear mace with a complete set of instructions. All employees must be trained in the proper use of bear spray, which includes reading the manufacturer's instructions and listening to discussions during project planning and daily health and safety meetings.
Cougar (potential attack)	X		If you come in contact with a cougar, stop, stand tall, and don't run. Try to appear larger than the cougar. Never take your eyes off the animal or turn your back. If the animal displays aggressive behavior, shout, wave your arms, and throw rocks. If the cougar attacks, fight back aggressively and stay on your feet.
Moose (between mother/calf)	X		If you come in contact with a moose, step back. Look for the nearest tree, fence, or building or other obstruction to hide behind. It's usually a good idea to run from a moose because it usually won't chase you far. If a moose knocks you down, curl up in a ball, protect your head with your arms and hands, and hold still. Don't move or try to get up until the moose moves a safe distance away.

2.2 PROJECT-SPECIFIC HAZARDS

Wildlife. As listed above, there is an abundance of wildlife in the study area. Based on previous sampling events in the study area during summer and fall months, there have been encounters with snakes, evidence of bear foraging, and bee/wasp nests both in trees and in the grass. Employees should remain alert and aware of their surroundings during the field event and follow proposed

safety procedures above for wildlife known to inhabit the area. In the event of a wildlife encounter that causes a safety concern, use field vehicles for shelter if the vehicles can be reached safely. Use your best judgement while still following safety tips described above to determine if you can reach the vehicle.

Water work. This work will include sampling by TAI field contractors on or near water where there is a potential to voluntarily, or involuntarily, enter the water. With a few exceptions for wadeable locations, sediment and porewater sample collection will occur from a boat within waterbodies in the study area. All employees, when working **in** or **near** water (i.e., within 10 ft/3 m) where the danger of drowning exists, must wear a Type III personal flotation device (PFD), Type V work vest, or better. The PFDs must be inspected prior to use and not used if defective. It is recommended that employees wear a PFD during oversight of sampling activities in water (even if the employee is located outside of the 10-ft exclusion zone near the water) in case an emergency situation arises, which may require the employee to move into the 10-ft exclusion zone by the water.

While working inside operator cabs of vessels, the operator must only wear a manually inflated PFD. This type of PFD has been shown to improve safe operator egress in the event of a submerged cab. Upon egressing the cab, the operator can activate the PFD to provide flotation. No hydrostatic PFDs shall be worn. This type of PFD can inhibit the safe egress of the operator in the event of a submerged cab. In addition, cabs must contain a break glass hammer and a bottle of emergency breathing air within reach of the operator. All Teck and long-term contractor equipment must have an emergency escape hatch in the roof of the cab.

All water work (including work near water) must be performed during daylight hours. All employees must maintain good housekeeping during all sampling activities to prevent slips, trips, and falls.

Traversing through rough terrain. If traversing unpaved roads or rough terrain, always drive slowly and cautiously on site and between sites. Do not attempt to drive in areas such as steep, degraded, and/or undrivable roads. If rough terrain is encountered while driving, stop the car in a secure location, and, if safe, attempt to assess the roadway condition on foot. If a roadway is blocked, stop the car, and, if safe by foot, determine if there is a suitable and safe alternative route around the obstruction at that location. Consult local maps to determine if an alternative route is available. If a different route is unavailable, contact the ERM principal investigator or TAI project coordinator to discuss alternative options.

3 CHEMICAL HAZARD EVALUATION

A chemical hazard evaluation is presented in the general SHSP (TCAI 2009) and incorporated herein by reference. However, the Phase 3 sediment study includes additional sampling methods that require the use of additional chemicals (ethanol and methanol) not covered in the general SHSP. A chemical hazard evaluation for these additional chemicals is provided below.

3.1 ADDITIONAL CHEMICALS USED IN THIS STUDY

Methanol and ethanol will be used during normal operations at sediment sampling locations (see Attachment A1-4 for Safety Data Sheets). A brief description of each chemical's associated hazards is included below.

Methanol: A flammable liquid that can cause adverse health effects through ingestion, skin absorption, and inhalation. Dermal contact may result in skin irritation; prolonged or repeated contact can cause a skin rash, dryness, and redness.

Ethanol: A flammable liquid, ethanol can cause adverse health effects through ingestion and inhalation. Dermal contact may result in skin irritation.

3.2 CHEMICAL PROPERTIES

Table 3-1 summarizes the properties of chemicals required for the Phase 3 sediment study, which are not described in the general SHSP (TCAI 2009), i.e., methanol and ethanol. Health and safety-related information for these chemicals, including chemical properties and OSHA's permissible exposure limit (PEL), short-term exposure limit (STEL), and immediately dangerous to life and health (IDLH) level, are also summarized.

Table 3-1. Chemical-Specific Information

Chemical of Concern	Maximum Concentration	Use	OSHA PEL	OSHA STEL	IDLH	Odor Threshold	Carcinogen or Other Hazard
Methanol	Concentrated	Coolant	200 ppm	250 ppm	6,000 ppm	4.2-5,960 ppm	N, Rep, F
Ethanol	90% by volume	Pres.	1,000 ppm	1,000 ppm	3,300 ppm	49-716 ppm	N, Rep, F

Notes:

F	Flammable
N	Neurotoxin
----	None established
PEL	Permissible exposure limit
ppm	Parts per million
Pres.	Preservative
Rep	Reproductive toxin
STEL	Short-term exposure limit

Source: NIH. Haz-Map. https://hazmap.nlm.nih.gov/category-details?id=481&table=copytblagents

3.3 CHEMICAL CHARACTERISTICS AND EXPOSURE ROUTES

Tables 3-2 and 3-3 summarize the potential chemical exposure routes at the Site and chemical characteristics. Safety Data Sheets are provided in Attachment A1-4.

Table 3-2. Potential Chemical Exposure Routes at the Site

Potential Chemical Exposure Routes at the Site	Likely	Possible	Unlikely
Inhalation			E, M
Ingestion			E, M
Skin absorption			E, M
Eye contact			E, M

Notes:
E = Ethanol; ethanol will be used as a preservative for benthic macroinvertebrate samples; this will be conducted outside on the deck of the boat and will be well-ventilated. Nitrile gloves and safety glasses/goggles will be worn.
M = Methanol; methanol will be used as a coolant for the freeze grab sampler. Inhalation is the primary concern; use will occur outside in a well- ventilated area and protective eyewear will be worn.

Table 3-3. Chemical Characteristics

Characteristic	Yes	No
Corrosive		E, M
Ignitable	E, M	
Reactive		E, M
Volatile	E, M	
Radioactive		E, M
Explosive		E, M
Biological agent		E, M
Particulates or fibers		E, M

Notes:
E = Ethanol; ethanol will be used as a preservative for benthic macroinvertebrate samples; this will be conducted outside on the deck of the boat and will be well ventilated. Nitrile gloves and safety glasses/goggles will be worn.
M = Methanol; methanol will be used as a coolant for the freeze grab sampler. Inhalation is the primary concern; use will occur outside in a well-ventilated area and protective eyewear will be worn.

Liquid methanol (~ 0.5 L) in conjunction with solid carbon dioxide (~ 3 L of dry ice) will be used as a coolant for sediment sampling attempts with the freeze grab sampler. Methanol, stored in a clearly labeled air tight container, will be poured into a ~1 L container located on the freeze grab sampler prior to each sampling attempt. Loading of the freeze grab will occur outside on the boat deck and will therefore be performed in a well-ventilated area. While dry ice is typically consumed during each sampling attempt, methanol will be reused; following each sampling attempt, the remaining methanol will be collected within a sealable plastic jug and retained for subsequent freeze grab attempts. Ingestion and skin contact of methanol is unlikely because nitrile gloves and safety glasses/goggles (and insulated gloves if deemed necessary) will be worn at all times while handling methanol and dry ice. Methanol will be used in small quantities and on the deck of a boat; therefore, it is unlikely that methanol will reach the PEL concentration listed in Table 3-1.

Ethanol will be used as a preservative for benthic macroinvertebrate samples. These samples will be placed within a 1-L wide-mouthed jar and filled two-thirds with ethanol, fully submerging the sample. Ethanol will be stored in an air tight container in a well-ventilated area and will be clearly labeled. While handling ethanol, safety goggles and nitrile gloves will be worn at all times. It is therefore unlikely that ingestion or skin contact will occur. In addition, because operations will occur on an open deck, it is unlikely that ethanol will be sufficient to reach the PEL concentration listed in Table 3-1.

4 PERSONAL PROTECTIVE EQUIPMENT AND SAFETY EQUIPMENT

The following sections address PPE and safety equipment required for completing the sampling activities.

4.1 PERSONAL PROTECTIVE EQUIPMENT

Based on chemical and physical hazards associated with sediment and porewater sample collection activities, Tables 4-1 and 4-2 identify the PPE required for sampling.

Table 4-1. Level of Protection Required for Site Activities

	Level of Protection	
Site Activity	Initial[a]	Contingency[b]
Sediment collection	MD	Leave Site, reassess situation
Porewater collection	MD	Leave Site, reassess situation
Sample handling	D	Leave Site, reassess situation

[a] See Table 4-2 for definitions

[b] Based on unexpected change in Site conditions

Table 4-2. Levels of Protection and Personal Protective Equipment

Protection Level	Required	Personal Protective Equipment
Level D	X	Long pants and shirt or work coveralls, safety glasses or goggles (as appropriate), and nitrile, neoprene, or Barrier® 5-layer laminate gloves (as appropriate). Hard hat and hearing protection as needed.
Level MD	X	Same as Level D with modification (M) of adding rain gear, insulated gloves, and PFD, as needed.

Is there potential for a respirator to be donned during field work? Yes _____ No X

4.2 SAFETY EQUIPMENT

The following safety equipment will be on site during the proposed field activities.

Air Monitoring (check the items required for this project):

- ☐ Photoionization detector
- ☐ Lower explosive limit/oxygen meter
- ☐ Hydrogen sulfide meter
- ☐ Detector pump and tubes
- ☐ Air sampling pumps
- ☐ Miniram
- ☐ Radiation meter
- ☐ Other _____

First Aid Kit (mandatory, including adhesive band-aids, gauze, tape, gloves, cardiopulmonary resuscitation shield, triangle bandage):

[X]	Emergency blanket	[X]	Sunscreen
[X]	Insect repellent	[ ]	Other _____

Other (check the items required for this project):

[X]	Eyewash	[ ]	Fit test supplies
[X]	Drinking water	[X]	Fire extinguisher
[ ]	Stop watch for monitoring heart	[ ]	Windsock
[ ]	Thermoscan® thermometer (or equivalent) for heat stress monitoring	[X]	Cellular telephone
		[X]	Radio sets (if no cellular or satellite telephone service)
[X]	Survival kit	[X]	Global positioning system
[X]	Personal flotation device	[ ]	Other:

5 AIR MONITORING

The principal chemicals of potential concern (COPCs) at the Site are not volatile (i.e., metals). There is a small chance for the COPCs to become airborne in dust form if the sediment is dry, although the sediments are unlikely to contain a significant amount of fine particles. In addition, the chemical hazard evaluation presented in the general SHSP (TCAI 2009) concluded that, based on previous evaluations, none of the sediment chemicals are expected to pose a threat to field personnel during sediment sampling activities. If windblown dust becomes problematic to the field crew, operations may be suspended. Tables 5-1 and 5-2 provide air monitoring requirements and action levels to be used during sampling activities.

Methanol and ethanol can cause adverse health effects at sufficient concentrations. Unsafe concentrations are unlikely to occur due to their use on an open boat deck with high levels of ventilation. The chemical hazard evaluation in Section 3 of this Addendum concluded that based on expected use, none of the additional chemicals listed will pose a threat to field personnel during sediment and porewater sampling activities.

Table 5-1. Site-specific Air Monitoring Requirements

Monitoring Instrument	Calibration Frequency	Parameters of Interest	Monitoring Frequency
Visual	Not applicable	Dust	Continuous

Table 5-2. Action Levels Established to Determine the Appropriate Level of Personal Protection

Instrument	Reading	Action [a]	Comments
Visual	Visual Dust	Leave site, if necessary	

6 EMERGENCY PLANNING

In case of any emergency affecting the Site, all affected personnel must immediately evacuate the work area and report to the Site safety officer at the following predetermined location:

DESIGNATED ASSEMBLY LOCATION—Field vehicle

In case of injury, field personnel should take precautions to protect the victim from further harm and notify local emergency services. In remote areas, it will be necessary to have first aid-trained personnel on the field team. The victim may require decontamination prior to treatment—requirements will vary based on Site conditions.

When working in Canada, call 911 for medical emergencies. For other non-life threatening injuries, field personnel should contact the field supervisor to determine whether to transport the victim to a medical facility in Canada or to one of the designated hospitals in the U.S.

Emergency medical care will be provided by:

[X] Local emergency medical provider (i.e., fire department; see Table 6-1 for local contact information)

[X] Facility emergency medical provider

[X] First aid-trained field staff (for remote areas only)

Table 6-1. Local Emergency Telephone Numbers

Local Resources	Name	Telephone	Notified Prior to Work (Yes/No)?
Fire	Varies by location	911	Yes. Notify the E911 coordinator for Stevens County (Kendle Allen; 509-684-5296) of the schedule and location of work
Police	Varies by location	911	Yes (see above)
Ambulance	Varies by location	911	Yes (see above)
Main Hospital	Mount Carmel Hospital, Colville, WA	509-684-2561	No
Alternative Hospitals	St. Joseph's Hospital, Chewelah, WA	509-935-8211	No
	Ferry County Memorial Hospital, Republic, WA	509-775-3333	No
	MultiCare Valley Hospital, Spokane, WA	509-924-6650	No
	Coulee Community Hospital, Grand Coulee, WA	509-633-1753	No
	Holy Family Hospital, Spokane, WA	509-482-0111	No
	Veterans Affairs Medical Center, Spokane, WA	509-434-7032	No
	Sacred Heart Medical Center, Spokane, WA	509-474-3131	No
	Deaconess Medical Center-Spokane, Spokane, WA	509-473-7178	No
	Lincoln Hospital, Davenport, WA	509-725-7101	No

Table 6-1. Local Emergency Telephone Numbers (continued)

Local Resources	Name	Telephone	Notified Prior to Work (Yes/No)?
Field cellular telephone or satellite telephone	Cellular telephone coverage is spotty in the vicinity of the sampling areas. If cellular telephone coverage is lost due to a mountain or hill, drive a little farther to get coverage. If cellular telephone coverage is available, the 911 system will work. A satellite telephone may be necessary for areas with limited cellular telephone coverage.	Cellular or satellite telephone number TBD	Not applicable
Directions to Mount Carmel Hospital	Begin traveling southeast on Highway 395. Highway 395 becomes Main Street in Colville. Turn LEFT on E. Columbia Avenue. Go 0.6 mile. Arrive at 982 E. Columbia Avenue. Hospital is on right. (See detailed hospital location maps in Attachment A1-1)		

In case of serious injuries, death, or other emergency, after local emergency services have been contacted, the TAI project coordinator and ERM task manager or ERM principal investigator must be notified immediately. Contact numbers are listed in Table 6-2.

Table 6-2. Corporate Emergency Telephone Numbers

Corporate Resources	Name	Work/Cellular Telephone
TAI Project Coordinator	Kris McCaig	Work: 509-623-4501 Cellular: 509-434-8542
TAI Assistant Project Coordinator	Denise Mills	Work: 509-623-4515 Cellular: 509-904-9375
ERM Task Manager	Kevin Lundmark	Work: 801-204-4313 Cellular: 801-440-8296
ERM Principal Investigator	Jennifer Holder	Work: 805-684-2801 Cellular: 805-680-8484

Table 6-3 provides local hospital contact and location information. See Attachment A1-1 for a detailed hospital location map.

Table 6-3. Project Area Hospital Information

Facility Name	Open for Emergency Services	Telephone Number	Address	City
Mount Carmel Hospital	24 hours	509-684-2561	982 East Columbia Street	Colville
St. Joseph's Hospital	24 hours	509-935-8211	500 East Webster Street	Chewelah
Ferry County Memorial Hospital	24 hours	509-775-3333	36 Klondike Road	Republic
MultiCare Valley Hospital	24 hours	509-924-6650	12606 E. Mission Avenue	Spokane
Coulee Community Hospital	24 hours	509-633-1753	411 Fortuyn Road	Grand Coulee
Holy Family Hospital	Dependent on case	509-482-0111	North 5633 Lidgerwood Avenue	Spokane
Veterans Affairs Medical Center	7:30 am to 4:00 pm	509-434-7032	North 4815 Assembly Street	Spokane
Sacred Heart Medical Center	24 hours	509-474-3131	West 101 Eighth Avenue	Spokane
Deaconess Medical Center-Spokane	24 hours	509-473-7178	West Fifth Avenue	Spokane
Lincoln Hospital	24 hours	509-725-7101	10 Nichols Street	Davenport

If any health or safety issue arises, after the victim receives appropriate medical treatment, the relevant field crew members will be interviewed to formally document, at a minimum, the incident by the field supervisor and task manager. All incidents will be documented in the field logbook. If applicable, a corrective action form will be filled out (see FSP Attachment A3) to ensure future health and safety issues are addressed.

7 WORK ZONES

The following work zones are defined for the sediment and porewater sampling activities:

Exclusion zone. The area immediately around the sampling activities will be designated as the exclusion zone. Because the majority of sampling will be on the water, and in remote locations, no designation (e.g., traffic cones or caution tape) will be used.

Contamination reduction zone. Not applicable. All sampling activities will occur within the exclusion zone.

Support zone. Not applicable. All sampling activities will occur within the exclusion zone.

Controls to be used to prevent entry by unauthorized persons. The sampling team will remain cognizant of people approaching the exclusion zone. All unauthorized persons will be instructed to remain outside of the sampling area.

8 DECONTAMINATION

The field team will decontaminate all sampling equipment used for sediment and porewater locations, including any equipment that comes into contact with sediment or porewater prior to the commencement of sampling at each location and upon completion of the study. This will include equipment such as trowels, mixing bowls, and utensils. The decontamination will consist of thoroughly rinsing all of the equipment with potable water, then with soap (i.e., Alconox®), and rinsed with potable water after each use.

Clean gloves will be worn at each sampling location to avoid transfer of potential contaminants among samples. Otherwise, decontamination procedures will follow those presented in the general SHSP (TCAI 2009) and are incorporated herein.

9 VEHICLE SAFETY, SPILL CONTAINMENT, AND SHIPPING INSTRUCTIONS

Vehicle safety, spill containment, and shipping instructions are presented in the general SHSP (TCAI 2009) and are incorporated herein.

10 TASK-SPECIFIC SAFETY PROCEDURES

Slips, trips, and falls are anticipated to be the greatest hazards to field personnel during the sediment and porewater sampling event, as well as unexpected contact with the sampling equipment. Always move about the boat and shore with caution. Wear properly fitting shoes or boots with non-slip soles and good ankle support. Be aware of the location and movement of the sampling equipment at all times. Ensure compressed gas canisters are placed securely onboard the boat to prevent movement or tipping during normal boat operations.

Inhalation exposure due to methanol, ethanol, carbon dioxide, and nitrogen is anticipated to be minimal due to the volume of these substances used, and their use outside or in well-ventilated locations. While handling these substances, appropriate safety gloves and safety glasses/goggles will be used at all times.

The Site is located in a remote region with limited cellular telephone coverage. All field crews will have two-way radios or a satellite telephone to maintain communication with the field supervisor. The field crews will coordinate departure and expected return times for all field activities with the field supervisor. Field crews will provide the field supervisor and principal investigator with status updates at least every 4 hours while performing field collection activities.

When working onboard a boat or near/over water, a PFD will be worn at all times. Inspect the PFDs daily prior to use, and do not use if defective or expired. Information on boating safety is presented in the general SHSP (TCAI 2009; Section 9.2).

Some of the areas that will be sampled are accessible to the public. Always be aware of your surroundings. Use the buddy system and keep in line-of-sight contact with other sampling personnel at all times. Do not leave samples or sampling equipment unattended. If you feel threatened, or if the situation feels unpredictable, leave the area immediately.

Always wear nitrile gloves and safety glasses or goggles when handling sampling equipment, samples, preservative chemicals, hot water, or methanol. Keep a 1-L eye wash solution accessible during all field work. Avoid getting preservatives, methanol, or hot water on your skin or clothes. If preservatives, methanol, or hot water are spilled or splashed on your skin or clothes, immediately rinse the affected area with potable water and seek medical attention, if warranted. If any preservative or methanol is splashed in the eye, flush the eye with the eye wash solution and get immediate medical attention, if warranted.

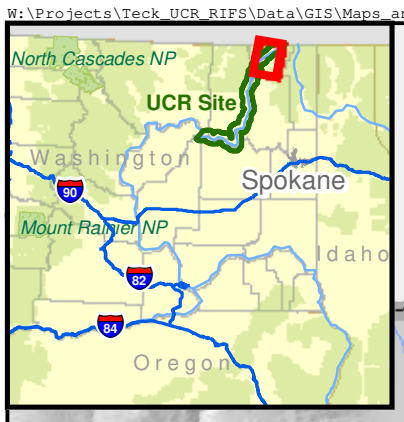
11 REFERENCES

TCAI (Teck Cominco American Incorporated). 2009. Upper Columbia River general site health and safety plan for the remedial investigation and feasibility study. Prepared for Teck American Incorporated. Integral Consulting Inc., Mercer Island, WA, and Parametrix, Seattle, WA.

ATTACHMENT A1-1

SITE MAP AND HOSPITAL LOCATION MAP

W:\Projects\Teck_UCR_RIFS\Data\GIS\Maps_and_Analyses\Phase 3 Support\Sediment QAPP\Site Health and Safety Plan\6841 Upper Reach OU.mxd @ 06/12/2019



U.S. - Canada Border

RM 744

RM 740

Deadman's Eddy

Big Sheep Creek

Deadman's Eddy

North Fork Deep Creek

251

Northport

RM 730

Deep Creek

25

China Bend

China Bend

RM 720

South Fork Deep Creek

Cable Ferry Landing

Bossburg Flat Beach

Evans Campground

RM 710

Evans

South Fork Deep Creek

Legend

- Upper Reach OU AOI
- Upper Columbia River
- Stream
- Populated Places
- State Highway
- Railroad
- River Mile (USGS)

Windward environmental LLC

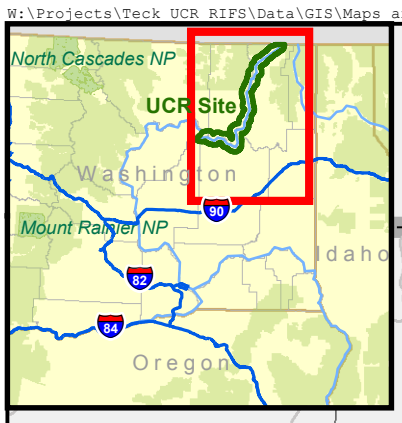
0 2 4 Km

0 1 2 Miles

N

Study Area Map
Upper Columbia River, WA

W:\Projects\Teck UCR RIFS\Data\GIS\Maps and Analyses\Phase 3 Support\Sediment QAPP\Site Health and Safety Plan\6900 Hospital Location Map.mxd @ 06/06/2019



U.S. - Canada Border

Deadman's Eddy
RM 744
RM 740
Deadman's Eddy
Northport
251
RM 730
China Bend
RM 720
China Bend
Cable Ferry Landing
Bossburg
Flat Beach
Evans
Evans Campground
RM 710
Marcus Flats
Ferry County Memorial Hospital
Kettle Falls
RM 700
Colville
Providence Mount Carmel Hospital
RM 690
RM 680
Gifford
Providence Saint Joseph's Hospital
RM 670
Colville Indian Reservation
RM 660
RM 650
Coulee Medical Center
Grand Coulee Dam
Keller Ferry
RM 600
RM 620
RM 610
RM 640
RM 630
Spokane Indian Reservation
Deer Park
Nine Mile Falls
Providence Holy Family Hospital
Mann - Grandstaff Veterans Affairs Medical Center
Lincoln Hospital
Multicare Valley Hospital
Multicare Deaconess Hospital
Providence Sacred Heart Medical Center
Spokane
Airway Heights
Cheney
Odessa Memorial Healthcare Center

21 20 25 155 174 2 395 231 232 211 292 291 290 206 902 904 27 28 23 195

Legend

- Hospital
- EPA Area of Interest
- Grand Coulee Dam
- Populated Places
- Interstate Highway
- US Highway
- State Highway
- Local Road
- County Lines
- Reservations
- River Mile (USGS)

Windward environmental LLC

0 10 20 Km

0 5 10 Miles

N

Hospital Location Map
Upper Columbia River, WA

ATTACHMENT A1-2

COLD-STRESS FACT SHEET

FROSTBITE

What happens to the body:

Freezing in deep layers of skin and tissue; pale, waxy-white skin color; skin becomes hard and numb; usually affects fingers, hands, toes, feet, ears, and nose.

What to do: (land temperatures)

- Move the person to a warm, dry area. Don't leave the person alone.
- Remove wet or tight clothing that may cut off blood flow to the affected area.
- **Do not** rub the affected area because rubbing damaged the skin and tissue.
- Gently place the affected area in a warm water bath (105°) and monitor the water temperature to **slowly** warm the tissue. Don't pour warm water directly on the affected area because it will warm the tissue too fast, causing tissue damage. Warming takes 25-40 minutes.
- After the affected area has been warmed, it may become puffy and blister. The affected area may have a burning feeling or numbness. When normal feeling, movement, and skin color have returned, the affected area should be dried and wrapped to keep it warm. **Note:** If there is a chance the affected area may get cold again, do not warm the skin. If the skin is warmed and then becomes cold again, it will cause severe tissue damage.
- Seek medical attention as soon as possible.

How to Protect Workers

- Recognize the environmental and workplace conditions that lead to potential cold-induced illnesses and injuries.
- Learn the signs and symptoms of cold-induced illnesses/injuries and what to do to help the worker.
- Train workers about cold-induced illnesses and injuries.
- Select proper clothing for cold, wet, and windy conditions. Layer clothing to adjust to changing environmental temperatures. Wear a hat and gloves, in addition to underwear that will keep water away from the skin (polypropylene.)
- Take frequent short breaks in warm, dry shelters to allow the body to warm up.
- Perform work during the warmest part of the day.
- Avoid exhaustion or fatigue because energy is needed to keep muscles warm.
- Use the buddy system (work in pairs.)
- Drink warm, sweet beverages (sugar water, sports-type drinks.) **Avoid drinks with caffeine** (coffee, tea, or hot chocolate) **or alcohol**.
- Eat warm, high-calorie foods like hot pasta dishes.

Workers are at increased risk when…

- They have predisposing health conditions such as cardiovascular disease, diabetes, and hypertension.
- They take certain medications. Check with your doctor, nurse, or pharmacy and ask if medicines you take affect you while working in cold environments.
- They are in poor physical condition, have a poor diet, or are older.

HYPOTHERMIA - (Medical Emergency)

What happens to the body:

Normal body temperature (98.6°F/37°C) drops to or below 95°F/35°C; fatigue or drowsiness; uncontrolled shivering; cool, bluish skin; slurred speech; clumsy movements; irritable, irrational, or confused behavior.

What to do: (land temperatures)

- Call for emergency help (i.e., ambulance or 911).
- Move the person to a warm, dry area. Don't leave the person alone.
- Remove wet clothing and replace with warm, dry clothing or wrap the person in blankets.
- Have the person drink warm, sweet drinks (sugar water or sports-type drinks) if he is alert. **Avoid drinks with caffeine** (coffee, tea, or hot chocolate) **or alcohol.**
- Have the person move his arms and legs to create muscle heat. If he is unable to do this, place warm bottles or hot packs in the armpits, groin, neck, and head areas. **Do not** rub the person's body or place him in a warm water bath. This may stop his heart.

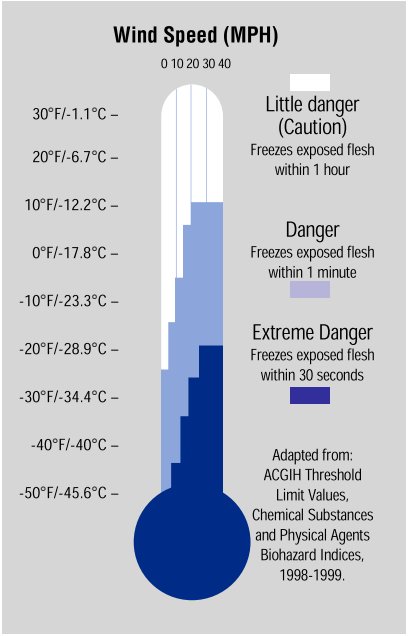
What to do: (water temperatures)

- Call for emergency help (i.e., ambulance or 911). Body heat is lost up to 25 times faster in water.
- **Do not** remove any clothing. Button, buckle, zip, and tighten any collars, cuffs, shoes, and hoods because the layer of trapped water closest to the body provides a layer of insulation that slows the loss of heat. Keep the head out of the water and put on a hat or hood.
- Get out of the water as quickly as possible or climb on anything floating. **Do not** attempt to swim unless a floating object or another person can be reached because swimming or other physical activity uses body heat and reduces survival time by about 50 percent.
- If getting out of the water is not possible, wait quietly and conserve body heat by folding arms across the chest, keeping thighs together, bending knees, and crossing ankles. If another person is in the water, huddle together with chests held closely.

THE COLD STRESS EQUATION

LOW TEMPERATURE + WIND SPEED + WETNESS = INJURIES & ILLNESS

When the body is unable to warm itself, serious cold-related illnesses and injuries may occur, and permanent tissue damage and death may result. **Hypothermia** can occur when *land temperatures* are **above** freezing or *water temperatures* are below 98.6°F/37°C. Cold-related illnesses can slowly overcome a person who has been chilled by low temperatures, brisk winds, or wet clothing.



Oregon Occupational Safety & Health Division
440-3336E-S (9/03)

ATTACHMENT A1-3

HEAT-RELATED ILLNESS PREVENTION POLICY

Instructions:

The following document has been provided to assist your company in developing a written Heat Related Illness (HRI) Prevention Policy for Outdoor Work activities per WAC 296-62-095 through WAC 296-62-09570, Heat Related Illnesses in the Outdoor Environment.

The program outline follows the recommendations found in DOSH Directive (WRD) 18.50, Heat Related Illness in the Outdoor Environment.

You must tailor these procedures to meet your specific work site conditions. Simply printing off the procedures would not comply with the provisions of the HRI Rule.

The underlined areas and tables must be filled in to tailor this program to meet your needs.

To assist you in tailoring these sample procedures to your work site conditions the following documents are available for reference:

Appendix A: Heat and Humidity Chart
Appendix B: Examples of Workload Activities
Appendix C: Sample HRI First Aid and Emergency Response Procedures

"Protecting Employees Working Outdoors from Heat-Related Illnesses"

"Training Guide for Heat-Related Illnesses"

DOSH Directive (WRD) 18.50: Heat Related Illness in the Outdoor Environment (June 5, 2007)

You can find these documents and other helpful tools by visiting the Department of Labor and Industries website at:

http://www.lni.wa.gov/safety/topics/atoz/heatstress/default.asp

Heat-Related Illness (HRI) Prevention
Outdoor Work Policy

⇨ _____is committed to preventing Heat Related Illnesses—HRI that can occur to employees working in the outdoor environment.

⇨ _____recognizes that exposure to extreme temperature, humidity and other environmental factors can lead to serious illnesses including heat fatigue, heat rash, fainting, heat cramps, heat exhaustion, and heat stroke. The following formal policy has been developed to protect employees from the hazards posed by working in the outdoor environment and to comply with the written procedures as required by WAC 296-62-095 through WAC 296-62-09570, Heat Related Illnesses in the Outdoor Environment. Outdoor work includes any employee assigned to work in the outdoor environment on a regular basis.

I. HRI Training Plan

Prior to assignment of any outdoor work activities, employees and supervisors of

⇨ _____ will be trained on our HRI procedures and the elements outlined below.
(See "Training Guide for Heat-Related Illness"-Found on DOSH website)

A. Employee Training

- Recognizing the environmental causes of HRI and personal factors that can increase the risk
- How our company identifies, evaluates, and controls HRI exposure
- Removal of Personal Protective Equipment during all breaks
- Frequently consuming water when HRI hazards are present
- Importance of acclimatization (Getting used to hot weather)
- Different types of HRI and the common signs and symptoms
- Importance of immediately reporting HRI symptoms of themselves or co-workers
- How our company will respond to HRI symptoms and emergencies
- The purpose and requirements of the HRI rules

B. Supervisor Training

- How to implement the provisions of the HRI rule
- What to do when an employee exhibits signs or symptoms of HRI, including emergency response
- How to safely move employees to a place that is easily reached by emergency medical providers
- How to provide clear directions to emergency medical providers so they can find the work site

II. Evaluation of HRI Hazards

⇨ _____ will evaluate HRI hazards based on a combination of factors including temperature, humidity, and other environmental conditions in all workplaces where outdoor work is performed. ⇨ _____ will routinely evaluate potential HRI hazards by checking one or more of the following:

(See Appendix A: Heat Index Chart as an evaluation option)

Air Temperature and Humidity *(list your source of information)*

- Local weather report predictions from:

  _____

- On-site temperature and humidity measuring equipment (and location):

  _____

- Historical area weather data to approximate work site conditions from:

  _____

Other Environmental Factors *(list what may be present and increase HRI risk)*

- **Radiant Heat** *(Example: Reflection of heat from asphalt, rocks, or composite roofing material; or work in direct sunlight)*

  _____

  _____

- **Air Movement** *(Example: Wind blowing and temperature above 95 degrees F)*

  _____

  _____

- **Conductive Heat Sources** *(Example: Operating orchard tractor for mowing)*

  _____

  _____

- **Workload Activity and Duration** *(Example: Hand sawing wood, carrying masonry blocks, digging with a shovel)*

  _____

  _____

- **Personal Protective Equipment/Clothing** *(Example: Wearing respirator, chemical resistant suit, and gloves for pesticide application or HAZMAT clean-up; or leathers and gloves for welding)*

  _____

  _____

III. Procedures for Controlling Environmental Factors

⇨ _____ will control HRI environmental factors at the worksite to reduce HRI risks. Depending on the environmental factors present, we will use one or more of the following methods for controlling HRI risks to protect employees:

List your control methods, when they will be used, and what the expected outcome is.

Control Method	When Used	Expected Outcome
Example 1: Use water hose to wet towels or clothing and place on the body; use cooling vest or cooling headbands	*When temperature is going to reach 95 degrees or more; or Heat Index reaches 90*	*Cool the body temperature*
Example 2: Take breaks in shaded area (house, garage, canopy, under trees)	*When working in direct sun light (e.g. roofers, asphalt pavers, berry pickers)*	*Cool the body temperature*
Example 3: Start work shift early (when daylight begins) and end shift early, or do not work during hottest parts of day	*When temperature expected to reach 90 degrees or more*	*Reduce time exposed to heat and keep body temperature cooler*
Example 4:Remove respirator, chemical suit and gloves, or welding leathers during breaks	*When temperature is going reach 80 degrees or more*	*Cool the body temperature and all reduce humidity close to body*

IV. Drinking Water

Sufficient potable drinking water will be provided and made accessible to employees.

⇨ _____ is responsible for ensuring sufficient water is available. At least **one quart of water per employee per hour** will be available when HRI hazards are present. **If you notice water is not present notify your supervisor immediately**. Water can be found in the following locations: *(List your water sources and locations)*

- _____
- _____
- _____

V. Adjusting Rest Breaks for Increased Work Load and Duration

⇨_____ will use an adjusted rest break schedule to minimize employees risk when there is an increased risk of HRI hazards due to work loads. Supervisors will adjust rest breaks as follows:

(See Appendix B: Examples of Work Load Activities)

Work Activity	Adjusted Rested Breaks and When Used
Example: Thinning apples 8-hours, roofing a residential house 6-hours, carrying masonry blocks 4-hours, shoveling hot asphalt for 8-hours	*Example: An additional break before and after lunch when. . .* *-temperature reaches 90 degrees and humidity is 50%* *-performing heavy work in direct sunlight or on hot surfaces*

VI. Procedures for Responding to Heat-Related Illnesses

⇨_____ will respond to HRI in a quick and safe manner. The table below outlines the potential types of heat-related illnesses, signs and symptoms, and specific First Aid and HRI Emergency procedures. The information will be present at all work sites where outdoor work activities are present.

- Emergency medical phone number:_____
- Specific work site address:_____
- Driving directions from a major roadway to the work site:_____

  .

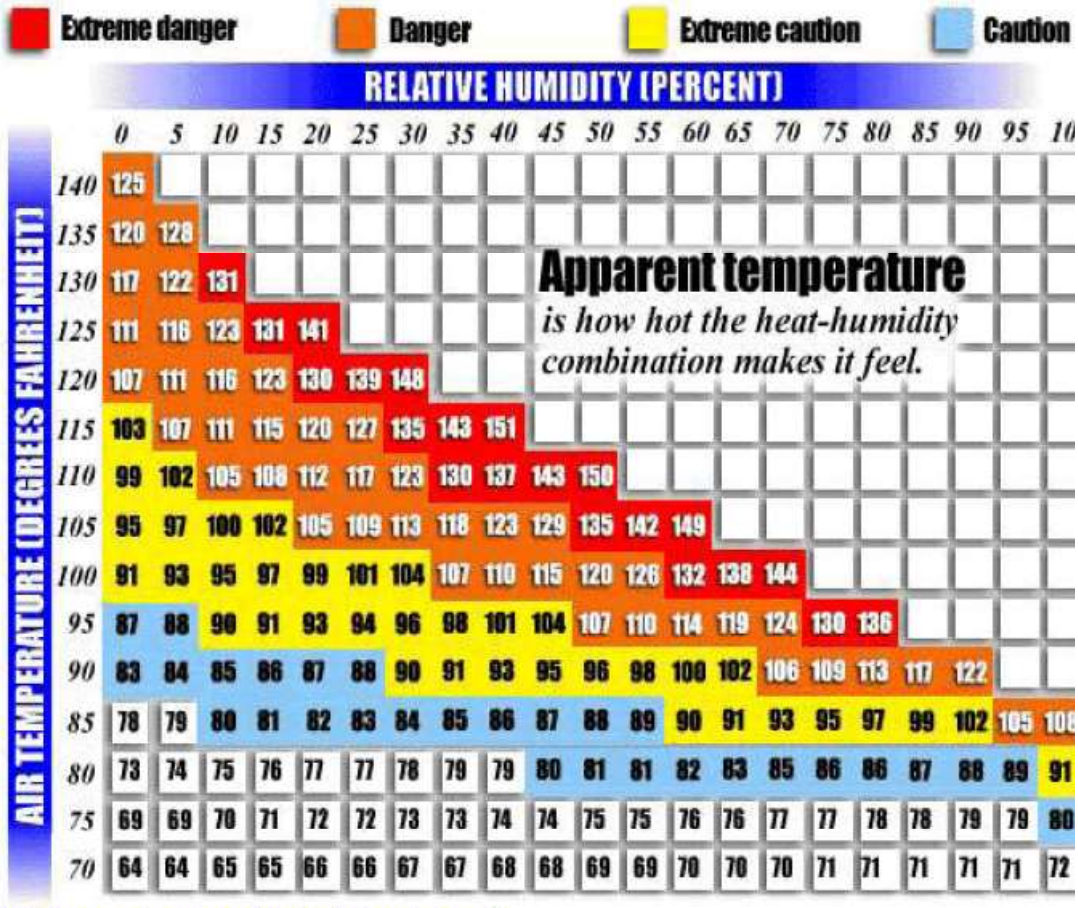
Procedures for Responding to Heat-Related Illnesses

(See Appendix C: Sample First Aid and Emergency Response Procedures)

Heat-Related Illness	Signs and Symptoms	First Aid and Emergency Response Procedures
Sunburn		
Heat Rash		
Heat Cramps		
Heat Exhaustion		
Heat Stroke		

APPENDIX A

Heat and Humidity Chart



http://www.crh.noaa.gov/dvn/tools/heatindex.pdf.

Heat Index	General Effect of Heat Index on People in Higher Risk Groups
80 - 89 *Caution*	Fatigue possible with prolonged exposure and physical activity.
90 - 104 *Extreme Caution*	Sunstroke, heat cramps, and heat exhaustion possible.
105 - 129 *Danger*	Sunstroke, heat cramps, and heat exhaustion likely, and heat stroke possible.
130 or higher *Extreme Danger*	Heat Stroke highly likely with continued exposure.

APPENDIX B

Examples of Workload Activities

Categories	Example Activities
Resting	Sitting quietly
	Sitting with moderate arm movements
Light	Sitting with moderate arm and leg movements
	Standing with light work at machine or bench while using mostly arms
	Using a table saw
	Standing with light or moderate work at machine or bench and some walking about
Moderate	Scrubbing in a standing position
	Walking about with moderate lifting or pushing
	Walking on level at 6 Km/hr while carrying 3 kg weight load
Heavy	Carpenter sawing by hand
	Shoveling dry sand
	Heavy assembly work on a non-continuous basis
	Intermittent heavy lifting with pushing or pulling (e.g. pick-and-shovel work)
Very Heavy	Shoveling wet sand

APPENDIX C:

Sample HRI First Aid and Emergency Response Procedures

Heat-Related Illness	Signs and Symptoms	First Aid and Emergency Response Procedures
Sunburn	• Red, hot skin • May blister	• Move to shade, loosen clothes to reduce temperature • Apply cool compress or water to cool burn • Get medical evaluation if severe
Heat Rash	• Red, itchy skin • Bumpy skin • Skin infection	• Apply cool water or compress to cool rash • Keep affected area dry to minimize infection • Control itching and infection with prescribed medication
Heat Cramps	• Muscle cramps or spasms • Grasping the affected area • Abnormal body posture	• Drink water or sports drinks to re-hydrate body • Rest, cool down in shaded area • Massage affected muscle to release body toxins • Get medical evaluation if cramps persist
Heat Exhaustion	• High pulse rate • Extreme sweating • Pale face • Insecure gait • Headache • Clammy and moist skin • Weakness • Fatigue • Dizziness	• Move to shade and loosen clothing to cool down • Initiate rapid cooling with fan, water mister, or ice packs • Lay flat and elevate feet to reduce heart rate and blood pressure • Monitor recovery (is body cooling?) • Drink small amounts of water to cool body and re-hydrate • Evaluate mental status (ask Who? Where? When? Q's) • **If no improvement call 911**
Heat Stroke	• Any of the above but more severe • Hot, dry skin (25-50% of cases) • Altered mental status with confusion and agitation • Can progress to loss of consciousness and seizures • Can be fatal	• **Call 911** • **Provide EMS with directions to work site** • Immediately remove from work activity to slow/stop body temp rise • Start rapid cooling with fan, water mister, or ice packs • Lay flat and elevate feet to reduce heart rate and blood pressure • If conscious give sips of water to cool body and re-hydrate • Monitor airway and breathing-administer CPR if needed

ATTACHMENT A1- 4

SAFETY DATA SHEETS

Ethyl Alcohol, 90% v/v

Safety Data Sheet

according to Federal Register / Vol. 77, No. 58 / Monday, March 26, 2012 / Rules and Regulations

Date of issue: 03/25/2014 Version: 1.0

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1. Product identifier

Product form : Mixture

Product name : Ethyl Alcohol, 90% v/v

Product code : VT240

Other means of identification : Ethanol, Denatured, 90% v/v

1.2. Relevant identified uses of the substance or mixture and uses advised against

Use of the substance/mixture : For laboratory and manufacturing use only.

1.3. Details of the supplier of the safety data sheet

Val Tech Diagnostics, A Division of LabChem Inc
Jackson's Pointe Commerce Park Building 1000
1010 Jackson's Pointe Court
Zelienople, PA 16063
T 412-826-5230
F 724-473-0647

1.4. Emergency telephone number

Emergency number : CHEMTREC: 1-800-424-9300 or 011-703-527-3887

SECTION 2: Hazards identification

2.1. Classification of the substance or mixture

GHS-US classification

Flam. Liq. 2	H225
Acute Tox. 4 (Oral)	H302
Skin Irrit. 2	H315
Eye Irrit. 2A	H319
Repr. 2	H361
STOT SE 3	H336
STOT SE 1	H370

2.2. Label elements

GHS-US labelling

Hazard pictograms (GHS-US) :

GHS02 GHS07 GHS08

Signal word (GHS-US) : Danger

Hazard statements (GHS-US) :
H225 - Highly flammable liquid and vapour
H302 - Harmful if swallowed
H315 - Causes skin irritation
H319 - Causes serious eye irritation
H336 - May cause drowsiness or dizziness
H361 - Suspected of damaging fertility or the unborn child
H370 - Causes damage to organs (central nervous system, optic nerve) (oral, Dermal)

Precautionary statements (GHS-US) :
P201 - Obtain special instructions before use
P202 - Do not handle until all safety precautions have been read and understood
P210 - Keep away from heat, hot surfaces, open flames, sparks. - No smoking
P233 - Keep container tightly closed
P240 - Ground/bond container and receiving equipment
P241 - Use explosion-proof electrical, lighting, ventilating equipment
P242 - Use only non-sparking tools
P243 - Take precautionary measures against static discharge
P260 - Do not breathe mist, spray, vapours
P264 - Wash exposed skin thoroughly after handling
P270 - Do not eat, drink or smoke when using this product
P271 - Use only outdoors or in a well-ventilated area

P280 - Wear eye protection, face protection, protective clothing, protective gloves
P301+P312 - IF SWALLOWED: call a POISON CENTER or doctor/physician if you feel unwell
P303+P361+P353 - IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower
P304+P340 - IF INHALED: remove victim to fresh air and keep at rest in a position comfortable for breathing
P305+P351+P338 - If in eyes: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
P308+P313 - IF exposed or concerned: Get medical advice/attention
P235 - Keep cool
P330 - If swallowed, rinse mouth
P332+P313 - If skin irritation occurs: Get medical advice/attention
P337+P313 - If eye irritation persists: Get medical advice/attention
P362 - Take off contaminated clothing and wash before reuse
P370+P378 - In case of fire: Use carbon dioxide (CO2), powder, alcohol-resistant foam for extinction
P403+P233 - Store in a well-ventilated place. Keep container tightly closed
P405 - Store locked up
P501 - Dispose of contents/container to comply with local, state and federal regulations

2.3. Other hazards

Other hazards not contributing to the classification : None.

2.4. Unknown acute toxicity (GHS-US)

No data available

SECTION 3: Composition/information on ingredients

3.1. Substance

Not applicable

Full text of H-phrases: see section 16

3.2. Mixture

Name	Product identifier	%	GHS-US classification
Ethanol	(CAS No) 64-17-5	74.55 - 80.55	Flam. Liq. 2, H225 Carc. 1A, H350 Repr. 2, H361
Water	(CAS No) 7732-18-5	9.63 - 14.45	Not classified
Isopropyl Alcohol (2-Propanol)	(CAS No) 67-63-0	3.69 - 4.83	Flam. Liq. 2, H225 Eye Irrit. 2A, H319 STOT SE 3, H336
Methanol	(CAS No) 67-56-1	3.34 - 4.83	Flam. Liq. 2, H225 Acute Tox. 3 (Oral), H301 Acute Tox. 3 (Dermal), H311 Acute Tox. 3 (Inhalation), H331 STOT SE 1, H370

SECTION 4: First aid measures

4.1. Description of first aid measures

First-aid measures general : Check the vital functions. Unconscious: maintain adequate airway and respiration. Respiratory arrest: artificial respiration or oxygen. Cardiac arrest: perform resuscitation. Victim conscious with laboured breathing: half-seated. Victim in shock: on his back with legs slightly raised. Vomiting: prevent asphyxia/aspiration pneumonia. Prevent cooling by covering the victim (no warming up). Keep watching the victim. Give psychological aid. Keep the victim calm, avoid physical strain. Depending on the victim's condition: doctor/hospital. Never give alcohol to drink.

First-aid measures after inhalation : Remove the victim into fresh air. Respiratory problems: consult a doctor/medical service.

First-aid measures after skin contact : Rinse with water. Take victim to a doctor if irritation persists.

First-aid measures after eye contact : Rinse immediately with plenty of water. Do not apply neutralizing agents. Take victim to an ophthalmologist if irritation persists.

First-aid measures after ingestion : Rinse mouth with water. Do not induce vomiting. Call Poison Information Centre (www.big.be/antigif.htm). Consult a doctor/medical service if you feel unwell. Ingestion of large quantities: immediately to hospital.

4.2. Most important symptoms and effects, both acute and delayed

Symptoms/injuries after inhalation : EXPOSURE TO HIGH CONCENTRATIONS: Dry/sore throat. Coughing. Irritation of the respiratory tract. Irritation of the nasal mucous membranes. Respiratory difficulties. Central nervous system depression. Symptoms similar to those listed under ingestion.

Symptoms/injuries after skin contact	:	Slight irritation.
Symptoms/injuries after eye contact	:	Redness of the eye tissue. Lacrimation. ON CONTINUOUS EXPOSURE/CONTACT: Irritation of the eye tissue.
Symptoms/injuries after ingestion	:	AFTER ABSORPTION OF HIGH QUANTITIES: Risk of aspiration pneumonia. Red skin. Body temperature rise. Damp/clammy skin. Excited/restless. Accelerated heart action. Central nervous system depression. Dizziness. Narcosis. Headache. Drunkenness. Nausea. Vomiting. Disturbed motor response. Coordination disorders. Visual disturbances. Impaired concentration. Delusions. Disturbed sensation of pain. Disturbances of heart rate. Disturbances of consciousness. Tremor. Cramps/uncontrolled muscular contractions. Dilated pupils.
Chronic symptoms	:	ON CONTINUOUS/REPEATED EXPOSURE/CONTACT: Dry skin. Gastrointestinal complaints. Enlargement/affection of the liver. Change in the haemogramme/blood composition. Cardiac and blood circulation effects. High arterial pressure. Impairment of the nervous system. Behavioural disturbances. Mental confusion. Disturbed tactile sensibility. Tremor. Affection of the bone marrow. Affection of the endocrine system. Weakening of the immune system.

4.3. Indication of any immediate medical attention and special treatment needed

No additional information available

SECTION 5: Firefighting measures

5.1. Extinguishing media

Suitable extinguishing media	:	Water spray. Alcohol-resistant foam. BC powder. Carbon dioxide.
Unsuitable extinguishing media	:	Solid water jet ineffective as extinguishing medium.

5.2. Special hazards arising from the substance or mixture

Fire hazard	:	DIRECT FIRE HAZARD. Highly flammable. Gas/vapour flammable with air within explosion limits. INDIRECT FIRE HAZARD. May be ignited by sparks. Gas/vapour spreads at floor level: ignition hazard. Reactions involving a fire hazard: see "Reactivity Hazard".
Explosion hazard	:	DIRECT EXPLOSION HAZARD. Gas/vapour explosive with air within explosion limits. INDIRECT EXPLOSION HAZARD. may be ignited by sparks. Reactions with explosion hazards: see "Reactivity Hazard".
Reactivity	:	Upon combustion: CO and CO2 are formed. Reacts violently with many compounds e.g.: with (strong) oxidizers: (increased) risk of fire/explosion. Violent to explosive reaction with (some) acids.

5.3. Advice for firefighters

Firefighting instructions	:	Cool tanks/drums with water spray/remove them into safety. Do not move the load if exposed to heat.
Protection during firefighting	:	Heat/fire exposure: compressed air/oxygen apparatus.

SECTION 6: Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

General measures	:	Remove ignition sources. Use special care to avoid static electric charges. No naked lights. No smoking.

6.1.1. For non-emergency personnel

Protective equipment	:	Gloves. Protective goggles. Protective clothing. Large spills/in enclosed spaces: compressed air apparatus.
Emergency procedures	:	Keep upwind. Mark the danger area. Consider evacuation. Seal off low-lying areas. Close doors and windows of adjacent premises. Stop engines and no smoking. No naked flames or sparks. Spark- and explosionproof appliances and lighting equipment. Keep containers closed. Wash contaminated clothes.

6.1.2. For emergency responders

Protective equipment	:	Equip cleanup crew with proper protection. Avoid breathing mist, spray, Vapors.
Emergency procedures	:	Ventilate area.

6.2. Environmental precautions

Prevent spreading in sewers.

6.3. Methods and material for containment and cleaning up

For containment	:	Contain released substance, pump into suitable containers. Consult "Material-handling" to select material of containers. Plug the leak, cut off the supply. Dam up the liquid spill. Try to reduce evaporation. Measure the concentration of the explosive gas-air mixture. Dilute/disperse combustible gas/vapour with water curtain. Provide equipment/receptacles with earthing. Do not use compressed air for pumping over spills.

Methods for cleaning up	:	Take up liquid spill into a non combustible material e.g.: sand, earth, vermiculite or kieselguhr, powdered limestone. Scoop absorbed substance into closing containers. See "Material-handling" for suitable container materials. Carefully collect the spill/leftovers. Damaged/cooled tanks must be emptied. Do not use compressed air for pumping over spills. Clean contaminated surfaces with an excess of water. Take collected spill to manufacturer/competent authority. Wash clothing and equipment after handling.

6.4. Reference to other sections

See Heading 8. Exposure controls and personal protection.

SECTION 7: Handling and storage

7.1. Precautions for safe handling

Precautions for safe handling	:	Comply with the legal requirements. Remove contaminated clothing immediately. Clean contaminated clothing. Handle uncleaned empty containers as full ones. Thoroughly clean/dry the installation before use. Do not discharge the waste into the drain. Do not use compressed air for pumping over. Use spark-/explosionproof appliances and lighting system. Take precautions against electrostatic charges. Keep away from naked flames/heat. Keep away from ignition sources/sparks. Observe normal hygiene standards. Keep container tightly closed. Measure the concentration in the air regularly. Work under local exhaust/ventilation.
Hygiene measures	:	Wash exposed skin thoroughly after handling.

7.2. Conditions for safe storage, including any incompatibilities

Technical measures	:	Proper grounding procedures to avoid static electricity should be followed. Ground/bond container and receiving equipment. Use explosion-proof electrical/ventilating/lighting/… equipment.
Storage conditions	:	Keep container tightly closed. Keep only in the original container in a cool, well ventilated place away from : incompatible materials. Keep in fireproof place.
Incompatible products	:	Strong bases. Strong acids.
Incompatible materials	:	Sources of ignition. Direct sunlight. Heat sources.
Heat and ignition sources	:	KEEP SUBSTANCE AWAY FROM: heat sources. ignition sources.
Prohibitions on mixed storage	:	KEEP SUBSTANCE AWAY FROM: oxidizing agents. (strong) acids. water/moisture.
Storage area	:	Keep out of direct sunlight. Store in a dry area. Ventilation at floor level. Fireproof storeroom. Provide for an automatic sprinkler system. Provide for a tub to collect spills. Provide the tank with earthing. Meet the legal requirements.
Special rules on packaging	:	SPECIAL REQUIREMENTS: closing. dry. clean. correctly labelled. meet the legal requirements. Secure fragile packagings in solid containers.
Packaging materials	:	SUITABLE MATERIAL: stainless steel. aluminium. iron. copper. nickel. synthetic material. glass.

7.3. Specific end use(s)

No additional information available

SECTION 8: Exposure controls/personal protection

8.1. Control parameters

Ethanol (64-17-5)		
USA OSHA	OSHA PEL (TWA) (mg/m³)	1900 mg/m³
USA OSHA	OSHA PEL (TWA) (ppm)	1000 ppm

Isopropyl Alcohol (2-Propanol) (67-63-0)		
USA ACGIH	ACGIH TWA (ppm)	200 ppm
USA ACGIH	ACGIH STEL (ppm)	200 ppm
USA OSHA	OSHA PEL (TWA) (mg/m³)	980 mg/m³
USA OSHA	OSHA PEL (TWA) (ppm)	400 ppm

Methanol (67-56-1)		
USA ACGIH	ACGIH TWA (ppm)	200 ppm
USA ACGIH	ACGIH STEL (ppm)	200 ppm
USA OSHA	OSHA PEL (TWA) (mg/m³)	260 mg/m³
USA OSHA	OSHA PEL (TWA) (ppm)	200 ppm

8.2. Exposure controls

Personal protective equipment	:	Avoid all unnecessary exposure.
Materials for protective clothing	:	GIVE EXCELLENT RESISTANCE: butyl rubber. viton. GIVE GOOD RESISTANCE: neoprene. tetrafluoroethylene. GIVE LESS RESISTANCE: nitrile rubber. polyethylene. GIVE POOR RESISTANCE: natural rubber. PVA. PVC.
Hand protection	:	Gloves.
Eye protection	:	Safety glasses.
Skin and body protection	:	Protective clothing.
Respiratory protection	:	Wear gas mask with filter type A if conc. in air > exposure limit.
Other information	:	Do not eat, drink or smoke during use.

SECTION 9: Physical and chemical properties

9.1. Information on basic physical and chemical properties

Physical state	:	Liquid
Appearance	:	Liquid.
Molecular mass	:	46.07 g/mol
Colour	:	Colourless.
Odour	:	Alcohol odour. Pleasant odour.
Odour threshold	:	100 ppm 188 mg/m³
pH	:	No data available
Relative evaporation rate (butylacetate=1)	:	2.4
Relative evaporation rate (ether=1)	:	8.3
Melting point	:	No data available
Freezing point	:	No data available
Boiling point	:	No data available
Flash point	:	25 °C
Self ignition temperature	:	No data available
Decomposition temperature	:	No data available
Flammability (solid, gas)	:	No data available
Vapour pressure	:	No data available
Relative vapour density at 20 °C	:	1.6
Relative density	:	No data available
Density	:	0.82 g/l
Solubility	:	Soluble in water. Soluble in ether. Soluble in acetone. Soluble in chloroform. Soluble in oils/fats. Soluble in methanol. Soluble in acids. Water: Complete Ethanol: Not applicable Ether: Complete Acetone: Complete
Log Pow	:	No data available
Log Kow	:	No data available
Viscosity, kinematic	:	No data available
Viscosity, dynamic	:	No data available
Explosive properties	:	No data available
Oxidising properties	:	No data available
Explosive limits	:	3.3 - 19.0 vol % 67 - 290 g/m³

9.2. Other information

Other properties	:	Gas/vapour heavier than air at 20°C. Clear. Hygroscopic. Volatile. Substance has neutral reaction.

SECTION 10: Stability and reactivity

10.1. Reactivity

Upon combustion: CO and CO2 are formed. Reacts violently with many compounds e.g.: with (strong) oxidizers: (increased) risk of fire/explosion. Violent to explosive reaction with (some) acids.

10.2. Chemical stability

Hygroscopic.

10.3. Possibility of hazardous reactions

Not established.

10.4. Conditions to avoid

Direct sunlight. Extremely high or low temperatures. Open flame.

10.5. Incompatible materials

Strong acids. Strong bases.

10.6. Hazardous decomposition products

fume. Carbon monoxide. Carbon dioxide. May release flammable gases.

SECTION 11: Toxicological information

11.1. Information on toxicological effects

Acute toxicity : Harmful if swallowed.

Ethanol (64-17-5)	
LD50 oral rat	10740 mg/kg (Rat; Experimental value,Rat; Experimental value)
LD50 dermal rabbit	> 16000 mg/kg (Rabbit)

Isopropyl Alcohol (2-Propanol) (67-63-0)	
LD50 oral rat	5045 mg/kg (5840 mg/kg bodyweight; Rat; Rat; Experimental value,5840 mg/kg bodyweight; Rat; Rat; Experimental value)
LD50 dermal rabbit	12870 mg/kg (16.4; Rabbit; Rabbit; Experimental value,16.4; Rabbit; Rabbit; Experimental value)
LC50 inhalation rat (mg/l)	73 mg/l/4h (Rat)

Water (7732-18-5)	
LD50 oral rat	≥ 90000 mg/kg

Methanol (67-56-1)	
LD50 oral rat	> 5000 mg/kg (1187-2769 mg/kg bodyweight; Rat; Rat)
LD50 dermal rabbit	15800 mg/kg (Rabbit)
LC50 inhalation rat (mg/l)	85 mg/l/4h (Rat)
LC50 inhalation rat (ppm)	64000 ppm/4h (Rat)

Skin corrosion/irritation : Causes skin irritation.

Serious eye damage/irritation : Causes serious eye irritation.

Respiratory or skin sensitisation : Not classified

Germ cell mutagenicity : Not classified

Based on available data, the classification criteria are not met

Carcinogenicity : Not classified

Ethanol (64-17-5)	
IARC group	1 - Carcinogenic to humans

Isopropyl Alcohol (2-Propanol) (67-63-0)	
IARC group	3 - Not classifiable

Reproductive toxicity : Suspected of damaging fertility or the unborn child.

Based on available data, the classification criteria are not met

Specific target organ toxicity (single exposure) : May cause drowsiness or dizziness. Causes damage to organs (central nervous system, optic nerve) (oral, Dermal).

Specific target organ toxicity (repeated exposure) : Not classified

Based on available data, the classification criteria are not met

Aspiration hazard : Not classified

Based on available data, the classification criteria are not met

Potential Adverse human health effects and symptoms	:	Harmful if swallowed. Based on available data, the classification criteria are not met.
Symptoms/injuries after inhalation	:	EXPOSURE TO HIGH CONCENTRATIONS: Dry/sore throat. Coughing. Irritation of the respiratory tract. Irritation of the nasal mucous membranes. Respiratory difficulties. Central nervous system depression. Symptoms similar to those listed under ingestion.
Symptoms/injuries after skin contact	:	Slight irritation.
Symptoms/injuries after eye contact	:	Redness of the eye tissue. Lacrimation. ON CONTINUOUS EXPOSURE/CONTACT: Irritation of the eye tissue.
Symptoms/injuries after ingestion	:	AFTER ABSORPTION OF HIGH QUANTITIES: Risk of aspiration pneumonia. Red skin. Body temperature rise. Damp/clammy skin. Excited/restless. Accelerated heart action. Central nervous system depression. Dizziness. Narcosis. Headache. Drunkenness. Nausea. Vomiting. Disturbed motor response. Coordination disorders. Visual disturbances. Impaired concentration. Delusions. Disturbed sensation of pain. Disturbances of heart rate. Disturbances of consciousness. Tremor. Cramps/uncontrolled muscular contractions. Dilated pupils.
Chronic symptoms	:	ON CONTINUOUS/REPEATED EXPOSURE/CONTACT: Dry skin. Gastrointestinal complaints. Enlargement/affection of the liver. Change in the haemogramme/blood composition. Cardiac and blood circulation effects. High arterial pressure. Impairment of the nervous system. Behavioural disturbances. Mental confusion. Disturbed tactile sensibility. Tremor. Affection of the bone marrow. Affection of the endocrine system. Weakening of the immune system.

SECTION 12: Ecological information

12.1. Toxicity

Ecology - water : Not harmful to fishes (LC50(96h) >1000 mg/l). Not harmful to invertebrates (Daphnia). Slightly harmful to algae (EC50 (72h): 100 - 1000 mg/l). Not harmful to bacteria (EC50 >1000 mg/l). Inhibition of activated sludge.

Ethyl Alcohol, 90% v/v	
Threshold limit other aquatic organisms 1	65 mg/l (72 h; Protozoa)
Threshold limit algae 1	1450 mg/l (192 h; Microcystis aeruginosa; Growth rate)
Threshold limit algae 2	5000 mg/l (168 h; Scenedesmus quadricauda; Growth rate)

Ethanol (64-17-5)	
LC50 fishes 1	14200 mg/l (96 h; Pimephales promelas; Nominal concentration)
EC50 Daphnia 1	9300 mg/l (48 h; Daphnia magna)
LC50 fish 2	13000 mg/l 96 h; Salmo gairdneri (Oncorhynchus mykiss)
EC50 Daphnia 2	10800 mg/l (24 h; Daphnia magna)
Threshold limit other aquatic organisms 1	65 mg/l (72 h; Protozoa)
Threshold limit algae 1	1450 mg/l (192 h; Microcystis aeruginosa; Growth rate)
Threshold limit algae 2	5000 mg/l (168 h; Scenedesmus quadricauda; Growth rate)

Isopropyl Alcohol (2-Propanol) (67-63-0)	
LC50 fishes 1	4200 mg/l (96 h; Rasbora heteromorpha; Flow-through system)
EC50 Daphnia 1	> 10000 mg/l (48 h; Daphnia magna)
LC50 fish 2	9640 mg/l (96 h; Pimephales promelas; Lethal)
EC50 Daphnia 2	13299 mg/l (48 h; Daphnia magna)
Threshold limit algae 1	> 1000 mg/l (72 h; Scenedesmus subspicatus; Growth rate)
Threshold limit algae 2	1800 mg/l (72 h; Algae; Cell numbers)

Methanol (67-56-1)	
LC50 fishes 1	15400 mg/l (96 h; Lepomis macrochirus; Lethal)
EC50 Daphnia 1	> 10000 mg/l (48 h; Daphnia magna; Lethal)
LC50 fish 2	10800 mg/l 96 h; Salmo gairdneri (Oncorhynchus mykiss)
EC50 Daphnia 2	24500 mg/l (48 h; Daphnia magna)
Threshold limit other aquatic organisms 1	6600 mg/l (16 h; Pseudomonas putida)
Threshold limit algae 1	530 mg/l (192 h; Microcystis aeruginosa)
Threshold limit algae 2	8000 mg/l (168 h; Scenedesmus quadricauda)

12.2. Persistence and degradability

Ethyl Alcohol, 90% v/v	
Persistence and degradability	Readily biodegradable in water. Biodegradable in the soil. No (test)data on mobility of the substance available.

Ethanol (64-17-5)	
Persistence and degradability	Readily biodegradable in water. Biodegradable in the soil. No (test)data on mobility of the substance available.
Biochemical oxygen demand (BOD)	0.8 - 0.967 g O^2/g substance
Chemical oxygen demand (COD)	1.70 g O^2/g substance
ThOD	2.10 g O^2/g substance
BOD (% of ThOD)	0.43 % ThOD

Isopropyl Alcohol (2-Propanol) (67-63-0)	
Persistence and degradability	Readily biodegradable in water. Biodegradable in the soil. Biodegradable in the soil under anaerobic conditions. No (test)data on mobility of the substance available.
Biochemical oxygen demand (BOD)	1.19 g O^2/g substance
Chemical oxygen demand (COD)	2.23 g O^2/g substance
ThOD	2.40 g O^2/g substance
BOD (% of ThOD)	0.49 % ThOD

Water (7732-18-5)	
Persistence and degradability	Not established.

Methanol (67-56-1)	
Persistence and degradability	Readily biodegradable in water. Biodegradable in the soil.
Biochemical oxygen demand (BOD)	0.6 - 1.12 g O^2/g substance
Chemical oxygen demand (COD)	1.42 g O^2/g substance
ThOD	1.5 g O^2/g substance
BOD (% of ThOD)	0.8 % ThOD

12.3. Bioaccumulative potential

Ethanol (64-17-5)	
Log Pow	-0.31 (Experimental value)
Bioaccumulative potential	Low potential for bioaccumulation (Log Kow < 4).

Isopropyl Alcohol (2-Propanol) (67-63-0)	
Log Pow	0.05 (Experimental value)
Bioaccumulative potential	Low potential for bioaccumulation (Log Kow < 4).

Water (7732-18-5)	
Bioaccumulative potential	Not established.

Methanol (67-56-1)	
BCF fish 1	< 10 (Leuciscus idus)
Log Pow	-0.77 (Experimental value; Other,Experimental value; Other)
Bioaccumulative potential	Low potential for bioaccumulation (BCF < 500).

12.4. Mobility in soil

Ethanol (64-17-5)	
Surface tension	0.022 N/m (20 °C)

Isopropyl Alcohol (2-Propanol) (67-63-0)	
Surface tension	0.021 N/m (25 °C)

Methanol (67-56-1)	
Surface tension	0.023 N/m (20 °C)

12.5. Other adverse effects

Other information : Avoid release to the environment.

SECTION 13: Disposal considerations

13.1. Waste treatment methods

Waste disposal recommendations : Remove waste in accordance with local and/or national regulations. Hazardous waste shall not be mixed together with other waste. Different types of hazardous waste shall not be mixed together if this may entail a risk of pollution or create problems for the further management of the waste. Hazardous waste shall be managed responsibly. All entities that store, transport or handle hazardous waste shall take the necessary measures to prevent risks of pollution or damage to people or animals. Recycle by distillation. Remove to an authorized waste incinerator for solvents with energy recovery. Do not discharge into surface water. May be discharged to wastewater treatment installation.

Additional information : LWCA (the Netherlands): KGA category 03. Hazardous waste according to Directive 2008/98/EC.

Ecology - waste materials : Avoid release to the environment.

SECTION 14: Transport information

In accordance with DOT

Transport document description : UN1987 Alcohols, n.o.s. (Ethanol, methanol), 3, III

UN-No.(DOT) : 1987

DOT NA no. : UN1987

DOT Proper Shipping Name : Alcohols, n.o.s.
Ethanol, methanol

Department of Transportation (DOT) Hazard Classes : 3 - Class 3 - Flammable and combustible liquid 49 CFR 173.120

Hazard labels (DOT) : 3 - Flammable liquid

Packing group (DOT) : III - Minor Danger

DOT Special Provisions (49 CFR 172.102) : 172 - This entry includes alcohol mixtures containing up to 5% petroleum products.
B1 - If the material has a flash point at or above 38 C (100 F) and below 93 C (200 F), then the bulk packaging requirements of 173.241 of this subchapter are applicable. If the material has a flash point of less than 38 C (100 F), then the bulk packaging requirements of 173.242 of this subchapter are applicable.
IB3 - Authorized IBCs: Metal (31A, 31B and 31N); Rigid plastics (31H1 and 31H2); Composite (31HZ1 and 31HA2, 31HB2, 31HN2, 31HD2 and 31HH2). Additional Requirement: Only liquids with a vapor pressure less than or equal to 110 kPa at 50 C (1.1 bar at 122 F), or 130 kPa at 55 C (1.3 bar at 131 F) are authorized, except for UN2672 (also see Special Provision IP8 in Table 2 for UN2672).
T4 - 2.65 178.274(d)(2) Normal..... 178.275(d)(3)
TP1 - The maximum degree of filling must not exceed the degree of filling determined by the following: Degree of filling = 97 / (1 + a (tr - tf)) Where: tr is the maximum mean bulk temperature during transport, and tf is the temperature in degrees celsius of the liquid during filling.
TP29 - A portable tank having a minimum test pressure of 1.5 bar (150.0 kPa) may be used provided the calculated test pressure is 1.5 bar or less based on the MAWP of the hazardous materials, as defined in 178.275 of this subchapter, where the test pressure is 1.5 times the MAWP.

DOT Packaging Exceptions (49 CFR 173.xxx) : 4b;150

DOT Packaging Non Bulk (49 CFR 173.xxx) : 203

DOT Packaging Bulk (49 CFR 173.xxx) : 242

DOT Quantity Limitations Passenger aircraft/rail (49 CFR 173.27) : 60 L

DOT Quantity Limitations Cargo aircraft only (49 CFR 175.75) : 220 L

DOT Vessel Stowage Location : A - The material may be stowed ‘‘on deck’’ or ‘‘under deck’’ on a cargo vessel and on a passenger vessel.

Additional information

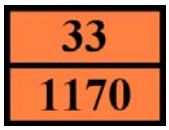
Other information : No supplementary information available.

State during transport (ADR-RID) : as liquid.

ADR

Transport document description	:	UN 1170 ethanol (ethyl alcohol), 3, III, (D/E)
Packing group (ADR)	:	III
Class (ADR)	:	3 - Flammable liquids
Hazard identification number (Kemler No.)	:	33
Classification code (ADR)	:	F1
Danger labels (ADR)	:	3 - Flammable liquids

Orange plates :



Tunnel restriction code : D/E

Transport by sea

UN-No. (IMDG)	:	1170
Class (IMDG)	:	3 - Flammable liquids
EmS-No. (1)	:	F-E
EmS-No. (2)	:	S-D

Air transport

UN-No.(IATA)	:	1170
Class (IATA)	:	3 - Flammable Liquids
Packing group (IATA)	:	II - Medium Danger

SECTION 15: Regulatory information

15.1. US Federal regulations

Ethyl Alcohol, 90% v/v	
SARA Section 311/312 Hazard Classes	Fire hazard

Ethanol (64-17-5)
Listed on the United States TSCA (Toxic Substances Control Act) inventory

Isopropyl Alcohol (2-Propanol) (67-63-0)
Listed on the United States TSCA (Toxic Substances Control Act) inventory Listed on SARA Section 313 (Specific toxic chemical listings)

Water (7732-18-5)
Listed on the United States TSCA (Toxic Substances Control Act) inventory

Methanol (67-56-1)	
Listed on the United States TSCA (Toxic Substances Control Act) inventory Listed on SARA Section 313 (Specific toxic chemical listings)	
RQ (Reportable quantity, section 304 of EPA's List of Lists) :	5000 lb
SARA Section 311/312 Hazard Classes	Immediate (acute) health hazard Fire hazard

15.2. International regulations

CANADA

Ethyl Alcohol, 90% v/v	
WHMIS Classification	Class B Division 3 - Combustible Liquid Class D Division 2 Subdivision A - Very toxic material causing other toxic effects

Isopropyl Alcohol (2-Propanol) (67-63-0)	
WHMIS Classification	Class B Division 2 - Flammable Liquid Class D Division 2 Subdivision B - Toxic material causing other toxic effects

Water (7732-18-5)	
Listed on the Canadian DSL (Domestic Sustances List) inventory.	
WHMIS Classification	Uncontrolled product according to WHMIS classification criteria

Methanol (67-56-1)	
Listed on the Canadian DSL (Domestic Sustances List) inventory.	
WHMIS Classification	Class B Division 2 - Flammable Liquid Class D Division 2 Subdivision A - Very toxic material causing other toxic effects Class D Division 2 Subdivision B - Toxic material causing other toxic effects

EU-Regulations

No additional information available

Classification according to Regulation (EC) No. 1272/2008 [CLP]

Classification according to Directive 67/548/EEC or 1999/45/EC

F; R11

Full text of R-phrases: see section 16

15.2.2. National regulations

Ethanol (64-17-5)
Listed on IARC (International Agency for Research on Cancer)

Water (7732-18-5)
Not listed on the Canadian Ingredient Disclosure List

Methanol (67-56-1)
Listed on the Canadian Ingredient Disclosure List

15.3. US State regulations

Methanol (67-56-1)				
U.S. - California - Proposition 65 - Carcinogens List	U.S. - California - Proposition 65 - Developmental Toxicity	U.S. - California - Proposition 65 - Reproductive Toxicity - Female	U.S. - California - Proposition 65 - Reproductive Toxicity - Male	No significance risk level (NSRL)
	Yes			

SECTION 16: Other information

Indication of changes : Revision - See : *.

Other information : None.

Full text of H-phrases: see section 16:

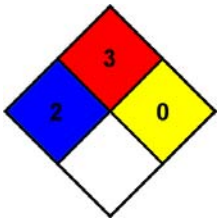
Acute Tox. 3 (Dermal)	Acute toxicity (dermal), Category 3
Acute Tox. 3 (Inhalation)	Acute toxicity (inhal.), Category 3
Acute Tox. 3 (Oral)	Acute toxicity (oral), Category 3
Acute Tox. 4 (Oral)	Acute toxicity (oral), Category 4
Carc. 1A	Carcinogenicity, Category 1A
Eye Irrit. 2A	Serious eye damage/eye irritation, Category 2A
Flam. Liq. 2	Flammable liquids, Category 2
Repr. 2	Reproductive toxicity, Category 2
Skin Irrit. 2	Skin corrosion/irritation, Category 2

STOT SE 1	Specific target organ toxicity — single exposure, Category 1
STOT SE 3	Specific target organ toxicity — Single exposure, Category 3, Narcosis
H225	Highly flammable liquid and vapour
H301	Toxic if swallowed
H302	Harmful if swallowed
H311	Toxic in contact with skin
H315	Causes skin irritation
H319	Causes serious eye irritation
H331	Toxic if inhaled
H336	May cause drowsiness or dizziness
H350	May cause cancer
H361	Suspected of damaging fertility or the unborn child
H370	Causes damage to organs

NFPA health hazard : 2 - Intense or continued exposure could cause temporary incapacitation or possible residual injury unless prompt medical attention is given.

NFPA fire hazard : 3 - Liquids and solids that can be ignited under almost all ambient conditions.

NFPA reactivity : 0 - Normally stable, even under fire exposure conditions, and are not reactive with water.



HMIS III Rating

Health : 2 Moderate Hazard - Temporary or minor injury may occur

Flammability : 3 Serious Hazard

Physical : 1 Slight Hazard

Personal Protection : D

SDS US ValTech

Information in this SDS is from available published sources and is believed to be accurate. No warranty, express or implied, is made and LabChem Inc assumes no liability resulting from the use of this SDS. The user must determine suitability of this information for his application.

Methanol
Safety Data Sheet
according to Federal Register / Vol. 77, No. 58 / Monday, March 26, 2012 / Rules and Regulations
Date of issue: 07/03/2013 Revision date: 12/12/2017 Supersedes: 12/12/2017 Version: 1.3

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1. Product identifier

Product form : Substance
Substance name : Methanol
CAS-No. : 67-56-1
Product code : VT430
Formula : CH4O
Synonyms : acetone alcohol / alcohol C1 / alcohol, methyl / carbinol / colonial spirits / columbian spirits / green wood spirits / manhattan spirits / methyl alcohol / methyl hydrate / methyl hydroxide / methylen / methylol / monohydroxymethane / pyroligneous spirit / pyroxylic spirit / wood alcohol / wood naphtha

1.2. Relevant identified uses of the substance or mixture and uses advised against

Use of the substance/mixture : Solvent

1.3. Details of the supplier of the safety data sheet

Val Tech Diagnostics, A Division of LabChem Inc
Jackson's Pointe Commerce Park Building 1000
1010 Jackson's Pointe Court
Zelienople, PA 16063
T 412-826-5230
F 724-473-0647

1.4. Emergency telephone number

Emergency number : CHEMTREC: 1-800-424-9300 or +1-703-741-5970

SECTION 2: Hazards identification

2.1. Classification of the substance or mixture

GHS-US classification

Flam. Liq. 2	H225
Acute Tox. 3 (Oral)	H301
Acute Tox. 3 (Dermal)	H311
Acute Tox. 3 (Inhalation)	H331
STOT SE 1	H370

Full text of H statements : see section 16

2.2. Label elements

GHS US labeling

Hazard pictograms (GHS US) :

GHS02 GHS06 GHS08

Signal word (GHS US) : Danger

Hazard statements (GHS US) : H225 - Highly flammable liquid and vapour
H301+H311+H331 - Toxic if swallowed, in contact with skin or if inhaled
H370 - Causes damage to organs (liver, kidneys, central nervous system, optic nerve) (Dermal, oral)

Precautionary statements (GHS US) : P210 - Keep away from heat, sparks, open flames, hot surfaces. - No smoking.
P233 - Keep container tightly closed.
P240 - Ground/bond container and receiving equipment.
P241 - Use explosion-proof electrical, ventilating, lighting equipment
P242 - Use only non-sparking tools.
P243 - Take precautionary measures against static discharge.
P260 - Do not breathe mist, vapors, spray.
P264 - Wash exposed skin thoroughly after handling.
P270 - Do not eat, drink or smoke when using this product.
P271 - Use only outdoors or in a well-ventilated area.

P280 - Wear protective gloves, protective clothing, eye protection, face protection.
P301+P310 - IF SWALLOWED: Immediately call a POISON CENTER or doctor/physician.
P303+P361+P353 - IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower.
P304+P340 - IF INHALED: Remove person to fresh air and keep comfortable for breathing.
P330 - If swallowed, rinse mouth
P361+P364 - Take off immediately all contaminated clothing and wash it before reuse.
P370+P378 - In case of fire: Use carbon dioxide (CO2), powder, alcohol-resistant foam to extinguish
P403+P235 - Store in a well-ventilated place. Keep cool.
P405 - Store locked up.
P501 - Dispose of contents/container to comply with local, state and federal regulations

2.3. Other hazards

Other hazards not contributing to the classification : None.

2.4. Unknown acute toxicity (GHS US)

No data available

SECTION 3: Composition/Information on ingredients

3.1. Substances

Substance type : Mono-constituent

Name	Product identifier	%	GHS-US classification
Methanol (Main constituent)	(CAS-No.) 67-56-1	100	Flam. Liq. 2, H225 Acute Tox. 3 (Oral), H301 Acute Tox. 3 (Dermal), H311 Acute Tox. 3 (Inhalation), H331 STOT SE 1, H370

Full text of H-phrases: see section 16

3.2. Mixtures

Not applicable

SECTION 4: First aid measures

4.1. Description of first aid measures

First-aid measures general : Check the vital functions. Unconscious: maintain adequate airway and respiration. Respiratory arrest: artificial respiration or oxygen. Cardiac arrest: perform resuscitation. Victim conscious with labored breathing: half-seated. Victim in shock: on his back with legs slightly raised. Vomiting: prevent asphyxia/aspiration pneumonia. Prevent cooling by covering the victim (no warming up). Keep watching the victim. Give psychological aid. Keep the victim calm, avoid physical strain.

First-aid measures after inhalation : Remove the victim into fresh air. Immediately consult a doctor/medical service.

First-aid measures after skin contact : Wash immediately with lots of water. Soap may be used. Do not apply (chemical) neutralizing agents. Remove clothing before washing. Consult a doctor/medical service.

First-aid measures after eye contact : Rinse with water. Remove contact lenses, if present and easy to do. Continue rinsing. Take victim to an ophthalmologist if irritation persists.

First-aid measures after ingestion : Rinse mouth with water. Immediately after ingestion, give alcohol to drink. Give nothing to drink. Do not induce vomiting. Immediately consult a doctor/medical service. Take the container/vomit to the doctor/hospital. Call Poison Information Centre (www.big.be/antigif.htm).

4.2. Most important symptoms and effects, both acute and delayed

Symptoms/effects after inhalation : EXPOSURE TO HIGH CONCENTRATIONS: Coughing. Symptoms similar to those listed under ingestion.

Symptoms/effects after skin contact : Symptoms similar to those listed under ingestion.

Symptoms/effects after eye contact : Redness of the eye tissue. Lacrimation.

Symptoms/effects after ingestion : Nausea. Vomiting. AFTER ABSORPTION OF LARGE QUANTITIES: FOLLOWING SYMPTOMS MAY APPEAR LATER: Change in the blood composition. Headache. Feeling of weakness. Abdominal pain. Muscular pain. Central nervous system depression. Dizziness. Mental confusion. Drunkenness. Coordination disorders. Disturbed motor response. Disturbances of consciousness. Visual disturbances. Blindness. Respiratory difficulties. Cramps/uncontrolled muscular contractions.

Chronic symptoms : Red skin. Dry skin. Skin rash/inflammation. Headache. Disturbed tactile sensibility. Visual disturbances. Sleeplessness. Gastrointestinal complaints. Cardiac and blood circulation effects.

4.3. Indication of any immediate medical attention and special treatment needed

Immediately after ingestion, give a glass of strong drink, beer or wine to drink. Hospitalize at once for treatment with the right antidotes.

SECTION 5: Firefighting measures

5.1. Extinguishing media

Suitable extinguishing media : Quick-acting ABC powder extinguisher. Quick-acting BC powder extinguisher. Quick-acting class B foam extinguisher. Quick-acting CO2 extinguisher. Class B foam (alcohol-resistant). Water spray if puddle cannot expand.

Unsuitable extinguishing media : Water (quick-acting extinguisher, reel); risk of puddle expansion. Water; risk of puddle expansion.

5.2. Special hazards arising from the substance or mixture

Fire hazard : DIRECT FIRE HAZARD. Highly flammable liquid and vapour. Gas/vapor flammable with air within explosion limits. INDIRECT FIRE HAZARD. May be ignited by sparks.

Explosion hazard : DIRECT EXPLOSION HAZARD. Gas/vapour explosive with air within explosion limits. INDIRECT EXPLOSION HAZARD. may be ignited by sparks. Reactions with explosion hazards: see "Reactivity Hazard".

Reactivity : Violent to explosive reaction with (some) metal powders and with (strong) oxidizers. Violent exothermic reaction with (some) acids and with (some) halogens compounds.

5.3. Advice for firefighters

Firefighting instructions : Cool tanks/drums with water spray/remove them into safety. Do not move the load if exposed to heat. Take account of toxic fire-fighting water. Use water moderately and if possible collect or contain it.

Protection during firefighting : Do not enter fire area without proper protective equipment, including respiratory protection.

SECTION 6: Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

General measures : No flames, no sparks. Eliminate all sources of ignition. No naked lights. No smoking. Dike and contain spill.

6.1.1. For non-emergency personnel

Protective equipment : Gas-tight suit.

Emergency procedures : Keep upwind. Mark the danger area. Consider evacuation. Close doors and windows of adjacent premises. Stop engines and no smoking. No naked flames or sparks. Spark- and explosion-proof appliances and lighting equipment. Keep containers closed. Wash contaminated clothes.

6.1.2. For emergency responders

Protective equipment : Equip cleanup crew with proper protection.

Emergency procedures : Stop leak if safe to do so. Ventilate area.

6.2. Environmental precautions

Prevent soil and water pollution. Prevent spreading in sewers.

6.3. Methods and material for containment and cleaning up

For containment : Contain released substance, pump into suitable containers. Plug the leak, cut off the supply. Dam up the liquid spill. Try to reduce evaporation. Measure the concentration of the explosive gas-air mixture. Dilute combustible/toxic gases/vapours with water spray. Take account of toxic/corrosive precipitation water. Provide equipment/receptacles with earthing. Do not use compressed air for pumping over spills.

Methods for cleaning up : Take up liquid spill into a non combustible material e.g.: sand, earth, vermiculite slaked lime or soda ash. Scoop absorbed substance into closing containers. Carefully collect the spill/leftovers. Damaged/cooled tanks must be emptied. Do not use compressed air for pumping over spills. Clean contaminated surfaces with an excess of water. Take collected spill to manufacturer/competent authority. Wash clothing and equipment after handling.

6.4. Reference to other sections

No additional information available

SECTION 7: Handling and storage

7.1. Precautions for safe handling

Precautions for safe handling : Use spark-/explosionproof appliances and lighting system. Take precautions against electrostatic charges. Keep away from naked flames/heat. Keep away from ignition sources/sparks. Measure the concentration in the air regularly. Work under local exhaust/ventilation. Comply with the legal requirements. Remove contaminated clothing immediately. Clean contaminated clothing. Handle uncleaned empty containers as full ones. Thoroughly clean/dry the installation before use. Do not discharge the waste into the drain. Do not use compressed air for pumping over. Keep container tightly closed.

Hygiene measures : Do not eat, drink or smoke when using this product. Wash hands and other exposed areas with mild soap and water before eating, drinking or smoking and when leaving work. Wash contaminated clothing before reuse.

7.2. Conditions for safe storage, including any incompatibilities

Incompatible products : Strong oxidizers. Strong bases. Strong acids. Acid anhydrides. Acid chlorides.

Incompatible materials : Direct sunlight. Heat sources. Sources of ignition.

Heat-ignition : KEEP SUBSTANCE AWAY FROM: heat sources. ignition sources.

Prohibitions on mixed storage : KEEP SUBSTANCE AWAY FROM: combustible materials. oxidizing agents. strong acids. (strong) bases. halogens. amines. water/moisture.

Storage area : Store in a cool area. Store in a dry area. Keep container in a well-ventilated place. Fireproof storeroom. Keep locked up. Provide for a tub to collect spills. Provide the tank with earthing. Unauthorized persons are not admitted. Aboveground. Meet the legal requirements.

Special rules on packaging : SPECIAL REQUIREMENTS: closing. dry. clean. correctly labelled. meet the legal requirements. Secure fragile packagings in solid containers.

Packaging materials : SUITABLE MATERIAL: steel. stainless steel. iron. glass. MATERIAL TO AVOID: lead. aluminium. zinc. polyethylene. PVC.

7.3. Specific end use(s)

No additional information available

SECTION 8: Exposure controls/personal protection

8.1. Control parameters

Methanol (67-56-1)		
USA ACGIH	ACGIH TWA (ppm)	200 ppm
USA ACGIH	ACGIH STEL (ppm)	250 ppm

8.2. Exposure controls

Appropriate engineering controls : Emergency eye wash fountains should be available in the immediate vicinity of any potential exposure. Keep concentrations well below lower explosion limits.

Personal protective equipment : Safety glasses. Protective clothing. Gloves. Full protective flameproof clothing. Face shield.

Materials for protective clothing : GIVE GOOD RESISTANCE: polyethylene/ethylenevinylalcohol. styrene-butadiene rubber. viton. GIVE LESS RESISTANCE: chloroprene rubber. chlorinated polyethylene. natural rubber. nitrile rubber/PVC. GIVE POOR RESISTANCE: leather. neoprene. nitrile rubber. polyethylene. PVA. PVC. polyurethane.

Hand protection : Protective gloves against chemicals (EN374).

Eye protection : Safety glasses.

Skin and body protection : Head/neck protection. Protective clothing.

Respiratory protection : Full face mask with filter type AX at conc. in air > exposure limit. High vapour/gas concentration: self-contained respirator.

SECTION 9: Physical and chemical properties

9.1. Information on basic physical and chemical properties

Physical state : Liquid

Appearance : Liquid.

Molecular mass : 32.04 g/mol

Color : Colourless.

Odor	:	Characteristic odour. Mild odour. Pleasant odour. Alcohol odour. Commercial/unpurified substance: irritating/pungent odour.
Odor threshold	:	No data available
pH	:	No data available
Relative evaporation rate (butyl acetate=1)	:	4.1
Relative evaporation rate (ether=1)	:	6.3
Melting point	:	-97.8 °C
Freezing point	:	No data available
Boiling point	:	64.7 °C (1013 hPa)
Flash point	:	9.7 °C (Closed cup, 1013 hPa, EU Method A.9: Flash-Point)
Critical temperature	:	240 °C
Auto-ignition temperature	:	455 °C (1013 hPa, DIN 51794: Self-ignition temperature)
Decomposition temperature	:	No data available
Flammability (solid, gas)	:	No data available
Vapor pressure	:	128 hPa (20 °C)
Vapor pressure at 50 °C	:	552 hPa
Critical pressure	:	79547 hPa
Relative vapor density at 20 °C	:	1.1
Relative density	:	0.79 - 0.80 (20 °C)
Relative density of saturated gas/air mixture	:	1
Specific gravity / density	:	790 - 800 kg/m³ (20 °C)
Solubility	:	Soluble in water. Soluble in ethanol. Soluble in ether. Soluble in acetone. Soluble in chloroform. Water: 100 g/100ml (20 °C) Ethanol: complete Ether: complete Acetone: complete
Log Pow	:	-0.77 (Experimental value)
Log Kow	:	No data available
Viscosity, kinematic	:	No data available
Viscosity, dynamic	:	0.544 - 0.59 mPa·s (25 °C)
Explosive properties	:	No data available
Oxidizing properties	:	No data available
Explosion limits	:	5.5 - 36.5 vol %

9.2. Other information

Minimum ignition energy	:	0.14 mJ
Saturation concentration	:	166 g/m³
VOC content	:	100 %
Other properties	:	Clear. Hygroscopic. Volatile. Neutral reaction.

SECTION 10: Stability and reactivity

10.1. Reactivity

Violent to explosive reaction with (some) metal powders and with (strong) oxidizers. Violent exothermic reaction with (some) acids and with (some) halogens compounds.

10.2. Chemical stability

Hygroscopic.

10.3. Possibility of hazardous reactions

No additional information available

10.4. Conditions to avoid

Direct sunlight. High temperature. Incompatible materials. Open flame. Sparks. Overheating.

10.5. Incompatible materials

Strong oxidizers. Strong bases. Strong acids. Peroxides. Acid anhydrides. Acid chlorides.

10.6. Hazardous decomposition products

Carbon dioxide. Carbon monoxide.

SECTION 11: Toxicological information

11.1. Information on toxicological effects

Acute toxicity : Not classified

Methanol (\f)67-56-1	
LD50 oral rat	1187 - 2769 mg/kg body weight (BASF test, Rat, Male / female, Weight of evidence, Aqueous solution, Oral, 7 day(s))
LD50 dermal rabbit	17100 mg/kg (Rabbit, Inconclusive, insufficient data, Dermal)
LC50 inhalation rat (mg/l)	128.2 mg/l air (BASF test, 4 h, Rat, Male / female, Experimental value, Inhalation (vapours))
ATE CLP (oral)	100 mg/kg body weight
ATE CLP (dermal)	300 mg/kg body weight
ATE CLP (gases)	700 ppmV/4h
ATE CLP (vapors)	3 mg/l/4h
ATE CLP (dust, mist)	0.5 mg/l/4h

Skin corrosion/irritation : Not classified

Serious eye damage/irritation : Not classified

Respiratory or skin sensitization : Not classified

Germ cell mutagenicity : Not classified

Carcinogenicity : Not classified

Reproductive toxicity : Not classified

Specific target organ toxicity – single exposure : Causes damage to organs (liver, kidneys, central nervous system, optic nerve) (Dermal, oral).

Specific target organ toxicity – repeated exposure : Not classified

Aspiration hazard : Not classified

Potential Adverse human health effects and symptoms : Toxic in contact with skin. Toxic if swallowed. Toxic if inhaled.

Symptoms/effects after inhalation : EXPOSURE TO HIGH CONCENTRATIONS: Coughing. Symptoms similar to those listed under ingestion.

Symptoms/effects after skin contact : Symptoms similar to those listed under ingestion.

Symptoms/effects after eye contact : Redness of the eye tissue. Lacrimation.

Symptoms/effects after ingestion : Nausea. Vomiting. AFTER ABSORPTION OF LARGE QUANTITIES: FOLLOWING SYMPTOMS MAY APPEAR LATER: Change in the blood composition. Headache. Feeling of weakness. Abdominal pain. Muscular pain. Central nervous system depression. Dizziness. Mental confusion. Drunkenness. Coordination disorders. Disturbed motor response. Disturbances of consciousness. Visual disturbances. Blindness. Respiratory difficulties. Cramps/uncontrolled muscular contractions.

Chronic symptoms : Red skin. Dry skin. Skin rash/inflammation. Headache. Disturbed tactile sensibility. Visual disturbances. Sleeplessness. Gastrointestinal complaints. Cardiac and blood circulation effects.

SECTION 12: Ecological information

12.1. Toxicity

Ecology - general : Not classified as dangerous for the environment according to the criteria of Regulation (EC) No 1272/2008.

Ecology - air : Not included in the list of substances which may contribute to the greenhouse effect (IPCC). Not included in the list of fluorinated greenhouse gases (Regulation (EU) No 517/2014). Not classified as dangerous for the ozone layer (Regulation (EC) No 1005/2009).

Ecology - water : Not harmful to crustacea. Not harmful to fishes. Groundwater pollutant. Inhibition of activated sludge. Nitrification of activated sludge is inhibited. Not harmful to algae. Not harmful to bacteria.

Methanol (67-56-1)	
LC50 fish 1	15400 mg/l (EPA 660/3 - 75/009, 96 h, Lepomis macrochirus, Flow-through system, Fresh water, Experimental value, Lethal)
EC50 Daphnia 1	18260 mg/l (OECD 202: Daphnia sp. Acute Immobilisation Test, 96 h, Daphnia magna, Semi-static system, Fresh water, Experimental value, Locomotor effect)
ErC50 (algae)	22000 mg/l (OECD 201: Alga, Growth Inhibition Test, 96 h, Pseudokirchneriella subcapitata, Static system, Fresh water, Experimental value)

12.2. Persistence and degradability

Methanol (67-56-1)	
Persistence and degradability	Readily biodegradable in the soil. Readily biodegradable in water.
Biochemical oxygen demand (BOD)	0.6 - 1.12 g O □/g substance
Chemical oxygen demand (COD)	1.42 g O □/g substance
ThOD	1.5 g O □/g substance

12.3. Bioaccumulative potential

Methanol (67-56-1)	
BCF fish 1	1 - 4.5 (72 h, Cyprinus carpio, Static system, Fresh water, Experimental value)
Log Pow	-0.77 (Experimental value)
Bioaccumulative potential	Low potential for bioaccumulation (BCF < 500).

12.4. Mobility in soil

Methanol (67-56-1)	
Surface tension	0.023 N/m (20 °C)
Log Koc	0.088 (log Koc, SRC PCKOCWIN v2.0, Calculated value)
Ecology - soil	Highly mobile in soil.

12.5. Other adverse effects

No additional information available

SECTION 13: Disposal considerations

13.1. Waste treatment methods

Waste disposal recommendations : Do not discharge into drains or the environment. Remove waste in accordance with local and/or national regulations. Hazardous waste shall not be mixed together with other waste. Different types of hazardous waste shall not be mixed together if this may entail a risk of pollution or create problems for the further management of the waste. Hazardous waste shall be managed responsibly. All entities that store, transport or handle hazardous waste shall take the necessary measures to prevent risks of pollution or damage to people or animals. Recycle by distillation. Incinerate under surveillance with energy recovery. Obtain the consent of pollution control authorities before discharging to wastewater treatment plants.

Additional information : Hazardous waste according to Directive 2008/98/EC, as amended by Regulation (EU) No 1357/2014 and Regulation (EU) No 2017/997.

SECTION 14: Transport information

In accordance with DOT

Transport document description : UN1230 Methanol, 3, II

UN-No.(DOT) : 1230

DOT NA no. : UN1230

Proper Shipping Name (DOT) : Methanol

Transport hazard class(es) (DOT) : 3 - Class 3 - Flammable and combustible liquid 49 CFR 173.120

Hazard labels (DOT) : 3 - Flammable liquid

DOT Symbols : D - Proper shipping name for domestic use only, or to and from Canada

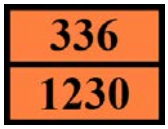
Packing group (DOT) : II - Medium Danger

DOT Special Provisions (49 CFR 172.102)	:	IB2 - Authorized IBCs: Metal (31A, 31B and 31N); Rigid plastics (31H1 and 31H2); Composite (31HZ1). Additional Requirement: Only liquids with a vapor pressure less than or equal to 110 kPa at 50 C (1.1 bar at 122 F), or 130 kPa at 55 C (1.3 bar at 131 F) are authorized. T7 - 4 178.274(d)(2) Normal..... 178.275(d)(3) TP2 - a. The maximum degree of filling must not exceed the degree of filling determined by the following: (image) Where: tr is the maximum mean bulk temperature during transport, tf is the temperature in degrees celsius of the liquid during filling, and a is the mean coefficient of cubical expansion of the liquid between the mean temperature of the liquid during filling (tf) and the maximum mean bulk temperature during transportation (tr) both in degrees celsius. b. For liquids transported under ambient conditions may be calculated using the formula: (image) Where: d15 and d50 are the densities (in units of mass per unit volume) of the liquid at 15 C (59 F) and 50 C (122 F), respectively.
DOT Packaging Exceptions (49 CFR 173.xxx)	:	150
DOT Packaging Non Bulk (49 CFR 173.xxx)	:	202
DOT Packaging Bulk (49 CFR 173.xxx)	:	242
DOT Quantity Limitations Passenger aircraft/rail (49 CFR 173.27)	:	1 L
DOT Quantity Limitations Cargo aircraft only (49 CFR 175.75)	:	60 L
DOT Vessel Stowage Location	:	B - (i) The material may be stowed ‘‘on deck’’ or ‘‘under deck’’ on a cargo vessel and on a passenger vessel carrying a number of passengers limited to not more than the larger of 25 passengers, or one passenger per each 3 m of overall vessel length; and (ii) ‘‘On deck only’’ on passenger vessels in which the number of passengers specified in paragraph (k)(2)(i) of this section is exceeded.
DOT Vessel Stowage Other	:	40 - Stow ‘‘clear of living quarters’’
Marine pollutant	:	-

Additional information

Other information : No supplementary information available.

ADR

Transport document description	:	
Hazard identification number (Kemler No.)	:	336
Orange plates	:	
Tunnel restriction code	:	D/E

Transport by sea

UN-No. (IMDG)	:	1230
Proper Shipping Name (IMDG)	:	methanol
Class (IMDG)	:	3 - Flammable liquids
Packing group (IMDG)	:	II - substances presenting medium danger
EmS-No. (1)	:	F-E
MFAG-No	:	19
EmS-No. (2)	:	S-D

Air transport

UN-No. (IATA)	:	1230
Proper Shipping Name (IATA)	:	Methanol
Class (IATA)	:	3 - Flammable Liquids
Packing group (IATA)	:	II - Medium Danger

SECTION 15: Regulatory information

15.1. US Federal regulations

Methanol (67-56-1)

Listed on the United States TSCA (Toxic Substances Control Act) inventory
Subject to reporting requirements of United States SARA Section 313

Methanol (67-56-1)	
RQ (Reportable quantity, section 304 of EPA's List of Lists)	5000 lb
SARA Section 311/312 Hazard Classes	Physical hazard - Flammable (gases, aerosols, liquids, or solids) Health hazard - Acute toxicity (any route of exposure) Health hazard - Specific target organ toxicity (single or repeated exposure)

15.2. International regulations

CANADA

Methanol (67-56-1)	
Listed on the Canadian DSL (Domestic Substances List)	
WHMIS Classification	Class B Division 2 - Flammable Liquid Class D Division 2 Subdivision A - Very toxic material causing other toxic effects Class D Division 2 Subdivision B - Toxic material causing other toxic effects

EU-Regulations

No additional information available

Classification according to Regulation (EC) No. 1272/2008 [CLP]

Flam. Liq. 2	H225
Acute Tox. 3 (Inhalation)	H331
Acute Tox. 3 (Dermal)	H311
Acute Tox. 3 (Oral)	H301
STOT SE 1	H370

Full text of H statements : see section 16

Classification according to Directive 67/548/EEC [DSD] or 1999/45/EC [DPD]

Not classified

15.2.2. National regulations

No additional information available

15.3. US State regulations

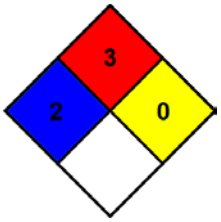
Methanol(67-56-1)	
U.S. - California - Proposition 65 - Carcinogens List	No
U.S. - California - Proposition 65 - Developmental Toxicity	Yes
U.S. - California - Proposition 65 - Reproductive Toxicity - Female	No
U.S. - California - Proposition 65 - Reproductive Toxicity - Male	No

SECTION 16: Other information

Full text of H-phrases: see section 16:

H225	Highly flammable liquid and vapour
H301	Toxic if swallowed
H311	Toxic in contact with skin
H331	Toxic if inhaled
H370	Causes damage to organs

NFPA health hazard	:	2 - Materials that, under emergency conditions, can cause temporary incapacitation or residual injury.
NFPA fire hazard	:	3 - Liquids and solids (including finely divided suspended solids) that can be ignited under almost all ambient temperature conditions.
NFPA reactivity	:	0 - Material that in themselves are normally stable, even under fire conditions.



Hazard Rating

Health	:	2 Moderate Hazard - Temporary or minor injury may occur
Flammability	:	3 Serious Hazard
Physical	:	0 Minimal Hazard
Personal protection	:	H

SDS US ValTech

Information in this SDS is from available published sources and is believed to be accurate. No warranty, express or implied, is made and LabChem Inc assumes no liability resulting from the use of this SDS. The user must determine suitability of this information for his application.

SAFETY DATA SHEET

Nitrogen

Airgas
an Air Liquide company

Section 1. Identification

GHS product identifier : Nitrogen

Chemical name : nitrogen

Other means of identification : nitrogen (dot); nitrogen gas; Nitrogen NF, Nitrogen FG

Product type : Gas.

Product use : Synthetic/Analytical chemistry.

Synonym : nitrogen (dot); nitrogen gas; Nitrogen NF, Nitrogen FG

SDS # : 001040

Supplier's details : Airgas USA, LLC and its affiliates
259 North Radnor-Chester Road
Suite 100
Radnor, PA 19087-5283
1-610-687-5253

24-hour telephone : 1-866-734-3438

Section 2. Hazards identification

OSHA/HCS status : This material is considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200).

Classification of the substance or mixture : GASES UNDER PRESSURE - Compressed gas
SIMPLE ASPHYXIANTS

GHS label elements

Hazard pictograms :

Signal word : Warning

Hazard statements : Contains gas under pressure; may explode if heated.
May displace oxygen and cause rapid suffocation.

Precautionary statements

General : Read and follow all Safety Data Sheets (SDS'S) before use. Read label before use. Keep out of reach of children. If medical advice is needed, have product container or label at hand. Close valve after each use and when empty. Use equipment rated for cylinder pressure. Do not open valve until connected to equipment prepared for use. Use a back flow preventative device in the piping. Use only equipment of compatible materials of construction.

Prevention : Not applicable.

Response : Not applicable.

Storage : Protect from sunlight. Store in a well-ventilated place.

Disposal : Not applicable.

Supplemental label elements : Keep container tightly closed. Use only with adequate ventilation. Do not enter storage areas and confined spaces unless adequately ventilated.

Hazards not otherwise classified : In addition to any other important health or physical hazards, this product may displace oxygen and cause rapid suffocation.

Section 3. Composition/information on ingredients

Substance/mixture : Substance

Chemical name : nitrogen

Other means of identification : nitrogen (dot); nitrogen gas; Nitrogen NF, Nitrogen FG

Product code : 001040

CAS number/other identifiers

CAS number : 7727-37-9

Ingredient name	%	CAS number
Nitrogen	100	7727-37-9

Any concentration shown as a range is to protect confidentiality or is due to batch variation.

There are no additional ingredients present which, within the current knowledge of the supplier and in the concentrations applicable, are classified as hazardous to health or the environment and hence require reporting in this section.

Occupational exposure limits, if available, are listed in Section 8.

Section 4. First aid measures

Description of necessary first aid measures

Eye contact : Immediately flush eyes with plenty of water, occasionally lifting the upper and lower eyelids. Check for and remove any contact lenses. Continue to rinse for at least 10 minutes. Get medical attention if irritation occurs.

Inhalation : Remove victim to fresh air and keep at rest in a position comfortable for breathing. If it is suspected that fumes are still present, the rescuer should wear an appropriate mask or self-contained breathing apparatus. If not breathing, if breathing is irregular or if respiratory arrest occurs, provide artificial respiration or oxygen by trained personnel. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation. Get medical attention if adverse health effects persist or are severe. If unconscious, place in recovery position and get medical attention immediately. Maintain an open airway. Loosen tight clothing such as a collar, tie, belt or waistband. In case of inhalation of decomposition products in a fire, symptoms may be delayed. The exposed person may need to be kept under medical surveillance for 48 hours.

Skin contact : Flush contaminated skin with plenty of water. Remove contaminated clothing and shoes. Get medical attention if symptoms occur. Wash clothing before reuse. Clean shoes thoroughly before reuse.

Ingestion : As this product is a gas, refer to the inhalation section.

Most important symptoms/effects, acute and delayed

Potential acute health effects

Eye contact : Contact with rapidly expanding gas may cause burns or frostbite.

Inhalation : At very high concentrations, can displace the normal air and cause suffocation from lack of oxygen.

Skin contact : Contact with rapidly expanding gas may cause burns or frostbite.

Frostbite : Try to warm up the frozen tissues and seek medical attention.

Ingestion : As this product is a gas, refer to the inhalation section.

Over-exposure signs/symptoms

Eye contact : No specific data.

Inhalation : No specific data.

Skin contact : No specific data.

Ingestion : No specific data.

Indication of immediate medical attention and special treatment needed, if necessary

Section 4. First aid measures

Notes to physician : In case of inhalation of decomposition products in a fire, symptoms may be delayed. The exposed person may need to be kept under medical surveillance for 48 hours.

Specific treatments : No specific treatment.

Protection of first-aiders : No action shall be taken involving any personal risk or without suitable training. If it is suspected that fumes are still present, the rescuer should wear an appropriate mask or self-contained breathing apparatus. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation.

See toxicological information (Section 11)

Section 5. Fire-fighting measures

Extinguishing media

Suitable extinguishing media : Use an extinguishing agent suitable for the surrounding fire.

Unsuitable extinguishing media : None known.

Specific hazards arising from the chemical : Contains gas under pressure. In a fire or if heated, a pressure increase will occur and the container may burst or explode.

Hazardous thermal decomposition products : Decomposition products may include the following materials:
nitrogen oxides

Special protective actions for fire-fighters : Promptly isolate the scene by removing all persons from the vicinity of the incident if there is a fire. No action shall be taken involving any personal risk or without suitable training. Contact supplier immediately for specialist advice. Move containers from fire area if this can be done without risk. Use water spray to keep fire-exposed containers cool.

Special protective equipment for fire-fighters : Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode.

Section 6. Accidental release measures

Personal precautions, protective equipment and emergency procedures

For non-emergency personnel : No action shall be taken involving any personal risk or without suitable training. Evacuate surrounding areas. Keep unnecessary and unprotected personnel from entering. Avoid breathing gas. Provide adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Put on appropriate personal protective equipment.

For emergency responders : If specialized clothing is required to deal with the spillage, take note of any information in Section 8 on suitable and unsuitable materials. See also the information in "For non-emergency personnel".

Environmental precautions : Ensure emergency procedures to deal with accidental gas releases are in place to avoid contamination of the environment. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air).

Methods and materials for containment and cleaning up

Small spill : Immediately contact emergency personnel. Stop leak if without risk.

Large spill : Immediately contact emergency personnel. Stop leak if without risk. Note: see Section 1 for emergency contact information and Section 13 for waste disposal.

Section 7. Handling and storage

Precautions for safe handling

Protective measures : Put on appropriate personal protective equipment (see Section 8). Contains gas under pressure. Avoid breathing gas. Use only with adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Do not puncture or incinerate container. Use equipment rated for cylinder pressure. Close valve after each use and when empty. Protect cylinders from physical damage; do not drag, roll, slide, or drop. Use a suitable hand truck for cylinder movement.

Avoid contact with eyes, skin and clothing. Empty containers retain product residue and can be hazardous.

Advice on general occupational hygiene : Eating, drinking and smoking should be prohibited in areas where this material is handled, stored and processed. Workers should wash hands and face before eating, drinking and smoking. Remove contaminated clothing and protective equipment before entering eating areas. See also Section 8 for additional information on hygiene measures.

Conditions for safe storage, including any incompatibilities : Store in accordance with local regulations. Store in a segregated and approved area. Store away from direct sunlight in a dry, cool and well-ventilated area, away from incompatible materials (see Section 10). Cylinders should be stored upright, with valve protection cap in place, and firmly secured to prevent falling or being knocked over. Cylinder temperatures should not exceed 52 °C (125 °F). Keep container tightly closed and sealed until ready for use. See Section 10 for incompatible materials before handling or use.

Section 8. Exposure controls/personal protection

Control parameters

Occupational exposure limits

Ingredient name	Exposure limits
Nitrogen	**ACGIH TLV (United States, 3/2017). Oxygen Depletion [Asphyxiant].**

Appropriate engineering controls : Use only with adequate ventilation. Use process enclosures, local exhaust ventilation or other engineering controls to keep worker exposure to airborne contaminants below any recommended or statutory limits.

Environmental exposure controls : Emissions from ventilation or work process equipment should be checked to ensure they comply with the requirements of environmental protection legislation. In some cases, fume scrubbers, filters or engineering modifications to the process equipment will be necessary to reduce emissions to acceptable levels.

Individual protection measures

Hygiene measures : Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

Eye/face protection : Safety eyewear complying with an approved standard should be used when a risk assessment indicates this is necessary to avoid exposure to liquid splashes, mists, gases or dusts. If contact is possible, the following protection should be worn, unless the assessment indicates a higher degree of protection: safety glasses with side-shields.

Skin protection

Hand protection : Chemical-resistant, impervious gloves complying with an approved standard should be worn at all times when handling chemical products if a risk assessment indicates this is necessary. Considering the parameters specified by the glove manufacturer, check during use that the gloves are still retaining their protective properties. It should be noted that the time to breakthrough for any glove material may be different for different glove manufacturers. In the case of mixtures, consisting of several substances, the protection time of the gloves cannot be accurately estimated.

Section 8. Exposure controls/personal protection

Body protection : Personal protective equipment for the body should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.

Other skin protection : Appropriate footwear and any additional skin protection measures should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.

Respiratory protection : The gas can cause asphyxiation without warning by replacing the oxygen in the air. Based on the hazard and potential for exposure, select a respirator that meets the appropriate standard or certification. If operating conditions cause high gas concentrations to be produced or any recommended or statutory exposure limit is exceeded, use an air-fed respirator or self-contained breathing apparatus. Respirators must be used according to a respiratory protection program to ensure proper fitting, training, and other important aspects of use. Respirator selection must be based on known or anticipated exposure levels, the hazards of the product and the safe working limits of the selected respirator.

Section 9. Physical and chemical properties

Appearance

Physical state : Gas. [Compressed gas.]

Color : Colorless.

Odor : Odorless.

Odor threshold : Not available.

pH : Not available.

Melting point : -210.01°C (-346°F)

Boiling point : -196°C (-320.8°F)

Critical temperature : -146.95°C (-232.5°F)

Flash point : [Product does not sustain combustion.]

Evaporation rate : Not available.

Flammability (solid, gas) : Not available.

Lower and upper explosive (flammable) limits : Not available.

Vapor pressure : Not available.

Vapor density : 0.967 (Air = 1) Liquid Density@BP: 50.46 lb/ft3 (808.3 kg/m3)

Specific Volume (ft^3/lb) : 13.8889

Gas Density (lb/ft^3) : 0.072

Relative density : Not applicable.

Solubility : Not available.

Solubility in water : Not available.

Partition coefficient: n-octanol/water : 0.67

Auto-ignition temperature : Not available.

Decomposition temperature : Not available.

Viscosity : Not applicable.

Flow time (ISO 2431) : Not available.

Molecular weight : 28.02 g/mole

Section 10. Stability and reactivity

Reactivity : No specific test data related to reactivity available for this product or its ingredients.

Chemical stability : The product is stable.

Possibility of hazardous reactions : Under normal conditions of storage and use, hazardous reactions will not occur.

Conditions to avoid : Do not allow gas to accumulate in low or confined areas.

Incompatible materials : No specific data.

Hazardous decomposition products : Under normal conditions of storage and use, hazardous decomposition products should not be produced.

Hazardous polymerization : Under normal conditions of storage and use, hazardous polymerization will not occur.

Section 11. Toxicological information

Information on toxicological effects

Acute toxicity

Not available.

Irritation/Corrosion

Not available.

Sensitization

Not available.

Mutagenicity

Not available.

Carcinogenicity

Not available.

Reproductive toxicity

Not available.

Teratogenicity

Not available.

Specific target organ toxicity (single exposure)

Not available.

Specific target organ toxicity (repeated exposure)

Not available.

Aspiration hazard

Not available.

Information on the likely routes of exposure : Not available.

Potential acute health effects

Eye contact : Contact with rapidly expanding gas may cause burns or frostbite.

Inhalation : At very high concentrations, can displace the normal air and cause suffocation from lack of oxygen.

Section 11. Toxicological information

Skin contact : Contact with rapidly expanding gas may cause burns or frostbite.

Ingestion : As this product is a gas, refer to the inhalation section.

Symptoms related to the physical, chemical and toxicological characteristics

Eye contact : No specific data.

Inhalation : No specific data.

Skin contact : No specific data.

Ingestion : No specific data.

Delayed and immediate effects and also chronic effects from short and long term exposure

Short term exposure

Potential immediate effects : Not available.

Potential delayed effects : Not available.

Long term exposure

Potential immediate effects : Not available.

Potential delayed effects : Not available.

Potential chronic health effects

Not available.

General : No known significant effects or critical hazards.

Carcinogenicity : No known significant effects or critical hazards.

Mutagenicity : No known significant effects or critical hazards.

Teratogenicity : No known significant effects or critical hazards.

Developmental effects : No known significant effects or critical hazards.

Fertility effects : No known significant effects or critical hazards.

Numerical measures of toxicity

Acute toxicity estimates

Not available.

Section 12. Ecological information

Toxicity

Not available.

Persistence and degradability

Not available.

Bioaccumulative potential

Product/ingredient name	$LogP_{ow}$	BCF	Potential
Nitrogen	0.67	-	low

Mobility in soil

Soil/water partition coefficient (K_{OC}) : Not available.

Section 12. Ecological information

Other adverse effects : No known significant effects or critical hazards.

Section 13. Disposal considerations

Disposal methods : The generation of waste should be avoided or minimized wherever possible. Disposal of this product, solutions and any by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements. Dispose of surplus and non-recyclable products via a licensed waste disposal contractor. Waste should not be disposed of untreated to the sewer unless fully compliant with the requirements of all authorities with jurisdiction. Empty Airgas-owned pressure vessels should be returned to Airgas. Waste packaging should be recycled. Incineration or landfill should only be considered when recycling is not feasible. This material and its container must be disposed of in a safe way. Empty containers or liners may retain some product residues. Do not puncture or incinerate container.

Section 14. Transport information

	DOT	TDG	Mexico	IMDG	IATA
UN number	UN1066	UN1066	UN1066	UN1066	UN1066
UN proper shipping name	NITROGEN, COMPRESSED	NITROGEN, COMPRESSED	NITROGEN, COMPRESSED	NITROGEN, COMPRESSED	NITROGEN, COMPRESSED
Transport hazard class(es)	2.2 	2.2 	2.2 	2.2 	2.2 
Packing group	-	-	-	-	-
Environmental hazards	No.	No.	No.	No.	No.

"Refer to CFR 49 (or authority having jurisdiction) to determine the information required for shipment of the product."

Additional information

DOT Classification : **Limited quantity** Yes.
Quantity limitation Passenger aircraft/rail: 75 kg. Cargo aircraft: 150 kg.

TDG Classification : Product classified as per the following sections of the Transportation of Dangerous Goods Regulations: 2.13-2.17 (Class 2).
Explosive Limit and Limited Quantity Index 0.125
Passenger Carrying Road or Rail Index 75

IATA : **Quantity limitation** Passenger and Cargo Aircraft: 75 kg. Cargo Aircraft Only: 150 kg.

Special precautions for user : **Transport within user's premises:** always transport in closed containers that are upright and secure. Ensure that persons transporting the product know what to do in the event of an accident or spillage.

Transport in bulk according to Annex II of MARPOL and the IBC Code : Not available.

Section 15. Regulatory information

U.S. Federal regulations : **TSCA 8(a) CDR Exempt/Partial exemption**: This material is listed or exempted.

Clean Air Act Section 112 (b) Hazardous Air Pollutants (HAPs) : Not listed

Clean Air Act Section 602 Class I Substances : Not listed

Clean Air Act Section 602 Class II Substances : Not listed

DEA List I Chemicals (Precursor Chemicals) : Not listed

DEA List II Chemicals (Essential Chemicals) : Not listed

SARA 302/304

Composition/information on ingredients

No products were found.

SARA 304 RQ : Not applicable.

SARA 311/312

Classification : Refer to Section 2: Hazards Identification of this SDS for classification of substance.

State regulations

Massachusetts : This material is listed.

New York : This material is not listed.

New Jersey : This material is listed.

Pennsylvania : This material is listed.

International regulations

Chemical Weapon Convention List Schedules I, II & III Chemicals

Not listed.

Montreal Protocol (Annexes A, B, C, E)

Not listed.

Stockholm Convention on Persistent Organic Pollutants

Not listed.

Rotterdam Convention on Prior Informed Consent (PIC)

Not listed.

UNECE Aarhus Protocol on POPs and Heavy Metals

Not listed.

Inventory list

Australia : This material is listed or exempted.

Canada : This material is listed or exempted.

China : This material is listed or exempted.

Europe : This material is listed or exempted.

Japan : **Japan inventory (ENCS)**: Not determined.
Japan inventory (ISHL): Not determined.

Malaysia : Not determined.

New Zealand : This material is listed or exempted.

Philippines : This material is listed or exempted.

Republic of Korea : This material is listed or exempted.

Section 15. Regulatory information

Taiwan : This material is listed or exempted.

Thailand : Not determined.

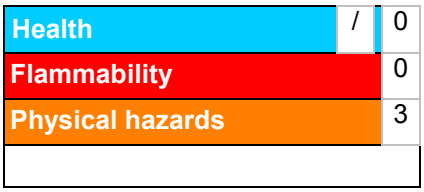
Turkey : Not determined.

United States : This material is listed or exempted.

Viet Nam : Not determined.

Section 16. Other information

Hazardous Material Information System (U.S.A.)



Caution: HMIS® ratings are based on a 0-4 rating scale, with 0 representing minimal hazards or risks, and 4 representing significant hazards or risks. Although HMIS® ratings and the associated label are not required on SDSs or products leaving a facility under 29 CFR 1910.1200, the preparer may choose to provide them. HMIS® ratings are to be used with a fully implemented HMIS® program. HMIS® is a registered trademark and service mark of the American Coatings Association, Inc.

The customer is responsible for determining the PPE code for this material. For more information on HMIS® Personal Protective Equipment (PPE) codes, consult the HMIS® Implementation Manual.

National Fire Protection Association (U.S.A.)

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Copyright ©2001, National Fire Protection Association, Quincy, MA 02269. This warning system is intended to be interpreted and applied only by properly trained individuals to identify fire, health and reactivity hazards of chemicals. The user is referred to certain limited number of chemicals with recommended classifications in NFPA 49 and NFPA 325, which would be used as a guideline only. Whether the chemicals are classified by NFPA or not, anyone using the 704 systems to classify chemicals does so at their own risk.

Procedure used to derive the classification

Classification	Justification
GASES UNDER PRESSURE - Compressed gas SIMPLE ASPHYXIANTS	Expert judgment Expert judgment

History

Date of printing : 4/30/2019

Date of issue/Date of revision : 4/30/2019

Date of previous issue : 4/30/2019

Version : 1.03

Key to abbreviations : ATE = Acute Toxicity Estimate
BCF = Bioconcentration Factor
GHS = Globally Harmonized System of Classification and Labelling of Chemicals
IATA = International Air Transport Association
IBC = Intermediate Bulk Container
IMDG = International Maritime Dangerous Goods
LogPow = logarithm of the octanol/water partition coefficient
MARPOL = International Convention for the Prevention of Pollution From Ships, 1973

Section 16. Other information

as modified by the Protocol of 1978. ("Marpol" = marine pollution)
UN = United Nations

References : Not available.

Notice to reader

To the best of our knowledge, the information contained herein is accurate. However, neither the above-named supplier, nor any of its subsidiaries, assumes any liability whatsoever for the accuracy or completeness of the information contained herein.
Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.

SAFETY DATA SHEET

Carbon Dioxide, Solid or Dry Ice

Airgas
an Air Liquide company

Section 1. Identification

GHS product identifier : Carbon Dioxide, Solid or Dry Ice

Chemical name : Carbon dioxide, solid

Other means of identification : Dry ice; carbonic anhydride

Product type : Solid.

Product use : Synthetic/Analytical chemistry.

Synonym : Dry ice; carbonic anhydride

SDS # : 001091

Supplier's details : Airgas USA, LLC and its affiliates
259 North Radnor-Chester Road
Suite 100
Radnor, PA 19087-5283
1-610-687-5253

24-hour telephone : 1-866-734-3438

Section 2. Hazards identification

OSHA/HCS status : Not classified.

Classification of the substance or mixture : Not classified by Globally Harmonized System of Classification and Labeling (GHS).

GHS label elements

Signal word : Warning

Hazard statements : May displace oxygen and cause rapid suffocation.
May increase respiration and heart rate.
May cause frostbite.

Precautionary statements

General : Read label before use. Keep out of reach of children. If medical advice is needed, have product container or label at hand.

Prevention : Not applicable.

Response : Not applicable.

Storage : Not applicable.

Disposal : Not applicable.

Hazards not otherwise classified : Contact with cryogenic liquid can cause frostbite and cryogenic burns.

Section 3. Composition/information on ingredients

Substance/mixture : Substance

Chemical name : Carbon dioxide, solid

Other means of identification : Dry ice; carbonic anhydride

Product code : 001091

CAS number/other identifiers

CAS number : 124-38-9

Ingredient name	%	CAS number
Carbon Dioxide	100	124-38-9

Any concentration shown as a range is to protect confidentiality or is due to batch variation.

Section 3. Composition/information on ingredients

There are no additional ingredients present which, within the current knowledge of the supplier and in the concentrations applicable, are classified as hazardous to health or the environment and hence require reporting in this section.

Occupational exposure limits, if available, are listed in Section 8.

Section 4. First aid measures

Description of necessary first aid measures

Eye contact : Immediately flush eyes with plenty of water, occasionally lifting the upper and lower eyelids. Check for and remove any contact lenses. Get medical attention if irritation occurs.

Inhalation : Remove victim to fresh air and keep at rest in a position comfortable for breathing. Get medical attention if symptoms occur.

Skin contact : Flush contaminated skin with plenty of water. Remove contaminated clothing and shoes. Get medical attention if symptoms occur.

Ingestion : Wash out mouth with water. Remove victim to fresh air and keep at rest in a position comfortable for breathing. If material has been swallowed and the exposed person is conscious, give small quantities of water to drink. Do not induce vomiting unless directed to do so by medical personnel. Get medical attention if symptoms occur.

Most important symptoms/effects, acute and delayed

Potential acute health effects

Eye contact : May cause eye irritation.

Inhalation : May be harmful if inhaled. May cause respiratory irritation.

Skin contact : Harmful if absorbed through the skin. May cause skin irritation.

Frostbite : Try to warm up the frozen tissues and seek medical attention.

Ingestion : May be harmful if swallowed and enters airways.

Over-exposure signs/symptoms

Eye contact : No specific data.

Inhalation : No specific data.

Skin contact : No specific data.

Ingestion : No specific data.

Indication of immediate medical attention and special treatment needed, if necessary

Notes to physician : Treat symptomatically. Contact poison treatment specialist immediately if large quantities have been ingested or inhaled.

Specific treatments : No specific treatment.

Protection of first-aiders : No action shall be taken involving any personal risk or without suitable training.

See toxicological information (Section 11)

Section 5. Fire-fighting measures

Extinguishing media

Suitable extinguishing media : Use an extinguishing agent suitable for the surrounding fire.

Unsuitable extinguishing media : None known.

Specific hazards arising from the chemical : No specific fire or explosion hazard.

Hazardous thermal decomposition products : Decomposition products may include the following materials:
carbon dioxide
carbon monoxide

Section 5. Fire-fighting measures

Special protective actions for fire-fighters : Promptly isolate the scene by removing all persons from the vicinity of the incident if there is a fire. No action shall be taken involving any personal risk or without suitable training.

Special protective equipment for fire-fighters : Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode.

Section 6. Accidental release measures

Personal precautions, protective equipment and emergency procedures

For non-emergency personnel : No action shall be taken involving any personal risk or without suitable training. Evacuate surrounding areas. Keep unnecessary and unprotected personnel from entering. Do not touch or walk through spilled material. Put on appropriate personal protective equipment.

For emergency responders : If specialized clothing is required to deal with the spillage, take note of any information in Section 8 on suitable and unsuitable materials. See also the information in "For non-emergency personnel".

Environmental precautions : Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air).

Methods and materials for containment and cleaning up

Small spill : Move containers from spill area. Vacuum or sweep up material and place in a designated, labeled waste container. Dispose of via a licensed waste disposal contractor.

Large spill : Move containers from spill area. Prevent entry into sewers, water courses, basements or confined areas. Vacuum or sweep up material and place in a designated, labeled waste container. Dispose of via a licensed waste disposal contractor. Note: see Section 1 for emergency contact information and Section 13 for waste disposal.

Section 7. Handling and storage

Precautions for safe handling

Protective measures : Put on appropriate personal protective equipment (see Section 8).

Advice on general occupational hygiene : Eating, drinking and smoking should be prohibited in areas where this material is handled, stored and processed. Workers should wash hands and face before eating, drinking and smoking. Remove contaminated clothing and protective equipment before entering eating areas. See also Section 8 for additional information on hygiene measures.

Conditions for safe storage, including any incompatibilities : Store in accordance with local regulations. Store in original container protected from direct sunlight in a dry, cool and well-ventilated area, away from incompatible materials (see Section 10) and food and drink. Keep container tightly closed and sealed until ready for use. Containers that have been opened must be carefully resealed and kept upright to prevent leakage. Do not store in unlabeled containers. Use appropriate containment to avoid environmental contamination. See Section 10 for incompatible materials before handling or use.

Section 8. Exposure controls/personal protection

Control parameters

Occupational exposure limits

Section 8. Exposure controls/personal protection

Ingredient name	Exposure limits
Carbon Dioxide	**ACGIH TLV (United States, 3/2017).** STEL: 54000 mg/m³ 15 minutes. STEL: 30000 ppm 15 minutes. TWA: 9000 mg/m³ 8 hours. TWA: 5000 ppm 8 hours. **NIOSH REL (United States, 10/2016).** STEL: 54000 mg/m³ 15 minutes. STEL: 30000 ppm 15 minutes. TWA: 9000 mg/m³ 10 hours. TWA: 5000 ppm 10 hours. **OSHA PEL (United States, 6/2016).** TWA: 9000 mg/m³ 8 hours. TWA: 5000 ppm 8 hours. **OSHA PEL 1989 (United States, 3/1989).** STEL: 54000 mg/m³ 15 minutes. STEL: 30000 ppm 15 minutes. TWA: 18000 mg/m³ 8 hours. TWA: 10000 ppm 8 hours.

Appropriate engineering controls : Good general ventilation should be sufficient to control worker exposure to airborne contaminants.

Environmental exposure controls : Emissions from ventilation or work process equipment should be checked to ensure they comply with the requirements of environmental protection legislation. In some cases, fume scrubbers, filters or engineering modifications to the process equipment will be necessary to reduce emissions to acceptable levels.

Individual protection measures

Hygiene measures : Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

Eye/face protection : Safety eyewear complying with an approved standard should be used when a risk assessment indicates this is necessary to avoid exposure to liquid splashes, mists, gases or dusts. If contact is possible, the following protection should be worn, unless the assessment indicates a higher degree of protection: safety glasses with side-shields.

Skin protection

Hand protection : Chemical-resistant, impervious gloves complying with an approved standard should be worn at all times when handling chemical products if a risk assessment indicates this is necessary.

Body protection : Personal protective equipment for the body should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.

Other skin protection : Appropriate footwear and any additional skin protection measures should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.

Respiratory protection : Based on the hazard and potential for exposure, select a respirator that meets the appropriate standard or certification. Respirators must be used according to a respiratory protection program to ensure proper fitting, training, and other important aspects of use.

Section 9. Physical and chemical properties

Appearance

Physical state : Solid. [WHITE SNOW-LIKE SOLID]

Color : White.

Odor : Not available.

Odor threshold : Not available.

pH : Not available.

Melting point : Sublimation temperature: -78.5°C (-109.3 to °F)

Boiling point : Not available.

Critical temperature : 31°C (87.8°F)

Flash point : Not available.

Evaporation rate : Not available.

Flammability (solid, gas) : Not available.

Lower and upper explosive (flammable) limits : Not available.

Vapor pressure : Not available.

Vapor density : Not available.

Specific Volume (ft^3/lb) : 0.6579

Gas Density (lb/ft^3) : 1.52

Relative density : Density Solid (Dry Ice) 97.5189 lb./ft.3 at -109.3° F

Solubility : Not available.

Solubility in water : Not available.

Partition coefficient: n-octanol/water : Not available.

Auto-ignition temperature : Not available.

Decomposition temperature : Not available.

Viscosity : Not available.

Flow time (ISO 2431) : Not available.

Molecular weight : 44.01 g/mole

Section 10. Stability and reactivity

Reactivity : No specific test data related to reactivity available for this product or its ingredients.

Chemical stability : The product is stable.

Possibility of hazardous reactions : Under normal conditions of storage and use, hazardous reactions will not occur.

Conditions to avoid : No specific data.

Incompatible materials : No specific data.

Hazardous decomposition products : Under normal conditions of storage and use, hazardous decomposition products should not be produced.

Hazardous polymerization : Under normal conditions of storage and use, hazardous polymerization will not occur.

Section 11. Toxicological information

Information on toxicological effects

Acute toxicity

Not available.

Irritation/Corrosion

Not available.

Sensitization

Not available.

Mutagenicity

Not available.

Carcinogenicity

Not available.

Reproductive toxicity

Not available.

Teratogenicity

Not available.

Specific target organ toxicity (single exposure)

Not available.

Specific target organ toxicity (repeated exposure)

Not available.

Aspiration hazard

Not available.

Information on the likely routes of exposure : Not available.

Potential acute health effects

Eye contact : May cause eye irritation.

Inhalation : May be harmful if inhaled. May cause respiratory irritation.

Skin contact : Harmful if absorbed through the skin. May cause skin irritation.

Ingestion : May be harmful if swallowed and enters airways.

Symptoms related to the physical, chemical and toxicological characteristics

Eye contact : No specific data.

Inhalation : No specific data.

Skin contact : No specific data.

Ingestion : No specific data.

Delayed and immediate effects and also chronic effects from short and long term exposure

Short term exposure

Potential immediate effects : Not available.

Potential delayed effects : Not available.

Long term exposure

Potential immediate effects : Not available.

Potential delayed effects : Not available.

Potential chronic health effects

Section 11. Toxicological information

Not available.

General : No known significant effects or critical hazards.

Carcinogenicity : No known significant effects or critical hazards.

Mutagenicity : No known significant effects or critical hazards.

Teratogenicity : No known significant effects or critical hazards.

Developmental effects : No known significant effects or critical hazards.

Fertility effects : No known significant effects or critical hazards.

Numerical measures of toxicity

Acute toxicity estimates

Not available.

Section 12. Ecological information

Toxicity

Not available.

Persistence and degradability

Not available.

Bioaccumulative potential

Not available.

Mobility in soil

Soil/water partition coefficient (K_{OC}) : Not available.

Other adverse effects : No known significant effects or critical hazards.

Section 13. Disposal considerations

Disposal methods : The generation of waste should be avoided or minimized wherever possible. Disposal of this product, solutions and any by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements. Dispose of surplus and non-recyclable products via a licensed waste disposal contractor. Waste should not be disposed of untreated to the sewer unless fully compliant with the requirements of all authorities with jurisdiction. Waste packaging should be recycled. Incineration or landfill should only be considered when recycling is not feasible. This material and its container must be disposed of in a safe way. Empty containers or liners may retain some product residues. Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers.

Section 14. Transport information

Section 14. Transport information

	DOT	TDG	Mexico	IMDG	IATA
UN number	UN1845	UN1845	UN1845	UN1845	UN1845
UN proper shipping name	CARBON DIOXIDE, SOLID OR DRY ICE	CARBON DIOXIDE, SOLID; OR DRY ICE	CARBON DIOXIDE, SOLID OR DRY ICE	CARBON DIOXIDE, SOLID (DRY ICE)	CARBON DIOXIDE, SOLID
Transport hazard class(es)	9 	9 	9 	9 	9 
Packing group	-	-	-	-	-
Environmental hazards	No.	No.	No.	No.	No.

"Refer to CFR 49 (or authority having jurisdiction) to determine the information required for shipment of the product."

Additional information

DOT Classification : **Limited quantity** Yes.
Quantity limitation Passenger aircraft/rail: 200 kg. Cargo aircraft: 200 kg.

TDG Classification : Product classified as per the following sections of the Transportation of Dangerous Goods Regulations: 2.43-2.45 (Class 9).
Explosive Limit and Limited Quantity Index 5
Passenger Carrying Ship Index 200
Special provisions 18

IATA : **Quantity limitation** Passenger and Cargo Aircraft: 200 kg. Cargo Aircraft Only: 200 kg.

Special precautions for user : **Transport within user's premises:** always transport in closed containers that are upright and secure. Ensure that persons transporting the product know what to do in the event of an accident or spillage.

Transport in bulk according to Annex II of MARPOL and the IBC Code : Not available.

Section 15. Regulatory information

U.S. Federal regulations : **TSCA 8(a) CDR Exempt/Partial exemption**: This material is listed or exempted.

Clean Air Act Section 112 (b) Hazardous Air Pollutants (HAPs) : Not listed

Clean Air Act Section 602 Class I Substances : Not listed

Clean Air Act Section 602 Class II Substances : Not listed

DEA List I Chemicals (Precursor Chemicals) : Not listed

DEA List II Chemicals (Essential Chemicals) : Not listed

SARA 302/304

Composition/information on ingredients

No products were found.

Section 15. Regulatory information

SARA 304 RQ : Not applicable.

SARA 311/312

Classification : Refer to Section 2: Hazards Identification of this SDS for classification of substance.

State regulations

Massachusetts : This material is listed.

New York : This material is not listed.

New Jersey : This material is listed.

Pennsylvania : This material is listed.

International regulations

Chemical Weapon Convention List Schedules I, II & III Chemicals

Not listed.

Montreal Protocol (Annexes A, B, C, E)

Not listed.

Stockholm Convention on Persistent Organic Pollutants

Not listed.

Rotterdam Convention on Prior Informed Consent (PIC)

Not listed.

UNECE Aarhus Protocol on POPs and Heavy Metals

Not listed.

Inventory list

Australia : This material is listed or exempted.

Canada : This material is listed or exempted.

China : This material is listed or exempted.

Europe : This material is listed or exempted.

Japan : **Japan inventory (ENCS)**: This material is listed or exempted.
Japan inventory (ISHL): This material is listed or exempted.

Malaysia : Not determined.

New Zealand : This material is listed or exempted.

Philippines : This material is listed or exempted.

Republic of Korea : This material is listed or exempted.

Taiwan : This material is listed or exempted.

Thailand : Not determined.

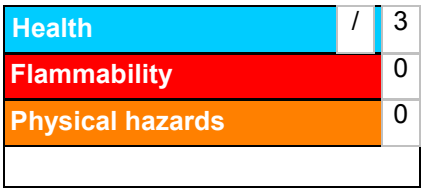
Turkey : This material is listed or exempted.

United States : This material is listed or exempted.

Viet Nam : Not determined.

Section 16. Other information

Hazardous Material Information System (U.S.A.)

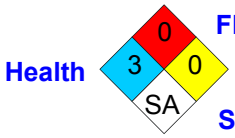


Caution: HMIS® ratings are based on a 0-4 rating scale, with 0 representing minimal hazards or risks, and 4 representing significant hazards or risks. Although HMIS® ratings and the associated label are not required on SDSs or products leaving a facility under 29 CFR 1910.1200, the preparer may choose to provide them. HMIS® ratings are to be used with a fully implemented HMIS® program. HMIS® is a registered trademark and service mark of the American Coatings Association, Inc.

Section 16. Other information

The customer is responsible for determining the PPE code for this material. For more information on HMIS® Personal Protective Equipment (PPE) codes, consult the HMIS® Implementation Manual.

National Fire Protection Association (U.S.A.)



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Copyright ©2001, National Fire Protection Association, Quincy, MA 02269. This warning system is intended to be interpreted and applied only by properly trained individuals to identify fire, health and reactivity hazards of chemicals. The user is referred to certain limited number of chemicals with recommended classifications in NFPA 49 and NFPA 325, which would be used as a guideline only. Whether the chemicals are classified by NFPA or not, anyone using the 704 systems to classify chemicals does so at their own risk.

Procedure used to derive the classification

Classification	Justification
Not classified.	

History

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Version : 1

Key to abbreviations : ATE = Acute Toxicity Estimate
BCF = Bioconcentration Factor
GHS = Globally Harmonized System of Classification and Labelling of Chemicals
IATA = International Air Transport Association
IBC = Intermediate Bulk Container
IMDG = International Maritime Dangerous Goods
LogPow = logarithm of the octanol/water partition coefficient
MARPOL = International Convention for the Prevention of Pollution From Ships, 1973 as modified by the Protocol of 1978. ("Marpol" = marine pollution)
UN = United Nations

References : Not available.

Notice to reader

To the best of our knowledge, the information contained herein is accurate. However, neither the above-named supplier, nor any of its subsidiaries, assumes any liability whatsoever for the accuracy or completeness of the information contained herein.
Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.

ATTACHMENT A2

STANDARD OPERATING PROCEDURES FOR THE 2019 PHASE 3 SEDIMENT STUDY

STANDARD OPERATING PROCEDURE SOP-1

POSITIONING AT BELOW-WATER STATIONS

Purpose

The purpose of this standard operating procedure (SOP) is to describe procedures used for locating sampling stations below water for the 2019 Phase 3 Sediment Study (hereinafter "the study") that will be conducted for Teck American Incorporated (TAI) in the Upper Reach Operable Unit (OU) of the Upper Columbia River (UCR) site.

Scope and Applicability

This SOP is applicable for determining the horizontal and vertical location of below-water stations. The SOP applies to all below-water surface sediment and porewater sampling locations accessed by boat, regardless of collection device.

Equipment and Materials

The horizontal positioning equipment will consist of a differential global positioning system (DGPS)[1] and associated navigation system (e.g., Hypack marine navigation software or similar navigation software). The display will be capable of showing the present location of the vessel relative to the desired station location and will provide a bearing and distance to the station. The equipment will be capable of being pre-programmed with the National Oceanic and Atmospheric Administration (NOAA) nautical chart and will include uploaded geographic information system (GIS) formatted point locations for all proposed sampling locations, plus sediment facies map polygons for real-time display during navigation and sampling. In the event normal global positioning system (GPS) reception is not available at a given location because of terrain blocking (e.g., canyon wall or ridges preventing satellite reception) or other causes, alternate methods will be used to establish positions (see next section).

Water depth will be measured with a calibrated vessel fathometer, or, in shallow water, a lead line and tape measure or a surveyor's rod. Vessel fathometers will be calibrated using a bar check or lead line to ensure accuracy. Calibration will be performed on a weekly basis or as needed.

[1] If a signal for the DGPS cannot be received, a handheld GPS unit will be used to locate sampling station coordinates.

Typical Procedures/Guidelines for Horizontal Positioning

Horizontal positioning for below-water stations will be accomplished using DGPS based on the U.S. Coast Guard (USCG) Maritime Differential GPS Service signal or GPS if the USCG differential signal cannot be received. USCG operates a GPS remote broadcast site from Spokane that broadcasts corrected GPS signals on marine radio beacon frequencies. Position errors with this system typically are within 1 to 3 m (3.3 to 9.8 ft).

The sampling vessel must locate and remain fixed on the general sampling location before sampling can begin. The vessel operator will be responsible for navigating the boat to each sample location. Upon arrival at a designated sampling location, the field sampling team leader will inspect the sediment bed composition using video and verify that the observed sediment bed appears consistent with the target strata (for locations at areas of interest) or facies (for locations at reference areas) specified in the quality assurance project plan (QAPP) and field sampling plan (FSP). If the sediment bed does not match the target stratum or facies, or if the location does not appear amenable to sample collection (e.g., due to presence of bedrock or large woody debris), then the team will attempt to identify a more suitable location using video.

It is important to note that the Cultural Resources Working Group, in association with the U.S. Environmental Protection Agency (EPA) advisor, must approve all UCR sampling locations prior to initiation of sampling activities, including the allowable distance for sample location adjustments away from the proposed sampling location coordinates. There may be some areas where sampling is prohibited due to cultural resources, and the field supervisor or cultural resources monitor will be responsible for ensuring that samples are collected in approved areas.

If the initial collection attempt is unsuccessful, the boat may be repositioned at any other location within the target contiguous sediment facies polygon; vessel position relative to the sediment facies polygon will be monitored real time using the navigation software, which will display the DGPS position on a GIS-based sediment facies map. A maximum of three attempts at or near each sample location will be made. If it is apparent that collecting a sample is unlikely, the field supervisor may elect to terminate efforts before three attempts are made, and the team will proceed to an alternate location where the field team leader will select the preferred sampling technique (if appropriate)[2]. The field supervisor, in consultation with EPA oversight personnel, will decide if either an alternate location is to

[2] At China Bend Area of Interest (AOI) judgmental sample locations, two specific alternate sample locations are designated. These alternate locations may not be used as alternate locations for statistically determined locations or repeat sample locations.

be sampled or another sampling method should be attempted at the original location (e.g., the modified Hamon power grab or freeze grab). These decisions will be discussed with EPA on update calls during the field effort.

For porewater, after three attempts, the field team leader will consult with the EPA oversight personnel to determine whether to move to an alternate location or perform additional sampling attempts. If the sample location is in shallow water, porewater may still be collected using the pole-mounted Trident sampler. The position recorded should be the location of the Trident probe, not the boat, which may require recording the sample location with a handheld GPS using methods outlined in SOP-2.

When the vessel is not under power, it will typically swing perpendicular to the wind or current. If the sampling equipment is deployed over the side of the vessel instead of the stern, this will be done on the upwind or upcurrent side to prevent the vessel drifting onto the hydrowire (winch wire) once the sampler has contacted the bottom. In shallow water (less than about 10 m deep) with drift rates exceeding about 0.5 m/sec (1.6 ft/sec), the sampler may not perform correctly because of its lateral speed when it hits the bottom. Under high drift rates, it will be necessary to either anchor or hold the vessel in position using engine power. The adverse effects of drift rate decrease as the water depth increases because the vessel must drift a longer distance on the surface to pull the sampler out of alignment on the bottom.

The angle of the hydrowire to the vertical will be limited to approximately 5 degrees or less for all sampling activities, if possible. Once wire angles exceed 5 degrees, the angle of the wire will be measured to determine the adjusted position of the sample location. This will be executed by measuring the exact amount of winch line in the water via the vessel integrate line counter sheave. This distance, together with the total water depth measured by the bow-mounted vessel sonar directly below the sheave, will be used to derive the angle of the cable and ultimately the lateral distance of the sample location behind the reference point of the vessel.

Water Depth

The depth of below-water stations will be measured using a fathometer, lead line, or survey rod. The depth to the station from the water surface will be converted to elevation based on the pool elevation.

Data Management

Electronic data generated from the vessel navigation system will be downloaded frequently (preferably daily when feasible) and stored on a field operations computer, at a secure location (see SOP-10).

STANDARD OPERATING PROCEDURE SOP-2

POSITIONING FOR WADEABLE SAMPLE LOCATIONS

Scope and Applicability

This standard operating procedure (SOP) describes procedures used for locating beach and wadeable sampling stations for the 2019 Phase 3 sediment study (hereinafter "the study") that will be conducted for Teck American Incorporated (TAI) in the Upper Reach Operable Unit (OU) of the Upper Columbia River (UCR) site. Accurate station positioning is required to help ensure quality and consistency in collecting samples and in data interpretation and analysis. Station positioning must be both absolutely accurate in that it correctly defines a position by northing/easting or latitude/longitude, and relatively accurate in that the position must be repeatable. The methods described in this SOP are usable for any handheld global positioning system (GPS); however, the owner's manual should be consulted for any GPS unit used to support this SOP.

This SOP is applicable for determining the horizontal location of wadeable sample locations. The SOP applies to all wadeable surface sediment and porewater sampling locations regardless of collection device. For porewater sampling at wadeable locations, a pole-mounted Trident probe may be required. If operated from the boat, the position recorded should be the location of the Trident probe, not the boat, and will follow the procedures for recording wadeable sampling locations.

Equipment and Materials

The following is a list of equipment and materials needed by the field sampling team:

- Handheld GPS unit with submeter accuracy spare batteries
- Charging unit.

A GPS hardware system will be used for locating sampling stations, such as a Trimble GeoXH GPS (or equivalent device). The GPS unit will be loaded with sampling locations prior to any visit to the UCR Site. The standard projection method to be used during field activities is the horizontal datum of UTM Zone 11N NAD83 in meters.

Positioning System Verification

GPS does not require any calibration because all signal propagation is controlled by the U.S. government (the Department of Defense for satellite signals, and the U.S. Coast Guard and

U.S. Forest Service for differential corrections). Verification of the accuracy of the GPS requires that coordinates be known for one (or more) horizontal control points within the study area. The GPS position reading at any given station can then be compared to the known control point. If possible, handheld GPS accuracy will be verified at the beginning or at the end of each sampling day that the GPS is used, using control points established as part of the Sediment Facies Mapping field work in 2018.

Station Location Procedures

Pre-selected sampling station locations will be uploaded into the handheld GPS unit prior to the sampling effort. In the event a proposed sampling location cannot be sampled, the coordinates of any alternate or additional sample locations will be entered into the GPS unit and recorded in the field logbook.

A brief summary of procedures to locate a specific increment location using a handheld GPS unit follows:

- Turn on the unit
- Wait for it to acquire the location of satellites
- Select desired sample location
- Follow GPS directions to desired sample location
- If a proposed sampling location cannot be safely accessed, then the field team leader, in consultation with the U.S. Environmental Protection Agency (EPA) advisor, will determine whether the location may be adjusted or if an alternate location should be used
- Save the sample location into the GPS memory, as well as note the site coordinates in the field logbook
- Charge the unit and batteries when not in use.

Upon completion of the sampling effort, all data points will be downloaded from the GPS unit and displayed in a geographic information system (GIS).

It is important to note that the Cultural Resources Working Group in association with EPA must approve all UCR sampling locations prior to initiation of sampling activities, including the allowable distance for sample location adjustments away from the proposed sampling location coordinates. There may be some areas where sampling is prohibited due to cultural resources, and the field team leader will be responsible for ensuring that samples are collected in approved areas.

Data Management

Electronic data generated from the GPS unit will be downloaded frequently (preferably daily when feasible) and stored on a field operations computer, at a secure location (see SOP-10).

STANDARD OPERATING PROCEDURE SOP-3

VAN VEEN POWER GRAB SEDIMENT SAMPLE COLLECTION

Scope and Applicability

The purpose of this standard operating procedure (SOP) is to describe the procedures used to collect surface sediment with a modified Van Veen power grab sampler[1] for the 2019 Phase 3 sediment study (hereinafter "the study") that will be conducted for Teck American Incorporated (TAI) in the Upper Reach Operable Unit (OU) of the Upper Columbia River (UCR) site. For the purposes of this study, surface sediment is defined as the upper 6 in. of the sediment column.

The procedures listed below may be modified in the field by the field supervisor and field personnel, based on field and site conditions, after appropriate annotations have been made in the field logbook.

A modified stainless-steel Van Veen power grab sampler is capable of collecting acceptable samples from a variety of substrates, such as mud, sand, gravel, and pebbles (APHA 1989; USEPA 2001). The modified Van Veen power grab sampler incorporates several design improvements over the traditional Van Veen grab sampler to improve the quality of the sediment samples. This custom-built sampler is also designed specifically for operating in hard-bottom materials and in higher water-flow areas. It consists of a 400-lb base frame and a Van Veen style bucket that is operated by a pneumatic cylinder with 900 lbs of closing force, using an on-board air compressor and top-side controller. The sampler is built completely from Stainless Steel 304 (see Figure 1 below).

The grab sampler has two doors on top to allow easy access to the sample for visual characterization and subsampling of undisturbed surface sediments. The interiors of the doors are made of screens to minimize disturbance of the sediment surface when the grab sampler is lowered to the bottom. Rubber flaps cover each screen as the grab sampler is retrieved to prevent disturbing the sediment sample as it is raised through the water column. The arms of the sampler are lengthened and arced to provide a stronger seal when the grab sampler is closed, thereby minimizing sample leakage when the grab sample is

[1] The procedures described in this SOP include those that would apply to other grab samplers (e.g., Ekman or standard Van Veen), which will be available as a backup sampler for the power grab.

retrieved. The procedures for collecting surface sediment samples using the modified Van Veen grab sampler are described below.

Figure 1. Illustration of Custom-designed Van Veen Power Grab Sampler

Equipment and Materials

Equipment required for sediment sampling using the Van Veen grab sampler includes the following:

- Stainless-steel Van Veen power grab sampler and spare parts
- Winch and Spectra or wire rope (with load capacities three times the weight of a full sampler)
- Underwater camera and sufficient cable for anticipated water depths
- Sample collection table
- Teflon® or polyethylene tubing for siphon
- Stainless-steel ruler
- Stainless-steel spoons/spatulas, or Lexan scoop
- Transparent Lexan tub and/or stainless-steel mixing bowl or pot
- Alconox, Liquinox, or equivalent detergent
- Scrub brush
- Socket and crescent wrenches
- Water pump and hose (for rinsing the grab sampler, sampling utensils, and sample collection table).

Procedures for Sediment Sample Collection

1. Start filling out a sediment grab collection form.
2. Locate the sample station as described in SOP-1. Label the sampling containers prior to filling in accordance with SOP-9.
3. Attach the grab sampler to the winch line with a swivel. The swivel minimizes the twisting forces on the sampler during deployment and ensures that proper contact is made with the bottom. For safety, the winch line, swivel, and all shackles should have a load capacity at least three times the weight of a full sampler.
4. Place the decontaminated grab sampler on a clean surface (e.g., the sample collection table) and open it.
5. Ensure that all doors are firmly latched shut.
6. Check connection and operation of underwater camera.
7. Start the winch, raise the sampler, and swing it outboard.

8. Lower the sampler through the water column at a slow and steady speed (e.g., 30 cm/sec).
9. The depth of the sampler as it is lowered through the water column should be determined either by rigging the winch line to a meter wheel or using pre-marked meter lengths on the cable itself. The depth can also be monitored using the underwater camera.
10. Once the sediment can be seen on the underwater camera, the sampler will be positioned so that any material that could interfere with sample collection is avoided. It may be necessary to reposition the sampling vessel.
11. Allow the grab sampler to contact the bottom gently, with only its weight being used to force it into the sediments. The sampler should not be allowed to "free fall" to the bottom because this may result in an excessive bow wake or improper orientation upon contact with the bottom. Allow approximately 60 cm of slack in the winch line after contact with the bottom is made to ensure the sampler has adequately penetrated the sediment surface.
12. When the cable is drawn taut, record the differential global positioning system (DGPS) coordinates.
13. After the grab sampler has rested on the bottom for approximately 5 seconds, the pneumatic-powered mechanism is activated to close the clam-shell sides and collect the sediment sample.
14. The grab sampler is then retrieved at a slow and steady rate (e.g., 30 cm/sec). Note that the amount of time that the grab sampler rests on the bottom is dependent upon the kind of substrate (e.g., sediment with a high moisture content will require less time on the bottom to avoid over-penetration).
15. Ensure that the sampling vessel is not headed into any waves before the sampler breaks the water surface to minimize vessel rolling and potential sample disturbance. Care must be taken to avoid loss of fine-grained sediments, mixing of sediment layers upon impact, and loss of sediment from tilting or washout upon ascent.
16. After the grab sampler breaks the water surface and is raised above the height of the sample collection table, swing the grab sampler inboard, keep the sampler in an upright position and gently lower it onto the table, maintaining tension on the winch line to prevent the grab sampler from rolling when it contacts the table. Avoid quick movements of the sampler, especially rotation, because this could disrupt the sediment surface interface.

17. When the grab sampler contacts the table, insert wedges under both jaws so that the grab sampler will be held in an upright position when tension on the winch line is relaxed.

18. Relax the tension on the cable and remove the release and retrieval chains from the surface of the grab sampler.

19. As soon as the grab sampler is secured, open the doors on the top of the grab sampler, and inspect the sample for acceptability. The following acceptability criteria should be satisfied:

    a. The sampler is not overfilled with the sample to the point that the sediment surface presses against the top of the sampler or is extruded through the top of the sampler.

    b. Overlying water is present (indicating minimal leakage).

    c. The overlying water is not excessively turbid (indicating minimal disturbance of the interface or winnowing). Excessive turbidity is determined based upon observation of other samples and best professional judgment. Turbidity will vary in water overlying different matrices (i.e., water overlying fine silt will naturally be more turbid than water overlying coarse sand).

    d. The sediment surface is relatively undisturbed; the sediment-water interface is intact and relatively flat with no sign of channeling or sample washout.

    e. The desired penetration depth is achieved.

    f. There is no sign of sediment loss (incomplete closure of the sampler, penetration at an angle, or tilting upon retrieval).

    g. The sample contains ≥ 20 percent fines (i.e., ≤ 2 mm).

Grab samples not meeting the above-listed acceptance criteria will be 'rejected,' but will be temporarily held onboard while subsequent sampling drops attempt to obtain an 'accepted' sample (i.e., a sample meeting all the acceptance criteria). At the discretion of the field team leader, rejected sample materials may be temporarily placed in a decontaminated, transparent Lexan tub for cultural inspection, and the sampling steps repeated until an accepted sample has been obtained or until a decision is made that sampling using this equipment would not work at this location. Should subsequent sampling attempts also fail to meet the above-listed acceptance criteria, additional rejected samples will be placed in the same or separate Lexan tub. Field personnel will use their experience and professional judgment applying the acceptance criteria to identify accepted and rejected samples.

If all sampling attempts fail to meet the acceptance criteria, prior to discarding any rejected sediments from this location, field personnel will (following inspection for cultural

resources) assess the overall grain-size distribution of rejected materials temporarily stored in the Lexan tub and photograph the collected materials. Field personnel will use their experience and professional judgment to evaluate the relative volume of fine-grained sediments (i.e., ≤ 2 mm). If there is sufficient volume to perform analyses according to Table A2 of the field sampling plan (FSP), sediment samples should be evaluated and homogenized as described in the steps below and retained for future analyses. The collection of these rejected sediments will allow some evaluation of the area if similar sampling difficulties are encountered at alternate locations.

Sample Removal and Processing

1. Penetration depth should be determined with a decontaminated stainless-steel ruler by measuring the distance from the top of the sampler to the sediment interface and subtracting this from the inside depth of the sampler. If the sample is fairly level inside the sampler, this measurement can be made at one edge. If the sample is uneven but has an intact interface, then measurements should be made on opposite edges of the sample and the average value used. This observation (i.e., that the sediment surface is slanted) and subsequent calculation of the average penetration depth should be recorded in the field logbook. If penetration depth is inadequate, add auxiliary weights, and repeat the above steps.
2. If necessary, remove the overlying water by slowly siphoning it off near one or more sides of the grab sampler. Ensure that the siphon does not contact the sediments or that fine-grained suspended sediment is not siphoned off. If sediment is suspended in the overlying water, do not proceed with siphoning until the sediment is allowed sufficient time to settle.
3. Once the water is removed, the sample container for acid volatile sulfides (AVS) and simultaneously extracted metals (SEM) testing should be filled to minimize exposure to air as follows:
    a. Place an excess of fine-grained sediment into a resealable plastic bag using a decontaminated stainless-steel spoon or other tool.
    b. Squeeze out any air remaining from the bag and seal it.
    c. Allow the cultural resources monitor to inspect the sample.
    d. If the sample passes cultural resources review, place the sediment into the sample jar for the AVS and SEM samples by cutting a corner of the bag. The jar should be filled completely to minimize headspace and sealed tightly. Continue to the next sample collection step.

e. If the sample fails cultural resources review, proceed as described in step 5 below at the direction of the cultural resources monitor.

4. Photograph the material in the grab sampler. The photograph identification (ID) should be documented in the field typically by photographing a white board with the sample ID immediately before photographing the sediment. This will enable subsequently labeling the photograph with station location, date, and time of sample.

5. Place the bulk sediment sample into a decontaminated transparent Lexan tub to facilitate on-site cultural resources observations. The onboard cultural resources monitor will examine the sediment to determine if cultural resources are present. If cultural resources are present, the field crew will follow instructions from the cultural resources monitor regarding what to do with the recovered sediment and cultural artifacts, as well as whether to abandon the sampling station (see SOP-16).

6. A qualified person[2] will characterize the sediment. Characteristics that will be recorded in the field data form include:

   a. Sediment type (e.g., silt, sand)

   b. Texture (e.g., fine, coarse, poorly sorted sand)

   c. Color

   d. Presence/absence of black silica glass particles (based on vitreous, conchoidal fractures, and a translucent appearance); if present, estimate relative percent composition

   e. Presence/location/thickness of the redox potential boundaries (a visual indication of black is often adequate for documenting anoxia)

   f. Presence of biological structures (e.g., amphipods, tubes, macrophytes)

   g. Presence of debris (e.g., twigs, leaves)

   h. Presence of shells

   i. Stratification, if any

   j. Presence of a sheen

   k. Odor (e.g., hydrogen sulfide, oil, creosote).

[2] A qualified person is either a Washington State Licensed Geologist (LG) or an engineer/scientist who has received site-specific training in the following: 1) identification of sedimentary deposits of the Upper Columbia River basin, 2) recognition of amorphous silica-rich glass, 3) particle size and percentage estimation, 4) soil/sediment classification systems, and 5) recording of observations.

7. For chemistry or bioassay samples, the sediment will be sieved, if necessary, as described below. For benthic macroinvertebrate (BMI) samples, proceed to step 8.
    a. The total sample mass will be determined by weighing the container containing the sample and subtracting the container mass.
    b. Sediment that are composed entirely of fine-grained material (≤ 2 mm) will be retained with no additional processing.
    c. If the sample simply contains a few pieces of gravel or cobble > 2 mm, then that material can simply be removed by hand during homogenization of the sample.
    d. Any material removed will be retained and weighed. Cobble and gravel will be weighed separately to allow for accurate representation of in situ grain size distribution.
    e. Samples with large proportions of materials that are > 2 mm will be coarsely sieved using a 5-mm sieve. Sieving will be performed by shaking or pressing (e.g., using gloved hands to break apart clumps) the sediment through the sieve. Unacceptable sieving techniques include drying the sediment or washing it through the sieve using water.
8. The smaller-sized fraction will be collected as the sample. The larger material will be separated into appropriate size categories and weighed. A brief summary of the steps required for BMI sampling is provided in this section. Please see SOP-8 (BMI sampling) for a more detailed explanation. Each sample consists of one complete grab; after evaluation by a cultural resources monitor, the following steps will occur:
    a. Transfer sample material (scoop and pour) to a Lexan tub and rinse residual material from the inside of the grab sampler into the tub with pumped and filtered river water.
    b. Pick out large gravel, cobble, and debris by hand, carefully washing with pumped and filtered river water so that the attached BMI stays in the tub. Discard the washed large gravel and debris.
    c. After as much coarse gravel, cobble, and debris as possible is washed from the sample, remove excess water from the sample by decanting through a 250-µm sieve and use a small amount of water to return any material retained on the sieve back into the sample container.
    d. Carefully transfer all material retained in the tub into pre-labeled plastic sample containers.

e. Do not fill containers more than two-thirds full with sediment. Add 90 percent ethanol until the volume of ethanol is equal to the volume of sediment. If the container is up to two-thirds full of sediment, fill the container to the top with 90 percent ethanol.

f. Proceed to step 12.

9. Using appropriate decontaminated tools (e.g., mechanical stainless-steel paddle wheel mixer, spoons, gloved hands), the sample will be homogenized in the Lexan tub until the texture and color of the sediment appears to be uniform.

10. Photograph the homogenized sediment. The photograph ID should be documented in the field so that the photograph can be subsequently labeled with station location, date, and time of sample.

11. For chemistry and bioassay samples, the homogenized sediment may be placed into labeled, laboratory-provided, sample containers. Sample containers for a field duplicate sample (if needed) will be filled from the same homogenized sediment as the primary sample. See Table A2 of the FSP for volume requirements for chemistry and bioassay samples.

    a. Fill all sediment sample containers for analytical chemistry or bioassays.

    b. Sediment samples for the analytical laboratory will be stored in a cooler with ice until they are transferred from the sampling vessel.

    c. Once placed into their 5-gal containers, bioassay samples will be covered with site water.

    d. Because bioassay samples are too large to place into a cooler, they will be cooled by placing bags of ice directly onto the sample until they can be delivered to a refrigerator.

12. If any sample remains in the grab sampler after the surface sediment has been collected, move the sampling vessel away from the station, open the jaws of the grab sampler using the pneumatic-powered mechanism, and allow the remainder of the sediment sample to fall onto the sample collection table or into waste sediment collection buckets or tubs. Discard this material away from the station and rinse away any sediment adhering to the inside of the grab sampler. Residual material can also be discarded by returning the grab to the water and opening the jaws. The grab sampler is now ready for additional sampling at the same station or decontamination before sampling at a new station.

13. Decontaminate the grab sampler and associated equipment (e.g., Lexan tub and scoop) between station locations in accordance with decontamination procedures (see SOP-14).

14. Rinse the boat deck clean after all grab samples are collected and secure the sampler before moving to the next station.

References

APHA. 1989. Standard methods for the examination of water and waste water. Seventeenth Edition. Prepared and published by American Public Health Association, the American Water Works Association, and the Water Pollutant Control Federation.

USEPA. 2001. Methods for collection, storage, and manipulation of sediments for chemical and toxicological analyses: Technical Manual. EPA-823-B-01-002. U.S. Environmental Protection Agency, Office of Water, Office of Science & Technology, Washington, DC.

STANDARD OPERATING PROCEDURE SOP-4

MODIFIED HAMON GRAB SEDIMENT SAMPLE COLLECTION

Scope and Applicability

The purpose of this standard operating procedure (SOP) is to describe the procedures used to collect surface sediment with a modified Hamon power grab[1] for the 2019 Phase 3 sediment study (hereinafter "the study") that will be conducted for Teck American Incorporated (TAI) in the Upper Reach Operable Unit (OU) of the Upper Columbia River (UCR) site. For the purposes of this study, surface sediment is defined as the upper 6 in. of the sediment column.

The procedures listed below may be modified in the field by the field supervisor and field personnel (including U.S. Environmental Protection Agency [EPA] oversight personnel), based on field and site conditions, after appropriate annotations have been made in the field logbook.

The rectangular frame of the modified Hamon grab provides support to a sampling bucket attached to a pivoted arm. Upon landing on sediment, the bucket will be driven through the sediment by a pneumatic arm that drives the sample bucket through the sediment and onto an inclined steel plate, sealing the sample completely. While the Hamon grab is known for its reliability, ease of use, and effectiveness in coarse substrates, potential drawbacks exist:

- Insufficient weight or refusal due to larger materials can cause the grab to "walk" by sliding the frame in the opposite direction as the bucket movement. The weight of the device (between 200 and 600 kg) helps to alleviate this issue but additional weight is sometimes added.
- Sample foreshortening (reduced penetration) occurs if the grab raises itself or walks during closure.
- Cobble is difficult to sample.

[1] A typical Hamon grab sampler is activated by release of tension in the cable (e.g., winch line) when the sampler contacts the sediment bed, and closed by tension on the cable during inhauling (Brown et al. 2002). The modified Hamon grab sampler developed for use at the UCR site is modified to use a pneumatic arm to drive the sampler's bucket through the sediment.

- Small sample size—the sampling bucket can collect a maximum of approximately 0.15 m^2 providing between 10 and 15 L of sediment.

Equipment and Materials

Equipment required for sediment sampling using the modified Hamon grab sampler includes the following:

- Stainless-steel modified Hamon power grab sampler and spare parts
- Winch and Spectra or wire rope (with load capacities three times the weight of a full sampler)
- Underwater camera and sufficient camera cable for anticipated water depths
- Compressor and/or compressed air tanks
- Sample collection table
- Teflon® or polyethylene tubing for siphon
- Stainless-steel ruler
- Stainless-steel spoons/spatulas, or Lexan scoop
- Transparent Lexan tub and/or stainless-steel mixing bowl or pot
- Alconox, Liquinox, or equivalent detergent
- Scrub brush
- Socket and crescent wrenches
- Water pump and hose (for rinsing the grab sampler, sampling utensils, and sample collection table).

Procedures for Sediment Sample Collection

1. Start filling out a sediment grab collection form.
2. Locate the sample station as described in SOP-1. Label sampling containers prior to filling in accordance with SOP-9.
3. Attach the grab sampler to the winch, the pneumatic line, and the camera cable.
4. Place the grab sampler on a clean surface (e.g., the sample collection table) and open it.
5. Decontaminate the sampler as described in SOP-14 if not already decontaminated.
6. Release the steel plate/door so that the sampler will close properly.
7. Start the winch, raise the sampler, and swing it outboard.
8. Lower the sampler through the water column at a slow and steady speed.

9. The depth of the sampler as it is lowered through the water column should be determined either by rigging the winch line to a meter wheel or using pre-marked meter lengths on the winch line itself. The depth can also be monitored using the underwater camera.

10. Once the sediment can be seen on the underwater camera, the sampler should be positioned so that any material that could interfere with sample collection is avoided. It may be necessary to reposition the sampling vessel.

11. Allow the grab sampler to contact the bottom gently and activate the pneumatic mechanism to push the scoop through the sediment and close the device.

12. When the scoop gets to vertical (i.e., maximum penetration), note the length of scoop above the sediment surface via the markings on the bucket. Video may also be reviewed, if necessary. Calculate penetration (scoop length minus length above sediment surface = penetration). Penetration of 4 in. to 8 in. is acceptable. If penetration is less than 4 in. it may be necessary to add weight or make additional attempts. If penetration is more than 8 in., the base of the device may need to be raised to prevent over penetration.

13. When the winch line is drawn taut, record the differential global positioning system (DGPS) coordinates.

14. The grab sampler is then retrieved at a slow and steady rate (e.g., 1 ft/sec).

15. Ensure that the sampling vessel is not headed into any waves before the sampler breaks the water surface to minimize vessel rolling and potential sample disturbance. Care must be taken to avoid loss of fine-grained sediments, mixing of sediment layers upon impact, and loss of sediment from tilting or washout upon ascent.

16. After the grab sampler breaks the water surface and is raised above the height of the sample collection table, swing the grab sampler inboard, keep the sampler in an upright position and gently lower it onto the table, maintaining tension on the winch line to prevent the grab sampler from rolling when it contacts the table.

17. Relax the tension on the winch line.

18. As soon as the grab sampler is secured, open the steel plate/door on the top of the grab sampler, and inspect the sample for acceptability. The following acceptability criteria should be satisfied:

    a. The sampler is closed so that material cannot escape during retrieval.

    b. The sampler is not overfilled with the sample to the point that the sediment surface presses against the top of the sampler or is extruded through the top of the sampler.

c. Overlying water is present (indicating minimal leakage).

d. The desired penetration depth was achieved (see step 12).

e. There is no sign of sediment loss (incomplete closure of the sampler, penetration at an angle, or tilting upon retrieval).

f. The sample contains ≥ 20 percent fines (i.e., ≤ 2 mm).

Grab samples not meeting the above-listed acceptance criteria will be 'rejected' but will be temporarily held onboard while subsequent sampling drops attempt to obtain an 'accepted' sample (i.e., a sample meeting all the acceptance criteria). At the discretion of the field team leader, rejected sample materials may be temporarily placed in a decontaminated, transparent Lexan tub for cultural inspection, and the sampling steps repeated until an accepted sample has been obtained or until a decision is made that sampling using this equipment would not work at this location. Should subsequent sampling attempts also fail to meet the above-listed acceptance criteria, additional rejected samples will be placed in the same or separate Lexan tub. Field personnel will use their experience and professional judgment applying the acceptance criteria to identify accepted and rejected samples.

If all sampling attempts fail to meet the acceptance criteria prior to discarding any rejected sediments from this location, field personnel will (following inspection for cultural resources) assess the overall grain-size distribution of rejected materials temporarily stored in the Lexan tub and photograph the collected materials. Field personnel will use their experience and professional judgment to evaluate the relative volume of fine-grained sediments (i.e., ≤ 2 mm). If there is sufficient volume to perform analyses according to Table A2 of the field sampling plan (FSP), sediment samples should be evaluated and homogenized as described in the steps below and retained for future analyses. The collection of these rejected sediments will allow some evaluation of the area if similar sampling difficulties are encountered at alternate locations.

Sample Removal and Processing

1. Remove the overlying water by slowly siphoning it off near one or more sides of the grab sampler. Ensure that the siphon does not contact the sediments or that fine-grained suspended sediment is not siphoned off. If sediment is suspended in the overlying water, do not proceed with siphoning until the sediment is allowed sufficient time to settle.

2. Once the water is removed, the sample container for acid volatile sulfide (AVS) and simultaneously extracted metals (SEM) testing should be filled to minimize exposure to air as follows:

a. Place an excess of fine-grained sediment into a resealable plastic bag using a decontaminated stainless-steel spoon or other tool.

b. Squeeze out any air remaining from the bag and seal it.

c. Allow the cultural resources monitor to inspect the sample.

d. If the sample passes cultural resources review, place the sediment into the container for the SEM and AVS samples by cutting a corner of the bag. The jar should be filled completely to minimize headspace and sealed tightly. Continue to the next sample collection step.

e. If the sample fails cultural resources review, proceed as described in step 4 below at the direction of the cultural resources monitor.

3. Photograph material in the grab sampler. The photograph identification (ID) should be documented in the field typically by photographing a white board with the sample ID immediately before photographing the sediment. This will enable subsequently labeling the photograph with station location, date, and time of sample.

4. Place the bulk sediment sample (i.e., all material in an acceptable Hamon grab) into a decontaminated transparent Lexan tub to facilitate on-site cultural resources observations. The onboard cultural resources monitor will examine the sediment to determine if cultural resources are present. If cultural resources are present, the field crew will follow instructions from the cultural resources monitor regarding what to do with the recovered sediment and cultural artifacts, as well as whether to abandon the sampling station (see SOP-16).

5. A qualified person[2] will characterize the sediment. Characteristics that will be recorded in the field data form include:

   a. Sediment type (e.g., silt, sand)

   b. Texture (e.g., fine, coarse, poorly sorted sand)

   c. Color

   d. Presence/absence of black silica glass particles (based on vitreous, conchoidal fractures, and a translucent appearance); if present, estimate relative percent composition

[2] A qualified person is either a Washington State Licensed Geologist (LG) or an engineer/scientist who has received site-specific training in the following: 1) identification of sedimentary deposits of the Upper Columbia River basin, 2) recognition of amorphous silica-rich glass, 3) particle size and percentage estimation, 4) soil/sediment classification systems, and 5) recording of observations.

e. Presence/location/thickness of the redox potential boundaries (a visual indication of black is often adequate for documenting anoxia)

f. Presence of biological structures (e.g., amphipods, tubes, macrophytes)

g. Presence of debris (e.g., twigs, leaves)

h. Presence of shells

i. Stratification, if any

j. Presence of a sheen

k. Odor (e.g., hydrogen sulfide, oil, creosote).

6. For chemistry or bioassay samples, the sediment will be sieved, if necessary, as described below. For benthic macroinvertebrate (BMI) samples, proceed to step 7.

   a. The total sample mass will be determined by weighing the container containing the sample and subtracting the container mass.

   b. Sediment that is composed entirely of fine-grained material (≤ 2 mm) will be retained with no additional processing.

   c. If the sample simply contains a few pieces of gravel or cobble > 2mm, then that material can simply be removed by hand during homogenization of the sample.

   d. Any material removed will be retained and weighed. Cobble and gravel will be weighed separately to allow for accurate representation of in situ grain size distribution.

   e. Samples with large proportions of materials that are > 2 mm will be coarsely sieved using a 5-mm sieve. Sieving will be performed by shaking or pressing (e.g., using gloved hands to break apart clumps) the sediment through the sieve. Unacceptable sieving techniques include drying the sediment or washing it through the sieve using water.

   f. The smaller-sized fraction will be collected as the sample. The larger material will be separated into appropriate size categories and weighed.

7. A summary of the steps required for BMI sampling are provided below. Please see SOP-8 (BMI sampling) for a more detailed explanation. Each sample consists of one

complete grab. After acceptance by a cultural resources monitor, the following steps will occur:

a. Transfer sample material (scoop and pour) to a Lexan tub and rinse residual material from the inside of the grab sampler into the tub with pumped and filtered river water.

b. Pick out large gravel, cobble, and debris by hand, carefully washing with pumped and filtered river water so that the attached BMI stays in the tub. Discard the washed large gravel and debris.

c. After as much coarse gravel, cobble, and debris as possible is washed from the sample, remove excess water from the sample by decanting through a 250-µm sieve and use a small amount of water to return any material retained on the sieve back into the sample container.

d. Carefully transfer all material retained in the tub into pre-labeled plastic sample containers.

e. Do not fill containers more than two-thirds full with sediment. Add 90 percent ethanol until the volume of ethanol is equal to the volume of sediment. If the container is up to two-thirds full of sediment, fill the container to the top with 90 percent ethanol.

f. Proceed to step 12.

8. Using appropriate decontaminated tools (e.g., mechanical stainless-steel paddle wheel mixer, spoons, gloved hands), homogenize the sample in the Lexan tub until the texture and color of the sediment appears to be uniform.

9. Photograph the homogenized sediment. The photograph ID should be documented in the field so that the photograph can be subsequently labeled with station location, date, and time of sample.

10. For chemistry and bioassay samples, the homogenized sediment may be placed into labeled, laboratory-provided, sample containers. Sample containers for a field duplicate sample (if needed) will be filled from the same homogenized sediment as the primary sample.

    a. Fill all sediment sample containers for analytical chemistry or bioassays.

    b. Sediment samples for the analytical laboratory will be stored in a cooler with ice until they are transferred from the sampling vessel.

c. Once placed into their 5-gal containers, bioassay samples will be covered with site water.

d. Because bioassay samples are too large to place into a cooler, they will be cooled by placing bags of ice directly onto the sample until they can be delivered to a refrigerator.

11. If any sample remains in the grab sampler after the surface sediment has been collected, move the sampling vessel away from the station, open the bucket of the grab sampler using the pneumatic-powered mechanism, and allow the remainder of the sediment sample to fall onto the sample collection table or into waste sediment collection buckets or tubs. Discard this material away from the station and rinse away any sediment adhering to the inside of the grab sampler. Residual material can also be discarded by returning the grab to the water and opening the jaws. The grab sampler is now ready for additional sampling at the same station or decontamination before sampling at a new station.

12. Decontaminate the grab sampler and associated equipment (e.g., Lexan tub and scoop) between station locations in accordance with decontamination procedures (see SOP-14).

13. Rinse the boat deck clean after all grab samples are collected and secure the sampler before moving to the next station.

References

Brown, C., D.S. Limpenny, and W. Meadows. 2002. The conduct of benthic surveys at aggregate extraction sites. Chapter 3 in Boyd, S.E., et al. Guidelines for the conduct of benthic studies at aggregate dredging sites. Produced by Centre for Environment, Fisheries and Aquaculture Science for Department for Transport, Local Government and the Regions. Crown Copyright, 171 pp. May. http://www.marbef.org/qa/documents/ConductofsurveysatMAEsites.pdf.

STANDARD OPERATING PROCEDURE SOP-5

FREEZE GRAB SEDIMENT SAMPLE COLLECTION

Scope and Applicability

The purpose of this standard operating procedure (SOP) is to describe the procedures used to collect surface sediment with a freeze grab sampler (Figure 1) for the 2019 Phase 3 sediment study (hereinafter "the study") that will be conducted for Teck American Incorporated (TAI) in the Upper Reach Operable Unit (OU) of the Upper Columbia River (UCR) site. For the purposes of this study, surface sediment is defined as the upper 6 in. of the sediment column.

The procedures listed below may be modified in the field by the field supervisor and field personnel, based on field and site conditions. Any modifications will be documented in the field notes and/or the field logbook and in a field deviation form that will be submitted for review and approval with the U.S. Environmental Protection Agency (EPA).

The freeze grab sampling device consists of a 12-in.-diameter metal pan with four 5-in.-long hollow rods protruding from the bottom to extract heat from the sediment. This pan will penetrate the sediment under its own mass or using mechanical force from a pneumatic hammer system. The freeze grab system may be used without the pneumatic hammer (Figure 1) or with the pneumatic hammer (Figure 2). A dry ice and methanol slurry will be used as the cooling agent. The dry ice is placed into the pan and the methanol is contained in a reservoir above the pan. The device is sealed and lowered to the sediment surface. Once the device penetrates the sediment, the methanol is released to initiate cooling. After approximately 5 to 10 minutes, the device is retrieved with sediment frozen to the hollow rods and the bottom of the pan.

Stainless steel pan with dry ice (~4L capacity)

Methanol reservoir (~1.2 L capacity)

Valve

Camera

Coated lead weights

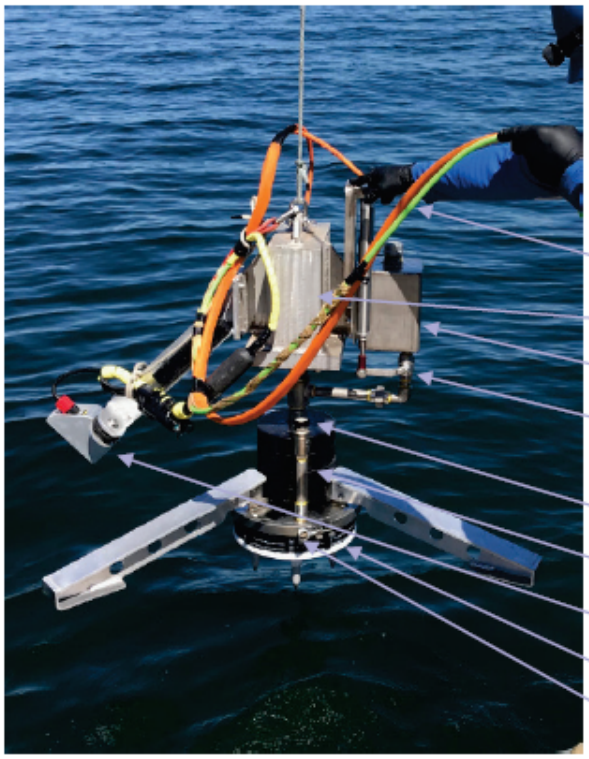
Gas Vent

Stainless steel pan

Compression ring and clamp

Figure 1
Freeze Grab Sampler – Without Hammer
ERM *10/2018*

Stainless steel pan with dry ice (~4L capacity)



Pneumatic line & camera cable
Hammer (in sealed box)
Methanol reservoir
Pneumatic methanol release valve
Gas vent
Coated lead weights
Camera
Stainless steel pan
Compression ring and clamp

Figure 2
Freeze Grab Sampler

With Hammer
ERM *07/2019*

Equipment and Materials

Accurate, representative samples should be collected with this procedure.

Equipment required for sediment sampling using the freeze grab sampler includes the following:

- Stainless-steel freeze grab sampling device
- Winch and Spectra or wire rope (with load capacities three times the weight of a full sampler)
- Underwater camera and sufficient cable for anticipated water depths
- Compressor and/or compressed air tanks (pneumatic hammer device only)
- Sample collection table
- Sufficient dry ice for the planned sampling
- Insulated gloves for handling dry ice
- Hammer or mallet for pulverizing dry ice
- Nail countersink or center punch to assist with pushing dry ice into hollow rods on the freeze grab
- Methanol
- Funnel for pouring methanol into the freeze grab reservoir
- Sample collection table
- Stainless-steel ruler
- Stainless-steel paddle wheel mixer and drill
- Spoons/spatulas, or Lexan scoop
- Transparent Lexan tubs
- Instant hot-water pot to assist with sample removal from the freeze grab
- Stainless-steel mixing bowls or pots
- Alconox, Liquinox, or equivalent
- Scrub brush
- Socket and crescent wrenches
- Water pump and hose (for rinsing the grab sampler, sampling utensils, and sample collection table).

- Sieves for screening

Procedures for Sediment Sample Collection

1. Start filling out a sediment grab collection form.
2. Locate the sample station as described in SOP-1. Label sampling containers prior to filling in accordance with SOP-9.
3. Attach the grab sampler to the winch line. For safety, the winch line, swivel, and all shackles should have a load capacity at least three times the weight of a full sampler.
4. Place the decontaminated pan on a clean surface (e.g., the sample collection table).
5. Fill pan approximately three-quarters full of dry ice, and fill the hollow rods with crushed dry ice (see upper-right photograph on Figure 1).
6. Add screen and lead weight on top of dry ice. This keeps the dry ice on the bottom of the pan.
7. Place silicone gasket into groove on top of pan.
8. Attach pan to sampler body using compression ring and clamp.
9. Add approximately 2 L of methanol to the reservoir; check and replace Teflon tape if necessary; tighten reservoir cap.
10. Allow device to pre-cool (approximately 5 minutes).
11. Use winch to hoist device and lower it through the water column.
12. The depth will be monitored using the depth sensor on the underwater camera and/or visually using the underwater camera.
13. Once the river bottom can be seen on the underwater camera, use the visual information to position the sampler so that any material that could interfere with sample collection is avoided. If necessary, reposition the sampling vessel within approximately 20 ft of the target coordinates to locate a better sampling location.
14. If using the freeze grab with the pneumatic hammer, drive the sampler so that the bottom of the pan is completely flush with the sediment surface by cycling the pneumatic valve on and off periodically.

15. Once the device appears to be flush with the sediment surface, release the methanol using the pneumatic control. Hold the methanol valve open for approximately 1 minute to ensure complete release of the methanol.
16. Allow sediment to freeze to the device for approximately 10 minutes or until bubbles are observed to diminish significantly, indicating dry ice is consumed. Bubbles may be observed in the water column or on the water surface, depending upon position of the sampling vessel relative to the sampling device.
17. When the cable is drawn taut, record differential global positioning system (DGPS) coordinates.
18. Retrieve the device and place it and collected sediment into a Lexan tub.
19. Remove the clamp and set sampler body on the boat deck.
20. Pour methanol from the pan into a plastic beaker for reuse.
21. As soon as the grab sampler is secured, inspect the sample for acceptability. The following acceptability criteria should be satisfied:
    a. The sample surface is smooth or reflects the material collected and does not indicate that material was lost during retrieval (i.e., there are no voids or discontinuities).
    b. The desired penetration depth is achieved.
    c. The sample contains ≥ 20 percent fines (i.e., ≤ 2 mm).
22. Fill the metal pan with boiling water to accelerate thawing.

Grab samples not meeting the above-listed acceptance criteria will be 'rejected,' but will be temporarily held onboard while subsequent sampling drops attempt to obtain an 'accepted' sample (i.e., a sample meeting all the acceptance criteria). At the discretion of the field team leader, rejected sample materials may be temporarily placed in a decontaminated, transparent Lexan tub for cultural inspection, and the sampling steps repeated until an accepted sample has been obtained or until a decision is made that sampling using this equipment would not work at this location. Should subsequent sampling attempts also fail to meet the above-listed acceptance criteria, additional rejected samples will be placed in the same or separate Lexan tub. Field personnel will use their experience and professional judgment applying the acceptance criteria to identify accepted and rejected samples.

If all sampling attempts fail to meet the acceptance criteria prior to discarding any rejected sediments from this location, field personnel will (following inspection for cultural resources) assess the overall grain-size distribution of rejected materials temporarily stored in the Lexan tub and photograph the collected materials. Field personnel will use their experience and

professional judgment to evaluate the relative volume of fine-grained sediments (i.e., ≤ 2 mm). If there is sufficient volume to perform analyses according to Table A2 of the field sampling plan (FSP), sediment samples should be evaluated and homogenized as described in the steps below and retained for future analyses. The collection of these rejected sediments will allow some evaluation of the area if similar sampling difficulties are encountered at alternate locations.

Sample Removal and Processing

1. Penetration depth should be determined by measuring the average depth of the frozen sediment sample.
2. The sample container for acid volatile sulfide (AVS) and simultaneously extracted metal (SEM) should be filled to minimize exposure to air as follows:
    a. As soon as possible to remove frozen sediment, place an excess of fine-grained sediment into a resealable plastic bag using a decontaminated stainless-steel spoon or other tool.
    b. Squeeze out any air remaining from the bag and seal it.
    c. Allow the cultural resources monitor to inspect the sample (this will likely require time for thawing).
    d. If the sample passes cultural resources review, place the sediment into the sample jar for the AVS and SEM sample by cutting a corner of the bag. The jar should be filled completely to minimize headspace and sealed tightly. Continue to the next sample collection step.
    e. If the sample fails cultural resources review, proceed as described in step 5 below at the direction of the cultural resources monitor.
3. Photograph material attached to the grab sampler. The photograph identification (ID) should be documented in the field typically by photographing a white board with the sample ID immediately before photographing the sediment. This will enable subsequently labeling the photograph with station location, date, and time of sample.
4. Thaw the sample by placing boiling water into the stainless-steel base that the sediment is attached to. This is done with the base inside a Lexan tub so that all material is retained.
5. Place the bulk sediment sample into a decontaminated transparent Lexan tub to facilitate on-site cultural resources observations. The onboard cultural resources monitor will examine the sediment to determine if cultural resources are present. If cultural resources are present, the field crew will follow instructions from the cultural resources monitor

regarding what to do with the recovered sediment and cultural artifacts, as well as whether to abandon the sampling station (see SOP-16).

6. A qualified person[1] will characterize the sediment. Characteristics that will be recorded in the field data form include:
   a. Sediment type (e.g., silt, sand)
   b. Texture (e.g., fine, coarse, poorly sorted sand)
   c. Color
   d. Presence/absence of black silica glass particles (based on vitreous, conchoidal fractures, and a translucent appearance); if present, estimate relative percent composition
   e. Presence/location/thickness of the redox potential boundaries (a visual indication of black is often adequate for documenting anoxia)
   f. Presence of biological structures (e.g., amphipods, tubes, macrophytes)
   g. Presence of debris (e.g., twigs, leaves)
   h. Presence of shells
   i. Stratification, if any
   j. Presence of a sheen
   k. Odor (e.g., hydrogen sulfide, oil, creosote).
7. For chemistry samples, the sediment will be sieved, if necessary, as described below. For benthic macroinvertebrate (BMI) samples, proceed to step 8.
   a. The total sample mass will be determined by weighing the container containing the sample and subtracting the container mass.
   b. Sediment that are composed entirely of fine-grained material (≤ 2 mm) will be retained with no additional processing.
   c. If the sample simply contains a few pieces of gravel or cobble > 2 mm, then that material can simply be removed by hand during homogenization of the sample.
   d. Any material removed will be retained and weighed. Cobble and gravel will be weighed separately to allow for accurate representation of in situ grain size distribution.

[1] A qualified person is either a Washington State Licensed Geologist (LG) or an engineer/scientist who has received site-specific training in the following: 1) identification of sedimentary deposits of the Upper Columbia River basin, 2) recognition of amorphous silica-rich glass, 3) particle size and percentage estimation, 4) soil/sediment classification systems, and 5) recording of observations.

e. Samples with large proportions of materials that are > 2 mm will be coarsely sieved using a 5-mm sieve. Sieving will be performed by shaking or pressing (e.g., using gloved hands to break apart clumps) the sediment through the sieve. Unacceptable sieving techniques include drying the sediment or washing it through the sieve using water.

f. The smaller-sized fraction will be collected as the sample. The larger material will be separated into appropriate size categories and weighed.

8. Please see SOP-8 (BMI sampling) for a more detailed explanation. Below is a brief summary of the steps required for BMI sampling. Each BMI sample consists of one or more complete grabs. After clearance by a cultural resources monitor, the following steps will occur:

   a. Fill the container filled with frozen sediment with warm/ambient river water to a depth that covers a sieve.

   b. Once thawed, transfer sample material (scoop and pour) to a Lexan tub and rinse residual material from the inside of the grab sampler into the tub with pumped and filtered river water.

   c. Pick out large gravel, cobble, and debris by hand, carefully washing with pumped and filtered river water so that the attached BMI stays in the tub. Discard the washed large gravel and debris.

   d. After as much coarse gravel, cobble, and debris as possible is washed from the sample, remove the water from the sample by pouring through a 250-µm sieve and use a small amount of water to return any material retained on the sieve back into the sample container.

   e. Carefully transfer all material retained in the tub into pre-labeled plastic sample containers.

   f. Do not fill containers more than two-thirds full with sediment. Add 90 percent ethanol until the volume of ethanol is equal to the volume of sediment. If the container is up to two-thirds full of sediment, fill the container to the top with 90 percent ethanol.

   g. Proceed to step 12.

   h. Using appropriate decontaminated tools (e.g., mechanical stainless-steel paddle wheel mixer, spoons, gloved hands), homogenize the sample in the Lexan tub until the texture and color of the sediment appears to be uniform.

9. Photograph the homogenized sediment. The photograph ID should be documented in the field so that the photograph can be subsequently labeled with station location, date, and time of sample.
10. For chemistry samples, the homogenized sediment may be placed into labeled, laboratory-provided, sample containers. Sample containers for a field duplicate sample (if needed) will be filled from the same homogenized sediment as the primary sample. See Table A2 of the FSP for volume requirements for chemistry and bioassay samples.
    a. Fill all remaining sediment sample containers for analytical chemistry.
    b. Sediment samples for the analytical laboratory will be stored in a cooler with ice until they are transferred from the sampling vessel.
11. Any excess sample or larger material that is not retained (i.e., cobble and gravel) can be returned in the vicinity of the sampling station.
12. Decontaminate the grab sampler and associated equipment (e.g., Lexan tub and scoop) between station locations in accordance with decontamination procedures (see SOP-14).
13. Rinse the boat deck clean after all grab samples are collected and secure the sampler before moving to the next station.

STANDARD OPERATING PROCEDURE SOP-6

ECKMAN, COOKIE CUTTER, OR SCOOP GRAB SEDIMENT SAMPLE COLLECTION

Scope and Applicability

The purpose of this standard operating procedure (SOP) is to describe the procedures used to collect surface sediment using either an Eckman Grab, a Cookie Cutter Grab, or by scooping for the 2019 Phase 3 sediment study (hereinafter "the study") that will be conducted for Teck American Incorporated (TAI) in the Upper Reach Operable Unit (OU) of the Upper Columbia River (UCR) site. For the purposes of this study, surface sediment is defined as the upper 6 in. of the sediment column.

The procedures listed below may be modified in the field by the field supervisor and field personnel, based on field and site conditions, after appropriate annotations have been made in the field logbook. Handheld samplers listed below are ordered by preference (Eckman Grab/Cookie Cutter Grab/Scoop Grab).

Eckman Grab

The Eckman grab is ideal for sampling in soft non-cohesive sediment (i.e., silt and clay). The sampler consists of a steel box with hinging flaps on one end and spring-loaded jaws on another end. The device is lowered to the sediment surface on a rope or it could be placed by hand in shallow water. Once it is settled on the bottom, a messenger is sent down the rope and triggers the jaws to close.

Cookie Cutter Grab

This device can be deployed manually in shallow water. It consists of a steel box and a plate that can be used to close the bottom of the box manually. The box is driven into the sediment manually and then the sediment adjacent to one side of the box is excavated. Once excavated, the steel plate is inserted into slots on the bottom of the box and a sample is retained upon retrieval.

Scoop Grab

This technique consists of scooping sediment into a covered scoop on the end of a handle. The sediment is then put into a container and the operation repeated until sufficient sediment is retained. Care must be taken during this process to ensure that fine sediment does not escape from the scoop during retrieval.

Equipment and Materials

Equipment required for sediment sampling using a handheld sampler includes the following:

- Eckman Grab, Cookie Cutter Grab, or Scoop
- Sample collection table
- Teflon® or polyethylene tubing for siphon
- Stainless-steel ruler
- Stainless-steel spoons/spatulas, or Lexan scoop
- Transparent Lexan tub and/or stainless-steel mixing bowl or pot
- Alconox, Liquinox, or equivalent detergent
- Scrub brush
- Socket and crescent wrenches
- Water pump and hose (for rinsing the grab sampler, sampling utensils, and sample collection table).

Procedures for Sediment Sample Collection

1. Start filling out a sediment grab collection form.
2. Locate the sample station as described in SOP-2. Label sampling containers prior to filling in accordance with SOP-9.
3. Record station coordinates.
4. Collect the sample as described above.
5. During collection, inspect each sample for acceptability as described below (as applicable). Ideally, the following acceptability criteria should be satisfied (note that most of these criteria are not applicable to scoop sampling):
    a. The sampler is not overfilled with the sample to the point that the sediment surface presses against the top of the sampler or is extruded through the top of the sampler.
    b. Overlying water is present (indicating minimal leakage).
    c. The overlying water is not excessively turbid (indicating minimal disturbance of the interface or winnowing). Excessive turbidity is determined based upon observation of other samples and best professional judgement. Turbidity will vary in water overlying different matrices (i.e., water overlying fine silt will naturally be more turbid than water overlying coarse sand).

d. The sediment surface is relatively undisturbed; the sediment-water interface is intact and relatively flat with no sign of channeling or sample washout.

e. The desired penetration depth is achieved.

f. There is no sign of sediment loss (incomplete closure of the sampler, penetration at an angle, or tilting upon retrieval).

g. The sample contains ≥ 20 percent fines (i.e., ≤ 2 mm).

Grab samples not meeting the above-listed acceptance criteria will be 'rejected,' but will be temporarily held onboard while subsequent sampling drops attempt to obtain an 'accepted' sample (i.e., a sample meeting all the acceptance criteria). At the discretion of the field team leader, rejected sample materials may be temporarily placed in a decontaminated, transparent Lexan tub for cultural inspection, and the sampling steps repeated until an accepted sample has been obtained or until a decision is made that sampling using this equipment would not work at this location. Should subsequent sampling attempts also fail to meet the above-listed acceptance criteria, additional rejected samples will be placed in the same or separate Lexan tub. Field personnel will use their experience and professional judgment applying the acceptance criteria to identify accepted and rejected samples.

In the event that all sampling attempts fail to meet the acceptance criteria, prior to discarding any rejected sediments from this location, field personnel will (following inspection for cultural resources) assess the overall grain-size distribution of rejected materials temporarily stored in the Lexan tub and photograph the collected materials. Field personnel will use their experience and professional judgment to evaluate the relative volume of fine-grained sediments (i.e., ≤ 2 mm). If there is sufficient volume to perform analyses according to Table A2 of the field sampling plan (FSP), sediment samples should be evaluated and homogenized as described in the steps below, and retained for future analyses. The collection of these rejected sediments will allow some evaluation of the area, in the event that similar sampling difficulties are encountered at alternate locations.

Sample Removal and Processing

1. Penetration depth should be determined with a decontaminated stainless-steel ruler by measuring the distance from the top of the sampler to the sediment interface and subtracting this from the inside depth of the sampler or by estimating or measuring the depth of scoop penetration. If the sample is fairly level inside the sampler, this measurement can be made at one edge. If the sample is uneven but has an intact interface, then measurements should be made on opposite edges of the sample and the average value used. This observation (i.e., that the sediment surface is slanted) and

subsequent calculation of the average penetration depth should be recorded in the field logbook. If penetration depth is inadequate, add auxiliary weights, and repeat the above steps.

2. If necessary, remove the overlying water by slowly siphoning it off near one or more sides of the grab sampler. Ensure that the siphon does not contact the sediments or that fine-grained suspended sediment is not siphoned off. If sediment is suspended in the overlying water, do not proceed with siphoning until the sediment is allowed sufficient time to settle.
3. Once the water is removed, the sample container for acid volatile sulfide (AVS) and simultaneously extracted metal (SEM) testing should be filled to minimize exposure to air as follows:
    a. Place an excess of fine grained sediment into a resealable plastic bag using a decontaminated stainless steel spoon or other tool.
    b. Squeeze out any air remaining from the bag and seal it.
    c. Allow the cultural resource monitor to inspect the sample.
    d. If the sample passes cultural resources review, place the sediment into the sample jar for the AVS and SEM sample by cutting a corner of the bag. The jar should be filled completely to minimize headspace and sealed tightly. Continue to the next sample collection step.
    e. If the sample fails cultural resources review, proceed as described in Step 4 below at the direction of the cultural resources monitor.
4. Photograph material in the grab sampler. The photograph identification (ID) should be documented in the field typically by photographing a white board with the sample ID immediately before photographing the sediment. This will enable subsequently labeling the photograph with station location, date, and time of sample.
5. Place the bulk sediment sample into a decontaminated transparent Lexan tub to facilitate on-site cultural resources observations. The onboard cultural resources monitor will examine the sediment to determine if cultural resources are present. If cultural resources are present, the field crew will follow instructions from the cultural resources monitor regarding what to do with the recovered sediment and cultural artifacts, as well as whether to abandon the sampling station (see SOP-16).

6. A qualified person[1] will characterize the sediment. Characteristics that will be recorded in the field data form include:
    a. Sediment type (e.g., silt, sand)
    b. Texture (e.g., fine, coarse, poorly sorted sand)
    c. Color
    d. Presence/absence of black silica glass particles (based on vitreous, conchoidal fractures, and a translucent appearance); if present, estimate relative percent composition
    e. Presence/location/thickness of the redox potential boundaries (a visual indication of black is often adequate for documenting anoxia)
    f. Presence of biological structures (e.g., amphipods, tubes, macrophytes)
    g. Presence of debris (e.g., twigs, leaves)
    h. Presence of shells
    i. Stratification, if any
    j. Presence of a sheen
    k. Odor (e.g., hydrogen sulfide, oil, creosote).
7. Conduct sample allocation on the vessel; transfer accepted sediment and sampling equipment back to the vessel prior to completing subsequent steps.
8. For chemistry or bioassay samples, the sediment will be sieved, if necessary, as described below. For benthic macroinvertebrate (BMI) samples, proceed to step 8.
    a. The total sample mass will be determined by weighing the container containing the sample and subtracting the container mass.
    b. Sediment that are composed entirely of fine-grained material (≤ 2 mm) will be retained with no additional processing.
    c. If the sample contains only a few pieces of gravel or cobble > 2 mm, then that material can simply be removed by hand during homogenization of the sample.

[1] A qualified person is either a Washington State Licensed Geologist (LG) or an engineer/scientist who has received site-specific training in the following: 1) identification of sedimentary deposits of the Upper Columbia River basin, 2) recognition of amorphous silica-rich glass, 3) particle size and percentage estimation, 4) soil/sediment classification systems, and 5) recording of observations.

d. Any material removed will be retained and weighed. Cobble and gravel will be weighed separately to allow for accurate representation of in situ grain size distribution.

e. Samples with large proportions of materials that are > 2 mm will be coarsely sieved using a 5-mm sieve. Sieving will be performed by shaking or pressing (e.g., using gloved hands to break apart clumps) the sediment through the sieve. Unacceptable sieving techniques include drying the sediment or washing it through the sieve using water.

f. The smaller-sized fraction will be collected as the sample. The larger material will be separated into appropriate size categories and weighed.

9. A brief summary of the steps required for BMI sampling is provided below. Please see SOP-8 (BMI sampling) for a more detailed explanation. Because of the smaller area sampled by handheld devices, BMI sediment samples will consist of composites of multiple successful samples. The number composited will differ per device. The sampling capability area of each device will be calculated in the field and used to calculate the number of samples required to reach an equivalent area of 0.1 m^2:

   a. Record the sampling device used and number of samples composited in the field sampling form.

   b. Transfer sample material (scoop and pour) to a Lexan tub and rinse residual material from the inside of the grab sampler into the tub with pumped and filtered river water.

   c. Pick out large gravel, cobble, and debris by hand, carefully washing with pumped and filtered river water so that the attached BMI stays in the tub. Discard the washed large gravel and debris.

   d. After as much coarse gravel, cobble, and debris as possible is washed from the sample, remove the water from the sample by pouring through a 250-µm sieve and use a small amount of water to return any material retained on the sieve back into the sample container.

   e. Carefully transfer all material retained in the tub into pre-labeled plastic sample containers.

   f. Do not fill containers more than two-thirds full with sediment. Add 90 percent ethanol until the volume of ethanol is equal to the volume of sediment. If the container is up to two-thirds full of sediment, fill the container to the top with 90 percent ethanol.

g. Proceed to step 12.

10. Using appropriate decontaminated tools (e.g., mechanical stainless-steel paddle wheel mixer, spoons, gloved hands), homogenize the sample in the Lexan tub until the texture and color of the sediment appears to be uniform.

11. Photograph the homogenized sediment. The photograph ID should be documented in the field so that the photograph can be subsequently labeled with station location, date, and time of sample.

12. For chemistry and bioassay samples, the homogenized sediment may be placed into labeled, laboratory-provided, sample containers. Sample containers for a field duplicate sample (if needed) will be filled from the same homogenized sediment as the primary sample.

    a. Fill all sediment sample containers for analytical chemistry or bioassays.

    b. Sediment samples for the analytical laboratory must be stored in a cooler with ice until they are transferred from the sampling vessel.

    c. Once placed into their 5-gal containers, bioassay samples will be covered with site water.

    d. Because bioassay samples are too large to place into a cooler, they will be cooled by placing bags of ice directly onto the sample until they can be delivered to a refrigerator.

13. Decontaminate the grab sampler and associated equipment (e.g., Lexan tub and scoop) between station locations in accordance with decontamination procedures (see SOP-14).

14. Rinse the boat deck clean after all grab samples are collected and secure the sampler before moving to the next station.

STANDARD OPERATING PROCEDURE SOP-7

SEDIMENT POREWATER SAMPLING

Scope and Application

This standard operating procedure (SOP) is specific to the sediment porewater sampling element of the Phase 3 sediment study (hereinafter "the study") that will be conducted for Teck American Incorporated (TAI) in the Upper Reach Operable Unit (OU) of the Upper Columbia River (UCR) site. The purpose of this SOP is to describe the procedures for collecting samples for sediment porewater characterization. The procedures described herein provide explanations for sampler operation, collection of porewater samples, and requirements for sample handling and field documentation.

Summary of Method

Sediment porewater will be sampled from the top 0 to 6 in. of sediment from an anchored boat using the Trident probe developed by Coastal Monitoring Associates (CMA). The Trident probe is a direct-push sampler with integrated temperature and conductivity sensors. The probe will be inserted into the sediment, and porewater will be collected by low-flow peristaltic pump extraction through a small-diameter Teflon™ sampling tube. The sampling tube will be routed into a glovebox on the vessel. Porewater will be collected into sampling containers inside a glovebox that has been purged with nitrogen to minimize oxidation. Chemical analyses will take place at the analytical laboratory. In addition, certain water quality parameters will be measured in the field as described below.

Equipment

The following equipment will be used during sampling:

- Trident probe and associated tubing, pumps, fittings, sensors, cables, etc., according to CMA's SOPs (Attachment 1)
- Glove box – Morgan LDS model MLDS-SM or similar
- Gloves (attached to glovebox) – OAK long-length large vinyl 96-337 or similar
- Gloves (for use over gloves attached to glovebox and for collection of samples for chemical analyses) – Vinyl, powder-free controlled environment gloves (HandPRO® Series 550 or similar)
- Gloves – Cole-Parmer® powder-free nitrile EW-81602-65 or comparable (general purpose gloves for handling sampling equipment)

- Oxygen meter – Bacharach model Oxor® III or similar
- Myron© multimeter (or equivalent)
- YSI ProODO optical dissolved oxygen (DO) sensor (or equivalent) and associated Teflon™ fittings
- Tubing rack – custom
- Nitrogen regulator – Harris® Model 25-200C
- Nitrogen bottle – 100 ft^3
- Nitrogen tubing – 3/8-in. reinforced Tygon®
- Nitrogen – ultrapure grade
- Wipes – Kimwipes™
- Wrap – parafilm
- Cleaner – Alconox®
- Lab water – American Society for Testing and Materials (ASTM) Type 1 deionized (DI) water
- Distilled water
- Geotech 0.45-μm capsule filters and associated Teflon™ fittings
- Whatman® Puradisc 25 polyvinylidene fluoride (PVDF) filters (0.45 μm) and associated Luer-Lok™ adapter fittings
- BD© 10-mL Luer-Lok™ tip syringes
- Pre-prepared sample bottles – amber glass and high-density polyethylene (HDPE) (see Table 2)
- Coolers and ice.

Positioning and Coordinates

See SOP-1 for vessel positioning procedures.

TRIDENT PROBE OPERATION

The Trident probe will be deployed and operated by CMA throughout the sampling effort. CMA's SOPs (Attachment 1) describe the probe design and procedures for deployment, sample collection, and real-time water quality data collection. Field methods for Trident probe operation are briefly summarized in this document; refer to Attachment 1 for more detailed information.

The Trident probe will be deployed in one of several ways, depending on the water depth, current velocity, and substrate type at each sample location. CMA will determine which Trident configuration to use based on the conditions. For example, a pole-mounted Trident probe may be used in shallow areas with low water velocity and soft substrate, while a Trident probe with a weighed frame and pneumatic hammer may be used in deeper areas with higher flow and coarser substrate.

The Trident probe will usually be deployed from an anchored boat. A camera can be mounted to the sampler frame to allow for real-time viewing of the sediment surface and probe position in deeper water locations. If very shallow water (e.g., < 1 m) is encountered at a sample location, the pole-mounted Trident probe may be deployed by wading instead of from the sampling vessel.

Decontamination Process

The Trident probe has a 15-cm-long pre-filter packed with glass beads to maximize the sampling surface area and minimize potential clogging by fine-grained sediment during sampling. The pre-filter and probe will be cleaned at the beginning of each sampling day and after collecting porewater at each location. The cleaning procedure entails removing the screens and glass filter beads, washing them with Alconox® solution, and rinsing them with DI water. The Teflon™ tubing will be decontaminated by pumping Alconox® solution through the tubes, then rinsing with DI water.

The primary limitations for porewater sampling with the Trident probe are related to factors (and combinations of factors) including high flows, deep water, sloped bottom, and extremely hard bottom substrate. Under high flow conditions, especially in combination with deeper water, it may not be possible to securely anchor the sampling vessel. Because the sampling process can take an extended period, the vessel needs to be securely anchored to allow for sampling. Under high flow conditions in deeper water, it may also prove difficult to control the frame system that is used to land and drive the probe into the bottom. Under highly sloped bottom conditions, the vertical stability of the frame system may not be adequate to support driving of the frame, and the frame may tip over. For bottoms with very hard substrate, the drive system of the frame may not provide adequate force to drive the probe into the bottom. Where system limitations are encountered, adjustments to the

system to accommodate the conditions will be considered first. This could include adding additional weight to the frame base, adding lateral stabilizing rods, and extending the sampling/telemetry cable length. If adjustments are not adequate to allow for sampling, then an alternative location will be selected with consideration.

POREWATER SAMPLE COLLECTION AND PROCESSING

All samples will be handled in a manner that minimizes exposure to contamination. This process will include using gloves to handle sampling equipment, using pre-cleaned sampling equipment and sample bottles, decontaminating work surfaces between sample handling, and donning fresh gloves prior to filling sample bottles at each sample location. Samples will be collected (and filtered as applicable) directly into the sample container to decrease exposure to additional sampling equipment.

Field Measurements

Porewater and near-bottom surface water conductivity and temperature will be monitored in situ during sampling via sensors mounted to the sampler. These parameters will be monitored during sample collection at each location for fluctuations that may indicate depletion of porewater or draw-in of overlying water or groundwater. If fluctuations are noted, the characteristics of the sampling location and sampler deployment will be evaluated to assess if the Trident probe should be moved to a new location and the sampling attempt re-started.

A Myron® (or equivalent) portable water quality multimeter will be used to measure surface water pH. The multimeter will also be used to measure porewater pH, conductivity, total dissolved solids (TDS), and oxidation reduction potential (ORP) incrementally during sample collection. Multimeter porewater measurements will be recorded at the beginning of sampling and after approximately every 200-mL volume of porewater collected into sample bottles[1]. In addition, DO will be measured with an in-line YSI© ProODO optical DO sensor (or equivalent). The porewater DO and ORP measurements will be used to determine if laboratory sulfide analysis is necessary at a given location (see Sample Collection for Laboratory Analyses below). Temperature sensors will be calibrated at the start of the study. Calibration checks for the conductivity sensors and multimeter will be conducted daily.

Sample Collection for Laboratory Analyses

Filter Preparation

Whatman® Puradisc 25 PVDF disc filters (0.45 μm) will be used for dissolved organic carbon (DOC) samples. Prior to use, disc filters will be flushed with 10 mL of DI water[2] using a Luer-Lok™ tip syringe. Geotech 0.45-μm capsule filters will be used for dissolved metals sample collection. Capsule filters do not require flushing prior to sample collection.

[1] Because the ORP sensor can take longer to stabilize than the other multimeter sensors, ORP may also be measured in the purge water prior to sample collection. Such measurements would not be recorded because they would only serve to condition the sensor.
[2] DI water will be sourced locally or ASTM Type 1 DI water will be provided by the analytical laboratory.

Glovebox Preparation

Bottles will be filled inside the glovebox to minimize porewater oxidation. Before each day of sampling and between sample locations, the glovebox will be prepared according to the following procedure:

- Wipe up any spilled liquids with clean lab wipes
- Spray surfaces with distilled water and wipe them down with clean lab wipes
- Spray surfaces with ASTM Type 1 DI water and wipe them down with clean lab wipes
- Close the glovebox and keep it sealed until ready for sampling.

Filling Sampling Containers

Once the Trident probe is in place in the sediment, the peristaltic pump will be turned on to draw porewater through the Teflon™ sampling tube attached to the probe. The following steps describe the procedures that will be used to collect sediment porewater in containers supplied by the analytical laboratory:

- Label each sampling container with the following information: sample identification (ID) (according to sample labeling SOP-9), sampling date, sampling time (fill in after sample collection), chemical analyses, sampler's initials, laboratory name, and container type.
- Flush one or two disc filters with ASTM Type 1 DI water as described above. Two pre-cleaned disc filters per sample location will be available in the event of filter clogging.
- Clean the glovebox as described above.
- Run the peristaltic pump at a rate low enough to avoid over-pressure and clogging or excessive vacuum bubbles in the sampling line.
- Route the Teflon™ sampling tube into the glovebox and begin purging porewater from the sampler into a waste container. Flush approximately 300 mL of porewater from the system before filling sample containers.
- Place the filters and labeled sample bottles inside the glovebox. Open the bottles and place the caps on clean lab wipes.
- Turn on the oxygen sensor and place it inside the glovebox.
- Close the glovebox and turn on the nitrogen gas. Purge the glovebox with nitrogen until the oxygen meter reads < 1 percent. Increase the flow of nitrogen into the glovebox if, at any time during sampling, the oxygen content increases to > 1 percent.

- Collect porewater in sample containers once the glovebox has been purged of oxygen and approximately 300 mL of porewater has been purged from the sampling tube. Fill sample containers in the following order: metals, DOC, total organic carbon (TOC), sulfide, and sulfate/chloride/alkalinity/pH. Use the following process to fill sample containers:

  1. Don a clean pair of powderless vinyl gloves over the gloves attached to the glovebox.
  2. Attach a Geotech 0.45-µm capsule filter to the sampling tube using Teflon™ fittings[3] and collect at least 60 mL of filtered porewater in a 125-mL HDPE bottle for metals, cations, and iron.
  3. Detach the capsule filter and attach a pre-cleaned Whatman® Puradisc 25 0.45-µm disc filter to the sampling tube using Luer-Lok™ adaptor fittings[3]. Collect at least 80 mL of filtered porewater in a 125-mL amber glass bottle for DOC. If the filter clogs during sample collection, replace the clogged filter with the second pre-cleaned disc filter stored in the glovebox.
  4. Detach the disc filter and collect at least 80 mL of unfiltered porewater in a 125-mL amber glass bottle for TOC.
  5. Porewater for sulfide analysis will only be collected if measurable sulfide is expected based on the DO and ORP readings as shown in Table 1 (i.e., the sulfide bottle should be filled if DO is not detected and the ORP reading is low enough to suggest that reducing conditions are present). If sulfide analysis is deemed necessary, completely fill a 250-mL HDPE bottle with unfiltered porewater for sulfide. Fill the sulfide bottle so that no headspace exists below the cap and no air bubbles are present inside the bottle.

Table 1. Sulfide sample collection criteria

DO Detected?	Collect porewater for sulfide analysis?
Yes[4]	No
No	No: If ORP is ≥ -150 mV Yes: If ORP is < -150 mV

DO – dissolved oxygen
ORP – oxidation reduction potential

[3] Fittings will be pre-cleaned with Alconox® solution and rinsed with DI water.

[4] The expected accuracy of the DO sensors is ±0.1 mg/L or ±1 percent of the reading, whichever is greater, for the range of 0 to 20 mg/L DO. The ORP measurement will be used to make the decision about whether to collect porewater for sulfide analysis if the DO reading is less than or equal to 0.1 mg/L.

6. Collect at least 100 mL of unfiltered porewater in a 125-mL HDPE bottle for sulfate/chloride/alkalinity.

- After all bottles have been filled and capped, turn off the nitrogen gas and open the glovebox.
- Write the sampling time on the bottle labels, place each bottle in a resealable plastic bag, and store bottles in a cooler with ice.

The total target porewater volume for all parameters at each sample location is 590 mL (320 mL if not collecting porewater for sulfide analysis), which includes sufficient volume for the analysis of laboratory quality control (QC) samples (e.g., matrix duplicate, matrix spike, and matrix spike duplicate samples as specified by the analytical methods).

Analyte List, Volume Requirements, and Holding Times

Chemical analysis of porewater samples will be conducted by ALS Environmental (ALS). Analytical methods and laboratory sample handling requirements for all measurement parameters are presented in Table 2. The minimum volume listed includes sufficient volume for quality assurance (QA/QC) analyses.

Table 2. Analytical methods and sample handling requirements for porewater samples

Parameter	Analytical Method	Container	Target Volume[a]	Preservative[b]	Sample Holding Time
Cations[c,d] and iron	EPA 6010D or 200.7	125-mL HDPE	60 mL	cool to ≤ 6°C; filtered with 0.45-µm filter; nitric acid to pH < 2 at least 24 hours prior to analysis	6 months
Metals[e]	EPA 6020A				
DOC	EPA 9060A	125-mL amber glass	80 mL	cool to ≤ 6°C; filtered 0.45-µm filter within 48 hours; sulfuric acid to pH < 2	28 days
TOC	EPA 9060A	125-mL amber glass	80 mL	cool to ≤ 6°C; sulfuric acid to pH < 2	28 days
Sulfide (select locations only)	SM 4500-S2 D	250-mL HDPE[f]	270 mL[g]	cool to ≤ 6°C; add zinc acetate and sodium hydroxide to pH > 9	7 days
Sulfate	EPA 300.0				28 days
Chloride	EPA 300.0	125-mL HDPE	100 mL	cool to ≤ 6°C	28 days
Alkalinity	SM 2320 B				14 days

[a] Target volumes listed are generally three times the minimum volume required by the laboratory for a single analysis; the listed amounts provide sufficient volume for analysis of laboratory quality control (QC) samples. The total target sample volume for each sample location is 320 or 590 mL, depending on the necessity of sulfide analysis.

[b] Dissolved organic carbon (COC) and metals samples will be field filtered. DOC, metals, total organic carbon (TOC), and sulfide samples will be field preserved.

[c] Cations include calcium, magnesium, potassium, and sodium.

[d] Hardness will be calculated following SM 2340 C.

[e] Metals include aluminum, antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, manganese, nickel, selenium, silver, thallium, vanadium, and zinc.

[f] At locations where sulfide analysis is deemed necessary (see Field Measurements in this standard operating procedure [SOP]), a 250-mL high-density polyethylene (HDPE) bottle will be filled to provide the laboratory with enough volume to distill the sample prior to analysis, if needed.

[g] Containers for sulfide will be filled with no headspace or air bubbles in the bottle. The total volume collected will be the total bottle capacity (i.e., approximately 270 mL for a 250-mL bottle).

Field Quality Control Samples

Field QA/QC samples, such as rinsate blanks and field duplicates, are generally used to evaluate the efficiency of field decontamination procedures and the variability attributable to sample handling.

One equipment blank per area of interest (AOI) will be generated for each Trident sampler used in the AOI. Equipment blanks will be collected by flushing ASTM Type 1 DI water through the sampler and sample tubing after conducting the decontamination procedure between sample collections. The specific Trident sampler used to collect each porewater sample will be documented on field forms, allowing the data validator to associate each equipment blank with a specific group of porewater samples. Filters will be not be included as part of the equipment blanks; separate filter blanks will be collected to evaluate filter cleanliness.

One filter blank will be generated for each lot and filter type used for the duration of the study. filter blanks will be collected by flushing ASTM Type 1 DI water through a filter of each type (i.e., one capsule filter per lot and one disc filter per lot). The disc filters will be pre-cleaned with a 10-mL flush of ASTM Type 1 DI water prior to collecting filter blanks. The capsule filter blank(s) will be analyzed for metals, and the disc filter blank(s) will be analyzed for DOC.

Field duplicates will be collected at the rate of 1 per 20 samples. It may not be possible to fill a complete set of sample bottles for a field duplicate without causing porewater excessive drawdown. In order to reduce the potential for porewater drawdown, the total volume of porewater collected at any one location will be minimized by filling only one field duplicate bottle at a given sample location. Because up to 5 bottles will be filled at each sample location to analyze for the parameters listed in Table 2, 1 duplicate sample bottle will be filled at up to 5 of every 20 sample locations. Duplicate bottles will be filled immediately after filling the first bottle for the same analyte. Laboratory QC samples (e.g., laboratory duplicates, matrix spikes) will be analyzed according to method requirements.

Sample Packaging and Shipping

Sample packaging and shipping are described in SOP-12. Because of the 7-day holding time for sulfide analysis, samples will be transported to ALS at least once a week. Delivery by field personnel or a courier service are the preferred methods for transporting samples to the laboratory; however, delivery by an overnight shipping service (e.g., FedEx or UPS) may be used instead.

Study-Derived Waste

All disposable materials, supplies used for sample collection and processing (e.g., gloves, paper towels), and rinse water and waste water from the decontamination procedures will be disposed of in accordance with Section 2.6 of the field sampling plan (FSP).

FIELD DOCUMENTATION

The integrity of each sample from the time of collection to the time of data reporting will be maintained. Proper record-keeping and chain-of-custody procedures will be implemented to allow samples to be traced from collection to final disposition. Representative photographs will be taken of each type of sampling activity performed during the study. Photographs from various angles within each AOI will be collected.

Field Forms and Field Logbook

All field activities and observations will be noted on field forms or in a field logbook. Two types of field forms will be used:

1. CMA's Trident log sheet—Used by CMA to document sample location coordinates, sampling times, Trident probe configuration, field-collected water quality data, and other observations
2. Chemistry sample collection form—Used by field personnel filling bottles for chemical analysis to document sampling time, sample type, field duplicates, and notes, such as sampler type, sample appearance, filter clogging, etc.

Field forms will be contained in binders. Examples of both types of forms are included in Attachment 2.

The field logbook will be used to record information such as the names of field personnel, weather conditions, date, sampling times, sample location identifiers, general observations, personnel changes, and deviations. Requirements for keeping field logbooks are provided in SOP-10.

Chain-of-Custody Procedures

Sample custody procedures are described in SOP-11.

ATTACHMENT 1. TRIDENT PROBE SOPS

TRIDENT PROBE STANDARD OPERATING PROCEDURES

TECHNOLOGY DESCRIPTION

The Trident probe is a direct-push, integrated temperature sensor, conductivity sensor, and porewater sampler developed to screen sites for areas where groundwater may be discharging to a surface water body (Chadwick et al., 2003; Figure 1). Differences in observed conductivity and temperature indicate areas where groundwater discharge is occurring. The integral porewater sampler can be used to rapidly confirm the presence of groundwater constituents and map the subsurface distribution of contaminants of concern.

Trident Conductivity/Temperature Sensors

The subsurface conductivity and temperature sensor consists of a ruggedized, digital, in-line sensor embedded near the tip of the stainless-steel probe (Figure 2). The temperature sensor has a measurement range of -5 to +45 °C at an accuracy of <0.1 °C, and a resolution of 0.001 °C. The temperature sensor response time is about 60 s. The subsurface conductivity sensor utilizes a small diameter, stainless steel, AC-excitation 3-electrode sensor, installed in the sampling line just above the screened section of the probe tip in the same element that houses the temperature sensor (Figure 2). The conductivity sensor has a range of 0 to 80 mS/cm, an accuracy of <2% of the calibrated range, and a resolution of 0.01 mS/cm. The in-line subsurface conductivity sensor is used to directly measure the porewater conductivity signal by pumping a small volume of water from the screen section of the probe through the sensing element until stable readings are achieved. A reference conductivity and temperature sensor also is mounted on the instrument frame to provide a direct comparison of the overlying surface water conditions with the interstitial water conditions (Figure 1). For the temperature sensor, areas of groundwater seepage may appear either as warm or cold contrast to the surface water depending on the seasonal and site characteristics. For the conductivity sensor, areas of likely groundwater seepage are generally associated with low conductivity in coastal areas where fresh groundwater is discharging to seawater, but may be associated

with high conductivity in rivers and lakes where the groundwater often has higher total dissolved solids relative to the surface water.

Porewater Sampler

The same probe that is used for the sensor measurements also probe allows interstitial waters to be extracted from the sediment at selected depths up to about 150 cm below the sediment water interface. Porewater is collected by a low-flow peristaltic pump extraction through small-diameter (1.6 mm ID; 3.2 mm OD), Teflon (or other suitable material) tubing (Figure 4). The screen section of the probe includes an inner stainless steel screen fitted over a grooved and holed section of stainless steel that forms the probe tip. A secondary stainless steel screen is fitted over this and the gap between them is typically filled with pre-cleaned glass filter beads to act as a pre-filter and prevent clogging of the sampler. The screen mesh size for both screens is 250 μm and the screen length is 15 cm. The screen section is easily removable for cleaning or replacement if required. Multiple probes can be used to together to further increase surface area, enhance sampling rate, and minimize potential clogging.

Data Acquisition System

Trident sensors are coupled through an underwater connecter and cable to a deck unit that integrates the probe and reference temperature and conductivity signals with the signal from a Global Positioning System (GPS) sensor mounted on the top of the push-pole (Figure 1). The GPS is a Garmin model 17 with a stated accuracy of <15 m in standard mode, and <3 m in Wide-Area Augmentation System (WAAS) mode. The integrated data stream from the deck unit is sent to a laptop via RS-232. The laptop is used in conjunction with the TridentTalk software to apply calibration and temperature corrections to the signals, and record and display the results.

FIELD SAMPLING PROCEDURE

Deployment Methods

A Trident survey is conducted by inserting the probe into the seabed (seabed is used here to mean the bottom of the ocean, estuary, bay, river, lake, etc.) from a boat or by wading. In operation, the Trident probe can be deployed in several ways depending primarily on

the depth of the site (Figure 6). In water of moderate depths (1-10 m), the probe is easily deployed from a small boat using the push rod (Figure 7). It is important that the boat be well anchored to minimize lateral loading on the probe during the insertion. In deeper water (>10 m), the probe can be deployed by diver, or can be attached to a landing frame (Figure 6). The landing frame (Vibra-Frame; Figure 8) can be driven by weight or by a combination of weight and vibration. In very shallow water (<1 m) the probe can be installed by wading. In areas of fast currents and rocky bottoms, a specially-developed "Drive-Frame" system can be used to install the system into the bottom (Figure 9).

Conductivity and Temperature Sampling

Once on station with the probe inserted, data is collected from the conductivity and temperature sensors using the TridentTalk software. The sensor cell is briefly purged until the sensor readings stabilize via the sampling line and peristaltic pump prior to data collection (Figure 3). The TridentTalk software provides a display of the probe and reference temperature and conductivity signals, along with the GPS position. The software also automatically calculates and displays the probe vs. reference temperature and conductivity contrast. Once the sensor readings have stabilized, the data is recorded by activating the "Log current data" button on the TridentTalk display. The data can then be reviewed in numeric format, or displayed spatially using the AGIS graphical information system software. The spatial AGIS display provides a capability for rapidly evaluating the most likely areas of groundwater discharge based on temperature and conductivity contrast. Once data recording is completed, the probe is retrieved. The screen and sensor cell may require cleaning between stations by removing any accumulated particles and rinsing the cell with appropriate solution (generally surface water). A typical shoreline sampling grid for a Trident sensor survey is shown in Figure 10. Typical results for a sensor survey are shown in Figure 11.

Porewater Sampling

Once on station with the porewater probe inserted, the probe and sampling tube is purged of ~3 volumes using the sampling pump. The pump should be run at a low enough rate to avoid over pressure and clogging or excessive vacuum bubbles in the sampling line. With the sampler purged, the porewater samples can then be collected in accordance with the

volume and quality control requirements of the project. Once the sampling is complete, the probe is retrieve and decontaminated in accordance with project requirements prior to sample collection at the next station. Typical results for a shoreline porewater sampling survey are shown in Figure 12.

REFERENCES

Chadwick, D.B., J. Groves, C. Smith, and R. Paulsen. 2003. Hardware description and sampling protocols for the Trident Probe and UltraSeep system: Technologies to evaluate contaminant transfer between groundwater and surface water. Technical Report #1902, SSC San Diego, United States Navy.

Chadwick, D.B., J. Guerrero, G. Rosen, J. Groves, C. Smith, R. Paulsen, A. Burton, and M. Greenberg, 2007. The Trident Probe capabilities and applications for identifying and mapping groundwater discharge zones. Proceedings of SETAC North America 28th Annual Meeting, Milwaukee, WI.

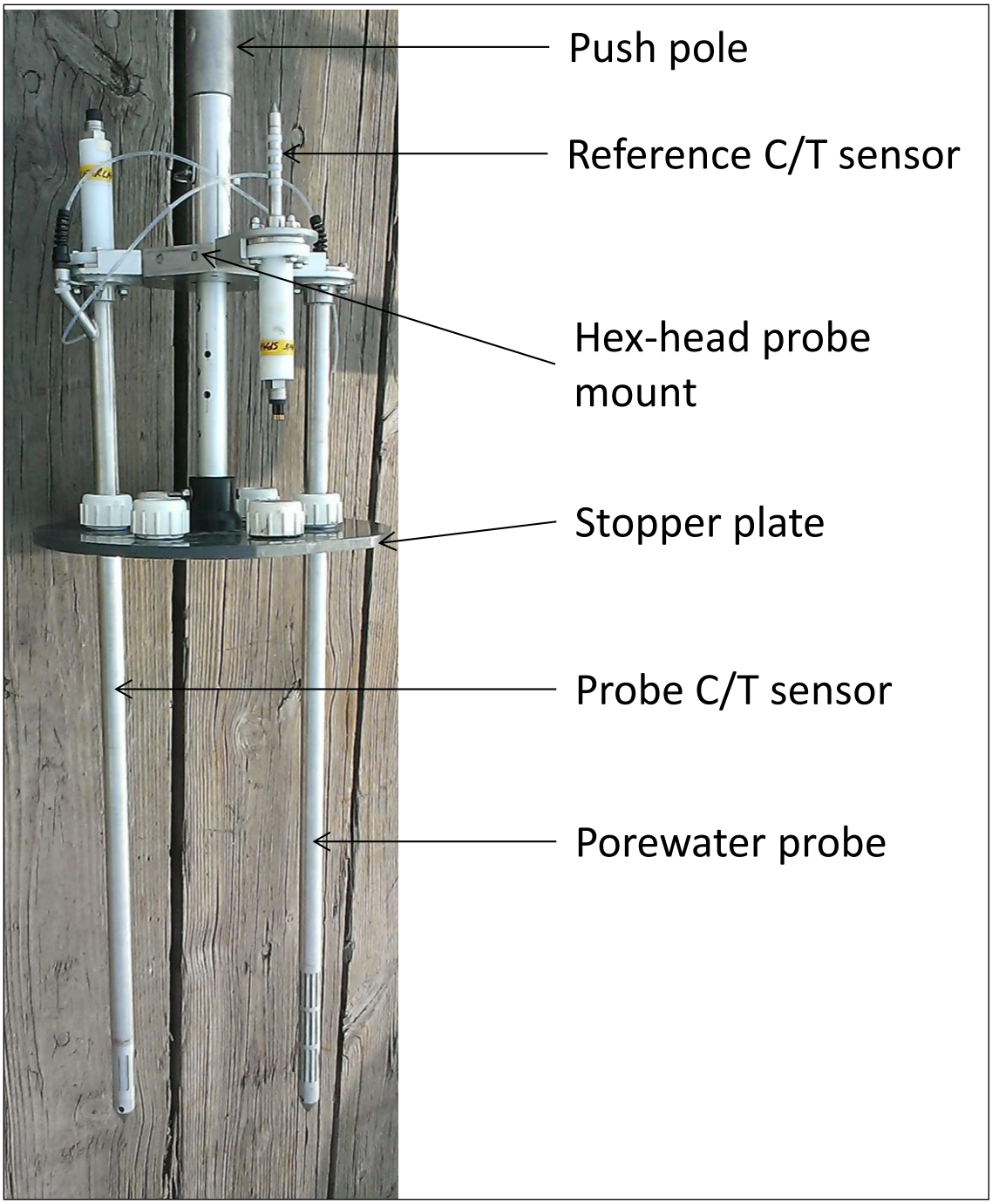


Figure 1. Complete Trident Probe showing sensor and water sampling probes, push-pole, hex-head and stopper plate.

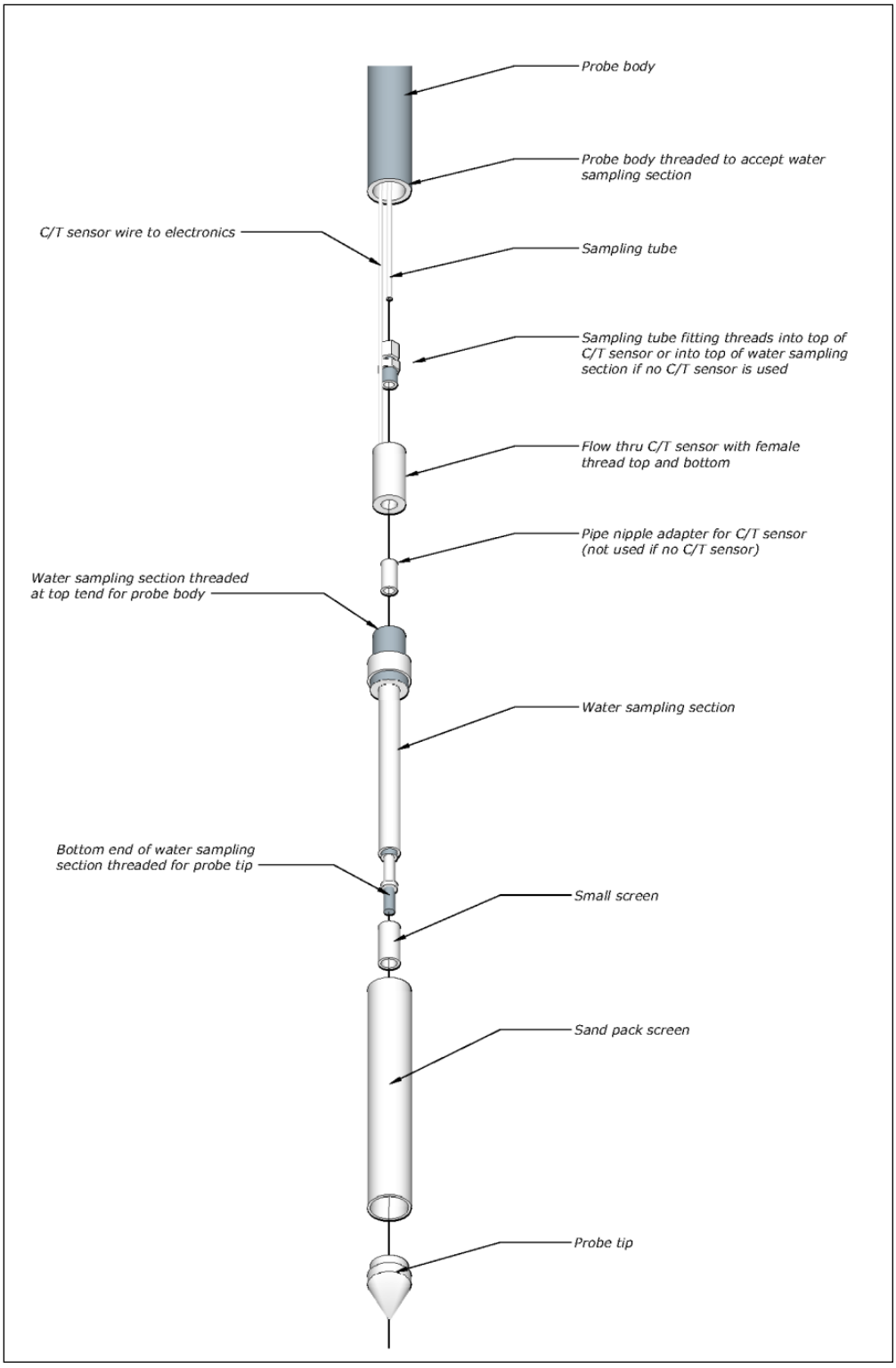


Figure 2. Schematic of the Trident Probe tip section showing the screen and sensor configuration.

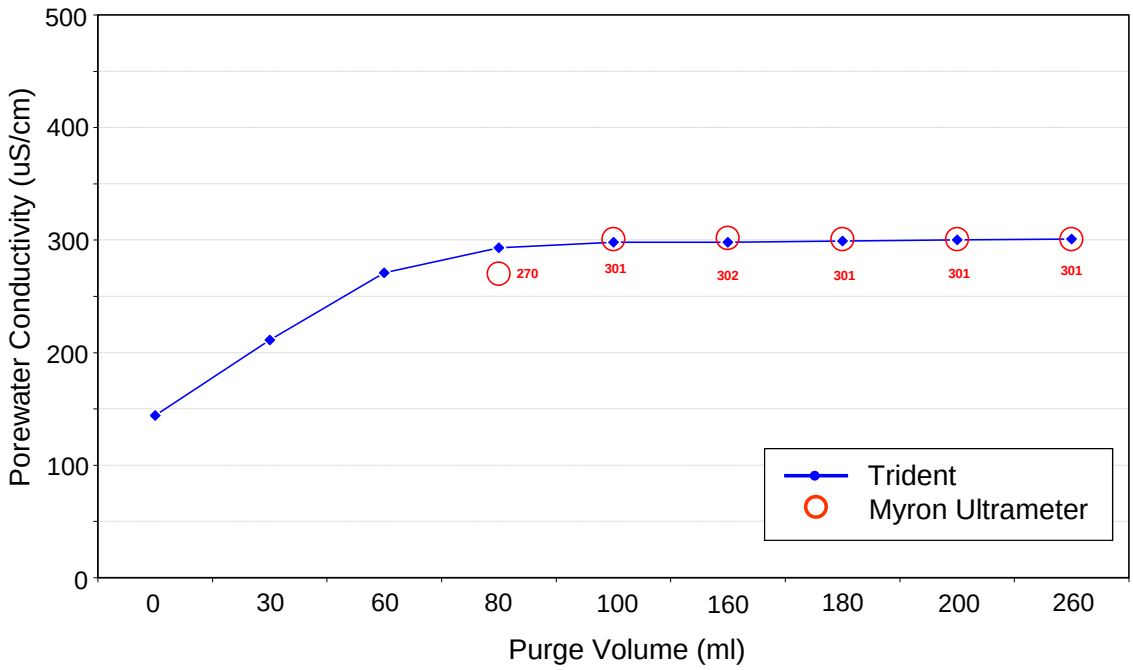


Figure 3. Typical porewater conductivity vs. purge volume for the liquid tip sensor.

Figure 4. Trident porewater sampling system components showing peristaltic pumps for multi-depth probes.

Figure 5. Multi-probe Trident porewater sampler setup with glass bead pre-filter system.

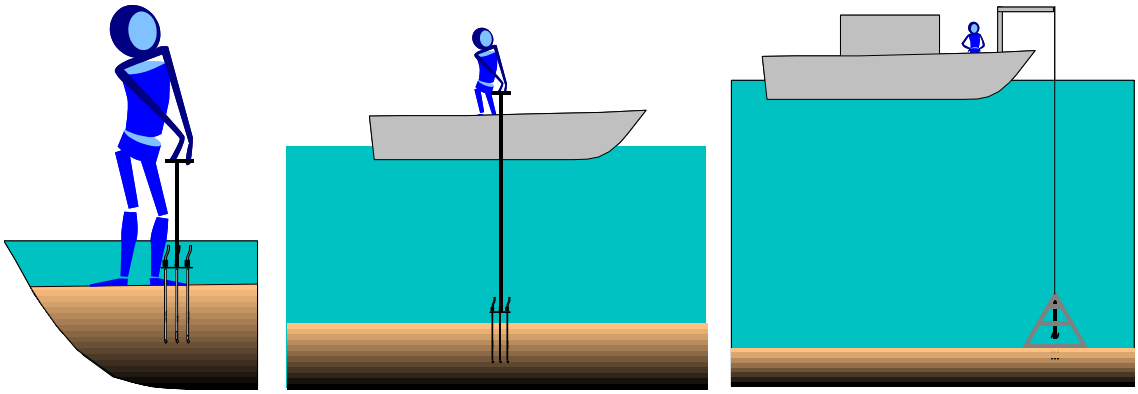


Figure 6. (Left to right) shallow-water (0 to 3 ft) push-pole, mid-range (3 to 30 ft) push-pole, and deep-water (>30 ft) deployment methods for Trident probe. Diver method not shown.

Figure 7. Trident push pole system installation.

Figure 8. Trident Vibra-Frame system.

Figure 9. Trident Drive-Frame system installation.

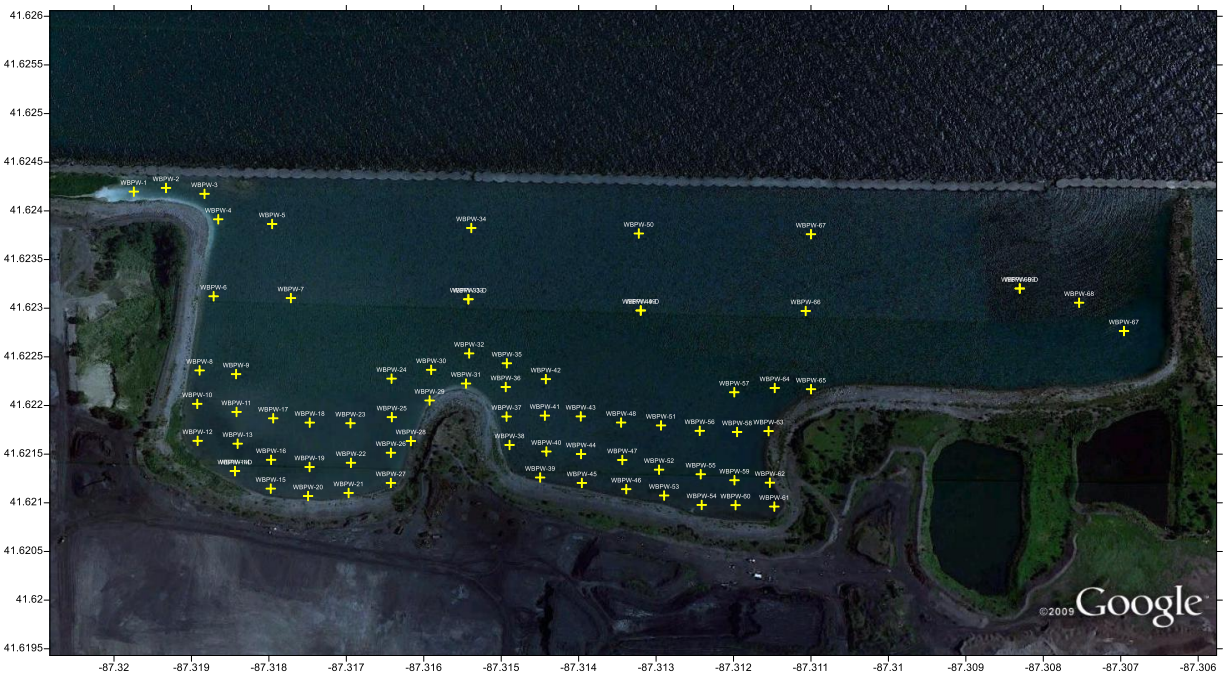


Figure 10. Typical shoreline survey grid for a Trident Probe survey.

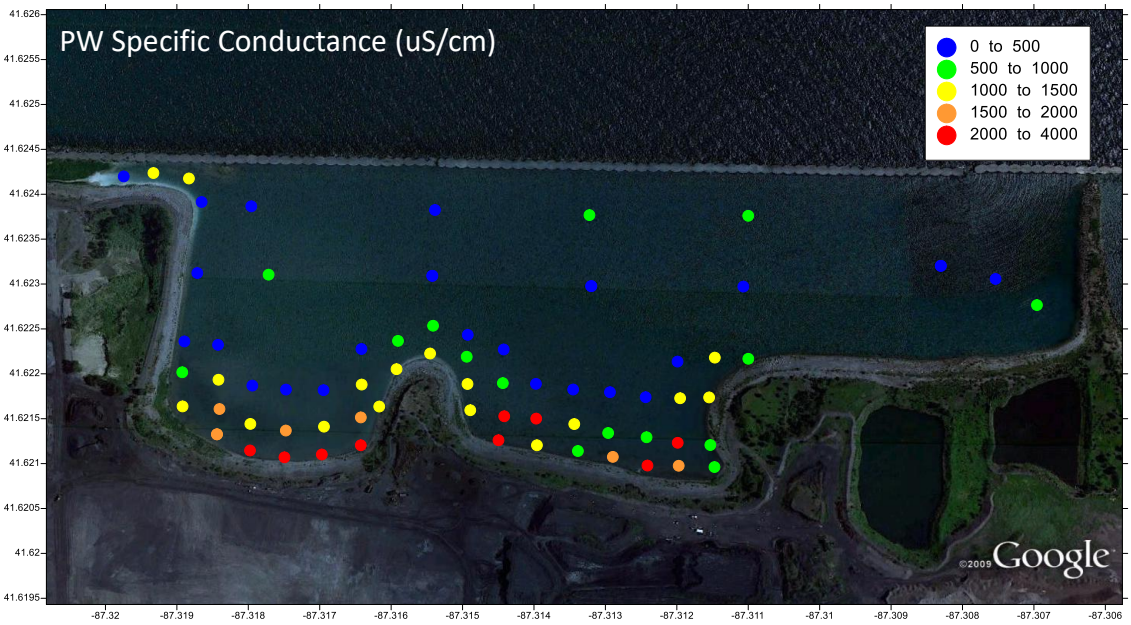


Figure 11. Example of liquid-tip sensor results for conductivity to detect groundwater discharge zones in a shoreline survey grid. In this case at a freshwater site, the groundwater was characterized by higher specific conductance levels than the surface water.

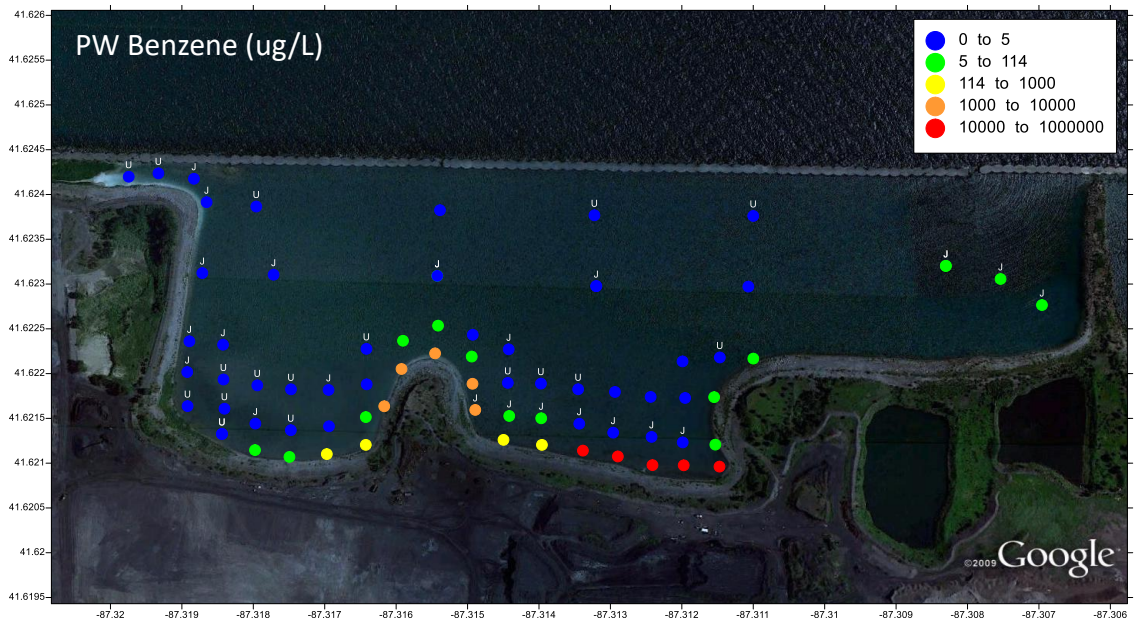


Figure 12. Example of porewater survey results for Benzene in a shoreline survey grid.

ADDENDUM 1. DETAILED FIELD PROCEDURES FOR TRIDENT PROBE SENSOR SAMPLING

Standard field procedures for Trident sensor sampling are described below. While these procedures are generally applicable, they serve as a guide and may be subject to site-specific variations depending on the particular study design and requirements.

Applicable Field Conditions

Trident sensor measurements are applicable to a wide range of field conditions. In general, the measurements focus on characterizing subsurface and surface water temperature and conductivity, and the contrast between these, at soft-bottom sediment sites with the potential for groundwater-surface water interaction. Using various configurations, the sensors have been extended to use in gravel, cobble, and other more resistant bottom types, but these typically require special armoring and drive systems. The temperature sensors are applicable over the widest range of conditions. The conductivity sensors can be used in either the "bulk" conductivity configuration, or the "liquid-tip" configuration.

In the bulk configuration, the conductivity sensor is exposed directly to the sediment, and the reading reflects the combined conductivity of the sediment and the porewater. Bulk measurements can be useful in certain applications, particularly when evaluating relative subsurface difference either in sediment properties (when the porewater conductivity is relatively constant), or when evaluating porewater conductivity differences (when the sediment properties are relatively constant). In general, these measurements will not be useful for measuring contrast with surface water because of the bias associated with the effect of the sediment on the reading. Also, it if often the case that the degree of uniformity of the porewater conductivity or sediment characteristics is not known or is known to be variable and then the bulk measurements may be difficult to interpret. The bulk conductivity probe should thus only be used with these factors in consideration.

In the liquid-tip configuration, the conductivity/temperature sensor is installed in-line just above the intake screen of the probe where the porewater is drawn in. Thus the liquid-tip configuration gives readings that reflect only the porewater conductivity. This allow for

more direct assessment of potential groundwater discharge zones and for direct comparison with surface water readings to evaluate contrast. The liquid-tip configuration utilizes a 250 micron inner and outer screen with a glass bead pre-filter. Thus it works well in a broad range of sediment types ranging from coarse to fine grain sediments. In this configuration, a pump is required to draw a small amount of porewater through the sensor. The system is generally pumped slowly until sensor readings stabilize, and then the reading is recorded.

Probe Configurations

The Trident provides for a range of different probe configurations. Sensor probes can be combined with water sampling probes. Multiple probes can be used for replication or at different sampling depths. Surface water sensors and samplers can be included. Probe configuration is largely a function of the study design so there is no standard configuration. The maximum number of probes for the hex-head Trident is 6 not including surface water probes. The maximum probe length is typically 90 cm, although longer probes up to 150 cm have been applied for special studies. The probe length can be adjusted by installing a different length probe body into the unit. The depth of penetration can be further adjusted using the extension plates where the probes attach to the hex head. Additional adjustment for each probe can be made for all probes using the adjustable stopper plate. In general, when using the sensor probes to detect groundwater upwelling zones, the strength of the signal tends to increase with depth. Thus setting the probes to deeper depths will generally result in stronger signals. Setting probes at depths less than about 6 inches can result in higher potential for draw-down, so shallow probe depths should be used with caution.

Sensor System Preparation

Preparation of the sensor system prior to field measurements is described below.

1. Gather the equipment and materials described in the equipment list.
2. Clean the sensor probes with warm water and a lab-grade detergent such as Alconox or RBS, using a green scrunge pad to polish the conductivity sensors thoroughly.

3. For the liquid-tip probe, install the in-line conductivity/temperature sensor inside the probe to be used for sensing.
4. Connect the probe(s) to the Trident deck unit and verify communications.
5. Run TridentTalk, select the probe settings option, note down all of the previous calibration coefficients, and then change all of the coefficients to a slope of one (+1.000) and an intercept of zero (+0.000).
6. Calibrate the temperature sensor(s) using a three-point calibration in a temperature bath (verified by NIST thermometer) spanning the range of expected values at the site, and three replicate measurements for each standard.
7. Input the calibration data into the standard calibration spreadsheet template and note the new calibration coefficients.
8. Enter the new coefficients into TridentTalk for the respective probes.
9. Using the temperature bath (verified by NIST thermometer) check the calibrated temperature readings against the thermometer. Relative percent differences (RPDs) should be in the range of 0.1-0.5%.
10. Calibrate the conductivity sensor(s) using a three-point calibration of NIST standards spanning the range of expected values at the site, and three replicate measurements for each standard. If the liquid-tip configuration is being used, calibrate with the probe armor and screen in place.
11. Input the calibration data into the standard calibration spreadsheet template and note the new calibration coefficients. Relative standard deviations (RSDs) of the replicates should be in the range of 0.1-1%.
12. Enter the new coefficients into TridentTalk for the respective probes.
13. Using the conductivity standards check the calibrated readings against the standards. Relative percent differences (RPDs) should be in the range of 0.1-1%.
14. Rinse the probes with clean DI water to remove any residual calibration solution, and ziptie a clean plastic bag over the tip to keep clean until ready for field use.
15. Assemble the probes onto the hex-head (and extension plates if needed) in the desired configuration.
16. Install the stopper plate including the stopper plate pole and adjustment rod.
17. Insert the shore extension pole into the hex-head with a retainer pin.

18. Connect the sensor cables and ziptie them to the short pole to provide strain relief. If desired, install the camera system on the frame for use in verifying the push depth.
19. Connect the communication cables to the deck unit and the deck unit to the field computer, start TridentTalk, and verify that all of the probes and the GPS unit are functioning properly. If installed, verify the camera is functioning properly.
20. If using the liquid-tip, connect a clean length of tubing of sufficient length to reach the bottom at the deepest target station, and secure it to the short pole using zipties. The tube and cables can be bundled with zipties as well.
21. The system is now ready for field use.

Field Sensor Measurements

Follow the procedure below to collect Trident sensor measurements in the field.

1. Assemble all of the required equipment from the equipment list, along with the assembled Trident system on the sampling boat or at the shoreline area if wading.
2. Connect the probes and the GPS to the deck unit, and the deck unit to the field laptop, start TridentTalk, and verify that everything is functioning properly.
3. In TridentTalk, setup the station name and data file as needed. Normally the station name is change for each station, and the filename is change for each day. Replicates at the same station are automatically designated under TridentTalk.
4. Setup the desired sampling interval in seconds.
5. Verify that the computer clock is properly set and synchronized in TridentTalk.
6. If using the liquid-tip, connect the purge tube to the pump.
7. Using the boat or wading, position to the target station. This can be done using the GPS, a navigation system, or by known landmarks.
8. Use a depth meter or other method to determine and record the water depth in the logbook. Assemble the required number of push poles to reach the bottom.
9. Lower the probe to the bottom, adding poles as needed to reach the target depth. If the push poles are to be released after the push, make sure an install the release pin in the first pole.

10. Gage the initial contact with the bottom by feel and note the pole height relative to the water level or the boat rail. Push the probe into the bottom until significant resistance is felt. Note the pole height and estimate if the probe is fully penetrated. If not, continue to work the probe in by hand or using a slide hammer or other drive method until full penetration is achieved. If installed, verify penetration with the camera. If using the release point, pull the release pin and remove the push poles. Note the bottom type in the logbook based on feel or visual observations in shallow water.
11. If using the liquid-tip, start the cell purge and purge a minimum of 100 ml, checking the stability of the temperature and conductivity readings during the purge using TridentTalk.
12. Install the Trident GPS in the top of the push pole. If using the release point, hold the GPS over the push location. If using a handheld GPS, hold it next to the push pole or above the push location and record the position.
13. Once the readings have stabilized, record the data for the station and note the values and the position data in the logbook.
14. Retrieve the probe to the surface using the push poles or retrieval line as applicable.
15. Clean the probe to remove any sediment or residue using a soft brush and DI water. If using the liquid-tip, remove the screen, check for excessive particles in the screen zone, and clean the screen, sensor and probe body. If significant contamination or residue is present (e.g. sheen), use a mild lab detergent to clean the probe and rinse with DI water.
16. If the liquid-tip is used, flush the tubing with surface water, and then pump any residual water out of the tubes. If significant contamination or residue is present the tubing can be deconed by pumping a mild lab detergent followed by DI water through the system, or the tubing can be changed out for new tubing.
17. Once the probe and the tubing are clean, re-assemble any screens, tips or tubing that was removed/disconnected, and the probe is ready for redeployment.
18. Once a day (generally at the end of the day), the conductivity sensor calibration should be checked by immersing the sensor in a NIST standard. Normally the

standard should be the one that is closest to the range of conductivities observed at the site. If the RPD of the reading is more than 2% different from the standard, the sensor should be lightly polished with a scrunge pad and the check repeated. If the reading is still more than 2% different from the standard, the sensor should be re-calibrated in accordance with steps described above in the System Preparation section.

19. The temperature sensor calibrations are generally very stable and should not require re-calibration during the period of a typical survey.

ADDENDUM 2. DETAILED FIELD PROCEDURES FOR TRIDENT PROBE WATER SAMPLING

Standard field procedures for Trident water sampling are described below. While these procedures are generally applicable, they serve as a guide and may be subject to site-specific variations depending on the particular study design and requirements.

Applicable Field Conditions

Trident water sampling is applicable to a wide range of field conditions. In general, the sampling focuses on collection of sufficient subsurface and surface water samples volume to characterize the target water quality and chemical conditions for the study. Using various configurations, the water samplers have been extended to use in conditions ranging from fine sediments to gravel, cobble, and other more resistant bottom types. The primary configurations for the water sampler uses an adjustable length probe body, fitted with an inner and outer screen with a glass bead pre-filter in between the screens.

Probe Configurations

The Trident provides for a range of different probe configurations. Water sampling probes can be combined with sensor probes. Multiple probes can be used for replication or at different sampling depths. Surface water sensors and samplers can be included. Probe configuration is largely a function of the study design so there is no standard configuration. The maximum number of probes for the hex-head Trident is 6 not including surface water probes. The maximum probe length is typically 90 cm, although longer probes (up to 150 cm) have been applied for special studies. Using the extension plates, each probe can be set to an independent subsurface penetration depth. Setting probes at depths less than about 6 inches can result in higher potential for draw-down, so shallow probe depths should be used with caution.

Water Sampling System Preparation

Preparation of the water sampling system prior to field measurements is described below.

1. Gather the equipment and materials described in the equipment list.

2. Clean the water sampling probes, screens and tips with warm water and a lab-grade detergent such as Alconox or RBS, using a soft bristle brush. Rinse thoroughly with DI water and allow to dry. Place the screens and tips in clean Ziploc bags. Note that the solutions used to decontaminate the probes my vary depending in if the probe is being used only to collect water quality samples, or if the probe is being used to collect samples for chemical analysis.
3. Replace the internal tubing in the probe with new, pre-cleaned Teflon tubing. Install a pre-cleaned Teflon tee or union fitting on the exposed end of the tubing and cover the open end with a blank ferrule fitting or parafilm.
4. Assemble the probes onto the hex-head (and extension plates if needed) in the desired configuration.
5. Install the stopper plate including the stopper plate pole and adjustment rod.
6. Insert the shore extension pole into the hex-head with a retainer pin.
7. Connect a pre-cleaned length of tubing to the probe coupling of sufficient length to reach the bottom at the deepest target station, and secure it to the short pole using zipties. A surface water sampling tube can also be ziptied to the pole or the frame at the desired height above the bottom. If multiple tubes are being used they can be bundled with zipties as well.
8. To install the glass beads in the pre-filter, stand the probe vertically with the probe tips pointing up and install the small inner and large outer screens. Fill the void between the inner and outer screen with a slurry of filter beads by rinsing it into the void with clean DI water. Leave about 1/8 inch unfilled for the tip to fit into. Install the large tip and re-cover the probe tip with the plastic bag.
9. The system is now ready for field use.

Field Water Sampling

Follow the procedure below to collect Trident sensor measurements in the field.

1. Assemble all of the required equipment from the equipment list, along with the assembled Trident system on the sampling boat or at the shoreline area if wading.
2. Using the boat or wading, position to the target station. This can be done using the GPS, a navigation system, or by known landmarks.

3. Use a depth meter or other method to determine and record the water depth in the logbook. Assemble the required number of push poles to reach the bottom.
4. Lower the probe to the bottom, adding poles as needed to reach the target depth. If the push poles are to be released after the push, make sure an install the release pin in the first pole.
5. Gage the initial contact with the bottom by feel and note the pole height relative to the water level or the boat rail. Push the probe into the bottom until significant resistance is felt. Note the pole height and estimate if the probe is fully penetrated. If not, continue to work the probe in by hand or using a slide hammer or other drive method until full penetration is achieved. If installed, verify penetration with the camera. If using the release point, pull the release pin and remove the push poles. Note the bottom type in the logbook based on feel or visual observations in shallow water.
6. Start the sample purge and purge a minimum of 100 ml, checking the stability of the water quality readings during the purge using the in-line sensor and/or the handheld Ultrameter.
7. Hold the GPS next to the push pole or above the push location and record the position.
8. Once the water quality readings have stabilized, record the data for the station and note the values and the position data in the logbook.
9. If chemical samples are to be collected, continue to pump and collect samples as required.
10. Retrieve the probe to the surface using the push poles or retrieval line as applicable.
11. Clean the exterior of the probe to remove any sediment or residue using a soft brush and Alconox solution. For the pre-filter, remove the tip and the outer screen and dispose of the beads. Remove the internal screen and clean the entire probe exterior, screens and tip with Alconox solution and a soft brush followed by DI rinse.
12. If the sample tubing is to be re-used, decon the tubing by back flushing with the sampling pump using Alconox solution followed by DI water (or other decon

solutions as required by the chemical sampling). Alternatively, the short length of internal probe tubing can be deconed in this way, and the long length of sampling tubing can be replaced with new pre-cleaned tubing. It is not advised to change the internal probe tubing in the field, but this can be done as well if the application requires. Rinse the probe tips again with DI after the back flush is completed.

13. Once the probe and the tubing are clean, re-assemble any screens, tips or tubing that was removed/disconnected. For the pre-filter, re-pack the probe with clean filter beads. The probe is ready for re-deployment.

ADDENDUM 3.TRIDENT EQUIPMENT LIST

General Hardware

- Standard Hex Head and Hardware
- Extension Plate Hex Head and Hardware
- Extension Plates and Hardware
- Stopper Plate with Seal Glands
- Stopper Plate Pole and Adjustment Rod
- Single Probe Hex Head (for single probe configurations only)
- Single Probe Extension Plates and Hardware (for single probe configurations only)
- Single Probe Stopper Plate (for single probe configurations only)
- Short (1 m) Push Pole
- Standard Push Poles (2 m) and Clips
- Probe Mounting Brackets

Sensor System

- C/T Sensor Probes
- C/T Reference Probes
- Inner and Outer Filter Screens
- Probe Tips

Water Sampling System

- PW Probes
- Inner and Outer Filter Screen
- Probe Tips
- Pump – Masterflex E/S Portable Sampler IP54
- Pump Head – Masterflex L/S #7518-10
- Pump Tubing – Masterflex silicone L/S 14
- Sample Tubing – Cole Parmer 1/8” Teflon FEP
- Couplings - Entegris Teflon PFA 1/8”SU2N, UT2N

Deck Gear and Ancillary Equipment

- C/T and GPS Cables - Impulse
- Trident Deck Unit
- Trident Integrated GPS – Garmin GPS16
- Handheld GPS – Trimble GeoXT
- Field Computers – Dell Inspiron
- Inverter – Black and Decker 1008 48-OC
- Battery – Duralast Marine Battery
- USB/Serial – Keyspan USA 19-HS
- GFI – TRD Model 14650Software – Trident Talk, Rosepoint Coastal Explorer
- Water Quality Meter – Myron L Ultrameter model 6P
- Hand-Held Depth Sounder – Vexilar LPS-1

Expendables

- Wipes – Kimwipes
- Gloves – Cole Parmer Powder free nitrile EW-81602-65
- Wrap - Parafilm
- Cleanrer - Alconox
- Lab-Water – 18 Mohm lab-grade deionized water
- Distilled water
- Filter Beads – Waterco glass bead filter media or equal
- AAA batteries for the deck unit

ATTACHMENT 2. FIELD FORMS

CHAIN OF CUSTODY

ALS Environmental

1317 South 13th Ave., Kelso, WA 98626 | +1 360 577 222 | +1 800 695 7222 | +1 360 636 1068 (fax)

SR# _____

PAGE _____OF_____COC#_____

PROJECT NAME
PROJECT NUMBER
PROJECT MANAGER
COMPANY NAME
ADDRESS
CITY/STATE/ZIP
E-MAIL ADDRESS
PHONE # FAX#
SAMPLER'S SIGNATURE

SAMPLE I.D.	DATE	TIME	LAB I.D.	MATRIX	NUMBER OF CONTAINERS		Semivolatile Organics by GC/MS ☐ SIM PAH ☐ 625 ☐ 8270 ☐ 8270LL	Volatile Organics ☐ BTEX ☐ 624 ☐ 8260 ☐ 8021	Hydrocarbons (*see below) ☐ Oil ☐ Gas ☐ Diesel	Oil & Grease/ TRPH ☐ 1664 SGT ☐ 1664 HEM	PCBs ☐ Congeners ☐ Aroclors	Pesticides/Herbicides ☐ 8151 ☐ 608 ☐ 3081 ☐ 8141	Chlorophenolics - 8151M ☐ PCP ☐ Tetra ☐ Tri	Metals, Total or Dissolved (See list below)	Cyanide ☐ Hex - Chrom	(circle) pH, Cond., Cl, SO_4, PH_4, F, NO_2, NO_3, BOD, TSS, TDS, Turb.	(circle) NH3-N, COD, TKN, TOC, DOC, NO2+NO3, T-Phos	TOX 9020 ☐ AOX 1650 ☐ 506	Alkalinity ☐ CO_3 ☐ HC(	Dioxins / Furans ☐ 1613 ☐ 8290	Dissolved Gases ☐ CO_2 ☐ Ethane ☐ Ethene ☐ Methane ☐ RSK 175				REMARKS

REPORT REQUIREMENTS

_____ I. Routine Report: Method Blank, Surrogate, as required

_____ II. Report Dup., MS, MSD as required

_____ III. CLP Like Summary (no raw data)

_____ IV. Data Validation Report

_____ V. EDD

INVOICE INFORMATION

PO # _____

Bill To: _____

TURNAROUND REQUIREMENTS

_____ 24 hr.

_____ 48 hr.

_____ 5 day

_____ Standard (15 working days)

_____ Requested Report Date

Circle which metals are to be analyzed:

Total Metals: Al As Sb Ba Be B Ca Cd Co Cr Cu Fe Pb Mg Mn Mo Ni K Ag Na Se Sr Tl Sn V Zn Hg

Dissolved Metals: Al As Sb Ba Be B Ca Cd Co Cr Cu Fe Pb Mg Mn Mo Ni K Ag Na Se Sr Tl Sn V Zn Hg

*** INDICATE STATE HYDROCARBON PROCEDURE: AK CA WI NORTHWEST OTHER: _____ (CIRCLE ONE)**

SPECIAL INSTRUCTIONS/COMMENTS:

☐ Sample Shipment contains USDA regulated soil samples (check box if applicable)

RELINQUISHED BY:		RELINQUISHED BY:		RELINQUISHED BY:		RELINQUISHED BY:	
Signature	Date/Time	Signature	Date/Time	Signature	Date/Time	Signature	Date/Time
Printed Name	Firm	Printed Name	Firm	Printed Name	Firm	Printed Name	Firm

Trident Log Sheet - Two Sampling Levels

Site:_____ Station:_____ Date:_____

Trident GPS
Latitude:_____
Longitude:_____

Station Time
On Station Time:_____
Off Station Time:_____

Station Conditions
Water Depth:_____

Trimble GPS
Latitude:_____
Longitude:_____
Accuracy:_____

Trident System
- ☐ Drop-Drive Frame
- ☐ Pneumatic-Drive Frame
- ☐ Vibra-Frame
- ☐ Push Pole
- ☐ Release Point

Bottom Type
Shallow:_____
Deep:_____

Trident Data

Sensor Level	Surface Water	Porewater
Sensor Number		
Sensor Depth (in)		
Start Logging Time		
Logging Period (s)		
Temperature (C)		
Conductivity (mS/cm)		
Data File Name		

Porewater Sensor Checks

Water Quality Data

Sample Level	Surface Water	Porewater
Sample Depth (in)		
Purge Volme (ml)		
Sample Time		
Temperature (C)		
Conductivity (mS/cm)		
TDS (ppm)		
pH		
ORP (mV)		
DO (mg/L)		

Porewater Water Quality Checks

Comments/Observations:_____ Recorded By:_____

UCR Phase 3 Sediment Porewater Chemistry Sample Collection Form

Sampling date:		Sampling time:	
Weather:		Sample collector:	
Location ID:		Field duplicate collected?	
Media type (circle one):	PW EB FB	Sample ID:	
Notes (e.g., Trident sampler type and ID, sample appearance, type of EB, etc.)			

Sampling date:		Sampling time:	
Weather:		Sample collector:	
Location ID:		Field duplicate collected?	
Media type (circle one):	PW EB FB	Sample ID:	
Notes (e.g., Trident sampler type and ID, sample appearance, type of EB, etc.)			

Sampling date:		Sampling time:	
Weather:		Sample collector:	
Location ID:		Field duplicate collected?	
Media type (circle one):	PW EB FB	Sample ID:	
Notes (e.g., Trident sampler type and ID, sample appearance, type of EB, etc.)			

STANDARD OPERATING PROCEDURE SOP-8

COLLECTING AND PRESERVING BENTHIC MACROINVERTEBRATE SAMPLES FROM SEDIMENT

Scope and Application

The purpose of this standard operating procedure (SOP) is to describe the procedures used to process and preserve benthic macroinvertebrate (BMI) samples obtained in the field from sediment sampling efforts (Van Veen power grab, modified Hamon power grab, handheld sampler, or freeze grab) prior to shipping to the taxonomic laboratory. Sediment samples are being collected for the 2019 Phase 3 sediment study (hereinafter "the study") that will be conducted for Teck American Incorporated (TAI) in the Upper Reach Operable Unit (OU) of the Upper Columbia River (UCR) site. The process of obtaining sediment samples from UCR sampling stations is outlined in SOP-3, SOP-4, SOP-5, and SOP-6.

The procedures listed below may be modified in the field by the field supervisor and field personnel, based on field and site conditions. Any modifications will be documented in the field notes and/or the field logbook and in a field deviation form that will be submitted for review and approval with the U.S. Environmental Protection Agency (EPA).

Summary of Method

Sediment samples for BMI will be collected in accordance with their respective SOPs (3, 4, 5, or 6). After the sample is determined to be acceptable, a qualified person will characterize the sediment. The sample will be placed into a Lexan tub for review by the cultural resources monitor. If the sediment sample was acquired via freeze grab, an additional gentle thawing step (soaking in warm/ambient river water) is required so that the sediment can be sieved and BMI retained. Large gravel and debris will be rinsed and removed, and remaining sediments carefully transferred to a pre-labeled plastic sample container. 90 percent ethanol is added until the volume of ethanol is equal to the volume of sediment. Internal and external sample labels will be affixed to the sampling jar (SOP-9) and prepared for shipment to the taxonomic laboratory, according to chain-of-custody procedures (see SOP-11).

Equipment and Materials

Equipment required for processing BMI collected from sediment sampling includes the following:

- Sample collection table
- Spoons/spatulas, or Lexan scoop
- Transparent Lexan tubs
- Scrub brush
- Water pump and hose (for thawing freeze grab samples, wet sieving the sediments, and for rinsing the grab sampler, sampling utensils, and sample collection table)
- 250-µm sieve
- Gloves
- Forceps.

Procedures for BMI Collection from Sediment Samples

1. The BMI sample will be collected using a sediment sampling technique included in the field sampling plan (FSP) (SOPs 3, 4, 5, or 6).
2. After the sediment sample has been accepted, the sediment sample will be deposited into a Lexan tub. The sampler will then be scraped or rinsed (filtered river water pumped through a hose assembly) with all material from inside the sampler going into the Lexan tub.
3. The onboard cultural resources monitor will examine the sediment to determine if cultural resources are present. If cultural resources are present, the field crew will follow instructions from the cultural resources monitor regarding what to do with the recovered sediment and cultural artifacts, as well as whether to abandon the sampling station (see SOP-16).
4. If the sediment sample was acquired using the freeze grab sampler, warm/ambient temperature river water will be added to the Lexan tub.

5. A qualified person[1] will characterize the sediment. Characteristics that should be recorded in the field logbook and/or data form include:
   a. Sediment type (e.g., silt, sand)
   b. Texture (e.g., fine, coarse, poorly sorted sand)
   c. Color
   d. Presence/absence of black silica glass particles (based on vitreous, conchoidal fractures, and a translucent appearance); if present, estimate relative percent composition
   e. Presence/location/thickness of the redox potential boundaries (a visual indication of black is often adequate for documenting anoxia)
   f. Presence of biological structures (e.g., amphipods, tubes, macrophytes)
   g. Presence of debris (e.g., twigs, leaves)
   h. Presence of shells
   i. Stratification, if any
   j. Presence of a sheen.
6. Pick out large gravel, cobble, and debris, carefully washing with pumped and filtered river water over the Lexan tub, allowing the rinse water to go into the tub with the sample. Remove and discard the large gravel, cobble, and debris.
7. Transfer sample material (scoop and pour) to a pre-labeled plastic sample container. A sample container is a 5-gal plastic bucket.
8. Remove excess water from the Lexan tub by decanting through a 250-µm sieve prior to transfer to the sample container. Residual material inside the Lexan tub should be rinsed with pumped and filtered river water to facilitate transfer to the sample container. Decant all water from the sample container through a 250-µm sieve. Use a small amount of the pumped and filtered river water to transfer the residue from the sieve back into the sample container. Do not fill containers more than two-thirds full.

[1] A qualified person is either a Washington State Licensed Geologist (LG) or an engineer/scientist who has received site-specific training in the following: 1) identification of sedimentary deposits of the Upper Columbia River basin, 2) recognition of amorphous silica-rich glass, 3) particle size and percentage estimation, 4) soil/sediment classification systems, and 5) recording of observations.

9. Add 90 percent ethanol until the volume of ethanol is equal to the volume of sediment. If the container is up to two-thirds full of sediment, fill the container to the top with the 90 percent ethanol. Safety glasses or goggles must be worn when preserving samples in ethanol.
10. Ensure BMI samples possess two labels per container:
    a. An internal Rite-in-the-Rain label recorded with a graphite pencil
    b. An external vinyl label filled out with indelible ink.
11. Label the BMI sample according to SOP-9.
12. Seal the junction of the sample container and lid with electrical tape. If a 5-gal bucket is used, a self-sealing lid or duct tape can be used.
13. Fill out the chain-of-custody form (see SOP-11).
14. Store preserved samples in a sturdy waterproof container, such as a cooler.
15. Store BMI samples at a secure location until sampling efforts are completed.

Sample Packaging and Shipping

Sample packaging and shipping are described in SOP-12. Following cessation of sampling efforts, BMI samples will be transported by ground via field personnel or a courier service to the taxonomy laboratory.

STANDARD OPERATING PROCEDURE SOP-9

SAMPLE LABELING

Scope and Applicability

This standard operating procedure (SOP) describes the general procedures for completing sample labels that will be used for the 2019 Phase 3 sediment study (hereinafter "the study") that will be conducted for Teck American Incorporated (TAI) in the Upper Reach Operable Unit (OU) of the Upper Columbia River (UCR).

Equipment and Materials

- Sample labels
- Indelible marker
- Table A1 of the field sampling plan (FSP).

Sample Identification

Field sample identification will be established before field sampling begins and applied to each sample as it is collected.

Each sampling location will be identified by the sampler on the field form(s). A unique sample identification (ID) will be entered on sample containers and the chain-of-custody form. This process is designed to fulfill three purposes: 1) to identify related samples (i.e., duplicates and splits) to ensure proper data analysis and interpretation; 2) to obscure the relationships between samples so that laboratory analysis will be unbiased by presumptive similarities between samples; and 3) to track individual sample containers to ensure that the laboratory receives all of the material associated with a single sample. The sample ID consists of codes as described below.

Each distinct sample will be assigned a unique sample ID. Sample IDs will be formatted to indicate sample location ID, matrix, sample type, and date, in the following format:

- Sample ID = Location ID – Matrix – Sample Type – Date
- Location ID = Area code (EV for Evans, CB for China Bend, DM for Deadman's Eddy, or "REF" for reference areas) and the station number (see FSP Table A1)
- Matrix Codes = SE for sediment, PW for porewater, or BMI for benthic macroinvertebrates. Quality control (QC) samples should be assigned the same

matrix codes for which they are associated. For example, an equipment blank for sediment sampling should be assigned matrix code "SE" even though the QC sample itself will be aqueous.

- Sample Type = primary (1), field duplicate (2), field split (3), and equipment rinsate blank (4)
- Date = month/day/year as MMDDYY.

Examples

Format: Location ID – Matrix – Sample Type – Date

CB025-SE-1-091919 = Primary sediment sample collected from the China Bend area of interest (AOI) station 025, on September 19, 2019.

CB025-PW-2-091919 = A duplicate porewater sample collected from the China Bend AOI station 025 on September 19, 2019.

EV031-SE-3-090819 = A field split sediment sample collected from the Evans AOI station 031 on September 8, 2019.

EV031-SE-4-090819 = An equipment rinsate blank collected on September 8, 2019 at the Evans AOI station 031.

Sample Labels

Each sample label will include the following information:

- Sample ID
- Project name (TAI_2019_Ph3Sed)
- Date (month/day/year) as MMDDYY
- Time (24-hour)
- Preservative (if applicable)
- Requested analysis
- Sampler's initials.

Information will be entered onto the waterproof sample label with an indelible marker or pen. If necessary, corrections will be made on the sample labels by drawing a single line through the error and entering the correct information with an indelible marker. All corrections will be initialed and dated by the person performing the correction.

The sample labels will be placed on each sample container. For BMI samples, an additional sample label will be placed inside the container using Rite-in-the-Rain paper and a graphite pencil (SOP-8). Sample packaging is discussed in SOP-12.

STANDARD OPERATING PROCEDURE SOP-10

FIELD DOCUMENTATION

Scope and Applicability

This standard operating procedure (SOP) presents the general information that should be documented for all field sampling activities for the 2019 Phase 3 sediment study (hereinafter "the study") that will be conducted for Teck American Incorporated (TAI) in the Upper Reach Operable Unit (OU) of the Upper Columbia River (UCR) site. All information pertaining to field operations during sample collection must be properly documented to ensure transparency (and reproducibility) of methods and procedures. Several types of field documents will be used for this purpose by field personnel.

Equipment and Materials

- Field logbook
- Black (or dark) waterproof ink pen
- Field data forms
- Digital Camera
- Chain-of-custody (COC) forms.

Field Logbooks

During field sampling events, field logbooks are used to record daily field activities. The purpose of the field logbook is to thoroughly document the sampling event to ensure transparency and reproducibility. The field logbook will contain sampling-related information supplemental to the field data sheets. Any deviations from the project-specific field sampling plan that occur during sampling (e.g., personnel, responsibilities, sample station locations) and the reasons for these changes will be documented in the field logbook. Other types of information that may be included in the field logbook include the following:

- Project sampling name and type
- Name of person making entries and other field staff
- On-site visitors, if any
- Observations made during sample collection, including collection complications, visible debris, and other details not entered in the field form
- A record of site health and safety meetings, updates, and related monitoring

- Presence of construction and maintenance activities or engineered features that may influence sediment composition or transport
- The locations of nearby surface water features (e.g., streams, wetlands, oxbows) or anthropogenic influences (e.g., roads, houses, campsite)
- Equipment calibration records (e.g., instrument type and serial number, calibration supplies used, calibration methods and calibration results, date, time, and personnel performing the calibration).

The field supervisor will maintain the field logbook and is responsible for ensuring that the field logbook and all field data forms are correct. Field logbooks and data forms will be turned over frequently (preferably daily) to the field supervisor and/or designated staff for review and copying. Requirements for logbook entries will include the following:

- Entries will be made legibly with black (or dark) waterproof ink
- Unbiased, accurate language will be used
- All logbook entries must be completed at the time any observations are made (while activities are in progress) or as soon afterward as possible (the date and time that the notation is made should be noted, as well as the time of the observation itself)
- Each consecutive day's first entry will be made on a new, blank page
- The field supervisor must sign and date the last page of each daily entry in the field logbook, striking out any unused remaining pages
- When field activity is complete, the logbook will be entered into the TAI project file.

Logbook corrections will be made by drawing a single line through the original entry, allowing the original entry to be read. The corrected entry will be written alongside the original. Corrections will be initialed and dated and may require a footnote for explanation.

Upon completion of the field sampling event, the field supervisor will be responsible for submitting all field logbooks to be copied. Backup copies of the pages having entries for the current day should be made regularly, preferably at the end of each day of sampling. These copies should be stored at a secure location (e.g., the hotel room) and not returned to the field. A discussion of copy distribution is provided below.

Field Data Forms

Field data forms will be used during this field sampling event to record the relevant sample information collected during a sampling event. These forms will be filled out completely by the sampling team during each sediment and porewater collection event and will include the minimum following information:

- Project name and date

- Name(s) of person completing the form
- A brief description of the weather
- The time each sample was collected or attempt was made
- The station number
- Station location details from the global positioning system (GPS) unit—northing, easting, positional accuracy, and elevation
- Sample collection method
- The sample identification (ID)
- Description of the sample
- Any additional collection comments.

Upon completion of the field sampling event, the field supervisor will be responsible for ensuring all field data forms are complete and correctly filled out prior to submitting them to be copied. A discussion of copy distribution is provided below.

Photographs

Digital photographs may be taken to document field activities, site conditions and features, and sampling locations. See SOP-13 (Digital Camera Use and Documentation Procedures) for procedures for camera use and photograph file management.

Chain-of-Custody Forms

Chain-of-custody (COC) forms will be completed to ensure that sample custody is traceable from the time of collection through processing and analysis until final disposition. See SOP-11 (Sample Custody) for COC procedures.

Distribution of Copies

Electronic scans of the field logbooks and forms will be made after completion of the field sampling event and stored electronically in the project files for use by project staff. The original field logbooks and forms will be placed in a locked file cabinet at the task manager's location.

The following documents may be included in the locked file cabinet:

- Original field logbooks
- Original field data forms
- Original signed COC forms
- Photographs in electronic files on thumb drive or other portable electronic media.

Electronic Data Files

Electronic data generated from the Trident probe system, handheld GPS, and the vessel navigation system will be downloaded frequently (preferably daily when feasible) and stored on a field operations computer, at a secure location. A rotating supply of portable hard drives will be made available to field teams to assist in the transfer of these files. Upon completion of the field sampling effort, the field supervisor will be responsible for ensuring that all electronic data are compiled and submitted to TAI.

STANDARD OPERATING PROCEDURE SOP-11

SAMPLE CUSTODY

Scope and Applicability

This standard operating procedure (SOP) describes procedures for custody management of environmental samples for the 2019 Phase 3 sediment study (hereinafter "the study") that will be conducted for Teck American Incorporated (TAI) in the Upper Reach Operable Unit (OU) of the Upper Columbia River (UCR) site. The procedures outlined herein will be used in conjunction with SOP-9, which covers sample labeling; SOP-10, which covers field documentation; and SOP-12, which covers sample packaging and shipping.

Chain-of-custody (COC) forms ensure that samples are traceable from the time of collection through processing and analysis until final disposition. A sample is considered to be in a person's custody if any of the following criteria are met:

1. The sample is in the person's possession
2. The sample is in the person's view after being in possession
3. The sample is in the person's possession and is being transferred to a designated secure area
4. The sample has been locked up to prevent tampering after it was in the person's possession.

At no time is it acceptable for samples to be outside the custody of a designated person unless the samples have been transferred to a secure area (i.e., locked up and custody sealed), transferred to a courier/shipper, or transferred to the laboratory. If the samples cannot be placed in a secure area, then a field team member must physically remain with the samples at all times (e.g., at meal times, etc.).

Materials and Methods

- COC forms may be produced in an electronic format using a database program (e.g., FORMS II Lite), in which case a computer and printer would be needed as well
- Custody seals
- Shipping airbills.

Chain-of-Custody Forms

The COC form is critical because it documents sample possession from the time of collection through the final disposition of the sample. The form also provides information to the laboratory regarding what analyses are to be performed on the samples that are shipped.

The COC form will be completed after each field collection activity and before the samples are shipped to the laboratory. Project-assigned sample identification (ID) will be recorded on the COC form. The COC form will also identify the sample collection date and time, the type of sample, the project, and the sampling personnel. Two copies of the COC form will be sent to the laboratory along with the samples. Copies of the COC form will be placed into a plastic re-sealable bag and secured to the inside top of each cooler. Another copy will be retained by the field supervisor for filing in the project files by the task manager at the completion of the study.

Sampling personnel are responsible for the care and custody of the samples until they are shipped. When transferring possession of the samples, the individuals relinquishing and receiving the samples must sign the COC form(s), indicating the time and date that the transfer occurs.

Procedures

The following guidelines will be followed to ensure the integrity of the samples:

1. Prior to sample shipping or storage, COC entries will be made for all samples. Information on the COCs will be checked against field logbook entries and/or field forms.
2. At the bottom of each COC form is a space for the signatures of the persons relinquishing and receiving the samples and the time and date that the transfer occurred. Under no circumstances should there be any time when custody of the samples is undocumented.
3. The COC form should not be signed until the information has been checked for inaccuracies by the field supervisor or a designee. All changes should be made by drawing a single line through the incorrect entry and initialing and dating the revision. Revised entries should be made in the space below the entries. Any blank lines remaining on the COC form after corrections are made should be marked out with single lines that are initialed and dated. This procedure will preclude any unauthorized additions.

4. If samples are sent by a commercial carrier not affiliated with the laboratory, such as Federal Express (FedEx) or United Parcel Service (UPS), the name of the carrier should be recorded on the COC form. The time of transfer should be as close to the actual drop-off time as possible. After two copies of the COC forms are signed, they should be sealed inside the transfer container. The other signed copy will be retained by the field supervisor.
5. If errors are found after the shipment has left the custody of sampling personnel, a corrected version of the forms must be made and sent by the field supervisor via email to all relevant parties (e.g., the receiving laboratory and the TAI laboratory coordinator) accompanied by an explanation of the error and the associated correction.
6. Upon completion of the field sampling event, the field supervisor will be responsible for submitting all COC forms to be copied.

Custody Seal

As security against unauthorized handling of the samples during shipping, three custody seals will be affixed to each sample cooler. The custody seals will be placed across the front and on each side of the cooler prior to shipping. Sampling personnel should ensure that the seals are properly affixed to the cooler so they cannot be removed during shipping. It may be prudent to use additional tape across the seal to prevent such removal.

Shipped Air Bills

When samples are shipped from the field to the testing laboratory via a commercial carrier (e.g., FedEx, UPS), an air bill or receipt is provided by the shipper. Upon completion of the field sampling event, the field supervisor will be responsible for submitting the sender's copy of all shipping airbills and/or receipts to the task manager.

Acknowledgement of Sample Receipt

In most cases, on the day samples are received by the testing laboratory, the laboratory will confirm receipt with the task laboratory coordinator. This confirmation may be via email or an official laboratory 'Acknowledgment of Sample Receipt' form that confirms the sample ID numbers and analysis to be performed. The laboratory coordinator will immediately review the Sample Receipt forms for errors. If an error is detected by the task laboratory coordinator, the laboratory will be called or contacted via email immediately. Decisions made during any telephone conversation should be documented in an email or written form and archived in the project file by the task manager.

STANDARD OPERATING PROCEDURE SOP-12

SAMPLE PACKAGING AND SHIPPING

Scope and Applicability

Specific requirements for sample packaging and shipping must be followed to ensure the proper transfer and documentation of environmental samples collected for the 2019 Phase 3 sediment study (hereinafter "the study") that will be conducted for Teck American Incorporated (TAI) in the Upper Reach Operable Unit (OU) of the Upper Columbia River (UCR) site. Procedures for the careful and consistent transfer of samples from the field to the laboratory are outlined herein. This standard operating procedure (SOP) presents the method to be used when packing samples that will either be hand-delivered or shipped by commercial carrier to the laboratory during the study.

Equipment and Materials

Specific equipment or supplies necessary to properly pack and ship environmental samples include the following:

- Field Sampling Plan for the 2019 Phase 3 Sediment Study
- Project-specific field logbook
- Resealable airtight bags (assorted sizes)
- Wet ice in doubled, sealable bags; frozen Blue Ice®
- Coolers
- Bubble wrap (roll or sample bags)
- Fiber-reinforced packing tape and duct tape
- Clear plastic packing tape
- Scissors or knife
- Chain-of-custody (COC) forms; these may be produced in an electronic format using a database program (e.g., FORMS II Lite), in which case, a computer and printer would be needed as well
- Custody seals
- Large plastic garbage bags (preferably 3 mil [0.003 in.] thick) for cooler lining

- Paper towels
- "Fragile," "This End Up," "Perishable," and/or "Handle With Care" labels
- Mailing labels
- Airbills for overnight shipment.

Procedure

Samples not shipped directly to the laboratory may be transferred from the field to a local storage facility where they will be stored refrigerated, if necessary. Depending on the logistics of the operation, field personnel may transport samples to the laboratory themselves or utilize a commercial courier or shipping service. Field personnel should be aware of potentially limiting factors to timely shipping (e.g., availability of overnight service and weekend deliveries to specific areas of the country, hazardous shipping regulations [e.g., dry ice or ethanol]) and transfer of samples across the United States-Canada international border prior to shipping the samples.

Sample Storage Prior to Shipment

Samples will be placed in secure storage (i.e., locked room, vehicle, or other form of secure storage) or remain in the possession of sampling personnel before shipment. Sample storage areas will be locked and secured to maintain sample integrity and COC requirements. If possible, and in accordance with requirements in the quality assurance project plan (QAPP), samples will be stored at 4°C until they are packaged for shipping to the off-site analytical laboratory.

Sediment benthic macroinvertebrate (BMI) samples, stored in ethanol, will be shipped via ground carrier to EcoAnalysts at the conclusion of sediment sampling within the UCR.

Sample Preparation

The following steps should be followed to ensure the proper transfer of samples from the field to the laboratory:

At the sample collection site:

1. Appropriately document all samples using the proper logbooks or field forms and required sample container identification (ID) (i.e., sample labels with unique IDs) described in SOP-9.
2. Clean the outside of sample containers, if necessary, to remove any residual sample material that may lead to cross-contamination.

3. Store each sample container in an individual sealable plastic bag that allows the sample label to be read.
4. If the samples require cooled storage as indicated in the QAPP, place samples in a cooler containing a sufficient amount of ice to keep samples cool until transfer to the local storage facility or until packaged for shipment to the laboratory. Ice should be replenished throughout the day, if needed.
5. At the local storage facility, store all sample containers at 4°C until ready for shipping, if required.

For samples being shipped in coolers:

1. Choose the appropriate size cooler and make sure that the outside and inside of the cooler is clean. If the cooler has an external drain, the drain should be capped and thoroughly taped shut with duct tape.
2. Line the cooler with bubble wrap and open and place a large plastic bag (preferably a bag with a thickness of 3 mm) inside the cooler.
3. Individually wrap each bagged, glass sample container in bubble wrap. If necessary, use tape or a rubber band to secure the bubble wrap in place. Place the wrapped samples into the large plastic bag in the cooler, leaving sufficient room for ice to keep the samples cold (i.e., 4°C). Place a temperature blank in the large plastic bag with the sample bottles.
4. Concurrently with placing samples in the shipping cooler, fill out a COC form with sample IDs and laboratory analyses to be performed (see example blank and filled out COC forms in Attachment A3 to the field sampling plan [FSP]).
    a. Make sure all applicable laboratory quality control sample designations have been made on the COC forms.
    b. Samples that will be archived for possible future analysis should be clearly identified on the COC form and should also be labeled as "Do Not Analyze: Hold and archive for possible future analysis" because some laboratories interpret "archive" to mean continue holding the residual sample after analysis.
5. Verify sample containers packed in coolers against the COC form to ensure all samples intended for shipment are included.

6. If sample preservation includes cooling, add enough ice to keep the samples refrigerated during shipping (i.e., 4°C). The amount of ice that may be required should always be overestimated. Ice should be enclosed in a re-sealable plastic bag and then placed in a second sealable plastic bag to prevent leakage. Avoid separating the samples from the ice with excess bubble wrap because it will insulate the containers from the ice.
7. After all samples and ice (if necessary) have been added to the cooler, close the plastic bag lining the cooler and use bubble wrap (or other available clean packing material) to fill any empty space to keep the samples from shifting during transport.
8. The field supervisor will sign and date the completed COC form and retain a copy for project files. Place the signed COC form in a re-sealable bag and tape the bag containing the form to the inside of the cooler lid. Each cooler should contain an individual (or multiple) COC form(s) for the samples contained in that particular cooler.
9. After the cooler is sufficiently packed to prevent shifting of the containers, close the lid and seal it shut with fiber-reinforced packing tape. The cooler should be taped shut around the opening between the lid and the bottom of the cooler and around the circumference of the cooler at both hinges.
10. If coolers will be shipped via commercial carrier, then as security against unauthorized handling of the samples, apply three custody seals across the opening of the cooler lid—one on the front of the cooler and one on each side. If possible, note how many containers are included in the shipment on the custody seal (e.g., 1 of 4). Be sure the seals are properly affixed to the cooler so they are not removed during shipment. Additional clear packing tape across the seal may be necessary if the outside of the cooler is wet.

Samples that are not shipped in coolers (e.g., buckets containing sediment for potential bioassay analysis) will be prepared for shipment in a manner appropriate for the method of shipment to the laboratory. These samples will be accompanied by a COC form.

Sample Shipping

Hand Delivery to the Testing Laboratory

1. The field supervisor will notify the laboratory contact and the task laboratory coordinator that samples will be delivered to the laboratory and the estimated arrival time.
2. Copies of all completed COC forms will be provided to the task laboratory coordinator.

Shipped by Commercial Carrier to the Laboratory

1. Label the cooler with destination and return addresses, and add other appropriate stickers, such as "This End Up," "Fragile," "Perishable," and "Handle With Care." If the shipment contains multiple coolers, indicate on the mailing label the number of coolers that the testing laboratory should expect to receive (e.g., 1 of 2; 2 of 2). Place clear tape over the mailing label to firmly affix it to the outside of the cooler and to protect it from the weather. This is a secondary label in case the airbill is lost during shipment.
2. Fill out the airbill as required and fasten it to tags provided by the shipper (or the top of the cooler if tags are not available). Do not fasten airbills to cooler handles because handles can break during shipment.
3. The field supervisor will notify the laboratory contact and the task laboratory, including providing shipment tracking information, if available. All sediment and porewater environmental samples are shipped overnight for next morning delivery. The field supervisor will provide copies of all COC forms to the task manager upon completion of the study.

For sediment BMI samples, which are stored in ethanol, samples will be transported via ground carrier to EcoAnalysts at the completion of sampling efforts.

STANDARD OPERATING PROCEDURE SOP-13

DIGITAL CAMERA USE AND DOCUMENTATION PROCEDURES

Scope and Applicability

This standard operating procedure (SOP) is specific for the 2019 Phase 3 sediment study (hereinafter "the study") that will be conducted for Teck American Incorporated (TAI) in the Upper Reach Operable Unit (OU) of the Upper Columbia River (UCR) site. This SOP applies to taking digital photographs and placing the digital data in a database. Digital photographs may be taken to document field activities, site conditions and features, and sampling locations.

Equipment and Materials

Equipment and materials for taking digital photographs are:

- Digital camera
- Digital storage card
- Spare storage card or memory stick
- Spare batteries
- 12-V charger
- Digital camera-carrying case and manual
- Field form
- Small whiteboards, dry erase markers, and whiteboard eraser or paper towels
- Field operation computer.

Typical Camera Features

- Ability to save photographs (in standard mode) directly to a memory stick, digital storage card, or comparable data storage device
- Auto focus; manual focus available if required
- Zoom appropriate for medium distances (no micro or macro lenses should be necessary)
- Brightness control
- Playback of photographs on camera screen
- Display of photograph number, date, and time

- Flash
- Timer
- Display showing time remaining on battery and remaining storage capacity (memory stick, secure digital card, or other)
- Ability to protect and delete images that have been taken.

Camera Use

Digital cameras will be used by the field team to document field activities. Each team will be directly responsible for the camera and ensure that it is not exposed to excessive heat, cold, or moisture. The field team leader will be responsible for digital photograph documentation or for assigning documentation duties to a team member. Backup cameras will be available in case a camera is damaged or stops working during the field sampling effort.

Digital photographs will be taken to document field activities and sampling locations. Examples of field activities for which photo documentation will be useful include: 1) individual sediment samples; 2) sediment sample location; and 3) field sampling techniques used, such as equipment use and operation.

Digital photographs will be collected at "best" or an equivalent high-pixel setting such that enlargements can be made with minimal degradation in picture quality. Telephoto or wide-angle shots will not be used because they cannot be used in enforcement proceedings.

Photograph Documentation

Field Team Responsibilities

A portable whiteboard will be used to write photo-specific information and will either be photographed before the pictures being taken (i.e., picture of a sediment sample or location) or will be included within each picture taken. The following location-specific data will be recorded on this whiteboard:

- Location identification (ID)
- Sample ID
- Photograph ID
- Photograph direction (if applicable)
- Photograph notes.

Digital Photograph File Name and Storage

The field team member who is responsible for the camera will transfer the electronic data from the camera to a field operations computer frequently (preferably at the end of each day). Once the files are transferred, the camera memory card may be wiped to ensure that sufficient space is available for future photo documentation.

The folder structure will be as follows:

\\DATA\PHOTOS\YYYYMMDD

The notation YYYYMMDD represents the year, month, and day.

Upon completion of the field sampling effort, the field supervisor will be responsible for ensuring that all digital photographs stored on field operation computers are compiled and distributed as described in SOP-10 (Field Documentation).

Key Checks and Items

Important checks for digital camera management are:

- Make sure the camera's battery and spare batteries are fully charged daily
- Keep extra memory sticks or digital storage cards available
- Use flash only when necessary to save battery life
- Make sure the camera quality level is set at "best" or equivalent (high pixel)
- Allow enough time at the end of the field day to transfer the data.

STANDARD OPERATING PROCEDURE SOP-14

DECONTAMINATION OF SEDIMENT SAMPLING EQUIPMENT

This standard operating procedure (SOP) describes procedures for decontaminating sediment sampling and processing equipment during the 2019 Phase 3 sediment study (hereinafter "the study") that will be conducted for Teck American Incorporated (TAI) in the Upper Reach Operable Unit (OU) of the Upper Columbia River (UCR) site.

To prevent potential cross contamination of samples, all reusable sediment sampling and processing equipment will be decontaminated before each use. Reusable sampling equipment includes the grab samplers, Lexan tubs, spoons, trowels, etc. Decontaminated equipment will be stored away from areas that may cause recontamination and where rinsate blanks will be collected. When handling decontamination chemicals, field personnel will follow all relevant procedures and will wear protective clothing as stipulated in the site-specific health and safety plan. Note that decontamination procedures for porewater sampling equipment are provided in SOP-7.

All decontamination-derived wastes will be disposed of appropriately. Disposable materials and supplies used for decontamination will be placed in heavyweight garbage bags or other appropriate containers. This waste will be placed in a typical refuse container for disposal at a solid waste landfill.

Equipment and Materials

Equipment required for decontamination includes the following:

- Plastic buckets (e.g., 5-gallon bucket)
- Tap water or site water
- Properly labeled squirt bottles (or large spray bottles if needed)
- Funnels
- Alconox®, Liquinox®, or equivalent industrial detergent
- Long-handled, hard-bristle brushes
- Plastic sheeting, garbage bags, and aluminum foil
- Personal protective equipment as specified in the health and safety plan.

Decontamination Procedures

Reusable sampling equipment should be decontaminated before and after the sampling effort, between sampling stations, and at any other times specified by the field sampling plan (FSP). The specific procedure for decontaminating reusable sampling equipment is as follows:

1. Rinse the equipment thoroughly with tap or site water to remove any visible sediment or debris.
2. Pour a small amount of concentrated detergent into a bucket (e.g., about 1/2 tablespoons per 5-gallon bucket) and fill it halfway with tap or site water. If the detergent is in crystal form, all crystals should be completely dissolved prior to use.
3. Scrub the equipment in the detergent solution using a long-handled brush with rigid bristles, using a back-and-forth motion. Be sure to clean the outside of samplers, bowls, and other tools that may be covered with sediment. Remove all particulate matter and surface films.
4. Double rinse the equipment with tap or site water and set right-side-up on a stable surface to drain.
5. If the decontaminated sampling equipment is not to be used immediately, wrap small items in aluminum foil (dull side facing the cleaned area).
6. If the sample collection or processing equipment is cleaned at the field laboratory and transported to the site, then the decontaminated equipment will be wrapped in aluminum foil (dull side facing the cleaned area) and stored and transported in a clean plastic bag (e.g., a trash bag) until ready for use, unless the project-specific FSP lists special handling procedures.

STANDARD OPERATING PROCEDURE SOP-15

BOAT INSPECTION AND CLEANING FOR AQUATIC INVASIVE SPECIES

Purpose

This standard operating procedure (SOP) applies to boat inspection and cleaning for aquatic invasive species for the 2019 Phase 3 sediment study (hereinafter "the study") that will be conducted for Teck American Incorporated (TAI) in the Upper Reach Operable Unit (OU) of the Upper Columbia River (UCR) site.

Aquatic invasive species (AIS) are a serious ecological and economic threat. Sediment sampling with research vessels and equipment has the potential to spread non-native noxious weeds, pathogens, and exotic flora and fauna among water bodies. Environmental ethics and Washington law prohibit the transportation of all aquatic plants, animals, and many noxious weeds. Specifically, it is a misdemeanor to transport aquatic plants on any state or public road, including forest roads, or to knowingly import, move within the state, or export animals.

Scope and Applicability

The goal of this SOP is to minimize the risk of spreading any organisms, especially AIS, within or between water bodies as a result of fieldwork, reconnaissance activities, or other operations.

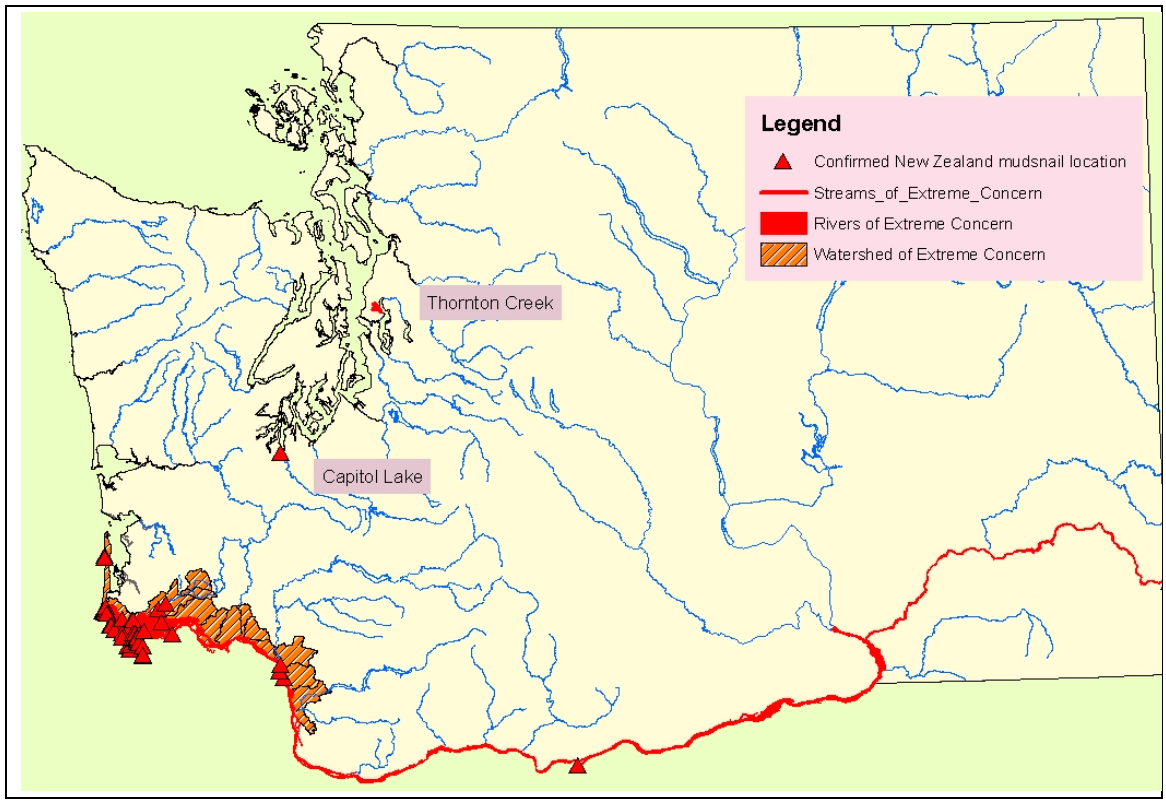
Research vessel captains and crew will be familiar with the risks of invasive species and will be trained on inspection and decontamination procedures. Watercraft will be thoroughly inspected and cleaned before the study to prevent transport of exotic species (e.g., New Zealand mudsnail, quagga and zebra mussels, and milfoil).

This SOP considers and incorporates prevention and control measures identified in the Washington State Department of Ecology's Hazard Analysis and Critical Control Point (HACCP) Plans for conducting operations in Areas of Extreme Concern and Areas of Moderate Concern. The UCR is **NOT** included in an Area of Extreme or Moderate Concern; further details are provided below.

Boats registered to non-Washington residents are required by the Washington Department of Fish and Wildlife to apply for an AIS Prevention Permit ($24.00). Online application can be found at: https://fishhunt.dfw.wa.gov/#/catalog/droducts.

Additional information on AIS and State of Washington guidance can be found at:

https://www.invasivespecies.wa.gov/documents/WDFW%20invasive%20species%20management%20protocols.pdf
https://wdfw.wa.gov/ais/



Statewide regions of extreme concern as published by:
http://www.ecy.wa.gov/programs/eap/InvasiveSpecies/AIS-PublicVersion.html.

Definitions

AIS (Aquatic Invasive Species). Any freshwater or marine species that is not native to an ecosystem and whose introduction does or is likely to cause economic, human health, or environmental harm.

Areas of Extreme Concern. Areas of the state documented as having established AIS is a particular environmental or economic threat, and hard to remove from sampling equipment, such as areas with New Zealand mudsnail populations. Most equipment and sampling gear used in these areas must undergo rigorous inspection and decontamination procedures to prevent accidental introductions to other waters. Maps of these areas are available at: https://ecology.wa.gov/Research-Data/Data-resources/Geographic-Information-Systems-GIS/Data#b under Invasive Species Areas of Extreme Concern. The UCR is **NOT** included in an Area of Extreme Concern.

Areas of Moderate Concern. Areas of the state not documented as having established New Zealand mudsnail or other species of extreme concern. These areas may have other invasive species, including plants, animals, fish, invertebrates, and fish pathogens that should not be spread. The UCR is **NOT** included in an Area of Moderate Concern.

Decontamination. A method used to kill invasive species that may be lodged in or on equipment. These include drying, hot water wash, freezing, and chemical treatments.

HACCP (Hazard Analysis and Critical Control Point). This is a systematic analysis tool used to identify the risks and the preventative procedures needed to significantly reduce the spread of aquatic species from sampling equipment and operations. HACCPs for areas of both Moderate and Extreme Concern are available at: http://www.ecy.wa.gov/programs/eap/InvasiveSpecies/AIS-PublicVersion.html.

Noxious Weed. A plant included on the State Noxious Weed List. They are invasive, non-native plants that are a threat to the natural resources, ecology, and economy of Washington. The list of noxious weeds and information about the State Noxious Weed Control Board is available at: http://www.nwcb.wa.gov/.

Equipment. This means all equipment that contacts water, sediment, plants, or the ground during site access, reconnaissance, and sample collection. Such equipment includes, but is not limited to, ropes, boats, trailers, vehicles, anchors, chain, cables, personal flotation devices, and others.

General Procedures

Use equipment that can be easily inspected and cleaned to both avoid spreading invasive species and reduce impacts to planned field schedules. Where feasible, especially when working in areas of extreme concern, dedicate gear to be used only in that water body. Keep this gear separate from others to avoid cross contamination.

When a water body is known to contain AIS:

- Boats entering the water are not required to be inspected and cleaned.
- Boats leaving the water must be inspected and cleaned according to these procedures.

When a water body is known to NOT be infected with AIS, such as the UCR:

- Arriving boats need to be inspected according to these procedures before entering the water. If ANY AIS is discovered, including milfoil, mussel adults, juveniles or larvae, a complete cleaning of all equipment according to these procedures is required.
- Boats leaving the water require no inspection or cleaning.

After field work is completed, inspect and clean the equipment; if working in an area of extreme concern, decontaminate equipment. This step is divided into two parts:

1. Thoroughly inspect the boat, trailer, and all equipment for mud and AIS (plants and mussels). In addition to looking, inspect by gently running your hand along the entire surface of the equipment. Take time and carefully feel for juvenile mussels (it will feel like sandpaper). Remove any visible vertebrates, invertebrates, plants, algae, or sediment. If necessary, use a scrub brush and rinse with clean water either from the site or brought for that purpose. Drain all water in bilges or other equipment that could hold water from the site.
2. If working in an area of extreme concern, decontaminate equipment that contacted aquatic sediment, aquatic vegetation, or detritus. Wipe smooth-surfaced sampling equipment that can be easily and fully wiped down until dry. The equipment must be smooth enough so there are no cracks or crevices that could harbor a sand-grain-sized juvenile mussel while being wiped dry.

Decontamination treatments should take place where the procedure can be carried out effectively and safely. Keep in mind that wash and rinse water must not drain to surface water, and all chemicals must be disposed of to a sanitary sewer.

Relaxing Requirements

Procedures described in this SOP must be followed prior to arriving at the UCR. Decontamination procedures as described in this SOP need not be followed when transiting to different sites within the UCR, or when leaving the UCR because it is NOT included in an Area of Extreme or Moderate Concern.

Equipment Storage

When moving between field sites, and upon returning from the field, store gear in a manner to facilitate drying. For example, boots should be stored on a drying rack until dry; open hatches, and leave out drain plugs on boats.

Decontamination Treatment

Decontamination employs freezing, drying, or hot water. Treatment options listed below use temperature (heat) to ensure that AIS will be exterminated. At this time, hot water or drying are the recommended treatments for large equipment such as boats and boat trailers.

Hot water sources

- Hot water is preferred for decontaminating boating equipment
- A portable steam cleaner is recommended to maintain 60°C to ensure proper decontamination
- Car washes can be used for rinsing and cleaning, but are not an option for decontamination; the water is not hot enough to kill aquatic organisms.

Treating equipment with hot water

- Wear appropriate personal protection equipment to prevent burns to self and others
- Avoid or protect parts of equipment that might be damaged by hot water
- Ensure that the water is at least 60°C at the discharge side of whatever is being treated
- Flush all equipment for at least 10 seconds
- After treatment, ensure equipment drains and dries before re-stowing equipment.

Boat Trailers

1. Flush all interior and exterior surfaces of trailers, wheels, and tires until clean. Interior surfaces are the inside of the trailer's metal tube framing.

Boat Hulls–Exterior and Interior

1. Remove gear as needed (e.g., deck mat, dip nets, net anchors, boat anchor and line, ropes) to provide access to all areas of the boat to allow for effective cleaning.
2. Wash down the boat working from bow to stern, and top to bottom. Flush all nooks and crannies to get at all areas where aquatic species may have gotten into. Wash all boat-related gear.
3. Wash all bilge areas where accessible using hot water, working from bow to stern. However, do not flush the bilge of the jet sled with hot water because of the fuel tank located there.
4. Raise the bow of the boat for effective draining of water and muck that gets into bilge. Work all of the bilge water, sediment, and muck out of the drain on the transom.
5. Flush all interior and exterior through-hull pipes and screens. These may be located on the bottom of the hull, on the transom, or inside the hull (e.g., Skookum's strainers for wash down pumps and engine cooling system). Try back-flushing bilge pumps by introducing water into the bilge pump discharge port (on transom or hull exterior) and check to see if water flows through the bilge pump and into the bilge.

Boat Engines–Propeller and Jet Pump

Boat engines pump ambient water through them for cooling and can pick up and harbor unwanted material, which may be transported to another water body. While most boat engines have fine-mesh screens (~2 mm) that can prevent debris from getting into the engine, sand and mud particles may pass through. Jet-pump engines operating in shallow waters often move sediment and fine debris through the cooling passages; therefore, more effort is needed to clean jet-pump engines. The external parts of engines can also collect weeds or other debris, especially propellers and other parts submerged in the water. Clean external parts of engines to remove all visible debris. Clean internal parts of engines by flushing with water as described below.

- Some engines have an adaptor that accepts garden hoses. Connect hose or adaptor and run water through the engine. Check to ensure that water is reaching and running from the cooling water pump intake areas.
- Some engines need the "ear muff" type flushing adaptor (many smaller engines): Connect hose to adaptor and attach adaptor to the engine. Turn on water. Start engine and let run at idle speed.
- Some engines have no flushing adaptor (some smaller engines). Mount the engine so that the lower unit can be submerged in a large container (e.g., 18-gallon tote) filled with water. Start engine and let run at idle speed.

Please note that all engines can be run while being flushed with cold water. However, running some engines while flushing with hot water could damage the engine; therefore, do not run engines while flushing with hot water. Many engines can be flushed with hot water as long as the engine is not run at the same time.

STANDARD OPERATING PROCEDURE SOP-16

HANDLING AND REPORTING OF CULTURAL RESOURCES

Scope and Applicability

This standard operating procedure (SOP) is specific to the 2019 Phase 3 sediment study (hereinafter "the study") that will be conducted for Teck American Incorporated (TAI) in the Upper Reach Operable Unit (OU) of the Upper Columbia River (UCR) site. This SOP describes the procedures to be followed by all Teck American Incorporated (TAI) field personnel, including subcontractors, should potential discoveries, including inadvertent discoveries of cultural materials and deposits, and/or Indian burials and human remains occur during execution of sediment sampling efforts. Cultural materials and deposits (including sacred objects, funerary objects, and objects of cultural patrimony) as well as Indian burials and human remains are defined in the Native American Graves Protection and Repatriation Act (NAGPRA).

The procedures detailed below were developed to ensure compliance with the National Historic Preservation Act (NHPA) and the applicable requirements, procedures, and standards of the National Park Service (NPS), U.S. Bureau of Reclamation (USBR), Confederated Tribes of the Colville Reservation (CCT), and the Spokane Tribe of Indians (STI). Detailed information regarding existing discovery protocols for these entities, as well as implementing regulations, notification requirements, archaeological monitoring requirements, and other cultural resource coordination activities for the Upper Columbia River remedial investigation and feasibility study (RI/FS) are provided in the cultural resources coordination plan (CRCP) in Appendix E of the quality assurance project plan (QAPP).

Discoveries When a Cultural Resources Monitor is Present

At the discretion of the cultural resources monitor or tribal representative, ground-disturbing sampling or associated activity may be slowed or halted at any time that a suspected archaeological object or archaeological resource is encountered. The objective of slowing or halting ground-disturbing activity is to allow the cultural resources monitor or tribal representative to confirm and/or make a preliminary assessment of the discovery.

At the request of the cultural resources monitor or tribal representative, the sampling personnel will either:

- Assist in securing access to the location of the discovery and take appropriate measures to protect the location of the discovery from rainfall, stormwater, and other possible disturbances as needed; or
- Assist in moving at-risk artifacts to a protected and secure area away from the immediate sampling area. Removal of artifacts from the discovery location will be undertaken only if leaving the artifacts in place could jeopardize their integrity due to erosion or collection by unauthorized individuals.

The cultural resources monitor, tribal representative, or a member of the TAI field team will remain on site to ensure the security of the find until more extensive efforts can be made to secure the site from further disturbance, or until a more extensive evaluation and documentation of the discovery can be made, as needed.

At the discretion of the cultural resources monitor or tribal representative, after recordation, an archaeological discovery and the sediment in which it is contained may be returned to the original location of discovery (or as near as possible if encountered from a submerged context). Any such relocation will be coordinated with the field supervisor and documented in the monitor's field notes. Handling and reporting of discovered or disturbed human remains and funerary items is discussed below.

Notification of any cultural resources that have the potential to delay or halt sampling activities (i.e., human remains or the items covered under NAGPRA) must be provided as soon as possible to the U.S. Environmental Protection Agency (EPA) for further coordination with the consulting parties.

Discovery of Human Remains

Native peoples in the study area consider the graves of their ancestors to be important in both their cultural identity and in defining their relationship with the land. These graves are therefore considered sacred and should be left undisturbed. Should inadvertent disturbance occur, the remains and associated materials (funerary objects) must be treated with respect and honor. All appropriate federal, tribal, and state laws, regulations, and procedures regarding burials should be rigorously enforced.

If likely or confirmed human remains are encountered, all further sampling or other ground-disturbing activity must cease immediately. The protocol and notification procedures to be followed for any potential discoveries of human remains are provided in protocols of the NPS, USBR, CCT, and STI (Attachment E1 to the CRCP). Any discoveries within the boundaries of the Colville Indian Reservation or the Spokane Indian Reservation must also be reported immediately to the respective tribe.

The TAI field team will assist the cultural resources monitor and tribal representative in securing the location of the discovery.

Other conditions for responses to discoveries of archaeological materials may be defined in an Archaeological Resources Protection Act permit issued for the sampling program (if required to address a discovery on federal lands). As detailed in the CRCP, responses to any discoveries of burials must also comply with provisions of NAGPRA and its implementing regulations, as well as the existing protocols of the NPS, USBR, CCT, and STI (Attachment B1 to the CRCP).

Discoveries When a Cultural Resources Monitor is not Present

As previously stated, a cultural resources monitor and/or tribal representative will be present during ground-disturbing sampling activities. In the event, however, that suspected or evident artifacts or other archaeological deposits are encountered when a cultural resources monitor or tribal representative is not present, the immediate vicinity of the discovery will be secured. The discovery will be mapped and photographed in place, but the discovery will be otherwise left as found (other than appropriate measures to secure the find and maintain this security).

In consultation with the land-managing agency or appropriate tribe, as well as other interested parties, TAI will arrange for the location of the discovery to be examined by a professional archaeologist and tribal representative in a timely manner. If the archaeologist confirms the presence of artifacts or other archaeological deposits, the procedures defined above for discoveries made during ground-disturbing activity monitored by an archaeologist will be implemented. The archaeologist will prepare appropriate State of Washington archaeological forms to document the find.

To ensure proper recognition of artifacts and other cultural items or deposits, all TAI field personnel will be trained by a professional archaeologist to recognize these materials prior to the initiation of any soil or sediment sampling.

Confidentiality

In accordance with state and federal law, all field personnel are required to keep the discovery of any found or suspected human remains, other cultural items, and potential historic properties confidential. Personnel are prohibited from contacting the media or any third party or otherwise sharing information regarding the discovery with any member of the public; they should immediately notify the field supervisor of any inquiry from the media or public. The field supervisor will then notify TAI of any such inquiries. To the extent permitted by law, prior to any release of information TAI, in coordination with EPA and other consulting parties, shall concur on the amount of information, if any, to be released to the public, any third party, and the media, and the procedures for such a release.

ATTACHMENT A3

EXAMPLES OF VARIOUS FIELD FORMS

Surface Sediment Field Sample Record

Project Name: **Station ID:**

Sampling Crew:

Sampling Vessel: Sampling Method:

Station Coordinates: N / Lat. Weather:

E / W / Long.

Datum: NAD 83 / WGS 84

Grab Number: _____ Water Depth:_____ Penetration/Sampled Depth: _____ Time: _____

Samples Collected? Tide Height (MLLW):

Sediment Type:	Sediment Color:	Sediment Odor:		Sheen:	Wood Debris
Surface:	Surface:	none	H2S	none	Surface Coverage:
		slight	Petroleum	slight	
Subsurface:	Subsurface:	moderate	other:	moderate	Subsurface Content:
		strong		heavy	
		overwhelming			

Additional Comments:

Grab Number: _____ Water Depth:_____ Penetration/Sampled Depth: _____ Time: _____

Station Coordinates: N / Lat.

E / W / Long.

Samples Collected? Tide Height (MLLW):

Sediment Type:	Sediment Color:	Sediment Odor:		Sheen:	Wood Debris
Surface:	Surface:	none	H2S	none	Surface Coverage:
		slight	Petroleum	slight	
Subsurface:	Subsurface:	moderate	other:	moderate	Subsurface Content:
		strong		heavy	
		overwhelming			

Additional Comments:

Recorded by:_____

Trident Log Sheet - Two Sampling Levels

Site:_____ Station:_____ Date:_____

Trident GPS
Latitude:_____
Longitude:_____

Station Time
On Station Time:_____
Off Station Time:_____

Station Conditions
Water Depth:_____

Trimble GPS
Latitude:_____
Longitude:_____
Accuracy:_____

Trident System
- ☐ Drop-Drive Frame
- ☐ Pneumatic-Drive Frame
- ☐ Vibra-Frame
- ☐ Push Pole
- ☐ Release Point

Bottom Type
Shallow:_____
Deep:_____

Trident Data

Sensor Level	Surface Water	Porewater
Sensor Number		
Sensor Depth (in)		
Start Logging Time		
Logging Period (s)		
Temperature (C)		
Conductivity (mS/cm)		
Data File Name		

Porewater Sensor Checks

Water Quality Data

Sample Level	Surface Water	Porewater
Sample Depth (in)		
Purge Volme (ml)		
Sample Time		
Temperature (C)		
Conductivity (mS/cm)		
TDS (ppm)		
pH		
ORP (mV)		
DO (mg/L)		

Porewater Water Quality Checks

Comments/Observations:_____ Recorded By:_____

UCR Phase 3 Sediment Porewater Chemistry Sample Collection Form

Sampling date:		Sampling time:	
Weather:		Sample collector:	
Location ID:		Field duplicate collected?	
Media type (circle one):	PW EB FB	Sample ID:	
Notes (e.g., Trident sampler type and ID, sample appearance, type of EB, etc.)			

Sampling date:		Sampling time:	
Weather:		Sample collector:	
Location ID:		Field duplicate collected?	
Media type (circle one):	PW EB FB	Sample ID:	
Notes (e.g., Trident sampler type and ID, sample appearance, type of EB, etc.)			

Sampling date:		Sampling time:	
Weather:		Sample collector:	
Location ID:		Field duplicate collected?	
Media type (circle one):	PW EB FB	Sample ID:	
Notes (e.g., Trident sampler type and ID, sample appearance, type of EB, etc.)			

CHAIN OF CUSTODY FORM

Page ____ of ____

Project: _____

Samplers: _____

Example

Project Contact:

Office _____

Phone _____

Ship to: Lab Name _____

Address _____

_____

_____

Contact _____

Phone _____

Soil Sample No.	Date	Time	Matrix	Preservative (if any)	ANALYSES REQUESTED					Extra Container	Archive	Comments

Analysis Turn Time: Normal Rush Rush Results Needed By:

Shipped by: Shipping Tracking No.:

Condition of Samples Upon Receipt: Custody Seal Intact?

Matrix Code:

SO - Soil

Other:

Relinquished by: _____ **Date/Time:** _____ **Received by:** _____ **Date/Time:** _____

(signature) *(signature)*

Relinquished by: _____ **Date/Time:** _____ **Received by:** _____ **Date/Time:** _____

(signature) *(signature)*

Special Intructions:

CHAIN OF CUSTODY FORM

Page ____ of ____

Example

Project: TAI UCR Soil Sampling

Samplers: Field S. Ampler, Helper S. Amplers

Project Contact: Project Manager

Office: Bellevue, Wa

Phone: 555-555-5555

Ship to:

Lab Name: Analytical Laboratory

Address: 111 Laboratory Lane

Seattle, WA 55555

Contact: Lab Mananger

Phone: 555-555-5555

Soil Sample No.	Date	Time	Matrix	Preservative (if any)	ANALYSES REQUESTED: Conventional Parameters	EPA TAL Metals	All Metal COIs	All Organic COIs		Extra Container	Archive	Comments
RF1-001	2010-06-01	1300	SO	None	x	x				N	N	None
RF1-002					x	x				N	N	None
RF1-003					x	x				N	N	None
RF1-004					x	x				N	N	None
RF1-005					x	x				N	N	None
RF1-006					x		x	x		N	N	None
RF1-007					x		x	x		N	N	None
RF1-008					x		x	x		N	N	None
RF1-009					x		x	x		N	N	None
RF1-010					x		x	x		N	N	None

Analysis Turn Time: (Normal) Rush Rush Results Needed By:

Shipped by: F. Sampler Shipping Tracking No.: 123456787463

Condition of Samples Upon Receipt: Custody Seal Intact?

Matrix Code:
SO - Soil
Other:

Relinquished by: Field S. Ampler *(signature)* **Date/Time:** 2010-06-01 1644 **Received by:** UPS *(signature)* **Date/Time:** 2010-06-01 1644

Relinquished by: *(signature)* **Date/Time:** **Received by:** *(signature)* **Date/Time:**

Special Intructions:

Custody Seal

CUSTODY SEAL

Example

Date: 2010-06-01 Time: 1630

Sampler Signature: *Field S. Ampler*

Sample Label

Example

Soil

Sample No: RF1-005 Date: 2010-06-01

Sampler: FSA Time: 0912

Preservative: None

	Field Change Request	

Field Change No.:_____
Page _____ to _____

Project number:
Project name:

CHANGE REQUEST
Applicable Reference:
Description of Change:

Reason for Change:

Impact on Present and Completed Work:

Requested by:
Date: ____/____/____
(Field Scientist)

Acknowledged by:
Date: ____/____/____
(Field Coordinator)

FIELD COORDINATOR RECOMMENDATION

Recommended Disposition:

Recommended by:
Date: ____/____/____

PROJECT MANAGER APPROVAL

Final Disposition:

Approved/Disapproved by:
Date: ____/____/____

CORRECTIVE ACTION RECORD

Page ___ of ___

Audit Report No. : _____ Date: _____

Report Originator:

Person Responsible for Response:

DESCRIPTION OF THE PROBLEM:

Date and Time Problem Recognized: _____ By: _____

Date of Actual Occurrence: _____ By: _____

Analyte: _____ Analytical Method:

Cause of Problem:

CORRECTIVE ACTION PLANNED:

Person Responsible for Corrective Action:

Date of Corrective Action:

Corrective Action Plan Approval: _____ Date:

DESCRIPTION OF FOLLOW-UP ACTIVITIES:

Person Responsible for Follow-up Activities:

Date of Follow-up Activity:

Final Corrective Action Approval: _____ Date:

ATTACHMENT A4

ARCHAEOLOGICAL MONITORING PROTOCOL

ARCHAEOLOGICAL MONITORING PROTOCOL

UPPER COLUMBIA RIVER RI/FS

Prepared for

Teck American Incorporated

P.O. Box 3087
Spokane, WA 99220-3087

Prepared by

1180 Eugenia Place, Suite 204
Carpinteria, CA 93013

August 2019

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CONFIDENTIALITY A4-3

ACRONYMS AND ABBREVIATIONS

CCT	Confederated Tribes of the Colville Reservation
CRCP	cultural resources coordination plan
EPA	U.S. Environmental Protection Agency
NAGPRA	Native American Graves Protection and Repatriation Act
NHPA	National Historic Preservation Act
NPS	National Park Service
QAPP	quality assurance project plan
RI/FS	remedial investigation and feasibility study
STI	Spokane Tribe of Indians
TAI	Teck American Incorporated
UCR	Upper Columbia River
USBR	U.S. Bureau of Reclamation

INTRODUCTION

This protocol provides a summary of procedures to be followed by all Teck American Incorporated (TAI) technical team field personnel, including subcontractors, should potential discoveries, of cultural materials and deposits, and/or Indian burials and human remains occur during execution of field sampling programs and other activities associated with the Upper Columbia River (UCR) Site remedial investigation and feasibility study (RI/FS). Cultural materials and deposits (including sacred objects, funerary objects, and objects of cultural patrimony) as well as Indian burials and human remains are defined in the Native American Graves Protection and Repatriation Act (NAGPRA).

The procedures detailed below were developed to ensure compliance with the National Historic Preservation Act (NHPA) and the applicable requirements, procedures, and standards of the National Park Service (NPS), U.S. Bureau of Reclamation (USBR), Confederated Tribes of the Colville Reservation (CCT), and the Spokane Tribe of Indians (STI). Detailed information regarding existing discovery protocols for these entities, as well as implementing regulations, notification requirements, archaeological monitoring requirements, and other cultural resource coordination activities for the RI/FS are provided in the cultural resources coordination plan (CRCP) in Appendix E of the quality assurance project plan (QAPP).

DISCOVERIES WHEN AN ARCHAEOLOGICAL MONITOR IS PRESENT

At the discretion of the archaeological monitor or Tribal representative, ground-disturbing sampling or associated activity may be slowed or halted at any time that a suspected archaeological object or archaeological resource is encountered. The objective of this slowing or halting of ground-disturbing cleanup activity is to allow the archaeological monitor or Tribal representative to confirm and/or make a preliminary assessment of the discovery. At the discretion of the archaeological monitor or Tribal representative, a specific sample may be relocated from the location of the discovery but still be within the sampling location. Such relocation will be coordinated with the field supervisor.

At the request of the archaeological monitor or Tribal representative, the sampling personnel will either:

- Assist in securing access to the location of the discovery and take appropriate measures to protect the location of the discovery from rain, stormwater, and other possible disturbances, or
- Assist in moving the artifacts to a protected and secure area of the site away from the immediate sampling area. Removal of artifacts from the discovery location will

be undertaken only if leaving the artifacts in place would jeopardize their integrity due to erosion or collection by unauthorized individuals.

The archaeological monitor, Tribal representative, or a member of the TAI technical team will remain on site to ensure the security of the find until more extensive efforts can be made to secure the discovery from further disturbance or conduct a more extensive evaluation and documentation of the discovery.

Notification of any cultural resources that have the potential to delay or halt sampling activities (i.e., human remains or those items covered under NAGPRA) must be provided as soon as possible to the U.S. Environmental Protection Agency (EPA) for further coordination with the consulting parties.

DISCOVERY OF HUMAN REMAINS

Native peoples in the study area consider the graves of their ancestors to be important in both their cultural identity and in defining their relationship with the land. These graves are therefore considered sacred and should be left undisturbed. Should inadvertent disturbance occur, the remains and associated materials (funerary objects) must be treated with respect and honor. All appropriate federal, tribal, and state laws, regulations, and procedures regarding burials should be rigorously enforced.

If likely or confirmed human remains are encountered, all further sampling or other ground-disturbing activity will cease immediately. The protocol and notification procedures to be followed for any potential discoveries of human remains are provided in protocols of the NPS, USBR, CCT, and STI (Attachment E1 to the CRCP). Any discoveries within the boundaries of the Colville or the Spokane reservations must be reported immediately to the respective tribe.

The TAI technical team will assist the archaeological monitor and tribal representative in securing the location of the discovery.

Other conditions for responses to discoveries of archaeological materials may be defined in the Archeological Resources Protection Act permit issued for the sampling program. As detailed in the CRCP, responses to any discoveries of burials must also comply with provisions of NAGPRA and its implementing regulations, as well as the existing protocols of the NPS, USBR, CCT, and STI (Attachment E1 to the CRCP).

DISCOVERIES WHEN AN ARCHAEOLOGICAL MONITOR IS NOT PRESENT

As previously stated, an archaeological monitor and/or Tribal representative will be present during all sampling activities. In the event, however, that suspected or evident artifacts or other archaeological deposits are encountered when an archaeological monitor or Tribal representative is not present, the immediate vicinity of the discovery will be secured. The

discovery will be mapped and photographed in place but will be otherwise left as found (other than appropriate measures to secure the find and maintain security). In consultation with the land-managing agency or appropriate tribe, as well as other interested parties, TAI will arrange for the location of the discovery to be examined by a professional archaeologist and/or Tribal representative in a timely manner. If the archaeologist confirms the presence of artifacts or other archaeological deposits, the procedures defined above for discoveries made during ground-disturbing activity monitored by an archaeologist will be implemented. The archaeologist will prepare appropriate State of Washington archaeological forms to document the find.

To ensure proper recognition of artifacts and other cultural items or deposits, all TAI field personnel will be provided with training in recognizing these materials by a professional archaeologist prior to the initiation of any sampling activities.

CONFIDENTIALITY

In accordance with state and federal law, all field personnel are required to keep the discovery of any found or suspected human remains, other cultural items, and potential historic properties confidential. Personnel are instructed that they are prohibited from contacting the media or any third party or otherwise sharing information regarding the discovery with any member of the public, and that they should immediately notify the field supervisor of any inquiry from the media or public. The field supervisor will then notify TAI of any such inquiries. To the extent permitted by law prior to any release of information, TAI, in coordination with EPA and other consulting parties, shall concur on the amount of information, if any, to be released to the public, any third party, and the media and the procedures for such a release.

APPENDIX B

QUALITY ASSURANCE MANUAL FOR ALS ENVIRONMENTAL

QUALITY ASSURANCE MANUAL

ALS ENVIRONMENTAL - KELSO FACILITY
1317 SOUTH 13TH AVENUE
KELSO, WA 98626
360-577-7222 (TEL)
360-636-1068 (FAX)
WWW.ALSGLOBAL.COM

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Current Data Quality Objectives (DQOs) may be requested from the laboratory for specified methods or projects.

QA MANUAL CROSS REFERENCE TABLE

ALS QA Manual	ISO 17025:2005 Section	TNI Standard 2009 Volume 1, Module 2 Section
2	4.1	4.1
3	4.2	4.2
4	4.3	4.3
5	4.4	4.4
6	4.5	4.5
7	4.6	4.6
8	4.7	4.7
9	4.8	4.8
15	4.9	4.9
16	4.10	4.10
16	4.11	4.11
16	4.12	4.12
17	4.13	4.13
18	4.14	4.14
19	4.15	4.15
2, 12, 13, 14	5.1	5.1
20	5.2	5.2
10	5.3	5.3
12, 13, 14	5.4	5.4
10	5.5	5.5
13	5.6	5.6
11	5.7	5.7
11, 12, 13	5.8	5.8
14	5.9	5.9
21	5.10	5.10

1) Introduction and Scope

ALS Environmental, Kelso is a professional analytical services laboratory which performs chemical and microbiological analyses on a wide variety of sample matrices, including drinking water, groundwater, surface water, wastewater, soil, sludge, sediment, tissue, industrial and hazardous waste, air, and other material.

We recognize that quality assurance requires a commitment to quality by everyone in the organization - individually, within each operating unit, and throughout the entire laboratory. Laboratory management is committed to ensuring the effectiveness of its quality systems and to ensure that all tests are carried out in accordance to customer requirements. Key elements of this commitment are set forth in the SOP *Laboratory Ethics and Data Integrity* (CE-GEN001) and in this Quality Assurance Manual. ALS - Kelso is committed to operate in accordance with these requirements and those of regulatory agencies, accrediting authorities, and certifying organizations. The laboratory also strives for improvement through varying continuous improvement initiatives and projects.

Quality Management Systems are established, implemented and maintained by management. Policies and procedures are established in order to meet requirements of accreditation bodies and applicable programs, such as the Department of Defense (DOD) Environmental Laboratory Accreditation Program, as well as client's quality objectives. Systems are designed so that there will be sufficient Quality Assurance (QA) activities conducted in the laboratory to ensure that all analytical data generated and processed will be scientifically sound, legally defensible, of known and documented quality, and will accurately reflect the material being tested. Quality Systems are applicable to all fields of testing in which the laboratory in involved.

Quality Control (QC) procedures are used to continually assess performance of the laboratory and quality systems. The laboratory maintains control of analytical results by adhering to written standard operating procedures (SOPs), using analytical control parameters with all analyses, and by observing sample custody requirements. All analytical results are calculated and reported in units consistent with project specifications to allow comparability of data.

This QAM is applicable to the facility listed on the title page. The information in this manual has been organized according to requirements found in the National Environmental Laboratory Accreditation Program (NELAP) Quality Systems Standards (2003 and 2009), the EPA Requirements for Quality Assurance Project Plans, EPA QA/R-5, USEPA, 2001; General Requirements for the Competence of Testing and Calibration Laboratories, ISO/IEC 17025:2005, and the ALS Quality Management System Summary (QMS01). A glossary of pertinent terms and acronyms is included in Appendix A.

2) Organization

The ALS Environmental, Kelso staff, consisting of approximately 95 employees, includes chemists, technicians and support personnel. They represent diverse educational backgrounds and experience, and provide the comprehensive skills that the laboratory requires. During seasonal workload increases, additional temporary employees may be hired to perform specific tasks. All employees share the responsibility for maintaining and improving the quality of our analytical services.

ALS – Kelso is legally identifiable as ALS Group USA, Corp., dba ALS Environmental. ALS Group USA, Corp. is a component of ALS Limited, a publicly held Australian company. The ALS global website may be referred to for corporate ownership information (www.alsglobal.com/Our-Company). The laboratory is divided into operational and managerial units based upon specific disciplines. Each department is responsible for establishing, maintaining and documenting QA and QC practices meeting laboratory needs. Organizational charts of the laboratory, as well as the resumes of these key personnel, can be found in Appendix B. This

laboratory organization is designed so that potential conflict of interest is avoided, and such that an adequate amount of supervisory personnel are in place to provide oversight and supervision of day to day operations.

3) Management

The purpose of the QA program at ALS Environmental, Kelso is to ensure that our clients are provided with analytical data that is scientifically sound, legally defensible, and of known and documented quality. The concept of Quality Assurance can be extended, and is expressed in the mission statement:

> "The mission of ALS Environmental, Kelso is to provide high quality, cost-effective, and timely professional testing services to our customers. We recognize that our success as a company is based on our ability to maintain customer satisfaction. To do this requires constant attention to customer needs, maintenance of state-of-the-art testing capabilities and successful management of our most important asset - our people - in a way that encourages professional growth, personal development and company commitment."

3.1 Quality Management Systems

In support of this mission, the laboratory has developed a Quality Management System to ensure all products and services meet our client's needs. The system is implemented and maintained by the Quality Assurance Manager with corporate oversight by the Quality Improvement Manager, USA. These systems are based upon ISO 17025:2005 standards, upon which fundamental programs (NELAC 2003, 2009 and DoD QSM) are based. Implementation and documentation against these standards are communicated in corporate policy statements, this QAM, and SOPs. Actual procedures, actions and documentation are defined in both administrative and technical SOPs. Quality systems include:

- Accreditation and certification program compliance
- Standard Operating Procedures
- Sample management and Chain of Custody procedures
- Document control
- Demonstration of Capability
- Analytical traceability
- Ethics training and data integrity processes
- Corrective action procedures
- Statistical control charting
- Management reviews

The effectiveness of the quality system is assessed in several ways, including:

- Internal and external audits
- Periodic reports to management
- Analysis of customer feedback
- Proficiency testing

The responsibilities of key positions within the laboratory are described below. Table 3-1 lists the ALS - Kelso personnel assigned to these key positions. Managerial staff members are provided the authority and resources needed to perform their duties. In the event that work is stopped in response to quality problems, as described below, only the Laboratory Director or Quality Assurance Manager has the authority to resume work.

Laboratory Director/General Manager (LD/GM) – The role of the Laboratory Director/General Manager is to provide operational, and administrative leadership through planning, allocation and management of personnel and equipment resources. The LD/GM provides leadership and support for the QA program and is responsible for overall laboratory efficiency and financial performance. The LD/GM has the authority to stop work in response to quality problems. The LD/GM also provides resources for implementation of the QA program, reviews and approves this QA Manual, reviews and approves standard operating procedures (SOPs), and provides support for business development by identifying and developing new markets through continuing support of the management of existing client activities.

Quality Assurance Manager (QAM) – The Quality Assurance Manager has the authority and responsibility for implementing, maintaining, and improving the quality system. This includes coordination of QA activities in the laboratory, ensuring that personnel understand the quality system, ensuring communication takes place in the laboratory regarding implementation of the quality system, ensuring adequate staff training, and monitoring overall quality system compliance. The QAM continually evaluates potential improvements in the quality system. Audit and surveillance results, control charts, proficiency testing results, data analysis, corrective and preventive actions, customer feedback, and management reviews are used to support quality system implementation. The QAM is responsible for ensuring compliance with all applicable regulatory compliance quality standards (i.e. NELAP/TNI, ISO, DoD QSM, etc.). The QAM works with laboratory staff to establish effective quality control and assessment processes and has the authority to stop work in response to quality problems. The QAM is responsible for maintaining the laboratory's certifications and approvals, for maintaining the QA Manual and performing an annual review of it, reviewing and approving SOPs and ensuring the annual review of technical SOPs, maintaining QA records (metrological records, archived logbooks, PT results, etc.), document control, conducting proficiency testing studies, approving nonconformity and corrective action reports, and performing internal QA audits.

The QAM reports directly to the Laboratory Director and reports indirectly to the ALS Quality Improvement Manager, USA. It is important to note that when evaluating data, the QAM does so in an objective manner and free of outside, or managerial, influence.

The Quality Improvement Manager, USA is responsible for the overall QA program at all the ALS Environmental Group laboratories. The Quality Improvement Manager, USA is responsible for oversight of the QAM's regulatory compliance efforts (NELAP, ISO, DOD, etc.) and may perform internal audits to evaluate compliance. The Quality Improvement Manager, USA provides assistance to the laboratory QA staff and laboratory managers as necessary.

Deputy Laboratory Director and QA Manager – In the case of extended absence of the Laboratory Director or QAM, deputies are assigned to act in that role. Default deputies for these positions are the Client Services Manager or Metals Department Manager (for the Laboratory Director) and the Laboratory Director (for the QAM).

Environmental Health and Safety (EH&S) Officer – The EH&S officer is responsible for the administration of the laboratory health and safety policies. This includes the formulation and implementation of safety policies, the supervision of new-employee safety training, the review of accidents, incidents and prevention plans, the monitoring

of hazardous waste disposal and the conducting of departmental safety inspections. The EH&S officer is also designated as the Chemical Hygiene Officer. The EH&S Officer has a dotted-line reporting responsibility to the ALS North America EH&S Manager.

Client Services Manager (CSM) – The CSM is responsible for the Client Services Department defined for the laboratory. This includes management and oversight of Project Managers, electronic deliverables, and support functions. The Client Services Department provides a complete interface with clients from initial project specification to final deliverables. The Client Services Manager has the responsibility and authority to stop work in response to accreditation/certification or quality problems, or in response to similar subcontractor quality problems. In the event of an extended absence, the CSM is to have an appointed deputy that is capable of assuming the role of the CSM.

Department Managers and Supervisors – Each manager or supervisor has the responsibility to ensure that QA and QC functions are carried out as specified when executing the analyses and related tasks and to ensure the production of high quality data. Managers and bench-level supervisors monitor the day-to-day operations to ensure that productivity and data quality objectives are met. A department manager has the authority to stop work in response to quality problems in their area. Managers and supervisors are responsible for ensuring that analysts perform testing according to applied methods, SOPs, and QC guidelines particular to the laboratory department. In the event of an extended absence, Department Managers are to have an appointed deputy meeting the qualifications specified in the appropriate standards to fill their role in the event of an extended absence.

Sample Management Office (SMO) – The Sample Management Office plays a key role in the laboratory QA program by handling all activities associated with receiving, storage, and disposal of samples, and maintaining documentation for all samples received. SMO staff is also responsible for the proper disposal of samples after analysis. The CSM oversees SMO and bottle preparation functions.

Information Technology (IT) – IT staff is responsible for the administration of the Laboratory Information Management System (LIMS) and other necessary support services. Other functions of the IT staff include laboratory network maintenance, IT systems development and implementation, education of analytical staff in the use of scientific software, Electronic Data Deliverable (EDD) support, and data back-up, archival and integrity operations.

3.2 Ethics, Professional Conduct and Data Integrity

One of the most important aspects of the success of ALS - Kelso is the emphasis placed on the integrity of the data provided and the services rendered. This success is reliant on both the professional conduct of all employees within ALS - Kelso as well as established laboratory practices. All personnel involved with environmental testing and calibration activities must familiarize themselves with the quality documentation and implement the policies and procedures in their work.

All employees are required to sign and adhere to the requirements set forth in the *ALS Code of Conduct Policy* and agree to the *Confidentiality Agreement (*Appendix C).

3.2.1 Professional Conduct

To promote quality ALS - Kelso requires certain standards of conduct and ethical performance among employees. The following examples of documented ALS policy are representative of these standards, and are not intended to be limiting or all-inclusive:

- Under no circumstances is the willful act of fraudulent manipulation of analytical data condoned. Such acts are to be reported immediately to senior management for appropriate corrective action.
- Unless specifically required in writing by a client, alteration, deviation or omission of written contractual requirements is not permitted. Such changes must be in writing and approved by senior management.
- Falsification of data in any form will not be tolerated. While much analytical data is subject to professional judgment and interpretation, outright falsification, whenever observed or discovered, will be documented, and appropriate remedies and punitive measures will be taken toward those individuals responsible.

3.2.2 Confidentiality

It is the responsibility of all laboratory employees to safeguard sensitive company information, client data, records, and information; and matters of national security concern should they arise. The nature of our business and the well-being of our company and of our clients is dependent upon protecting and maintaining confidential and/or proprietary company and client information. All information, data, and reports (except that in the public domain) collected or assembled on behalf of a client is treated as confidential.

Information may not be given to third parties without the consent of the client. Unauthorized release of confidential information about the company or its clients is taken seriously and is subject to formal disciplinary action. All employees sign a confidentiality agreement upon hire to protect the company and client's confidentiality and proprietary rights.

3.2.3 Prevention and Detection of Improper, Unethical or Illegal Actions

It is the intention of ALS - Kelso to proactively prevent and/or detect any improper, unethical or illegal action conducted within the laboratory. This is performed by the implementation of a program designed for not only the detection but also prevention. Prevention consists of educating all laboratory personnel in their roles and duties as employees, company policies, inappropriate practices, and their corresponding implications as described here.

In addition to education, appropriate and inappropriate practices are included in SOPs such as manual integration, data review and specific method procedures. Electronic and hardcopy data audits are performed regularly, including periodic audits of chromatographic electronic data. Requirements for internal QA audits are described in the SOP *Internal Audits* (CE-QA001). All aspects of this program are documented and retained on file according to the company policy on record retention.

The ALS Employee Handbook also contains information on the ALS ethics and data integrity program, including mechanisms for reporting and seeking advice on ethical decisions.

3.2.4 Laboratory Data Integrity, Ethics, and Computer Security Training

Each employee receives data integrity and ethics training on an annual basis. The topics covered and training participation are documented. It is the responsibility of the QAM to ensure that the training is conducted as described. Additionally, new employees are given a new employee QA and data

integrity/ethics orientation within the first two month of hire, followed by the routine annual training.

Key topics covered are the organizational mission and its relationship to the critical need for honesty and full disclosure in all analytical reporting, record keeping, and reporting data integrity issues. Training includes discussion regarding all data integrity procedures, data integrity training documentation, in-depth data monitoring and data integrity procedures. Training topics also cover examples of improper actions, legal and liability implications (company and personal), causes, prevention, awareness, and reporting options. Computer security is also included, covering ALS computing security awareness, passwords and access, and related topics.

Trainees are required to understand that any infraction of the laboratory data integrity procedures will result in an investigation that could lead to serious consequences including immediate termination, or civil/criminal prosecution.

3.2.5 Management and Employee Commitment

ALS - Kelso makes every attempt to ensure that employees are free from any commercial, financial, or other undue pressures that might affect their quality of work. Related policies are described in the ALS Employee Handbook. This includes:

- ALS Open Door Policy (ALS Employee Handbook) – Employees are encouraged to bring any work related problems or concerns to the attention of local management or their Human Resources representative. However, depending on the extent or sensitivity of the concern, employees are encouraged to directly contact any member of upper management.
- ALS Integrity Hotline – An anonymous and confidential reporting system available to all employees that is used to communicate misconduct and other concerns. The program shall help minimize negative morale, promote a positive work place, and encourage reporting suspected misconduct without retribution. Associated upper management is notified and the investigations are documented.
- Use of flexible work hours. Within reason and as approved by supervisors, employees are allowed flexible work hours in order to help ease schedule pressures which could impact decision-making and work quality.
- Operational and project scheduling assessments are continually made to ensure that project planning is performed and that adequate resources are available during anticipated periods of increased workloads. Procedures for subcontracting work are established, and within the ALS Environmental laboratory network additional capacity is typically available for subcontracting, if necessary.
- Gifts and Favors (ALS Employee Handbook) – To avoid possible conflict of interest implications, employees do not give unusual gifts or favors to, nor accept such gifts or favors from, persons outside the Company who are, or may be, in any way concerned with the projects on which the Company is professionally engaged.

Table 3-1
Summary of Technical Experience and Qualifications – Key Personnel

Personnel	Years of Experience	Project Role
Ambrose Hughey, B.S.	14	General Manager
Carl Degner, M.S.	34	Quality Assurance Manager
Les Kennedy, B.A.	26	Client Services Manager
Jeff Coronado, B.S.	29	Metals & Inorganics Department Manager
Todd Poyfair, B.S.	26	Organics Department & Extractions Manager
Eileen Arnold, B.A.	34	Environmental Health and Safety Officer
Joe Caulfield	17	Information Technology

4) Document Control

Procedures for control and maintenance of documents are described in SOP *Document Control* (CE-GEN005). The requirements of the SOP apply to all laboratory logbooks (standards, maintenance, run logbooks, etc.), certificates of analysis, SOPs, QAMs, quality assurance project plans (QAPPs), Environmental Health & Safety (EHS) manuals, and other controlled ALS Environmental documents.

Each controlled copy of a controlled document is released after a document control number is assigned and the recipient is recorded on a document distribution list. Filing and distribution is performed by the QAM, or designee, and ensure that only the most current version of the document is distributed and in use. A document control number is assigned to logbooks. Completed logbooks that are no longer in use are archived in a master logbook file. Logbook entries are standardized following SOP *Making Entries onto Analytical Records* (CE-QA007). The logbook entries are reviewed and approved at a regular interval (quarterly).

A records system is used which ensures all laboratory records (including raw data, reports, and supporting records) are retained and available. The archiving system is described in SOP *Data Archiving* (ADM-ARCH).

External documents relative to the management system are managed by the QAM. To prevent the use of invalid and/or outdated external documents, the laboratory maintains a master list of current documents and their availability. The list is reviewed before making the documents available. External documents are not issued to personnel.

5) Review of Requests, Tenders and Contracts

Requests for new work are reviewed prior to signing any contracts or otherwise agreeing to perform the work. The specific methods to be used are agreed upon between the laboratory and the client. A capability review is performed to determine if the laboratory has or needs to obtain certification to perform the work, to determine if the laboratory has the resources (personnel, equipment, materials, capacity, skills, expertise) to perform the work, and if the laboratory is able to meet the client's required reporting and QC limits. The results of this review are communicated to the client and any potential conflict, deficiency, lack of appropriate accreditation status, or concerns of the ability to complete the client's work are resolved. Any differences between the request or tender and the contract shall be resolved before any work commences. The client should be notified at this time if work is expected to be subcontracted. Each contract shall be acceptable both to the laboratory and the client. Records are maintained of pertinent discussions with a client relating to the client's requirements or the results of the work. If a contract needs to be amended after work has commenced, the contract review process is repeated and any amendments are communicated to all affected personnel. Changes in accreditation status affecting ongoing projects must be reported to the client.

6) Subcontracting of Tests

Analytical services are subcontracted when the laboratory needs to balance workload or when the requested analyses are not performed by the laboratory. Subcontracting is only done with the knowledge and approval of the client and to qualified laboratories. Subcontracting to another ALS Environmental Group laboratory is preferred over external-laboratory subcontracting. Further, subcontracting is done using capable and qualified laboratories. Established procedures are used to qualify external subcontract laboratories. These procedures are described in SOP *Qualification of Subcontract Laboratories* (CE-QA004). The Quality Assurance staff is responsible for maintaining a list of qualified subcontract laboratories.

7) Purchasing Services and Supplies

The quality level of reagents and materials (grade, traceability, etc.) required is specified in analytical SOPs. Department supervisors ensure that the proper materials are purchased. Inspection and verification of material ordered is performed at the time of receipt by receiving personnel. The receiving staff labels the material with the date received. Expiration dates are assigned as appropriate for the material. Storage conditions and expiration dates are specified in the analytical SOP. *Quality of Reagents and Standards* (CE-QA012) and Reagent and *Standards Login and Tracking* (ADM-RLT) provides default expiration requirements. Supplies and services that are critical in maintaining the quality of laboratory testing are procured from pre-approved vendors. The policy and procedure for purchasing and procurement are described in SOP *Procurement and Control of Laboratory Services and Supplies* (CE-GEN007).

Receipt procedures include technical review of the purchase order/request to verify that what was received is identical to the item ordered. The laboratory checks new lots of reagents for unacceptable levels of contamination prior to use in sample preservation, sample preparation, and sample analysis by following SOP *Reagent and Standards Login and Tracking* (ADM-RLT).

8) Service to the Client

ALS - Kelso utilizes a number of processes to ensure that adequate resources exist to meet service demands. Senior staff meetings, tracking of outstanding proposals, and a current synopsis of incoming work all assist the senior staff in properly allocating sufficient resources. Status/production meetings are conducted regularly with the laboratory and Project Managers to inform the staff of the status of incoming work, future projects, or project requirements.

The Project Manager is a scientist assigned to each client to act as a technical liaison between the client and the laboratory. The Project Manager is responsible for ensuring that the analyses performed by the laboratory meet all project and contract requirements. This entails coordinating with the laboratory staff to ensure that client-specific needs are understood and that the services provided are properly executed and satisfy the requirements of the client.

Laboratory management also monitors a number of other indicators to assess the overall ability of the laboratory to successfully perform analyses for its clients. This includes on-time performance, customer complaints, training reports and non-conformity reports. A frequent assessment is made of the laboratory's facilities and resources in anticipation of accepting an additional or increased workload.

All Requests for Proposal (RFP) documents are reviewed by the Project Manager and appropriate managerial staff to identify any project specific requirements that differ from the standard practices of the laboratory. Any requirements that potentially cannot be met are noted and communicated to the client, as well as requesting the client to provide any applicable project specific Quality Assurance Project Plans (QAPPs).

When a client requests a modification to an SOP, policy, or standard specification the Project Manager will discuss the proposed deviation with the Client Services Manager, Laboratory Director, and department manager to obtain approval for the deviation. The QAM may also be involved. All project-specific requirements must be on-file and with the service request upon logging in the samples. The modification or deviation must be documented. A Project-Specific Communication Form, Form V, or similar, may be used to document such deviations.

The laboratory affords clients cooperation to clarify the client's request and to monitor the laboratory's performance in relation to the work performed, provided that the laboratory ensures confidentiality to other clients. The laboratory maintains and documents timely communication with the client for the purposes of seeking feedback and clarifying customer

requests. Feedback is used and analyzed to improve the quality of services. The SOP *Handling Customer Feedback* (CE-GEN010) is in place for these events.

9) Complaints

In addition to project communication and internal communication of data issues, the laboratory also maintains a system for dealing with customer complaints. The procedure is described in SOP *Handling Customer Feedback* (CE-GEN010). The person who initially receives feedback in the form of a complaint (typically the Project Manager) is responsible for documenting the complaint. If the Project Manager is unable to satisfy the customer, the complaint is brought to the attention of the Client Services Manager, Laboratory Director, or QAM for final resolution. The complaint and resolution are documented.

10) Facilities and Equipment

The ALS Environmental Kelso laboratory features over 45,000 square feet of laboratory and administrative workspace. The laboratory has been designed and constructed to provide safeguards against cross-contamination of samples and is arranged according to work function, which enhances the efficiency of analytical operations. The ventilation system has been specially designed to meet the needs of the analyses performed in each work space. Also, ALS - Kelso minimizes laboratory contamination sources by employing janitorial and maintenance staff to ensure that good housekeeping and facilities maintenance are performed. In addition, the segregated laboratory areas are designed for safe and efficient handling of a variety of sample types. These specialized areas (and access restrictions) include:

- Shipping and Receiving
- Sample Management Office, including controlled-access sample storage areas
- Inorganic/Metals Sample Preparation Laboratories (2)
- Inorganic/Metals “clean room” sample preparation laboratory
- ICP-AES Laboratory
- ICP-MS Laboratory
- Low-level Mercury Laboratory
- Water Chemistry & General Chemistry Laboratories (3)
- Semi-volatile Organics Sample Preparation Laboratory
- Gas Chromatography and High Performance Liquid Chromatography Laboratories
- Gas Chromatography/Mass Spectrometry Laboratories (2)
- Semi-volatile Organics Drinking Water Laboratory
- Volatile Organics Laboratory
    - Separate sample preparation laboratory
    - Access by semi-volatile sample preparation staff only after removing lab coat and solvent-contaminated gloves, etc.
- Microbiology Laboratory
- Laboratory Deionized Water Systems (2)
- Laboratory Management, Client Service, Report Generation and Administration

- Data Archival, Data Review and support functions areas

In addition, the designated areas for sample receiving, refrigerated sample storage and dedicated sample container preparation and shipping areas provide for the efficient and safe handling of a variety of sample types. The laboratory is equipped with state-of-the-art analytical and administrative support equipment. The equipment and instrumentation are appropriate for the procedures in use. Refer to Appendix D for a Laboratory Floor Plan and Appendix E for a list of major equipment, illustrating the laboratory's overall capabilities and depth.

11) Sample Management

11.1 Sampling and Sample Preservation

The quality of analytical results is highly dependent upon the quality of the procedures used to collect, preserve and store samples. ALS - Kelso recommends that clients follow sampling guidelines described in 40 CFR 136, 40 CFR 141, USEPA SW 846, and state-specific sampling guidelines, if applicable. Sampling factors that must be taken into account to insure accurate, defensible analytical results include:

- Amount of sample taken
- Type of container used
- Type of sample preservation
- Sample storage time
- Proper custodial documentation

The laboratory uses the sample preservation, container, and holding-time recommendations published in a number of documents. The primary documents of reference are: USEPA SW-846, Third Edition and Updates I, II, IIA, IIB, III, IV for hazardous waste samples; USEPA 600/4-79-020, 600/4-91-010, 600/4-82-057, 600/R-93/100, 600/4-88-039, 600/R-94-111, and Supplements; EPA 40CFR parts 136 and 141 and associated Method Update Rules; and Standard Methods for the Examination of Water and Wastewater for water and wastewater samples (see Section 23 for complete references). The container, preservation and holding time information for these references is summarized in Appendix F for soil, water, and drinking water. The current EPA CLP Statement of Work should be referred to for CLP procedures. Where allowed by project sampling and analysis protocols (such as Puget Sound Protocols) the holding time for sediment, soil, and tissue samples may be extended for a defined period when stored frozen at -20˚C.

ALS - Kelso provides clients with sample containers with applicable preservatives. Containers are purchased as pre-cleaned to a level 1 status, and conform to the requirements for samples established by the USEPA. Certificates of analysis for sample containers are available upon request. Reagent water used for sampling blanks (trip blanks, etc.) and chemical preservation reagents are tested by the laboratory to ensure that they are free of interferences and documented. Our sample kits typically consist of pre-cleaned, rinsed, and air-dried shipping coolers with foam liners, specially prepared and labeled sample containers individually wrapped in protective material (VOC vials are placed in a specially made foam holder), chain-of-custody (COC) forms, and custody seals. Container labels and custody seals are provided for each container. Figure 11-1 shows the chain-of-custody form routinely used at ALS - Kelso and included with sample kits. Gel ice is included upon request. For large sample container shipments the containers may be shipped in their original boxes. Such shipments will consist of labeled and preserved sample containers and sufficient materials (bubble

wrap, COC forms, custody seals, shipping coolers, etc.) for return to ALS, unless otherwise instructed by the client.

ALS - Kelso also provides courier service that makes regularly scheduled trips on the I-5 corridor between the greater Portland, Oregon area and the greater Seattle/Tacoma area, and nearby communities and facilities.

Returning shipping coolers are cleaned and decontaminated. If any such cooler exhibits an odor or other abnormality after receipt and cleaning, a more vigorous decontamination process is employed. Containers which cannot be decontaminated are discarded. ALS - Kelso keeps client-specific shipping requirements on file and utilizes major transportation carriers to necessary to meet sample shipping requirements (same-day, overnight, etc.).

When ALS - Kelso ships samples to other laboratories for analysis, similar sample integrity processes are used to ensure preservation and proper sample handling, and to avoid any possible breakage, cross-contamination of samples, or identification problems. Alternatively, the receiving laboratory's procedures may be specified. Chain of custody is maintained during the process.

11.2 Sample Receipt and Handling

Standard procedures are established for the receiving of samples into the laboratory and are found in SOP SMO-GEN, *Sample Receiving*. These procedures ensure that samples are received and properly logged into the laboratory, and that all associated documentation, including chain of custody forms, is complete and consistent with the samples received.

Once samples are received or delivered to the laboratory the sample management office uses a Cooler Receipt and Preservation Check Form (CRF - Figure 11-2) is used to assess the shipping cooler and its contents as received by the laboratory. Any anomalies or discrepancies observed during the initial assessment are recorded on the CRF and COC documents. Verification of sample integrity includes the following activities:

- Assessment of custody seal presence/absence, location and signature;
- Temperature of sample containers upon receipt;
- Chain of custody documents properly used (entries in ink, signature present, etc.);
- Sample containers checked for integrity (broken, leaking, etc.);
- Sample is clearly marked and dated (bottle labels complete with required information);
- Appropriate containers (size, type) are received for the requested analyses;
- The minimum amount of sample material is provided for the analysis.
- Sample container labels and/or tags agree with chain of custody entries (identification, required analyses, etc.);
- Assessment of proper sample preservation (if inadequate, corrective action is employed); and
- VOC containers are inspected for the presence/absence of bubbles. (Assessment of proper preservation of VOC containers is performed by lab personnel).

Samples are logged into a Laboratory Information Management System (LIMS). Potential problems with a sample shipment are addressed by contacting the client and discussing the pertinent issues. When the Project Manager and client have reached a satisfactory resolution, the login process may continue and analysis may begin. During the login process each sample container is given a unique laboratory code and a Service Request form is generated which contains client information, sample descriptions, sample matrix information, required analyses, sample collection dates, analysis due dates and other pertinent information. The service request is reviewed by the applicable Project Manager for accuracy and completeness.

Samples are stored as per method requirements until analysis, unless otherwise specified, using various refrigerators, freezers, or designated secure areas. ALS - Kelso has multiple walk-in and refrigerator cold storage units which house the majority of samples, including dedicated refrigerated storage of VOC samples. The VOC storage units are monitored using storage blanks as described in SOP VOC-BLAN, *VOA Storage Blanks*. ALS - Kelso also has multiple sub-zero freezers capable of storing samples at -10 to -30˚C primarily used for tissue and sediment samples. The temperature of each sample storage unit is monitored real time with an electronic temperature monitoring system.

ALS - Kelso adheres to the method-prescribed or project-specified holding times for all analyses. Analysts monitor holding times by obtaining analysis-specific reports from the LIMS. These reports provide holding time information on all samples for the analysis, calculated from the sampling date and the holding time requirement. To document holding time compliance, the date and time analyzed is printed or written on the analytical raw data. Unless other arrangements have been made in advance, aqueous samples are retained for 60 days from receipt, soil samples are retained for 60 days from receipt, and tissue samples are retained frozen for 90 days. Upon expiration of these time limits, the samples are either returned to the client, disposed of according to approved disposal practices, or archived. Sample extracts are retained as specified in analytical SOPs. All samples are characterized according to hazardous/non-hazardous waste criteria and are segregated accordingly. All hazardous waste samples are disposed of according to formal procedures outlined in the ALS Environmental Health and Safety Manual and in accordance with applicable laws. Documentation is maintained for each sample from initial receipt through final disposal to ensure that an accurate history of the sample from “cradle to grave” is available.

11.3 Sample Custody

Sample custody transfer at the time of sample receipt is documented using chain-of-custody (COC) forms accompanying the samples. During sample receipt, it is also noted if custody seals were present.

Facility security and access is important in maintaining the integrity of samples received at ALS - Kelso. Access to the laboratory facility is limited by use of locked exterior doors with a coded/card entry, except for the reception area and sample receiving doors, which are staffed during business hours and locked at all other times. In addition, the sample storage area within the laboratory is a controlled access area with locked doors with a coded entry. The facility is equipped with an alarm system and the laboratory employs a private security firm to provide nighttime and weekend security.

A barcoding system is used to document internal sample custody. The system uniquely identifies sample containers and provides an electronic record of the sample custody. Procedures are also defined for sample extracts, digestates, and leachates.

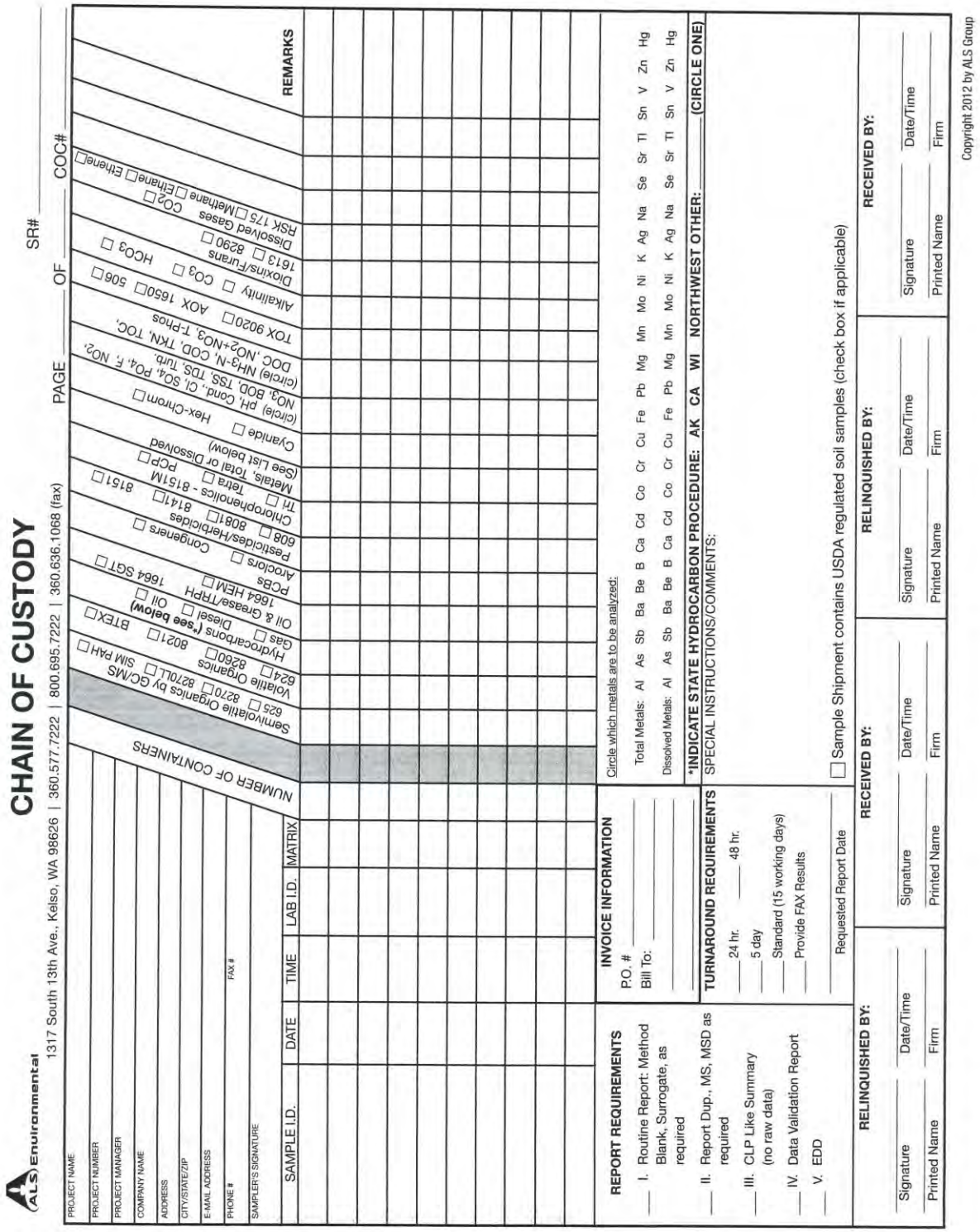
The procedures are described in the SOP SMO-SCOC, *Sample Tracking and Internal Chain of Custody*.

11.4 Project Setup

The analytical method(s) used for sample analysis are chosen based on the client's requirements. LIMS codes are chosen to identify the analysis method used for analysis. The Project Manager ensures that the correct methods are selected for analysis, deliverable requirements are identified, and due dates are specified on the Service Request. For SW-846 methods, some projects may require the most recent promulgated version, and some projects may require the most recent published version. The Project Manager will ensure that the correct method version is used. Functionality incorporated in the LIMS is used to communicate and specify project-specific requirements and demographics, including the use of attachments to LIMS delivery group (SDG or SR) such as specification forms, analyte lists, deliverable requirements, and other pertinent information.

Figure 11-1

ALS Environmental Standard Chain of Custody Form



PC_____

Cooler Receipt and Preservation Form

Client _____ Service Request *K18*_____

Received:_____ Opened:_____ By:_____ Unloaded:_____ By:_____

1. Samples were received via? *USPS* *Fed Ex* *UPS* *DHL* *PDX* *Courier* *Hand Delivered*
2. Samples were received in: (circle) *Cooler* *Box* *Envelope* *Other*_____ *NA*
3. Were custody seals on coolers? NA Y N If yes, how many and where?_____
   If present, were custody seals intact? Y N If present, were they signed and dated? Y N

Raw Cooler Temp	Corrected Cooler Temp	Raw Temp Blank	Corrected Temp Blank	Corr. Factor	Thermometer ID	Cooler/COC ID NA	Tracking Number NA	Filed

4. Packing material: *Inserts* *Baggies* *Bubble Wrap* *Gel Packs* *Wet Ice* *Dry Ice* *Sleeves* _____
5. Were custody papers properly filled out (ink, signed, etc.)? NA Y N
6. Were samples received in good condition (temperature, unbroken)? *Indicate in the table below.* NA Y N
   If applicable, tissue samples were received: *Frozen* *Partially Thawed* *Thawed*
7. Were all sample labels complete (i.e analysis, preservation, etc.)? NA Y N
8. Did all sample labels and tags agree with custody papers? *Indicate major discrepancies in the table on page 2.* NA Y N
9. Were appropriate bottles/containers and volumes received for the tests indicated? NA Y N
10. Were the pH-preserved bottles (*see SMO GEN SOP*) received at the appropriate pH? *Indicate in the table below* NA Y N
11. Were VOA vials received without headspace? *Indicate in the table below.* NA Y N
12. Was C12/Res negative? NA Y N

Sample ID on Bottle	Sample ID on COC	Identified by:

Sample ID	Bottle Count Bottle Type	Out of Temp	Head-space	Broke	pH	Reagent	Volume added	Reagent Lot Number	Initials	Time

Notes, Discrepancies, & Resolutions:_____

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Cooler Receipt and Preservation Form

Client _____ Service Request *K18* _____

Thermometer ID	Corr. Factor	@20 min, Raw Blank	@20 min, Corr. Blank	@40 min. Raw Blank	@40 min. Corr. Blank	@60 min. Raw Blank	@60 min Corr. Blank

Sample ID on Bottle	Sample ID on COC	Identified by:

Sample ID	Bottle Count Bottle Type	Out of Temp	Head-space	Broke	pH	Reagent	Volume added	Reagent Lot Number	Initials	Time

Notes, Discrepancies & Resolutions:

_____

_____

_____

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Cooler Receipt and Preservation Form

Client _____ Service Request *K18* _____

Notes, Discrepancies & Resolutions:

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12) Analytical Procedures

ALS - Kelso employs methods and analytical procedures from a variety of external sources. The primary method references are: USEPA SW-846, Third Edition and Updates I, II, IIA, IIB, III, IVA, IVB, V, and online updates for hazardous waste samples, and USEPA 600/4-79-020, 600/4-91-010, 600/4-82-057, 600/R-93/100, 600/4-88-039, 600/R-94-111, EPA 40CFR parts 136 and 141 and associated Method Update Rules and Supplements; Standard Methods for the Examination of Water and Wastewater for water and wastewater samples, and American Society for Testing and Materials (ASTM). Complete citations for these references can be found in Section 23. Other published procedures, such as state-specific methods, program-specific methods (such as Puget Sound Protocols), or in-house methods may be used. Several factors are involved with the selection of analytical methods to be used in the laboratory. These include the method detection/reporting limit, the expected concentration of the analyte(s) being measured, method selectivity, accuracy and precision of the method, the type of sample being analyzed, and the regulatory compliance objectives. The implementation of methods by ALS - Kelso is described in SOPs specific to each method. A list of NELAP-accredited methods is given in Appendix J.

12.1 Standard Operating Procedures (SOPs) and Laboratory Notebooks.

ALS Environmental, Kelso maintains SOPs for use in both technical and administrative functions. SOPs are written following standardized format and content requirements as described in SOP *Preparation of Standard Operating Procedures* (CE-GEN009). Each SOP is reviewed and approved by a minimum of two managers (the Laboratory Director and/or Department Manager and the Quality Assurance Manager). All SOPs undergo a documented review to make sure current practices are described. The QAM maintains a comprehensive list of current SOPs. The document control process ensures that only the most currently approved version of an SOP is being used. The procedures for document control are described in SOP *Document Control* (CE-GEN005). In addition to SOPs, each laboratory department maintains the current methods used to perform analyses accessible to all laboratory staff. Laboratory notebook entries are standardized using the procedure in SOP *Making Entries onto Analytical Records* (CE-QA007). Laboratory notebook entries are reviewed and approved by the appropriate supervisor at a regular interval. A list of current SOPs is given in Appendix G.

12.2 Deviation from Standard Operating Procedures

When a client requests a modification to an SOP (such as a change in reporting limit, addition or deletion of target analyte(s), etc.), the Project Manager handling that project must discuss the proposed deviation with the department manager in charge of the analysis and obtain their approval to accept the project. The Project Manager is responsible for documenting the approved or allowed deviation from the SOP by placing a description of the deviation attached with the project documents and also providing an instructional comment with the Service Request.

For circumstances when a deviation or departure from company policies or procedures involving any non-technical function is found necessary, approval must be obtained from the appropriate supervisor, manager, the Laboratory Director, or other level of authority. Frequent departure from policy is not encouraged. However, if frequent departure from any policy is noted, the laboratory director will address the possible need for a change in policy.

12.3 Modified Procedures

ALS - Kelso strives to perform published methods as described in the referenced documents. If there is a material deviation from the published method, the method is cited as a “Modified” method in the analytical report. Modifications to the published methods are listed in the standard operating procedure. Standard operating

procedures are available to analysts and are also available to our clients for review. Client approval is obtained for the use of "Modified" methods prior to the performance of the analysis.

12.4 Analytical Batch

The basic unit for analytical quality control is the analytical batch. The definition that ALS - Kelso has adopted for the analytical batch is listed below. The overriding principle for describing an analytical batch is that all the samples in a batch, both field samples and quality control samples are to be handled exactly the same way, and all of the data from each analysis is to be manipulated in exactly the same manner. The minimum requirements of an analytical batch are:

1) The number of (field) samples in a batch is not to exceed 20.

2) All (field) samples in a batch are of the same matrix.

3) The QC samples to be processed with the (field) samples include:

- Method Blank (a.k.a. Laboratory Reagent Blank)
- Laboratory Control Sample
- Matrix Spiked (field) Sample (a.k.a. Laboratory Fortified Sample Matrix)*
- Duplicate Matrix Spiked (field) Sample or Duplicate (field) Sample (a.k.a. Laboratory Duplicate)*

* A sample identified as a field blank, an equipment blank, or a trip blank is not to be matrix spiked or duplicated.

4) A single lot of reagents is used to process the batch of samples.

5) Each operation within the analysis is performed by a single analyst, technician, chemist, or by a team of analysts/technicians/chemists.

6) Samples are analyzed in a continuous manner over a timeframe not to exceed 24-hours between the start of processing of the first and last sample of the batch.

7) Samples are analyzed in a continuous manner over a timeframe not to exceed 24-hours.

8) Field samples are assigned to batches commencing at the time that sample processing begins.

9) The QC samples are to be analyzed in conjunction with the associated field samples prepared with them. However, for tests which have a separate sample preparation step that defines a batch (digestion, extraction, etc.), the QC samples in the batch do not require analysis each time a field sample within the preparation batch is analyzed (multiple instrument sequences to analyze all field samples in the batch need not include re-analyses of the QC samples).

10) The batch is to be assigned a unique identification number that can be used to correlate the QC samples with the field samples.

11) Batch QC refers to the QC samples that are analyzed in a batch of (field) samples.

12) Project-specific requirements may be exceptions. If project, program, or method requirements are more stringent than these laboratory minimum requirements, then the project, program, or method requirements will take

precedence. However, if the project, program, or method requirements are less stringent than these laboratory minimum requirements, these laboratory minimum requirements will take precedence.

12.5 Specialized Procedures

ALS - Kelso not only strives to provide results that are scientifically sound, legally defensible, and of known and documented quality; but also strives to provide the best solution to analytical challenges. Procedures using specialized instrumentation and methodology have been developed to improve sensitivity (provide lower detection limits), selectivity (minimize interferences while maintaining sensitivity), and overall data quality for low concentration applications. Examples are trace-level Mercury and Methyl Mercury analyses, reductive precipitation metals analysis, leaching procedures, incremental sampling protocols, specialized GC/MS analyses, LC/MS analyses, and ultra-low level organics analyses (including PAHs, pesticides and PCBs); including those for emerging contaminants of concern.

12.6 Sample Cleanup

The laboratory commonly employs several cleanup procedures to minimize known common interferences prior to analysis. EPA methods (3620, 3630, 3640, 3660, and 3665) for cleanup of sample extracts for organics analysis are routinely used to minimize or eliminate interferences that may adversely affect sample results and data usability.

13) Measurement Traceability and Calibration

All equipment and instruments used at ALS - Kelso are operated, maintained and calibrated according to the manufacturer's recommendations and criteria set forth in the analytical methods. All analytical measurements generated are performed using materials that are traceable to a reference material, unless unavailable. Documentation of calibration information is maintained in appropriate reference files. Brief descriptions of the calibration procedures for our major laboratory equipment are described below. Calibration verification is performed according to the analytical methods and SOPs, and criteria are listed in the SOPs. Documentation of calibration verification is maintained in appropriate reference files. Records are maintained to provide traceability of reference materials and reference equipment.

Laboratory support equipment (thermometers, balances, and weights) are routinely verified on an annual basis by a vendor accredited to ISO/IEC 17025:2005, or more frequently if program-specified. Metrology equipment (analytical balances, thermometers, etc.) is calibrated using reference materials traceable to the National Institute of Standards and Technology (NIST). These primary reference materials are themselves recertified on an annual basis. Vendors used for metrology support are required to verify compliance to International Standards by supplying the laboratory with a copy of their scope of accreditation.

Equipment shown by verification to be malfunctioning or defective is taken out of service until it is repaired. When an instrument is taken out of service, an “Out of Service” sign is placed by the laboratory on the instrument. The equipment is placed back in service only after verifying, by calibration, that the equipment performs satisfactorily.

13.1 Temperature Control Devices

Temperatures are monitored and recorded each day for all of the temperature-regulating support equipment such as sample refrigerators, freezers, and standards refrigerators/freezers. Temperatures are recorded in either laboratory logbook or through Check Point® Wireless Monitoring System. During weekends and holidays a min/max thermometer may be used.

Laboratory records contain the recorded temperature, identification and location of equipment, acceptance criteria and the initials of the technician who performed the checks. The procedure for performing these measurements is provided in the SOP *Support Equipment Monitoring and Calibration* (ADM-SEMC).

Where the operating temperature is specified as a test condition (such as ovens, incubators, evaporators) the temperature is recorded on the raw data. All thermometers are identified according to serial number, and the calibration is checked annually against a National Institute of Standards and Technology (NIST) certified thermometer. The NIST thermometer is recertified by a vendor accredited to ISO/IEC 17025:2005 on an annual basis.

13.2 Analytical Balances

The calibration of each analytical balance is checked by the user each day of use with three Class S or S-1 weights, which assess the accuracy of the balance at low, mid-level and high levels bracketing the working range. Records are kept which contain the recorded measurements, identification of the balance, acceptance criteria, and the initials of user who performed the check. The procedure for performing these measurements and use of acceptance criteria is described in the SOP *Support Equipment Monitoring and Calibration* (ADM-SEMC). The weights are recertified using NIST traceable standards by an accredited metrology organization on an annual basis. As needed, the balances are recalibrated using the manufacturers recommended operating procedures. Analytical balances are serviced on a semi-annual basis by an accredited metrology organization.

13.3 Water Purification Systems

ALS - Kelso uses two independent water purification systems is designed to produce deionized water meeting method specifications. One system consists of a series of pumps, filters, and resin beds designed to yield deionized water meeting the specifications of ASTM Type II water, and Standard Methods for the Examination of Water and Wastewater (SM1080, 20th Ed.) High Quality water. Activated carbon filters are also in series with the demineralizers to produce "organic-free" water. A second system consists of pumps, filters, and treatment components designed to yield deionized water meeting the specifications of ASTM Type I water, and Standard Methods for the Examination of Water and Wastewater (SM1080, 20th Ed.) High Quality water. The status of each system is monitored continuously for conductivity and resistivity with an on-line meter and indicator light, and readings recorded daily. The meter accuracy is verified annually. Deionizers are rotated and replaced on a regular schedule. Microbiology water is checked on a daily basis at a point downstream of the purification system at a tap in the laboratory.

13.4 Standards and Reference Materials

Consumable reference materials routinely purchased by the laboratories (e.g., analytical standards) are purchased from nationally recognized, reputable vendors. All vendors where possible have fulfilled the requirements for 9001 certification and/or are ISO 17025 accredited. ALS - Kelso relies on a primary vendor for the majority of its analytical supplies. Consumable primary stock standards are obtained from certified commercial sources or from sources referenced in a specific method. Supelco, Ultra Scientific, AccuStandard, Chem Services, Inc., Aldrich Chemical Co., Baker, Spex, etc. are examples of the vendors used. Reference material information is recorded in the appropriate logbook(s) and materials are stored under conditions that provide maximum protection against deterioration and contamination. The logbook entry includes such information as an assigned logbook identification code, the source of the material (i.e. vendor identification), solvent (if applicable) and concentration of

analyte(s), reference to the certificate of analysis and an assigned expiration date. The date that the standard is received in the laboratory is marked on the container. When the reference material is used for the first time, the date of usage and the initials of the analyst are also recorded on the container.

Stock solutions and calibration standard solutions are prepared fresh as often as necessary according to their stability. All standard solutions are properly labeled as to analyte concentration, solvent, date, preparer, and expiration date; these entries are also recorded in the appropriate notebook(s) following the SOP for *Reagent Login and Tracking* (ADM-RTL). Prior to sample analysis, all calibration reference materials are verified with a second, independent source of the material.

13.5 Inductively Coupled Plasma-Atomic Emission Spectrograph (ICP-AES)

Each emission line on the ICP is calibrated daily against a blank and against standards whose concentrations fall within the instruments linear range. Analyses of calibration standards, initial and continuing calibration verification standards, and inter-element interference check samples are carried out as specified in the applicable method SOP and analytical method (i.e. EPA 200.7, 6010B, 6010C, CLP SOW, etc.).

13.6 Inductively Coupled Plasma-Mass Spectrometer (ICP-MS)

Each element of interest is calibrated for using a blank and a single standard. Prior to calibration, a short-term stability check is performed on the system. Following calibration, an independent check standard is analyzed, and a continuing calibration verification standard (CCV) is analyzed with every ten samples.

13.7 Atomic Absorption Spectrophotometers (AAS)

These instruments are calibrated daily using a minimum of four standards and a blank. Calibration is validated using reference standards, and is verified at a minimum frequency of once every ten samples. Initial calibration points cannot be “dropped” from the resulting calibration curve.

13.8 GC/MS Systems

All GC/MS instruments are calibrated at multiple concentration levels for the analytes of interest (unless specified otherwise) using procedures outlined in Standard Operating Procedures and/or appropriate USEPA method citations. All reference materials used for this function are vendor-certified standards. Calibration verification is performed at method-specified intervals following the procedures in the SOP. For internal standard and isotope dilution procedures, the internal standard response and/or labeled compound recovery must meet method criteria. Method-specific instrument tuning is regularly checked the method-specified compounds. Mass spectra for the tuning compounds must meet method/SOP criteria before analyses can proceed. Calibration policies for organics chromatographic analyses are described in the SOP *Calibration of Instruments for Organics Chromatographic Analyses* (SOC-CAL).

13.9 Gas Chromatographs and High Performance Liquid Chromatographs

Calibration and standardization follow SOP guidelines and/or appropriate USEPA method citations. All GC and HPLC instruments are calibrated at a minimum of five different concentration levels for the analytes of interest (unless specified otherwise). The lowest standard is equivalent to the method reporting limit; additional standards define the working range of the GC or LC detector. Results are used to establish response factors (or calibration curves) and retention-time windows for each analyte. Calibration is verified at a minimum frequency of once every ten samples, unless otherwise specified by the reference method. Calibration policies for organics

chromatographic analyses are described in the SOP *Calibration of Instruments for Organics Chromatographic Analyses* (SOC-CAL).

LC/MS Systems:

Calibration and tuning procedures are included in analytical SOPs written specifically for these tests. In general, multiple concentration levels for the analytes of interest are used to generate calibration curves. All reference materials used for this function are vendor-certified standards. Calibration and tuning verification is performed at SOP-defined intervals. Any other system performance checks are described in the applicable SOP. Calibration policies for organics chromatographic analyses are described in the SOP *Calibration of Instruments for Organics Chromatographic Analyses* (SOC-CAL).

13.10 UV-Visible Spectrophotometer (manual colorimetric analyses)

Routine calibrations for colorimetric and turbidimetric analyses involve generating a 5 point calibration curve including a blank. Initial calibration points cannot be "dropped" from the resulting calibration curve. Correlation coefficients must meet method or SOP specifications before analysis can proceed. Independent calibration verification standards (ICVs) are analyzed with each batch of samples. Continuing calibration is verified at a minimum frequency of once every ten samples. Typical UV-Visible spectrophotometric methods at ALS Environmental, Kelso include total phenolics, phosphates, surfactants and tannin-lignin.

13.11 Flow Injection Analyzer (automated colorimetric analysis)

A minimum of six standards and a blank are used to calibrate the instrument for cyanide analysis. A blank and (minimum of) five standards are used to calibrate the instrument for all other automated chemistries. Initial calibration points cannot be "dropped" from the resulting calibration curve. Standard ALS Environmental, Kelso acceptance limits are used to evaluate the calibration curve prior to sample analysis.

13.12 Discrete Auto-Analyzer (automated absorbance analysis)

A minimum of five standards and a blank are used to calibrate the instrument. Initial calibration points cannot be "dropped" from the resulting calibration curve. Method specific acceptance limits are used to evaluate the calibration curve prior to sample analysis.

13.13 Ion Chromatographs

Calibration of the ion chromatograph (IC) involves generating a calibration curve with the method-specified number of points (or more). Initial calibration points cannot be "dropped" from the resulting calibration curve. A correlation coefficient of > 0.995 for the curve is required before analysis can proceed. Quality Control (QC) samples that are routinely analyzed include blanks and laboratory control samples. The target analytes typically determined by the IC include nitrate, nitrite, chloride, fluoride, sulfate and drinking water inorganic disinfection byproducts. Calibration verification is performed at method-specified intervals following the procedures in the SOP and reference method.

13.14 Turbidimeter

Calibration of the turbidimeter requires analysis of three Nephelometric Turbidity Unit (NTU) formazin standards. Quality Control samples that are routinely analyzed include blanks, Environmental Resource Associates QC samples (or equivalent) and duplicates.

13.15 Ion-selective electrode

The method-prescribed numbers of standards are used to calibrate the electrodes before analysis. The slope of the curve must be within acceptance limits before

analysis can proceed. Quality Control samples that are routinely analyzed include blanks, LCSs and duplicates.

13.16 Pipets

The calibration of pipets and autopipettors used to make critical-volume measurements is verified following SOP *Checking Volumetric Labware* (ADM-VOLWARE). Both accuracy and precision verifications are performed, at intervals applicable to the pipet and use. The results of all calibration verifications are recorded in bound logbooks.

13.17 Other Instruments

Calibration for the total organic carbon (TOC), total organic halogen (TOX), and other instruments is performed following manufacturer's recommendations and applicable SOPs.

14) Assuring the Quality of Results

A primary focus of ALS - Kelso's QA Program is to ensure the accuracy, precision and comparability of all analytical results. Prior to using a procedure for the analysis on field samples, acceptable method performance is established by performing demonstration of capability analyses. Performance characteristics are established by performing method detection limit studies and assessing accuracy and precision according to the reference method. ALS - Kelso has established Quality Control (QC) objectives for precision and accuracy that are used to determine the acceptability of the data that is generated. These QC limits are either specified in the test methodology or are statistically derived based on the laboratory's historical data. Quality Control objectives are defined below.

14.1 Quality Control Objectives

14.1.1 Demonstration of Capability - A demonstration of capability (DOC) is made prior to using any new test method or when a technician is new to the method. This demonstration is made following regulatory, accreditation, or method specified procedures. In general, this demonstration does not test the performance of the method in real world samples, but in the applicable clean matrix free of target analytes and interferences.

A quality control sample material may be obtained from an outside source or may be prepared in the laboratory. The analyte(s) is (are) diluted in a volume of clean matrix (for analytes which do not lend themselves to spiking, e.g., TSS, the demonstration of capability may be performed using quality control samples). Where specified, the method-required concentration levels are used. Four aliquots are prepared and analyzed according to the test procedure. The mean recovery and standard deviations are calculated and compared to the corresponding acceptance criteria for precision and accuracy in the test method or laboratory-generated acceptance criteria (if there are not established mandatory criteria). All parameters must meet the acceptance criteria. Where spike levels are not specified, actual Laboratory Control Sample results may be used to meet this requirement, provided acceptance criteria is met.

14.1.2 Accuracy - A measure of the closeness of an individual measurement (or an average of multiple measurements) to a true or expected value and expressed as percent recovery (% REC.) of the measured value, relative to the true or expected value. If a measurement process produces results whose mean is not the true or expected value, the process is said to be biased. Bias is the systematic error either inherent in a method of analysis or caused by an

artifact of the measurement system (e.g., contamination). Ongoing accuracy is determined by calculating the mean value of results from ongoing analyses of laboratory control sample, standard reference materials, or standard solutions. In addition, matrix-spiked samples are also measured and recovery indicates the accuracy or bias in the actual sample matrix.

ALS - Kelso utilizes several quality control measures to eliminate analytical bias, including systematic analysis of method blanks, laboratory control samples and independent calibration verification standards. Because bias can be positive or negative, and because several types of bias can occur simultaneously, only the net, or total, bias can be evaluated in a measurement.

14.1.3 Precision - Precision is the ability of an analytical method or instrument to reproduce its own measurement. It is a measure of the variability, or random error, in sampling, sample handling and in laboratory analysis. The American Society of Testing and Materials (ASTM) recognizes two levels of precision: repeatability - the random error associated with measurements made by a single test operator on identical aliquots of test material in a given laboratory, with the same apparatus, under constant operating conditions, and reproducibility - the random error associated with measurements made by different test operators, in different laboratories, using the same method but different equipment to analyze identical samples of test material.

"Within-batch" precision is measured using replicate sample or QC analyses and is expressed as the relative percent difference (RPD) between the measurements. The "batch-to-batch" precision is determined from the variance observed in the analysis of standard solutions or laboratory control samples from multiple analytical batches.

14.1.4 Control Limits - The control limits for accuracy and precision originate from two different sources. For analyses having enough QC data, control limits are calculated at the 99% confidence limits. For analyses not having enough QC data, or where the method is prescriptive, control limits are taken from the method on which the procedure is based. If the method does not have stated control limits, then control limits are assigned method-default or reasonable values based on similar methods. Control limits are reviewed each year and may be updated if new statistical limits are generated for the appropriate surrogate, laboratory control sample, and matrix spike compounds (typically once a year) or when method prescribed limits change. The updated limits are reviewed by the QAM. The new control limits replace the previous limits and data is assessed using the new values. Current *Data Quality Objectives*, including acceptance limits for accuracy and precision are available from the laboratory. For inorganics, the precision limit values listed are for laboratory duplicates. For organics, the precision limit values listed are for duplicate laboratory control samples or duplicate matrix spike analyses. Procedures for establishing control limits are found in SOP *Control Limits* (CE-QA009).

14.1.5 Representativeness - The degree to which the field sample, being properly preserved, free of contamination, and properly analyzed, represents the overall sample site or material. This can be extended to the sample itself, in that representativeness is the degree to which the subsample that is analyzed represents the entire field sample submitted for analysis. ALS - Kelso has sample handling procedures to ensure that the sample used for analysis is representative of the entire sample. These include the SOP for *Subsampling and Compositing of Samples* (SOILPREP-SUBS) and the SOP for *Tissue Sample*

Preparation (MET-TISP). Further, analytical SOPs specify sample handling and sample sizes to further ensure the sample aliquot that is analyzed is representative in entire sample.

14.1.6 Comparability – Comparability expresses the confidence with which one data set can be compared to another and is directly affected by data quality (accuracy and precision) and sample handling (sampling, preservation, etc.). Only data of known quality can be compared. The objective is to generate data of known quality with the highest level of comparability, completeness, and usability. This is achieved by employing the quality controls listed below and standard operating procedures for the handling and analysis of all samples. Data is reported in units specified by the client and using ALS Environmental, Kelso or project-specified data qualifiers.

14.2 Method Detection Limits, Method Reporting Limits, Limits of Detection, and Limits of Quantitation

Method Detection Limits (MDL) for methods performed at ALS - Kelso are determined during initial method set up and when significant changes are made. If an MDL study is not performed annually, the established MDL is verified by performing a Limit of Detection (LOD) verification on every instrument used in the analysis. The MDLs are determined by following the SOP *Performing Method Detection Limit Studies and Establishing Limits of Detection and Quantitation* (CE-QA011), which is based on the procedure in 40 CFR Part 136, Appendix B. As required by NELAP and DoD protocols, the validity of MDLs is verified using LOD verification samples.

The Method Reporting Limit (MRL) is the lowest amount of an analyte in a sample that can be quantitatively determined with stated, acceptable precision and accuracy under stated analytical conditions (i.e. Limit of Quantitation- LOQ). LOQ are analyzed at the frequency specified in the SOP *Performing Method Detection Limit Studies and Establishing Limits of Detection and Quantitation* (CE-QA011) and at specified concentrations (not lower than the lowest calibration standard). Current MDL/LOD and MRL/LOQ values are available from the laboratory.

14.3 Quality Control Procedures

The specific types, frequencies, and processes for quality control sample analysis are described in detail in method-specific standard operating procedures and listed below. These sample types and frequencies have been adopted for each method and a definition of each type of QC sample is provided below. Unique test-specific requirements may also exist and are found in the laboratory SOP.

14.3.1 Method Blank (a.k.a. Laboratory Reagent Blank)

The method blank is an analyte-free matrix (water, soil, etc.) subjected to the entire analytical process. When analyte-free soil is not available, anhydrous sodium sulfate, organic-free sand, or an acceptable substitute is used. The method blank is analyzed to demonstrate that the analytical system itself does not introduce contamination. The method blank results should be below the Method Reporting Limit (MRL) or, if required for DoD projects, < ½ MRL for the analyte(s) being tested. Otherwise, corrective action must be taken. A method blank is included with the analysis of every sample preparation batch, every 20 samples, or as stated in the method, whichever is more frequent.

14.3.2 Calibration Blank

For some methods, calibration blanks are prepared along with calibration standards in order to create a calibration curve. Calibration blanks are free of

the analyte of interest and, where applicable, provide the zero point of the calibration curve. Additional project-specific requirements may also apply to calibration blanks.

14.3.3 Continuing Calibration Blank

Continuing calibration blanks (CCBs) are solutions of analyte-free water, reagent, or solvent that are analyzed in order to verify the system is contamination-free when CCV standards are analyzed. The frequency of CCB analysis is either once every ten samples or as indicated in the method, whichever is greater. Additional project-specific requirements may also apply to continuing calibration blanks.

14.3.4 Calibration Standards

Calibration standards are solutions of known concentration prepared from primary standard or stock standard materials. Calibration standards are used to calibrate the instrument response with respect to analyte concentration. Standards are analyzed in accordance with the requirements stated in the particular method being used.

14.3.5 Initial (or Independent) Calibration Verification Standard (ICV)

The ICV standard is prepared from materials obtained from a source independent of that used for preparing the calibration standards ("second-source"). The ICV is analyzed after calibration but prior to sample analysis in order to verify the validity and accuracy of the standards used in calibration. Once it is determined that there is no defect or error in the calibration standard(s), the standards are considered valid and may be used for subsequent calibrations and quantitative determinations (as expiration dates and methods allow). ICVs are also analyzed in accordance with method-specific requirements.

14.3.6 Continuing Calibration Verification Standard

Continuing calibration verification (CCV) standards are midrange standards that are analyzed in order to verify that the calibration of the analytical system is still acceptable. The frequency of CCV analysis is either once every ten samples, or as indicated in the method.

14.3.7 Internal Standards

Internal standards are known amounts of specific compounds that are added to each sample prior to instrument analysis. Internal standards are generally used for GC/MS and ICP/MS procedures to correct sample results that have been affected by changes in instrument conditions or changes caused by matrix effects. The requirements for evaluation of internal standards are specified in each method and SOP.

14.3.8 Surrogates

Surrogates are organic compounds which are similar in chemical composition and analytical behavior to the analytes of interest, but which are not normally found in environmental samples. Depending on the analytical method, one or more of these compounds is added to method blanks, calibration and check standards, and samples (including duplicates, matrix spike samples, duplicate matrix spike samples and laboratory control samples) prior to extraction and analysis in order to monitor the method performance on each sample. The percent recovery is calculated for each surrogate, and the recovery is a measurement of the overall method performance.

Recovery (%) = (M/T) x 100

Where: M = The measured concentration of analyte,
T = The known concentration of analyte added.

14.3.9 Laboratory Control Samples (a.k.a Laboratory Fortified Blank – LFB)

The laboratory control sample (LCS) is an aliquot of analyte-free water or analyte-free solid (or anhydrous sodium sulfate or equivalent) to which known amounts of the method analyte(s) is (are) added. A reference material of known matrix type, containing certified amounts of target analytes, may also be used as an LCS. An LCS is prepared and analyzed at a minimum frequency of one LCS per 20 samples, with every analytical batch or as stated in the method, whichever is more frequent. The LCS sample is prepared and analyzed in exactly the same manner as the field samples.

The percent recovery of the target analytes in the LCS is compared to established control limits and assists in determining whether the methodology is in control and whether the laboratory is capable of making accurate and precise measurements at the required reporting limit. Comparison of batch-to-batch LCS analyses enables the laboratory to evaluate batch-to-batch precision and accuracy.

Recovery (%) = (M/T) x 100

Where: M = The measured analyte concentration,
T = The known analyte concentration added.

14.3.10 Laboratory Fortified Blank – MRL Level

A laboratory blank fortified at the MRL used to verify that the method reporting limit can be achieved. This LFB is carried through the entire extraction and analytical procedure. A MRL LFB is required with every batch of drinking water samples.

14.3.11 Matrix Spikes (MS)

Matrix spiked samples are aliquots of samples to which a known amount of the target analyte (or analytes) is (are) added. The samples are then prepared and analyzed in the same analytical batch, and in exactly the same manner as are routine samples. For the appropriate methods, matrix spiked samples are prepared and analyzed and at a minimum frequency of one spiked sample (and one duplicate spiked sample, if appropriate) per twenty samples. The spike recovery measures the effects of interferences caused by the sample matrix and reflects the accuracy of the method for the particular matrix in question. Spike recoveries are calculated as follows:

Recovery (%) = (S - A)/T x 100

Where: S = The measured analyte concentration in the spiked sample,
A = The measured analyte concentration in the parent sample,
T = The known analyte concentration added to the spiked sample.

14.3.12 Laboratory Duplicates and Duplicate Matrix Spikes

Duplicates are additional replicates of samples that are subjected to the same preparation and analytical scheme as the original sample. Depending on the method of analysis, either a duplicate analysis (and/or a matrix spiked sample) or a matrix spiked sample and duplicate matrix spiked sample (MS/DMS) are analyzed. The relative percent difference between duplicate analyses or between an MS and DMS is a measure of the precision for a given method and analytical batch. The relative percent difference (RPD) for these analyses is calculated as follows:

Relative Percent Difference (RPD) = (S1 - S2) x 100 ÷ S_{avg}

Where:

S1 and S2 = The analyte concentrations in the sample and its duplicate, or in the matrix spike and its duplicate matrix spike, and,

S_{avg} = The average of analyte concentrations in the sample and its duplicate, or in the matrix spike and its duplicate matrix spike.

Depending on the method of analysis, either duplicates (and/or matrix spikes) or MS/DMS analyses are performed at a minimum frequency of one set per 20 samples. If an insufficient quantity of sample is available to perform a laboratory duplicate or duplicate matrix spikes, duplicate LCSs will be prepared and analyzed.

14.3.13 Interference Check Samples (ICS)

An ICS is a solution containing both interfering and analyte elements of known concentration that can be analyzed to verify background and interelement correction factors in metals analyses. The ICS is prepared to contain known concentrations (method or program specific) of elements that will provide an adequate test of the correction factors. The ICS is analyzed at the beginning and end of an analytical run or at a method-specified frequency. Results must meet method criteria and any project-specific criteria.

14.3.14 Post Digestion Spikes

Post digestion spikes are samples prepared for metals analyses that have an analyte spike added to determine if matrix effects may be a factor in the results. The spike addition should produce a method-specified minimum concentration above the method reporting limit. A post digestion spike is analyzed with each batch of samples and recovery criteria are specified for each method.

14.3.15 Control Charting

The generation of control charts is routinely performed at ALS. Surrogate, Matrix Spike and LCS recoveries are all monitored and charted. In addition, the laboratory also monitors the Relative Percent Difference (RPD) measurement of precision. Control charts are available to each individual laboratory unit to monitor the data generated in its facility using control charts that have been programmed to identify various trends in the analytical results. If trends in the data are perceived, various means of corrective action may then be employed in order to prevent future problems with the analytical system(s). Finally, data quality reports using control charts are generated for

specific clients and projects pursuant to contract requirements. The control charting procedure is described in SOP *Control Limits* (CE-QA009).

14.3.16 Glassware Washing

Glassware washing and maintenance play a crucial role in the daily operation of a laboratory. The glassware used at ALS - Kelso undergoes a rigorous cleansing procedure prior to every usage. A number of SOPs have been generated that outline the various procedures used at ALS; each is specific to the end-use of the equipment as well as to the overall analytical requirements of the project. In addition, other equipment that may be routinely used at the laboratory is also cleaned following instructions in the appropriate SOP.

14.3.17 Uncertainty

Measurement uncertainty is associated with most of the results obtained in laboratory testing. It may be meaningful to estimate the extent of the uncertainty associated with each result generated by the laboratory. It is also useful to recognize that this measurement uncertainty is likely to be much less than that associated with sample collection activities. The uncertainty associated with the analytical measurement processes can be estimated from quality control data. When requested, the laboratory provides uncertainty information as described in the SOP *Estimate of Uncertainty of Analytical Measurements* (CE-QA010). The estimation of uncertainty relates only to measurements conducted in the laboratory.

14.4 When data quality objectives or quality control measures are not met, due to the sample matrix or anomalies, incompatibility of the methodology and sample type, statistical outliers, random error, or other factors, it may be necessary to apply data qualifiers to reported data. A list of standard data qualifiers is given in Appendix H.

15) Control of Non-Conforming Environmental Testing Work

The laboratory takes all appropriate steps necessary to ensure all sample results are reported with acceptable quality control results. When sample results do not conform to established quality control procedures, responsible management will evaluate the significance of the nonconforming work and take corrective action to address the nonconformance.

Nonconforming events such as errors, deficiencies, deviations from SOP, proficiency (PT) failure or results that fall outside of established QC limits are documented using the NCAR database. The procedure and responsibilities for addressing nonconforming work is defined in SOP *Nonconformance and Corrective Action* (CE-QA008). Nonconformances are reported to the client using various means (voice, email, narrative, etc.). When a nonconformance occurs that casts doubt on the validity of the test results or additional client instructions are needed, the Project Manager notifies the client the same business day that the nonconformance is confirmed and reported. The QAM reviews each problem, ensuring that appropriate corrective action has been taken by the appropriate personnel. The QAM periodically reviews all NCARs looking for chronic, systematic problems that need more in-depth investigation and alternative corrective action consideration. In addition, the appropriate Project Manager is promptly notified of any problems in order to inform the client and proceed with any action the client may want to initiate.

Results from non-conforming environmental testing work generally require the need for qualified data on analytical reports. A list of standard data qualifiers is given in Appendix H. Additionally, the report narrative will provide an explanation of the nonconformance and potential impact on results.

16) Corrective Action, Preventive Action, and Improvement

If a quality control measure is found to be out of control, and the data is to be reported, all samples associated with the failed quality control measure shall be reported with the appropriate data qualifier(s). Failure to meet established analytical controls, such as the quality control objectives, prompts corrective action. Corrective action may take several forms and may involve a review of the calculations, a check of the instrument maintenance and operation, a review of analytical technique and methodology, and reanalysis of quality control and field samples. If a potential problem develops that cannot be solved directly by the responsible analyst, the supervisor, team leader, the department manager, and/or the QAM may examine and pursue alternative solutions. In addition, the appropriate Project Manager is notified in order to ascertain if the client needs to be notified.

Part of the corrective action process involves determining the root cause. Identifying the root cause of a nonconformance can be difficult, but important for implementing effective corrective action. Root cause principles are used to determine assignable causes, which leads to corrective action taken to prevent recurrence. Various preventive action processes are used for eliminating a potential problem or averting a problem before it occurs. This is explained in SOP *Nonconformance and Corrective Action* (CE-QA008).

Preventive action is focused on using existing information or experiences to anticipate potential problems and eliminating the likely causes of them. Preventive action is a pro-active process and tied to results from corrective action as well as opportunities for improvement. ALS – Kelso used preventive action processes to avoid errors and implement improvements. The SOP *Preventive Action* (CE-GEN004) describes procedures used. Examples of preventive action are given in the SOP. The laboratory also uses ideas from staff, client feedback, and other input mechanisms to identify potential improvements. The monthly lab-wide meeting regularly includes reports on improvements made or underway.

16.1 Preventive maintenance

Preventive maintenance is a crucial element of the QA program. Equipment and instruments at ALS - Kelso are regularly maintained by qualified laboratory staff or under commercial service contracts. All instruments are operated and maintained according to the instrument operating manuals. All routine and special maintenance activities pertaining to the instruments are recorded in instrument maintenance logbooks. The maintenance logbooks used at ALS Environmental, Kelso contain extensive information about the instruments used at the laboratory, including:

- The equipment's serial number;
- Date the equipment was received;
- Date the equipment was placed into service;
- Condition of equipment when received (new, used, reconditioned, etc.); and
- Prior history of damage, malfunction, modification or repair (if known).

Preventive maintenance procedures, frequencies, etc. are available for each instrument used at ALS. They may be found in the various SOPs for routine methods performed on an instrument and may also be found in the operating or maintenance manuals provided with the equipment at the time of purchase.

Responsibility for ensuring that routine maintenance is performed lies with the section supervisor. In the case of non-routine repair of capital equipment, the section supervisor is responsible for providing the repair, either by performing the repair themselves with manufacturer guidance or by acquiring on-site manufacturer repair. Each laboratory section maintains a critical parts inventory. This inventory or "parts

list" also includes the items needed to perform any other routine maintenance and certain in-house non-routine repairs such as gas chromatography/mass spectrometry jet separators and electron multipliers and ICP/MS nebulizer. When performing maintenance on an instrument (whether preventive or corrective), additional information about the problem, attempted repairs, etc. is also recorded in the notebook. Typical logbook entries include the following information:

- Details and symptoms of the problem;
- Repairs and/or maintenance performed;
- Description and/or part number of replaced parts;
- Source(s) of the replaced parts;
- Analyst's signature and date; and
- Demonstration of return to analytical control.

See the Appendix E for a list of equipment and whether primarily maintained by laboratory of service providers.

17) Control of Records

ALS - Kelso maintains a records system which ensures that all laboratory records of analysis data retained and available. Analysis data is retained for 5 years from the report date unless contractual terms or regulations specify a longer retention time. The archiving system is described in the SOP for *Data Archiving* (ADM-ARCH).

17.1 Documentation and Archiving of Sample Analysis Data

The archiving system includes the following items for each set of analyses performed:

- Benchsheets describing sample preparation (if appropriate) and analysis;
- Instrument parameters (or reference to the data acquisition method);
- Sample analysis sequence;
- Instrument printouts, including chromatograms and peak integration reports for all samples, standards, blanks, spikes and reruns;
- Logbook ID number for the appropriate standards;
- Copies of report sheets submitted to the work request file; and
- Copies of Nonconformity and Corrective Action Reports, if necessary.

Individual sets of analyses are identified by analysis date and service request number. Since many analyses are performed with computer-based data systems, the final sample concentrations can be automatically calculated. If additional calculations are needed, they are written on the integration report or securely stapled to the chromatogram, if done on a separate sheet.

For organics analysis, data applicable to all analyses within the batch, such as GCMS tunes, CCVs, batch QC, and analysis sequences; are kept using a separate documentation system. This system is used to archive data on a batch-specific basis and is segregated according to the date of analysis. This system also includes results for the most recent calibration curves, as well as method validation results.

18) Audits

Quality audits are an essential part of the Quality Assurance program. There are two types of audits used at the facility: System Audits are conducted to qualitatively evaluate the operational details of the QA program, while Performance Audits are conducted by analyzing proficiency testing samples in order to quantitatively evaluate the outputs of the various measurement systems.

18.1 System Audits

The system audit examines the presence and appropriateness of laboratory systems. External system audits of ALS/Kelso are conducted regularly by various regulatory agencies and clients. Appendix J lists the certification and accreditation programs in which ALS/Kelso participates. Programs and certifications are added as required.

Internal system audits of ALS/Kelso are conducted regularly under the direction of the Quality Assurance Manager. The internal audit procedures are described in SOP *Internal Audits* (CE-QA001). The internal audits are performed as follows:

- System audit – this is an annual audit of the implementation of the quality system in the laboratory.
- Process audit – this is an audit of all operational areas in the laboratory to evaluate compliance with operational and technical procedures. Focus is on sample handling, preparation and analysis and technically sound practices. Three primary concepts are 1) is the procedure in use the same as that described in the SOP, 2) the use of sound analytical techniques and practices, and 3) sample handling/preparation. Topics as calibration, sample/analytical batching, standards traceability, QC criteria, instrument operation and maintenance, data interpretation, and reporting results are included. Hardcopy data and/or report audits may be included.

  Process audits may be one larger audit event or a series of audits such that all areas of the laboratory are audited over a one year period. Audits conducted over the four calendar quarters will follow the schedules listed in an audit plan.
- Electronic data audits focus on organic chromatographic data and include an examination of audit trails, peak integrations, calibration practices, GCMS tuning data, use of appropriate files, and other components of the analysis. Each applicable instrument is periodically audited using audit software and randomly selected data files.

All audit findings and corrective actions are documented. The results of each audit are reported to the Laboratory Director and Department Managers for review. Any deficiencies identified are summarized in the audit report. Managers must respond with corrective actions correcting the deficiency within a defined timeframe. Should problems impacting data quality be found during an internal audit, any client whose data is adversely impacted will be given written notification within the corrective action period (if not already provided).

Additional internal audits or data evaluations may be performed as needed to address any potential data integrity issues that may arise.

18.2 Performance Audits

ALS - Kelso participates in the analysis of inter-laboratory proficiency testing (PT) samples. Participation in PT studies is performed on a regular basis and is designed to evaluate all analytical areas of the laboratory. General procedures for these analyses are described in SOP *Proficiency Sample Testing Analysis* (CE-QA006). ALS - Kelso routinely participates in the following studies:

- Water Pollution (WP) and additional water parameters, 2 per year.

- Water Supply (WS) PT studies, 2 per year.
- Hazardous Waste/Soil/UST PT studies, 2 per year.
- Microbiology (WS and WP) PT studies, 2 per year.
- State-specific Underground Storage Tank PT studies, 1 per year, or as specified for accreditation.
- Other studies as required for certifications, accreditations, or validations.

PT samples are processed by entering them into the LIMS system as samples and are processed the same as field samples (following the PT provider instructions). The laboratory sections handle samples the same as field samples, performing the analyses following method requirements and performing data review. The laboratory sections submit results to the QA Manager for subsequent reporting to the appropriate agencies or study provider. Results of the performance evaluation samples and audits are received by the QAM and distributed to Laboratory Director and department managers for review. For any results outside acceptance criteria, the analysis data is reviewed to identify a root cause for the deficiency, and corrective action is taken and documented through nonconformance (NCAR) procedures.

19) Management Review

An annual Review of the laboratory's quality system and testing activities is conducted by the laboratory's management team to ensure the continuing suitability and effectiveness of the quality system and testing activities and to introduce any necessary changes or improvements. The review ensures that the quality system of the laboratory continues to conform to the requirements of the ISO 17025:2005 and various accrediting authorities, including NELAP/TNI.

General procedures for the Review are described in *Laboratory Management Review* (SOP CE-QA005). When conducting the review a standard list of items and categories is evaluated. The quality policies and their relation to testing activities are reviewed and any changes that are necessary are identified. The review also notes significant changes that have taken place or need to take place in the quality system; and the organization, facilities, equipment, procedures, and activities of the laboratory.

The Review is documented by the laboratory QA Manager. Action items, including preventive actions and improvements, should be identified. Results should feed into the laboratory's planning process planning.

20) Personnel

20.1 Personnel Training

Job descriptions, including technical position descriptions, are used for all employees, regardless of position or level of seniority. These documents are maintained by the Human Resources personnel and are available for review. In order to assess the technical capabilities and qualifications of a potential employee, all candidates for employment are evaluated, in part, against the appropriate technical description.

Training begins the first day of employment at ALS - Kelso when the company policies are presented and discussed. Safety and Quality System requirements are integral parts of initial and ongoing training processes at the laboratory. Safety training begins with the reading of the ALS Chemical Hygiene Plan. Employees are also required to attend periodic safety meetings where additional safety training may be performed by the Environmental, Health and Safety Officer.

Quality Systems training begins with QA orientation for new employees which includes reading the Quality Assurance Manual and ethics/data integrity introductory training. Additional training on laboratory quality systems as they relate to job functions is incorporated into training plans. Employees are responsible for complying with the requirements of the QA Manual and QA/QC requirements associated with their function(s).

ALS - Kelso also encourages its personnel to continue to learn and develop new skills that will enhance their performance and value to the company. Ongoing training occurs for all employees through a variety of mechanisms. The corporate, company-wide training and development program, external and internal technical seminars and training courses, and laboratory-specific training exercises are all used to provide employees with professional growth opportunities.

All technical training is documented and records are maintained in the QA department. Training requirements and its documentation are described in SOP *ALS-Kelso Training Procedure* (ADM-TRAIN). A training plan is developed whenever an employee starts a new procedure to new position. The training plan includes a description of the step-by-step process for training an employee and for initial demonstration of capability. Where the analyst performs the entire procedure, a generic training plan may be used.

20.2 Initial Demonstration of Capability (IDOC)

Training in analytical procedures typically begins with the reading of the SOP for the method. Hands-on training begins with the observation of an experienced analyst performing the method, followed by the trainee performing the method under close supervision, and culminating with independent performance of the method on quality control samples. Successful completion of the applicable Demonstration of Capability analysis qualifies the analyst to perform the method independently. Demonstration of Capability is performed by one of the following:

- Successful completion of an Initial Precision and Recovery (IPR) study (required where mandated by the method).
- Analysis of 4 consecutive Laboratory Control Samples, with acceptable accuracy and precision.
- Where spiking is not possible but QC standards are used (“non-spiked” LCS), analysis of 4 consecutive LCS analyses with acceptable accuracy and precision.
- Where one of the three above is not possible, special requirements are as follows:
    - Total Settleable Solids: Successful single-blind PT sample analysis and duplicate results with RPD<10%.
    - Color: Four consecutive prepared LCSs with acceptable accuracy and precision of <10% RSD.
    - Physical Tests (Grain size, Corrosivity to Steel, etc.): Supervisor acknowledgement of training and approval.

A flowchart identifying the Demonstration of Proficiency requirements is given in Figure 20-1. The flowchart identifies allowed approaches to assessing Demonstration of Capability when a 4-replicate study is not mandated by the method, when spiking is not an option, or when QC samples are not readily available.

20.3 Continuing Demonstration of Proficiency

A periodic demonstration of proficiency is required to maintain continuing qualification. Continuing Demonstration of Proficiency is required each year, and may be performed one of the following ways:

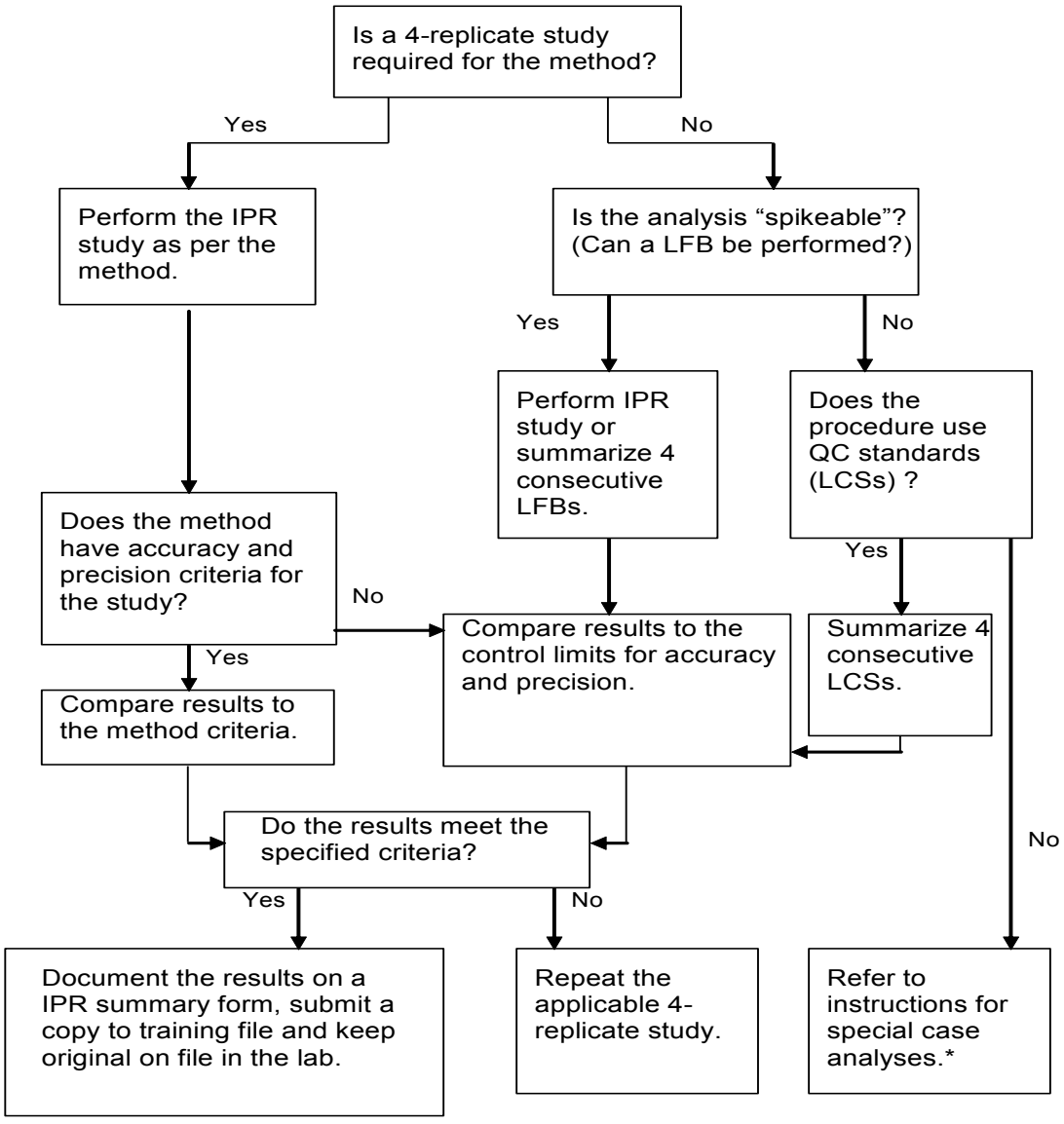
- Successful performance on external (independent) single-blind sample analyses using the test method, or a similar test method using the same technology. I.e. PT sample or QC sample blind to the analyst.
- Performing Initial Demonstration of Capability as described above, with acceptable levels of precision and accuracy.
- Analysis of at least 4 consecutive LCSs with acceptable levels of accuracy and precision from in-control analytical batches.
- If the above cannot be performed, analysis of authentic samples with results statistically indistinguishable from those obtained by another trained analyst.
- For methods for which PT samples are not available and a spiked analysis (LFB, MDL, etc.) is not possible, analysis of field samples that have been analyzed by another analyst with statistically indistinguishable results.

20.4 Documentation of Training

Records are maintained to indicate the employee has the necessary training, education, and experience to perform their functions. Information of previously acquired skills and abilities for a new employee is maintained in Human Resources personnel files and internal resumes. The QA department maintains a record of the various technical skills and training acquired while employed by ALS. Information includes the employee's name, a description of the skill including the appropriate method and SOP reference, the mechanism used to document proficiency, and the date the training was completed. General procedures for documenting technical training are described in SOP *ALS-Kelso Training Procedure* (ADM-TRAIN).

Figure 20-1

Demonstration of Proficiency Flowchart



21) Reporting of Results

ALS - Kelso reports the analytical data produced in its laboratories to the client via the Analytical Report. This report includes a transmittal letter, a case narrative, client project information, sample receipt and chain of custody information, specific test results, quality control data (as requested), and any other project-specific support documentation. The following procedures describe the procedures used for data reduction, validation and reporting.

21.1 Data Reduction and Review

Results are generated by the analyst who performs the analysis and works up the raw data. All data is initially reviewed and processed by analysts using appropriate methods (e.g., chromatographic software, instrument printouts, hand calculation, etc.). Equations used for calculation of results are found in the applicable analytical SOPs. Policies and procedures for manual editing of data are established. The analyst making the change must initial and date the edited data entry, without obliteration of the original entry. The policies and procedures are described in the SOP *Making Entries onto Analytical Records* (CE-QA007).

The resulting data set is either manually entered (e.g., titrimetric or microbiological data) into an electronic report form or is electronically transferred into the report. Once the complete data set has been transferred into the proper electronic report form(s), it is then printed. The resulting hardcopy version of the electronic report is then reviewed by the analyst for accuracy. Once the primary analyst has checked the data for accuracy and acceptability, the data and report hardcopy is forwarded to the supervisor or second qualified analyst who reviews the data. Where calculations are not performed using a validated software system, the reviewer rechecks a minimum of 10% of the calculations. Analysts performing routine testing are responsible for generating a data quality narrative or data review document with every analytical batch processed. This report also allows the analyst to provide appropriate notes and/or a narrative if problems were encountered with the analyses. A Nonconformance and Corrective Action Report (NCAR) may also be attached to the data prior to review. Supervisors or qualified analysts review all of the completed analytical batches to ensure that all QC criteria have been examined and any deficiencies noted and addressed. Data review procedures are described in the SOP for *Laboratory Data Review Process* (ADM-DREV).

Policies and procedures for electronic manual integration of chromatographic data are established. The analyst performing the integration must document the integration change by printing both the “before” and “after” integrations and including them in the raw data records. The policies and procedures are described in SOP *Manual Integration Policy* (CE-QA002) and SOP *Manual Integration of Chromatographic Peaks* (ADM-MI).

21.1.1 Validation of Results

The validity of the data generated is assessed through the evaluation of the sample results, calibrations, and QC samples (method blanks, laboratory control samples, sample duplicates, matrix spikes, trip blanks, etc.). A brief description of the evaluation of these analyses is described below, with details listed in applicable SOPs. The criteria for evaluation of QC samples are listed within each method-specific SOP. Other data evaluation measures may include (as necessary) a check of the accuracy check of the QC standards and a check of the system sensitivity. Data transcriptions and calculations are also reviewed.

Note: Within the scope of this document, all possible data assessment requirements for various project protocols cannot be included in the listing below. This listing gives a general description of data evaluation practices used in the laboratory in compliance with NELAP Quality Systems requirements. Additional requirements exist for certain programs, such as projects under the DoD QSM protocols, and project-specific QAPPs.

- Initial Calibration – Following the analysis of calibration standards according to the applicable SOP the data is fit to an applicable and allowed calibration model (correlation coefficient, linear, average response factor, quadratic, etc.) and the resulting calibration is compared to specified criteria. If the calibration meets criteria analysis may continue. If the calibration fails, any problems are isolated and corrected and the calibration standards reanalyzed. Following calibration and analysis of the independent calibration verification standard(s) the percent difference for the ICV is calculated. If the percent difference is within the specified limits the calibration is complete. If not, the problem associated with the calibration and/or ICV are isolated and corrected and verification and/or calibration is repeated.
- Continuing Calibration Verification (CCV) – Following the analysis of the CCV standard the percent difference is calculated and compared to specified criteria. If the CCV meets the criteria analysis may continue. If the CCV fails, routine corrective action is performed and documented and a 2nd CCV is analyzed. If this CCV meets criteria, analysis may continue, including any reanalysis of samples that were associated with a failing CCV. If the routine corrective action failed to produce an immediate CCV within criteria, then either acceptable performance is demonstrated (after additional corrective action) with two consecutive calibration verifications or a new initial calibration is performed.
- Method Blank – Results for the method blank are calculated as performed for samples. If results are less than the MRL (<½ MRL for DoD projects), the blank may be reported. If not, associated sample results are evaluated to determine the impact of the blank result. If possible, the source of the contamination is determined. If the contamination has affected sample results the blank and samples are reanalyzed. If positive blank results are reported, the blank (and sample) results are flagged with an appropriate flag, qualifier, or footnote.
- Sample Results (Inorganic) – Following sample analysis and calculations (including any dilutions made due to the sample matrix) the result is verified to fall within the calibration range. If not, the sample is diluted and analyzed to bring the result into calibration range. When sample and sample duplicates are analyzed for precision, the calculated RPD is compared to the specified limits. The sample and duplicate are reanalyzed if the criteria are exceeded. The samples may require re-preparation and reanalysis. For metals, additional measures as described in the applicable SOP may be taken to further evaluate results (dilution tests and/or post-digestion spikes). Results are reported when within the calibration range, or as estimates when outside the calibration range. When dilutions are performed the MRL is elevated accordingly and qualified. Efforts are made to meet the project MRL's including alternative analysis.

- Sample Results (Organic) – For GC/MS analyses, it is verified that the analysis was within the prescribed tune window. If not, the sample is reanalyzed. Following sample analysis and calculations (including any dilutions made due to the sample matrix) peak integrations, retention times, and spectra are evaluated to confirm qualitative identification. Internal standard responses and surrogate recoveries are evaluated against specified criteria. If internal standard response does not meet criteria, the sample is diluted and reanalyzed. Results outside of the calibration range are diluted to within the calibration range. For GC and HPLC tests, results from confirmation analysis are evaluated to confirm positive results and to determine the reported value. The procedure to determine which result to report is described in the SOP for *Confirmation Procedure for GC and HPLC Analysis* (SOC-CONF). If obvious matrix interferences are present, additional cleanup of the sample using appropriate procedures may be necessary and the sample is reanalyzed. When dilutions are performed the MRL is elevated accordingly and qualified. Efforts are made to meet the project MRL's including additional cleanup.
- Surrogate Results (Organic) – The percent recovery of each surrogate is compared to specified control limits. If recoveries are acceptable, the results are reported. If recoveries do not fall within control limits, the sample matrix is evaluated. When matrix interferences are present or documented, the results are reported with a qualifier that matrix interferences are present. If no matrix interferences are present and there is no cause for the outlier, the sample is reprepared and reanalyzed. However, if the recovery is above the upper control limit with non-detected target analytes, the sample may be reported. All surrogate recovery outliers are appropriately qualified on the report.
- Duplicate Sample and/or Duplicate Matrix Spike Results – The RPD is calculated and compared to the specified control limits. If the RPD is within the control limits the result is reported. If not, an evaluation of the sample is made to verify that a homogenous sample was used. Despite the use of homogenizing procedures prior to sample preparation or analysis, the sample may not be homogenous or duplicate sample containers may not have been sample consistently. If non-homogenous, the result is reported with a qualifier about the homogeneity of the sample. Also, the results are compared to the MRL. If the results are less than five times the MRL, the results are reported with a qualifier that the high RPD is due to the results being near the MRL. If the sample is homogenous and results above five times the MRL, the samples and duplicates are reanalyzed. If re-analysis also produces out-of-control results, the results are reported with an appropriate qualifier.
- Laboratory Control Sample Results – The LCS percent recovery is calculated and compared to specified control limits. If the recovery is within control limits, the analysis is in control and results may be reported. If not, this indicates that the analysis is not in control. Samples associated with the 'out of control' LCS, shall be considered suspect and the samples re-extracted or re-analyzed or the data reported with the appropriate qualifiers. For analysis where a large number of analytes are in the LCS, it becomes more likely that some analytes (marginal exceedances) will be outside the control limits. The

procedure described in the 2009 NELAC standards, V1M4 Section 1.7.4.2 are used to determine if the LCS is effective in validating the analytical system and the associated samples.

- Matrix Spike Results – The MS percent recovery is calculated and compared to specified control limits. If the recovery is within control limits the results are reported. If not, and the LCS is within control limits, this indicates that the matrix potentially biases analyte recovery. It is verified that the spike level is at least five times the background level. If not, the results are reported with a qualifier that the background level is too high for accurate recovery determination. If matrix interferences are present or results indicate a potential problem with sample preparation, steps may be taken to improve results; such as performing any additional cleanups, dilution and reanalysis, or re-preparation and reanalysis. Results that do not meet acceptance limits are reported with an appropriate qualifier.

21.1.2 Qualitative Data Evaluation

All sample results and QC results are reviewed to ensure correct identification of target analytes, when not inherent to the test method. Details particular to each analysis are given in the analytical SOP.

Identification criteria for GC, LC or GC/MS methods are summarized below:

- GC and LC Methods
  - The analyte must fall within the retention time window specified in the applicable SOP. The retention time window is established prior to analysis and documented.
  - For analyses all positive results are confirmed by a second column, a second detector, a second wavelength (HPLC/UV), or by GC/MS analysis. Details for confirmation analysis are described in the SOP *Confirmation Procedures for GC and HPLC Analyses* (SOC-CONF). Confirmation data will be provided as specified in the method.
  - When sample results are confirmed by two dissimilar columns or detectors, the agreement between quantitative results must be evaluated. The relative percent difference between the two results is calculated and evaluated against SOP and/or method criteria.
- GC/MS and LC/MS Methods - Two criteria are used to verify identification:
  - Elution of the analyte is at the same relative retention time (as defined by the method) as demonstrated in the standard.
  - The mass spectrum of the analyte in the sample must, in the opinion of a qualified analyst or the department manager, correspond to the spectrum of the analyte in the standard or the current GC/MS reference library.
  - When Tentatively Identified Compounds are to be reported for GC/MS, the spectrum for non-target peaks is compared to the current GC/MS reference library.

21.2 Data Reporting

It is the responsibility of each laboratory unit to provide the Project Manager with a final report of the data for each analysis, accompanied by signature approval. When the entire data set has been found to be acceptable, a final copy of the report is generated and approved by the laboratory supervisor, departmental manager or designated laboratory staff. The entire data package for the analysis is then placed into the service request file, and an electronic copy of the final data package is forwarded to the appropriate personnel for archival. Footnotes and/or narrative notes must accompany any data package if problems were encountered that require further explanation to the client. Each data package is submitted to the appropriate Project Manager.

When all analyses and departmental reports are completed the Project Manager reviews the entire collection of analytical data for completeness and to ensure that any and all client-specified objectives were successfully achieved. A report narrative is written by the Project Manager to explain any unusual problems with a specific analysis or sample, etc. Prior to release of the report to the client, the Project Manager reviews and approves the entire report for completeness and to ensure that any and all client-specified objectives were successfully achieved. The original raw data, along with a copy of the final report, is scanned and archived by service request number.

To the extent possible, samples shall be reported only if all QC measures are acceptable. If a QC measure is found to be out of control, and the data is to be reported, all samples associated with the failed quality control measure shall be reported with the appropriate data qualifier(s). The SOP for *Data Reporting and Report Generation* (ADM-RG) addresses the flagging and qualification of data. The ALS-defined data qualifiers, state-specific data qualifiers, or project-defined data qualifiers are used depending on project requirements. A case narrative may be written by the Project Manager to explain problems with a specific analysis or sample, etc.

When requested by the client or relevant to the validity of reported results, the estimation of measurement uncertainty will be provided to a client or regulatory agency. How the uncertainty will be reported may be dictated by the client's reporting specifications. Procedures for determining and reporting uncertainty are given in SOP *Estimation of Uncertainty of Analytical Measurements* (CE-QA010).

For subcontracted analyses, the Project Manager verifies that the report received from the subcontractor is complete. This includes checking that the correct analyses were performed, the analyses were performed for each sample as requested, a report is provided for each analysis, and the report is signed. The Project Manager accepts the report if all verification items are complete. Acceptance is demonstrated by forwarding the report to the client.

21.3 Deliverables

In order to meet individual project needs, ALS - Kelso provides several levels of analytical reports. Standard specifications for each level of deliverable are described in Table 21-1. Variations may be provided based on client or project specifications. This includes (but is not limited to) deliverables for DoD QSM projects and state-specific drinking water formats.

When requested, ALS - Kelso provides Electronic Data Deliverables (EDDs) in the format specified by client need or project specification. ALS - Kelso is capable of generating EDDs with many different formats and specifications. The EDD is prepared by report production staff using the electronic version of the laboratory report to minimize transcription errors. User guides and EDD specification outlines are used in preparing the EDD. The EDD is reviewed and compared to the hard-copy report for accuracy.

Table 21-1
Descriptions of ALS Environmental - Kelso Standard Data Deliverables*
Tier I. Routine Analytical Report includes the following:
• Transmittal letter
• Chain of custody documents and sample/cooler receipt documentation
• Sample analytical results
• Method blank results
• Surrogate recovery results and acceptance criteria for applicable organic methods
• Dates of sample preparation and analysis for all tests
• Case narrative - optional
Tier II. In addition to the Tier I Deliverables, this Analytical Report includes the following:
• Laboratory Control Sample results with calculated recovery and associated acceptance criteria
• Matrix spike results with calculated recovery and associated acceptance criteria if performed on client specific sample. Batch QC not reported unless specifically requested by client.
• Duplicate or duplicate matrix spike result(s) (as appropriate to method), with calculated relative percent difference if performed on client specific sample. Batch QC not reported unless specifically requested by client.
• Case narrative - optional
Tier III. Data Validation Package. In addition to the Tier II Deliverables, this CAR includes the following:
• Case narrative - required
• Summary forms for all associated QC and Calibration parameters, with associated control criteria/acceptance limits if performed on client specific sample. Batch QC not reported unless specifically requested by client.
• Other summary forms specified in QAPPs or project/program protocols, or those related to specialized analyses such as HRGC/MS are included.
Tier IV. Full Data Validation Package.
• All raw data associated with the sample analysis, including but not limited to: • Preparation and analysis bench sheets and instrument printouts, • For organics analyses, all applicable chromatograms, spectral, confirmation, and manual integration raw data. For GC/MS this includes tuning results, mass spectra of all positive results, and the results and spectra of TIC compounds when requested.
• QC data
• Calibration data (initial, verification, continuing, etc.),
• Calibration blanks or instrument blanks (as appropriate to method).

* If a project QAPP or program reporting protocol applies the report will be presented as required for the project.

22) Summary of Changes and Document History

Revision Number	Effective Date	Document Editor	Description of Changes
26.1	6/25/2018	C. Degner	Minor changes and updates to text sections 1-23, updated key personnel, organization charts, and SOP list. Updated appendices.

23) References for Quality System Standards, External Documents, Manuals, and Test Procedures

The analytical methods used at ALS Environmental, Kelso generally depend upon the end-use of the data. Since most of our work involves the analysis of environmental samples for regulatory purposes, specified federal and/or state testing methodologies are used and followed closely. Typical methods used at ALS Environmental, Kelso are taken from the following references:

- National Environmental Laboratory Accreditation Program (NELAP), 2009 Quality Standards.
- TNI Standard – Environmental Laboratory Sector, Volume 1, *Management and Technical Requirements for Laboratories Performing Environmental Analysis,* EL-V1-2009.
- Quality Standards. American National Standard *General requirements for the competence of testing and calibration laboratories,* ANSI/ISO/IEC 17025:2005(E)
- *DoD Quality Systems Manual for Environmental Laboratories,* Versions 4.2, 5.0, and 5.1.
- *Good Automated Laboratory Practices, Principles and Guidance to Regulations For Ensuring Data Integrity In Automated Laboratory Operations*, EPA 2185 (August 1995).
- *Manual for the Certification of Laboratories Analyzing Drinking Water*, 5th Edition, EPA 815-B-97-001 (January 2005).
- *Procedure Manual for the Environmental Laboratory Accreditation Program,* Washington Department of Ecology, 10-03-048, September 2010.
- *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, SW-846, Third Edition, (September 1986) and Updates I (July 1992), II (September 1994), IIA (August 1993), IIB (January 1995), III (December 1996), Final Update IV (February 2007), and updates posted online at https://www.epa.gov/hw-sw846/sw-846-compendium. See Chapters 1, 2, 3, and 4.
- *Methods for Chemical Analysis of Water and Wastes*, EPA-600/4-79-020, (Revised March 1983).
- *Methods for the Determination of Inorganic Substances in Environmental Samples*, EPA/600/R-93/100 (August 1993).
- *Methods for the Determination of Metals in Environmental Samples*, EPA/600/4-91/010 (June 1991) and Supplements.
- *Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater*, EPA 600/4-82-057 (July 1982) and 40 CFR Part 136, Appendix A.
- *Methods for the Determination of Organic Compounds in Drinking Water*, EPA/600/4-88/039 (December 1988) and Supplements.

- Standard Methods for the Examination of Water and Wastewater, 22th Edition (2012) and SM On-Line. See Introduction in Part 1000.
- 40 CFR Part 136, Guidelines for Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act, and EPA Method Update Rule 2007, 2012, and 2017.
- 40 CFR Part 141, National Primary Drinking Water Regulations and EPA Method Update Rule 2007.
- Analytical Methods for Petroleum Hydrocarbons, ECY 97-602, Washington State Department of Ecology, June 1997.
- State-specific total petroleum hydrocarbon methods for the analysis of samples for gasoline, diesel, and other petroleum hydrocarbon products (Alaska, Arizona, California, Oregon, Washington, Wisconsin, etc.).
- Annual Book of ASTM Standards, Part 31, Water.
- U. S. EPA Contract Laboratory Program National Functional Guidelines for Organic Data Review, EPA-540/R-94/012 (February 1993).
- U. S. EPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review, EPA-540/R-94/013 (February 1994).
- Recommended Protocols for Measuring Selected Environmental Variables in Puget Sound, for USEPA and USACE (March 1986), with revisions through April 1997.
- WDOE 83-13, Chemical Testing Methods for Complying with the State of Washington Dangerous Waste Regulations (March 1982) and as Revised (July 1983 and April 1991).
- Identification and Listing of Hazardous Waste, California Code of Regulations, Title 22, Division 4.5, Chapter 11.
- Analytical Methods for the Determination of Pollutants in Pulp and Paper Industry Wastewater, EPA 821-R-93-017 (October 1993).
- Analytical Methods for the Determination of Pollutants in Pharmaceutical Manufacturing Industry Wastewaters, EPA 821-B-98-016 (July 1998).
- National Council of the Pulp and Paper Industry for Air and Stream Improvement (NCASI).

Internal program-level QA documents are listed in Appendix I.

APPENDIX A – Glossary

Acceptance Criteria: Specified limits placed on characteristics of an item, process, or service defined in requirement documents.

Accreditation: The process by which an agency or organization evaluates and recognizes a laboratory as meeting certain predetermined qualifications or standards, thereby accrediting the laboratory.

Accreditation Body: The territorial, state or federal agency having responsibility and accountability for environmental laboratory accreditation and which grants accreditation.

Accreditation Standard: The document describing the elements of laboratory accreditation that has been developed and established within the consensus principles of standard setting and meets the approval requirements of standard adoption organizations procedures and policies.

Accuracy: The degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias) components that are due to sampling and analytical operations; a data quality indicator.

Analysis Date: The calendar date of analysis associated with the analytical result reported for an accreditation or experimental field of proficiency testing.

Analyst: The designated individual who performs the "hands-on" analytical methods and associated techniques and who is the one responsible for applying required laboratory practices and other pertinent quality controls to meet the required level of quality.

Analytical Uncertainty: A subset of Measurement Uncertainty that includes all laboratory activities performed as part of the analysis.

Assessment: The evaluation process used to measure or establish the performance, effectiveness, and conformance of an organization and/or its systems to defined criteria (to the standards and requirements of laboratory accreditation).

Audit: A systematic and independent examination of facilities, equipment, personnel, training, procedures, record-keeping, data validation, data management, and reporting aspects of a system to determine whether QA/QC and technical activities are being conducted as planned and whether these activities will effectively achieve quality objectives.

Bias: The systematic distortion of a measurement process, which causes errors in one direction (i.e., the expected sample measurement is different from the sample's true value).

Calibration: A set of operations that establish, under specified conditions, the relationship between values of quantities indicated by a measuring instrument or measuring system, or values represented by a material measure or a reference material, and the corresponding values realized by standards.

Calibration Standard: A substance or reference material used for calibration.

Certified Reference Material (CRM): Reference material accompanied by a certificate, having a value, measurement uncertainty, and stated metrological traceability to a national metrology institute.

Chain of Custody: Record that documents the possession of the samples from the time of collection to receipt in the laboratory. This record generally includes: the number and types of containers; the mode of collection; the collector; time of collection; preservation; and requested analyses.

Confirmation: Verification of the identity of a component through the use of an approach with a different scientific principle from the original method. These may include, but are not limited to: second column confirmation, alternate wavelength, derivatization, mass spectral interpretation, alternative detectors, or additional cleanup procedures.

Data Reduction: The process of transforming the number of data items by arithmetic or statistical calculation, standard curves, and concentration factors, and collating them into a more useful form.

Demonstration of Capability: A procedure to establish the ability of the analyst to generate analytical results of acceptable accuracy and precision.

Field of Accreditation: Those matrix, technology/method, and analyte combinations for which the accreditation body offers accreditation.

Field of Proficiency Testing (FoPT): Analytes for which a laboratory is required to successfully analyze a PT sample in order to obtain or maintain accreditation, collectively defined as: matrix, technology/method, analyte.

Finding: An assessment conclusion referenced to a laboratory accreditation standard and supported by objective evidence that identifies a deviation from a laboratory accreditation standard requirement.

Holding Time: The specified maximum time that can elapse between two specified sampling and/or analytical activities.

Internal Standard: A known amount of standard added to a test portion of a sample as a reference for evaluating and controlling the precision and bias of the applied analytical method.

Laboratory Control Sample (however named, such as laboratory fortified blank, spiked blank, or QC check sample): A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes and taken through all sample preparation and analytical steps of the procedure unless otherwise noted in a reference method. It is generally used to establish evaluate accuracy and bias for associated sample analyses.

Legal Chain of Custody Protocols: Procedures employed to record the possession of samples from the time of sampling through the retention time specified by the client or program. These procedures are performed at the special request of the client and include the use of a Chain of Custody Form that documents the collection, transport, and receipt of compliance samples by the laboratory. In addition, these protocols document all handling of the samples within the laboratory.

Limit of Detection (LOD): A laboratory's estimate of the minimum amount of an analyte in a given matrix that an analytical process can reliably detect.

Limit of Quantitation (LOQ): The minimum levels, concentrations, or quantities of a target variable (e.g., target analyte) that can be reported with a specified degree of confidence.

Lower Limit of Quantitation (LLOQ): A criteria specific to SW-846 8000 series methods. The LLOQ is the lowest concentration at which the laboratory has demonstrated target analytes can be reliably measured and reported with a certain degree of confidence, which must be ≥ the lowest point in the calibration curve.

Matrix: The substrate of a test sample.

Matrix Duplicate: A replicate matrix prepared in the laboratory and analyzed to obtain a measure of precision.

Matrix Spike (spiked sample or fortified sample): A sample prepared, taken through all sample preparation and analytical steps of the procedure unless otherwise noted in a referenced method, by adding a known amount of target analyte to a specified amount of sample for which an independent test result of target analyte concentration is available. Matrix spikes are used to determine the effect of the matrix on a method's recovery efficiency.

Matrix Spike Duplicate (spiked sample or fortified sample duplicate): A replicate matrix spike prepared in the laboratory and analyzed to obtain a measure of the precision of the recovery for each analyte.

Measurement System: A method, as implemented at a particular laboratory, and which includes the equipment used to perform the test and the operator(s).

Method: A body of procedures and techniques for performing an activity (e.g., sampling, chemical analysis, quantification), systematically presented in the order in which they are to be executed.

National Institute of Standards and Technology (NIST): A federal agency of the US Department of Commerce's Technology Administration that is designed as the United States National Metrology Institute (NMI).

Precision: The degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves; a data quality indicator.

Preservation: Any conditions under which a sample must be kept in order to maintain chemical and/or biological integrity prior to analysis.

Primary Accreditation Body (Primary AB): The TNI-NELAP accreditation body responsible for assessing a laboratory's total quality system, on-site assessment, and PT performance tracking for fields of accreditation.

Procedure: A specified way to carry out an activity or process. Procedures can be documented or not.

Proficiency Testing (PT): A means to evaluate a laboratory's performance under controlled conditions relative to a given set of criteria, through analysis of unknown samples provided by an external source.

Proficiency Testing Provider (PTP): A person or organization accredited by the TNI-approved Proficiency Testing Provider Accreditor to operate a TNI-compliant PT program.

Proficiency Testing Sample (PT Sample): A sample, the composition of which is unknown to the laboratory and is provided to test whether the laboratory can produce analytical results within the specified acceptance criteria.

Proficiency Testing Study (PT Study): A single complete sequence of circulation of proficiency testing samples to all participants in a proficiency test program.

Quality Assurance: An integrated system of management activities involving planning, implementation, assessment, reporting, and quality improvement to ensure that a process, item, or service is of the type and quality needed and expected by the client.

Quality Control: The overall system of technical activities that continually measures the performance of a process, item, or service against defined standards to verify that they meet the stated requirements. Also, the system of activities and checks used to ensure that measurement systems are maintained within prescribed limits, providing protection against "out of control" conditions and ensuring that the results are of acceptable quality.

Quality Control Sample: A sample used to assess the performance of all or a portion of the measurement system.

Quality Manual: A document stating the management policies, objectives, principles, organizational structure and authority, responsibilities, accountability, and implementation of an agency, organization, or laboratory, to ensure the quality of its product and the utility of its product to its users.

Quality System: A structured and documented management system describing the policies, objectives, principles, organizational authority, responsibilities, accountability, and implementation plan of an organization for ensuring quality in its work processes, products (items), and services. The quality system provides the framework for planning, implementing, and assessing work performed by the organization and for carrying out required quality assurance (QA) and quality control (QC) activities.

Quality System Matrix: These matrix definitions be used for purposes of batch and quality control requirements:

Air and Emissions: Whole gas or vapor samples including those contained in flexible or rigid wall containers and the extracted concentrated analytes of interest from a gas or vapor that are collected with a sorbent tube, impinger solution, filter, or other device.

Aqueous: Any aqueous sample excluded from the definition of Drinking Water or Saline/Estuarine. Includes surface water, ground water effluents, and TCLP or other extracts.

Biological Tissue: Any sample of a biological origin such as fish tissue, shellfish, or plant material. Such samples are grouped according to type of tissue (i.e. marine vs. plant).

Chemical Waste: A product or by-product of an industrial process that results in a matrix not otherwise defined.

Drinking Water: Any aqueous sample that has been designated a potable or potential potable water source.

Non-Aqueous Liquid: Any organic liquid, product, or solvent not miscible in water and with <15% settleable solids.

Saline/Estuarine: Any aqueous sample from an ocean or estuary, or other salt water source.

Solids: Includes soils, sediments, sludges and other matrices with >15% settleable solids.

Raw Data: The documentation generated during sampling and analysis that records the original work steps, observations, and measurements, whether performed by an analyst or instrument. This documentation includes, but is not limited to field notes, electronic data, analysis bench sheets, run/injection logs, printouts, chromatograms, instrument outputs, and handwritten records for calibration, sample preparation, and sample analysis for field samples and QC samples.

Reference Material: Material or substance one or more of whose property values are sufficiently homogeneous and well established to be used for the calibration of an apparatus, the assessment of a measurement method, or for assigning values to materials.

Reference Standard: Standard used for the calibration of working measurement standards in a given organization or at a given location.

Sampling: Activity related to obtaining a representative sample of the object of conformity assessment, according to a procedure.

Secondary Accreditation Body (Primary AB): A TNI-NELAP accreditation body responsible that accredits the laboratory based on the Primary AB accreditation and procedures.

Selectivity: The ability to analyze, distinguish, and determine a specific analyte or parameter from another component that may be a potential interferent or that may behave similarly to the target analyte or parameter within the measurement system.

Sensitivity: The capability of a method or instrument to discriminate between measurement responses representing different levels (e.g., concentrations) of a variable of interest.

Standard Operating Procedure (SOP): A written document that details the process for an operation, analysis, or action, with thoroughly prescribed techniques and steps. SOPs are officially approved as the procedures for performing certain routine or repetitive tasks.

Technology: A specific arrangement of analytical instruments, detection systems, and/or preparation techniques.

Traceability: The ability to trace the history, application, or location of an entity by means of recorded identifications. In a calibration sense, traceability relates measuring equipment to national or international standards, primary standards, basic physical constants or properties, or reference materials. In a data collection sense, it relates calculations and data generated throughout the project back to the requirements for the quality of the project.

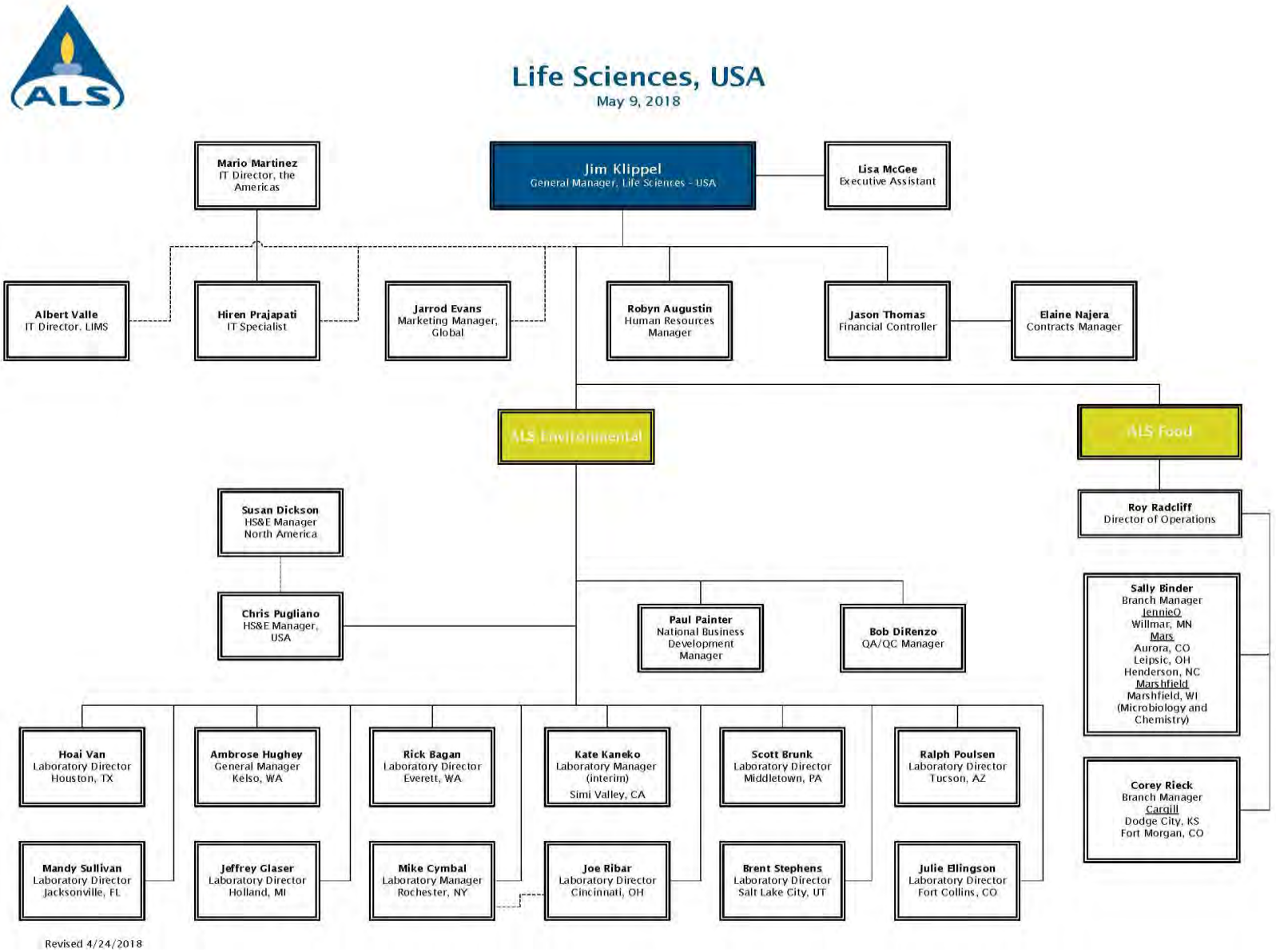
Verification: Confirmation by examination and objective evidence that specified requirements have been met.

Acronyms

ASTM - American Society for Testing and Materials
A2LA - American Association for Laboratory Accreditation
CARB - California Air Resources Board
CAS - Number Chemical Abstract Service registry Number
CFC - Chlorofluorocarbon
CFU - Colony-Forming Unit
DEC - Department of Environmental Conservation
DEQ - Department of Environmental Quality
DHS - Department of Health Services
DoD - Department of Defense
DOE - Department of Ecology
DOH - Department of Health
EPA - U. S. Environmental Protection Agency
ELAP - Environmental Laboratory Accreditation Program
GC - Gas Chromatography
GC/MS - Gas Chromatography/Mass Spectrometry
LOD - Limit of Detection
LOQ - Limit of Quantitation
LUFT - Leaking Underground Fuel Tank
M - Modified
MCL - Maximum Contaminant Level is the highest permissible concentration of a substance allowed in drinking water as established by the USEPA.
MDL - Method Detection Limit
MPN - Most Probable Number
MRL - Method Reporting Limit
NA - Not Applicable
NC - Not Calculated
NCASI - National Council of the Paper Industry for Air and Stream Improvement
ND - Not Detected
NIOSH - National Institute for Occupational Safety and Health

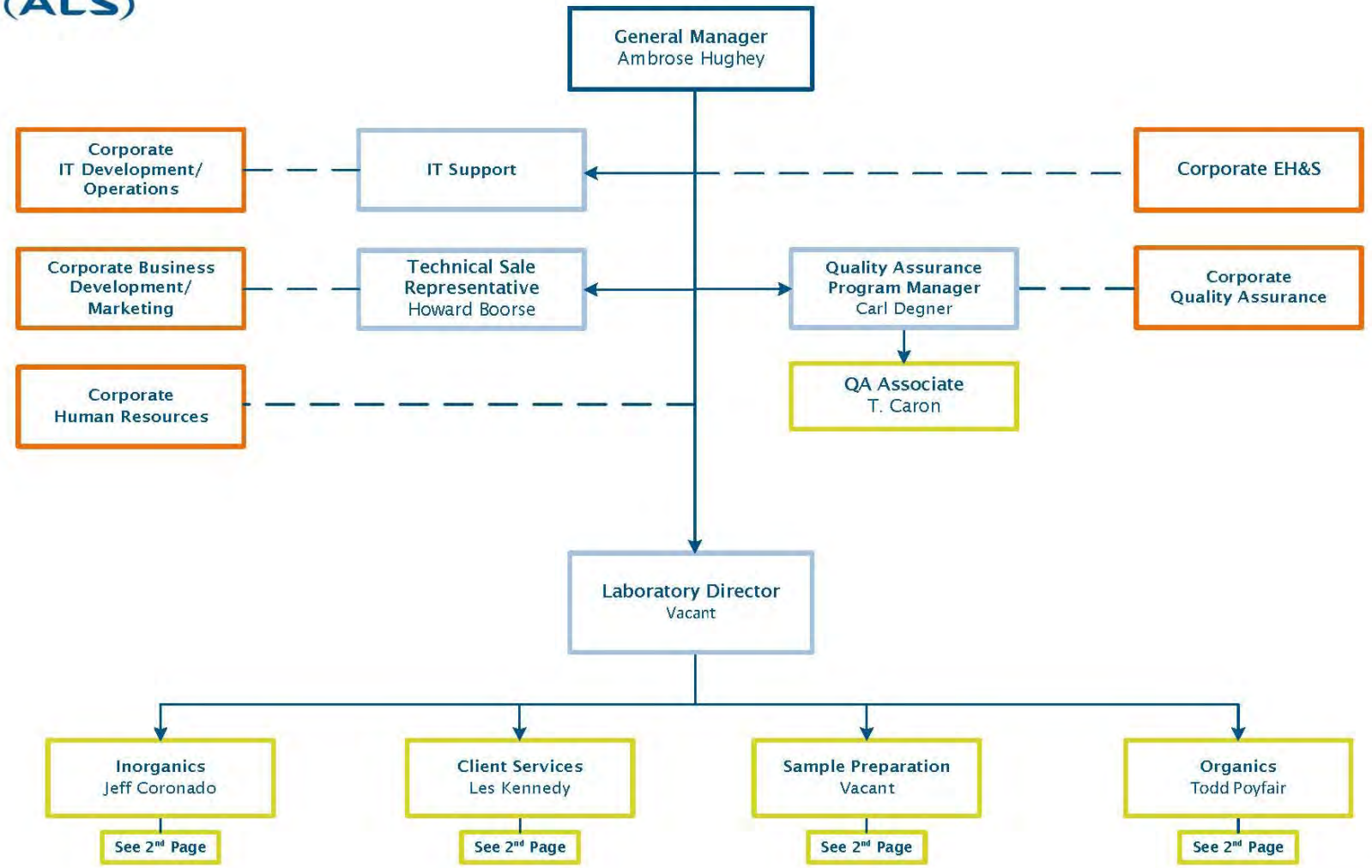
PQL - Practical Quantitation Limit
RCRA - Resource Conservation and Recovery Act
SIM - Selected Ion Monitoring
TNI – The NELAC Institute
TPH - Total Petroleum Hydrocarbons

APPENDIX B – Organization Charts, Key Personnel, and Report Signatories


Life Sciences, USA
May 9, 2018
Mario Martinez
IT Director, the Americas
Jim Klippel
General Manager, Life Sciences - USA
Lisa McGee
Executive Assistant
Albert Valle
IT Director, LIMS
Hiren Prajapati
IT Specialist
Jarrod Evans
Marketing Manager, Global
Robyn Augustin
Human Resources Manager
Jason Thomas
Financial Controller
Elaine Najera
Contracts Manager
ALS Environmental
ALS Food
Susan Dickson
HS&E Manager North America
Chris Pugliano
HS&E Manager, USA
Paul Painter
National Business Development Manager
Bob DiRenzo
QA/QC Manager
Roy Radcliff
Director of Operations
Sally Binder
Branch Manager
JennieO
Willmar, MN
Mars
Aurora, CO
Leipsic, OH
Henderson, NC
Marshfield
Marshfield, WI
(Microbiology and Chemistry)
Corey Rieck
Branch Manager
Cargill
Dodge City, KS
Fort Morgan, CO
Hoai Van
Laboratory Director
Houston, TX
Ambrose Hughey
General Manager
Kelso, WA
Rick Bagan
Laboratory Director
Everett, WA
Kate Kaneko
Laboratory Manager (interim)
Simi Valley, CA
Scott Brunk
Laboratory Director
Middletown, PA
Ralph Poulsen
Laboratory Director
Tucson, AZ
Mandy Sullivan
Laboratory Director
Jacksonville, FL
Jeffrey Glaser
Laboratory Director
Holland, MI
Mike Cymbal
Laboratory Manager
Rochester, NY
Joe Ribar
Laboratory Director
Cincinnati, OH
Brent Stephens
Laboratory Director
Salt Lake City, UT
Julie Ellingson
Laboratory Director
Fort Collins, CO
Revised 4/24/2018

Kelso, WA Laboratory

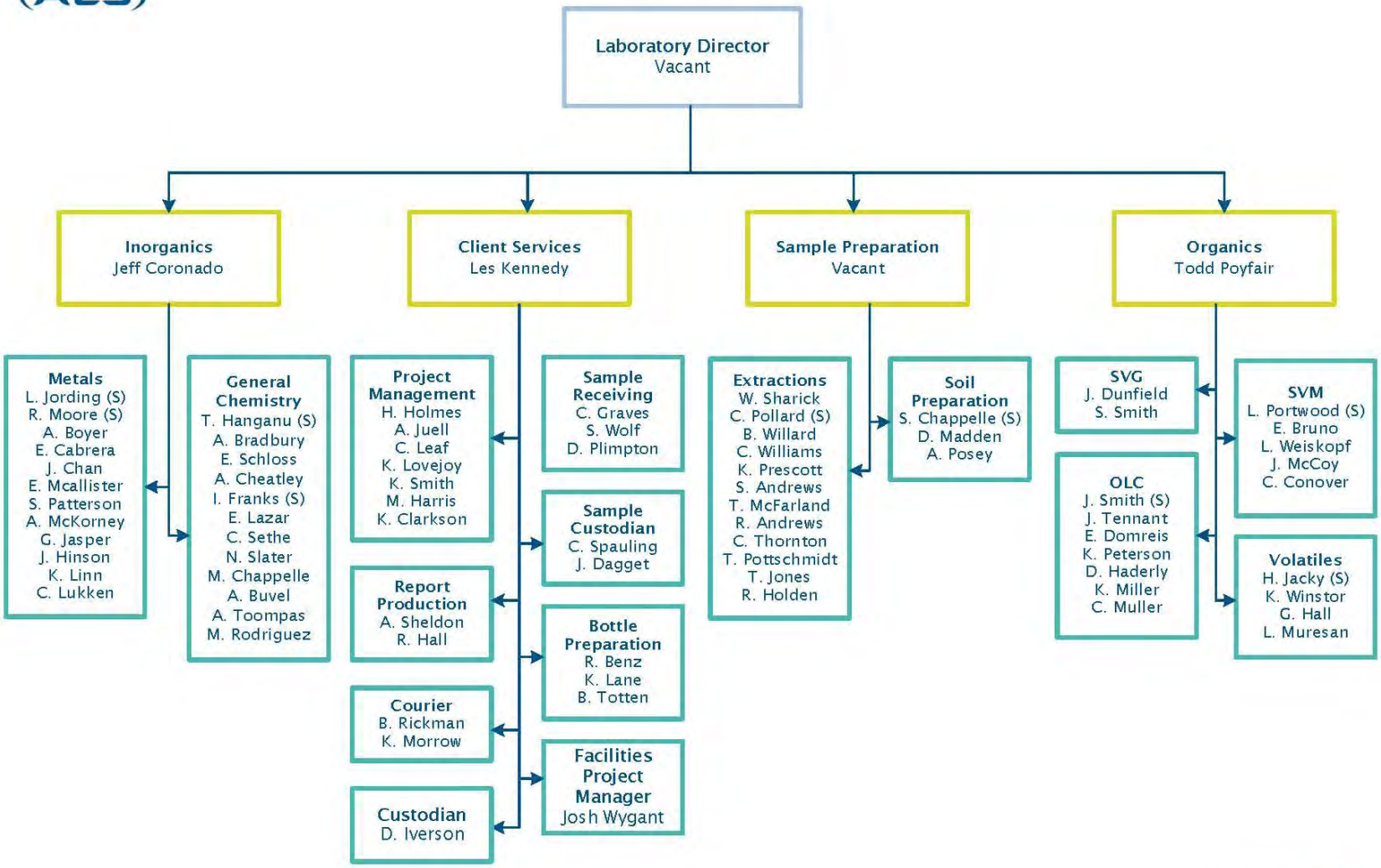
May 25, 2018



Revised 5/25/18

Kelso, WA Laboratory

May 25, 2018



Revised 5/25/18

ALS Group USA, Corp.
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Kelso, WA 98626
T +1 360 577 7222 F +1 360 636 1068

Ambrose Hughey

General Manager, 2018 – Present
Kelso Laboratory

Responsible for all phases of laboratory operations at the Kelso Laboratory, including project planning, budgeting and quality assurance. Primary duties include the direct management and operational oversight of the Kelso laboratory and all department managers.

PREVIOUS EXPERIENCE

Western Region Business Manager, 2016 – 2018
ALS Tribology
Portland, OR

Responsible for achieving the budgeted financial performance and profitable growth of the western USA business as well assisting Lab Managers with monitoring ways to increase productivity and efficiency through equipment upgrading or new technology. Develop and maintain relationships with key customer accounts for western USA including, client visits, presentations, preparation of quotations and tenders as required. Ensure the regional business is run according to strategic and business plans.

Business Manager, Portland, 2010 – 2016
ALS Tribology
Portland, OR

Multiple site business/lab manager with duties similar to laboratory manager noted below. Promote the laboratories through client contact and formal presentations, including, client visits, presentations, preparation of quotations and tenders as required. Implement ISO 17025 and gain accreditation for each location.

Laboratory Manager, Portland, 2004 – 2010
ALS Tribology
Portland, OR

Ensure staff members have the training and skills to successfully complete the tasks assigned to their positions. Optimizing sample turnaround times to ensure timely delivery of reports to clients. Advise on the recommended purchase of capital equipment and preparing CEPs as required. Prepare the annual operating budget and meet/exceed the targets as specified in that budget.

EDUCATION

Southern Illinois University
Carbondale, Illinois
BS, Chemistry
2003

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CARL DEGNER

Quality Manager, 2015 – Present
Kelso Laboratory

Directing the quality systems and ethics programs for the Kelso, WA laboratory facility. Responsible for ensuring that ALS quality systems and data integrity standards are implemented. Act as liaison with government entities involving quality, technical and operational issues. This includes maintaining accreditations and certifications, and maintaining all necessary documents (QA Manual, SOPs, and QA records). Act as primary point of contact during laboratory audits and provide audit responses and corrective actions. Coordinate performance audits (PE/PT testing) and conduct internal audits.

PREVIOUS EXPERIENCE

Technical Manager, SVM, 2011–2014
ALS Group USA, Corp.
Kelso, WA

Responsible for daily operation of Semi-volatiles GC/MS laboratory. This includes scheduling workloads of 3 analyst, data review, reporting and long-range planning for SVM laboratory. Work with PMs on client specific project requirements.

Technical Manager, SVM, 2001–2011
Columbia Analytical Services, Inc.
Kelso, WA

Same as above.

Scientist IV, SVM, 1998–2001
Columbia Analytical Services, Inc.
Kelso, WA

Responsible for all phases of operation of GC/MS systems, utilizing SIM and 8270C methodologies, including preparation of standards, QC verifications, data review, and reporting.

Project Chemist/Principal Organic Scientist, 1993–1998
Environ Express Laboratory
LaPorte, TX

Responsible for SV Extractions and GC/MS laboratories. Set up, operated, and maintained three HP GC/MS systems and worked with clients on technical issues.

EDUCATION

University of Houston – Houston, TX
MS Environmental Management
1998

University of Houston – Houston, TX
BS Biochemistry/Biophysical Science
1984

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EILEEN ARNOLD

Health, Safety and Environmental Manager, Western USA, 2015 – Present

Responsibilities include development, support and implementation of Environmental, Health and Safety policies for lab locations in the Western US, including national corporate policies for respiratory protection and hazardous waste generation. At the Kelso facility, also responsible for incident reporting and investigation, maintenance of all safety related equipment, review of monthly safety audits, and completion of all Federal and State mandated EH&S reports.

PREVIOUS EXPERIENCE

Scientist IV Metals Laboratory/Kelso Health and Safety Officer, 2012–2015
ALS Group USA, Corp.
Kelso, WA

Supervisor of the Metals reporting group responsible for ensuring timely, accurate reporting of all metals reports. Responsible for updating instrument specific data, such as MDL and control limits. Analyst for the Inductively Coupled Argon Plasma (ICAP) Emission Spectrometer. This involves digestion, instrumental analysis, and report generation for environmental samples using approved EPA techniques. Also, Environmental, Health and Safety Officer.

Scientist IV Metals Laboratory/Kelso Health and Safety Officer, 1994–2012
Columbia Analytical Services, Inc.
Kelso, WA

Same as above.

Project Chemist, 1992–1994
Columbia Analytical Services, Inc.
Kelso, WA

Duties included technical project management and customer service. Responsible for meeting the clients' needs of timely and appropriate analyses, and to act as liaison for all client-related activities within Columbia Analytical Services, Inc.

EDUCATION

Immaculata College –
Immaculata, PA
BS Chemistry
1977

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JEFF CORONADO

Manager - Specialty Laboratory Area, Metals Department Manager, 1992 - Present, General Chemistry Department Manager, 2017 - Present, Kelso Laboratory

Management of the Kelso General Chemistry and Metals Departments with a staff of 28 and annual revenues in excess of $5 million. Responsible for data quality and timeliness, revenues, expenses, workload coordination, method development efforts, and resource allocation. Participation in multiple LIMS development teams responsible for defining the ALS product.

PREVIOUS EXPERIENCE

Supervisor, GFAA Laboratory, 1989-1992
Columbia Analytical Services, Inc.
Kelso, WA

Responsibilities included supervision of metals analysis by graphite furnace atomic absorption following SW 846 and EPA CLP methodologies. Duties include workload scheduling, data review, instrument maintenance, personnel training and evaluation.

EDUCATION

Western Washington University - Bellingham, WA
BS Chemistry
1988

Western Washington University - Bellingham, WA
BA Business Administration
1985

Winter Conference on Plasma Spectrochemistry - Tucson, AZ, 2012

LC/ICP-MS Training Course - PerkinElmer, 2008

Field Immunaossay Training Course - EnSys Inc., 1995

Winter Conference on Plasma Spectrochemistry - San Diego, CA, 1994

ICP-MS Training Course - VG-Elemental, 1992

ALS Group USA, Corp.
10450 Stancliff Road, Suite 210
Houston, TX 77099
T +1 281 530 5656 F +1 281 530 5887

TODD POYFAIR

Organics Manager, 10/2017 – Present
Kelso Laboratory

Oversee the operation of the Volatiles, Semi-volatiles, and OLC laboratories. Responsibilities included organizing and prioritizing workload, training and development of staff, working with PMs on client-specific project requirements, workload coordination, method development efforts and resource allocation. Responsible for the quality and timeliness of analytical reports. Other responsibilities include ensuring compliance with ALS QA protocols, assisting staff with troubleshooting equipment, and procedural problems.

PREVIOUS EXPERIENCE

Technical Scientific and Business Development Representative, 2012-2017
ALS Group USA, Corp.
Kelso, WA
Worked with clients to define project requirements and expectations. Responsible for project development and technical project management, ensuring overall data quality and compliance with client requirements. Serve as liaison to clients and regulatory agencies functioning as a technical consultant to clients, coordinating technical proposals and sales for ALS Kelso.

Corporate IT Director / Vice President 2010-2012
Kelso, WA
Columbia Analytical Services
Phoenix, AZ

Laboratory Director / Vice President 2008-2010
Columbia Analytical Services
Phoenix, AZ
Responsible for all phases of laboratory operations at the Phoenix and Tucson Laboratories, including project planning, budgeting and quality assurance. Primary duties include the direct management and operational oversight of the Kelso laboratory and all department managers.

Department Manager 1993-2009
Columbia Analytical Services
Kelso, WA

EDUCATION

Portland State University
BS Chemistry
BA Foreign Language/German
1990/1991

ADDITIONAL EXPERIENCE

Laboratory Manager
04/1993 – 09/2008
Columbia Analytical Services, Kelso, WA

Chemist, Project Manager
08/1991 – 09/2008
Columbia Analytical Services, Kelso, WA

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Houston, TX 77099
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Lester "Les" J. Kennedy

Client Services Manager 2017–Present
Kelso, WA

Management of the Client Services Departments: Project Management, Electronic Data Deliverables & Report Production, Sample Management, Sample Control , Bottle Preparation, General Lab Receiving & Shipping, and Courier Services. Oversee the client services for approximately $15 million in revenue annually. Responsible for employee supervision, workload coordination, and adherence to all standard operating procedures within the departments. Additional duties include the permit holder with direct oversight of the labs Quarantined Soil program as well as maintaining the ALS corporate US Fish and Wildlife import permits for US locations.

PREVIOUS EXPERIENCE

Support Services Manager 2012–2017
SMO Supervisor 2006–2012
ALS/Columbia Analytical Services, Inc.
Kelso, WA

Responsible for the operation of the Sample Management, Sample Control, and Bottle Preparation departments. Daily oversight of sample receiving, courier services, sample storage and disposal, bottle preparation and shipping, and general freight receiving.

Project Manager 1999–2006
Columbia Analytical Services, Inc.
Kelso, WA

Responsible for the technical project management, ensuring overall data quality and compliance with customer requirements. Provided technical support to clients in project setup and data review. Additionally, acts as a consultant to clients regarding industrial & environmental compliance issues; serving as liaison between client and regulatory agencies.

Supervisor Organic Extractions Lab 1997–1999
Senior Analyst, GC/MS Department 1996–1997
Senior Analyst, Organic Extractions 1991–1996
Columbia Analytical Services, Inc.
Kelso, WA

Senior analyst and supervisor in the organic extractions department over an 8 year span. Responsibilities included sample preparation and cleanup; managing the workload; directing efficiencies; and ensuring that all critical hold times and QC requirements were met. Additional responsibilities included running GC/FID and GC/MS instruments and completing all steps in the data review and reporting processes.

EDUCATION

Lower Columbia College –
Longview, WA
General Sciences
Coursework for transfer
1988-1991

Portland Bible College –
Portland, OR
BA Theology
2009

APPROVED SIGNATORIES FOR FINAL ANALYTICAL REPORTS

ALS Environmental, Kelso, WA

CLARKSON, KURT
CORONADO, JEFF
DEGNER, CARL
HARRIS, MARK
HOLMES, HOWARD
JACKY, HARVEY
JUELL, AMANDA
KENNEDY, LES
LEAF, CHRIS
LOVEJOY, KELLEY

Updated: June 20, 2018 Approved by: Les Kennedy, Client Services Manager

APPENDIX C

ALS Environmental Confidentiality Agreement

Confidentiality Agreement

The Confidentiality Agreement (the "Agreement") is entered into by and between ALS Group (hereinafter referred to as the "Company") and _____ (hereinafter referred to as "Employee").

WHEREAS, employee is presently employed by the Company in a position in which Employee will receive and have access to confidential business information and other secrets of the Company, and shall, to the best of Employee's ability, assist the Company in improving and developing the products and services of the Company; and

WHEREAS, employee is desirous of continuing such employment and receiving such disclosures of confidential business information, and assisting the Company in improving and developing its products and services.

NOW, this Agreement being a condition therefore and ancillary thereto, and in further consideration of the benefits to Employee pursuant to the employment by the Company, the receipt and sufficiency of all such consideration being hereby acknowledged by Employee, it is agreed between the Company and Employee as follows:

1. **Confidential Business Information.** Employee recognizes and agrees that the Company has certain confidential business information, including, but not limited to, compilations of information, customer lists, customer data, records, specifications, and trade secrets, and related business methods and techniques, which confidential business information are used by the Company to obtain a competitive advantage over the Company's competitors who do not know or use this information. Employee further recognizes and agrees that the protection of such confidential business information against unauthorized disclosure and use is of critical importance to the company to maintain its competitive position and Employee therefore agrees that use of, or disclose to any other person or entity, except as authorized by the Company in writing, any of the confidential business information of the Company. Employee also agrees not to disclose to the Company or utilize on the Company's behalf, any of the trade secrets or other confidential information of any of the Employee's former employers.

2. **Return of Confidential Business Information.** Upon termination of his employment for any reason, employee shall promptly deliver to the Company all drawings, manuals, letters, photographs, tapes or video recordings, records of any kind, and all copies thereof, that may be in the possession of, or under the control of, Employee pertaining to the Company's employers.

3. **Assignment of Rights to Company.** Employee agrees to assist the Company in all possible ways in the discovery, perfection, and development of new ideas, inventions, discoveries, devices, and methods in processes, all for the benefit of the Company and as its exclusive property. Employee agrees to and does hereby assign, transfer, and convey to the Company, or at the written direction of the Company and which are made, developed or conceived by Employee, either solely or jointly with others, during Employee's employment with the Company, whether prior or subsequent to the signing of this Agreement, whether made, developed or conceived by Employee during or outside of regular working hours or on or away from the

Company's premises or at Employee's expense, the expense of the Company or some other person or persons. At any time, the Employee shall execute such documents requested by the Company to confirm the rights of the Company in the ideas, inventions, discoveries, and devices, methods and processes referenced in this Section 3.

4. **Reasonableness of Covenants**. Employee specifically acknowledges and agrees as follow: (I) the covenants set forth in this Agreement are reasonable and necessary to protect the goodwill and the operations and business of the Company; (ii) the time duration of the covenants set forth in this Agreement and are reasonable and necessary to protect the goodwill and the operations and business of the Company; (iii) the geographical area limitations of the covenants set forth in this Agreement are reasonable and necessary to protect the goodwill and the operations and business of the Company; (iv) the covenants set forth in this Agreement are not oppressive to Employee and do not impose a greater restraint on Employee than is necessary to protect the goodwill and the operations and business of the Company.

5. **Remedies**. Employee recognizes that irreparable injury or damage will result to the business of the company in the event to the breach of any covenant contained in this Agreement and Employee therefore agrees that in the event of such breach on the part of the Employee, the Company shall be entitled, in addition to any legal or equitable remedies and damages available, to an injunction to restrain the violation thereof by Employee and all other persons action for or on behalf of Employee. Any claim of Employee against the Company shall not prevent the Company from enforcing any provision of this agreement. Further, in the event legal action is necessary to enforce any of Employee's obligations hereunder and the Company prevails in such legal action, the Company shall be entitled to a recovery of its attorney's fees expended in such action.

6. **Reformation**. Whenever possible, each provision of this agreement shall be interpreted in such manner as to be effective and valid under applicable law; provided, however, incase any on or more of the provisions contained in this Agreement shall, for any reason, be held to be invalid, illegal, or unenforceable in any respect, such invalidity, illegality, or unenforceability shall no affect any other provision of this agreement, and this Agreement shall be construed as if such invalid, illegal, or unenforceable provision had never been contained herein. Should a court of competent jurisdiction declare any of the provisions of this Agreement unenforceable due to any restriction of duration, territorial coverage, scene of activity, or otherwise, in lieu of declaring such provisions unenforceable, the parties hereto expressly authorize the court, to the extent permissible by law, to revise or reconstruct such provisions in a manner sufficient to cause them to be enforceable.

7. **Affiliates**. This agreement, and Employee's obligations hereunder, shall apply to any confidential business information, formulas, recipes, patterns, devices, secret inventions, processes, compilations of information, materials, ingredients, customer lists, records, specifications and trade secrets of any affiliate of the Company. For the purpose of this Agreement, the "affiliate" means any person that, directly or indirectly, controls, or controlled by, or is under common control with, another person'; "person" means any individual, corporation, partnership, joint venture, limited liability company, association, joint stock company, trust, unincorporated

organization or any other form of entity; and "control" means the power to direct or cause the direction of the management and policies of a person, directly or indirectly, whether through the ownership of voting securities by contract, or otherwise.

8. **Compelled Disclosure**. In the event that Employee is requested or required (by oral questions, interrogatories, requested for information or documents, subpoenas, civil investigative demand or similar process) to disclose any of the confidential business information of the Company, it is agreed that Employee will provide the Company with immediate notice of such request(s), so that the Company may seek an appropriate protective order or, if appropriate, waive Employee's compliance with this agreement. Employee agreed that, if in the absence of a protective order or the receipt of a waive hereunder, Employee is nonetheless, in the reasonable opinion of Employee's counsel, legally compelled to disclose the confidential business information of the Company or else stand liable for contempt or suffer other censure or penalty, Employee may, after prior notice to the Company, disclose such the confidential business information of the Company to the extent legally required.

9. **Indemnity**. Employee agrees to indemnify and hold harmless the Company, and its directors, officers, employees, agents, and attorneys, from and after the date hereof, against any and all actions, causes of action, claims, suites, proceedings, demands, assessments, demands, settlement, judgment, damages, loses, costs, and legal and other expenses arising out of or resulting from the breach or failure of Employee to Company with any covenant or agreement made herein.

10. **Choice of Law: Waiver of Trial by Jury**. This Agreement shall be construed in accordance with, and governed for all purposes by the laws of the State of Texas and obligations and undertakings of each of the parties to this contract shall be performable at Houston, Harris County. TO THE EXTENT NOT PROHIBITED BY APPLICABLE LAW, THE PARTIES HEREBY KNOWLINGLY, VOLUNTARILY, AND INTENTIONALLY WAIVE ANY RIGHT TO TRIAL BY JURY THAT THE COMPANY OR EMPLOYEE MAY HAVE IN ACTION OR PROCEEDING, IN LAW OR IN EQUITY, IN CONNECTION WITH THIS AGREEMENT, EACH PARTY REPRESENTS AND WARRANTS THAT NEITHER PARTY HAS REPRESENTED, EXPRESSLY, OR OTHERWISE THAT IT WILL NOT, IN THE EVENT OF LITIGATION, SEEK TO ENFORCE THIS RIGHT TO JURY TRIAL WAIVER. EACH PARTY ACKNOWLEDGES THAT THE OTHER PARTY HAS BEEN INCLUDED TO ENTER INTO THIS AGREEMENT BY, AMONG OTHER THINGS, THE PROVISIONS OF THE WAIVER.

11. **Waiver**. No waiver of any provision of this Agreement shall constitute a waiver of any other provision of this agreement, nor such waiver constitute a waiver of any subsequent breach of such provision.

12. **Acknowledgement of Receipt.** Employee acknowledges a receipt of a copy of this Agreement, which has been executed in multiple copies, all executed copies of that shall be deemed originals.

13. **No Promise of Employment.** It is expressly agreed that this Agreement is not a promise of future employment.

14. **Assignment**: **Survival**. This agreement shall not be assignable by Employee. This agreement and the obligations of Employee hereunder, shall survive the termination of Employee's employment with the Company.

15. **Entire Agreement**. This Agreement entered into by the Company and Employee, embodies the entire agreement and understanding between the Company and the Employee relating to the subject matter hereof, and supersedes all prior agreements and understandings relating to the employment and compensation of the Employee and may only be amended by a written agreement signed by all parties hereto.

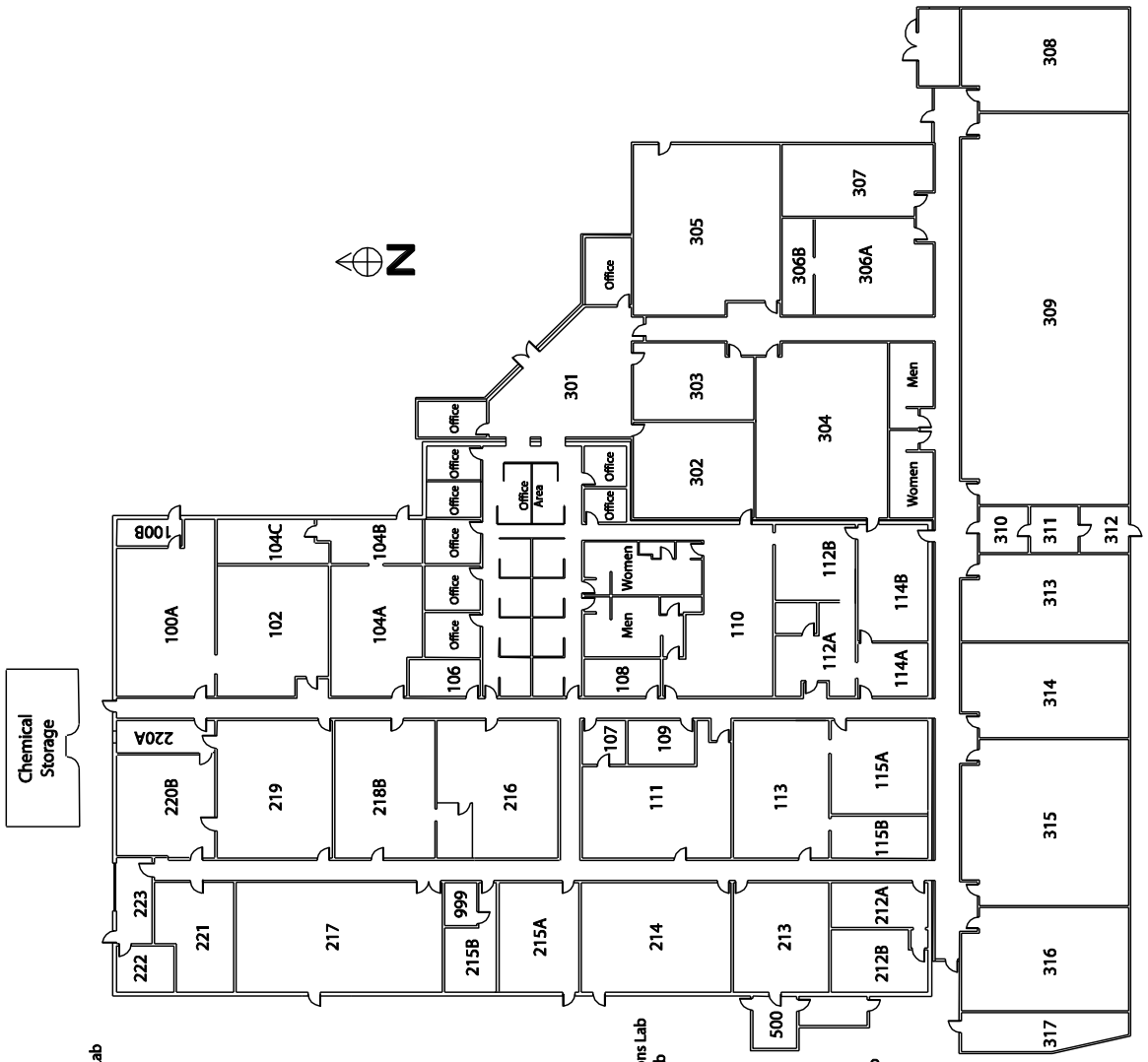
Employee Signature: _____ Date: _____

Employee Printed Name: _____

Witness: _____ Date: _____

Witness Printed Name: _____

APPENDIX D – Laboratory Floor Plan



Room #	
100A	Semivolatile Organics GC Instrument Lab
100B	Electrical Room
102	Semivolatile Organics GC Office
104 A - C	Organics LC Labs and Offices
106	Deionized Water System Room
107	Oven Room
108	Zero Headspace Extraction Lab
109	Storeroom
110	Lunch Room
111	General Chemistry Lab
112A	Microbiology Lab
112B	Copy Center
113	ICP MS Lab
114A	Grain Size
114B	Total Solids/Oven Room
115A	ICP Lab
115B	Metals Reporting
212A	Mercury and Flame AA Lab
212B	Low Level Mercury Lab
213	General Chemistry Lab
214	General Chemistry Lab
215A	Drinking Water Lab
215B	Information Technology
216	Data Review & Storage
217	Sample Storage
218	Volatiles Organics Lab
219	Semivolatile Organics GC/MS Lab
220A	Semivolatile Organics GC/MS Office
220B	Semivolatile Organics GC/MS Extractions Lab
221	Drinking Water Sample Preparation Lab
222	Purchasing Office
223	General Receiving
301	Reception Lobby
302	Lunch Room
303	Conference Room
304	Sample Storage
305	Sample Receiving
306A	Pharmaceutical Metals
306B	Pharmaceutical Microbiology
307	Pharmaceutical Instrument Lab
308	Pharmaceutical General Chemistry Lab
309	Organics Sample Preparation Lab
310	Communication Room
311	Electrical Room
312	Fire Room/Water System
313	Glass Wash Room
314	Clean Room
315	Metals Digestion Room
316	Tissue Preparation
317	Mechanical
500	Janitorial Room
999	Computer Room

Revised 9/21/10

APPENDIX E – Analytical Equipment

GENERAL CHEMISTRY/WATER CHEMISTRY LABORATORY			
Equipment Description	**Year Acquired**	**Manufacturer or Laboratory Maintained (MM/LM)**	**# of Trained Operators**
Analytical Balances (8):			
Sartorius, Mettler, Ohaus, Fisher	1990-2011	LM	13
Autoclave - Market Forge Sterilmatic	1988	LM	5
Autoclave – Heidolph Brinkman 3870EP	2010	LM	3
Autotitrator – Thermo Orion 500	2007	LM	2
Calorimeters (2):			
Parr 1241 EA Adiabatic	1987	LM	2
Parr 6300 Isoparabolic	2005	LM	2
Centrifuge - Damon/IEC Model K	1992	LM	13
Colony Counter - Quebec Darkfield	1988	LM	2
Conductivity Meter (1):			
YSI Model 3200	2004	LM	4
Digestion Systems (5):			
COD (3)	1989	LM	2
Kjeldahl, Lachat 46-place (1)	1999	LM	2
Skalar Micro Digester, 120 place (1)	2016	LM	2
Dissolved Oxygen Meter - YSI Model 5000, 5100 (2)	2006, 2009	LM	4
Distillation apparatus – Simple Dist – Hot Block (1)	2014	LM	3
Drying Ovens (7):			
Shel-Lab and VWR models	1990-2010	LM	13
Flash Point Tester (1):			
Petroleum Systems Services	2005	LM	3
Flow-Injection Analyzers (3):			
Bran-Leubbe	2002	LM	3
Lachat 8500	2007	LM	3
Skalar	2017	LM	3
Ion Chromatographs (4)			
Thermo/Dionex ICS-2500	2002	LM	3
Thermo/Dionex ICS-2000	2006	LM	3
Thermo/Dionex ICS-1600	2009	LM	3
Thermo/Dionex ICS-1600	2015	LM	3
Meters (ISE and pH) (4)			
Orion Dual Star	2016	LM	3
Orion Star A214	2016	LM	2
Symphony SB90M5	2013	LM	2
Symphony SP80P1	2012	LM	2
Muffle Furnace- Thermolyne 1300	1991	LM	13

Shatter Box (2):			
GP 1000	1989	LM	5
SPEX 8530	2011	LM	5
Sieve Shakers (2):			
CE Tyler - Portable RX 24	1990	LM	5
WS Tyler - RX 86	1991	LM	5
Total Organic Carbon (TOC) Analyzers (3)			
Coulemetrics Model 5012	1997	LM	2
Teledyne Tekmar Fusion 1	2009	LM	2
Analytik Jena 2500	2013	LM	2
Total Organic Halogen (TOX) Analyzers (3):			
Mitsubishi TOX-100 (2)	2001	LM	3
Mitsubishi AOX-200 (1)	2015	LM	3
Turbidimeter - Hach Model 2100N	1996	LM	4
UV-Visible Spectrophotometers (2):			
Beckman-Coulter DU520	2005	LM	4
Perkin Elmer Lambda 25	2008	LM	4
Discrete Autoanalyzer – Westco SmartChem AD20-1	2011	LM	2
Vacuum Pumps (3):			
Welch Duo-Seal Model 1376	1990	LM	13
Water Baths/Incubators (17): Various Fisher Scientific, VWR, and Shell Lab models	1986 - 2009	LM	13
Drill Press – Craftsman	2012	-	4

METALS LABORATORY

Equipment Description	Year Acquired	Manufacturer or Laboratory Maintained (MM/LM)	# of Trained Operators
Analytical Balance (8)			
Mettler AE 200 analytical balance	1988-2010	MM	12
Various Mettler, Sartorius, and Ohaus models			
Atomic Absorption Spectrophotometers (4):			
Perkin Elmer AAnalyst 200 Flame AA	2005	MM	3
CETAC Mercury Analyzer M-6100	2010	MM	3
Buck AA Spectrophotometer Model 205	2008	LM	3
Atomic Fluorescence Spectrophotometer (2)			
Brooks-Rand Model III	2005	LM	3
Brooks-Rand Merx	2014	LM	3
Centrifuge - IEC Model Clinical Centrifuge	1990	LM	12
Drying Oven - VWR Model 1370F	1990	LM	12
Environmental Express HotBlocks – 100 mL (4), 50 mL (4), 10 mL (1)	2000-2016	LM	6
Free Standing Oven – Shell Lab	2014	LM	6

Freeze Dryers (1) - Labconco	2006	LM	5
Glove Box – Plas Lab	2013	LM	2
Inductively Coupled Plasma Atomic Emission Spectrometer (ICP-AES) (2)			
Thermo Scientific Model iCAP 6500	2007	MM	3
Thermo Scientific Model iCAP 6500	2012	MM	3
Inductively Coupled Plasma Mass Spectrometers (ICP-MS) (4):			
Agilent 7700	2014	MM	2
Agilent 7800	2016	MM	2
Nexion Model 300D	2011	MM	2
Muffle Furnace (2) - Thermolyne Furnatrol - 53600	1991, 2005	LM	5
Shaker - Burrell Wrist Action Model 75	1990	LM	12
TCLP Extractors (3)	1989, 2002	LM	5
Turbidimeter – Hach			
SEMIVOLATILE ORGANICS SAMPLE PREPARATION LABORATORY			
Equipment Description	**Year Acquired**	**Manufacturer or Laboratory Maintained (MM/LM)**	**# of Trained Operators**
Analytical Balance (3)			
Mettler PM480, AG204, AE240	1999 - 2015	MM	6
Sartorius LP3200D	2016	MM	
Centrifuge – Sorvall GLC-1 (2)	2014	LM	3
Drying Ovens (2)			
Fisher Model 655G	1991	LM	3
VWR Model 1305U	1999	LM	3
Evaporators/concentrators			
Organomation N-Evap (7)	1990-2010	LM	4
Organomation S-Evap (7)	1990-2010	LM	7
Biotage Turbovap (3)	2013 - 2016	LM	2
Extractor Heaters: Lab-Line Multi-Unit for Soxhlet and Continuous Liquid-Liquid Extractions (90)	1987-2007	LM	4
Solids Extractors:			
Sonic Bath VWR	1994	LM	3
Sonic Horn (4)	1994	LM	3
Soxtherm		LM	
Gerhardt (4)	2000	LM	2
OI Analytical (5)	2008	LM	2

Extractors, TCLP (8):			
Millipore TCLP Zero Headspace Extractors (10)	1992-2011	LM	1
TCLP 12 position Extractor/Tumbler (2)	1989-2011	LM	1
Gel Permeation Chromatography (GPC) (4)			
J2 Scientific AccuPrep (3)	2005, 2010	LM	2
Gilson (1)	2013	LM	2
Muffle Furnace (2)	2006, 2009	LM	1
Solid Phase Extractors (18) – Horizon SPE-Dex 4790	2003, 2006,2008	LM	4
Microwave Extractor – Mars 6	2014	LM	2
Edmund Buhler 3-Storey top frame VKS 'Shaker table' (1)	2016	LM	1
GC SEMIVOLATILE ORGANICS INSTRUMENT LABORATORY			
Equipment Description	**Year Acquired**	**Manufacturer or Laboratory Maintained (MM/LM)**	**# of Trained Operators**
Gas Chromatographs (18):			
Agilent 6890 GC with Agilent 7683 Autosampler and Dual ECD Detectors (6)	2001, 2005, 2007,2011	LM	2
Agilent 6890 GC with Agilent 7683 Autosampler and Dual FPD Detectors	2003	LM	2
Agilent 7890A Dual ECD Detectors Agilent 7683B autosampler (4)	2010 - 2014	LM	2
Hewlett-Packard 5890 GC with HP 7673 Autosampler and FID Detector	1995	LM	1
Agilent 6890 with Dual FID Detectors and Agilent 7873 Autosampler (4)	2001, 2005	LM	1
Agilent 7890A Dual NPD Detectors and Agilent 7683B autosampler	2012	LM	2
Varian Ion trap GC/MS:	2003	LM	1
Varian 3800 GC w/CP8400 autosampler	2006	LM	1
Varian Saturn 2100T mass spectrometer	2003	LM	1
Thermo Ion Trap ITQ-90C GC/MS w/TriPlus autosampler	2008	LM	1
GC/MS SEMIVOLATILE ORGANICS INSTRUMENT LABORATORY			
Equipment Description	**Year Acquired**	**Manufacturer or Laboratory Maintained (MM/LM)**	**# of Trained Operators**
Analytical Balance - Mettler AB 104-S	2000	MM	4

Semivolatile GC/MS Systems (11): Agilent 6890/5973 with ATAS Optic2 LVI and HP 7673 Autosampler (2) Agilent 5890/5970 and HP 7673 Autosampler Agilent 5890/5972 with ATAS Optic2 LVI and HP 7673 Autosampler (1) Agilent 6890/5973 with ATAS Optic3 LVI and HP 7683 Autosampler Agilent 6890/5973 with Agilent PTV Injector and 7683 Autosampler (2) Agilent7890A/5975C with Agilent 7693 Autosampler (4)	 1997, 2001 1990 1993, 1994 2005 2007 2010 - 2011	 LM LM LM LM LM LM	 3 3 3 3 3 3
Semivolatile GC/MS/MS – Waters Quattro Micro GC MicroMass with Agilent 6890, Agilent PTV Injector, 7683B Autosampler	2008	MM	1
HPLC LABORATORY			
Equipment Description	**Year Acquired**	**Manufacturer or Laboratory Maintained (MM/LM)**	**# of Trained Operators**
Analytical Balance - Mettler AB1045	2013	MM	7
Drying Oven - Binder	-	LM	3
Evaporator – Turbo Vap, Biotage	2016	LM	7
Centrifuge (2) Beckman Coulter Eppendorf	 2002 2012	 LM LM	 7 7
High-Performance Liquid Chromatographs (3): Agilent 1260 Infinity with Diode Array UV Detector	2011	LM	2
High-Performance LC/MS (5) API 5000 LC/MS/MS and SIL-20AC autosampler AB Sciex 5500 and Shimadzu DGU 20A5 Shimadzu LC/MS 8050 with 2x LC-30AD UHPLC pumps and SIL-30AC MP autosampler Shimadzu LC/MS 8050 with 2x LC-30AD UHPLC pumps and SIL-30AC MP autosampler	 2008 2011 2016 2016	 MM MM MM MM	 4 4 2 2
Sonic Bath	2016	LM	7
VOLATILE ORGANICS LABORATORY			
Equipment Description	**Year Acquired**	**Manufacturer or Laboratory Maintained (MM/LM)**	**# of Trained Operators**
Analytical Balance - Mettler PE 160	1989	MM	4
Fisher Vortex Mixer	1989	LM	4

Drying Ovens (1): Boekel 107801	1989	LM	4
Sonic Water Bath - Branson Model 2200	1989	LM	4
Volatile GC/MS Systems (8):			
Agilent 5890/5970	1989	LM	4
Tekmar 3000 Purge and Trap Concentrator	1995	LM	4
Dynatech ARCHON 5100 Autosampler	1996	LM	4
Agilent 6890/5973	2001	LM	4
Tekmar 3100 Purge and Trap Concentrator	2001	LM	4
Encon Centurion Autosampler	2001	LM	4
Agilent 6890/5973	2005	LM	4
Tekmar Velocity Purge and Trap Concentrator	2005	LM	4
Tekmar Aquatech Autosampler	2005	LM	4
Agilent 7980A/5975C (2)	2010, 2011	LM	3
Teledyne Tekmar-Atomx	2010, 2011	LM	3
Agilent 6890/5973	2013	LM	4
Encon Evolution Purge and Trap Concentrator	2013	LM	4
Encon Centurion Autosampler	2013	LM	4
Agilent 7890/5977A	2014	LM	4
Encon Evolution Purge and Trap Concentrator	2014	LM	4
Encon Centurion Autosampler	2014	LM	4
Agilent 7890B/5977B	2016	LM	3
Teledyne Tekmar Atomx	2016	LM	3
Agilent 7890 GC with FID Encon Evolution Purge and Trap Concentrator Encon Centurion Autosampler	2013	LM	2
Agilent 7890 GC with FID Encon Evolution Purge and Trap Concentrator Encon Centurion Autosampler	2013 2016	LM	2

AUTOMATED DATA PROCESSING EQUIPMENT			
Equipment Description	**Year Acquired**	**Manufacturer or Laboratory Maintained (MM/LM)**	**# of Trained Operators**
1 - WAN: LIMS Sample Manager using Oracle 11gR2 Enterprise RDBMS running on Red Hat Enterprise Linux Advanced Server v.6.6 platform connected via DMVPN circuits (100 Mbps)	2013	LM	NA
1 - Network Server for reporting and data acquisition running Windows Server 2008 R2 with a 1.4 TB capacity, 1 - Application server running Windows Server 2008 R2	2012	LM	NA
Approximately 90+ HP (3015, 4000, 4014, 4050, 4200, 4250, 4300), Dell 1720dn, and Lexmark M5155 printers.	2010 - 2015	LM	NA
Approximately 220+ Dell/HP PC workstations	2010 - 2015	LM	NA

running Windows XP/Windows 7 on LAN connected via 100BT/1GigE network			
Microsoft Office 2013 Professional as the base office application suite for all PC workstations. Some systems using Microsoft Office 2003/2007/2010	1996 - 2014	LM	NA
E-mail via Exchange 2010 with webmail via Outlook Web Access. Microsoft Outlook 2013 is standard email client, with some using Outlook 2010	2011 - 2014	LM	NA
Facsimile Machines - Brother 4750e, Brother 2920, and Brother 1860	2005 - 2008	LM	NA
Copier/Scanners - BizHub 283, BizHub 600, BizHub 601 (2), BizHub 654, BizHUb754e (2), BizHub 951, BizHub 1050.	2005 - 2015	LM	NA
Target, MARRS, Stealth, Harold, Blackbird, EDDGE, CASLIMS, & LabCoat reporting software systems.	1998 - 2014	LM	NA
Data processing terminals (79) - EnviroQuant, Target, Saturn, MassHunter, Chromeleon, MassLynx, Insight.	1996 - 2016	LM	NA

APPENDIX F – Containers, Preservation and Holding Times

DETERMINATION[a]	MATRIX[b]	CONTAINER[C]	PRESERVATION	HOLDING TIME
Bacterial Tests				
Coliform, Colilert (SM 9223)	W, DW	P, Bottle or Bag	Cool, 4˚C, 0.008% $Na_2S_2O_3$[d]	6-24 hours[e]
Coliform, Fecal and Total (SM 9221, 9222D)	W, S, DW	P,G	Cool, 4˚C, 0.008% $Na_2S_2O_3$[d]	6-24 hours[e]
Enterococci (Enterolert)	W	P	Cool, 4˚C, 0.008% $Na_2S_2O_3$[d]	8 hours
Inorganic Tests				
Acidity (SM 2310B)	W	P,G	Cool, 4˚C	14 days[EPA]
Alkalinity (SM 2320B)	W, DW	P,G	Cool, 4˚C	14 days[EPA]
Ammonia (SM 4500 NH_3)	W, DW	P,G	Cool, 4˚C, H_2SO_4 to pH<2	28 days
Biochemical Oxygen Demand(SM 5210B)	W	P,G	Cool, 4˚C	48 hours
Bromate (EPA 300.1)	W, DW	P,G	50mg/L EDA, cool to 4˚C	28 days
Bromide (EPA 300.1)	W, DW	P,G	None Required	28 days
Chemical Oxygen Demand (SM 5220C)	W	P,G	Cool, 4˚C, H_2SO_4 to pH<2	28 days
Chloride (EPA 300.0)	W, DW	P,G	None Required	28 days
Chloride (EPA 9056)	W, S	P,G	Cool, 4˚C	28 days
Chlorine, Total Residual (SM 4500 Cl F)	W, S	P,G	None Required	24 hours
Chlorite (EPA 300.1)	W, DW	P,G	50mg/L EDA, cool to 4˚C	14 days
Chlorophyll-A (SM 11200H)	W	G Amber	Cool, 4˚C	48 hours
Chromium VI (EPA 7196A)	W	P,G	Cool, 4˚C	24 hours
Color (SM 2120B)	W, DW	P,G	Cool, 4˚C	48 hours
Cyanide, Total and Amenable to Chlorination (EPA 335.4, 9010, 9012) (SM 4500 CN E,G)	W, S, DW	P,G	Cool, 4˚C, NaOH to pH>12, plus 0.6 g Ascorbic Acid	14 days
Cyanide, Weak Acid Dissociable (SM 4500 CN I)	W, S	P,G	Cool, 4˚C, NaOH to pH >12	14 days

DETERMINATION[a]	MATRIX[b]	CONTAINER[c]	PRESERVATION	HOLDING TIME
Ferrous Iron (ALS SOP)	W, D	G Amber	Cool, 4˚C	24 hours
Fluoride (EPA 300.0, 9056, SM 4500 F-C)	W, S	P,G	Cool, 4˚C	28 days
Formaldehyde (ASTM D6303)	W	G Amber	Cool, 4˚C	48 hours
Formaldehyde (NCASI 99.02)	W	G Amber	Cool, 4˚C	14 days
Formaldehyde (NCASI 98.01)	W	G Amber	Cool, 4˚C	28 days
Hardness (SM 2340C)	W, DW	P,G	HNO_3 to pH<2	6 months
Hydrogen Ion (pH) (SM 4500H B)	W, DW	P,G	None Required	Analyze immediately
Kjeldahl and Organic Nitrogen (ASTM D3590-89)	W	P,G	Cool, 4˚C, H H_2SO_4 to pH<2	28 days
Nitrate (EPA 300.0)	W, DW	P,G	Cool, 4˚C	48 hours
Nitrate (EPA 9056)	W, S	P,G	Cool, 4˚C	48 hours
Nitrate-Nitrite (EPA 353.2)	W, DW	P,G	Cool, 4˚C, H_2SO_4 to pH<2	28 days
Nitrite (EPA 300.0)	W, DW	P,G	Cool, 4˚C	48 hours
Nitrite (EPA 353.2)	W, S	P,G	Cool, 4˚C	48 hours
Nitrite (EPA 9056)	W	P,G	Cool, 4˚C	48 hours
Nitrocellulose	S	G	Cool, 4˚C	28 days
Oil and Grease, Hexane Extractable Material (EPA 1664)	W	G, Teflon Lined Cap	Cool, 4˚C, H_2SO_4 or HCL to pH<2	28 days
Organic Carbon, Total (9060 & SM 5310 C)	W	P,G	Cool, 4˚C, H_2SO_4 to pH<2	28 days
Organic Carbon, Total (ASTM-D4129)	S	P,G	Cool, 4˚C	28 days
Organic Halogens, Adsorbable (EPA 1650C)	W	G, Teflon Lined Cap	Cool, 4˚C, HNO_3 to pH<2	6 months
Organic Halogens, Total (EPA 9020B)	W	G, Teflon Lined Cap	Cool, 4˚C, H_2SO_4 to pH<2, No headspace	28 days
Orthophosphate (SM 4500 P-E)	W, DW	P,G	Cool, 4˚C	48 hours
Oxygen, Dissolved (Probe) (SM 4500O G)	W, DW	G, Bottle and Top	None Required	Analyze immediately
Oxygen, Dissolved (Winkler)	W, DW	G, Bottle and Top	Fix on Site and Store in Dark	8 hours

DETERMINATION[a]	MATRIX[b]	CONTAINER[c]	PRESERVATION	HOLDING TIME
Perchlorate (EPA 314.0)	W, DW ,S	P,G	Protect from temp. extremes	28 days
Phenolics, Total (EPA 420.1, 9065)	W, S	G Amber	Cool, 4˚C, H_2SO_4 to pH<4	28 days
Phosphorus, Total (EPA 365.3)	W	P,G	Cool, 4˚C, H_2SO_4 to pH<2	28 days
Residue, Filterable (TDS) (SM 2540C)	W	P,G	Cool, 4˚C	7 days
Residue, Nonfilterable (TSS) (SM 2540D)	W	P,G	Cool, 4˚C	7 days
Residue, Settleable (SM 2540F)	W	P,G	Cool, 4˚C	48 hours
Residue, Total (SM 2540B)	W	P,G	Cool, 4˚C	7 days
Residue, Volatile (EPA 160.4)	W	P,G	Cool, 4˚C	7 days
Salinity (SM 2520 B)	W	P,G	Cool, 4˚C	28 days
Silica (SM 4500 SiO2 C & E)	W	P Only	Cool, 4˚C	28 days
Specific Conductance (SM 2510 B)	W, DW	P,G	Cool, 4˚C	28 days
Sulfate (EPA 300.0)	W, DW	P,G	Cool, 4˚C	28 days
Sulfate (EPA 9056)	W, S	P,G	Cool, 4˚C	28 days
Sulfide (9030/9034)	W, S	P,G	Cool, 4˚C, Add Zinc Acetate, plus Sodium Hydroxide to pH>9	7 days
Sulfide (SM 4500 S_2 D)	W	P,G	Cool, 4˚C, Add Zinc Acetate, plus Sodium Hydroxide to pH>9	7 days
Sulfide (SM 4500 S_2 F)	W	P,G	Cool, 4˚C, Add Zinc Acetate, plus Sodium Hydroxide to pH>9	7 days
Sulfite (SM 4500 SO_3 B)	W	P,G	None Required	24 hours
Sullfides, Acid Voaltile	S	G	Cool, 4˚C	14 days
Surfactants (MBAS) (SM 5540 C)	W	P,G	Cool, 4˚C	48 hours
Tannin and Lignin (SM 5550B)	W	P,G	Cool, 4˚C	28 days
Turbidity (EPA 180.1)	W, DW	P,G	Cool, 4˚C	48 hours
Metals				

DETERMINATION[a]	MATRIX[b]	CONTAINER[c]	PRESERVATION	HOLDING TIME
Arsenic Species 1632	W	G	HCL to pH<2, Cool < 4ºC	28 days
Mercury (1631E)	W	F	HCl to pH<2	90 days
Mercury (1631E)	S	F	Freeze < -15ºC	1 Yr
Mercury (7471)	S	P,G	Cool, 4˚C	28 days
Mercury (EPA 245.1, 7470, 7471)	W, DW	P,G	HNO_3 to pH<2	28 days
Metals (200.7, 200.8, 200.9, 6010, 6020)	W, DW	P,G	HNO_3 to pH<2	6 months
Metals (200.7, 200.8, 200.9, 6010, 6020)	S	G, Teflon Lined cap	Cool, 4˚C	6 months
Methyl Mercury (1630)	W	F	HCL to pH<2, Cool < 4ºC	6 months
Methyl Mercury (1630)	S	G	Frozen < -10 ºC	6 months
Methyl Mercury (1630)	T	G, Teflon-Lined Cap	Frozen < -10 ºC/Freeze dried	1 year
Volatile Organics				
Gasoline Range Organics (8015, NWTPH-Gx)	W	G, Teflon-Lined, Septum Cap	Cool, 4˚C, HCl to pH<2, No headspace	14 days
Gasoline Range Organics (8015, NWTPH-Gx)	S	G, Teflon- Lined Cap	Cool, 4ºC, Minimize Headspace	14 days
Purgeable Halocarbons (624, 8260)	W	G, Teflon-Lined, Septum Cap	No Residual Chlorine Present; HCl to pH<2, Cool, 4˚C, No Headspace	14 days
Purgeable Halocarbons (624, 8260)	W	G, Teflon-Lined, Septum Cap	Residual Chlorine Present; 10% $Na_2S_2O_3$, HCl to pH<2, Cool, 4˚C	14 days
Purgeable Halocarbons (8260)	S	G, Teflon- Lined Cap	Cool, 4˚C, Minimize Headspace	14 days
Purgeable Halocarbons (8260)	S	Method 5035	Terracore/Encore device, Freeze at -20˚C Methanol, Cool, 4C	48 hrs to prepare from device, 14 days after preparing.
Purgeable Halocarbons (8260)	S	Method 5035	Sodium Bisulfate Cool, 4˚C	48 hrs to prepare, 14 days after preparation

DETERMINATION[a]	MATRIX[b]	CONTAINER[c]	PRESERVATION	HOLDING TIME
Purgeable Aromatic Hydrocarbons (including BTEX and MTBE 624, 8260)	W	G, Teflon-Lined,Septum Cap, No Headspace	No Residual Chlorine Present: HCl to pH<2, Cool, 4˚C, No Headspace	14 days
Purgeable Aromatic Hydrocarbons (including BTEX and MTBE 624, 8260)	W	G, Teflon-Lined,Septum Cap, No Headspace	Residual Chlorine Present: 10% $Na_2S_2O_3$, HCl to pH<2, Cool 4˚C	14 days
Purgeable Aromatic Hydrocarbons (including BTEX and MTBE 624, 8260)	S	G, Teflon- Lined Cap	Cool, 4˚C, Minimize Headspace	14 days
Purgeable Aromatic Hydrocarbons (including BTEX and MTBE 624, 8260)	S	Method 5035	Encore, Freeze at -20˚C Methanol, Cool, 4C	48 hr to prepare from Encore, 14 days after preparation.
Purgeable Aromatic Hydrocarbons (including BTEX and MTBE 624, 8260)	S	Method 5035	Sodium Bisulfate, Cool, 4˚C	48 hr to prepare from Encore, 14 days after preparation
Acrolein, Acrylonitrile, Acetonitrile (624, 8260)	W	G, Teflon - Lined Septum Cap	Adjust pH to 4-5, Cool, 4˚C, No headspace	14 days
2-chloroethyl vinyl ether (8260)	W	G, Teflon - Lined Septum Cap	Cool, 4˚C, Minimize Headspace	7 days
Semivolatile Organics				
Nonylphenols	W	G, Teflon-Lined Cap	H_2SO_4 to pH<2, Cool, 4˚C	28 days until extraction;40 days after extraction
Organotins (ALS SOP)	W, S	G, Teflon-Lined Cap	Cool, 4˚C	7[f] days until extraction;40 days after extraction
Otto Fuel		G, Teflon-Lined Cap	Cool, 4˚C	7[f] days until extraction;40 days after extraction
Methanol in Process Liquid NCASI 94.03	L	G, Teflon-Lined Cap	Cool, 4˚C	30 days
HAPS – Condensates NCASI 99.01		G, Teflon-Lined Cap	Cool, 4˚C	14 days
HAPS – Impinger/Canisters NCASI 99.02			Cool, 4˚C	21 days

DETERMINATION[a]	MATRIX[b]	CONTAINER[c]	PRESERVATION	HOLDING TIME
Perfluorinated Compounds HPLC/MS/MS (537 Modified)	W,S, T	P	Cool, 4˚C	14 days until extraction; 40 days after extraction
PBDE/PBB – ROHS GC/MS	W, S, T	G	Cool, 4˚C	40 days after extraction
Pharma Personal Care Products (EPA 1694)	W, S	Amber G, Teflon-Lined Cap	Cool, < 6˚C	7[f] days until extraction; 30 days after extraction
Nitroaromatics and Nitramines (EPA 8330B)	W, S	G, Teflon-Lined Cap	Cool, 4˚C	7[f] days until extraction; 40 days after extraction
Organic Acids HPLC/MS/MS	W	G, Teflon-Lined, Septum Cap	H_2SO_4 to pH<2, Cool, 4˚C	7 days unpreserved, 14 days preserved
Perchlorate (EPA 6850)	W, S	P, G	Cool, 4˚C	28 days to analysis (H_2O), 28 days to extraction, 28 days after prep (solid)
Petroleum Hydrocarbons, Extractable (Diesel-Range Organics) (EPA 8015)	W, S	G, Teflon-Lined Cap	Cool, 4˚C	7[f] days until extraction, 40 days after extraction
Alcohols and Glycols (EPA 8015)	W, S	G, Teflon-Lined Cap	Cool, 4˚C[g]	7[f] days until extraction; 40 days after extraction
Acid Extractable Semivolatile Organics (EPA 625, 8270)	W	G, Teflon-Lined Cap	Cool, 4˚C[g]	7[f] days until extraction; 40 days after extraction
Base/Neutral Extractable Semivolatile Organics (EPA 625, 8270)	W	G, Teflon-Lined Cap	Cool, 4˚C[g]	7[f] days until extraction; 40 days after extraction
Acid Extractable Semivolatile Organics (EPA 8270)	S	G, Teflon-Lined Cap	Cool, 4˚C[g]	14 days until extraction; 40 days after extraction
Base/Neutral Extractable Semivolatile Organics (EPA 8270)	S	G, Teflon-Lined Cap	Cool, 4˚C[g]	14 days until extraction; 40 days after extraction

DETERMINATION[a]	MATRIX[b]	CONTAINER[c]	PRESERVATION	HOLDING TIME
Chlorinated Herbicides (EPA 8151)	W, S	G, Teflon-Lined Cap	Cool, 4˚C[g]	7[f] days until extraction; 40 days after extraction
Chlorinated Phenolics (EPA 1653)	W	G, Teflon-Lined Cap	H_2SO_4 to pH<2, Cool, 4˚C[g]	30 days until extraction; 30 days after extraction
Polynuclear Aromatic Hydrocarbons (EPA 625, 8270)	W, S	G, Teflon-Lined Cap	Cool, 4˚C, Store in Dark[g]	7[f] days until extraction; 40 days after extraction
Organochlorine Pesticides and PCBs (EPA 608, 8081, 8082, GC/MS/MS)	W, S	G, Teflon-Lined Cap	Cool, 4˚C	7[f] days until extraction; 40 days after extraction
Organophosphorus Pesticides (EPA 8141, GC/MS/MS)	W, S	G, Teflon-Lined Cap	Cool, 4˚C, Store in Dark[g]	7[f] days until extraction; 40 days after extraction
Nitrogen- and Phosphorus-Containing Pesticides (EPA 8141)	W,S	G, Teflon-Lined Cap	Cool, 4˚C[g]	7[f] days until extraction; 40 days after extraction
Drinking Water Organics				
EDB, DBCP, and TCP (EPA 504.1)	DW	G, Teflon-Lined Cap	Cool, 4˚C, 3 mg $Na_2S_2O_3$, No Headspace	14 days
Purgeable Organics (EPA 524.2)	DW	G, Teflon-Lined, Septum cap	Ascorbic Acid, HCl to pH≤2, Cool, 4˚C, No Headspace	14 days
PFAS (EPA 537.1)	DW	P	1.25g Trizma, Cool, 6˚C	14 days to extraction, 28 days after extraction.
Haloacetic Acids (EPA 552.2)	DW	G, Amber, Teflon-Lined Cap	100 mg/L NH_4Cl, Cool, 4˚C	14 days until extraction; 7 days after extraction
Toxicity Characteristic Leaching Procedure (TCLP)				
Semivolatile Organics (EPA 1311/8270)	HW	G, Teflon - Lined Cap	Sample: Cool, 4˚C, Store in dark[g]	14 days until TCLP extraction
			TCLP extract: Cool, 4˚C, Store in dark[g]	7 days until extraction; 40 days after extraction
Organochlorine Pesticides (EPA 1311/8081)	HW	G, Teflon Lined Cap	Sample: Cool, 4˚C	14 days until TCLP extraction

DETERMINATION[a]	MATRIX[b]	CONTAINER[c]	PRESERVATION	HOLDING TIME
			TCLP extract: Cool, 4˚C	7 days until extraction; 7 days after extraction
Chlorinated Herbicides (EPA 1311/8151)	HW	G, Teflon Lined Cap	Sample: Cool, 4˚C	14 days until TCLP extraction
			TCLP extract: Cool, 4˚C	7 days until extraction; 7 days after extraction
Mercury(EPA 1311/7470)	HW	P,G	Sample: Cool, 4°C	28 days until extraction
			TCLP extract: HNO_3 to pH<2	28 days after extraction
Metals, except Mercury (EPA 1311/6010)	HW	P,G	Sample: Cool, 4°C	180 days until extraction;
			TCLP extract: HNO_3 to pH<2	14 days until TCLP extraction
Volatile Organics (EPA 1311/8260)	HW	G, Teflon Lined Cap	Sample: Cool, 4˚C , Minimize Headspace	14 days until TCLP extraction
			Extract: Cool 4°C, HCL to pH,2, No Headspace	14 days after extraction

a For EPA SW-846 methods the method listed generically, without specific revision suffixes
b DW = Drinking Water, W = Water; S = Soil or Sediment; HW = Hazardous Waste
c P = Polyethylene; G = Glass, F- Fluoropolymer
d For chlorinated water samples
e The maximum holding time dependent upon the geographical proximity of sample source to the lab.
f Fourteen days until extraction for soil, sediment, and sludge samples.
g If the water sample contains residual chlorine, 10% sodium thiosulfate is used to dechlorinate.

APPENDIX G – Standard Operating Procedures

General and Quality Assurance SOPs

SOP TITLE	SOP ID	Revision
Laboratory Ethics and Data Integrity	CE-GEN001	4.00
Records Management Policy	CE-GEN003	2.00
Preventive Action	CE-GEN004	1.00
Document Control	CE-GEN005	2.00
Data Recall	CE-GEN006	2.00
Procurement and Control of Laboratory Services and Supplies	CE-GEN007	2.00
Method Development	CE-GEN008	1.00
Establishing Standard Operating Procedures	CE-GEN009	3.00
Handling Customer Feedback	CE-GEN010	1.00
Assigning and TSR to a Project	CE-GEN011	0.00
Policy for the Use of Accreditation Organization Names, Symbols, and Logos	CE-GEN012	1.00
Policy for Continuous Quality Improvement	CE-GEN016	0.00
Internal Audits	CE-QA001	2.00
Manual Integration Policy	CE-QA002	2.10
Training Policy	CE-QA003	3.00
Qualification of Subcontract Laboratories	CE-QA004	2.00
Laboratory Management Review	CE-QA005	2.00
Proficiency Testing Sample Analysis	CE-QA006	2.00
Making Entries onto Analytical Records	CE-QA007	2.00
Nonconformance and Corrective Action	CE-QA008	3.00
Control Limits	CE-QA009	1.00
Estimation of Uncertainty of Analytical Measurements	CE-QA010	1.00
Performing Method Detection Limit Studies and Establishing Limits of Detection and Quantitation	CE-QA011	1.00
Quality of Reagents and Standards	CE-QA012	1.00
New Instrument Suitability and Validation	CE-QA013	0.00
Quality Management System Summary	QMS01	0.00

LABORATORY SOPs

SOP TITLE	SOP ID	Revision
DATA ARCHIVING	ADM-ARCH	7
DOCUMENTING LABORATORY BALANCE AND TEMPERATURE CHECKS	ADM-BAL	7
SAMPLE BATCHES	ADM-BATCH	11
CONTROL CHARTING QUALITY CONTROL DATA	ADM-CHRT	4
DEPARTMENT OF DEFENSE PROJECTS LABORATORY PRACTICES AND PROJECT MANAGEMENT	ADM-DOD	7
DEPARTMENT OF DEFENSE PROJECTS LABORATORY PRACTICES AND PROJECT MANAGEMENT – QSM 5.0	ADM-DOD5	2
LABORATORY DATA REVIEW PROCESS	ADM-DREV	11
CONTINGENCY PLAN FOR LABORATORY EQUIPMENT FAILURE	ADM-ECP	5
METHOD VALIDATION DOCUMENTATION	ADM-MDLC	5
MANAGEMENT OF CHANGE	ADM-MOC	0
MANUAL INTEGRATION OF CHROMATOGRAPHIC PEAKS	ADM-MI	2
PROJECT MANAGEMENT	ADM-PCM	15
DATA REPORTING AND REPORT GENERATION	ADM-RG	9
REAGENT AND STANDARDS LOGIN AND TRACKING	ADM-RLT	6
SUPPORT EQUIPMENT MONITORING AND CALIBRATION	ADM-SEMC	14
SOFTWARE QUALITY ASSURANCE AND DATA SECURITY	ADM-SWQADATA	0
ALS KELSO TRAINING PROCEDURE	ADM-TRAIN	3
CHECKING VOLUMETRIC LABWARE	ADM-VOLWARE	6
COLIFORM, FECAL	BIO-9221FC	10
COLIFORM, TOTAL	BIO-9221TC	6
COLIFORM, TOTAL (MEMBRANE FILTER PROCEDURE)	BIO-9222B	1
COLIFORM, FECAL (MEMBRANE FILTER PROCEDURE)	BIO-9222D	5
COLILERT® , COLILERT-18®, & COLISURE®	BIO-9223	10
ENTEROLERT	BIO-ENT	3
HEPTEROTROPHIC PLATE COUNT	BIO-HPC	7
MICROBIOLOGY QUALITY ASSURANCE AND QUALITY CONTROL	BIO-QAQC	17
SHEEN SCREEN/OIL DEGRADING MICROORGANISMS	BIO-SHEEN	4

SOP TITLE	SOP ID	Revision
SEPARATORY FUNNEL LIQUID-LIQUID EXTRACTION	EXT-3510	12
ORGANIC COMPOUNDS IN WATER BY MICROEXTRACTION	EXT-3511	0
CONTINUOUS LIQUID - LIQUID EXTRACTION	EXT-3520	17
SOLID PHASE EXTRACTION	EXT-3535	7
SOXHLET EXTRACTION	EXT-3540	11
AUTOMATED SOXHLET EXTRACTION	EXT-3541	11
MICROWAVE EXTRACTION	EXT-3546	1
ULTRASONIC EXTRACTION	EXT-3550	12
WASTE DILUTION EXTRACTION	EXT-3580	7
SILICA GEL CLEANUP	EXT-3630	5
GEL PERMEATION CHROMATOGRAPHY	EXT-3640A	10
REMOVAL OF SULFUR USING COPPER	EXT-3660	8
REMOVAL OF SULFUR USING MERCURY	EXT-3660M	5
SULFURIC ACID CLEANUP	EXT-3665	6
CARBON CLEANUP	EXT-CARCU	5
DIAZOMETHANE PREPARATION	EXT-DIAZ	8
FLORISIL CLEANUP	EXT-FLOR	6
ORGANIC EXTRACTIONS GLASSWARE CLEANING	EXT-GC	7
PERCENT LIPIDS IN TISSUE	EXT-LIPID	6
EXTRACTION METHOD FOR ORGANOTINS IN SEDIMENTS, WATER, AND TISSUE	EXT-OSWT	9
PREPARATION OF REAGENTS AND BLANK MATRICES USED IN SEMIVOLATILE ORGANICS ANALYSIS	EXT-REAG	3
MEASURING SAMPLE WEIGHTS AND VOLUMES FOR ORGANIC ANALYSIS	EXT-WVOL	5
ZERO HEADSPACE EXTRACTION (EPA METHOD 3511)	EXT-ZHE	0
FACILITY AND LABORATORY CLEANING	FAC-CLEAN	4
OPERATION AND MAINTENANCE OF LABORATORY REAGENT WATER SYSTEMS	FAC-WATER	3
FLASHPOINT DETERMINATION - SETAFLASH	GEN-1020	8
COLOR	GEN-110.2	7
TOTAL SOLIDS	GEN-160.3	14

SOP TITLE	SOP ID	Revision
SOLIDS, TOTAL VOLATILE AND PERCENT ASH IN SOIL AND SOLID SAMPLES	GEN-160.4	8
SETTEABLE SOLIDS	GEN-160.5	6
HALIDES, ADSORBABLE ORGANIC (AOX)	GEN-1650	5
GRAVIMETRIC DETERMINATION OF HEXANE EXTRACTABLE MATERIAL (1664)	GEN-1664	11
ALKALINITY TOTAL	GEN-2320	11
HARDNESS, TOTAL	GEN-2340	10
DETERMINATION OF INORGANIC ANIONS IN DRINKING WATER BY ION CHROMATOGRAPHY	GEN-300.1	8
PERCHLORATE BY ION CHROMATOGRAPHY	GEN-314.0	14
CHLORIDE (TITRIMETRIC, MERCURIC NITRATE)	GEN-325.3	6
CHLORINE, TOTAL/FREE RESIDUAL	GEN-330.4	4
TOTAL RESIDUAL CHLORINE - METHOD 330.5	GEN-330.5	2
AMMONIA BY FLOW INJECTION ANALYSIS	GEN-350.1	14
NITRATE/NITRITE, NITRITE BY FLOW INJECTION ANALYSIS	GEN-353.2	10
PHOSPHORUS DETERMINATION USING COLORMETRIC PROCEDURE	GEN-365.3	13
PHENOLICS, TOTAL	GEN-420.1	15
AMMONIA AS NITROGEN BY ION SPECIFIC ELECTRODE	GEN-4500 NH3 E	8
DISSOLVED SILICA	GEN-4500 SIO2C	4
SILICA DETERMINATION USING SMARTCHEM METHOD	GEN-4500 SiO2E	2
ORTHOPHOSPHATE DETERMINATION USING COLORIMETRIC PROCEDURE	GEN-4500-P-E	2
SULFIDE, METHYLENE BLUE	GEN-4500S2D	4
SULFIDE, TITRIMETRIC (IODINE)	GEN-4500S2F	3
HALOGENS TOTAL AS CHLORIDE BY BOMB COMBUSTION	GEN-5050	4
BIOCHEMICAL OXYGEN DEMAND	GEN-5210B	6
HALIDES, ADSORBABLE ORGANIC (AOX) - SM 5320B	GEN-5320B	3
AQUATIC HUMIC SUBSTANCES	GEN-5510B	2
DETERMINATION OF METHYLENE BLUE ACTIVE SUBSTANCES (MBAS)	GEN-5540C	8
TANNIN AND LIGNIN	GEN-5550	8
HALIDES, TOTAL ORGANIC (TOX)	GEN-9020	9

SOP TITLE	SOP ID	Revision
HALIDES, EXTRACTABLE ORGANIC (EOX)	GEN-9020M	5
CATION-EXCHANGE CAPACITY OF SOILS – AMMONIUM ACETATE	GEN-9080	0
TOTAL SULFIDES BY METHYLENE BLUE DETERMINATION	GEN-9030	11
ACIDITY	GEN-ACIDITY	5
TOTAL CARBON IN SOIL	GEN-ASTM	12
SULFIDES, ACIDS VOLATILE	GEN-AVS	8
HEAT OF COMBUSTION	GEN-BTU	5
CHLOROPHYLL-a BY COLORIMETRY	GEN-CHLOR	4
TOTAL CYANIDES AND CYANIDES AMENABLE TO CHLORINATION	GEN-CN	19
CYANIDE, WEAK ACID DISSOCIABLE	GEN-CNWAD	2
CHEMICAL OXYGEN DEMAND	GEN-COD	9
CONDUCTIVITY IN WATER AND WASTES	GEN-COND	12
CORROSIVITY TOWARDS STEEL	GEN-CORR	2
HEXAVALENT CHROMIUM - COLORIMETRIC	GEN-CR6	15
STANDARD TEST METHODS FOR DETERMINING SEDIMENT CONCENTRATION IN WATER SAMPLES	GEN-D3977	2
CARBONATE (CO3) BY EVOLUTION AND COLUMETRIC TITRATION	GEN-D513-82M	2
SULFIDE, SOLUBLE DETERMINATION OF SOLUBLE SULFIDE IN SEDIMENT	GEN-DIS.S2	3
BULK DENSITY OF SOLID WASTE FRACTIONS	GEN-E1109	1
FREE CYANIDE IN WATER, WASTEWATER, AND SOIL BY MICRODIFFUSION	GEN-FCN	0
FDA EXTRACTABLES	GEN-FDAEX	3
FERROUS IRON IN WATER	GEN-FeII	5
FLUORIDE BY ION SELECTIVE ELECTRODE	GEN-FISE	10
FORMALDEHYDE COLORIMETRIC DETERMINATION	GEN-FORM	3
HYDROGEN HALIDES BY ION CHROMATOGTRAPHY (METHOD 26)	GEN-HA26	4
HYDAZINE IN WATER USING COLORIMETRIC PROCEDURE	GEN-HYD	2
TOTAL SULFUR FOR ION CHROMATOGRAPHY	GEN-ICS	3
ION CHROMATOGRAPHY	GEN-IONC	19
COLOR, NCASI	GEN-NCAS	4

SOP TITLE	SOP ID	Revision
NITROCELLULOSE IN SOIL	GEN-NCEL	2
OXYGEN CONSUMPTION RATE	GEN-O2RATE	1
CARBON, TOTAL ORGANIC DETERMINATION (WALKELY BLACK METHOD)	GEN-OSU	4
Ph IN SOIL AND SOLIDS	GEN-pHS	16
Ph IN WATER	GEN-pHW	16
PARTICLE SIZE DETERMINATION - ASTM PROCEDURE	GEN-PSASTM	4
PARTICLE SIZE DETERMINATION	GEN-PSP	9
SULFIDES, REACTIVE	GEN-RS	5
TOTAL SULFIDE BY PSEP	GEN-S2PS	2
SULFITE	GEN-SO3	3
SPECIFIC GRAVITY	GEN-SPGRAV	2
SOLIDS, TOTAL DISSOLVED (TDS)	GEN-TDS	13
THIOCYANATE	GEN-THIOCN	2
NITROGEN, TOTAL AND SOLUBLE KJELDAHL	GEN-TKN	15
TOTAL NITROGEN AND TOTAL PHOSPHORUS BY ALKALINE PERSULFATE DIGESTION NCASI METHOD TNTP-W10900	GEN-TNTP	1
TOTAL ORGANIC CARBON IN WATER	GEN-TOC	14
SOLIDS, TOTAL SUSPENDED (TSS)	GEN-TSS	13
TURBIDITY MEASUREMENT	GEN-TURB	7
GLASSWASHING FOR INORGANIC ANALYSES	GEN-WASH	5
PHARMACEUTICALS, PERSONAL CARE PRODUCTS AND ENDOCRINE DISRUPTING COMPOUNDS BY HPLC/TANDEM MASS SPECTROMETRY	LCP-1694	5
DETERMINATION OF SELECTED PERFLUORINATED ALKYL ACIDS IN DRINKING WATER BY SOLID PHASE EXTRACTION AND TANDEM	LCP-537	5
PERCHLORATE IN WATER, SOILS, AND SOLID WASTE USING LIQUID CHROMATOGRAPHY TANDEM MASS SPECTROMETRY (LC/MS/MS)	LCP-6850	1
ALDEHYDES BY HPLC	LCP-8315	7
Quantitative Determination of Carbamate Pesticides in Solid Matrices by High Performance Liquid Chromatography/Tandem Mass	LCP-8321(S)	1
Determination of Carbamates in Water by EPA 8321 Using LC Tandem Mass Spectrometry	LCP-8321W	2
NITROAROMATICS AND NITRAMINES BY HIGH PERFORMANCE LIQUID CHROMATOGRAPHY(HPLC)	LCP-8330B	5
Acrylamide by High Performance Liquid Chromatography/tandem mass spectrometry (HPLC/MS/MS)	LCP-ACRYL	2
Dioctyl sulfosuccinate by High Performance Liquid Chromatography/tandem mass spectrometry (HPLC/MS/MS)	LCP-DOS	5

SOP TITLE	SOP ID	Revision
QUANTITATION OF NITROAROMATICS AND NITRAMINES IN WATER, SOIL, AND TISSUE BY LIQUID CHROMATOGRAPHY AND TANDEM MASS SPECTROMETRY (LC-MS/MS)	LCP-LCMS4	3
NITROGUANIDINE BY HIGH PERFORMANCE LIQUID CHROMATOGRAPHY	LCP-NITG	7
ORGANIC ACIDS IN AQUEOUS MATRICES BY HPLC	LCP-OALC	5
QUANTITATIVE DETERMINATION OF OPTICAL BRIGHTENER 220 By High Performance Liquid Chromatography (HPLC)	LCP-OPBr	1
OXYANIONS IN WATER USING LIQUID CHROMATOGRAPHY TANDEM MASS SPECTROMETRY (LC/MS/MS)	LCP-OXY	1
PERFLUORINATED COMPOUNDS BY HPLC/MS/MS	LCP-PFC	8
PERFLUORINATED COMOUNDS BY HPLC/MS/MS FOR DOD PROJECTS	LCP-PFCDOD	0
METHYL MERCURY IN SOIL AND SEDIMENT BY ATOMIC FLUORESCENCE SPECTROMETRY	MET-1630S	4
METHYL MERCURY IN TISSUE BY ALCOHOLIC POTASSIUM HYDROXIDE DIGESTION, ETHYLATION, PURGE AND TRAP, AND COLD VAPOR	MET-1630T	3
METHYL MERCURY IN WATER BY ATOMIC FLUORESCENCE SPECTROMETRY	MET-1630W	4
MERCURY IN WATER BY OXIDATION, PURGE&TRAP, AND COLD VAPOR ATOMIC FLUORES. SPECTROMETRY	MET-1631	14
DETERMINATION OF ARSENIC SPECIES BY HYDRIDE GENERATION CRYOGENIC TRAPPING GAS CHROMATOGRAPHY ATOMIC ABSORPTION	MET-1632	4
MERCURY IN WATER	MET-245.1	16
METALS DIGESTION	MET-3010A	15
METALS DIGESTION	MET-3020A	18
METALS DIGESTION	MET-3050B	15
CLOSED VESSEL OIL DIGESTION	MET-3051M	5
CLOSED VESSEL DIGESTION OF SILICEOUS AND ORGANICALLY BASED MATRICIES	MET-3052M	3
DETERMINATION OF METALS & TRACE ELEMENTS BY INDUCTIVELY COUPLED PLASMA-MS (METHOD 6020)	MET-6020	17
ARSENIC BY BOROHYDRIDE REDUCTION ATOMIC ABSORPTION	MET-7062	5
MERCURY IN LIQUID WASTE	MET-7470A	17
MERCURY IN SOLID OR SEMISOLID WASTE	MET-7471	19
SELENIUM BY BOROHYDRIDE REDUCTION ATOMIC ABSORPTION	MET-7742	6
BIOACCESSIBILITY OF METALS IN SOIL AND SOLID WASTE	MET-BIOACC	3
METALS DIGESTION OF AQUEOUS SAMPLES	MET-DIG	18
SAMPLE FILTRATION FOR METALS ANALYSIS	MET-FILT	4
METALS LABORATORY GLASSWARE CLEANING	MET-GC	8
DETERMINATION OF METALS AND TRACE ELEMENTS BY ICP/AES	MET-ICP	26

SOP TITLE	SOP ID	Revision
DETERMINATION OF METALS & TRACE ELEMENTS BY INDUCTIVELY COUPLED PLASMA-MS (METHOD 200.8)	MET-ICPMS	17
TRACE METALS IN WATER BY PRECONCENTRATION USING REDUCTIVE PRECIPITATION FOLLOWED BY ICP-MS	MET-RPMS	8.1
METALS AND SEMIVOLATILES SPLP EXTRACTION (EPA METHOD 1312)	MET-SPLP	2
WASTE EXTRACTION TEST (WET) PROCEDURE (STLC) for NONVOLATILE and SEMIVOLATILE PARAMETERS	MET-STLC	3
METALS AND SEMIVOLATILES TCLP EXTRACTION (EPA METHOD 1311)	MET-TCLP	9
SAMPLE PREPARATION OF BIOLOGICAL TISSUES FOR METALS ANALYSIS BY GFAA, ICP-OES, AND ICP-MS	MET-TDIG	5
TISSUE SAMPLE PREPARATION	MET-TISP	11
ANALYSIS OF WATER AND SOLID SAMPLES FOR ALIPHATIC HYDROCARBONS	PET-ALIPHAT	2
ANALYSIS OF WATER, SOLIDS AND SOLUBLE WASTE SAMPLES FOR SEMI-VOLATILE FUEL HYDROCARBONS	PET-SVF	15
ANALYSIS OF WATER AND SOLIDS SAMPLES FOR TOTAL PETROLEUM HYDROCARBONS	PET-TPH	2
ANALYSIS OF SOLID AND AQUEOUS SAMPLES FOR STATE OF WISCONSIN DIESEL RANGE ORGANICS	PTE-WIDRO	5
BOTTLE ORDER PREPARATION AND SHIPPING	SMO-BORD	17
SAMPLE DISPOSAL	SMO-DISP	13
FOREIGN SOILS HANDLING TREATMENT	SMO-FSHT	12
SAMPLE RECEIVING	SMO-GEN	35
SAMPLE TRACKING AND INTERNAL CHAIN OF CUSTODY	SMO-SCOC	17
ORGANOCHLORINE PESTICIDES AND PCBs (METHOD 608)	SOC-608	9
1,2-DIBROMOETHANE (EDB) AND 1,2-DIBROMO-3-CHLORO-PROPANE (DBCP) IN AQUEOUS SAMPLES BY MICROEXTRACTION AND GAS	SOC-8011	1
1,2-DIBROMOETHANE (EDB) AND 1,2-DIBROMO-3-CHLORO-PROPANE (DBCP) IN SOLIDS BY MICROEXTRACTION AND GAS CHROMATOGRAPHY	SOC-8011S	1
GLYCOLS	SOC-8015	13
ORGANOCHLORINE PESTICIDES BY GAS CHROMATOGRAPHY: CAPILLARY COLUMN TECHNIQUE	SOC-8081	20
PCBS AS AROCLORS	SOC-8082Ar	18
CONGENER-SPECIFIC DETERMINATION OF PCBS BY GC/ECD	SOC-8082Co	15
DETERMINATION OF NITROGEN OR PHOSPHORUS CONTAINING PESTICIDES	SOC-8141	15
CHLORINATED HERBICIDES	SOC-8151	17
CHLORINATED PHENOLS METHOD 8151 MODIFIED	SOC-8151M	12
METHANOL IN PROCESS LIQUIDS AND STATIONARY SOURCE EMISSIONS	SOC-9403	9
HAZARDOUS AIR POLLUTANTS (HAPS) IN PULP AND PAPER INDUSTRY CONDENSATES	SOC-9901	6

SOP TITLE	SOP ID	Revision
HAPS AND OTHER COMPOUNDS IN IMPINGER/CANISTER SAMPLES FROM WOOD PRODUCTS FACILITIES	SOC-9902	5
ALCOHOLS	SOC-ALC	3
BUTYLTINS	SOC-BUTYL	14
CALIBRATION OF INSTRUMENTS FOR ORGANICS CHROMATOGRAPHIC ANALYSES	SOC-CAL	10
CONFIRMATION PROCEDURE FOR GC AND HPLC ANALYSES	SOC-CONF	8
DETERMINATION OF OTTO FUEL II IN WATER	SOC-OTTO	2
ALIQUOTING OF SAMPLES	SOILPREP-ALIQUOT	0
SUBSAMPLING AND COMPOSITING OF SAMPLES	SOILPREP-SUBS	0
1,2-DIBROMOETHANE, 1,2-DIBROMO-3-CHLOROPROPANE, AND 1,2,3-TCP BY GC	SVD-504	11
HALOACETIC ACIDS IN DRINKING WATER	SVD-552	8
CHLORINATED PHENOLICS BY IN-SITU ACETYLATION AND GC/MS	SVM-1653A	10
SEMIVOLATILE ORGANIC COMPOUNDS BY GC/MS	SVM-625	8
SEMIVOLATILE ORGANIC COMPOUNDS BY GC/MS - METHOD 8270D	SVM-8270D	5
SEMIVOLATILE ORGANIC COMPOUNDS BY GC/MS - LOW LEVEL PROCEDURE	SVM-8270L	10
POLYNUCLEAR AROMATIC HYDROCARBONS BY GAS CHROMATOGRAPHY/MASS SPECTROMETRY SIM	SVM-8270P	10
SEMIVOLATILE ORGANIC COMPOUNDS BY GC/MS SELECTED ION MONITORING	SVM-8270S	8
ANTRHAQUINONE IN PAPERBOARD BY GC/MS SELECTED ION MONITORING	SVM-AQ	0
QUANTITATIVE GEOCHEMICAL BIOMARKERS BY GC/MS SELECTIVE ION MONITORING	SVM-BIO	2
PCB CONGENERS BY GC/MS SELECTIVE IION MONITORING	SVM-CON	0
DIISOPROPYL METHYLPHOSPHONATE BY GC/MS SELECTIVE ION MONITORING	SVM-DIMP	0
NONYLPHENOLS ISOMERS AND NONYLPHENOL ETHOXYLATES	SVM-NONYL	6
ORGANOPHOSPHOROUS PESTICIDES BY GC/MS/MS	SVM-OPPMS2	2
CHLORINATED PESTICIDES BY GC/MS/MS	SVM-PESTMS2	5
POLYBROMINATED DIPHENYL ETHERS (PBDEs) AND POLYBROMINATED BIPHENYLS (PBBs) BY GC/MS	SVM-ROHS	2
PURGE AND TRAP FOR AQUEOUS SAMPLES	VOC-5030	10
PURGE AND TRAP/EXTRACTION FOR VOC IN SOIL AND WASTE SAMPLES , CLOSED SYSTEM	VOC-5035	12
VOLATILE ORGANIC COMPOUNDS BY GC/MS	VOC-524.2	17
VOLATILE ORGANIC COMPOUNDS IN WATER BY GC/MS SIM	VOC-524.2SIM	2

SOP TITLE	SOP ID	Revision
VOLATILE ORGANIC COMPOUNDS BY GC/MS	VOC-624	13
VOLATILE ORGANIC COMPOUNDS BY GC/MS	VOC-8260	20
VOLATILE ORGANIC COMPOUNDS BY GC/MS SELECTIVE ION MONITORING	VOC-8260S	3
VOA STORAGE BLANKS	VOC-BLAN	10
SAMPLE SCREENING FOR VOLATILE ORGANIC COMPOUNDS IN SOIL, WATER AND MISC. MATRICES	VOC-BVOC	8
GASOLINE RANGE ORGANICS BY GAS CHROMATOGRAPHY	VOC-GRO	12

APPENDIX H – Data Qualifiers

Inorganic Data Qualifiers

*	The result is an outlier. See case narrative.
#	The control limit criteria is not applicable. See case narrative.
B	The analyte was found in the associated method blank at a level that is significant relative to the sample result as defined by the DOD or NELAC standards.
E	The result is an estimate amount because the value exceeded the instrument calibration range.
J	The result is an estimated value.
U	The analyte was analyzed for, but was not detected ("Non-detect") at or above the MRL/MDL. *DOD-QSM 4.2 definition* : Analyte was not detected and is reported as less than the LOD or as defined by the project. The detection limit is adjusted for dilution.
i	The MRL/MDL or LOQ/LOD is elevated due to a matrix interference.
X	See case narrative.
Q	See case narrative. One or more quality control criteria was outside the limits.
H	The holding time for this test is immediately following sample collection. The samples were analyzed as soon as possible after receipt by the laboratory.

Metals Data Qualifiers

#	The control limit criteria is not applicable. See case narrative.
J	The result is an estimated value.
E	The percent difference for the serial dilution was greater than 10%, indicating a possible matrix interference in the sample.
M	The duplicate injection precision was not met.
N	The Matrix Spike sample recovery is not within control limits. See case narrative.
S	The reported value was determined by the Method of Standard Additions (MSA).
U	The analyte was analyzed for, but was not detected ("Non-detect") at or above the MRL/MDL. *DOD-QSM 4.2 definition* : Analyte was not detected and is reported as less than the LOD or as defined by the project. The detection limit is adjusted for dilution.
W	The post-digestion spike for furnace AA analysis is out of control limits, while sample absorbance is less than 50% of spike absorbance.
i	The MRL/MDL or LOQ/LOD is elevated due to a matrix interference.
X	See case narrative.
+	The correlation coefficient for the MSA is less than 0.995.
Q	See case narrative. One or more quality control criteria was outside the limits.

Organic Data Qualifiers

*	The result is an outlier. See case narrative.
#	The control limit criteria is not applicable. See case narrative.
A	A tentatively identified compound, a suspected aldol-condensation product.
B	The analyte was found in the associated method blank at a level that is significant relative to the sample result as defined by the DOD or NELAC standards.
C	The analyte was qualitatively confirmed using GC/MS techniques, pattern recognition, or by comparing to historical data.
D	The reported result is from a dilution.
E	The result is an estimated value.
J	The result is an estimated value.
N	The result is presumptive. The analyte was tentatively identified, but a confirmation analysis was not performed.
P	The GC or HPLC confirmation criteria was exceeded. The relative percent difference is greater than 40% between the two analytical results.
U	The analyte was analyzed for, but was not detected ("Non-detect") at or above the MRL/MDL. *DOD-QSM 4.2 definition* : Analyte was not detected and is reported as less than the LOD or as defined by the project. The detection limit is adjusted for dilution.
i	The MRL/MDL or LOQ/LOD is elevated due to a chromatographic interference.
X	See case narrative.
Q	See case narrative. One or more quality control criteria was outside the limits.

Additional Petroleum Hydrocarbon Specific Qualifiers

F	The chromatographic fingerprint of the sample matches the elution pattern of the calibration standard.
L	The chromatographic fingerprint of the sample resembles a petroleum product, but the elution pattern indicates the presence of a greater amount of lighter molecular weight constituents than the calibration standard.
H	The chromatographic fingerprint of the sample resembles a petroleum product, but the elution pattern indicates the presence of a greater amount of heavier molecular weight constituents than the calibration standard.
O	The chromatographic fingerprint of the sample resembles an oil, but does not match the calibration standard.
Y	The chromatographic fingerprint of the sample resembles a petroleum product eluting in approximately the correct carbon range, but the elution pattern does not match the calibration standard.
Z	The chromatographic fingerprint does not resemble a petroleum product.

APPENDIX I – Controlled and Normative Documents

Internal QA Documents	Location
Quality Assurance Manual	Q:\QA Manual\QAM.rXX.DOC
ALS-Kelso Certifications/Accreditations	Cert_kel.xls (QA Dept.)
MDL/LOD/LOQ Tracking Spreadsheet	MDL_LIST_Master.xls
Technical Training Summary Database	TrainDat.mdb
Approved Signatories List	QAM App A
Personnel resumes/qualifications	HR Department
Personnel Job Descriptions	HR Department/QA Training Files
ALS – Kelso Data Quality Objectives	Kelso DQO table-QA Maintained.xls
Master Logbook of Laboratory Logbooks	QA Masterlog-001
Standard Operating Procedures and Spreadsheet	1_ Kelso SOP.xls
Proficiency Testing Schedule and Tracking Spreadsheet	PT_Schedule.xls
External Normative Documents	**Location**
USEPA Manual for the Certification of Laboratories Analyzing Drinking Water, 5th Edition, EPA 815-B-97-001 (January 2005)	QA Department and online access
USEPA 40 CFR Part 136, Guidelines for Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act, and EPA Method Update Rule 2007, 2012, 2016.	QA Department and online access
USEPA 40 CFR Part 141, National Primary Drinking Water Regulations and EPA Method Update Rule 2007.	QA Department and online access
National Environmental Laboratory Accreditation Program (NELAP), 2003 Quality Standards.	QA Department
TNI: TNI Standard – Environmental Laboratory Sector, Volume 1, Management and Technical Requirements for Laboratories Performing Environmental Analysis, EL-V1-2009.	QA Department
Quality Standards. American National Standard General requirements for the competence of testing and calibration laboratories, ANSI/ISO/IEC 17025:2005(E).	QA Department
DoD Quality Systems Manual for Environmental Laboratories, Versions 4.2, 5.0, and 5.1.	QA Department and online access
Analytical Methods (see References section).	Laboratory Departments and Online access

APPENDIX J – Laboratory Accreditations

The list of accreditations, certifications, licenses, and permits existing at the time of this QA Manual revision is given below, followed by the entire primary NELAP and DOD ELAP accreditations (un-numbered attachments). Current accreditation information is available at any time by contacting the laboratory or viewing the ALS Global website www.alsglobal.com.

Program	Number
National Programs	
ISO:IEC 17025:2005	L18-129
DoD ELAP	L18-128
State Programs	
Alaska DEC CSLAP	17-004
Arizona DHS	AZ0339
Arkansas - DEQ	88-0637
California DHS	2795
Florida DOH	E87412
Hawaii DOH	-
Louisiana DEQ	3016
Maine DHS	WA01276
Minnesota DOH	053-999-457
Nevada DEP	WA35
New Jersey DEP	WA005
New York DoH	12060
North Carolina DWQ	605
Oklahoma DEQ	9801
Oregon - DOH (primary NELAP)	WA100010
South Carolina DHEC	61002
Texas CEQ	T104704427-16-11
Washington DOE	C544
Miscellaneous	
Foreign Soil Permit	USDA
Plant Import Permit	USDA
Controlled Substances Permit	US DEA
Controlled Substances Permit	WA DOH

END

OF

DOCUMENT

APPENDIX C

QUALITY ASSURANCE INFORMATION FOR PACIFIC ECORISK

Pacific EcoRisk

Quality Manual

PACIFIC ECORISK
ENVIRONMENTAL CONSULTING & TESTING

Pacific EcoRisk

Quality Manual

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Revision 21

May 2019

Approved by:

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QA Policy Statement

Pacific EcoRisk (PER) maintains a Quality Manual that provides a detailed description of quality assurance (QA) and quality control (QC) policies and procedures for all toxicity testing and chemical analyses performed by PER. These policies and procedures apply to all aspects of toxicity testing that can potentially affect data quality and interpretation, including, but not limited to, sampling and handling of test materials, collection, holding, and conditioning of test organisms, test conditions and procedures, calibration of instruments, experimental design, reference toxicant testing, record keeping, and statistical evaluation of data.

The primary objective of PER management is to ensure that all of the data generated and reported are scientifically valid, legally defensible, and of known accuracy, precision, representativeness, and comparability. In accordance with this objective, the PER Technical Directors require that:

- All personnel concerned with environmental testing are familiarized with this Quality Manual and implement the policies and procedures in their work;
- All personnel are free from undue pressures, which might adversely affect the quality of work;
- All data is reviewed relative to method requirements and the Quality Manual. Corrective actions are implemented when data fail to meet established quality control criteria;
- Standard operating procedures have been developed in accordance with test methods established by the U.S. Environmental Protection Agency (USEPA), ASTM, and Standard Methods and are used in order to ensure that good quality data is collected; and
- All final reports are reviewed in order to meet the clients' objectives with respect to quality and completeness.

The scientific staff is composed entirely of degreed professional scientists experienced in performing both routine and regulatory testing, and many of the scientists have extensive expertise in research and methods development for more specific non-routine studies. Management and technical personnel have the authority and resources to carry out their duties and have procedures to identify and correct departures from the laboratory's management system. Personnel understand the relevance and importance of their duties as related to the maintenance of PER's management system.

The experienced staff, the modern facility, and strict adherence to the policies and procedures described in the Quality Manual contribute to an overall commitment to timely production of the highest quality product and services in compliance with the TNI Standard. PER continually looks to improve the effectiveness of the management system through regular reviews and revisions to the Quality Manual.

As a result of the exceptional quality of the data, PER is capable of providing technical support related to NPDES, Water Quality Criteria Development, 404 Certification (Dredging), Ecological Risk Assessment, ambient monitoring, and product/chemical registration programs.

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Acronyms

USACE	Army Corps of Engineers
ASTM	American Society for Testing Materials
CBI	confidential business information
cm	centimeter
COC	chain-of-custody
CV	coefficient of variation
°C	degrees Celsius
DMR-QA	Discharge Monitoring Report – Quality Assurance
DO	dissolved oxygen
DOC	demonstration of capability
DTSC	Department of Toxic Substances Control
DQO	data quality objective
ECx	effective concentration in X% of the population.
EDD	electronic data deliverable
ELAP	Environmental Laboratory Accreditation Program
ELISA	enzyme linked immunosorbent assay
g/L	grams per liter
ICx	inhibitory concentration in X% of the population.
ISO/IEC	International Organization for Standardization/International Electrochemical Commission
LCx	lethal concentration in X% of the population.
mg	milligram
mg/L	milligram per liter
mL	milliliter
SDS	safety data sheet
NELAC	National Environmental Laboratory Accreditation Conference
NELAP	National Environmental Laboratory Accreditation Program
NIST	National Institute of Standards and Technology
NPDES	National Pollutant Discharge Elimination System
PAR	photosynthetically active radiation
PER	Pacific EcoRisk
ppt	parts per thousand
psu	practical salinity unit
PT	proficiency test(ing)
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
SAP	Sampling and Analysis Plan
SI	International System of Units

SOP	standard operating procedure
SWAMP	Surface Water Ambient Monitoring Program
TIE	toxicity identification evaluation
TNI	The NELAC Institute
µS	microsiemen
USEPA	United States Environmental Protection Agency

1. INTRODUCTION

This Quality Manual defines the policies, procedures, and documentation that ensure Pacific EcoRisk's testing services continually meet a defined standard of quality that is designed to provide clients with data of known and documented quality and, where applicable, demonstrate regulatory compliance.

This Quality Manual sets the standard under which all laboratory operations are performed, including the laboratory's organization, objectives, and operating philosophy. The Quality Manual has been prepared to ensure compliance with the 2009 TNI Environmental Laboratory Sector Standard – Volume 1 – Management and Technical Requirements for Laboratories Performing Environmental Analysis (EL-V1-M1 through M7-ISO-2009). It is also compliant for PER's accreditations through the Oregon Health Authority's Environmental Laboratory Accreditation Program, the California Department of Public Health's Environmental Laboratory Accreditation Program (ELAP), and the Washington Department of Ecology (Appendix A). In addition, the policies and procedures outlined are compliant with the various accreditation and certification programs that PER maintains. A glossary of terms used in this Quality Manual is provided in Appendix B.

The QA Manager is responsible for maintaining the currency of the Quality Manual. The Quality Manual is reviewed annually by the QA Manager and his/her designees to ensure it still reflects current practices and meets the requirements of any applicable regulations, certifications, accreditations, or client specifications.

The Quality Manual is considered confidential within PER and may not be altered in anyway except by approval of the Technical Director(s). If it is distributed to external users, it is for the purpose of reviewing PER's management system and may not be used for any other purpose without written permission.

PER's scope of testing services includes testing under the following regulatory programs/study areas: NPDES, Water Quality Criteria Development, 404 Certification (Dredging), Ecological Risk Assessment, ambient monitoring, and product/chemical registration programs. The scope of testing follows methods listed in Appendix C.

2. ORGANIZATION

PER is a commercial laboratory located in Fairfield, CA. The laboratory is a legally defensible organization and is responsible for carrying out toxicity testing activities that:

- Meet the requirements of the TNI Standard;
- Conform to the specifications and requirements of the methods and procedures for which the laboratory is certified to perform;

- Meet the requirements of the client, regulatory agencies (*e.g.*, USEPA, Regional Water Quality Control Boards, USACE, DTSC, etc.), and accrediting bodies through application of the policies and procedures outlined in this Section and throughout the Quality Manual; and
- Ensure the protection of its clients' confidential information and proprietary rights.

The organizational structure of the company and the relationship between quality management, technical operations, and administrative support services is summarized in Figure 2-1.

The job descriptions, roles, responsibilities, and authority of laboratory management are described in Section 3. The organizational chart specific to laboratory operations and job descriptions for all other staff can be found in Section 18.

2.1 Conflict of Interest and Undue Pressure

PER ensures that it is impartial and that personnel are free from undue commercial, financial, or other pressures that might influence their technical judgment.

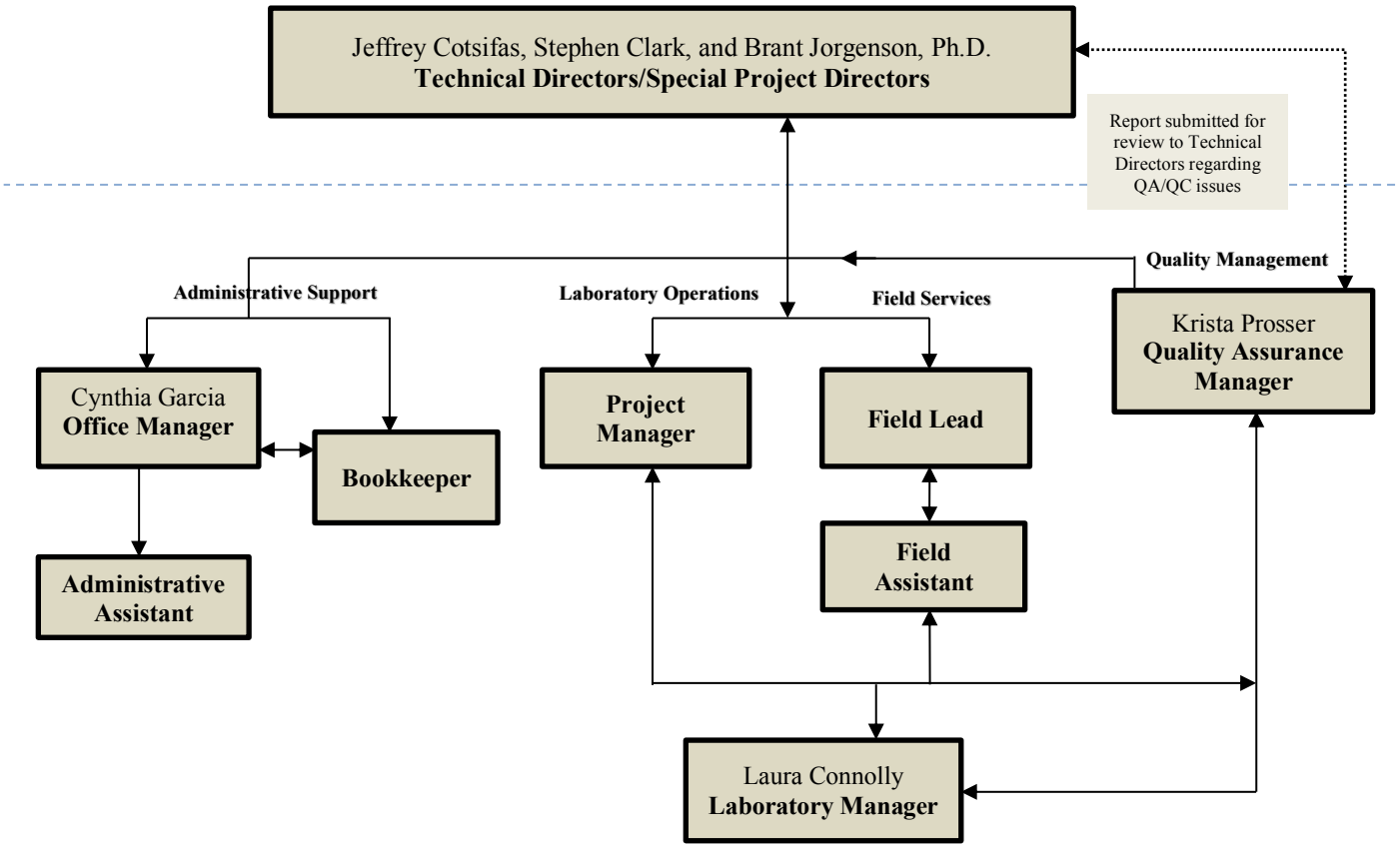
The company is organized in such a way that ensures conflicts of interest do not influence the technical judgment of analytical personnel. In addition, procedures are in place to prevent outside pressures or involvement in activities that may affect competence, impartiality, judgment, operational integrity, or the quality of the work performed at the laboratory.

Policies and procedures to prevent commercial, financial, or other influences that may negatively affect the quality of the work or negatively reflect on competence, impartiality, judgment, or operational integrity are described in depth in the **Statement of Scientific Integrity** and the **Employee Handbook**.

2.2 Client Confidentiality

All data, reports, and electronic deliverables generated by PER are considered confidential and proprietary to the client from whom the work has been contracted. It is the policy of PER that no employee shall share client information with any other party without expressed written guidance from the client. Electronic files are accessible on computers that require passwords from qualified PER staff. PER employees shall not participate in any activity that would compromise client confidentiality.

Figure 2-1. Company Organizational Chart



3. MANAGEMENT

PER has a well-defined management structure. Top management consists of the Technical Directors/Special Projects Directors. Additional management staff includes the Project Manager(s), Laboratory Manager(s), Field Manager(s), Quality Assurance Manager, and the Office Manager.

Management has overall responsibility for the technical operations and the authority needed to generate the required quality of laboratory operations. Management ensures communication within the organization maintains an effective management system and communicates the importance of meeting client, statutory, and regulatory requirements. Management ensures that the system documentation is known and available so that appropriate personnel can implement their part. When changes to the management system occur or are planned, managers ensure that the integrity of the system is maintained.

PER has appointed deputies for top managerial positions in the case when one of the managers is not in the office. Regarding the Technical Directors, another Technical Director will act as a deputy to the absent Technical Director.

Management's commitment to good professional practice and to the quality of its products is defined in the QA Policy Statement, which can be found on the first page of this document.

Management ensures that testing activities meet the requirements of the TNI Standards, the ISO/IEC 17025 Standard, and the needs of the client.

Management implements, maintains, and improves the management system and identifies noncompliance with the management system of procedures. Managers initiate actions to prevent or minimize noncompliance.

Management defines the minimal level of education, qualifications, experience, and skills necessary for all positions in the laboratory and ensures that technical staff has demonstrated capabilities in their tasks.

Management ensures technical competence of personnel operating equipment, performing tests, evaluating results, or signing reports and limits authority to perform laboratory functions to those appropriately trained and/or supervised. This is achieved through hiring staff with minimum education requirements, providing in-house training by senior staff, and requiring staff to read appropriate manuals and SOPs for their job description. Training is kept up to-date-as described in Section 18 by periodic review of training records and through employee performance reviews.

3.1 Management Roles and Responsibilities

Responsibilities and job descriptions of administrative staff and personnel who manage, perform, or verify work affecting the quality of toxicity tests is documented in this section and in Section 18. The job responsibilities for top PER management are as follows:

3.1.1 Technical Director/Special Projects Director

The Technical Director/Special Projects Director (and designees) provides the resources necessary to implement an effective quality and data integrity program. The Technical Director/Special Projects Director is a full-time staff member who supervises laboratory operations and data reporting. The Technical Director meets the general and education requirements and qualifications found in Sections 4.1.7.2 and 5.2.6.1 of the TNI Standard - EL-V1M2-2009. The Technical Director's proof of experience in the fields of accreditation may be found in his/her employee file and resume.

If a Technical Director is absent for fifteen (15) calendar days or more, a designee with appropriate qualifications will perform the Technical Director's duties. Beyond a thirty-five (35) calendar day absence, management will notify the primary accreditation body in writing of the absence of the Technical Director and the appointment of the designee.

PER Technical Directors are not the technical directors of more than one accredited environmental laboratory.

The Technical Director/Special Projects Director is responsible for:

- Design and overseeing performance of individual projects;
- Overseeing all laboratory scientists participating in the project;
- Approval of and adherence to SOPs and the Quality Manual;
- Data interpretation;
- Preparation of final reports;
- Consultation daily with the Laboratory Manager and QA Manager to evaluate laboratory operations;
- Overseeing general operation of the laboratory, including monitoring performance data and validity of operations;
- Implementation of any necessary corrective actions;
- Hiring of technical and administrative personnel;
- Procuring new clients;
- Reviewing invoices;
- Reviewing new contracts; and
- Annually reviewing staff performance.

3.1.2 QA Manager

The QA Manager (and designees) is responsible for the oversight and review of quality control data and operates independently from the laboratory operations for which he/she has quality assurance oversight. The QA Manager (and designees) is also responsible for the daily review of data generated by laboratory operations and generating QA/QC program reports for submittal to the Technical Director(s) to ensure compliance with the TNI Standard. The QA Manager's proof of experience in QA/QC procedures, knowledge of analytical methods, and the laboratory's management system may be found in his/her employee file and resume. The QA Manager has the following responsibilities:

- Develops, reviews, and implements quality control policies and programs, including statistical procedures and techniques, for the maintenance of quality control standards;
- Revises and updates the Quality Manual on a regular basis, and as needed;
- Monitors quality assurance activities to determine conformance with the guidelines established in PER SOPs;
- Reviews and revises (as needed) PER SOPs at a minimum of at least every 2 years;
- Evaluates new ideas and current developments relative to the field of quality control and quality assurance and recommends the means for their implementation;
- Has the authority to stop a project;
- Evaluates data quality and maintains records on related quality control charts and other pertinent information;
- Coordinates and/or conducts quality assurance investigations (*e.g.,* intra- and inter-laboratory programs);
- Reviews the overall QA/QC effort and reports issues to Technical Directors;
- Maintains a file of all laboratory accreditation information;
- Ensures the technical competence of technical staff;
- Assesses laboratory performance through control charts and proficiency testing, as well as performing annual audits;
- Evaluates data objectively and performs assessment without outside (*e.g.,* managerial) influence;
- Consults daily with the Laboratory Manager and Technical Directors to evaluate laboratory operations and reports deviations;
- Reviews all internal QC charts and outside QC programs to ensure that the quality of the data is maintained over time. Makes recommendations based upon these trends in order to consistently provide data that is of the highest quality; and
- Manages non-conforming data evaluations, corrective action reports, and performance reports.
- Contributes to staff performance evaluations.

3.1.3 Project Manager

Project Managers (and designees) prepare project quotes and proposals, study plans, QAPPs, and SAPs. Project Managers are responsible for communicating with clients, reporting results,

tracking project performance and costs, and assuring that client deliverables meet required turn-around times. Project Managers contribute to staff performance evaluations. Project Managers represent PER at meetings and are familiar with outside projects.

3.1.4 Laboratory Manager

The Laboratory Manager (and designees) oversees daily operation of the laboratory. The Laboratory Manager coordinates activities of Project Managers and consults daily with Technical Director(s) and QA Manager to evaluate laboratory operations and review of new project requirements to ensure appropriate facilities and resources are available. The Laboratory Manager provides direction and guidance to Scientists and Laboratory Assistants regarding planning of day and task completion. The Laboratory Manager limits authorization to perform laboratory functions to those appropriately trained and/or supervised and performs training of laboratory staff. The Laboratory Manager also requests and summarizes staff performance evaluations from Project and QA Managers; the Laboratory Manager leads annual performance reviews for all Scientists and Laboratory Assistants.

3.2 Documentation of Management/Quality System

The management system is defined through the policies and procedures provided in this Quality Manual and written laboratory Standard Operating Procedures (SOPs) and policies.

3.2.1 Quality Manual

The Quality Manual contains the following required items:

- Document title;
- Laboratory's full name and address;
- Name, address (if different from above), and telephone number of individual(s) responsible for the laboratory;
- Identification of all major organizational units that are to be covered by this Quality Manual and the effective date of the version;
- Identification of the laboratory's approved signatories;
- Signed and dated concurrence (with appropriate names and titles) of all responsible parties including the quality manager(s), technical manager(s), and the agent who is in charge of all laboratory activities, such as the laboratory director or laboratory manager;
- Objectives of the management system and contain or reference the laboratory's policies and procedures;
- Laboratory's official quality policy statement, which shall include management system objectives and management's commitment to ethical laboratory practices and to upholding the requirements of laboratory accreditation Standards; and
- Table of contents and applicable lists of references, glossaries, and appendices.

This Quality Manual contains or references all required elements as defined by the TNI Standard.

3.2.2 Standard Operating Procedures (SOPs)

A Standard Operating Procedure (SOP) is available for all laboratory procedures that require specific knowledge and/or adherence to a specific sequence of procedural steps. PER SOPs are reviewed and revised (as required) at a minimum at least every 2 years. The reviewed SOPs include, but is not restricted to, the following:

- Sample collection, preservation, and holding time;
- Sample custody, receipt, and document control;
- Analytical methods;
- Instrument calibration and maintenance;
- Test methods; and
- Sample holding and disposal.

All laboratory personnel participating in, or performing, any testing-related activity in the laboratory must be fluently familiar with the relevant SOPs. A copy of each SOP shall be maintained in each of the following locations:

- Staff Server;
- Office, in clearly-labeled binder(s); and
- Laboratory, in clearly labeled binder(s).

3.2.3 Order of Precedence

In the event of a conflict or discrepancy between policies, the order of precedence is as follows unless otherwise noted:

- Quality Manual;
- SOPs and Policies; and
- SAP, Study Plan, and Client Communications.

4. DOCUMENT CONTROL

All documents that are part of the document control system of the laboratory (*e.g.,* SOPs) include a date when the procedure was effective, and electronic copies are write-protected to prohibit unauthorized revisions. The QA/QC documents are periodically reviewed and revised as necessary to ensure continuing suitability with the applicable method; old records are moved to the QA/QC Program server (which can only be accessed by management and the QA staff) where the documents will be retained as historical records for at least five years. Technical Director(s) must approve any revision to any QA/QC documentation. All old document control system documents have a revision number, a date that the document was put into effect, and a date once the document was no longer in effect.

A master list of all QA/QC documents related to the PER Quality Manual is maintained so as to identify the current revision status of each document. Copies of the approved QA/QC documents are available on the Staff server and in the office and laboratory; obsolete versions of the hard copy documents are promptly removed from all points of use and shredded, and obsolete electronic copies are placed on the QA/QC Program server (see above). Obsolete documents retained for legal or knowledge preservation are suitably marked as obsolete and stored in the PER library. Revised QA/QC documents have altered text identified in the "History of Change" section, are edited using track changes software, and are reviewed by the Technical Director(s); approved documents are re-issued as soon as practicable.

5. REVIEW OF REQUESTS, TENDERS, AND CONTRACTS

Prior to accepting a new project, the Technical Director(s) review the scope of the project to determine if it is consistent with the services provided by PER, including a review of the requested methods, certifications/accreditation, requirements for laboratory facilities, and available laboratory and staff resources. Should the review indicate any potential conflict or deficiency, the Technical Director(s) will discuss such limitations with the requesting party. The use of non-standard methods is subject to an agreement between PER and the client, and will include a written request (*e.g.,* contract or scope of work) from the client prior to the use of non-standard methods. Projects will only be accepted that can be properly completed with the laboratory resources. Any differences between the request for services and a formal contract are resolved prior to initiation of the project in the form of a tender and must be acceptable to both parties in writing. When both parties accept the request and tender a contract, the project will then be initiated. Records of all conversations and e-mail related to requests for services are maintained by the Technical Director(s) and are placed in the contract/client file when appropriate. Records are maintained for every contract or work request, when appropriate. Upon project completion, a Technical Director reviews test reports to determine if conditions outlined in the contract have been met. Clients are informed of any deviations from a contract. Following the review of a request for services, the Technical Director(s) or Project Manager prepares a **Test Order Form**, and a project number and test folder are generated for the project. The project number is used to track all project-associated data and the test folder is used to contain relative documentation required for each specific project. The Technical Director(s) or Project Manager prepares all of the necessary data sheets for the testing required for the project, ensures that sample collection and delivery are coordinated with the client, orders test organisms when necessary, and transfers the test folder to the laboratory.

For projects that include field sampling, the project management role may vary (PER or the client generates a SAP and/or field log that specifies work to be performed that is consistent with the project contract and QAPP). For a project managed by PER, the Technical Director or Project Manager prepares the SAP and field logs, which are provided to the field scientists that

will perform the sampling. The Project Manager or field scientists will ensure that the supplies specified in the field log are ordered and arrive in time to perform the sampling.
All project-related communications with the client, including e-mails, fax, and telephone conversations, are maintained by the Technical Director(s) and Project Manager in one or more of the following locations:

- E-mail program files on the Technical Director(s) or Project Manager's computer;
- Telephone conversations are documented in phones logs or laboratory notebooks; and
- Hard copies of fax or e-mail communications are maintained in the project folder.

6. SUBCONTRACTING OF ENVIRONMENTAL TESTS

A subcontract laboratory is defined as a laboratory external to PER, or at a different location than the address indicated on the front cover of this manual, which performs analyses for this laboratory. Toxicity tests for which PER is certified are generally not subcontracted; only analytical samples in support of toxicity tests or monitoring programs PER oversees are subcontracted.

When subcontracting analytical services, PER ensures that work requiring accreditation is placed with an appropriately accredited laboratory or one that meets applicable statutory and regulatory requirements for performing the tests. When PER has the flexibility to select the subcontractor, preference is given to NELAP accredited laboratories. The Office and Quality Managers maintain a list of subcontract laboratories. On an annual basis, the subcontract laboratories are required to submit the following documentation that is maintained on the PER server:

- Quality Manual;
- Results of recent proficiency testing;
- Results of their most recent audit;
- Statement of qualifications; and
- Laboratory accreditation certificate, including fields of testing/analysis.

The Technical Director(s) or their designees notifies the client of the intent to subcontract the work in writing. When possible, the laboratory gains the approval of the client to subcontract their work prior to implementation, preferably in writing. The laboratory performing the subcontracted work is identified in the final report. PER assumes responsibility to the client for the subcontractor's work, except in the case where a client or a regulating authority specified which subcontractor is to be used.

7. PURCHASING SERVICES AND SUPPLIES

The laboratory ensures that purchased supplies and services that affect the quality of environmental tests are of the required or specified quality by using approved suppliers and products.

The laboratory has procedures for purchasing, receiving, and storage of supplies that affect the quality of environmental tests. The Office Manager maintains the list of approved suppliers of services and supplies and the QA Manager or his/her designees approves technical content of purchasing documents prior to ordering.

Policies for receipt of supplies are documented in the **Incoming Supplies and Equipment Approval Checklist**. The purchased supplies and reagents must be identical with those noted on the packing slip (*e.g.*, class, grade, and amount) and are inspected or otherwise verified on this checklist as complying with requirements defined in the test method. Chemicals are further checked for storage conditions on the Safety Data Sheet (SDS) and stored accordingly in the laboratory. The checklist and supporting manufacturers documentation are maintained in the **Incoming Supplies and Equipment Approval Checklist** binder in the laboratory.

Records for equipment maintenance, calibration, or certificates of analyses are stored with the appropriate equipment log.

8. SERVICE TO THE CLIENT

PER provides its clients, or their representatives, with full cooperation when a request is made to clarify a client's testing request and to monitor the laboratory's performance in relation to the work performed, provided that confidentiality is maintained for testing performed for other clients.

8.1 Client Confidentiality

The laboratory confidentiality policy is to not divulge or release any information to a third party without proper authorization. Third party requests for data and information are referred to the client. Data and records identified as proprietary, privileged, or confidential are exempt from disclosure. All electronic data (storage or transmissions) are kept confidential, based on technology and laboratory limitations, as required by client or regulation. When necessary, confidentiality statements are used in e-mails and documents.

8.2 Client Support

Communications with the client, or their representative, are maintained to provide proper instruction and modification for testing. Technical staff are available to discuss any technical questions or concerns the client may have. The client, or their representative, may be provided reasonable access to laboratory areas for witnessing testing.

The Technical Director(s) or Project Manager communicate delays or major deviations to the testing to the client immediately.

The Technical Director(s) or Project Manager will provide the client with all requested information pertaining to the analysis of their samples. An additional charge may apply for additional data/information that was not requested prior to the time of sample analysis or previously agreed upon.

8.3 Client Feedback

The laboratory routinely seeks both negative and positive feedback by including an optional survey link in all e-mail communications from Technical Directors and Project Managers. Feedback provides acknowledgement, corrective actions where necessary, and opportunities for continuous improvement. Client feedback is solicited via e-mail and a Client Survey.

9. COMPLAINTS

PER's policy is to document and respond to any complaints filed by a client or other parties about the laboratory activities. Where a complaint, or any other circumstance, raises doubt concerning the laboratory's compliance with the laboratory's policies or procedures, or the TNI Standard requirements, or concerning the quality of the laboratory testing, the Technical Director(s) ensure that those areas of activity and responsibility are promptly audited. This may include tracking of quality checks, internal audits, a quality control assessment, and corrective action implementation and monitoring. In addition, a **Preventative Action** form may be completed by staff to minimize a future occurrence. Records of the complaint and subsequent actions are maintained in the QA/QC Program files in the laboratory.

10. CONTROL OF NON-CONFORMING ENVIRONMENTAL TESTING WORK

Non-conforming work is work that does not meet acceptance criteria or requirements. Non-conformances can include departures from standard operating procedures or test methods or unacceptable quality control results (see Section 23). Identification of non-conforming work can come through client complaints, quality control, instrument calibration, evaluating consumable

materials, staff observation, final report review, management reviews, and internal and external audits.

10.1 Exceptionally Permitting Departures from Documented Policies and Procedures

Requests for departures from laboratory procedures are approved by the Technical Director(s), confirmed with the QA Manager, and are documented in the same fashion as other client communications as outlined in Section 5. Planned departures from procedures or policies do not require audits or investigations.

10.2 Non-Conforming Work

PER's policy for control of non-conforming work is to identify the non-conformance, determine if it will be permitted, and take appropriate action. The QA Manager and his/her designees oversee proper communication of non-conforming work and implementation of the applicable procedures associated with non-confirming work.

The investigation and associated corrective actions of non-conforming work involving alleged violations of the company's Data Integrity and Ethics Program follow the procedures outlined in Section 17.

Corrective actions for routine, one-time non-conformances, such as transcription errors, may be documented on raw datasheets, logbooks, e-mail, or deviation from protocol sheets. The QA Manager documents more serious corrective actions (non-conforming work that could reoccur or where there is doubt that the laboratory is following its own policies or procedures) by using a more formal corrective action form. The procedure for investigating and taking appropriate corrective actions of non-conforming work are described in Section 12.

PER evaluates the significance of the non-conforming work and takes corrective action immediately. The client is notified if their data has been impacted. The laboratory allows the release of non-conforming data only with approval by the Technical Director(s) on a case-by-case basis. Reports reflect any non-conforming work that is deemed conditionally acceptable based on the "Best Professional Judgment" of the Technical Director(s) when the degree of departure did not affect the outcome of the test.

The discovery of a non-conformance for results that have already been reported to the client must be immediately evaluated for significance of the non-conformance, if the data is acceptable to the client, and determination of the appropriate corrective action.

10.3 Stop Work Procedures

For any non-conforming testing, it is PER's policy that the Laboratory Manager and/or QA Manager must immediately notify the Technical Director(s) so that the significance of the non-conforming work can be evaluated and work can be stopped if deemed appropriate by the Technical Director(s). After work has been stopped, the Technical Director(s) authorizes the resumption of work. The evaluation of the issue, root cause, and resolution of the corrective action are documented in an "Evaluation of Non-Conforming Data" report.

11. IMPROVEMENT

Improvement in the overall effectiveness of the laboratory and field activities management system is a result of the implementation of the various aspects of PER's management system: quality policy and objectives (Section 3), internal auditing practices (Section 15), the review and analysis of data (Section 23), the corrective action (Section 12) and preventive action (Section 13) processes, and the annual management review of the quality management system (Section 16) where the various aspects of the management/quality system are summarized and evaluated and where plans for improvement are developed.

12. CORRECTIVE ACTION

Corrective action is the action taken to eliminate the causes of an existing non-conformity, defect, or other undesirable situation, in order to prevent recurrence. Deficiencies cited in external assessments, internal quality audits, data reviews, client feedback/complaints, control of non-conforming work, or managerial reviews are documented and are followed by corrective action. Corrective actions taken are appropriate for the magnitude of the problem and the degree of risk.

Sample data associated with a failed quality control (*i.e.,* failed to meet test acceptability criteria, etc.) are evaluated for the need to be reanalyzed or qualified. Unacceptable quality control results are documented and an evaluation is performed and documented in an "Evaluation of Non-Conforming Data" report. If a corrective action is determined to be necessary based on the results of this investigation, it is implemented following the procedures outlined in this section. The Technical Director(s) review "Evaluation of Non-Conforming Data" reports and suggest improvements, alternative approaches, and procedures where needed. If the data reported are affected adversely by the non-conformance, the affected data is clearly identified in the report and the client is notified.

Procedures for corrective actions associated with audits are discussed in Section 15 but follow the same general procedures outlined here.

12.1 General Procedure

Corrective actions start with assessment of the cause of the problem. PER uses an "Evaluation of Non-Conforming Data" report to document and track investigations of non-conforming work and, where necessary, as documentation of implementation and monitoring of corrective actions. The QA Manager and his/her designees is responsible for initiating corrective action on routine data reviews where a non-conformance is found that could reoccur or where there is doubt about the compliance of the laboratory to its own policies and procedures. All deficiencies are investigated and a corrective action plan is developed and implemented if determined to be necessary. The QA Manager and his/her designees monitor the effectiveness of corrective actions.

12.1.1 Cause Analysis

When failures due to systematic errors have been identified, the first step of the corrective action process starts with the initial investigation and determination of root cause(s) of the problem. Records are maintained of non-conformances requiring corrective action to show that the root cause(s) was investigated and to show the results of the investigation. These evaluations are documented in an "Evaluation of Non-Conforming Data" report and are maintained by the QA Manager and his/her designees (See Section 10). They are located on the QA/QC Program server and are available only to authorized personnel who have been granted access to this server.

Where there may be non-systematic errors and, as such, the initial cause is readily identifiable or expected random failures (*e.g.,* failed quality control), a formal root cause analysis is not performed and the process begins with selection and implementation of corrective action.

12.1.2 Selection and Implementation of Corrective Actions

Where uncertainty arises regarding the best approach for analysis of the cause of non-conformances that require corrective action, appropriate personnel (*e.g.,* QA Manager, Laboratory Manager) will recommend corrective actions that are appropriate to the magnitude and risk of the problem and that will most likely eliminate the problem and prevent recurrence. The Technical Director(s) and their designees ensure that the corrective actions are discharged within the agreed upon time frame.

12.1.3 Monitoring of Corrective Actions

The QA Manager will monitor implementation and documentation of the corrective action to ensure that the corrective actions were effective. Monitoring of corrective actions may include an audit, where necessary (see Section 15).

13. PREVENTATIVE ACTION

PER promotes a workplace environment that encourages critical thinking and observation skills by its scientists and assistants. As part of the PER QA/QC program, we encourage scientists and assistants to be proactive and complete a **Preventative Action** form to propose changes to our QA/QC program that will result in improvements in the quality of work or to reduce sources of non-conformance with the current QA/QC program. The Technical Director(s) review any submitted **Preventative Action** form during their weekly Management Meeting and work with an individual scientist or assistant to develop an action plan to implement the proposed preventative action, should it be compatible with TNI Standard and have an acceptable cost for the proposed benefit. The QA Manager tracks the revisions to the QA/QC program to ensure that they are effective.

14. CONTROL OF RECORDS

The laboratory maintains a record system appropriate to its needs, records all laboratory activities, and complies with applicable standards or regulations as required. The record system is designed to produce unequivocal, accurate records that document all laboratory activities. Records allow for the historical reconstruction of laboratory activities related to sample handling and analysis and help establish factors affecting the uncertainty of the test and enable test repeatability under conditions as close as possible to the original. Data is recorded immediately and legibly in permanent black ink. Corrections are initialed and dated. A single line strikeout is used to make corrections so that the original record is not obliterated. A **Comments and Observation** form should be completed with the reason for corrections other than transcription errors.

14.1 Records Maintained

At minimum, the Office Manager and QA Manager (or designees) maintain the following records:

- Original observations;
- Sample receiving and storage records (COCs, sample ID codes, etc.);
- Instrument and support equipment logbooks;
- Proficiency testing results;
- Calibration records;
- Demonstrations of capability;
- Project–specific correspondence relating to laboratory QC testing;
- Corrective action records including evaluations of non-conforming data;
- Preventative action records;
- Management reviews;
- Internal and external audits;

- Data review and verification records;
- Personnel qualification, experience, and training records;
- A record of names, initials, and signatures for all individuals who are responsible for signing or initialing any laboratory record; and
- A hard and electronic copy of each project report.

14.2 Records Management and Storage

All records are retained for a minimum of five years, which allows for a historical reconstruction of all laboratory activities. Hard copies of client reports containing original test data are filed alphabetically by client for each year, and electronic copies are stored by client on the PER server and accessible only by staff with authorized passwords for the server and desktop computers; the PER server is automatically backed up daily and electronic files can only be accessed by scientists through password-protected computers. Hard copies of all QA/QC files (*e.g.,* old log books, audits, management reviews, corrective actions, etc.) are stored in the "QA/QC Program" filing cabinets and/or electronically on the server in the "QA/QC Program" folder. Following the minimum five-year holding period for all files, the Technical Director(s) must approve the disposal, via shredding or deletion from server, of any file; the QA and administrative staff maintain master lists of such files.

Records (including electronic records) are easy to retrieve, legible, and protected from deterioration or damage. Records are also held securely and in confidence and are available to accrediting bodies for a minimum of five years or as required by regulation or contract. Records that are stored only on electronic media are supported by the hardware and software necessary for their retrieval. Access to protected records is limited to management and their designees to prevent unauthorized access or amendment.

Additional information regarding control of data is included in Section 20.

14.3 Legal Chain-of-Custody Records

All samples that arrive at PER are treated as though the data generated using the sample may be used as legal evidence. Therefore, all samples are required to have a COC record that includes the client, client contact, sample ID, collected date and time, sample type (*e.g.,* freshwater, stormwater, sediment, etc.), sample volume, sample container type/size, tests required, and custody of the sample (*i.e.,* the signature of the person collecting/releasing the sample [and date and time relinquished] and the signature of the person receiving the sample [and date and time received]).

15. AUDITS

Audits measure laboratory performance and verify compliance with accreditation/certification and project requirements. Audits specifically provide management with an on-going assessment of the management system. They are also instrumental in identifying areas where improvement in the management/quality system will increase the reliability of data. Audits are of four main types: internal, external, performance, and system. Section 15.3 discusses the handling of audit findings.

15.1 Internal Audits

PER follows a schedule of internal audit tasks designed to be performed throughout the year such that all elements are audited on an annual basis. These audits verify compliance with the requirements of the management/quality system, including testing methods, SOPs, the Quality Manual, ethics policies, data integrity, other laboratory policies, and the TNI Standard. It is the responsibility of the QA Manager (and his/her designees) to plan and organize audits as required by the schedule and requested by management. Wherever resources permit, trained and qualified personnel, who are independent of the activity to be audited, carry out these audits. The area audited, the audit findings, and corrective actions are recorded. Audits are reviewed after completion to ensure that corrective actions were implemented and effective.

15.2 External Audits

It is the laboratory's policy to cooperate and assist with all external audits, whether performed by clients or an accrediting body. Management ensures that all areas of the laboratory are accessible to auditors as applicable and that appropriate personnel are available to assist in conducting the audit. Findings of external audits are responded to within the time frame agreed to at the time of the audit.

15.2.1 Confidential Business Information (CBI) Considerations

During on-site audits, on-site auditors may come into possession of information claimed as business confidential. A business confidentiality claim is defined as "a claim or allegation that business information is entitled to confidential treatment for reasons of business confidentiality or a request for a determination that such information is entitled to such treatment." When information is claimed as business confidential, PER places on (or attaches to) the information a cover sheet, stamped or typed legend, or other suitable form of notice, employing language such as "trade secret," "proprietary," or "company confidential" at the time it is submitted to the auditor. Confidential portions of documents otherwise non-confidential are clearly identified. CBI may be purged of references to client identity by the responsible laboratory official at the time of removal from the laboratory. However, sample identifiers may not be obscured from the information.

15.3 Audit Findings and Corrective Actions

Internal or external audits may result in findings that cast doubt on the effectiveness of the laboratory operation to produce data of known and documented quality or that question the correctness or validity of sample results an investigation is performed. If corrective action is needed, the implementation of the corrective action and follow-up tracking of the effectiveness of the corrective action is documented. The responsibility for developing and implementing corrective actions to findings is the responsibility of the QA Manager and his/her designees. Corrective actions are documented through the corrective action process described in Section 12. The QA Manager (and his/her designees) prepare monthly audit reports that outline any internal audit findings, corrective actions, and monitoring of the effectiveness of the corrective actions. The monthly audit reports are reviewed by the Technical Director(s). Documentation may also be in the form of a memo or an "Evaluation of Non-Conforming Data" report. Responses to comments and findings of external audits are communicated to the auditor.

Should the findings of an audit cast doubt on the quality of testing performed for a client, the client is notified in writing within 30 days of discovering the issue and is informed of the corrective action(s) that were implemented to address the problem; records of such client communications are retained in the affected project folders. Management ensures that this notification is carried out within the specified time frame.

Should an audit indicate that inappropriate actions were taken by PER staff that resulted in questions related to data integrity (See Section 17), the issue is handled in a confidential manner by the Technical Director(s) and will include a full investigation, appropriate corrective action(s), documentation of the issue (signed and dated), a follow-up evaluation, and appropriate notification to affected client(s).

15.4 Additional Audits

In addition to the scheduled internal audits, it may sometimes be necessary to conduct special audits as a follow-up to corrective actions, PT results, complaints, regulatory audits, alleged data integrity issues, or when requested by the Technical Director(s). This can also be done when a serious issue or risk to the laboratory has been identified.

Where the identification of non-conformances or departures from normal laboratory procedures casts doubt on PER's compliance with its own policies and procedures, or its compliance with the TNI Standard, the laboratory ensures that the appropriate areas of activity are audited as soon as possible. These audits address specific issues. The area audited, the audit findings, corrective actions, and monitoring of corrective actions are recorded.

PER's management system is audited though annual management reviews. Refer to Section 16 for further discussion of management reviews.

16. MANAGEMENT REVIEWS

PER top management (as defined in Section 3) performs an Annual Management Review during the first quarter of each year. This program includes a review of the laboratory management and quality systems and environmental testing activities to ensure continuing suitability and effectiveness in achieving the TNI standard and implements any necessary changes to improve on the quality of testing and client services. The program consists of an evaluation of:

- The suitability of policies and procedures;
- Reports from managerial and supervisory personnel;
- Outcomes of internal audits, external audits, and assessments by external bodies;
- A review of corrective and preventative actions;
- Results of inter-laboratory comparison and proficiency testing;
- Changes in the volume and type of work;
- Client feedback;
- Client complaints;
- Recommendations for improvement; and
- Other relevant factors, such as quality control activities, resources, and staff training.

The Annual Management Review is documented with an Annual Management Review Report, for which an electronic copy is stored on the Owner and QA/QC Program servers. Two copies are prepared, one including Confidential Business Information (CBI) for in-house use (located on the Owner server) and one with CBI excluded for public use (located on the QA/QC Program server). Any actions recommended in the Annual Management Review Report are implemented within 60 days of the completion of the report.

Findings and follow-up actions from Annual Management Reviews are recorded in the "Annual Management Review" report.

17. DATA INTEGRITY AND ETHICS PROGRAM

Pacific EcoRisk is committed to ensuring the integrity of our data and providing valid data and documented quality to our clients. Upon hiring and during an annual staff meeting, each employee is required to read the **Statement of Scientific Integrity** and acknowledge, understand, and agree to their personal ethical responsibilities and legal responsibilities, including potential punishment and penalties for improper, unethical, or illegal actions.

17.1 Ethics and Integrity Training

PER maintains a Data Integrity Training Program that is documented in writing, and includes an overview of the company mission, relationship to the critical need for honesty and full disclosure in reporting results, how and when to report data integrity issues, and a description of the record keeping required under the program. Employees are informed that any infractions of the program can result in immediate termination and could result in civil/criminal prosecution. Attendance for both the orientation and annual meetings are documented via a signed certification from each staff member that they understand their obligations related to data integrity. Records of this training are maintained in personnel files and in the Data Integrity Program file on the QA/QC Program server. The Technical Director(s) fully support these procedures and are integrally involved with the implementation of the program.

17.2 Improper Actions

Improper actions are defined as deviations from contract-specified or method-specified practices and may be intentional or unintentional. Unethical or illegal actions are defined as the deliberate falsification of analytical or quality assurance results where failed method or contractual requirements are made to appear acceptable. Prevention of improper, unethical, or illegal actions in the laboratory begins with the zero-tolerance policy established by the PER Technical Director(s).

17.3 Prevention and Detection Program for Improper, Unethical, or Illegal Actions

The PER management maintains a proactive program for the prevention and detection of improper, unethical, or illegal activities. The program includes:

- An ethics policy that is read and signed by all personnel;
- Initial and annual ethics training;
- Internal audits;
- Inclusion of anti-fraud language in subcontracts;
- Analyst notation and sign-off on manual integration changes to data;
- "No-fault" policy that encourages laboratory personnel to come forward and report ethical, data integrity, or fraudulent activities; and
- Assessment of data integrity performed by QA Manager during the daily program review.

17.4 Investigation of Ethics Violations or Data Integrity Violations

The QA Manager serves as the PER Data Integrity Officer, to whom laboratory personnel can report improper, unethical, or illegal practices. The PER Technical Director(s) will perform a full investigation should any ethical or data integrity violations occur. The outcome of the investigation may result in immediate suspension or termination or may result in civil/criminal

prosecution. Clear documentation of the investigation is maintained and the need for any further detailed investigation (*e.g.*, civil/criminal prosecution) is clearly documented.

17.5 Annual Review of Data Integrity Program

The Data Integrity Program is reviewed annually by the Technical Director(s) during the Annual Management Review and is modified, as necessary.

17.6 Client Notification

A Technical Director will notify a client in writing in all cases when data quality is impacted by non-conformance to testing protocols; re-testing would be performed, if necessary. Furthermore, a Technical Director would notify the client in writing when any aspect or result of the environmental testing work does not conform to the agreed requirements specified by the client.

18. PERSONNEL

PER employs competent personnel based on education, training, professional experience, and demonstrated skills, as required. All personnel are responsible for complying with all QA/QC requirements that pertain to their organizational/technical function. All personnel who are involved in activities related to sample collection, sample analysis, evaluation of results, or who sign test reports must demonstrate competence in their area of responsibility. Appropriate supervision is given to any personnel in training and the trainer is accountable for the quality of the trainee's work. Personnel are qualified to perform the tasks they are responsible for based on education, training, experience, and demonstrated skills as required for their area of responsibility.

Key laboratory operations positions include the QA Manager, Project Manager, Laboratory Manager, Laboratory Assistant Supervisor, Field and Facilities Operations Technician, Field Lead, Scientist I, II, and III (possess academic or work background in the field of aquatic toxicology), and Laboratory Assistant I, II, and III; an outline of the laboratory operations organizational chart is depicted as a flow-chart in Figure 18-1. Individuals filling these jobs have the required training, degree, and/or professional experience to meet the job responsibilities (*e.g.,* Scientist I, II, and III are required to possess a minimum of a BS degree). In the event that contracted support staff are used, they are trained in the method and related laboratory control system and are supervised by a trained scientist at a higher job level and/or the Laboratory Manager.

Figure 18-1. Laboratory Operations Organizational Chart

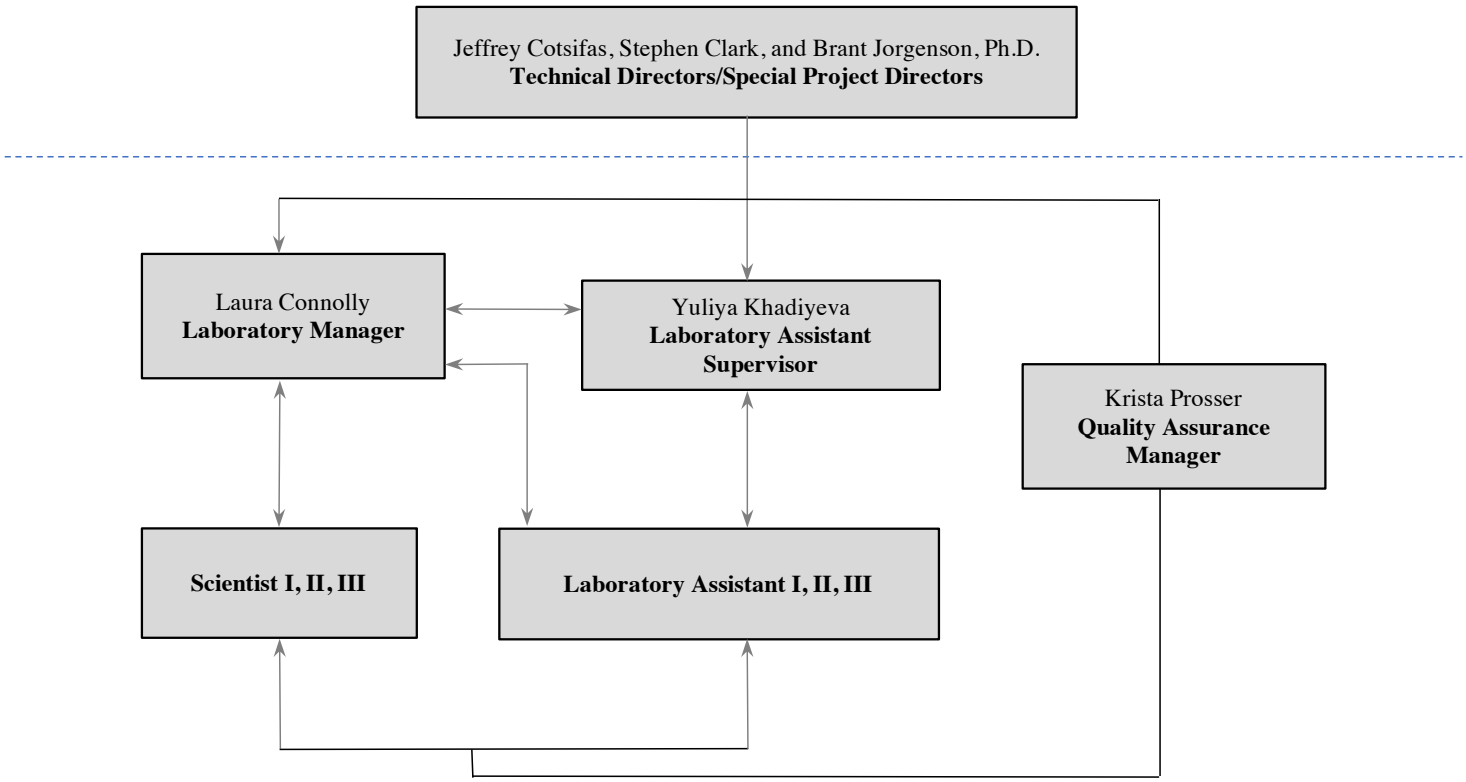
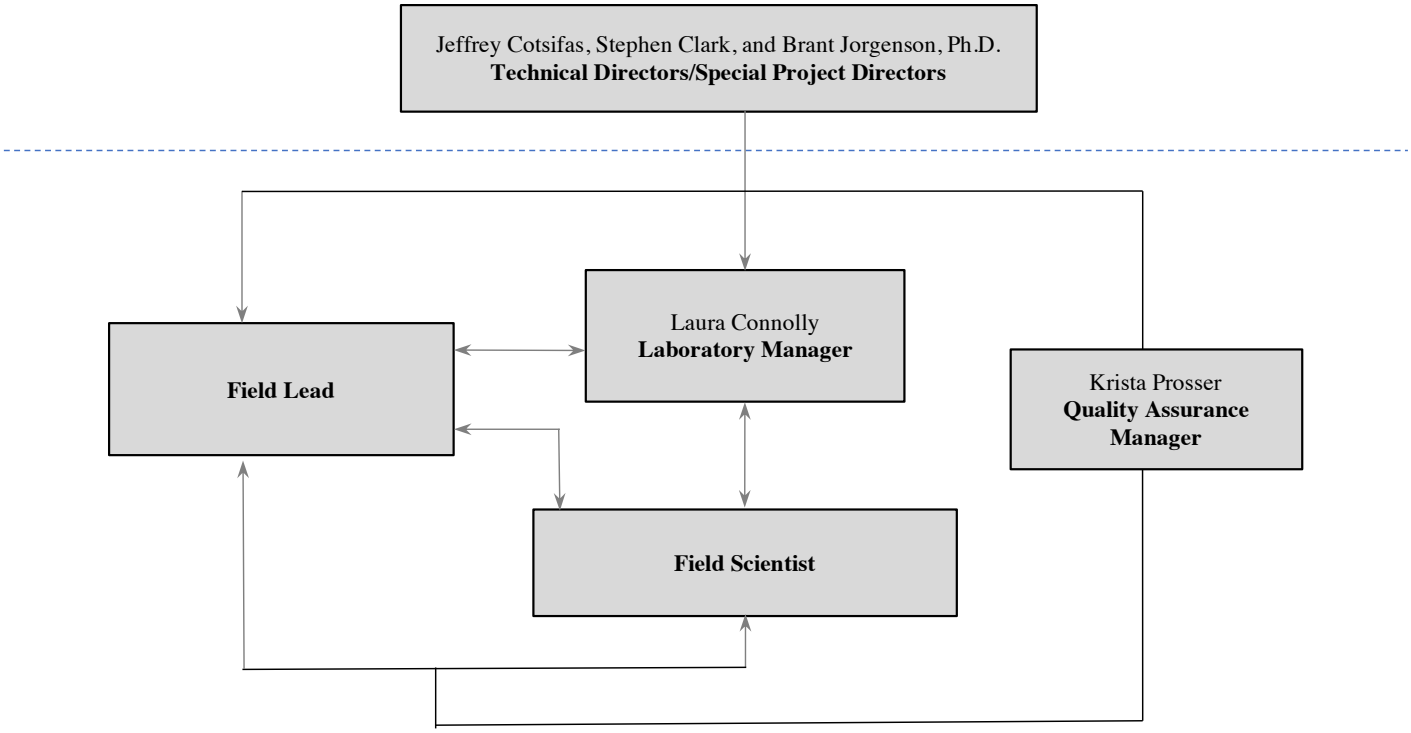


Figure 18-2. Field Operations Organizational Chart



18.1 Personnel Roles and Responsibilities

The job responsibilities for each member of PER management are outlined Section 3. An outline of the company organization is presented in Section 2 and is depicted as a flowchart in Figure 2-1. Job responsibilities for administrative, field, and laboratory staff are as follows:

18.1.1 Office Manager

The Office Manager (and designees) provides administrative support for all projects. The Office Manager also manages personnel files and business operations files. The Technical Director(s) coordinates the Office Manager activities.

18.1.2 Administrative Assistant

The Administrative Assistant provides administrative support for all projects, assists Office Manager in maintenance of records, and prepares reports for delivery to clients. The Office Manager coordinates the Administrative Assistant activities.

18.1.3 Bookkeeper

The Bookkeeper prepares all accounts receivable and accounts payable records. The Bookkeeper prepares all client invoices, maintains client contracts/quotes, and provides contract support.

18.1.4 Laboratory Assistant I

Laboratory Assistant I staff are responsible for sample pick-up and log-in, completion of chain-of-custody records, shipping, cleaning of all glassware, performance of water quality analyses, preparation of synthetic waters, weight determinations, processing samples, animal husbandry, etc. Laboratory Assistant I staff maintain unencumbered laboratory work areas through regular cleaning and organization.

18.1.5 Laboratory Assistant II

Laboratory Assistant II staff may provide maintenance of *Ceriodaphnia* and daphnid cultures, and may participate in scoring of embryo development tests. These staff members may perform daily calibration and maintenance of water quality meters. These staff members also possess the skills of the Laboratory Assistant I position.

18.1.6 Laboratory Assistant III

Laboratory Assistant III staff are responsible for performing all aspects of routine acute freshwater and marine toxicity testing, including solution preparation. These staff members also possess the skills of the Laboratory Assistant II position.

18.1.7 Laboratory Assistant Supervisor

The Laboratory Assistant Supervisor assigns daily tasks to Laboratory Assistants, oversees training of Laboratory Assistants, and possesses the vast majority of skills of the Laboratory

Assistant II position. The Laboratory Assistant Supervisor also manages laboratory supplies, including oversight of stocking, organization, and ordering.

18.1.8 Field and Facilities Operations Technician

The Field and Facilities Operations Technician performs field sampling and preventative maintenance on support equipment, manages oversight of field equipment, maintains PER vehicles and vessels, assesses condition of and/or repair facilities, and maintains the PER shop and supplies.

18.1.9 Scientist I

Scientist I staff are responsible for the daily performance of the following tests: acute and chronic freshwater and estuarine/marine invertebrates and fish. Scientist I staff are responsible for the daily performance of these tests, including data acquisition, recording, review, and analyses. When necessary, Scientist I staff provide sample manipulations (*e.g.,* pH adjustment, zeolite treatment, de-chlorination, etc.) necessary to perform testing. Scientist I staff perform the statistical analyses of test results and prepare electronic data deliverables (EDDs). Scientist I staff may write reports for the methods/tests that they are certified to perform. Scientist I staff participate in field sampling projects and are familiar with field sampling procedures and operation of field equipment.

18.1.10 Scientist II

Scientist II staff are responsible for the daily performance of the following tests: embryo development, freshwater/marine sediment, and freshwater/marine algal growth. Scientist II staff are responsible for the daily performance of these tests, including data acquisition, recording, review, and analyses. When necessary, Scientist II staff provide more technical sample manipulations (*e.g*. TIE manipulations) necessary to perform testing. Scientist II staff perform the QA review of statistical analyses of test results. Scientist II staff write reports for the methods/tests that they are certified to perform. Scientist II staff manage analytical samples that are submitted to subcontract laboratories. Scientist II staff possess the skills of the Scientist I position.

18.1.11 Scientist III

Scientist III staff are responsible for technical testing, including the performance of Toxicity Identification Evaluations (TIE), enzyme-linked immunosorbent assay (ELISA) analyses, and water effects ratio testing (WER). Scientist III staff provide proactive planning with Field and Laboratory Managers, logistical support for planning testing, and coordinate activities with Laboratory Assistants. Scientist III staff write reports for the methods/tests that they are certified to perform. Scientist III staff possess the skills of the Scientist II position.

18.1.12 Field Lead

Field Leads are familiar with SAPs for field sampling projects and participates in, oversees, and organizes field-sampling events. They lead sampling teams in the field with oversight from Project Managers. Field Leads possess, at a minimum, the skills of the Scientist I position.

18.2 Training

Based on the job descriptions described above, PER hires Laboratory Assistants and Scientists that have appropriate academic and/or professional experience to perform the tasks for their given job classification. The Office Manager (and designees) maintains these records in the employee files. In addition, PER has an extensive training program to ensure that each Assistant and Scientist is trained in the specific methods necessary to perform their job under the QA/QC Program. Prior to participation in any testing, field activity, or analyses, the Scientists and Assistants are required to read the SOPs and appropriate manuals that describe tasks that are part of their job description; all staff members must also read and be familiar with the Quality Manual.

Hands-on training involves an experienced staff member demonstrating all aspects of the method for the inexperienced staff member. This training is documented in their training log. When warranted (e.g., it is their first time handling that type of organism, the species is sensitive to handling stress, there is an aspect of the test that they have not participated in with other organisms, etc.), the inexperienced staff member is required to demonstrate capability in performing a test or analysis with oversight by an experienced staff member by performing a Demonstration of Capability (DOC) test in which they perform as much of the test as possible (i.e., if the test duration is longer than 5 days, another scientist will need to maintain it while the staff member is on his/her weekend). The QA Manager reviews the DOC test and approves/disapproves the staff member for the associated test or analysis. If not approved, the QA Manager will schedule a retraining session with the staff member and they will perform a second DOC test. The training program is viewed as an ongoing process as staff continue to take on additional responsibilities as they develop professionally.

Since the duration of many toxicity tests is greater than the standard workweek (*i.e.,* staff do not solely perform a toxicity test from test initiation to termination), ongoing demonstrations of capability by staff must focus on individual adherence to the QA/QC Program. In order to maintain their ongoing DOC, staff members with < 3 years of experience in their job position at PER are required to maintain their continued proficiency through yearly participation in test initiation, test maintenance, and test termination for each test that the scientist is certified to perform. Scientists document continued proficiency training in their continued proficiency log. This information is used to establish the DOC for each method at the beginning of each year. Scientists with ≥ 3 years of experience with the methods are not required to participate in each test method on a yearly basis given their advanced level of experience with the methods; such

scientists are expected to review the SOPs prior to participating in the testing that they have not performed for some time (*i.e.,* 12 months).

Toxicity tests used to document initial and ongoing DOC must meet all test acceptability criteria specified in the EPA testing manuals in order to be considered acceptable for continued proficiency training.

"Group training workshops" are provided, as necessary, by a Laboratory Manager, QA Manager, or Project Manager(s), and are documented, both in terms of content and attendance. These workshops may focus on a review of a given method, an introduction of a new method, or on the use of new equipment.

The QA Manager (or designee) maintains the training log. The training log serves as the official record of capabilities for each staff member. The Technical Director(s) are responsible for completing the training log for each staff member by signing the DOC sheets. Staff are required to record the date that they have completed the initial and ongoing DOC for a given method in their toxicity test training and proficiency logs. Detailed instructions related to completion of toxicity test training and proficiency logs are provided in Section 20.

19. ACCOMMODATIONS AND ENVIRONMENTAL CONDITIONS

Successful evaluation of contaminated waters and sediments by PER is due, in no small part, to our state-of-the-art laboratory facilities. The laboratory, located in Fairfield, provides over 4,000 ft^2 of office and conference facilities and over 12,000 ft^2 of actual laboratory space for conducting bioassays, culturing test organisms, preparing and storing water, effluent, and sediment samples for use in the tests, routine chemical analyses, and TIE fractionations. The facility also has an additional 3,500 ft^2 of storage for supplies, laboratory equipment, and field equipment.

The laboratory facility is designed and organized to facilitate testing of environmental samples. The various laboratory rooms comprising our facility are all designed for efficient and optimal performance of the testing services we provide and include a total of 9 large walk-in constant temperature rooms, 5 walk-in refrigerators, and 8 water baths. A figure depicting the floor plan of the facility is provided as Figure 19-1.

Laboratory space is arranged to minimize cross-contamination between incompatible areas of the laboratory. For example, the organism culturing areas are separated from the testing areas and the sediment processing area is separated from the rest of the work areas. Some of the different laboratory work areas include:

- Sample receipt;
- Sample storage;

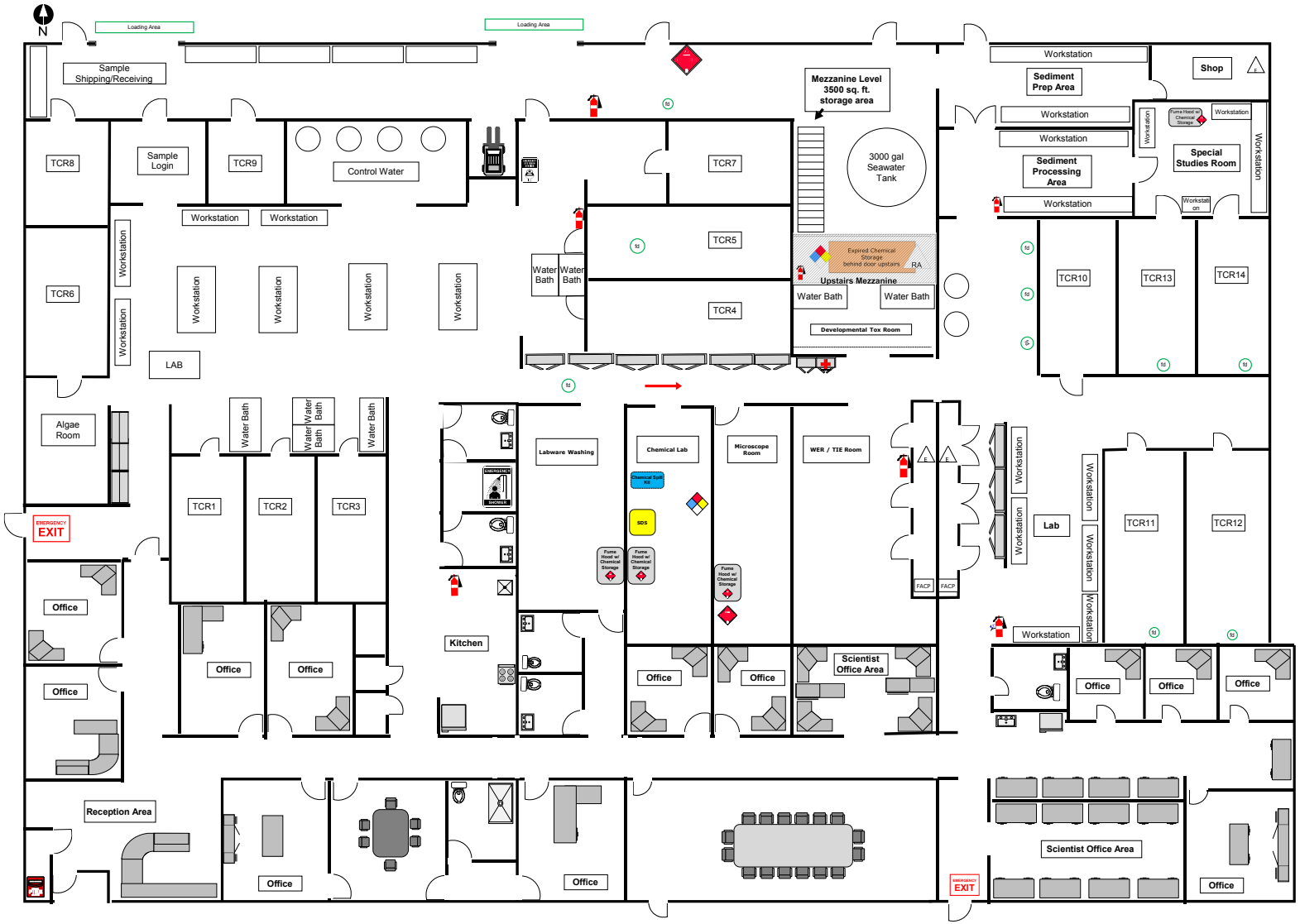
- Wet chemistry and analysis;
- Chemical storage;
- Toxicity testing;
- Organism culturing;
- Sediment sample processing;
- Special studies;
- Microscopic enumeration; and
- WER/TIE preparation.

Environmental conditions (*e.g.,* temperature and light) are monitored to ensure that conditions do not invalidate results or adversely affect the required quality of any measurement.

The laboratory is kept secure during off hours with locks, an alarm system, and video surveillance. Laboratory personnel accompany all visitors in the facility.

PER provides accommodations for a variety of field activities and maintains a fleet of vehicles and sampling vessels to provide high quality sampling of creeks, rivers, agricultural drains, lakes, ponds, bays, and estuaries. These vessels allow for sampling during inclement conditions and on limited notice. PER field staff are trained and approved for a variety of sampling procedures and use of sampling equipment including: surface water, stormwater, and sediment collection and monitoring, collection of field organisms, "Clean Technique" sampling, pesticide application monitoring, biological assessment, and physical habitat characterization.

Figure 19-1. Floor Plan



20. ENVIRONMENTAL METHODS AND METHOD VALIDATION

Methods and/or procedures are available for all activities associated with the analysis of samples, including preparation and testing. For purposes of this section, "method" refers to the toxicity test method. A table of the methods PER performs is attached in Appendix C.

Before being put into use, a method is confirmed by a demonstration of capability or method validation process. All methods are published or documented. Deviations from the methods are allowed only if the deviation is documented, technically justified, authorized by management, and accepted by the client.

20.1 Method Selection

PER will use methods that meet the needs of our clients. Such methods will be based on the latest edition of the method unless it does not meet the needs of the client. When the regulatory authority mandates or promulgates methods for a specific purpose, only those methods will be used. For example, toxicity testing for NPDES clients will be performed in accordance with their NPDES permit, using methods specified in 40 CFR Part 136.

If a method proposed by a client is considered to be inappropriate or out-of-date or if the method is not specified, the client is informed and the issue is resolved before proceeding with analysis of any sample(s) (see Section 5). The client will be informed of the selected method and must approve its use before the method is used. All communications between the laboratory and the client are documented.

20.2 Laboratory-Developed Methods

For non-standard sampling and analysis methods, sample matrices, or other unusual situations, appropriate method validation study information shall be documented to confirm the performance of the method for the particular need. The purpose of this validation method is to assess the potential impact on the representativeness of the data generated. For example, if a non-standard method is used, rigorous validation of the method may be necessary. Such validation studies may include round-robin studies performed by USEPA or other organizations. If previous validation studies are not available, some level of single-user validation study should be performed during the project and included as part of the project's final report. The process of designing and validating the method is carefully planned and documented. All personnel involved in the method design, development, and implementation will be in constant communication during all stages of development. Approval of non-standard methods ultimately is the responsibility of the Technical Director(s).

20.3 Method Validation

Validation is the confirmation, by examination and objective evidence, that the particular requirements for a specific intended use are fulfilled. At a minimum, all methods are validated by performing an initial demonstration of capability.

Non-standard methods may require additional validation documentation. The validation is designed so that the laboratory can demonstrate that the method is appropriate for its intended use. All records (*e.g.*, planning, method procedure, raw data, and data analysis) shall be retained while the method is in use. Based on the validation process, the laboratory will make a statement in the method or SOP of the intended use requirements and whether or not the validated method meets the use requirements.

20.4 Demonstration of Capability

Due to the following limitations, PER has established DOC documentation that separates the DOC documentation for scientist staff from the method itself:

- The duration of many toxicity tests occurs during a greater duration than the standard work week (*i.e.,* staff do not solely perform a toxicity test from test initiation to termination);
- The duration of toxicity tests (*i.e.*, one test can have a duration of more than 50 days for some methods) are too long for each scientist to demonstrate their capability by successful performance of five tests. The cost of training all scientist staff would be prohibitive due to the time requirements alone;
- The cost of test organisms makes ordering a separate batch of organisms for five tests for each test method for each scientist is prohibitive; and
- The cost of test organisms and PT samples for five tests for each scientist for each test method for which PT samples can be obtained is cost prohibitive.

20.4.1 Demonstration of Capability for Scientist Staff

The Demonstration of Capability for Scientist staff is a procedure for Scientists to become part of the work cell for a particular test method through demonstration of their ability to generate toxicity test results that meet the quality control requirements of the method. A summary of the Scientists that have established their initial DOC and have maintained their ongoing DOC for each test method (or "work cell") is summarized on the "Scientific Demonstration of Capability Master List" that is posted in the laboratory. The process for Scientists to develop their initial and ongoing DOC is established in Section 18.2.

20.4.2 Demonstration of Capability for Toxicity Testing Methods

A satisfactory initial Demonstration of Capability is required prior to acceptance and institution of any method for data reporting. It is also required to validate a non-standard method. DOC for a toxicity test method is a procedure to establish the ability of the work cell for a particular method to generate analytical results of acceptable accuracy and precision. A minimum of five acceptable reference toxicant tests, using the same test conditions, age of test organisms, feeding, etc., but different batches of test organisms are required for an initial DOC. The %CV for those five tests must be within the acceptable range specified in the test method in order to be considered a satisfactory initial DOC. The data is documented in the reference toxicant test database for that particular test method. When more than 20 tests have been performed, an ongoing DOC will satisfy this requirement. The documentation of ongoing laboratory performance (*i.e.,* ongoing DOC) is outlined in the corresponding toxicity test method manuals and includes documentation with Control charts. PER evaluates these regularly as part of the data review process (Section 23.4) and internal audits (Section 15.1).

20.5 Control of Data

To ensure that data are protected from inadvertent changes or unintentional destruction, the laboratory uses procedures to check calculations and data transfers (both manual and automated).

20.5.1 Computer and Electronic Data Requirements

PER ensures that computers, automated equipment, or microprocessors used for the acquisition, processing, recording, reporting, storage, or retrieval of environmental test data are:

- Documented in sufficient detail and validated as being adequate for use;
- Protected for integrity and confidentiality of data entry or collection, data storage, data transmission, and data processing;
- Maintained to ensure proper functioning and are provided with the environmental and operating conditions necessary to maintain the integrity of environmental test data; and
- Held secure, which includes the prevention of unauthorized access to and the unauthorized amendment of, computer records. Data archive security is addressed in Section 14 and building security is addressed in Section 19.

The laboratory controls access to all programs that are used to acquire, process, record, or report data. All programs are password-protected. Each employee is granted access only to those programs that he or she uses. The password is unique to the individual and cannot be shared. The company server is automatically backed up on a daily basis.

20.5.2 Data Reduction

As a part of the management system, PER ensures that another individual checks all manual calculations. In addition, all data transfers (data entry, transcribing raw or calculated data, etc.)

are checked for accuracy. If any of the checked values are found to be incorrect, corrections are made to ensure that the calculations are correct. All raw data calculations are maintained in the appropriate project folder, or where appropriate (as described in Section 14).

20.5.3 Data Review Procedures

Data review procedures are located in Section 23.4.

20.6 Measurement Uncertainty

PER reports measurement uncertainty for quantitative analytical results under the conditions required by the TNI standard when required by the method, when instructed by a client, or when the uncertainty affects the compliance to a regulatory limit. PER uses a Type B method to evaluate measurement uncertainty. The Type B method uses historical data, experience with the behavior and properties of relevant materials and instruments, manufacturer's specifications, and data provided during calibration procedures (ISO 5725 Guide to the Expression of Uncertainty of Measurement).

21. LABORATORY EQUIPMENT

PER provides all the necessary equipment required for the performance of toxicity testing and field sampling. A list of the equipment used in the performance of the toxicity testing is provided in Appendix D. All equipment and software used for testing and sampling are capable of achieving the accuracy required for complying with the specifications of the environmental test methods as specified in the laboratory SOPs. Authorized and trained personnel operate equipment (see Section 18). All equipment is calibrated or verified before being placed in use to ensure that it meets laboratory specifications and relevant standard specifications.

Equipment and supply purchases are approved by a Technical Director(s) and ordered by administrative staff (and designees). Supplies and equipment are ordered from a supplier on the "Approved Suppliers List". Following receipt of supplies and equipment, shipping manifests are given to administrative staff to ensure the correct items were received. Upon receipt, supplies and equipment are inspected and documented in the **Incoming Supplies and Equipment Approval Checklist** in order to ensure the supplies and equipment received comply with specifications prior to use in the laboratory.

The laboratory staff informs the administrative staff when consumable supplies or supplies with an expiration date (*e.g.,* chemicals and pH standards) need to be re-ordered in time to ensure that an adequate amount of supplies are available at all times.

21.1 Support Equipment Maintenance Program

PER considers all laboratory equipment to be support equipment. The Support Equipment Maintenance Program is overseen by the QA Manager (and designees) and includes:

- A comprehensive list of laboratory support equipment;
- Support equipment maintenance and repair records;
- The specified frequency of maintenance tasks; and
- Support equipment maintenance and documentation task assignments.

The Support Equipment Maintenance Program includes but is not limited to: balances, ovens, refrigerators, freezers, incubators, water baths, temperature measuring devices, volumetric dispensing devices, pumps, fume hoods, microscopes, spectrophotometers, and a Type I water system. All equipment and instruments are maintained according to the requirements of the test method, the TNI Standard, and manufacturer recommendations. Regular maintenance of laboratory equipment is performed at least annually. Each piece of equipment is uniquely identified and all maintenance and repair information for each piece of equipment is recorded in an equipment maintenance log.

Equipment maintenance records include the following:

- Identity of the equipment and its software;
- Manufacturer's name, type identification, serial number, or another unique identifier;
- Check that the equipment complies with specifications of applicable tests;
- Current location;
- Manufacturer's instructions, if available, or a reference to their location;
- Dates, results, and copies of reports and certificates of all calibrations, adjustments, acceptance criteria, and the due date of next calibration (See Section 21.2);
- Maintenance plan, where appropriate, and maintenance carried out to date;
- Documentation on all routine and non-routine maintenance activities and reference material verifications; and
- Any damage, malfunction, modification, or repair to the equipment.

Equipment that is no longer used or maintained, has been subject to overloading or mishandling, given suspect results, or shown to be defective or outside specifications is taken out of service. The equipment is isolated to prevent its use or clearly labeled as being out of service until it has been shown to function properly. Before placing equipment back in service, maintenance and repair information is documented in the equipment maintenance log and the equipment must meet the requirements of the test method, the TNI Standard, and manufacturer recommendations. In and out of service dates are recorded for each piece of equipment.

If it is shown that previous tests are affected by equipment outside of specifications, then procedures for non-conforming work are followed and results are documented (see Section 10 and Section 12).

When equipment is used that is outside of permanent control of the laboratory, PER ensures the equipment meets the requirements of this manual prior to its use by inspecting or otherwise testing it.

All equipment and supplies purchased for laboratory use, including general supplies, must either be pre-cleaned or undergo laboratory cleaning before use in the toxicity tests.

21.2 Instrument Calibration and Standardization

Support equipment such as balances, ovens, refrigerators, and freezers are verified each day, prior to use, to ensure operation is within the expected range for the application for which the equipment is to be used. Verifications are performed with a NIST traceable reference or equipment calibrated with a NIST traceable reference. Volumetric dispensing devices (except Class A glassware and Glass microliter syringes) are checked for accuracy in-house on a quarterly basis. Calibrations are performed annually by an external service provider.

All support equipment is calibrated or verified annually over the entire range of use using NIST traceable references, where available. The results of the calibration of support equipment meet method requirements or manufacturer specifications. If correction factors are used, this information is clearly marked on or near the equipment. Calibration of NIST traceable reference materials is outlined in Section 21.3.

Requirements for instrument calibration and standardization for use in toxicity tests and routine water quality analyses are briefly described below. Detailed descriptions of the analyses are described in laboratory SOPs. Each instrument calibration or verification is recorded in an instrument-specific logbook and are verified to be within method specifications prior to use each day.

Temperature - Temperature is measured to the nearest 0.1˚C using digital thermometers, alcohol thermometers, or continuous temperature measuring devices. All temperature measuring devices are verified semi-annually against a NIST traceable thermometer (See Section 21.3). Correction factors are assigned as needed. NIST traceable thermometers are re-calibrated every five years.

Conductivity/Salinity - Conductivity is measured to the nearest µS/cm and salinity is measured to the nearest ppt or psu using a verified and calibrated meter. The meter and probe are used and maintained according to factory specifications. Standards are stored in accordance with the manufacturer's recommendations, method requirements, and the requirements of the Pacific EcoRisk Health and Safety Program. Handling of standards is minimized by using sub-samples for multiple calibrations. Calibrations are performed when verification values fall outside specifications.

pH - pH is measured to the nearest 0.01 pH unit using an appropriately-calibrated meter and probe. The meter and probe are used and maintained according to factory specifications. Each pH probe/meter is calibrated daily using buffer solutions that bracket the pH range of the samples (typically, pH buffers at pH 4, pH 7, and pH 10).

Dissolved Oxygen - Dissolved oxygen (DO) is measured to the nearest 0.1 mg/L with an appropriately calibrated meter and probe. The meter and probe are used and maintained according to factory specifications. Each probe/meter is calibrated as specified in the method or manufacturer's instructions.

Irradiance (Light) - Irradiance is measured using an appropriate meter and an irradiance sensor that measures photosynthetically active radiation (PAR, photons) in units of foot-candles or lux. Each meter is factory-calibrated at intervals recommended by the manufacturer.

Total Ammonia - Ammonia is measured to the nearest 0.01 mg/L using a spectrophotometer. The spectrophotometer is maintained according to factory specifications. Each water sample is added to a vial containing reagents and measured on the spectrophotometer using the factory-installed method for ammonia analysis.

Total Residual Chlorine - Chlorine is measured to the nearest 0.1 mg/L colorimetrically using an appropriate colorimeter. Each water sample is prepared for analysis using commercial reagents. The colorimeter is used and maintained according to factory specifications and is verified daily in accordance to manufacturer's instructions.

Weights and Volumes - Calibration of the balances is checked daily before use with weights traceable to NIST standards. Each balance is certified annually by a service representative and is used and maintained according to factory specifications. Calibration weights are calibrated annually by a service representative; weights are inspected and discarded if corroded or otherwise suspect. Liquid volumes contained or delivered by pipettes/pipettors are verified in-house on a quarterly basis by weighing volumes of distilled water on an analytical balance. Calibrations are performed annually by an external service provider.

21.3 Measurement Traceability

Measurement quality assurance comes in part from traceability of standards to certified materials. All equipment affecting the quality of test results are calibrated prior to being put into service and on a continuing basis (see Section 23). These calibrations are traceable to national standards of measurement where available. If traceability of measurements to SI units is not possible or not relevant, evidence for correlation of results through inter-laboratory comparisons, proficiency testing, or independent analysis is provided.

The laboratory handles and transports reference standards and materials in a manner that protects the integrity of the materials. Reference standard and material integrity is protected by separation from incompatible materials and/or minimizing exposure to degrading environments or materials. Reference standards and materials are stored according to manufacturer's recommendations and method SOP requirements and are stored separately from samples.

21.3.1 Reference Standards

The following reference standards are sent out for calibration to a national standard as indicated in Section 21.2:

- Class 1 weights; and
- NIST traceable reference thermometers.

The Class 1 weights are used for daily balance verification and are calibrated annually. The NIST traceable reference thermometer, used to calibrate all other thermometers and continuous temperature monitoring devices, is calibrated every five years.

21.3.2 Reference Materials

Reference materials are substances that have concentrations that are sufficiently well established to use for calibration or as a frame of reference. Reference materials, where commercially available, are traceable to national standards of measurement or to Certified Reference Materials, usually by a Certificate of Analysis.

Purchased reference materials require a Certificate of Analysis, where available. If a reference material cannot be purchased with a Certificate of Analysis, it is verified by analysis and comparison to a certified reference material and/or demonstration of capability for characterization.

Internal reference materials, such as reference toxicant stock solutions, working standards, or intermediate stock solutions, are checked as far as is technically and economically practical and are documented as outlined in Section 21.4.

21.4 Standards, Reagents, and Reference Materials

The laboratory has procedures for purchase, receipt, distribution, and storage of standards, reagents, and reference materials as described in Section 7 and the Pacific EcoRisk Health and Safety Program.

Expiration dates can be extended if the reference standard or material's integrity is verified. The extended date may not be beyond the expiration date of the referenced standards used to re-verify.

All containers of prepared standards, reagents, or materials are labeled with the material (*e.g.*, KCl), date prepared, and concentration (*i.e.*, this information constitutes our unique ID).

Prepared reagents are verified to meet the requirements of the test method through traceability to purchased stock or neat chemicals. Purchased reagent quality is verified to meet the requirements of the test method upon receipt following procedures in the **Incoming Supplies and Equipment Approval Checklist**. If the original container does not have an expiration date provided by the manufacturer or vendor, it should be labeled with an expiration date that is three years after the receipt date. If an expiration date is provided, the original containers and container of any standards or reagents prepared from it must be labeled with the expiration date.

21.4.1 Purchased Standards, Reagents, Reference Materials, and Media

Records for all standards, reagents, reference materials, and media are recorded in the chemical inventory and include the:

- Manufacturer/vendor name (or traceability to purchased stocks or neat compounds);
- Manufacturer's Certificate of Analysis or purity (if supplied);
- Date of receipt; and
- SDS.

In methods where the purity of reagents is not specified, reagent grade is used. If the purity is specified, that is the minimum acceptable grade. Purity is verified and documented according to Section 7.

21.4.2 Prepared Standards, Reagents, Reference Materials, and Media

Records for preparation of standards, reagents, reference materials, and media should include:

- Traceability to purchased stock or neat compounds;
- Reference to the method of preparation;
- Date of preparation;
- Expiration date after which the material shall not be used (unless its reliability is verified by the laboratory); and
- Preparer's initials.

22. SAMPLE COLLECTION AND HANDLING

PER provides sampling services on a project specific basis. For these projects, sampling SOPs can be found in the corresponding QAPP or SAP. The laboratory uses sampling plans provided by clients or prepared in consultation with the client. The plan must include any factors that must be controlled to ensure the validity of the test. Sampling plans and written sampling procedures are used for collecting environmental samples, substances, materials, or products for testing. The QAPP or SAP is made available at the sampling location. When the client requests any deviations from the sampling plan or sampling procedures, the deviations are documented and

included in the final report. All field measurements, records, and notes (*e.g.*, temperature, salinity, etc.) are logged in bound field notebooks when samples are collected by PER staff. Sufficient information is recorded in detail in the field notebook to completely reconstruct the sampling event(s).

Precautions are taken to ensure that methods for collection and storage of samples (including materials used) do not contribute to sample toxicity (*i.e.,* use appropriately cleaned sample containers, etc.); this may include the use of field blanks, which will be specified in the project QAPP. Samples may be shipped in glass or plastic (*e.g.,* polyethylene or polypropylene) bottles, or in disposable cubitainers. All samples should be shipped on ice, under chain-of-custody with a temperature blank.

For projects for which PER does not provide sampling services, the laboratory provides the sampler with the necessary coolers, sample containers, COC forms, and packing materials required to properly preserve, pack, and ship samples to the laboratory.

22.1 Sampling Containers

The laboratory offers clean sampling containers for use by clients. Containers are obtained following procedures outlined in Section 7 and meet the requirements of the test methods. Containers are provided to the client upon request.

22.2 Chain-of-Custody

The purpose of using a chain-of-custody (COC) record is to maintain an accurate written record that can be used to trace the custodianship (possession) of the sample from its collection through its receipt at the PER testing laboratory. COC documentation begins in the field. The sample collector is responsible for the care and custody of the sample(s) until they are received at the appropriate laboratory or relinquished to an assigned custodian.

Samples must be accompanied by a COC record that includes the name of the study, a unique sample ID for each sample, location of collection (or station number and location), date and time of collection, type of sample, number of containers, analysis required (including applicable method number), and the collectors' signatures. The COC can act as an order for laboratory services in the absence of a formal contract. When turning over possession of samples, the person relinquishing the sample(s) *and* the recipient must *both* record the date and time of the transfer and sign their name to verify the transaction. For certain projects, an additional sample transfer sheet is initiated to track the sample through the laboratory during storage, sample preparation, and generation of raw data. Samples are discarded only upon approval of a Technical Director(s) after it is certain that all tests and analyses have been properly performed and recorded. An example COC is provided in Appendix E. Chain-of-custody and any additional

records received at the time of sample submission are maintained by the laboratory in the project folder and is provided in the final report.

22.3 Sample Receipt, Handling, Storage, and Disposal

Upon receipt, staff ensure each sample has an identification label or tag securely attached to the sample container. If PER is collecting the samples, staff ensure the sample is labeled at the time of collection. The sample label, including any subsamples for auxiliary analyses, typically contains the following information:

- Name of the client and project;
- Sampling station name/location;
- Sample date, time, and duration, where applicable, of sample collection;
- Type of sample (*i.e.,* grab vs. composite); and
- Unique identifying number.

Samples are delivered to the laboratory via third-party shipper, courier (either PER staff or contracted), or the client. Procedures for picking up samples by PER staff are outlined in the **Sample Pickup SOP**. Samples that are transported under the responsibility of PER, where necessary, are done so safely and according to storage conditions. This includes moving bottles within the laboratory. Sample shipping procedures are described in the **Sample Shipment SOP**.

The laboratory has sample acceptance, storage, and disposal procedures that are provided in the **Sample Receipt & Handling SOP** and the **Sample and Chemical Disposal SOP**. Upon receipt at the laboratory, all samples from a given project are assigned a unique sample ID number. This number is used throughout the project. For effluent and receiving/ambient water samples, measurement of initial temperature, pH, D.O., salinity, conductivity, and total ammonia, as well as the initials of the person that recorded the data, are recorded on the sample login sheets. Total residual chlorine is also measured for effluents collected from facilities that use chlorination in their disinfection process. The remaining sample is stored at 0-6˚C until needed for test initiation. PER maintains SOPs for all required analyses that are available to staff.

PER complies with the sample hold time requirements found in the applicable toxicity testing SOP(s). If preservation or holding time requirements outlined in the SOP or test methods are not met, deviations shall be documented on the sample log-in data sheet. In general, if these conditions are not met, the client is contacted by the Project Manager prior to any further processing. The sample is then either rejected or the decision to proceed is documented and agreed upon with the client. The condition is noted on the sample log-in sheet and the data are qualified in the report.

23. QUALITY ASSURANCE FOR ENVIRONMENTAL TESTING

PER has procedures for monitoring the validity of the testing it performs. To evaluate the quality of toxicity test results, the laboratory utilizes standard toxicity testing QA/QC procedures to ensure that the test results are valid. Standard QA/QC procedures include the use of negative controls, positive controls (reference toxicant tests), reference sediment samples, replicates, and measurements of water quality during testing.

Toxicity testing results are analyzed and, when found to be outside pre-defined criteria, action is taken to correct the problem and to prevent incorrect results from being reported. Data associated with quality control data outside of criteria and still deemed reportable will be qualified so the end user of the data may make a determination of the usability of the data. The corrective actions taken are dependent upon the magnitude of the problem.

23.1 Essential Quality Control Procedures

Laboratory personnel follow the quality control procedures specified in test methods and Data Quality Objectives (DQOs) identified in project specific QAPPs. For test methods that do not provide acceptance criteria for an essential quality control element or where no regulatory criteria exist, acceptance criteria would be developed based on information in the literature or best professional judgment.

Written procedures to monitor routine quality controls, including acceptance criteria, are located in the test method SOPs and include such procedures as:

23.1.1 Source and Condition of Organism

All test organisms are obtained from reputable suppliers who have provided PER with organisms in the past. Normally, all test organisms are maintained in the laboratory for acclimation to test conditions. If mortality in excess of 10% is noted in the holding stock, the animals may be discarded and a new batch ordered. All organism suppliers must provide taxonomic identification documentation annually.

23.1.2 Maintenance of Test Conditions and Corrective Actions

Each of the biological tests has a set of specific test conditions that are defined in the standard testing. For example, water quality measurements are monitored to ensure that test conditions are within the prescribed limits for each test procedure. The limits for various test condition parameters are noted in the section on the acceptability of each test.

23.1.3 Reference Toxicant Testing and Data Accuracy and Precision

Reference toxicant tests are used to assess accuracy (*i.e.,* to establish that the test organisms are responding to toxic stress in a typical fashion). For instance, acceptable accuracy is defined as a

calculated reference toxicant dose-response value (*i.e.,* statistically-derived point estimate such as the EC_{50} or IC_{25}) that is within the "typical test organism response" range established by the mean $\pm$ 2 standard deviations of the 20 most-recently performed tests; this information is maintained in the PER reference toxicant database and can be quickly assessed by reviewing the reference toxicant control charts. Reference toxicant testing performance is determined by reviewing the data against the EPA method requirements.

PER performs toxicity testing with species for which a minimum of 5 reference toxicant tests have been completed with different batches of organisms. If a specific project requires the performance of a reference toxicant test, the reference toxicant testing may be performed concurrently or monthly; this is determined by the client's permit. A monthly reference toxicant test must be performed for any species tested for a project in a month's time, even if the project did not require the performance of a reference toxicant test. In addition, a reference toxicant test is performed for each species at least on an annual basis.

The precision of toxicity tests is assessed via measures of variability (*e.g.,* coefficient of variation [CV] for a given test treatment). While there are no "acceptability limits" placed on the CV for most test responses, these can be evaluated using "Best Professional Judgment" to characterize whether or not the test response at a given treatment is subject to too much variability for use in a given test.

23.2 Internal Quality Control Practices

The following procedures are performed as internal quality control checks to ensure that all infrastructural functions and generation of data in the laboratory are within acceptable performance ranges:

- Test temperature monitoring;
- Type I water quality monitoring;
- Review of test data;
- Instrumentation calibration log entries and reviews;
- Test organisms log-in and husbandry log;
- Sample log-in;
- Calibration of equipment according to SOPs;
- Continual training of laboratory personnel, including their ethical and legal responsibilities; and
- All QC data is assessed and evaluated on an on-going basis, so that trends are detected.

23.3 Proficiency Test Samples or Inter-Laboratory Comparisons

PER participates in applicable proficiency testing (PT) or inter-laboratory comparisons (*e.g.*, DMR-QA). The proficiency standard testing program consists of a yearly toxicant test regulated by external agencies. Toxicity testing is performed on all available and applicable PT samples. PT results are made available and clients are notified of results and any related corrective actions.

The laboratory does not share PT samples, communicate results, or attempt to obtain the assigned values or results from other laboratories or PT providers. PT samples are treated as standard testing samples and processed using standard procedures.

23.4 Data Review

Throughout testing, as well as upon completion of a project, a thorough data review is performed. The data review consists of the following procedures:

- Determinations of whether the results of testing, examining, or analyzing the sample meet the accepted protocols for interpretation;
- Checks to determine the accuracy of any calculations;
- Checks for transcription errors, omissions, or mistakes;
- Checks to determine consistency with project-specific measurement quality objectives;
- Checks to ensure that the appropriate preparatory and analytical SOPs and standardized methods were followed;
- Checks to ensure that the chain-of-custody is complete and that holding times were met;
- Checks to ensure that requirements for equipment calibrations were met; and
- A tiered system of verification/review consisting of the Scientist performing the testing, Laboratory Manager (or designees) verifying performance, QA Manager (or designees) reviewing results, and a Project Manager/Technical Director(s) reviewing reports.

24. REPORTING RESULTS

The results of each test performed are reported accurately, clearly, unambiguously, and objectively and comply with all specific instructions contained in the test method.

Laboratory results are reported in a test report that includes all the information requested by the client and necessary for the interpretation of the test results and all information required by the method used.

24.1 Test Reports

The report format has been designed to accommodate each type of test performed and to minimize the potential for misunderstanding or misuse. Each test report generated contains the following information:

- Title;
- Name and address of the laboratory;
- Unique project identification number for the test report and a pagination system that ensures that each page is recognized as part of the test report and a clear identification of the end of the report, such as *3/10*;
- Name and address of the client;
- Identification of the method used;
- Description of, the condition of, and unambiguous identification of the sample(s) tested, including the client identification code;
- Date of sample receipt when it is critical to the validity and application of the results, date and time of sample collection, dates the tests were performed, the time of sample preparation and analysis, if the required holding time for either activity is less than or equal to 72 hours;
- Reference to the sampling plan and procedures used by the laboratory where these are relevant to the validity or application of the results;
- Test results, an indication of when non-conforming data is identified, and an identification of the statistical package used to analyze the data;
- Name, function, signature (or equivalent electronic identification) of the person authorizing the test report, and the date of issue;
- Where relevant, a statement to the effect that the results relate only to the samples;
- Any non-accredited tests or parameters are clearly identified as such to the client; and
- Statement that the report shall not be reproduced except in full without written approval of the laboratory.

24.2 Supplemental Test Report Information

When necessary for interpretation of the results or when requested by the client, test reports include the following additional information:

- Deviations from, additions to, or exclusions from the test method, information on specific test conditions (*e.g.*, environmental conditions), any non-standard conditions that may have affected the quality of the results, and any information on the use and definitions of data qualifiers;
- Statement of compliance/non-compliance when requirements of the management system are not met including identification of test results that did not meet the laboratory and regulatory sample acceptance requirements (*e.g.*, holding time);
- Where applicable and when requested by the client, a statement on the estimated uncertainty of the measurement;

- Where appropriate and needed, opinions and interpretations. When opinions and interpretations are included, the basis upon which the opinions and interpretations are documented. Opinions and interpretations are clearly marked as such in the test report; and
- Additional information that may be required by specific methods or client.

In addition to the items above, the following is provided when necessary for the interpretation of the results for test reports that contain the results of sampling:

- Date of sampling;
- Unambiguous identification of the material sampled;
- Locations of the sampling, including diagrams, sketches, or photographs;
- Reference to the sampling plan and procedures used;
- Details of any environmental conditions during sampling that may affect the interpretations of the test results; and
- Any standard or other specification for the sampling method or procedure and deviations, additions to, or exclusions from the specification concerned.

24.3 Environmental Testing Obtained from Subcontractors

Test results obtained from tests performed by subcontractors are clearly identified on the test report by subcontractor name and/or accreditation number. The subcontractors report their results in writing or electronically. A copy of the subcontractor's report is provided as an appendix to the client's report.

24.4 Electronic Transmission of Results

All test results transmitted by telephone, fax, telex, e-mail, or other electronic means comply with the requirements of the TNI Standard and associated procedures to protect the confidentiality and proprietary rights of the client. PER controls electronic documents with Adobe Acrobat® electronic signatures to prevent unauthorized modification to test reports.

24.4.1 Electronic Data Deliverables

Electronic data deliverables (EDD) include PDF copies of toxicity reports and Surface Water Ambient Monitoring Program (SWAMP) EDDs. The SWAMP EDDs are generated via a cross walk from the CETIS statistical software and are then populated with additional information (*e.g.*, pH, dissolved oxygen, conductivity, etc.) that are not included in the CETIS entry. Scientist III or Project Managers review all SWAMP EDDs and ensure that they conform to the SWAMP data entry requirements.

24.5 Amendments to Test Reports

Material amendments to a test report after it has been issued are made only in the form of a "supplemental" report with the revisions being clearly identified in the report cover letter. An electronic version of each supplemental report is saved with a suffix that includes the letter "S" for supplemental and a number (*e.g.*, "1") for the number of the supplement so as to clearly distinguish it from the initial version of the report. All supplemental reports meet all the requirements for the initial report and the requirements of this Quality Manual.

Appendix A

Laboratory Accreditation/Certification/Recognition

Pacific EcoRisk maintains the following certifications and accreditations with state and national entities:

Organization	Certification	Certificate Number
Oregon Health Authority	NELAP	4043
California Department of Public Health	ELAP	2085
Washington Department of Ecology	ELAP	C848

The certificates and parameter lists (which may differ) for each organization are provided on the Fields of Accreditation included with the accreditation certificate, which are stored in the QA/QC Program folder on the Pacific EcoRisk server.

Should accreditation be terminated or suspended, Pacific EcoRisk would immediately cease to use the certificate number reference in any way and inform clients impacted by the change.

Appendix B

Glossary

Glossary

Accuracy	Degree of agreement between an analytical result and the true value. Accuracy is affected by both random error (imprecision) and systematic error (bias) but is sometimes used improperly to denote only systematic error.
Analytical Method	Written instructions describing an analytical procedure followed to obtain a numerical estimate of the chemical (analyte) in a sample or samples.
Blank	A sample expected to contain none of the analyte or chemical of interest. *Field blanks* are used to obtain information on contamination introduced during sample collection, transport, or storage. *Method blanks* are most commonly used to reveal contamination in the laboratory (as opposed to in the sampling process) or as an assessment of the effects of a given treatment in a TIE study.
Control Chart	A graphical representation of the precision of QC test results indicating whether the measurement system is in statistical control. For repeated analyses of standards, the chart is usually based on the average result of those analyses (20 results are generally accepted as the minimum to ensure valid statistics) and upper and lower control limits based on the standard deviation of the results. (See *Control Limits*)
Control Limits	Statistical warning and action limits calculated for control charts, used to make decisions on acceptability of control test results. *Warning limits* usually established at two standard deviations above and below the mean of repeated analyses of a standard. *Action limits* are established at three standard deviations.
Holding Time	The allowed time from when a sample was collected or extracted until it must be analyzed. For composite samples, the holding time starts when the last composite aliquot is collected.
Precision	A measure of the variability (spread) in the results for replicate measurements caused by random error. Also referred to as *imprecision*. Precision is usually measured as *standard deviation, percent relative standard deviation* (%RSD*),* or *relative percent difference* (RPD).
Quality Assurance	The total integrated program for ensuring the reliability of monitoring and measurement data.
Quality Control	The routine application of statistically based procedures to evaluate and control the accuracy of results from analytical measurements.
Standard Operating Procedure	A detailed written description of a procedure designed to systematize performance of the procedure.

Appendix C

Toxicity Test Methods

Methods Used for Aquatic Effluent & Receiving Water Toxicity Testing
Ambient Water Quality/Toxicity Monitoring

Certification	Manual	Title	Method	Species
NELAP ELAP	EPA-821-R-02-012	Methods for measuring the acute toxicity of effluents to freshwater and marine organisms, Fifth Edition	2002.0 2021.0 2019.0 2000.0 2007.0 Topsmelt 2004.0 2006.0 *Hyalella* *Chironomus*	*Ceriodaphnia dubia* *D. magna & D. pulex* *Oncorhynchus mykiss* *Pimephales promelas* *Americamysis bahia* *Atherinops affinis* *Cyprinodon variegatus* *Menidia beryllina* *Hyalella* *Chironomus*
NELAP ELAP	EPA-821-R-02-013	Short-term methods for estimating the chronic toxicity of effluents and receiving waters to freshwater organisms, Fourth Edition	1003.0 1002.0 1000.0	*Selenastrum capricornutum* *Ceriodaphnia dubia* *Pimephales promelas*
NELAP ELAP	EPA-821-R-02-014	Short-term methods for estimating the chronic toxicity of effluents and receiving waters to marine and estuarine organisms, Third Edition	1007.0 1006.0 1004.0 1006.0	*Americamysis bahia* *Atherinops affinis* *Cyprinodon variegatus* *Menidia beryllina*
NELAP ELAP	EPA/600/R-95-136	Short-term methods for estimating the chronic toxicity of effluents and receiving waters to West Coast marine and estuarine organisms	1005.0 1008.0 Sand Dollar 1008.0 Purple Urchin 1005.0 1009.0 Red Abalone	*Crassostrea gigas* *Dendraster excentricus* *Strongylocentrotus purpuratus* *Mytilus spp.* *Macrocystis pyrifera* *Haliotis rufescens*
NELAP ELAP	ASTM-1218	Standard guide for conducting static toxicity tests with of microalgae	E-1218	*Selenastrum capricornutum* *Thalassiosira pseudonana* *Skeletonema costatum*
NELAP ELAP	Polisini & Miller	Static acute bioassay procedures for hazardous waste samples	Polisini & Miller	*Pimephales promelas* *Oncorhynchus mykiss*

Methods Used for Sediment Toxicity & Bioaccumulation Testing Evaluations of Ambient Sediments, Dredged Materials, and Dredging Operations

Certification	Manual	Title	Method	Species
NELAP	EPA 600/R-99/064	Methods for measuring the toxicity and bioaccumulation of sediment-associated contaminants with freshwater invertebrates, Second Edition	100.1 100.2 100.3 100.4 100.5	*Hyalella azteca* *Chironomus dilutus* *Lumbriculus variegatus*
NELAP	EPA 600/R-94/025	Methods assessing the toxicity of sediment-associated contaminants with estuarine and marine amphipods	100.4	*Ampelisca abdita* *Eohaustorius estuaries* *Leptocheirus plumulosus* *Rhepoxynius abronius*
N/A	EPA/600/R-01/020	Methods assessing the chronic toxicity of marine and estuarine sediment-associated contaminants with the amphipod *Leptocheirus plumolosus*	N/A	*Leptocheirus plumulosus*
N/A	ASTM E724	Standard guide for conducting toxicity tests starting with embryos of four species of saltwater bivalve molluscs	E724	*Crassostrea gigas* *Mytilus spp.*
NELAP	ASTM E1676-12	Standard guide for conducting laboratory soil toxicity or bioaccumulation tests with the lumbricid earthworm *E. fetida* and the enchytraeid potworm *E. albidus*	E1676-12	*Eisenia fetida*
N/A	ASTM E1367	Standard test method for measuring the toxicity of sediment-associated contaminants with estuarine and marine invertebrates	E1367	*Ampelisca abdita* *Eohaustorius estuaries* *Leptocheirus plumulosus* *Rhepoxynius abronius*
NELAP	ASTM E1611	Standard guide for conducting sediment toxicity test with polychaetous annelids	E1611	*Neanthes arenaceodentata*
NELAP	ASTM E1688	Standard guide for determination of sediment-associated contaminants by benthic invertebrates	E1688	*Macoma nasuta* *Nereis virens* *Nephtys caecoides*
N/A	ASTM E1706	Standard test method for measuring the toxicity of sediment-associated contaminants with freshwater invertebrates	E1706	*Hyalella azteca* *Chironomus dilutus*

Toxicity Identification Evaluations / Toxicity Reduction Evaluations (TIEs / TREs)

- Methods for Aquatic Toxicity Identification Evaluations: Phase 1 Toxicity Characterization Procedures (Second Edition). EPA-600/6-91/003. U.S. EPA, Environmental Research Laboratory, Duluth, MN.
- Methods for Aquatic Toxicity Identification Evaluations: Phase II Toxicity Identification Procedures for Samples Exhibiting Acute and Chronic Toxicity. EPA/600/R-92/080. U.S. EPA, Office of Research and Development, Washington, D.C.
- Methods for Aquatic Toxicity Identification Evaluations: Phase III Toxicity Confirmation Procedures for Samples Exhibiting Acute and Chronic Toxicity. EPA/600/R-92/081. U.S. EPA, Office of Research and Development, Washington, D.C.
- Toxicity Reduction Evaluation Protocol for Municipal Wastewater Treatment Plants. EPA/600/2-88/062. U.S. EPA, Water Engineering Research Laboratory, Cincinnati, OH.
- Sediment Toxicity Identification Evaluation (TIE): Phase 1, Phase II, and Phase III Guidance Document. EPA-600/R-07/080. U.S. EPA, Office of Research and Development, Washington, D.C.

References

- Long-term management strategy (LTMS) for the placement of dredged material in the San Francisco Bay Region. U.S. EPA Region 9, U.S. Army Corps of Engineers, San Francisco Bay Conservation and Development Commission, San Francisco Bay Regional Water Quality Control Board, California State Water Resources Control Board.
- Evaluation of dredge material proposed for ocean disposal - Testing Manual. EPA-503/8-91/001. U.S. EPA-U.S. Army Corps of Engineers, Washington, D.C.
- Evaluation of dredged material proposed for discharge in waters of the U.S. - Inland Testing Manual. EPA-823/B-94/002. U.S. EPA-U.S. Army Corps of Engineers, Washington, D.C.
- QA/QC guidance for sampling and analysis of sediments, water, and tissues for dredged material evaluations. Phase 1 - Chemical evaluations. EPA 823-B-95-001. U.S. EPA, Office of Water, Washington, D.C.
- Guidance manual: bedded sediment bioaccumulation tests. EPA-600/X-89/302. U.S. EPA Environmental Research Laboratory, Newport, OR.
- Standard test method for measuring the toxicity of sediment-associated contaminants with freshwater invertebrates. ASTM E1706. American Society for Testing and Materials, Philadelphia, PA.
- Standard guide for collection, storage, characterization, and manipulation of sediments for toxicological testing and for selection of samplers used to collect benthic invertebrates. ASTM E1391-03. American Society Testing & Materials, Philadelphia, PA.
- Sediment toxicity identification evaluation: Phase 1 (characterization), Phase II (identification), and Phase III (confirmation). Modifications of effluent procedures. EPA-600/6-91/007. U.S. EPA, Environmental research Laboratory, Duluth, MN.

Appendix D

Laboratory Equipment

Laboratory Equipment

Laboratory Equipment - Pacific EcoRisk has all of the equipment necessary to successfully perform the EPA and ASTM water, effluent, soil, and sediment toxicity tests. All testing and analytical equipment is maintained and calibrated as per the Quality Manual. All plastic and glass labware is cleaned according to EPA guidelines and is stored in clean, dust-free cabinets until used. A selected list of PER laboratory testing equipment is provided on the accompanying pages.

Toxicity Testing

Market Forge Ind.	STERILMATIC	Electric Autoclave
VWR	S-500	Platform Shaker
Porta-Trace	1118-30W	Light Boxes
Stanplatec	Drykeeper	Desiccators
Air Whist	AW-1000	Air Pumps
Sweetwater	Blower S-31	Regenerative Blower
Rio	2100	Circulation Pumps
Universal Marine Ind.	UTCH-2	Digital Chiller/Heater Units
EBO-Jäger	250W	Submersible Heaters
VWR	2005	Low Temperature Incubator
Westpointe/Lakewood	Multiple	Electrical Fans
Intermatic	TN311	Light Timers

Microscopy

Leica	DM500	Compound Microscope
Wolfe	N/A	Dissecting Microscope
Bausch Lomb	Stereozoom 5	Dissecting Microscope
Zeiss	Invertoskop	Inverted Microscope
Leica	DFC290	Inverted Microscope
Leica	DMIL	Inverted Microscope
Hausser Sci.	3800	Sedgewick-Rafter Chamber
Reichert	N/A	Hemocytometers

Balances and Weights

Ohaus	AP2500	Analytical Balance
Mettler/Toledo	MS40025	Top Loading Balance
Ohaus	Scout II Top Loader	Top Loading Balance
Ohaus	DU215CD	Discovery Balance
Ohaus	D71P60HR1	Top Loading Balance
VWR	Class S	Calibration Weights

Water Quality Analyses

Orion	3-Star	D.O. Meter
Orion	5-Star	Conductivity/Salinity meter
Orion	Star A221	pH meter

Beckman	pH1410	pH meter
Control Company	35519-055	Barometer
CO_2 Meter.com	0-30% CO_2 Sampler	CO_2 meter
Hach	DR/3900	Spectrophotometer
Hach	DR/3800	Spectrophotometer
Hach	Pocket II	Colorimeter
VWR	Dual-Range	Illuminance Meter
Onset	UTBI-001	Continuous Temperature Loggers
Hach	N/A	Digital Titrators
VWR	N/A	Digital Thermometers
H-B Instrument Co.	NIST	NIST Thermometer

Sample Storage

Raetone	AR-47-SS	Laboratory Refrigerator
LG	LBC225	Industrial Refrigerator
True	H-74	Industrial Refrigerator
Frigidaire	FFU21M7HWJ	Industrial Freezer

Sample Manipulation/Preparation

Forma Scientific	5682	Centrifuge
Forma Scientific	Centra-GP8R	Centrifuge
Hydro-Photon Inc.	Steripen Classic	Handheld UV Light
Laguana Clay Co.	N/A	Sediment Termination Booths
IKA	IKA-RW20-DS1	Benchtop Elutriate Mixer
Bellco	N/A	Roller Apparatus
Nalgene	N/A	Filtration Units
ASTM	Various mesh	ASTM Stainless Steel Sediment Sieves
Corning/VWR	Multiple	Magnetic Stirplates

Laboratory Water Storage/Preparation

Pentair	PS53SS	Seawater Pump
Ryan Herco	3000 Gallon	Seawater Tank
Pacific Water Systems	Type I Water	RO/DI System
Lifeguard Aquatics	Aquastep 25W	UV Sterilizer
Emperor Aquatics	Smart UV 25W	UV Sterilizer
Cora Lite	Turbo Twist 36W	UV Sterilizer
Pondmaster	24, 700, and 1200	Magnetic Drive Pumps

General Laboratory Equipment

Scienceware	N/A	Calipers
VWR Scientific	1326	Gravity Oven
Thermolyne	N/A	Benchtop Muffle Furnace
MasterFlex	L/S and H/S	Peristaltic Pumps
Gast	DAA-V715-EB	Vacuum Pump
Miele Professional	G 7804	Lab Glassware Dishwasher

Gilson/Rainin/Eppendorf	N/A	Automatic Pipettors
Pyrex	Class A	Volumetric Pipettes/Flasks
Pyrex/Nalgene	Misc. Griffin beakers	
Pyrex/Nalgene	Misc. Erlenmeyer Flasks	
Pyrex/Nalgene	Misc. Graduated Cylinders	

Safety Equipment

Bradley	Barrier Free	Eyewash Station
Bradley	519-270HD	Eyewash Station
Kiddie	Pro 340	Fire Extinguishers
Labconco	1060200	Fume/Ventilation Hood
Labconco	N/A	Acid Storage Cabinet
Labconco	N/A	Solvent Storage Cabinet
Global	N/A	Safety Storage Cabinet
Hydro Farm	ACDF8	Air Scrubber

Appendix E

Chain-of-Custody Form

Pacific EcoRisk
2250 Cordelia Rd., Fairfield, CA 94534
(707) 207-7760 FAX (707) 207-7916

CHAIN-OF-CUSTODY RECORD

Results To:				**Invoice To:**				**REQUESTED ANALYSIS**												
Address:				**Address:**																
Phone:				**Phone:**																
Attn:				**Attn:**																
E-mail:				**E-mail:**																
Project Name:																				
P.O.#/Ref:																				
	Client Sample ID	**Sample Date**	**Sample Time**	**Sample Matrix***	**Grab/ Comp**	**Container Number**	**Container Type**													
1																				
2																				
3																				
4																				
5																				
6																				
7																				
8																				
9																				
10																				

Samples Collected By:		
Comments/Special Instruction:	**RELINQUISHED BY:**	**RECEIVED BY:**
	Signature:	**Signature:**
	Print:	**Print:**
	Organization:	**Organization:**
	Date: **Time:**	**Date:** **Time:**
	RELINQUISHED BY:	**RECEIVED BY:**
	Signature:	**Signature:**
	Print:	**Print:**
	Organization:	**Organization:**
	Date: **Time:**	**Date:** **Time:**

***Example Matrix Codes**: (**EFF** - Effluent) (**FW** = Freshwater); (**SW** = Saltwater); (**WW** = Wastewater); (**STRMW** = Stormwater); (**SED** = Sediment); or other

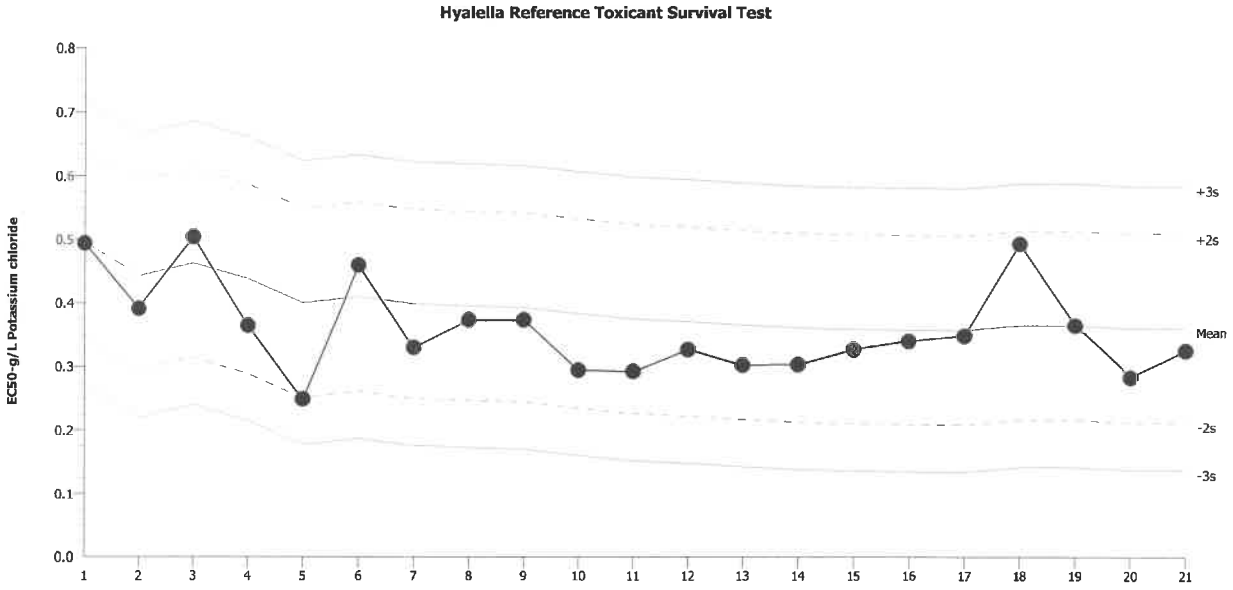
Pacific EcoRisk Summary of Negative Control Performance in Recent Testing
Comparison of negative control types and feeding regimes

Sediment Type	Feeding Regime	Date	Mean 28 D Survival (%)	Mean 28 D Dry Weight (mg/indiv)	Mean 28 D Biomass (mg)	Mean 42 D Survival (%)	Mean 42 D Dry Weight (mg/indiv)	Mean 42 D Biomass (mg)	Mean Offspring/Female
Old PER Control (San Francisco Bay)	YCT + Spirulina	10/26/2016	92.5	0.575	0.531	92.5	0.790	0.729	16.0
		10/26/2016	96.7	0.562	0.537	90.0	0.732	0.717	15.0
		10/26/2016	95.0	0.615	0.597	87.5	0.720	0.634	16.1
		9/13/2018	90.0	0.582	0.524	86.7	0.903	0.783	13.4
		9/13/2018	95.0	0.585	0.556	95.0	1.011	0.960	11.2
		9/13/2018	95.0	0.697	0.662	95.0	0.990	0.941	11.7
New PER Control (Missouri Spring River)	YCT + Tetramin	9/13/2018	95.0	0.645	0.613	88.3	0.952	0.841	13.2
		9/13/2018	93.3	0.640	0.597	90.0	0.878	0.790	18.2
		9/13/2018	93.3	0.733	0.684	91.7	0.899	0.824	16.0
		2/12/2019	97.5	0.698	0.681	96.3	1.080	1.040	15.2
		2/13/2019	91.7	0.651	0.597	90.0	0.986	0.887	13.4
		2/14/2019	91.7	0.744	0.682	88.8	1.100	0.977	15.9

UCR Phase 3 Individual Test TAC	PER Results	Historic Performance	PER Results
1. Mean 28-d control survival must be ≥ 80%	TAC met in all tests	1. Historic mean 28-d control survival should average ≥ 85%	93.9
2. Mean 28-d control weight must be ≥ 0.35 mg/individual	TAC met in all tests	2. Historic mean 28-d control weight should average ≥ 0.40 mg/individual	0.644
3. Mean 42-d control survival must be ≥ 80%	TAC met in all tests	3. Historic mean 42-d control survival should average ≥ 85%	91.0
4. Mean 42-d control weight must be ≥ 0.50 mg/individual	TAC met in all tests	4. Historic mean 42-d control weight should average ≥ 0.65 mg/individual	0.920
5. Mean 42-d control reproduction must be ≥ 6.0 young/female	TAC met in all tests	5. Historic mean 42-d control reproduction should average ≥ 8.0 young/female	14.6

Hyalella Reference Toxicant Survival Test **Pacific EcoRisk**

Test Type:	Survival (96h)	**Organism:**	Hyalella azteca (Freshwater Amphip	**Material:**	Potassium chloride
Protocol:	EPA-821-R-02-012 (2002)	**Endpoint:**	96h Survival Rate	**Source:**	Reference Toxicant-REF



Mean:	0.3604	**Count:**	20	**-2s Warning Limit:**	0.2118	**-3s Action Limit:**	0.1375
Sigma:	0.07432	**CV:**	20.60%	**+2s Warning Limit:**	0.5091	**+3s Action Limit:**	0.5834

Quality Control Data

Point	Year	Month	Day	Time	QC Data	Delta	Sigma	Warning	Action	Test ID	Analysis ID
1	2018	Jan	17	15:40	0.4938	0.1334	1.796			17-7568-9822	12-5928-4930
2		Feb	8	15:57	0.391	0.03064	0.4122			13-6969-1958	02-2461-7172
3		Mar	2	17:52	0.5037	0.1433	1.928			10-1610-0738	05-9100-3645
4		Apr	8	13:38	0.3642	0.003763	0.05063			14-6470-8596	05-1973-4354
5		May	16	17:55	0.2486	-0.1118	-1.504			05-9866-1037	11-2195-3653
6		Jun	14	16:35	0.4595	0.09908	1.333			18-1605-2758	14-8406-0239
7		Jul	18	16:20	0.3299	-0.03046	-0.4098			11-4094-7394	20-3811-7615
8		Aug	6	14:44	0.3732	0.01281	0.1724			16-9077-3352	08-2793-0151
9			9	17:00	0.3732	0.01281	0.1724			14-1761-7282	03-9488-5843
10			16	11:27	0.2941	-0.06628	-0.8919			12-7542-2334	14-0979-7400
11			21	16:03	0.2922	-0.06822	-0.9179			19-3911-4177	09-8363-6416
12		Sep	4	14:11	0.3265	-0.03394	-0.4567			00-7654-6742	11-6933-8211
13		Oct	22	15:45	0.3021	-0.05831	-0.7846			08-4484-9174	20-9708-5657
14		Nov	8	16:10	0.3031	-0.05726	-0.7704			20-3402-4533	15-9735-9663
15		Dec	30	10:50	0.3265	-0.03394	-0.4567			07-2846-0604	07-9228-2474
16	2019	Jan	16	15:28	0.3394	-0.02096	-0.282			05-9424-3991	13-8222-5294
17		Feb	4	14:55	0.3482	-0.01218	-0.1639			13-3563-0230	03-4597-8225
18		Mar	16	14:47	0.4925	0.1321	1.777			20-8092-8579	07-7078-6737
19			20	13:32	0.3642	0.003763	0.05063			01-7546-0826	05-9037-7090
20		Apr	20	15:01	0.2828	-0.07756	-1.044			16-6914-2737	19-6559-5883
21		May	18	16:51	0.3249	-0.0355	-0.4777			06-3838-3283	17-8731-6575

PACIFIC ECORISK

Upper Columbia River Phase 3 Project Specific Standard Operations Procedure for *Hyalella azteca* 42-Day Survival, Growth, and Reproduction Sediment Toxicity Test

Effective date: August 21, 2019

Revised/Reviewed/Approved by:

Action	Name	Title	Signature	Date
Revised by:	Michael McElroy	Sr. Project Manager		
Reviewed by:	Krista Prosser	QA Manager		
Approved by:	Stephen L. Clark	Vice President		

Hyalella azteca
42-Day Survival, Growth, and Reproduction
Sediment Toxicity Test
UCR Project-Specific Standard Operating Procedures

This standard operating procedure (SOP) has been developed specifically for use in the Upper Columbia River (UCR) Phase 3 Sediment Study for Teck American Incorporated (TAI) and is based upon a modification of the EPA Method 100.4 described in Methods for Measuring the Toxicity and Bioaccumulation of Sediment-associated Contaminants with Freshwater Invertebrates, Second Edition (EPA/600/R-99/064). It is also in general accordance with ASTM Standard E1706-19, Standard Test Method for Measuring the Toxicity of Sediment-Associated Contaminants with Freshwater Invertebrates.

Modifications from the standard EPA and ASTM methods are based on updated draft guidance from EPA and discussions with EPA during webinars in Spring 2019 (McCaig 2019).

1. INTRODUCTION

This test is based on a 28-day static-renewal exposure of 7-8 day old *Hyalella azteca* to sediments, followed by a 14-day exposure to water only during which reproduction is evaluated. The final test endpoints include survival, growth, and reproduction (survival and growth on Day 28; survival and reproduction on Day 35; survival, growth, and reproduction on Day 42; and number of adult males and females on Day 42).

H. azteca are often an important component of the benthos in freshwater ecosystems. They have been used in sediment toxicity testing and have been shown to be a sensitive indicator of contaminants associated with sediments. They have a wide tolerance of sediment grain size with acceptable survival in sediments ranging from > 90% fines to 100% sand (Ingersoll and Nelson, 1990).

2. TEST PREPARATION

2.1 Equipment and Supplies Needed

1. The analytical lab will provide pre-cleaned and decontaminated sample containers for the field crew to use in the collection of sediment. A minimum volume of 2.5 L of sediment is necessary (> 5 L is preferred) to provide sediment for the bioassay and for the accompanying sediment pore water characterization. Additional volume will be necessary for further characterization of sediment (e.g., grain size characteristics, contaminant concentrations, porewater generation for Biotic Ligand Model (BLM) constituents).
2. Test organisms, 7-8 day old *H. azteca.*

3. Temperature-controlled room, set to 23˚C.
4. Laboratory control water (Type I water and salts to produce SAM-5S reconstituted water per Borgmann (1996) modified to contain 0.4 mg Br/L). Performance based criteria: > 0.02 mg Br/L and > 15 mg Cl/L.
5. Control sediment consists of a field collected freshwater sediment from Spring River, Missouri, or other project specific controls sediments (such as quartz sand).
6. Food, YCT (prepared in-house, preferred) and TetraMin® fish flake food.
7. Stainless-steel bowls and spatulas (or spoons), to homogenize sediments prior to placement in replicate containers.
8. Sieves, 250 µm, 500 µm, and 1 mm, for removing excess debris and indigenous organisms from test sediments and collecting organisms on Day 28 and Day 42.
9. Test chambers (20 per treatment; 12 for the sediment exposure, Day 0-28, 8 for the water only exposure, Day 28-42, and any additional replicates required for additional pore water/sediment analytical chemistry parameters), consisting of 300 mL tall-form glass beakers, modified as follows:
    a. The flared lip of the beakers should be cut off and the upper rim flame-polished. The prepared beakers must be appropriately cleaned before further use (See the Glassware & Plasticware Washing SOP).
    b. Cut a 2.5 cm-wide band of 120 µm Nitex®, approximately 25 cm in length. Using aquarium-safe silicon sealant, attach the band of Nitex around the upper lip of the beaker, such that ~two-thirds of the width of the Nitex band is above the glass. Make sure to completely seal the Nitex such that there are no openings or seams into which the test organisms might become entrapped. Allow the silicon sealant to cure for a minimum of 24 hrs. The resulting test containers must be appropriately cleaned and rinsed, and then pre-soaked for 48 hrs in Type I water [i.e., reverse-osmosis, de-ionized (RO/DI)], before use in testing.
10. Modified Zumwalt-type water delivery system, consisting of a lower plastic tub to hold replicate containers in position, and an upper plastic tub, plumbed with 60 mL syringes with flow restricting frits for delivery of water to replicate containers.
11. Plastic 25 mL disposable pipette with 120 µm Nitex® screen over one end, for collecting water sub-samples to measure water quality.
12. 50 mL plastic cup, to composite water sub-samples from each replicate to measure water quality.
13. Meters (D.O., pH, and conductivity), needed to document test water quality, calibrated and used as per the appropriate SOPs.
14. Type I water and wash bottles, for rinsing of probes, etc.

15. Sample bottles, titrators, and reagents, required to measure hardness and alkalinity.
16. Colorimeter and reagents, required to measure ammonia, calibrated and used as per the appropriate SOP.
17. Thermometer (NIST certified), for documenting test water temperature.
18. Disposable plastic transfer pipettes, for the collection and transfer of test organisms.
19. Glass tray, for the sorting and collection of test organisms at test initiation and at test termination.
20. Plastic weigh boats, for collection of test organisms at test termination.
21. Light boxes, for the sorting and collection of test organisms at test initiation, Day 28, and at test termination.
22. Aeration system, in cases where the chambers need to be aerated when the D.O. drops below acceptable levels.
23. Methanol, for euthanizing organisms prior to placing them in the drying oven.
24. Fine-tip forceps, for use in consolidating organisms at test initiation and for collecting individual organisms from test material at Day 28 and test termination.
25. Aluminum Foil Weighing Pans, for drying and weighing of *H. azteca* for test initiation, Day 28, and Day 42 weights.
26. Drying oven, at 60˚C for drying *H. azteca* at Day 28 and test termination.
27. Desiccators, for holding dried organisms.
28. Balance, capable of weighing to 0.01 mg, calibrated and used as per the appropriate SOP.
29. Reference weights, for calibration of balance.
30. Microscope and calibrated software, for determining sex at Day 42, if necessary.
31. 5 mL clean quartz sand and 7x1 cm strips of 120 µm NITEX or stainless-steel mesh, for thigmotactic substrate for the post-28-day water exposure.

2.2 Ordering and Holding of Test Organisms

2.2.1 Ordering and Holding of Test Organisms from Commercial Supplier

1. Test organisms should be ordered far enough in advance so as to ensure the arrival of 6-7 day old organisms 24 hrs prior to Day 0 (7-8 days old at Day 0). Approximately 15-25% more animals should be ordered than are actually needed for the test, so as to allow for some attrition of organisms that are stressed from the shipping, etc.

2. Order *H. azteca* from:
    a. Aquatic BioSystems, Inc. (800) 331-5916.
    b. Aquatic Research Organisms. (800) 927-1650.
    c. Aquatic Indicators. (904) 829-2780.
3. Upon receipt, the test organism culture should be transferred into 4 L HDPE tanks containing test water at 23˚C; the culture should be gently aerated, and should be fed YCT and TetraMin®. For additional instruction on the receipt and handling of the test organisms, see the **Test Organism Receipt and Handling SOP**.

2.2.2 Organism Health

Test organisms must appear healthy (not pale in color, not noticeably injured), behave normally (active when disturbed, not continually floating and getting stuck in the water surface tension), have been fed well, and have low mortality in the cultures during holding. There should be < 10% mortality in the cultures prior to test initiation.

2.3 Collection and Holding of Sediment Samples

Grab or composite samples should be collected into appropriately-cleaned glass or plastic container(s), and immediately be placed on ice (or "blue ice" type product) to bring the temperature to ≤ 4°C. The sample should be shipped or transported to the testing laboratory ASAP. Upon receipt of the sample(s) in the laboratory, each sample should be logged in, and then placed in the sample refrigerator at 4°C in the dark. For instruction on the log-in of incoming samples, see the **Sample Receipt & Handling SOP**. The test sample(s) used to start the test should be < 8 weeks old; however, the UCR Phase 3 sediment study Quality Assurance Project Plan (QAPP) may have project-specific established sediment hold times; the QAPP will supersede method recommendations. For each site tested, a minimum of 2.5 L of sample will be needed for this testing, but > 5 L is preferred. Chemistry analyses will require additional samples.

NOTE: Samples can be tested up to eight weeks after collection or as established in the UCR Phase 3 QAPP; however, it is recommended to test them as soon as possible after collection. Depending on chemicals of interest and composition of the sediment, degradation and decomposition can occur the longer the sample is in storage.

3. TEST INITIATION

Before test initiation begins, be aware of any client-specific testing requirements and read the attached "**Summary of Test Conditions and Test Acceptability Criteria for Conducting the 42-Day *Hyalella azteca* Survival, Growth, and Reproduction Sediment Toxicity Test.***"*

3.1 Pre-Test: Obtaining Test Organisms (Day –8, or before):

1. If in-house organisms are to be used for testing. A sufficient number of neonate *H. azteca* will be obtained and isolated from the culture. The neonate culture will be maintained for the next 7-8 days until test initiation per the **Test Organism Receipt and Handling SOP**.
2. If organisms for testing will be obtained from a test organism supplier, on Day -10 or before, an order for 5-6 or 6-7 day old amphipods will be ordered for receipt 1 to 2 days in advance of test initiation. Once received, the amphipods will be maintained prior to testing per the **Test Organism Receipt and Handling SOP**.

3.2 Pre-test: Sediment Loading/Equilibration, Sample Collection Prior to Test Initiation (Day -7):

1. Remove the sediment from the sample storage refrigerator and allow thermal equilibration to room temperature. Re-homogenize the sediment along with any overlying water that has developed.
2. Sample sediments for physical and chemical characteristics.
3. Sample pore water for water quality analyses following the **UCR Phase 3 Centrifugation SOP**:
    a. Place approximately 500 mL of each homogenized sediment into 750-mL centrifuge bottles, and centrifuge at g-force to be determined (TBD) for TBD min.[1] Additional porewater may need to be obtained based on UCR Phase 3 QAPP analytical program.
    b. Decant sediment porewater, and measure routine water quality characteristics of the porewater (as per Phase 3 QAPP). Record the water quality data onto the appropriate test data sheet. Collect additional porewater volume for analytical program following approved UCR Phase 3 QAPP.
4. Label 18 test replicate containers. Label the test containers with their treatment and replicate ID code (Replicates “A” through “L” for bioassay test replicates, Replicates “M” through “R” for peeper deployment replicates).
5. For each sediment sample, use a stainless-steel spoon or spatula to transfer approximately 100 mL of homogenized sediment into each of the replicates, carefully “tamping” down the sediments. Carefully pour approximately 175 mL of SAM-5S water modified to contain 0.4 mg Br/L into each beaker, taking care to minimize disturbance of the sediment. Peeper deployment replicates will be similarly established following the **UCR Phase 3 Peeper Preparation, Deployment, and Retrieval SOP**. Place the test replicates into the water bath or test room, with the temperature-controlled at 23˚C, under cool-white fluorescent lighting on a 16L:8D photoperiod.

[1] The centrifugal force that will be used for the Phase 3 Sediment Study will be established after completion of the porewater extraction method study (initiated July 30, 2019) and discussions between TAI and EPA.

3.3 Sediment Equilibration Period (Day -7 to Day 0):

Use the pre-calibrated modified Zumwalt water delivery system to add approximately 175 mL of control water to each test chamber. Place the test chambers in the lower plastic tub to hold them in place. Place the tub with the test chambers directly under the syringes connected to the upper splitting chamber of the Zumwalt water delivery system and add 1.8 L of overlying water to the splitting chamber. Once the upper reservoir has completely drained into the test chambers, adjust the volume of water in each test chamber so the surface of the water is approximately 1 cm below the mesh screen. Drain the water that has overflowed into the lower plastic tub and return the test chambers to the test area. During the sediment equilibration period, any water lost due to evaporation will be replaced with reverse osmosis-deionized water.

3.4 Immediately Prior to Test Initiation (Day 0):

1. Use the pre-calibrated modified Zumwalt water delivery system to add approximately 175 mL of control water to each test chamber. Place the test chambers in the lower plastic tub to hold them in place. Place the tub with the test chambers directly under the syringes connected to the upper splitting chamber of the Zumwalt water delivery system and add 1.8 L of overlying water to the splitting chamber. Once the upper reservoir has completely drained into the test chambers, adjust the volume of water in each test chamber so the surface of the water is approximately 1 cm below the mesh screen. Drain the water that has overflowed into the lower plastic tub and return the test chambers to the test area.
2. After the water is renewed, use a plastic 25 mL disposable pipette with 120 µm Nitex® screen over one end to collect approximately 20 mL of overlying water from each replicate. Overlying water should be sampled 1-2 cm above the sediment surface. Composite into a beaker for a final volume of approximately 240 mL.
3. From the composite, collect sub-samples for analysis of alkalinity, hardness, and ammonia. Measure routine water quality parameters (temperature, pH, D.O., and conductivity) in the remaining composited water (**NOTE** – D.O. levels must be > 2.5 mg/L) and record onto the data sheet. Bring the volume of overlying water in each test chamber back to the appropriate level with overlying water.
4. If the D.O. levels fall below 2.5 mg/L, implement gentle aeration of each test replicate.
5. Isolation and Collection of Individual Test Organisms:
    a. Immediately prior to test initiation, transfer a small portion of test organisms and test water into a shallow glass dish or plastic freezer box placed on top of light box.
    b. Cut the tip off of the transfer pipette so as to not damage organisms when handling.
    c. Using plastic pipette, agitate the culture material. This disturbance will cause the larval *H. azteca* to swim up, facilitating their capture. However, if there is substrate present in the culture (e.g., leaves or Nitex screen), use a pair of tweezers to move the substrate to

the glass dish/freezer box and gently shake the organisms off. Repeat this step until enough organisms are isolated to initiate the entire test.

3.5 Initiate the Test (Day 0):

1. Identify how many total replicates are in the test and gather an equal number of transfer dishes (e.g., plastic weigh boat). Aliquot a small amount of control water into each transfer dish and begin carefully transferring ten 7-8 day old *H. azteca* into each dish (these counts must be confirmed by a second scientist). Periodically verify that the organisms are not escaping from the pan and desiccating; re-submerge or replace any escaping organisms. **NOTE** – do not leave organisms in the transfer dishes for an extended amount of time as this will stress the organisms. If loading a large number of sites, it is possible to load one or two replicates at a time.
2. Allocate ten 7-8 day old *H. azteca* into each replicate beaker by gently pouring the organisms from the transfer dishes into the test chambers; make sure that organisms are below the water surface in the test replicate chambers. Use a transfer pipette to rinse organisms from the dish into the test chamber, if necessary. Load all "A" replicate containers first, with the order of test treatments being randomized. Repeat process for the "B" replicates, with the order of test treatments being re-randomized. Continue until all test replicates are loaded. Place the weigh boat above the chamber to show that it has been loaded. Once every chamber is loaded carefully remove the weigh boat and double check that no organisms are stuck to the bottom.
3. Immediately re-examine the replicates, replacing any dead or injured animals. Due to surface tension, some organisms may be "trapped" on the water surface. Examine each replicate to ensure that all test organisms are below the water surface. Using a transfer pipette, organisms that are at the water surface should be moved into the water by gently squirting the organisms with test water.
4. Randomly place the replicate containers into the temperature-controlled water bath or room at 23°C, under cool-white fluorescent lighting on a 16L:8D photoperiod.
5. After the water is changed in the afternoon each replicate should get fed by adding 1.0 mL of the YCT and 0.25 mg Tetramin® Tropical Flakes (sieved through 300-µm screen).
6. At t=0, a minimum of 80 organisms should be dried as described below in Section 5.1 to assess growth (as per EPA guidelines).

4. TEST MAINTENANCE (DAYS 1-27)

1. AM Maintenance:
   a. Examine each replicate container. Any dead organisms observed on the water surface are to be removed via pipette, and the number of mortalities is recorded onto the test data sheet.

b. Measure the temperature in the test water from one randomly-selected replicate for each treatment and record data onto test datasheet.

c. Using a plastic 25 mL disposable pipette with 120 µm Nitex® screen over one end, collect "old" test water from 1-2 cm above the sediment from a replicate chamber being careful not to remove any *H. azteca* (multiple replicates may need to be sampled). Composite the replicate water samples for each treatment into a 50 mL plastic cup to provide a total volume of ~40 mL; the pipet must be inspected to ensure no organisms were removed during sampling.

d. Measure the "old" D.O. and record data onto the test data sheet. If the D.O. levels fall below 2.5 mg/L, implement gentle aeration of each test replicate. Measure pH in addition to D.O. three times per week (e.g., Tuesday, Thursday, and Saturday) and measure conductivity once per week.

e. Every 7 days, collect sub-samples for analysis of alkalinity, hardness, and ammonia analysis as described in Section 3.4, Step 3.

f. Renew the overlying water using the Zumwalt water delivery system to deliver at least one replicate water volume to each replicate container as described above in Section 3.4.1.

g. Return the test to the test area.

h. Collect "new" test water and measure water quality parameters as described in Section 4.1.c.

2. PM Maintenance:

a. Examine each replicate container. Any dead organisms observed on the water surface are to be removed via pipette, and the number of mortalities recorded onto the test data sheet.

b. Renew the overlying water using the Zumwalt water delivery system to deliver at least one replicate water volume to each replicate container as described above in Section 3.4.1.

c. Return the test replicates to the test area, and feed each replicate YCT+flake fish food. The YCT is fed at 1.0 mL/replicate/day for the entire test period. The Tetramin® food amount is increased each week to account for organism growth.

   i. Week 1: 0.25 mg/beaker-day Tetramin® fish flake suspension.

   ii. Week 2: 0.5 mg/beaker-day Tetramin® fish flake suspension.

   iii. Week 3: 1.0 mg/beaker-day Tetramin® fish flake suspension.

   iv. Week 4: 1.5 mg/beaker-day Tetramin® fish flake suspension.

d. Initial "PM" maintenance on data sheet.

3. Day 7: Retrieve peepers from three peeper replicates and collect samples for analytical chemistry analysis following the **UCR Phase 3 Peeper Deployment and Retrieval SOP**.
4. Day 21: Retrieve peepers from three peeper replicates and collect samples for analytical chemistry analysis following the **UCR Phase 3 Peeper Deployment and Retrieval SOP**.

5. DAY 28 TEST TERMINATION & INITIATION OF WATER-ONLY EXPOSURES

5.1 Day 28: Interim Assessment of Survival and Growth

NOTE: Survival and growth at 28 days will be assessed in **four** of the original 12 replicates, as follows.

1. Examine each replicate container. Any dead organisms should be removed via pipette, and the number of mortalities recorded onto the test data sheet.
2. Measure the temperature in the test water in one randomly-selected replicate for each treatment and record data onto test data sheet.
3. Collect sub-samples and measure water quality parameters per Sections 3.4.2 and 3.4.3.
4. Label plastic weigh boats with the corresponding treatment and replicate identification for each test chamber and fill with a small volume of clean test water.
5. Terminating growth replicates:
    a. Using a squirt bottle containing clean test water, vigorously squirt water onto the surface of the sediment so as to disturb the surficial layer – this will facilitate the collection of the *H. azteca*. Swirl and pour the slurry of water and sediment into a glass sorting dish atop a light box.
    b. Using a plastic transfer pipettes with the tip cut, remove the *H. azteca* (adult or young) from the dish and place them into the corresponding weigh boat. Sort through the slurry until all of the *H. azteca* have been removed.
    c. In order to monitor for early reproduction and quantify if it does occur (observation of neonates), pour the slurry of water and sediment from the glass sorting dish through stacked U.S. Standard #40 (425-µm opening), and U.S. Standard #60 (250-µm opening) sieves. The contents of the sieves will then be washed, transferred into the glass sorting dish atop a light box, and any observed surviving organisms (adult or young) will be recovered.
    d. If the turbidity of the transferred material is too high to effectively locate the amphipods, the contents will be rinsed again in the 250-µm sieve and re-examined.
    e. Repeat steps 5.a. – 5.d. If no young are recovered after two cycles, it is assumed that there are no young present. If no young are present and all 10 adult amphipods have been recovered, then recovery is considered complete and the remaining sediment can be discarded. If no young are present but all 10 adult amphipods have not yet been recovered, then all the remaining sediment is sieved through a U.S. Standard #40

sieve (425-µm opening) using a gentle stream of water. Material retained by the sieve is then rinsed into a glass sorting dish, and checked for additional amphipods. If young are recovered, repeat steps 5.a. – 5.d. until all sediment in the test replicate has been processed.

f. If no young are found during processing of the growth replicates, then it can be assumed no reproduction has occurred in that treatment and the reproduction replicates can be processed without monitoring for young. If young are recovered in the growth replicates, then it should be assumed that the reproduction replicates may contain young and should also be sieved so that young are recovered and counted.

g. Once all the *H. azteca* have been removed, dump the slurry into a waste bucket and rinse the sorting dish with test water.

6. Record the number of live amphipods in each replicate.
7. Using a squirt bottle, rinse the organisms with clean test water to remove any sediment or other clinging material. Using the transfer pipette, transfer the individual *H. azteca* into weigh boats containing methanol. Once euthanized, use forceps to transfer the organisms to Type I water to rinse the organisms.
8. Place a piece of Nitex screen on a paper towel. Using a pipette, transfer the organisms from the Type I rinse to the Nitex screen. This removes excess water from the organisms.
9. Lastly, use forceps to transfer the organisms to a pre-labeled, -dried, and -weighed aluminum foil drying pan corresponding to the appropriate treatment replicate. Make sure to fold down the edges of the weigh pan so the organisms do not "pop out" once dry. When fold the pan do not create any holes in the foil as organisms can be lost.
10. Repeat Sections 5.1.5- 5.1.10 for each test replicate.
11. Growth - When all of the replicates have been transferred into their respective drying pans, place the pans into the drying oven, and dry at 60˚C for 24 hrs. After 24 hrs, the pans should be removed from the oven and allowed to cool in a desiccator. Once cool, the pans should be weighed as per the **Weighing of Test Organisms SOP**.
12. Data analysis – Day 28 test endpoints include:

    a. Day 28 % survival, and

    b. Day 28 growth (as dry weight and biomass).

    The survival and weight data for each replicate, which are recorded on the appropriate data sheets, are entered into the most current CETIS™ statistical software data file labeled for identification of the specific test. Statistical analyses are performed in accordance with EPA guidelines.

5.2 Day 28: Initiation of Water-Only Exposures for Survival, Reproduction, and Growth

1. For each of the remaining **eight** replicates, prepare a new 'water only' replicate (300 mL glass beakers); labeled each replicate appropriately, and filled with ~270 mL control water.
2. Add 5 mL clean quartz sand and one 7x1 cm strip of 120 µm NITEX per replicate for thigmotactic substrate.
3. Process each test replicate as described above (Section 5.1, Steps 1-6). For each replicate, record the number of young recovered (if any), record adult survival, and transfer adults to new "water only" exposure chambers.
    a. If no young are found during processing of the growth replicates, then it can be assumed no reproduction has occurred in that treatment and the reproduction replicates can be processed without monitoring for young. If young are recovered in the growth replicates, then it should be assumed that the reproduction replicates may contain young and should also be sieved so that young are recovered and counted.
4. Return the "water only" replicates to the temperature-controlled room under the same test conditions used in the initial 28-days of testing.

6. TEST MAINTENANCE FOR WATER-ONLY EXPOSURE (DAY 28-42)

1. Perform test maintenance as described in Section 4.0, with the below adjustments to feeding rates:
    a. YCT+flake fish food. The YCT is fed at 1.0 mL/replicate/day for the entire test period. The Tetramin® food amount is increased each week to account for organism growth.
        i. Week 5: 2.0 mg/beaker-day Tetramin® fish flake suspension.
        ii. Week 6: 2.5 mg/beaker-day Tetramin® fish flake suspension.
2. On Day 35, reproduction of the amphipods is measured. Obtain the test chambers and a sorting tray filled with Control Water.
    a. Collect sub-samples for analysis of alkalinity, hardness, and ammonia. Measure routine water quality parameters (temperature, pH, D.O., and conductivity) per Section 3.4.2 and 3.4.3.
    b. Carefully pour the contents of the test chamber into the sorting tray. Fill up the test chamber with control water. If sand is being used as the thigmotactic substrate, add new rinsed sand to the test chamber at this time.
    c. Using a wide bore pipette, count and then return the adult *H. azteca* to the test chamber.
    d. Count the offspring in the sorting tray and then discard them. Be sure not to count debris as offspring. It is helpful to do this over a light box.

e. Return the test replicates to the test room, and continue to maintain the test for the remaining six days per Section 4.0.

7. TEST TERMINATION FOR WATER ONLY EXPOSURE (DAY 42)

1. On Day 42, collect ~25 mL of test water from each test replicate using a 25 mL disposable pipet. Composite the replicate water samples for each test treatment to provide a total volume of ~240 mL; the pipet must be inspected to ensure no organisms were removed during sampling.
2. From the composite, collect sub-samples for analysis of alkalinity, hardness, and ammonia, which are recorded in their respective logbooks. Then measure routine water quality parameters (temperature, pH, D.O., and conductivity) in the remaining composited water. Record the final water quality data onto the appropriate data sheet.
3. Remove and count adults and young in each replicate, and record on test data sheet. This is best accomplished by pouring the contents of the test chambers into a sorting tray on a light box.
4. Fill a weigh pan with methanol and euthanize the adult organisms.
5. Determine and record the number of adult males and females for each replicate. Mature male amphipods are distinguished by the presence of an enlarged second gnathopod.
6. From the number of young produced from Day 28 to 42 and the number of adult females at Day 42, calculate and record the number of young produced per female for each replicate.
7. Measure dry weight and biomass as described above in Section 5.1, Step 12.

8. DATA ANALYSIS

Test endpoints include:

- Day 28: % survival,
- Day 28: growth (biomass and dry weight),
- Day 35: % survival,
- Day 35: number of offspring,
- Day 42: % survival,
- Day 42: growth (biomass and dry weight),
- Day 42: number of males and females, and
- Day 42: reproduction (as number of young/female).

The survival, weight, and reproduction data for each replicate, which are recorded on the appropriate data sheets, are entered into the most current CETIS statistical software data file labeled for identification of the specific test. Statistical analyses are performed in accordance with EPA guidelines.

9. PROJECT SPECIFIC TEST ACCEPTABILITY REQUIREMENTS

As per the UCR Phase 3 QAPP, "It is recommended that the following test performance requirements[2] be met":

1. Mean % survival must be ≥ 80% in the Control treatment on Day 28; target performance-based criteria of ≥ 80% in the Control treatment on Day 42.
2. Performance goal of Control mean dry weight ≥ 0.35 mg/individual on Day 28 and ≥ 0.50 mg/individual on Day 42.
3. Performance goal for reproduction of ≥ 6.0 young/female from Day 28 to Day 42.
4. Test organisms must come from a single culture cohort, must be within 24 hours of age, and should be between 7 and 8 days old at the start of the test. Initial dry weights of the test organisms must be determined.
5. Hardness, alkalinity, and ammonia in the overlying water typically should not vary by more than 50% during the test, and dissolved oxygen should be maintained above 2.5 mg/L in the overlying water.

10. QUALITY CONTROL

1. Control water, consisting of consisting of SAM-5S reconstituted water per Borgmann (1996) modified to contain 0.4 mg Br/L, will be used as the overlying water in this test. Performance based criteria indicate that the water used in testing should have > 0.02 mg Br/L and > 15 mg Cl/L.
2. To ensure that the organisms being used in the test are responding to test conditions in a "typical" manner, a lab "Control" sediment of known quality is run side-by-side with the test sediment. The control sediment consists of a field collected freshwater sediment from Spring River, Missouri; other project specific controls sediments (such as rinsed quartz sand) may be included. Reference test set-up, maintenance, and termination are identical to those described above.
3. All equipment is calibrated and operated as described in each applicable equipment SOP.
4. All staff working independently on any test shall have previously demonstrated familiarity and competency with the test, analytical equipment used, and the corresponding SOPs.

[2] EPA (2000) guidance uses the term test acceptability requirements, which includes criteria that must be met for a test to be considered acceptable and other criteria that should be met as a goal for conducting a good test. For the purposes of providing clear language for the Phase 3 Sediment Study and as was used in the Phase 2 sediment study, the two types of requirements are distinguished as follows: test acceptability criteria that must be met are referred to as criteria and those that should be met are referred to as performance goals.

11. REFERENCE TOXICANT TESTING

To ensure that the organisms being used in the test are responding to chemical stress in a "typical" manner, a reference toxicant test may be performed side-by-side with the sediment test. The reference toxicant results are then compared with an in-house database to make this determination. Information regarding the reference toxicity test is presented in the ***Hyalella* Reference Toxicant Test SOP**.

12. TEST INTERFERENCES

Characteristics of a sediment, aside from sediment-associated chemical constituents of concern, that can potentially affect test organism survival and growth should be assessed prior to preparing data submittals to the client. Interferences for this test generally fall into the categories of contaminant and non-contaminant factors.

1. Contaminant Interferences
    a. All efforts should be made to avoid contaminating any component of the test system or sediments used in testing so as to avoid both false positives and false negatives. Standard "clean techniques" should be used in the lab at all times.
    b. Measurable concentrations of ammonia are common in the pore water of many sediments and have been found to be a common cause of toxicity in pore water. Total ammonia concentrations should be measured to determine if they exceed the reported tolerance limit for this test species.
2. Non-contaminant Interferences
    a. Natural geomorphological and physico-chemical characteristics, such as sediment texture, may influence the response of test organisms. A control sediment that includes characteristics (e.g., grain size, organic carbon) that are within the tolerance range of the test organism should be included in the study design. This may best be accomplished by using a formulated sediment.
    b. Morphologically similar indigenous organisms in a sediment sample may be confused with the test species during test termination, and result in overestimates in survival. In addition, indigenous organisms may also compete for food or prey on the test species. Should indigenous organisms be observed during test termination, the scientist should immediately notify the Project Manager, as it may be necessary to identify the indigenous organism, and determine the number or biomass in order to better interpret the growth data.
    c. During water changes, it is important to observe the water stream from the syringes as they clog easily. If clogged, the corresponding test replicate will not receive a sufficient water renewal, which could result in low D.O. levels. To un-clog the syringe, insert the end of a paperclip into the tip of the syringe.

13. SAFETY

There is little risk to those performing the 42-d *Hyalella* toxicity test. Staff should wear appropriate PPE. Sediments can contain pathogenic organisms and appropriate precautions should be observed when handling this material. After the test is complete, the sediments should be disposed of in an appropriate fashion.

14. REFERENCES

Borgmann U. 1996. Systematic analysis of aqueous ion requirements of *Hyalella azteca*: a standard artificial medium including the essential bromide ion. Arch Environ Contam Toxicol 30:356-363.

McCaig K. 2019. Personal communication (email from K. McCaig, TAI, to K. Cerise, EPA, summarizing outcome of bioassay webinars). Teck American Incorporated, Spokane, WA. May 9, 2019.

15. HISTORY OF CHANGE

Revision	Date	Description of Change
-	8/21/19	Original Document.

SUMMARY OF TEST CONDITIONS AND TEST ACCEPTABILITY CRITERIA FOR CONDUCTING THE 42-DAY *HYALELLA AZTECA* SURVIVAL GROWTH, AND REPRODUCTION SEDIMENT TOXICITY TEST		
1.	Test type	Whole-sediment toxicity test; 28 days of sediment exposure followed by 14 days of reproduction monitoring in clean water.
2.	Test duration	42 days + 7 day pre-test equilibrium period.
3.	Temperature	23 ± 1°C.
4.	Light quality	Wide-spectrum fluorescent lights.
5.	Light intensity	About 100 to 1000 lux.
6.	Photoperiod	16L:8D.
7.	Test chamber size	300-mL high-form lipless beaker.
8.	Test sediment volume	100 mL.
9.	Overlying water	SAM-5S Reconstituted Water (Borgmann 1996) modified to contain 0.4 mg Br/L. Performance based criteria: > 0.02 mg Br/L and > 15 mg Cl/L.
10.	Overlying water volume	175 mL for Days 0-28, 270 mL for Days 28-42.
11.	Overlying water quality	Hardness, alkalinity, and ammonia are measured at Day 0, 28, 35, and 42. Temperature and D.O. daily. pH three times per week. Conductivity weekly.
12.	Overlying water renewal	2 intermittent volume additions per day (i.e., one volume addition twice per day).
13.	Age of test organisms	7- to 8-d old at the start of the test.
14.	No. of organisms per test chamber	10.
15.	No. of rep. chambers/concentration	Minimum 12, but depends on the objective of the test; 8 replicates for 42-day endpoints, 4 replicates for 28-day endpoints; replicates for any additional water/sediment chemistries.
16.	Feeding regime	YCT+flake fish food. YCT: 1.0 mL/beaker-day. Flake fish food suspension: 1. Week 1: 0.25 mg/beaker-day. 2. Week 2: 0.5 mg/beaker-day. 3. Week 3:1.0 mg/beaker-day. 4. Week 4: 1.5 mg/beaker-day. 5. Week 5: 2.0 mg/beaker-day. 6. Week 6: 2.5 mg/beaker-day.

17.	Test chamber cleaning	If screens become clogged during the test, gently brush the *outside* of the screen.
18.	Test solution aeration	None, unless DO in overlying water drops below 2.5 mg/L.
19.	Endpoints	Survival (Day 28, 35, and 42), growth (as dry weight and biomass on Day 28 and 42), reproduction (number of young/female from Day 28-42), and number of adult males and females on Day 42.
20.	Sample and sample holding requirements	Grab or composite samples should be stored at 4°C in the dark.
21.	Sample volume required	5 Liter minimum, >5 L preferred.
22.	Project specific test acceptability requirements-	1. Mean 28-d control survival must be ≥ 80%. 2. Mean 28-d control weight performance-basedgoal ≥ 0.35 mg/individual. 3. Mean 42-d control survival performance-based goal ≥ 80%. 4. Mean 42-d control weight performance-based goal ≥ 0.50 mg/individual. 5. Mean 42-d control reproduction performance-based goal ≥ 6.0 young/female (Day 42). Test organisms must come from a single culture cohort, must be within 24 h of age, and should be between 7 and 8 d old at the start of the test. Initial dry weights of the test organisms must be determined.

General Activity Schedule for Conducting a Long-term Sediment Toxicity Test with the amphipod *Hyalella azteca* (adapted ASTM 2019 and USEPA 2000).	
Day	Activity
About -10	Inform organism supplier of the need to isolate <24-h old amphipods from mass culture, and to observe isolated amphipods daily to evaluate health.
-7	Sample sediments for physical and chemical characteristics and sample pore water for water quality analyses. Analytical program will follow approved UCR Phase III QAPP. Place peepers into six chemistry beakers with sediments. Place sediments into exposure beakers and add overlying water for about a 7-d equilibration period at 23°C. Start delivery of overlying water to the exposure beakers.
-2 to -1	5-6 or 6-7 day old amphipods are received from the test organism supplier and maintained prior to testing. Amphipods are fed and observed daily to evaluate health.
0	Measure total water quality of overlying water (pH, temperature, dissolved oxygen, hardness, alkalinity, conductivity, ammonia). Transfer ten test organisms into each test chamber. Release organisms under the surface of the water. Add appropriate food to each test chamber. Isolate 80 amphipods for T0 weight measurement.
1–27	Feed test organisms 1.0 mL/beaker-day of YCT and 0.25 mg/beaker-day. Perform AM and PM water changes (2 volume additions per day). Measure temperature and dissolved oxygen (DO) daily, pH three times a week, and conductivity weekly. Observe behavior of test organisms.
7	Sample peepers from three chemistry beakers that were loaded on Day -7. Analytical program will follow approved UCR Phase III QAPP.
7-13	Increase Tetramin® feeding to 0.5 mg/beaker-day.
14–20	Increase Tetramin® feeding to 1.0 mg/beaker-day.
21	Sample peepers from three chemistry beakers that were loaded on Day -7. Analytical program will follow approved UCR Phase III QAPP.
21–27	Increase Tetramin® feeding to 1.5 mg/beaker-day.
28	Measure temperature, dissolved oxygen, pH, hardness, alkalinity, conductivity, and ammonia. End the sediment-exposure portion of the test by collecting the test organisms with a #40 mesh sieve (425-µm mesh; U.S. standard size sieve). Count survivors in test replicates A-L. For test replicates A-D, weigh test organisms for biomass and mean dry weight test endpoints. Prepare eight amphipod replicate beakers for reproduction measurements: Place survivors from test replicates E-L in individual water-only beakers containing control water, 5 mL clean quartz sand, and one 7x1 cm strip of 120 µm NITEX per replicate for thigmotactic substrate. Add food to each test beaker.
28–34	Increase Tetramin® feeding to 2.0 mg/beaker-day. Measure temperature and dissolved oxygen (DO) daily, pH three times a week, and conductivity weekly. Perform AM and PM water changes (2 volume additions per day).
35	Record the number of surviving adults and remove offspring. Return adults to their original individual beakers and add food.
35–41	Increase Tetramin® feeding to 2.5 mg/beaker-day. Measure temperature and dissolved oxygen (DO) daily, pH three times a week, and conductivity weekly. Perform AM and PM water changes (2 volume additions per day).
42	Measure total water quality (pH, temperature, dissolved oxygen, hardness, alkalinity, conductivity, ammonia). Record the number of surviving adults and offspring. Surviving adult amphipods on Day 42 are observed for determination of the number of males and females in each replicate. This information is used to calculate the number of young produced per female per replicate from Day 28 to Day 42. Weigh adult test organisms for biomass and mean dry weight test endpoints.

Supplemental SOP Language

Definitions:

ACS:	American Chemical Society
ASAP :	As soon as possible
ASTM :	American Society for Testing Materials
°C :	degrees Celsius
dH_2O :	distilled water
D.O.:	dissolved oxygen
ECx:	Effective concentration in X% of the population.
hrs :	hours
ICx:	Inhibitory concentration in X% of the population.
LCx:	Lethal concentration in X% of the population.
LOEC:	Lowest Observed Effect Concentration
mg :	milligram
mg/L :	milligram per liter
mL :	milliliter
NOEC:	No Observed Effect Concentration
NPDES :	National Pollutant Discharge Elimination System
S.O.P.:	Standard Operation Procedure
TIE:	Toxicity Identification Evaluation
U.S. EPA :	United States Environmental Protection Agency

Interferences:

In an effort to eliminate interferences, SOPs have been established for every procedure involved in conducting a successful bioassay test. Additionally, a rigorous daily QA/QC inspection is designed to identify potential sources of interference. Prior to the initiation of toxicity tests every effort is made to identify and eliminate potential sources of interference that could compromise test results. These can include but are not limited to the following: clean and functional facilities, equipment and test chambers; sample storage and handling; test organism and food quality; laboratory water quality.

Pollution Prevention

As a pollution prevention measure, wastes generated during toxicity testing must be properly handled and disposed of in an appropriate manner. Care should be taken not to generate excessive wastes when preparing solutions for testing. All materials identified as hazardous should be labeled and appropriately stored for hazardous waste disposal.

Data Assessment

Bioassay and water quality data are assessed each day during the course of testing for accuracy and compliance with established criteria. At test termination, the data for each replicate, which

are recorded on the appropriate data sheets, are entered into a CETIS™ data file labeled for identification of the specific test. Statistical analyses are performed in accordance with EPA guidelines for statistical analysis. Control data for all endpoints are evaluated for compliance with established test acceptability criteria. Water Quality data are assessed for compliance with specifications outlined in the appropriate USEPA testing manuals.

Corrective Actions and Contingencies for Out-of-Control Data

If control performance is not met, a project manager should be notified immediately and, upon approval, the test is to be repeated. The potential cause(s) of poor control performance will be documented by scientific staff and evaluated and assessed by a project manager. Corrective actions will be determined on a case-by-case basis. The results of all tests will be summarized in reports for the regulatory authorities with an explanation of the results.

Upper Columbia River Phase III Project Specific Standard Operations Procedures for Peeper Preparation, Deployment, and Retrieval and Collection of Sediment Samples for Analysis of AVS/SEM

Effective date: August 21, 2019

Revised/Reviewed/Approved by:

Action	Name	Title	Signature	Date
Drafted by:	Alison Briden	Sr. Project Manager		
Reviewed by:	Krista Prosser	QA Manager		
Approved by:	Jeffrey Cotsifas	President		

Peeper Preparation, Deployment, and Retrieval and Collection of AVS/SEM Sediment Samples

UCR Project-Specific Standard Operating Procedures

The purpose of this standard operating procedure (SOP) is to describe procedures used to decontaminate/prepare, deploy, and retrieve peepers (i.e., diffusive sampling devices) for use in bioassay testing as per methods developed by the United States Geological Society (USGS) Columbia Environmental Research Center (CERC [Brumbaugh 2014]). It also describes the procedures for collection of sediment from bioassay chambers for which peepers were deployed for analysis of AVS/SEM.

1. INTRODUCTION

Peepers are used for in-situ sampling of sediment porewater for dissolved metals and other ions. The peeper volume is kept small relative to that of the surrounding sediment so as to minimize disturbance to the sediment/pore-water equilibrium and depletion of dissolved metals in the surrounding pore water. For laboratory sediment toxicity tests, "mini" peepers are prepared from a 2.9-mL (2.5 mL nominal), low-density polyethylene snap-cap vial (Fisher Sci cat. no. 03-338-1B) and a 0.45 µm pore-size, 25 mm diameter polyether-sulfone (PES) filter membrane (VWR Sci cat no 28147-617).

2. PEEPER PREPARATION

2.1 Equipment and Supplies Needed

1. Roper-Whitney hand punch model 5JR: for punching holes in vial caps.
2. 1 L wide-mouth HDPE or PTFE bottle with lid: for storing prepared peepers.
3. 4M HNO_3, 2M HCl solution: for decontaminating peeper vials.
4. De-oxygenated de-ionized (DODI) water: for preparing peepers.
5. Squirt bottle of DODI water: for rinsing probes and peepers.
6. Ultrapure water: for storing peepers.
7. 2.5 mL nominal volume, low-density polyethylene (LDPE) snap-cap vial (Fisher Sci cat. no. 03-338-1B or equivalent): vials for peepers.
8. 0.45 µm, 25 mm diameter polyether-sulfone (PES) filter membrane (VWR Sci cat no 28147-617): membrane for peepers.
9. Polyethylene (PE) tub, acid-cleaned: for preparing peepers in.
10. 10-cm nylon cable tie, pre-soaked in DI water: to attach to peepers to aid in retrieval.

11. Thermometer: NIST certified, for documenting water bath temperature.
12. Water bath capable of maintaining 50˚C: for peeper decontamination.
13. Top-loading balance, capable of weighing to 0.01 mg: for weighing peeper samples. Calibrate and use as per the appropriate SOP.
14. Reference weights: for calibration of balance.
15. Chelex-100™ resin: for preparation of "sink" peepers.
16. Nitrogen gas: for preparation of DODI water.
17. Dissolved Oxygen (D.O.) meter: needed to document dissolved oxygen, calibrated and used as per the appropriate SOPs.
18. Type I water and wash bottles: for rinsing of probes, etc.
19. Clean, disposable waterproof gloves: rinsed prior to use with peepers.
20. High purity 1.1% (v/v) HNO_3: for collecting peeper porewater samples.
21. Plastic (hemostat type) forceps: for deploying and retrieving peepers.
22. LDPE mini-pipette: for transferring peeper porewater samples into sample containers.
23. Sample containers consisting of acid-cleaned 15-mL centrifuge tube and cap provided by analytical lab: for peeper porewater samples.
24. Pre-cleaned sample containers consisting of wide mouth jars and lids provided by analytical lab: for AVS/SEM samples.
25. Test tube rack.
26. Kimwipes™.

2.2 Peeper Construction and Cleaning

Prepare six mini peepers for each test treatment; three peeper replicates are established for each monitoring interval (i.e., $T_{Day\ 7}$, $T_{Day\ 21}$), for each treatment. Prepare additional peepers for use as method blanks to be analyzed at the frequency outlined in the UCR Phase III QAPP. Peepers are constructed and cleaned as follows:

1. Use a hole-punch tool to punch out a single 6-mm diameter hole in the center of each vial cap for the mini peeper.
2. A suitable number of hole-punched caps and vials are cleaned by soaking overnight in an acid-cleaned plastic bottle containing 4M HNO_3, 2M HCl; shake 2-3 times to wet all vial surfaces. Place the bottle of acid-soaked vials in a water bath at approximately 50˚C. Do not heat much above 50˚C as this could cause the vials to become distorted and affect proper sealing of the membrane.

3. Vials are then triply rinsed with DI water then stored in ultra-pure water until further preparation.
4. Prepared de-oxygenated, de-ionized water (DODI water) using nitrogen and monitor with a D.O. probe to confirm that water has been adequately de-oxygenated.
5. To prepare the peepers, a small acid-cleaned plastic tub is half-filled with freshly prepared DODI water and up to 20 cleaned and punched vials (caps in the open position) are submerged in it (use a fresh batch of DODI water for each 20 vials).
6. The DODI water in the tub is continuously bubbled with nitrogen while peepers are being processed. All peeper manipulations are performed while wearing suitably clean waterproof gloves that have been rinsed with high purity water, and gloves are re-rinsed whenever any potentially unclean surface have been contacted.
7. To facilitate successful sealing of the peeper membrane without causing it to rupture, each vial is first “primed” while submerged in the DODI water by pressing the cap down tightly (without a membrane) into the vial body, thus causing the vial opening to expand slightly.
8. To seal the membrane on the peeper, a submerged vial is grasped with the cap open and removed from the tub of DODI water such that a convex meniscus of DODI water forms above the chamber.
9. Making sure there are no air bubbles inside, a PES filter membrane is placed over it and the perforated cap is slowly pushed down to seal the membrane. With a little practice, greater than 75% success rate of sealing the membrane without rupture is attainable. Once seated, the membrane is inspected for rupture and the peeper is inverted momentarily above the water to check for leaks. A correctly filled and sealed peeper will have no air bubbles inside.
10. After membranes have been seated in all peepers, the excess membrane material on the outside of each is torn away and discarded, but a small portion opposite the hinge is left intact to facilitate grasping the membrane and cap when opening after retrieval.
11. Next, a small nylon cable tie (e.g., 10-cm long for the mini-peeper) is strapped snugly around the mid-portion of the vial body, but not so tight as to distort the vial body. After attaching the cable tie on the peeper, rotate it so that the locking "tab" is aligned with the hinge tab on the cap. This will aid in gauging the relative depth when inserting into the sediment and it facilitates the retrieval.
12. The finished batch of peepers are rinsed with ultra-pure water then transferred to a wide-mouth, 1-L (small peepers) acid-cleaned HDPE container containing DODI water.
13. Finally, one peeper per each batch (per containment bottle) is prepared to act as a trace metal “sink”. For that, an empty peeper vial is filled with 0.5-1.0 g of a metal-chelating resin (e.g., Chelex-100™) before sealing the membrane. The resin is washed briefly in a PTFE beaker with a few volumes of ultra-pure water and then added to the peeper by pouring from the beaker as a slurry. The sink peeper is prepared without a nylon cable tie strap, which allows

for easy visual identification, and if it is filled completely with resin and without any air bubbles, it will sink to the bottom of the storage container. Note: Make sure that the peepers do not come in direct contact with the resin.

14. After the 20 vials are prepared and the sink peeper is added, the storage bottle is topped off with DODI water, then capped tightly and placed in a refrigerator. Peepers can be stored in this manner for several weeks before use, but the surrounding water should be replaced with fresh DODI water at least 48 hours in advance if they are to be stored for more than 48 hours before use. Note: This is a somewhat arbitrary guideline for minimizing DO inside the peeper.

3. PEEPER DEPLOYMENT

1. Deployment of peepers for laboratory studies is performed at the same time sediments are loaded in beakers. However, with this approach it may be difficult to avoid entrapment of air in the cap of the peeper.
2. Carefully remove the peeper from the storage/de-oxygenation solution by means of plastic forceps. Record the D.O. of the storage solution.
3. When removing the peeper from the DODI water and transferring into the test chamber, it is important to orient the cap end upward so as to avoid causing an air bubble to become trapped between the outer rim of the cap and the membrane. Before deploying, ensure there are no air bubbles.
4. Depending on sediment density and grain size, one of two techniques is used. For most fine-grain sediments the peeper can be pressed into the sediment while grasping the cable tie with a gloved hand or plastic (hemostat type) forceps. The bottom (closed end) of the peeper is situated next to the wall of the container and the membrane/cap end near the center so as to maximize the sediment volume “seen” by the membrane face. The peeper should be buried so that the top edge is between 0.5 and 1 cm below the surface of the sediment.
5. If necessary, a small cavity can be created with one or two spatulas. The peeper is then gently “back-filled” with a small amount of surficial sediment. This is done most easily if one spatula is first inserted perpendicular to, and touching the wall of the beaker. The second spatula inserted parallel to the first one, then moved slightly to create a small trench while the peeper is being inserted.
6. If difficulty is encountered with that approach, (e.g., for sandy or coarse granular sediments), a somewhat larger cavity is first dug into the sediment next to the wall of the beaker. The two spatulas are inserted parallel and alongside the wall of the beaker, and then moved and rotated together to 45-degree angles, thereby creating a cavity alongside the beaker wall and a small mound of sediment grains towards the middle of the beaker. The peeper is inserted into the cavity, the spatulas are removed and the peeper is backfilled as necessary to completely bury it.

7. Blanks/Controls: Prepare three peepers to serve as a blank. Blanks will be prepared at the frequency outlined in the UCR Phase III QAPP. After deployment of peepers in sediments, replace the DODI water surrounding the remaining blank peepers with fresh ultra-pure water and store the bottle(s) containing the blanks and the control peepers in a refrigerator until processed with sediment bioassay test replicate peeper samples at the $T_{Day\ 7}$ and $T_{Day\ 21}$ retrieval intervals.

4. PEEPER RETRIEVAL

1. To retrieve the peepers, collect the three peeper replicates labeled with the same sample ID and corresponding monitoring interval (i.e., $T_{Day\ 7}$, $T_{Day\ 21}$). The peepers will be retrieved one at a time and the peeper porewaters from each will be combined into a single sample container.
2. Before retrieving the peepers, place the test tub rack on the top-loading balance and tare the balance. Place the corresponding pre-labeled sample container in the rack and record the weight of the sample container.
3. The first peeper is pulled from the sediment by grasping the tag end of the cable tie with the plastic forceps (or by hand, gloved and DI-water rinsed). The peeper is then carefully agitated in the overlying test water to remove loosely adhering sediment particles.
4. It is then rinsed with a stream of ultra-pure water, first to the peeper body, then directed tangentially to the lid and membrane until all visible particles are displaced.
5. When getting ready to transfer the peeper contents, the cable tie is removed before blotting the peeper dry with a lab wipe. The cable tie is removed by pushing the bottom of the vial body up through the loop of the cable tie, then grasp the peeper with a small Kimwipe™ to dry the vial body.
6. Then use a second small Kimwipe™ to blot dry the cap area, including the cavity above the membrane. This will ensure that any liquid in the cavity outside the membrane does not end up spattering into the opened peeper when opening it.
7. The membrane/cap assembly is carefully opened with a DI-water rinsed, gloved hand by grasping the protruding edge of membrane in conjunction with the edge of the cap. It must be opened carefully to prevent the membrane from falling into the liquid inside the vial and to avoid contamination by any remaining particles that may have adhered around the cap area. While opening the cap, bend it backward on the hinge as far as possible so as to keep it away from the vial opening after you release your grip on the cap.
8. With the hand not holding the peeper, a mini-pipette is rinsed by drawing a small volume of high-purity 1% nitric acid, inverting to rinse the “bulb”, and then expelling the liquid to waste. The same sequence is then repeated with ultra-pure water. The acid rinse and water rinse liquids are discarded and replenished with fresh liquid after every 8-10 peeper transfers.

9. The liquid inside the peeper is then transferred to the acid-rinsed sample container provided by the analytical lab using the cleaned, disposable, LDPE mini-pipette.
10. Repeat Steps 3 through 9 for the remaining two peepers.
11. Record the weight of the sample container plus the peeper porewater from all three peepers in grams. Also record the approximate peeper porewater volume in milliliters.
12. Add 2.5 mL of high purity 1.1% (v/v) HNO_3 to each of the three empty peeper vials using a repeater pipet. Transfer the acid from the peeper to the sample bottle using the LDPE mini-pipette for a total of 7.5 mL of 1.1% nitric acid for all three peepers. Record the weight of the sample container plus the peeper porewater plus 1% nitric acid in grams.

5. COLLECTION OF SEDIMENT FOR AVS/SEM

At the time of peeper retrieval at $T_{Day\ 21}$, samples of the remaining sediment from the three peeper replicates is composited into a single sample container for AVS and SEM analyses.

1. After the peeper is retrieved, pour off any remaining overlying water.
2. Using an acid-cleaned plastic spoon, collect the sediment from each peeper replicate and place in a pre-cleaned wide-mouth glass sample jar provided by the analytical laboratory. Place the sample jar at an angle while collecting the sediment.
3. Immediately pass nitrogen gas over the sediment in the jar while the sediment from the remaining treatment replicates is being collected.
4. Ensure the jar is no more than 80% full to reduce the likelihood that the jar will crack when frozen.
5. Once the sediment from all three peeper replicates is collected and placed into the sample jar, carefully cap the jar under a flow of nitrogen so ensure sample is capped with nitrogen headspace.
6. Do not tap the jar. If the sediment is compacted the jar will be more likely to break when frozen.
7. Place sample jars in a cardboard box and place the box at an angle in the freezer.
8. If any of the samples crack during freezing, double-bag the cracked jar under nitrogen and then place inside another larger jar with nitrogen headspace prior to shipment to the analytical lab.

6. REFERENCES

Brumbaugh, W. 2014. USGS CERC peeper method for in-situ sampling of sediment pore water. Prepared by United States Geological Society Columbia Environmental Research Center. Columbia, Missouri.

7. HISTORY OF CHANGE

Revision	Date	Description of Change
-	8/21/19	Original document.

PACIFIC ECORISK

Upper Columbia River Phase 3 Project Specific Standard Operating Procedure for Sediment Porewater Extraction via Centrifugation

Effective Date: August 21, 2019

Revised/Reviewed/Approved by:

Action	Name	Title	Signature	Date
Revised by:	Michael McElroy	Sr. Project Manager		
Reviewed by:	Krista Prosser	QA Manager		
Approved by:	Stephen L. Clark	Vice President		

ACCREDITED IN ACCORDANCE WITH nelac

Sediment Porewater Extraction via Centrifugation

UCR Project-Specific Standard Operating Procedures

1.0 INTRODUCTION

This standard operating procedure provides instructions for the extraction of porewater samples via centrifugation. Sediment porewater (or interstitial water), consists of the water occupying the spaces between sediment particles. A centrifuge can be used to separate the sediment (precipitate) and pore water (supernatant liquid) of a sediment mixture using centrifugal force. Sufficient sediment porewater will be obtained from each site and reference sediment sample to support the porewater analytical chemistry program outlined in the Upper Columbia River (UCR) Phase 3 Quality Assurance Project Plan (QAPP).

2.0 PREPARATION

2.1 Equipment and Supplies Needed

1. Thermo Forma General Purpose Centrifuge.
2. Minimum of 2 x 750 mL Centrifuge Bottles (Max of 4).
3. Homogenized Sediment Sample.
4. Mettler Toledo MS4002S Balance.
5. Paper Towels.
6. Large Water Quality Cup or Beaker.
7. Stainless Steel Spoons/Spatulas.
8. Pre-cleaned and preserved (as necessary) sample bottles provided by the analytical laboratory.

3.0 PROCEDURE

3.1 Loading Sediment into Centrifuge Bottles

1. Ensure the sediment being centrifuged has been properly homogenized following the **UCR Phase 3 QAPP Sediment Homogenization SOP**. If the sample is being stored prior to centrifugation, interstitial water may accumulate on the surface. This overlying water must be mixed back into the sediment sample prior to collecting a sediment subsample for centrifugation.
2. Ensure that the balance calibration has been performed prior to use. If the calibration has not been performed, calibrate the balance according to the **"Mettler Toledo MS4002S/03 Top Loading Balance SOP"**.

3. Turn on the balance and make sure it is level. Tare the balance.
4. Put a piece of labeling tape on each of the centrifuge bottles and label that tape corresponding to the sample that is in that bottle.
5. Place the centrifuge bottle with the cap, onto the balance. Fill the bottle to about ¾ using a spoon. Record the weight of the container on the label.
6. Once the weight of the first sediment sample has been determined, all other samples must be within 1 g of that weight or the centrifuge will not function properly.
7. Clean the bottles of any debris before putting in the centrifuge.

3.2 Centrifuging Samples

1. Before turning on the centrifuge, clear the centrifuge area of any debris and loose paper. Allow 6 inches of clearance near the rear ventilation grill.
2. Press the On/Off switch on the lower right-hand corner of the front panel.
3. Press the OPEN key to open the centrifuge lid. A yellow light will turn on as long as the lid is open and it will turn off once the lid is closed.
4. Place either 2 or 4 of the centrifuge bottles in the rotor assembly making sure the bottles that are within 1 g of each other are in opposing positions.
5. Adjust the run parameters using the touch switches on the front panel. Adjust the parameters to the following settings. Press the arrow keys to change each parameter:

Run Parameters	Settings
Temperature	4 ºC
g-force	TBD g[1]
Speed	Based on centrifuge and rotor[2]
Time	TBD
Accelerate	Maximum
Brake	Maximum
Rotor	218

TBD: to be determined

6. Close the cover by lowering the centrifuge lid so that the cover rests on the chamber gasket. Place hands on both sides of the cover and press down firmly.
    a. Always assure the lid is locked and secure before starting. The machine will make a loud

[1] The centrifugal force that will be used for the Phase 3 Sediment Study will be established after completion of the porewater extraction method study (initiated July 30, 2019) and discussions between TAI and EPA.
[2] Pacific EcoRisk is purchasing a new centrifuge and will establish the setting specific to the new centrifuge to obtain the desired g-force prior to initiating the Phase 3 Sediment Study.

"clicking" sound when it locks or unlocks.

7. Press START.
8. Do not walk way immediately after pressing start as an imbalance could occur. When an imbalance occurs, a sensor shuts the unit down and triggers a warning message (BAL) on the screen.
9. Once the centrifuge has completed its run and come to a complete stop, open the centrifuge lid and recover the centrifuge bottles. A separated layer of supernatant (the pore water) and precipitate should be visible.
10. Carefully decant and composite the supernatant from each centrifuge bottle into a beaker. If sufficient supernatant was not produced during the centrifugation process, repeat the preceding steps until adequate porewater volume is collected for requisite analyses.
11. Pour the composited porewater into pre-cleaned sample bottles provided by the analytical chemistry lab, fill out the provided Chain of Custody (COC), and prepare for shipment to the analytical laboratory.

4.0 INTERFERENCES

When centrifuging coarse sand, recovery of pore water may be more difficult. In this case, a greater volume of sediment may be required to retrieve the desirable amount of pore water.

5.0 SAFETY

1. Use caution when closing the centrifuge lid, making sure not to close it on your fingers.
2. Centrifuge operation poses little to no risk to the operator.

6.0 HISTORY OF CHANGE

Revision	Date	Description of Change
-	8/21/19	Original document.

STANDARD OPERATING PROCEDURE SOP 17

HOMOGENIZING AND PREPARING SEDIMENT SAMPLES FOR BIOASSAYS OR ANALYSES

Scope and Applicability

This standard operating procedure (SOP) describes the general procedures for processing sediment samples stored in bulk containers (e.g., 2-gal or 5-gal buckets) for bioassays or other analyses for the Phase 3 sediment study. Sediment samples for potential bioassays (including toxicity identification evaluations [TIEs]) will be collected in accordance with the Final Quality Assurance Project Plan (QAPP) for the Phase 3 sediment study and shipped to ALS Environmental (ALS) in Kelso, WA for refrigerated storage. Sediment samples identified for future bioassay testing will be shipped under chain of custody from ALS to the appropriate laboratory. This SOP applies to processing of sediment from buckets for any purpose, including preparing aliquots for bioassay testing or other analysis and preparing split samples.

Equipment and Materials

Specific equipment and materials required to prepare sediment aliquots or split samples at the laboratory include the following:

- One Lexan tub
- One electric drill (preferably 18 volts)
- One stainless steel mixer paddle
- Two plastic scoop (s)
- Labeled Sample Containers (assumed to be provided by the laboratory)
- Rubber hammer to close bucket lids
- Six 5-gallon buckets to collect decontamination rinse water
- Two Spray bottles, one containing deionized ((DI) water and one containing detergent (Liquinox or similar) solution
- Scrub brush
- Health and safety equipment (safety glasses, nitrile gloves, and coveralls or apron)

Procedures

The steps listed below should be followed to collect sediment aliquots or split samples at the laboratory:

1. Identify and locate sediment samples to be homogenized.
2. Don appropriate health and safety equipment
3. Identify a suitable decontamination area and containers used to collect the rinse waters.
4. Decontaminate the following in accordance with SOP-14 of the QAPP.
    a. Lexan tub
    b. Two plastic scoops
    c. One stainless steel homogenizer paddle
5. Each sample will be processed individually. Only one bucket should be open at a time.
6. Identify a sample to be processed and take the bucket to the processing area.
7. Remove bucket lid.
8. If sediment is primarily sand-sized particles the contents of the bucket may be emptied into a decontaminated Lexan tub for homogenization (**Proceed to step 10**). If sediment is primarily fine-grained particles and the bucket is approximately three quarters full, the material may be homogenized in the sample bucket (**Proceed to step 9**). If the bucket is more than three quarters full, the sediment may be emptied into a decontaminated Lexan tub for homogenization (**Proceed to Step 10**).
9. For material mixed in the sample bucket the following should occur:
    a. Insert homogenizer paddle attached to drill into bucket.
    b. Turn drill on and move paddle throughout the sample until the sample is thoroughly mixed.
    c. Using a decontaminated plastic scoop, remove sediment from the bucket and place into sample container(s). Label the sample containers if necessary, or verify the sample label information is accurate and complete.
    d. Replace the lid on the bucket and return the bucket and remaining sediment to storage.
    e. Decontaminate the mixing paddle and scoops in accordance with SOP-14 and proceed to the next sample (**Step 6**) until all samples have been processed.
10. For material mixed in the decontaminated Lexan tub the following should occur:
    a. Place sediment into the decontaminated Lexan tub.
    b. Use scoops to homogenize the material if the material is primarily sand sized particles. Use the decontaminated mixing paddle to homogenize the material if the sediment is primarily fine grained particles.

c. Mix the sample until it is thoroughly mixed
d. Using a decontaminated plastic scoop, remove sediment from the bucket and place into sample container(s). Label the sample containers if necessary, or verify the sample label information is accurate and complete.
e. Return the homogenized sediment to the bucket it originally came from.
f. Replace the lid on the bucket and return the bucket and sediment to storage.
g. Decontaminate the mixing paddle, Lexan tub and scoops in accordance with SOP-14 if used to mix the sample. Proceed to the next sample (**Step 6**) until all samples have been processed.

11. After all samples have been mixed and the necessary sample containers filled, ensure that the equipment used to homogenize the sample (tub, scoop and mixing paddle) has been decontaminated in accordance with SOP-14 of the QAPP. Using laboratory supplied DI water, perform a final rinse of the equipment. After the final rinse is complete, collect equipment rinsate (ER) blank samples for total metals analysis. ER blank samples are collected at a frequency of once per day during sample homogenization activities. Collect three ER samples, one for each type of equipment (tub, scoop and mixing paddle). Pour additional DI water over the equipment and collect it in laboratory-provided samples bottles listed in the QAPP. Two bottles will be filled for each ER sample and submitted for metals analysis by ALS in accordance with the QAPP. The ER samples will have the following Sample IDs, where Location ID (see Phase 3 sediment study QAPP Table B1-1) corresponds to the aliquot or split sample collected following the last decontamination of the sample processing equipment:
    a. Lexan Tub ER samples: ER-Location ID-LAB-1-Date
    b. Homogenizing paddle ER samples: ER-Location ID-LAB-2-Date
    c. Scoop ER samples: ER-Location ID-LAB-3-Date
12. Clean up area and ensure sample containers and buckets are stored properly.
13. Sign over custody of the sediment samples to the receiving laboratory or authorized representative.

APPENDIX D

QUALITY ASSURANCE INFORMATION FOR ECOANALYSTS

QUALITY MANAGEMENT PLAN

Prepared by

1420 South Blaine Street, Suite 14
Moscow, ID 83843

July 2016

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TITLE AND APPROVAL PAGE

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Quality Management Plan

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ACRONYMS

ANSI/ASQC	American National Standards Institute/American Society of Quality Control
ASTM	American Society for Testing and Materials
CAD	Computer-Aided Design
CAR	Corrective Action Report
CEO	Chief Executive Officer
DP	Designated Project
DQO	Data Quality Objective
EcoAnalysts	EcoAnalysts Consultants, Inc.
GIS	Geographic Information System
HAZWOPER	Hazardous Waste Operations and Emergency Response
IT	Information Technology
OSHA	Occupational Safety & Health Administration
PIC	Principal-In-Charge
PM	Project Manager
PQO	Project Quality Objectives
QA	Quality Assurance
QAM	Quality Assurance Manager
QAP	Quality Assurance Plan
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
QC	Quality Control
QMP	Quality Management Plan
QS	Quality System
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey

SECTION 1

INTRODUCTION

1.1 Purpose of the Plan

This QMP is a quality management tool that documents EcoAnalysts, Inc. (EcoAnalysts) guidance for planning, documenting, and assessing the effectiveness of activities supporting environmental data operations and environmental programs.. This QMP is an "umbrella" quality assurance (QA) document that describes the processes and procedures that management and staff follow in the collection and reporting of environmental data. It is patterned after a national consensus standard, American National Standards Institute/American Society of Quality Control (ANSI/ASQC) E4-1994 standard, and USEPA guidance documents developed to assist agency contractors in developing their own agency-specific QMPs (http://www.epa.gov/quality/qa_docs.html). EcoAnalysts has prepared this QMP in accordance with USEPA Requirements for Quality Management Plans (QA/R-2), guidance document USEPA/240/B-01/002.

1.2 Source Documents

The following source documents have been used to assist in the preparation of this QMP:

- ANSI/ASQC E4-1994, Specifications and Guidelines for Quality Systems for Environmental Data Collection and Technology Programs, American National Standards Institute, January 1995. http://e-standards.asq.org/perl/catalog.cgi.
- USEPA Requirements for Quality Management Plans (QA/R-2), (USEPA/240/B-01/002), March 2001.
- USEPA Requirements for Quality Assurance Project Plans (QA/R-5), (USEPA/240/B-01/003), March 2001.
- Instructions on the Preparation of a Superfund Division Quality Assurance Project Plan, based on USEPA QA/R-5, June 2000.
- Guidance for the Data Quality Objectives Process (QA/G-4), (USEPA/240/B-06/001), February 2006.
- Guidance for Preparation of Standard Operating Procedures for Quality-Related Operations (QA/G-6), (USEPA/240/B-01/004), March 2001.

- Uniform Federal Policy for Quality Assurance Project Plans (UFP-QAPP), OSWER Directive 9272.01-17.

1.3 Scope of Covered Activities

The QS elements described in this QMP apply to EcoAnalysts environmental involving data collection, reporting, modeling, and design activities.

1.4 Revisions to the Plan

This QMP will be reviewed and updated on an annual basis by the EcoAnalysts Quality Assurance Manager (QAM). The annual review process is designed to ensure that quality management practices are consistent with changing project needs and regulatory requirements. Recommended changes to the QMP are reviewed and approved by the Chief Executive Officer (CEO) and a representative of EcoAnalysts' Risk Management Committee. If there are significant changes that make the QMP no longer applicable, a revised QMP is prepared before the annual revision date.

SECTION 2

MANAGEMENT AND ORGANIZATION

2.1 EcoAnalysts' Mission Statement

The mission of EcoAnalysts is to help our clients make highly informed decisions regarding the condition and stewardship of our natural resources.

2.2 EcoAnalysts' Quality Policy

EcoAnalysts has implemented a QS that utilizes a graded approach to QA. The levels of managerial controls and resource allocation for QA purposes are based on the intended use of the data that are collected and the degree of certainty needed in the data. Under this plan, EcoAnalysts is committed to ensuring that quality management principles and practices are utilized for activities involving the production of environmental data and the use of historical data. The intent of EcoAnalysts' QS is to develop a systematic approach to QA to ensure the collection of data that are scientifically sound, legally defensible, and of known and documented quality.

The CEO ensures that adequate resources, including both budgeted funds and personnel, are allocated to achieve EcoAnalysts' quality policy.

2.3 Assignment of Responsibility

EcoAnalysts has a tiered management system in place to assure that managers and staff maintain work quality and follow EcoAnalysts' Quality Policy. In addition, QS documents and Standard Operating Procedures (SOPs) are established to maintain quality. Periodic reviews and QS assessments are performed to verify that quality is being maintained. In the tiered management system, each member has certain roles and responsibilities. Individuals are identified on a project-specific basis. The following describes the roles and responsibilities of the personnel identified in Figure 1.

2.3.1 Chief Executive Officer

The CEO is responsible for overall implementation of the QMP, including:

- Identifying the appropriate Principal-In-Charge (PIC) for each project;
- complying with overall requirements of the QMP;
- reviewing and approving revisions to the QMP;

- ensuring that QS training is provided to staff; and
- conducting a management review to assess the effectiveness of the QS.

2.3.2 Principal-In-Charge

The PIC is responsible for project-specific implementation of and compliance with the QMP, including:

- Complying with project-specific requirements of the QMP;
- identifying activities and resources to accomplish project quality objectives (PQOs);
- resolving unresolved disputes regarding the QS;
- maintaining data quality; and
- maintaining technical accuracy of documents and records.

The PIC has overall supervisory responsibility for the project, including meeting scope, schedule, and budget. Day-to-day activities are delegated to the Project Manager (PM).

2.3.3 Quality Assurance Manager

The QAM is responsible for and has the authority to implement the QS in accordance with this QMP, including:

- Developing and revising the QMP;
- providing assistance to EcoAnalysts personnel on QS procedures applicable to the implementation of the QMP for specific projects;
- reviewing and approving QS planning documents, including Quality Assurance Project Plans (QAPPs), Sampling and Analysis Plans (SAPs), and SOPs;
- identifying QS training needs;
- conducting QS assessments, identifying deficiencies, documenting findings, evaluating proposed corrective actions, and verifying the effectiveness of the corrective actions; and
- conducting annual QS reviews with EcoAnalysts management to present the status of QS documents and procedures, to review the results of assessments and corrective

actions, to assess the strengths and weaknesses in the QS elements, and to identify opportunities for improvement.

The QAM has an independent role on the project team and is not directly involved in generating, compiling, or evaluating environmental data. For projects where the QAM has this project role, another QAM or designee conducts QA tasks. The QAM routinely has access to corporate and regional management through telephone and electronic mail correspondence to conduct QS activities.

2.3.4 Project Manager

With regard to this QMP, the PM is responsible for:

- Identifying project-specific quality goals;
- identifying resource needs to achieve project-specific quality goals;
- informing project personnel of the QMP and its requirements;
- developing project-specific sampling, analytical, and data handling practices in SOPs that are functional and accurate, and that are reviewed and approved by the QAM throughout the project for continued adequacy;
- managing application of EcoAnalysts' QS procedures on the specific project;
- arranging for project-specific staff review of project data quality objectives (DQOs), SAPs, and QAPPs, and other QS documents;
- ensuring that the project-specific QS documents are implemented, that project assessments are performed as necessary, and that adequate review or validation steps have been employed to determine that only data of adequate quality are used in environmental decision-making; and
- identifying and implementing QS corrective actions.

2.3.5 Environmental Data Collection and Analysis Staff

Environmental data collection and analysis staff are responsible for:

- Conducting work under approved project-specific QS documents;
- adhering to project-specific sampling practices and procedures as prescribed in project-specific QS documents;

- adhering to good laboratory practices and methodologies as prescribed in project-specific QS documents;
- documenting deviations from established methodologies, SOPs, and other quality protocols, and reporting the deviations to their supervisor;
- identifying possible project-specific data quality problems and potential areas for quality improvements, and reporting these to their supervisor; and
- identifying to the PM opportunities for SOP improvement and operations that are in need of SOPs.

2.4 Technical Activities and Programs Supported by the QMP

This QMP applies to specific designated projects (DPs). DPs may include, but not be limited to, projects that involve:

- Subsurface investigation;
- collection of environmental data in the field;
- collection of samples for laboratory analysis;
- laboratory sample analysis;
- design and implementation of treatability studies;
- design of remediation systems;
- installation and operation of remediation systems; and
- preparation of project-specific reports.

The appropriate elements of the QMP are applied to the DP's subcontracted service providers.

The QAM ensures that the applicable QS elements and associated criteria are communicated to the project team at the project initiation meeting. This meeting includes the participation of the PIC, the QAM, the PM, and other project personnel. The QAM leads the discussion regarding the specific elements of the QS that apply to ensure that these elements are understood and implemented.

2.5 Dispute Resolution

Disputes that arise regarding the application of QS procedures to a specific project should be resolved by the QAM. Should the dispute remain unresolved, the PIC resolves the dispute.

SECTION 3

QUALITY SYSTEM COMPONENTS

The EcoAnalysts QS provides the framework for planning, implementing, documenting and assessing activities relevant to environmental data operations and environmental technology activities and for carrying out required quality assurance/quality control (QA/QC) activities for the organization. The EcoAnalysts QS is comprised of a number of functional components including the following:

- Documentation of project activities;
- annual reviews and planning;
- management assessments and reviews;
- training;
- systematic planning of projects;
- project-specific quality documentation; and
- project and data assessments.

3.1 Quality Management Plan

The EcoAnalysts QMP is the "umbrella" document that describes the QS and its various components. The QAM is responsible for preparation, review, and revision of the QMP. EcoAnalysts senior management and PMs have the responsibility for implementation of the QMP and its various elements. The QMP and other documents pertaining to projects are stored on a server. EcoAnalysts uses an intranet system to maintain documents pertaining to management operations and EcoAnalysts procedures.

3.2 Quality Assurance Project Plans

QAPPs are formal documents that describe in comprehensive detail the required quality control (QC), QA, and related technical activates that are carried out for a specific project so that project deliverables are met and that the data results from the project are of sufficient quality to reliably meet the project objectives. Project-specific QAPPs are prepared in accordance with the USEPA guidance documents identified in Section 1. The PM is responsible for development of the QAPP, with review and approval by the QAM.

3.3 Standard Operating Procedures

SOPs are written documents that describe the detailed procedures for a method of operations, activity, or analysis so procedures can be consistently reproduced. SOPs are generally developed for activities that are conducted on a repetitive basis, often by multiple staff members performing the same task (see Section 9.1). Areas appropriate for the development of SOPs include routine data collection activities, monitoring, and field measurement activities. SOPs are included as a part of or are referenced in the project-specific QAPP. SOPs can be developed internally for specialized tasks or can be adopted from approved procedures developed by state and federal agencies or standards development organizations. The sources for SOPs are clearly defined in the QAPP.

3.4 Management Assessments

Management assessments are routine and ongoing processes of review by EcoAnalysts PMs to monitor the effectiveness of the QS. This process begins at the time of project inception. The QAM and the PM review the project proposal to determine if adequate QA protocols have been incorporated in the projects. They also have the responsibility for reviewing applicable regulatory quality guidelines pertaining to the project. At the discretion of senior management, external assessment may be requested in the form of an outside reviewer or assessment team to assist in evaluating whether the projects are meeting their desired objectives.

3.5 Systematic Planning Process

Project planning requires a systematic process that is coordinated by the PM. Once the project objectives are identified, a scope of work (including project deliverables), budget, and time schedule are developed with proposed project team members who are involved in the planning process. QA protocols are included in the project planning process. Financial and human resources necessary for implementation of the quality management program are included in the overall project budget. Project-specific DQOs are also identified during the planning process. DQOs include the desired bias and precision (uncertainty), completeness, and representativeness characteristics that are required to meet the project goals. The need for a separate QAPP is assessed during the planning process. If a stand-alone QAPP is not required, project proposals include QA protocols that are followed to meet the project objectives.

Environmental monitoring and measurement programs conducted by or for EcoAnalysts projects are designed to produce technically and legally defensible data of a quality sufficient to support its intended use. EcoAnalysts policy is to implement the DQO process, as appropriate, for projects involved in environmental data collection.

The DQO process is a systematic planning tool to facilitate the planning of environmental data collection activities. DQOs are qualitative and quantitative statements developed from the DQO process. The DQO process is a seven-step planning approach used to prepare for data collection activities. It provides a systematic approach for defining the criteria that a data collection design should satisfy, including when, where, and how to collect samples; tolerable decision error rates; and the number of samples to collect. The DQO process helps investigators ensure that the data collected are of the right type, quantity, and quality needed to support environmental decision.

The seven steps of the DQO process are:

- State the problem;
- identify the decision;
- identify inputs to the decision;
- define the study boundaries;
- develop a decision rule;
- specify limits on decision errors; and
- optimize the design for obtaining data.

The DQO process defines qualitative and quantitative criteria for determining when, where, and how many samples (measurements) to collect for a desired level of confidence. This information, along with sampling procedures, analytical procedures and appropriate QA/QC procedures is documented in the QAPP.

3.6 Technical Reviews

Technical reviews, conducted during the course of a project, are documented assessments of project work to evaluate documents, activities, materials, data, or other work products that require technical verification for bias, precision, completeness, or representativeness. Technical reviews are conducted by EcoAnalysts personnel who may or may not be independent of the project team, but with equivalent experience and training in the project discipline. Reviews may also be conducted by external individuals. Technical reviews result in a written record of the review findings with a documented response from the PM that addresses the reviewer's findings. The PM is responsible for retaining records that document the review findings and responses.

3.7 Data Quality Assessments

Data quality assessments are scientific evaluations of results to determine their validity and appropriateness for their intended use. Routine data quality assessments are incorporated into the project design, with clear indication of the personnel responsible for conducting the assessments. The assessments are conducted on a predetermined frequency, and a written record is maintained to document the results of the data review. Deviations from the DQOs that are discovered during the assessments are reported to the PM for corrective action. Some projects may require that data quality assessments be conducted by a qualified third party.

SECTION 4

PERSONNEL QUALIFICATIONS AND TRAINING

4.1 Qualifications

EcoAnalysts policy is that personnel meet the minimum academic and professional experience qualifications for their positions and work responsibilities. These requirements are stated on the EcoAnalysts intranet website in written position descriptions that include:

- general statement of duties;
- duties and responsibilities;
- qualifications; and
- career development.

The Human Resources Department of EcoAnalysts is responsible for maintaining job position descriptions.

EcoAnalysts project personnel who engage in field activities at hazardous waste sites are required by Occupational Safety and Health Administration (OSHA) to have Hazardous Waste Operations and Emergency Response (HAZWOPER) 40-hour training together with an annual 8-hour HAZWOPER refresher and medical monitoring. Training may be conducted by internal or external staff.

4.2 Commitment to Training

EcoAnalysts trains its staff to conduct project tasks consistent with SOPs and other project requirements. Training is conducted on a project-specific basis. Project personnel training requirements are included in the project-specific QAPP.

EcoAnalysts' employee policies encourage employees to attend applied training courses that are directly related to their job function and career development. These may be offered within EcoAnalysts, at colleges and universities, by local, state, or federal agencies, through computer hardware, and software, or by professional societies and conference sponsors. Resources available for training include annual conferences, internal and external webinars, and on-site sessions.

EcoAnalysts uses an intranet website to store information pertaining to personnel, technical action and user groups, health and safety, management operations, and EcoAnalysts procedures.

4.3 Training Roles and Responsibilities

The application of sound QA policies and procedures requires that staff, including PMs, field personnel, and data processors who generate or use environmental data are provided with the appropriate level of QA training commensurate with their duties. PMs and field supervisors are responsible for ensuring that each employee with QA-related assignment has the necessary qualifications and proficiency for the work assigned. It is a responsibility of the PM or their designee to discuss QA training needs with personnel involved in environmentally-related data gathering activities.

A QA training requirement should appear within the project-specific QAPP for project staff, as appropriate (including subcontractors). For example, PMs and field supervisors are responsible for ensuring that contract personnel involved with the gathering of environmental data have the necessary and appropriate QA training for their tasks and functions. The QAM determines the need for retraining, based on the results of QS assessments and changing circumstances.

The PIC is ultimately responsible for the quality of data. Therefore, it is critical that PMs and field supervisors receive the necessary training to ensure their understanding of the importance of QA, their responsibilities with regard to environmental data collection activities, and specific QA policies and procedures. Therefore, retraining based on changing requirements occurs as needed.

The QAM is responsible for maintaining a library of pertinent QA documentation to assist technical staff and communicating any necessary retraining.

The PIC, PM, and staff will participate in project QA training as appropriate.

4.4 Documentation of Staff Training and Education

Job opening announcements for new employees are based on the requirements of the position in terms of education and experience. Applicants must meet these minimum requirements to be hired. A permanent record of the successful applicant's resume, with education and work experience, is maintained in the Human Resources Department. New staff are also required to provide written acknowledgements that appropriate policy and safety manuals have been provided and that the employee understands the provisions contained in the documentation. Existing employees are to provide the same documented acknowledgments for new or revised policies. This documentation is maintained in the Human Resources Department.

As part of the personnel evaluation process, personnel provide updated resumes that include formal education and any other subsequent training, certifications, or licenses that have been received. The PM or designee encourages professional development in the annual evaluation

process and supports personnel by identifying qualified training programs that are responsive to technical changes. The PM or designee assesses effectiveness of the training in the annual evaluation process. Individual employees maintain their own training records on an updated resume. They may submit their records to Human Resources for maintenance in their permanent file. Human Resources maintains health and safety training records.

SECTION 5

PROCUREMENT OF ITEMS AND SERVICES

Applicable project-specific procurement contracts meet established administrative and QA requirements. These procedures are re-evaluated on a periodic basis. In those procurements and contracts where higher level quality requirements apply, appropriate clauses can be included in the contract.

After contract award, when requesting services either through the issuance of a work assignment, task order, or delivery order, the quality requirements specified in the project-specific quality documents are followed.

5.1 Procurement Source Evaluation and Selection

The PM has the primary responsibility for determining that goods and services procured to meet project deliverables are of sufficient quality to provide reliable and consistent performance. Purchase requests for goods and services should include adequate detail to specify the quality and performance requirements of the acquired items. PMs are responsible for ensuring that agreements describe the QS elements for which the supplier is responsible. This is particularly important for goods and services that are subject to bid processes. PMs are responsible for bid evaluations and take into account the suppliers' quality-related documentation and quality aspects of the offered goods and services based on the performance specifications that were indicated on the request for bid forms. The PM reviews and approves applicable responses to bid solicitations to ensure that they satisfy technical and quality requirements.

EcoAnalysts purchasing and contracting personnel are responsible for maintaining lists of approved vendors for a broad category of goods and services. They are also responsible for assisting the PM in obtaining competitive pricing schedules. Any quality defects that affect the performance of goods and services obtained should be reported by the PM to purchasing and contracting personnel.

Contractors retained to provide services are pre-approved and have evidence of insurance, bonding, and appropriate documentation of licenses and certifications, depending on the vendor type. External providers of laboratory services provide adequate documentation to show compliance with accreditation requirements, including the availability of Quality Assurance Plans (QAPs), QMPs, and SOPs, where applicable.

5.2 Evaluation of Quality of Vendor-Supplied Commodities, Services, and Equipment

As applicable, the PM is responsible for providing specifications on the purchase request to determine that procured goods and services are of acceptable quality to meet the project objectives. The PM verifies vendors' conformance to EcoAnalysts requirements. Certifications of performance, quality, and warranty information that accompany goods and services are maintained by the PM in the appropriate project file. This includes Material Safety Data Sheets that accompany chemical purchases. External providers of laboratory services provide adequate QC information to assess the bias and precision (uncertainty) of the reported results.

SECTION 6

DOCUMENTS AND RECORDS

Maintenance of documents and records (both printed and electronic) associated with a specific project is the responsibility of the PM for the project and the staff conducting the work. In its Risk Management Program, EcoAnalysts has established procedures for identifying, controlling, filing, storing, protecting, and accessing documents and records. Documents include guidance documents, policy memoranda, written procedures, reports, and QA management and project planning documents. Records provide objective evidence of an item or process and include lab reports, field notes, data recording media, photographs, and drawings.

The QAM is responsible for documents and records associated with the implementation of the QS.

6.1 Process for Identifying Quality-Related Documents and Records Requiring Control

The QAM identifies specific project documents and records that require control. The control of quality-related documentation and records is described in the following documents that are subject to the review of the QAM:

- QMP;
- project-specific QAPPs;
- SOPs;
- technical system audit reports;
- QA document review reports;
- sub-contractor-specific QAPs; and
- additional contract-specific documents, including contract agreements.

These documents also require that personnel involved in environmental data collection, laboratory analysis, and environmental technology activities maintain QA-related records (both written and electronic) including, but not limited to:

- Chain of custody records;
- field sampling notes;

- field and fixed analytical records for the transfer, preparation, and analysis of samples;
- data reports, including analytical results forms; and
- communication records.

The PM or designee prepares quality-related documents and records. The QAM or designee reviews and approves these documents, as described in the EcoAnalysts Risk Management Program. The QAM is also responsible for and has been delegated the authority to develop requirements and approve guidance documents relevant to QS-related documents and records. The QAM assesses conformance to these requirements through its QS assessments and data validation programs. The QAM is responsible for and has been delegated the authority to develop requirements and approve guidance documents relevant to QS-related documents and records. The QAM assesses conformance to these requirements through its QS assessments and data validation programs.

6.2 Process for Ensuring Documents and Records Accurately Reflect Completed Work

The PIC is responsible for establishing procedures for ensuring consistency and technical accuracy of documents and project records. It is the PM's responsibility to implement these procedures and ensure that records and documents accurately reflect completed work. The PM uses a Peer Review Form for documenting the review of documents. Engineering calculations and drawings are peer reviewed and checked; this process is documented on the cover page or title block of the document. Data tables and figures made using project data are also peer reviewed and checked for accuracy. Data transcriptions (i.e., from lab report to database, from database to map or table) are spot checked for accuracy.

Data archives are accompanied by documentation that describes the hardware and software used to read and write the archives, the variables stored in the archives, the format and units of the variables, the conditions under which they were collected, and any other information that may inform the user about the nature of the data, the quality, or the use. Data will be archived in such a way that the quality of the records will not be compromised. Records will be stored in a secure location with controlled access and adequate temperature control to maintain their integrity.

6.3 Process for Maintaining Documents and Records

- Consistent with the EcoAnalysts Risk Management Program, the PM or designee is responsible for establishing and implementing procedures for maintaining quality-related documents and records, including transmittal, distribution, retention, access, preservation, traceability, retrieval, removal of obsolete documentation, and

disposition. Maintenance of a file system for each project is the responsibility of the individual PMs.

6.4 Process for Establishing and Implementing Chain of Custody and Confidentiality Procedures

In accordance with the Risk Management Program, EcoAnalysts has established a procedure for establishing chain of custody for evidentiary records. The EcoAnalysts Employee Manual establishes confidentiality procedures for work. The PM or designee ensures that required procedures are implemented.

SECTION 7

COMPUTER HARDWARE AND SOFTWARE

EcoAnalysts uses many different computer hardware and software systems in the course of project-specific work. EcoAnalysts' Information Technology (IT) Department is responsible for managing the selection of system components, general system operation and maintenance, system integrity and security, and system planning.

7.1 Information Management Systems

EcoAnalysts' IT Department evaluates the quality of computer hardware and software, assesses its usability, and then integrates hardware and software into company use. IT assesses and documents the impact of changes to user requirements and/or the hardware and software on performance, using the following process:

- Where available, IT requests the product from manufacturers for the purpose of beta testing. If the product is commercially available and manufacturer approved, beta testing typically does not exceed 60 days;
- new products are tested against existing computing systems to ensure compatibility, while assessing the risks associated with the use of the technology and ensuring that specific product process goals and objectives are met, as expected;
- IT prepares a documented project plan prior to implementing the product for general use. Depending on the complexity of the product, documentation and/or training may be used to introduce the product for use;
- IT provides training, which may include self-help documentation, online materials including manufacturer-provided interactive training, as well as individual one-on-one sessions; and
- IT maintains relevant documentation and materials supporting the technology. Any sensitive procedures, checklists, documentation, and related resources are stored in a secure location (e.g., license keys, etc.). End user related materials are made readily available on the EcoAnalysts intranet and are updated by the IT lead when changes are made.

The IT Director is responsible for the management of IT operations and functioning support teams within the department. The IT Director is also responsible for maintaining relationships with respective employees of the firm that receive benefits from the health and well-being of our

geographic network and will provide for additional technical support or make recommendations as needed.

7.2 Hardware and Software

Hardware and software purchases require preparation of business justification to be submitted for approval by the PM or designee. Business justifications for purchases that will be used at the corporate, department, or office location levels are initiated by the IT Department.

If approved, the purchase request will proceed following established company procurement policies. For higher risk or high cost initiatives, IT verifies the need for the technology being considered. The process for evaluating hardware and software includes:

- Identifying goals and objectives of intended software/hardware;
- identifying business requirements and intended benefits of the software/hardware;
- identifying an existing solution if a replacement/upgrade is in order;
- identifying a proposed new solution;
- identifying risks which may be associated with the product; and
- identifying the total cost of ownership including maintenance, recurring or additional costs, and any other budgetary considerations.

IT obtains input and recommendations from approved vendors with a preference to stay with top tier manufacturers to ensure stability in the marketplace, lower risks, and ensure better compatibility with existing systems. Consideration may be given to proprietary technology sources as driven by business-specific needs. Where available, IT will request actual product reviews from manufacturers.

The final technology selection process is completed and the business justification formalized to include pilot feedback, a general scope of work, along with a basic delivery and implementation timeline. Upon approval, IT proceeds by adhering to established company procurement policies.

7.3 Data Standards

In many cases, specific data standards may be mandated for data produced in response to Federal and State regulations. It is EcoAnalysts policy to identify such data needs, if required, and to comply with guidance concerning data standards. It is the responsibility of each PM to be

aware of the current standards and regulations and communicate those standards to the IT Director.

SECTION 8

PLANNING

8.1 Systematic Planning Process

The PM has the primary responsibility for implementing a project planning process that involves relevant stakeholders, which may include clients, appropriate project task managers, QA representatives, project personnel, external consultants, and vendors. These participants are involved during the preliminary planning process in order to address relevant scientific and administrative issues early in the project.

The planning process includes the development of written project proposals. It includes project goals, objectives, and technical and logistical questions that are addressed in the project. The written project proposals, which ultimately are incorporated into the QAPP, are reviewed and approved by the PIC, project team members, regulatory agencies, and other key stakeholders. The number of personnel involved with the production and review of the project proposals is commensurate to the size and complexity of the project.

8.2 Identification of Project Schedule, Budget, Staff Resources, and Deliverables

It is the PM's responsibility to develop project schedules and budget requirements, including the proposed allocation of personnel time necessary to meet the project goals. Project deliverables and deliverable dates are developed in conjunction with project team members. A summary of the project deliverables should be clearly stated in the written project proposal.

8.3 Identification of Data Collection Needs and How Data Use Meets Project Goals

In determining data needs for a project, the first step is evaluating existing data to determine if they meet project needs. Secondary data may include data generated for or by external, independent parties which are then transmitted to the current user. Secondary data may also include data collected in other investigations designed to answer similar or different questions than those posed in the current investigation. Using data and information that are not generated for the same quality objectives as the current investigation may result in erroneous decisions; therefore, it is essential to identify use limitations for secondary data. This identification process is performed and illustrated during the development of project-specific QAPPs.

As part of the planning process, the PM and appropriate project team members identify what data will need to be collected and what methods will be used for data collection. The data collection methods and types of data collected depend on the project objectives. The methods

for data collection and the types of data to be collected are clearly stated in the written project proposal or the QAPP.

The customers that will utilize the information are identified. The QAPP identifies what types of information are needed (e.g., summary information, detailed trends, graphs, GIS, etc.). This information assists the PM in determining the necessary data quality to meet customer satisfaction criteria.

8.4 Identification of Required QA and QC Protocols to Meet DQOs

The project proposal or QAPP describes in detail the QA protocols that are used to meet the specified DQOs (Section 3.5). Written DQOs include bias and precision (uncertainty) characteristics for field and laboratory measurements, data completeness criteria, and a discussion of how data representativeness will be assessed. Specific QC activities that are used to meet the DQOs are also described in the project proposal or QAPP. Responsible parties for implementing the QA program are included in the project proposal or QAPP, as well as a schedule for internal and external technical and systems assessments.

8.5 Protocols for Development, Review, and Approval of the QAPP

The primary responsibility for the development of the QAPP resides with the PM. The development of QAPPs is described in Section 3.2. However, depending on the nature and size of the project, this function may be delegated to a project team member with qualifications and experience in developing QA documents. The EcoAnalysts Project QAM serves as a technical resource for developing and reviewing QAPPs. Once developed and reviewed, each QAPP is submitted for approval. Approved QAPPs are reviewed, and revised if changes in project scope, personnel responsibilities, or QA goals occur.

SECTION 9

IMPLEMENTATION OF WORK PROCESSES

The PIC is responsible for overall project supervision to determine that work is performed according to approved project proposals, scopes of work, QAPPs, SOPs, and contractual requirements. The PM is responsible for routine tracking of project scope, schedule, and budget. Project Task Managers may be identified at the discretion of the PM, depending on the size and complexity of the project. The PM or designee conducts periodic reviews or assessments to ensure that work is performed as planned.

9.1 Standard Operating Procedure Development

The PM, in conjunction with the PIC and QAM, identifies the need for the development of SOPs for critical and routine technical and administrative tasks that are important in satisfying the project objectives. SOPs may be developed independently or may be adopted or modified from a previously approved SOP from an appropriate standards development organization such as USEPA, the United States Geological Survey (USGS), or the American Society for Testing and Materials (ASTM). The use of SOPs is recommended to minimize the variability in tasks that are critical to meeting project DQOs.

SOPs are prepared by project personnel, reviewed by senior project personnel, and approved by the PM. SOPs may be revised by senior project personnel for approval by the PM. As appropriate, SOPs are deemed obsolete and removed from the QS by the PM.

QS-related SOPs are prepared, reviewed, and approved by the QAM.

9.2 Standard Operating Procedure Implementation

The PM is responsible for ensuring that the processes described in project-specific SOPs are followed and implemented as written. The PM ensures that project personnel using SOPs are appropriately trained. The PM communicates changes to SOPs to project personnel and verifies that changes are implemented and obsolete SOPs are removed from the QS.

9.3 Standard Operating Procedure Document Control

QS planning documents, including SOPs, are subject to the document control procedures as described in Section 6 of this QMP. Electronic versions are controlled. Hard copies are considered uncontrolled. Project personnel verify the use of the most recent version of SOPs.

SECTION 10

ASSESSMENT AND RESPONSE

10.1 Quality System Assessment

The EcoAnalysts QS is assessed on an ongoing basis to identify opportunities for improvement. The QAM is responsible for assessments and will communicate the results to the PICs, and PMs. If changes to the quality management system are necessary, the QMP and associated procedures will be revised accordingly. Individual project QA will be conducted by the PM or designee.

10.2 Conducting Assessments

The QAM or similarly experienced designee conducts ongoing QS assessments. The assessor may not have project management responsibilities, or have direct technical involvement, for the work being assessed. As a higher level manager, the QAM has access to project personnel and documentation for conducting the assessment without disruption. The QS assessment tools include checklists for completion of project QA tasks, such as project planning, QAPP and SAP implementation, data validation, and peer review of deliverables. Additional tools may include internal or external audits.

Periodic project assessments are conducted by the QAM or PM. The QAM or PM has the responsibility to select those tools that best meet the DQOs of the project. Tools may include internal or external audits, data quality assessments, peer reviews, and technical systems reviews. In selecting assessment tools, the PM complies with applicable statutory and regulatory requirements, as well as requirements stipulated by the client.

10.3 Corrective Actions

The PM is responsible for identifying and implementing corrective actions in response to project assessments or the QS assessment. Corrective actions are implemented by the PM in a timely fashion. The assessor verifies the corrective action.

10.4 Documentation and Tracking

- The content requirements and format for documenting and tracking assessments are determined by the QAM.

10.5 Dispute Resolution

If disputes arise as a result of an assessment and related response, the dispute resolution process outlined in Section 2.4 of this QMP applies.

SECTION 11

QUALITY IMPROVEMENT

The EcoAnalysts QS is a dynamic set of policies and procedures that is intended to encourage ongoing quality improvement throughout project activities. Through the assessment and corrective action processes, the QS corrects systematic problems, improves consistency, enhances individual system components, re-engineers ineffective work processes and procedures, and customizes quality tools. Through review of assessments and project closeout, management and staff are encouraged to establish communications among themselves and with clients and contractors to explore areas for improved service.

Personnel involvement is required to enhance the quality of the data, reports, and publications. It is the responsibility of each project team member to identify conditions that are adverse to quality and to suggest improvements to the quality management system. This can be done through the corrective action process. When deficiencies or shortcomings in the quality management system are identified, project personnel should promptly complete a CAR for submittal to the QAM for review and verification. Project team members are encouraged to use the CAR for supplier process improvements.

11.1 Quality Management System Review

The QAM conducts reviews of the QS with the PM and other members of management, as appropriate. The review serves to communicate major quality issues to EcoAnalysts management and to identify opportunities for improvement. Based upon this review, the PM recommends changes to the QS and allocates resources to address QA needs.

Laboratory Analysis: Benthic Macroinvertebrates Laboratory Sorting and Identification Teck 2019

Standard Operating Procedure

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Revision No. 2

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QA Officer Signature and Date

Prepared by

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Introduction

This standard operating procedure (SOP) is specific to the sediment facies mapping element of the Phase 3 Sediment Study (hereinafter "the study") being conducted for Teck American Incorporated (TAI) in the Upper Reach Operable Unit (OU) of the Upper Columbia River (UCR). The purpose of this SOP is to describe the laboratory procedures for processing benthic macroinvertebrate community samples.

This SOP details the laboratory operations and processes for analyzing benthic macroinvertebrate community samples. The following procedures provide an explanation for how these datasets will be used for the purpose of riverbed sediment classification.

Summary of Method

The processing of benthic macroinvertebrate community samples requires two main steps. The first step is to systematically remove all benthic invertebrates from the sample matrix. Following removal of all of the benthic invertebrates, a qualified taxonomist will identify the organisms to appropriate phylagenic level. This SOP outlines the laboratory processing as well as the quality control steps that are performed to determine efficacy of these processes.

Equipment

- Digital imaging cameras and software for high quality microsope and field images
- Glassware (beakers, graduated cylinders, centrifuge tubes) and micropipettes for accurately measuring sample volume
- LIMS – A custom software system developed for our project, sample, and data management. Our LIMS incorporates sample login and tracking, sorting and QA process data, taxonomy and QA processes, data warehousing/management/reporting, and a reporting module for clients who request custom output formats.
- Dissecting microscopes for sorting
- High quality dissecting microscopes for identifications (Zeiss, Meiji, Leica)
- Compound microscopes (Zeiss, Olympus, Meiji, Leica), 4 of which have phase contrast for identifications
- LED light sources
- Fiber-optic light sources (Dolan-Jenner, V-Lux)
- Federal industrial use alcohol permit and ethanol

Benthic Macroinvertebrate Community Sample Sorting

A sample is checked out by a sorting technician via the LIMS. A sorting bench sheet is printed that contains the EcoAnalysts sample identification information and sorting protocols assigned to it. The sorter records the primary matrix type and approximates the volume of detritus prior to sieving. The standard descriptors for the types of sample matrix are: Inorganic, Coarse Organic, Fine Organic, Vegetation, and Filamentous Algae.

The sample is elutriated entirely (no subsampling) by emptying the matrix into a sieve (250 µm) to remove preservative and fine sediment. If the sample matrix is made up of a significant percentage of inorganic material, the organic material will be elutriated from the inorganic material prior to sorting. For elutriation, the whole sample is washed into a shallow pan of water. At this time any large pieces of organic material can be rinsed and inspected thoroughly by the original technician and a secondary technician for attached and burrowing aquatic invertebrates.

If large organic matter is deemed removable from the sample, it is retained separately as sample residues. The sample is agitated with water to separate any organic matter from inorganic sediments. After agitating the sample in water, the lighter organic material is poured back into the sieve. The inorganic portion of the sample remaining in the pan is repeatedly washed and decanted into the sieve until no more organic matter remains in the pan with the inorganic material. Once the elutriate process is completed, the remaining material will be sieved through a stack sieve (500 and 250 µm) to separate into size fractions.

The remaining inorganic sediments are inspected under a magnifying lamp (3X) to look for any invertebrates too heavy to have been elutriated (e.g. mollusks, snails, etc.). If there are significant numbers of heavy invertebrates in the inorganic material – too many to easily remove under the magnifying lamp – the inorganic and organic matrix is recombined into the sieve and entire sample matrix will be prepared for subsample. If there are not significant numbers of heavy invertebrates in the inorganic material, they are removed under the magnifying lamp and placed with the organic matrix. A second technician inspects the inorganic material for organisms until it is determined there are no more invertebrates in the inorganic fraction of the sample. Unless otherwise requested, the inorganic elutriate is discarded.

The organic material and other contents of the sieve are then evenly distributed into the bottom of a Caton-style tray. These are trays of various sizes consisting of uniform grids, each grid being 2 inches per side and the bottom is constructed of 250-micron mesh. A grid (or a standardized portion of a grid) is randomly selected and its contents transferred to a Petri dish. The material in the Petri dish is sorted under a dissecting microscope (minimum magnification = 10X). The individual organisms are counted as they are placed into vials containing 70% ethanol.

Sorters are trained to pick and count only benthic macroinvertebrates, with heads, that were alive during sampling and contain the attributes required for taxonomic identification. Organisms picked are placed in one of five vials corresponding either to Crustacea, Polychaeta, Mollusca, Generals (miscellaneous taxa), and Special Organisms if requested by the client (SPORGS: Copepods and Ostracods). Specimens rejected according to EcoAnalysts' standard include: Nematodes, Zooplankton, Exuviae, and any organism without a head. Each size fraction (500 and 250 µm) will have a 500 count minimum sort. When the target count of organisms has been reached or the target percentage of the sample has been sorted but not fully sorted, a special large and rare protocol may be followed on any remaining unsorted material. Organisms deemed relatively large or rare to the sample (in comparison with the target taxa enumerated in the final count) are found by a naked eye scan in the unsorted sample remnants and are not counted but picked and placed in a separate vial.

Taxonomic Identification of Benthic Macroinvertebrates

A taxonomist selects a sample for identification via the LIMS and empties it into a Petri dish. Under a dissecting and/or compound microscope, the organisms are identified to the lowest practical level, generally genus/species or taxonomic level specified for the project. The taxonomist enters each taxon directly into the project database using a unique taxonomic code (this is done while at the microscope). The number of individuals of each taxon is counted and entered into the database. As the sample is being identified, the taxonomist enters data directly into the LIMS database and user interface.

A synoptic reference collection will be prepared, where at least one specimen (preferably 3-5 specimens) of each taxon encountered is placed into a vial containing 70% ethanol and is properly labeled with identity and sample number. This reference collection will be used for taxonomy QA where a second taxonomist will examine the specimens to verify the accuracy of all taxa identified in the project.

Data QA/QC

Sorting Efficacy

At least 10% of each sample will be re-sorted by a quality control technician, who did not originally sort the sample, to ensure at least 90% of the organisms have been removed. The QC checks are performed by technicians who have shown to achieve 90% efficacy on a minimum of 90% of samples they process. The estimated percent efficacy is calculated, using the following equation:

Equation 1 Sorting Efficacy

$$Sorting\ Efficacy\ \% = \left(\frac{Original\ Count}{Original\ count + \left(\left(\frac{QC\ count}{QC'd\ Grids} \right) * QC\ total\ grids \right)} \right) * 100$$

Where:
OriginalCount = the number of organisms picked by the first sorter
QCCount = the number of organisms found in the Quality Control sort
QC'd grids = the number of grids sorted during the QC process
QC Total grids = the total number of grids in the QC Caton

Sorting efficacy is measured as the estimated percent of the total organisms found during the original sorting process. If the estimated percent sorting efficacy is 90% or greater, the sample passes the quality control check. If the estimate is less than 90%, the sample is re-sorted. When this happens, the sample undergoes the quality control process again until it passes the 90% efficacy requirement. Supplemental project specific guidance that may be provided by the lab manager, such as photo reference guides for rejects.

Taxonomic Accuracy

Taxonomic accuracy is evaluated by having individual specimens of selected taxa identified by recognized experts. Samples will be identified using the most appropriate technical literature that is accepted by the taxonomic discipline and reflects the accepted nomenclature. All taxonomists will be certified for the group that they will identify by the Society for Freshwater science. A reference collection will be compiled as the samples are identified.

Taxonomic precision is quantified by comparing whole-sample identifications completed by a second taxonomist who did not perform the primary identification. Accuracy of taxonomy is qualitatively evaluated through specification of target hierarchical levels (e.g., family, genus, or species) and the specification of appropriate technical taxonomic literature or other references (e.g., identification keys, voucher specimens). Percent similarity is a measure of similarity between two communities or two samples (Washington 1984). Values range from 0% for samples with no species in common, to 100% for samples that are identical. It is calculated as follows:

Equation 2. Percent Similarity

$$PSC = 1 - 0.5 \sum_{i-1}^{k} |a - b|$$

where:

a and b = for a given species, the relative proportions of the total samples A and B, respectively, which that species represents.

An MQO of ≥85% is recommended for percent similarity of taxonomic identification. If the MQO is not met, the reasons for the discrepancies between analysts should be discussed. If a major discrepancy is found in how the two analysts have been identifying organisms, the last batch of samples counted by the analyst under review may have to be re-identified.

Data Processing

Data Management and Reporting

Data is directly entered into the LIMS database. Throughout the project and sample analysis, data entry is double checked for accuracy, and validated by the laboratory managers. The appropriate data are combined for each sample to obtain the sorting statistics and comprehensive taxa lists and counts.

Quality assurance data sheet checks are part of the sample validation process, and include scanning for apparent entry errors, measurement errors, omissions, and anomalies. Suspect data are flagged and/or excluded from use. Data may be presented in table, graph, and chart format. Unusual data are rechecked to verify their accuracy.

Data are delivered in an electronic format specified by the client.

Laboratory Analysis: Benthic Macroinvertebrates Laboratory Sample Receipt and Handling Teck 2019

Standard Operating Procedure

Effective Date: May 15, 2019

Revision No. 1

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Introduction

This standard operating procedure (SOP) is specific to the sediment facies mapping element of the Phase 3 Sediment Study (hereinafter "the study") being conducted for Teck American Incorporated (TAI) in the Upper Reach Operable Unit (OU) of the Upper Columbia River (UCR). The purpose of this SOP is to describe the procedures for tracking and maintaining chain-of-custody (COC) and receipt of benthic macroinvertebrate samples.

This SOP details the operation and procedures associated with packaging, shipping, and receipt of these samples while maintaining chain of custody.

Summary of Method

Samples collected for benthic invertebrate community analyses will be contained in a sample jar in the field. These samples will be labelled internally and externally and sealed with electricians' tape. Chain-of-custody forms will be filled out containing each individual sample. These forms will be transferred with the samples until receipt at the laboratory. Once received at the laboratory, the samples will be verified and checked into the laboratory information management system (LIMS) database. A notice of receipt will be sent to the project manager and client.

Equipment

- External and internal sample labels
- Chain-of-custody tracking sheet
- Electrician tape
- Indelible pens and pencils

Sample Labels

Two labels will be created for each sample, one label will be attached to the outside of each sample containers and the other will be included inside the sample container. The labels will identify the project title, sample type, station number, and sample number. The internal label will be written in pencil on waterproof paper and another adhesive label will be created using indelible ink and affixed to the exterior of the sample contain. Specific sample information is written on both labels for the following:

- Date and time collected
- Sample replicate number
- Preservative used (if any)
- Collector's name or initials

Chain-of-Custody Record

Sample custody is initiated with the detailed record keeping by the field sampling personnel. Chain of custody establishes the documentation and control necessary to identify and trace a sample from sample collection to final analysis. It includes field sample labeling to prevent mix-up and secure custody and provides the recorded support information for potential litigation. Chain-of-custody forms are used to document the integrity of all samples. To maintain a record of sample collection, transfer between personnel, shipment, and receipt by the laboratory, a chain-of-custody form will be filled out for each sample set at each sampling location. The chain-of-custody form will contain the following information:

Project Name/Survey/Project Number

This is the identification for this set of samples. This will be listed in the final report and on each page of the analytical results. When completing this section, also check the appropriate lab, date, and number of pages.

Customer Information

This section identifies for whom the analytical work is to be done. It also indicates who is to be billed for the work, who performed the sampling, and serves to generally identify the samples as a group.

- Project manager. The person to whom the final report should be sent. Also, the person to whom questions about the chain of custody should be directed. (If these are not thesame, the name of the person to answer any questions should be provided in the Comments section of the chain of custody.)
- Company. The person or company to whom the final report should be sent.
- Address. The address where the final report should be sent.
- Phone. The telephone number for the project manager. Include extension number if appropriate.

Sample Identification

This section identifies each sample. There is room for 15 samples on each chain-of-custody. If more space is needed, use additional forms. Please use only one line per sample and do not skip lines. Begin with line #1.

- Client sample ID. Your identification of the sample. A single sample is a sample taken from a single point; a single sample may require more than one container. Multiple containers of the same sample should be listed on a single line. You may choose to identify samples by sample location, depth, connection, etc. This ID will help you distinguish samples on the final report.
- Sample date. The date you collected the sample. Many analyses have short holding times. It is important for the lab to know when a sample was taken so the samples can be analyzed within the holding time.
- Sample time. The time the sample was taken.
- Sample matrix. What kind of material the sample is. Common matrices are: Liquid or Sediment. Do not use identifiers such as “grab” or “composite”.
- Initials. The person who performed the actual sampling.
- Container(s). The number and type of containers for each sample. Common containers are: 1-L cube, 4-L cube, 5-gal. cube.

Requested Analysis

This section shows what analyses are to be performed on each sample. For each sample, place an X in the box under the requested analysis. (It is not necessary that each sample be tested for the same analytes.) A single sample can be tested for more than one analyte. All analytes for that sample should be requested on the same horizontal line (across) corresponding to the sample identification.

Preserved How/Comments

This section notes whether the samples have been properly preserved and transported for the requested analyses.

Special Instructions/Comments

This section provides additional information not specified elsewhere on the chain-of-custody form.

Shipping Method/Airbill No.

Enter the shipping method (i.e., Federal Express, priority) and the airbill number.

Custody Section

This section tracks the samples from the point the sample is taken until it reaches the lab. When you, as the sampler, give the samples to someone else, you fill out the box under Relinquished By. He or she then fills out the corresponding section under Received By. When he or she gives the samples to someone else this process is repeated until the samples reach the lab.

The individual in charge of shipping samples to the laboratory is responsible for completing the chain-of-custody form. This individual will also inspect the form for completeness and accuracy. All cells must be filled in (if not relevant, "NA" or "not applicable" should be used). Any changes made to the chain-of-custody form shall be initialed by the person making the change.

Transfer of Custody and Shipment

Samples are to be accompanied by an approved chain-of-custody record. When the possession of samples is transferred, the individual relinquishing the samples signs, and records the date and time on the chain-of-custody document. The individual receiving the samples repeats the procedure. This record represents the official documentation for all sample custody transfers until the samples have arrived at the laboratory. Field or other personnel relinquishing the samples will keep a copy of the signed COC form.

The following is a description of the procedure followed when transporting environmental samples from the sampling site to the laboratory:

- Sample collection points, depth increments, and sampling devices are identified and documented.
- Log book entries, sample tags, chain-of-custody forms, and field record sheets with sample identification points, date, time and names or initials of all persons handling the sample in the field are completed.
- Where appropriate, sample and trip blanks are placed into a sample cooler provided by the laboratory along with ice. After the cooler is filled, the appropriate chain-of-custody form is placed inside the cooler for shipment to the laboratory.
- Glass sample containers are wrapped or placed with plastic material to prevent contact with other sample containers or the inner walls of the cooler.

Additional Procedures

Further tracking protocols of samples may be utilized in situations deemed appropriate (eg. known or potential litigation work). This could include any/all of the following procedures:

- In addition to hard copies, digital chain-of-custody forms completed and uploaded into secure database
- Tamper-resistant custody seals placed both on sample containers and the outside of coolers
- Thorough tracking of packages from sample collection to receipt at the laboratory in addition to acknowledgement of sample receipt
- Photos of samples received with detailed logs of sample description or observances; scanning of all documentation back to client and/or secure database.

Sample Receipt Procedures

Immediately upon receipt of benthic macroinvertebrate and samples, all containers are inspected for damage or leakage. Sample labels are checked against chain of custody forms and/or packing slips and any discrepancies are noted. Receipt records are reported to the client within one business day of sample receipt. Chain of custody logs are reported, throughout the project, according to timelines and methods requested by the client. Samples are logged into the EcoAnalysts, Inc. custom LIMS database and assigned a unique sample tracking number.

APPENDIX E

CULTURAL RESOURCES COORDINATION PLAN

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ACRONYMS AND ABBREVIATIONS

ACHP	Advisory Council on Historic Preservation
AOI	area of interest
APE	area of potential effects
ARPA	Archaeological Resources Protection Act of 1979
CCT	Confederated Tribes of the Colville Reservation
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
CRCP	cultural resources coordination plan
EPA	U.S. Environmental Protection Agency
Lake Roosevelt	Franklin D. Roosevelt Lake
MOA	Memorandum of Agreement
NAGPRA	Native American Graves Protection and Repatriation Act
National Register	National Register of Historic Places
NHPA	National Historic Preservation Act
NPS	National Park Service
OU	operable unit
QAPP	quality assurance project plan
RCW	Revised Code of Washington
RI/FS	remedial investigation and feasibility study
RM	river mile
SHPO	State Historic Preservation Officer
Site	Upper Columbia River site
STI	Spokane Tribe of Indians
TAI	Teck American Incorporated
THPO	Tribal Historic Preservation Officer
UCR	Upper Columbia River
USBR	U.S. Bureau of Reclamation
USC	United States Code
USGS	United State Geological Service
WAC	Washington Administrative Code

UNITS OF MEASURE

amsl	above mean sea level
ft	foot/feet
ft/sec	foot/feet per second
gal	gallon(s)
in.	inch(es)
L	liter(s)
m	meter(s)
mm	millimeter(s)
mL	milliliter(s)
oz	ounce(s)
sqkm	square kilometer

1 INTRODUCTION

This document presents the cultural resources coordination plan (CRCP) for the Upper Columbia River (UCR) site (herein the 'Site') remedial investigation and feasibility study (RI/FS) with emphasis placed on field activities associated with the Phase 3 sediment study. Sample collection will consist of surface sediment and porewater sampling, defined as the top 6 in. of sediment.

1.1 BACKGROUND

As specified in the Statement of Work associated with the June 2, 2006 Settlement Agreement (USEPA 2006), "For all RI/FS activities at the Site involving sediment collection or ground penetration/disturbance, the Company shall work with the potentially affected parties to assess the effects of the planned work and seek ways to avoid, minimize or mitigate any adverse effects on historic properties." The purpose of this CRCP is to describe known or likely physical impacts of proposed sediment and porewater sampling, provide relevant background information, define measures for protecting resources, and define procedures for consulting with the appropriate state, federal, and tribal parties with interests in the cultural resources of the Site.

The Site is located wholly within the state of Washington and includes approximately 150 river miles of the Columbia River extending from the U.S.-Canada border to the Grand Coulee Dam, as well as areas in proximity to contamination necessary for implementation of the response actions described in the 2006 Settlement Agreement. The Colville Indian Reservation borders the UCR from approximately river mile (RM) 690 to the Grand Coulee Dam. The Spokane Indian Reservation borders the UCR to the east from approximately RM 650 to RM 640. Franklin D. Roosevelt Lake (Lake Roosevelt) and associated lands are administered by the U.S. Bureau of Reclamation (USBR) and the National Park Service (NPS) of the U.S. Department of the Interior.

The U.S. Environmental Protection Agency (EPA) has responsibilities under the National Historic Preservation Act (NHPA) to consider how its undertakings would affect historic properties. As defined in the NHPA, "historic properties" include archaeological resources, historic-period buildings and structures, and traditional cultural places listed in or determined eligible for listing in the National Register of Historic Places (National Register). To meet the NHPA requirements, EPA must ensure that sampling and other activities would avoid, minimize, or mitigate any adverse effects to any historic properties.

The CRCP is organized into six sections, as follows: 1) this introductory section, which includes summary information on the archaeology, prehistory, Native peoples, and Euroamerican historical development of the project area; 2) an overview of the relevant federal, state, and tribal laws and regulations, and other appropriate procedures and requirements; 3) a description of the proposed sampling program and its potential physical effects; 4) a plan for coordination and consultation with all affected parties to address known and likely impacts to cultural resources in implementing the proposed work; 5) a list of references; and 6) a glossary of terms.

1.2 CULTURAL SETTING

The broader context of the cultural development of the upper Columbia region[1] provides the critical framework for understanding the importance of the cultural resources in the area. Archaeological and historical resources reflect broad patterns of cultural use and development, just as ongoing traditional use of areas and natural resources represents cultural continuity that can be important to individual and social identities. This section of the CRCP serves as a brief introduction to the cultural history of the upper Columbia region. The primary source of information on the prehistory of the area is Goodal et al. (2004); for Native peoples, the source is Kennedy and Bouchard (1998); and for Euroamerican history, McKay and Renk (2002).

Archaeological research contributes significantly to understanding of the prehistoric past. In the upper Columbia region, systematic archaeological research began in the late 1930s and has continued to the present. Almost 500 archaeological resources have been recorded in and along Lake Roosevelt, representing prehistoric, protohistoric, ethnohistoric, and historic-period human use and occupation. Research at some of these resources has provided the outlines of prehistoric cultural development in the upper Columbia region. Human presence in the region extends back at least 11,000 years. These first humans lived in small groups and were mobile foragers, hunting and gathering plants. The presence of the Columbia River led to an early focus on the abundance of riverine resources. Beginning about 8,000 years ago, populations appear to have increased and led to a gradual trend to less mobility and more

[1] The phrase "upper Columbia region" herein refers to the drainage of the upper Columbia River from around Grand Coulee to the Arrow Lakes area in British Columbia. The upper Columbia region includes, but is not limited to, the Site as defined in the Settlement Agreement. This distinction is important because general patterns of cultural development in the upper Columbia region as a whole provide the framework for addressing the significance of the cultural resources within the Site boundaries.

permanent settlements. The growing population also led to use of a greater diversity of resources and increasing reliance on fish.

Permanent settlements increased in size and became concentrated in the river valleys beginning about 6,000 years ago, probably in response to continued population growth. Use of resources in upland areas expanded to meet the needs of the burgeoning populations and settlements. These trends continued until about 1,000 years ago, when there is evidence for a decline in population size. There were fewer settlements, villages were smaller, and there was less use of upland areas.

Cultural patterns of the late prehistoric period were reflected in the lives of the Native peoples at the time of Euroamerican contact. At the time of contact, the UCR was the homeland of the Lakes, Colville, Spokane, and Sanpoil peoples. The Lakes people occupied the Columbia River valley from the vicinity of modern Northport, Washington, north into the Arrow Lakes area of modern British Columbia. The Colville lived along the river downstream of the Lakes as far as around the mouth of the Spokane River. Downriver of the Colville were the Spokane, in the Spokane River drainage, and the Sanpoil, who lived along the Columbia River from around the mouth of the Spokane River to near the modern location of the Grand Coulee Dam.

All of these groups spoke Interior Salish languages and shared many cultural features. Their cultural differences largely reflected differences in the local environments in which they lived. The social, political, and economic foundation of these groups was historically the winter village. The villages were concentrated in the river valleys, and each village was politically independent. Residents of the villages relied on provisions gathered, dried, and stored during the summer to survive through the winter. With the coming of spring, families began moving out of the winter village and shifting among the warm-season camps near resource locations. Gathering of plants and hunting game in upland areas were important subsistence activities during this season, but salmon constituted the most important food staple. Kettle Falls was a major aboriginal fishery, attracting people from throughout the region.

Native life began to change with the introduction of elements of Euroamerican culture. Horses reached the region in the 1700s and significantly changed Native travel and transportation. European diseases such as smallpox appeared in the late 1700s and had disastrous consequences for Native groups. Populations may have declined as much as 80 percent between the 1780s and 1840s. Direct contact with Euroamericans came in the early 1800s, when fur-trade posts were established on the Spokane River and at Kettle Falls.

When American settlement began in the 1840s, it bypassed the upper Columbia region. The discovery of gold in the region in the 1850s led to a major influx of Americans and growing conflict between the new settlers and Indian groups. A series of treaties with Indian groups was signed in 1855 but did not include the peoples of the upper Columbia region. As American settlement continued, the federal government responded by Presidential Executive Order creating the Colville Reservation in 1872 for the Colville, Spokane, Methow, Okanogan, Sanpoil, Lakes, Calispel, Coeur d'Alene, and scattering bands. Separate reservations were later set aside for the Spokane, Calispel, and Coeur d'Alene tribes. The Colville and Spokane reservations have subsequently lost lands to the allotment process in the late 1800s and early 1900s as well as inundation from the waters of Lake Roosevelt. The Colville Reservation is now the home of the 12 tribes that comprise the Confederated Tribes of the Colville Reservation (CCT); the Spokane Reservation is the home of the Spokane Tribe of Indians (STI).

As noted above, the direct Euroamerican presence in the upper Columbia region began with the establishment of fur-trade posts on the Spokane River and at Kettle Falls. These posts were constructed between 1810 and 1825. The fur traders were followed by Christian missionaries in the 1830s and 1840s. A more substantial Euroamerican presence in the region developed in the 1850s, with the discovery of gold near Fort Colville. Conflicts between miners and Indians led to a military campaign in the Spokane River valley in 1858 and the establishment of an army post (Fort Colville) near Kettle Falls in 1859.

American settlement in the upper Columbia River drainage accelerated in the 1860s, initially spurred by mining. Farmers eventually followed the miners, but agricultural activity was limited until the construction of the Spokane Falls and Northern Railway through the region in 1890. With improved access to markets, farming—especially orchard crops—developed as one of the economic mainstays of the area, although mining has continued to play an important role.

The growing demands for agriculture led to plans to construct a dam at Grand Coulee. The dam would provide water for irrigation and inexpensive hydroelectric power. Construction of the dam began in 1934 and was completed in 1942. More than 82,000 acres above the dam were flooded, resulting in the relocation of 11 towns and about 3,000 residents. Since its creation, Lake Roosevelt has provided a growing number of recreational and tourist activities, which have become increasingly important to local economies.

2 OVERVIEW OF LAWS AND REGULATIONS

Implementation of the RI/FS would occur primarily on federal and tribal lands. Federal and tribal laws and regulations addressing cultural resources will therefore provide the primary legal framework for this coordination plan. It is possible, however, that implementation of the RI/FS may require activities on private or nonfederal, nontribal public lands. This overview therefore includes a brief description of relevant state laws and executive orders. Ferry, Lincoln, and Stevens counties, which border the UCR, do not appear to have any ordinances addressing cultural resources that would be relevant to the Site RI/FS.

Relevant federal, tribal, and state laws and regulations directly addressing cultural resources are briefly outlined below, as well as pertinent executive orders issued by the President of the United States and the Governor of Washington.

2.1 FEDERAL LEGISLATION AND REGULATIONS

An overview of federal legislation and regulations is provided below. There are three key laws relevant to Site RI/FS activities. The NHPA guides all federal agency actions that could affect cultural resources. Implementation of the RI/FS constitutes an "undertaking" as defined in the NHPA; therefore, complying with the NHPA requirements is the responsibility of EPA. The Archaeological Resources Protection Act of 1979 (ARPA) and the Native American Graves Protection and Repatriation Act (NAGPRA) apply to activities that could affect archaeological resources and Indian burials on federal and tribal lands. These laws and their implementing regulations would therefore apply to RI/FS activities conducted on federal and tribal lands.

2.1.1 National Historic Preservation Act of 1966, as Amended through 1992 (16 USC 470-470w)

The NHPA is the centerpiece of federal legislation protecting cultural resources. In the Act, Congress states that the federal government will "provide leadership in the preservation of the prehistoric and historic resources of the United States," including resources that are federally owned, administered, or controlled. For federal agencies, Sections 106 and 110 of the Act provide the foundation for how federal agencies are to manage cultural resources, but other sections provide further guidance. The implementing regulations for the NHPA are in 36 Code of Federal Regulations (CFR) Part 800. These regulations are summarized below.

2.1.1.1 Section 106

Similar to the National Environmental Policy Act of 1969, Section 106 of the NHPA requires federal agencies to take into account the effects of their actions or programs specifically on historic and archaeological properties, prior to implementation. This is accomplished through consultation with the State Historic Preservation Officer (SHPO) and/or the Advisory Council on Historic Preservation (ACHP). On lands held by a tribe with a Tribal Historic Preservation Officer (THPO), the THPO has the same duties and responsibilities as the SHPO. If an undertaking on federal lands may affect properties having historic value to a federally recognized Indian tribe, such tribe shall be afforded the opportunity to participate as interested persons during the consultation process defined in 36 CFR 800. Compliance can also be accomplished using agreed-upon streamlined methods and agreement documents such as programmatic agreements.

The Section 106 process is designed to identify possible conflicts between historic preservation objectives and the proposed activity, and to resolve those conflicts in the public's interest through consultation. Neither the NHPA nor the ACHP regulations require that all historic properties be preserved. Rather, they only require the agency proposing the undertaking to consider the effects of the proposed undertaking prior to implementation.

Failure to take into account the effects of an undertaking on historic or cultural properties can result in formal notification from the ACHP to the head of the federal agency for foreclosure of the ACHP's opportunity to comment on the undertaking pursuant to NHPA. A notice of foreclosure can be used by litigants against the federal agency in a manner that can halt or delay critical activities or programs.

The process for compliance with Section 106 consists of the following steps:

1. **Identification of Historic Properties**—Identification of historic properties located within the area of potential effects (APE) is accomplished through review of existing documentation and/or field surveys.
2. **Property Evaluation**—Evaluation of the identified historic properties is accomplished using National Register criteria (36 CFR Part 63) in consultation with the SHPO and, if necessary, the ACHP. Properties that meet the criteria will be considered "Eligible" for listing in the National Register, and will be subject to further review under Section 106. Properties that do not meet the criteria will be considered "Not Eligible" for listing in the National Register, and will not be subject to further Section 106 review.

3. **Determination of Effect**—An assessment is made of the effects of the proposed project on properties that were determined to meet the National Register criteria, in consultation with the SHPO and, if necessary, the ACHP. One of the following effect findings will be made:

   - No Historic Properties Affected—If no historic properties are found or no effects on historic properties are found, the agency official provides appropriate documentation to the SHPO/THPO and notifies consulting parties. However, the federal agency must proceed to the assessment of adverse effects when it finds that historic properties may be affected or the SHPO/THPO or ACHP objects to a "No Historic Properties Affected" finding. The agency must notify all consulting parties and invite their views.

   - No Historic Properties Adversely Affected—When the Criteria of Adverse Effect are applied (36 CFR 800.5(a)), and it is found that historic properties will not be adversely affected by the undertaking, the agency may make a finding of "No Historic Properties Adversely Affected." This finding is submitted to the SHPO for concurrence. Typically, the ACHP will not review "No Adverse Effect" determinations. However, the ACHP will intervene and review "No Historic Properties Adversely Affected" determinations if it deems it appropriate, or if the SHPO/THPO or another consulting party and the federal agency disagree on the finding and the agency cannot resolve the disagreement. If Indian tribes disagree with the finding, they can request the ACHP's review directly, but this must be done within the 30-day review period. Agencies must retain records of their findings of "No Historic Properties Adversely Affected" and make them available to the public. The public should be given access to the information when they so request, subject to the Freedom of Information Act and other statutory limits on disclosure, including the confidentiality provisions in Section 304 of the NHPA. Failure of the agency to carry out the undertaking in accordance with the finding requires the agency official to reopen the Section 106 process and determine whether the altered course of action constitutes an adverse effect.

   - Historic Properties Adversely Affected—Adverse effects occur when an undertaking may directly or indirectly alter characteristics of a historic property that qualify it for inclusion in the National Register. Reasonably foreseeable effects caused by the undertaking that may occur later in time, be farther removed in distance, or be cumulative also need to be considered. The finding of "Historic Properties Adversely Affected" is submitted to the SHPO for concurrence. The SHPO/THPO may suggest changes in a project or impose

conditions so that adverse effects can be avoided and thus result in a "No Historic Properties Adversely Affected" determination.

4. **Resolution of Adverse Effects/Mitigation**—When adverse effects are found, the consultation must continue among the federal agency, SHPO/THPO, and consulting parties to attempt to resolve them. The agency official must notify the ACHP when adverse effects are found, and should invite the ACHP to participate in the consultation when circumstances exist, as outlined in 36 CFR 800.6(a)(1)(i)(A)-(C). A consulting party may also request the ACHP to join the consultation.

   When resolving adverse effects without the ACHP, the agency official consults with the SHPO/THPO and other consulting parties to develop a Memorandum of Agreement (MOA). The MOA will outline the steps or actions to be taken prior to implementation of the project, in order to mitigate the adverse effects on the historic property. Stipulations included in an MOA may include (but are not limited to) documentation, modification of the project to lessen the adverse effects on the property, efforts to sell or relocate the resource, or step-by-step consultation with interested parties throughout the process to ensure it is carried out according to plan.

   The MOA is executed between the agency official and the SHPO/THPO and filed with required documentation with the ACHP. This filing is the formal conclusion of the Section 106 process and must occur before the undertaking is approved.

In some cases, streamlining of the Section 106 process can be accomplished through the use of programmatic agreements. The ACHP and the agency official may negotiate a programmatic agreement to govern the implementation of a particular program or the resolution of effects from complex projects or multiple undertakings. Programmatic agreements are particularly useful when programs or projects affecting historic properties are similar and repetitive, and have known effects, such as routine maintenance or a series of similar rehabilitation projects.

2.1.1.2 Section 101(d)(2)

This section of the NHPA provides for the assumption by federally recognized Indian tribes of all or any part of the functions of a SHPO with respect to tribal lands (e.g., all lands within the exterior boundaries of any Indian reservation and all dependent Indian communities). Section 101(d)(2) requires federal agencies, in carrying out their Section 106 responsibilities, to consult with federally recognized Indian tribes that attach religious or cultural significance to a historic property. The agency will consult with federally recognized Indian tribes in the

Section 106 process to identify, evaluate, and treat historic properties that have religious or cultural importance to those groups.

2.1.1.3 Section 110

Section 110 of the NHPA is intended to ensure that historic preservation is integrated into the ongoing programs of federal agencies. This section of the Act requires agencies to identify, evaluate, and nominate for listing in the National Register, historic properties owned or controlled by the agency; use historic properties to the maximum extent feasible; ensure documentation of historic properties that are to be altered or damaged; carry out programs and projects that further the purpose of the Act; and undertake such planning and actions as may be necessary to minimize harm to any formally designated National Historic Landmark properties.

2.1.1.4 Section 111

Section 111 of the NHPA requires agency officials, to the extent practicable, to establish and implement alternatives for historic properties, including adaptive use, that are not needed for current or projected agency uses or requirements. Further, Section 111 allows the proceeds from any lease to be retained by the agency to defray the cost of administration, maintenance, repair, and related expenses of historic properties.

2.1.1.5 Section 112

Section 112 of the NHPA requires that agency officials who are responsible for protection of historic properties pursuant to the NHPA ensure that all actions taken by employees or contractors meet professional historic preservation standards established by the Secretary of the Interior (Professional Qualifications Standards of the Secretary of the Interior's Standards and Guidelines in Archaeology and Historic Preservation [NPS 1983]).

2.1.1.6 Section 304

Section 304 of the NHPA requires that information about the location, character, or ownership of a historic property be withheld from public disclosure when the federal agency head or other public official determines that disclosure may cause a significant invasion of privacy, risk, and/or harm to the historic property, or impede the use of a traditional religious site by practitioners.

2.1.1.7 Comprehensive Environmental Response, Compensation and Liability Act and the National Historic Preservation Act

EPA's Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) manual, CERCLA Compliance with Other Laws Manual: Part II. Clean Air Act and Other Environmental Statutes and State Requirements (USEPA 1989), outlines how "substantive compliance" with the NHPA is to be achieved in CERCLA actions.[2] The initial step is determining if cultural resources are known or are likely to be present "in or near the area under study in the RI." This step may require conducting a survey of the location of the proposed remedial action and any associated actions that would occur off site. The CERCLA manual referenced above defines three stages of a survey: Stage IA, literature search and sensitivity study; Stage IB, field investigation; and Stage II, site definition and evaluation. All studies should include Stage IA but implementation of Stage IB is contingent on the results of Stage IA, and the need for Stage II is contingent on the results of Stage IB. If results of the survey identify significant cultural resources (i.e., resources listed or considered eligible for listing in the National Register), effects of the proposed remedial action and associated actions to the significant resources must be evaluated. Adverse effects to significant resources must be either avoided or mitigated. Any proposed mitigation measures must be incorporated into the remedial design process.

2.1.2 Archaeological Resources Protection Act of 1979 (16 USC 470aa-470ll)

ARPA is essentially an update to the 1906 Antiquities Act. It expands and strengthens the activities prohibited under the Antiquities Act, increases the criminal penalties for violation, establishes civil penalties, and provides further guidelines for the issuance of permits. This Act continues to apply only to federal and Indian lands (the definition of "Indian lands" in ARPA differs very slightly from the definition of "Tribal lands" in the NHPA). Most archaeological excavations and collection of artifacts on these lands are allowed only with an ARPA permit. Trafficking in illegally obtained archaeological resources from federal and Indian lands is also prohibited. Individuals convicted of violating the Act are liable for the value of the archaeological resource itself, and the cost of restoration or repair of the damage caused by illegal excavation or collection.

[2] As stated in the June 2, 2006 Settlement Agreement (USEPA 2006), "The Parties intend that this RI/FS, while not being carried out under an administrative order or judicial order issued pursuant to the provisions of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), will be consistent with the National Contingency Plan ('NCP'), 40 CFR Part 300."

The implementing regulations are 43 CFR Part 7 (U.S. Department of the Interior), which applies to federal lands that are not within military reservations or national forests. The regulations include detailed definitions of "archaeological resource" and "Indian lands" (lands held in trust by the United States on behalf of a federally recognized tribe or individual members of a federally recognized tribe).

2.1.3 Native American Graves Protection and Repatriation Act (25 USC 3001-3013)

NAGPRA establishes that Native American human remains and associated funerary objects found on federal or tribal lands belong to the lineal descendants of the Native American. When the lineal descendants cannot be determined, the remains belong to the tribe on whose land the remains were found (when found on tribal lands), or to the Indian tribe with the "closest cultural affiliation."[3] This latter rule also applies to unassociated funerary objects, sacred objects, and objects of cultural patrimony (all defined in the Act). NAGPRA applies to both human remains intentionally excavated (which would require an ARPA permit) and those accidentally discovered.

NAGPRA also requires all federal agencies and museums to inventory their holdings of Native American human remains and funerary objects. Once the inventories are completed, the agencies and museums are to notify the appropriate tribes of the remains and other objects in their collections. The remains and associated funerary objects are to be returned (repatriated) at the request of the lineal descendants or tribe. The same requirement applies to unassociated funerary objects, sacred objects, and objects of cultural patrimony for which a cultural affiliation can be demonstrated. Exceptions to the repatriation requirement are objects that are "indispensable for completion of a specific scientific study, the outcome of which would be of major benefit to the United States."

The implementing regulations are 43 CFR Part 10, which largely expand on the elements of the statute. The regulations detail 1) the process of consultation with Indian tribes to address either intentional excavation of human remains or inadvertent discovery of human remains; 2) how agencies and museums are to inventory their collections; and 3) the repatriation process. When human remains, funerary objects, sacred objects, and objects of cultural patrimony are inadvertently discovered on federal lands, the following steps are to be followed: 1) ongoing activity in the area of the find must cease and a reasonable effort made to protect the find; and 2) the federal land agency (i.e., the federal agency on whose lands

[3] Cultural affiliation is defined in the implementing regulations, 43 CFR 10.2(e), and refers to a relationship of shared group identity, which can be reasonably traced historically or prehistorically between a present-day Indian tribe or Native Hawaiian organization and an identifiable earlier group.

the remains or objects have been found) must be immediately notified by telephone, with written confirmation. The federal land agency must then notify the appropriate tribe(s) and further secure and protect the discovery. The activity may be halted for up to 30 days while an appropriate response to the find is negotiated by the federal agency and the appropriate tribe(s).

2.1.4 American Indian Religious Freedom Act (42 USC 1996)

This Act states that it is the policy of the United States to protect and preserve the rights of American Indians to practice traditional religions. That policy includes rights of access to sacred sites and to the use and possession of sacred objects. There are no implementing regulations.

2.2 PRESIDENTIAL EXECUTIVE ORDERS

Presidential executive orders define policies and procedures for federal agencies to facilitate their execution of laws passed by the U.S. Congress or clarify how specific laws are to be implemented. Presidential executive orders can be considered instructions or directives from the President to federal agencies on how to carry out specific laws. The executive orders listed below are either directly related to cultural resources or define relationships between federal agencies and tribes.

2.2.1 Executive Order 11593. Protection and Enhancement of the Cultural Environment

Issued in 1971, Executive Order 11593 states that the federal government would provide leadership in "preserving, restoring, and maintaining the historic and cultural environment of the Nation." Federal agencies were directed to inventory cultural resources under their jurisdiction and nominate National Register-eligible properties to the National Register. Properties that have been determined eligible are not to be transferred, sold, demolished, or altered without providing the ACHP with an opportunity to comment. Properties to be demolished or substantially altered were to be documented prior to demolition or alteration. National Register properties or National Register-eligible properties under federal control were to be maintained following standards set by the Secretary of the Interior. Executive Order 11593 also assigns specific responsibilities to the Secretary of the Interior, including managing the National Register and assisting and advising other federal agencies in the management of cultural resources.

2.2.2 Executive Order 13007. Indian Sacred Sites

Issued in 1996, Executive Order 13007 directs federal agencies to provide access and ceremonial use of Indian sacred sites, where practicable, legal, and not inconsistent with essential agency functions. Agencies are also directed to avoid adversely affecting sacred sites and to maintain the confidentiality of such sites. A "sacred site" as defined by this executive order is a specific location that is sacred because of its religious significance to or ceremonial use in an Indian religion.

2.2.3 Executive Order 13175. Consultation and Coordination with Indian Tribal Governments

Issued in 2000, Executive Order 13175 directs federal agencies to consult with tribal officials in the development of policies and regulations that have "tribal implications" or that preempt tribal law. Executive Order 13175 also emphasizes the importance of government-to-government relationships between the U.S. government and tribes. Agencies must designate an official responsible for implementing the Executive Order and must document tribal consultation in the development of the relevant policies and regulations.

2.3 TRIBAL LEGISLATION AND REGULATIONS

Tribal laws and regulations addressing cultural resources would apply to lands on the reservations and off-reservation trust lands. The CCT and the STI are the two tribes whose laws and regulations would be potentially applicable to the Site. The legal code of the CCT addresses cultural resources, as summarized below. This code applies to both on-reservation actions and off-reservation actions by federal agencies that could affect cultural resources. STI does not currently have laws that specifically address cultural resources. Both tribes have THPOs, who have the same authority and responsibilities as the SHPO on their respective reservations and on off-reservation trust lands.

2.3.1 Confederated Tribes of the Colville Reservation. Colville Tribal Law and Order Code Chapter 4-4, Cultural Resources Protection

This Colville Tribal Code establishes the Colville Cultural Resources Board, which has the responsibility of developing policies and procedures to protect cultural resources of interest and concern to the CCT, both on and off the Colville Reservation. The Board reviews proposed federal agency actions off the reservation and is responsible for reviewing all proposed on-reservation actions that could affect significant cultural resources. The code

also establishes a Colville Register of Historic and Archaeological Properties for listing of historic properties on the Colville Reservation.

This code defines the roles and responsibilities of the Colville History and Archaeology Department, which include identifying significant cultural resources on the reservation, nominating properties to the National Register and the Colville Register, and promoting efforts to protect cultural resources on the reservation.

Chapter 4-4 of the Colville Tribal Code prohibits the excavation, disturbance, or other adverse effects to archaeological resources and historic properties on the reservation without a permit issued by the Colville History and Archaeology Department. The code defines the procedure for the issuance of permits and the responsibilities of permittees.

2.4 STATE LEGISLATION AND REGULATIONS

Washington State laws and regulations regarding archaeological and historical resources, as well as the law protecting Indian graves, are not applicable on federal lands or on tribal trust lands. These laws would apply, however, to any RI/FS-related activities that would affect private lands or nonfederal or nontribal public lands.

2.4.1 Revised Code of Washington (RCW) Chapter 27.44, Indian Graves and Records

This legislation prohibits the removal or other disturbance of Indian burials, cairns, and "glyptic or painted records." "Burials" and "graves" are not defined in the statute. Excavation or removal of burials is permitted only under provisions of a permit issued by the Washington Department of Archaeology and Historic Preservation. Procedures for obtaining permits are defined in Washington Administrative Code (WAC) Chapter 25-48.

2.4.2 RCW Chapter 27.53, Archaeological Sites and Resources

This legislation prohibits the excavation or disturbance of archaeological sites on public and private lands in Washington except under provisions of a permit issued by the Washington Department of Archaeology and Historic Preservation. Procedures for obtaining permits are defined in WAC Chapter 25-48.

2.4.3 RCW Chapter 68.60, Abandoned and Historic Cemeteries and Historic Graves

This legislation prohibits the destruction, alteration, or other disturbance of historical and abandoned cemeteries and historic graves (Indian graves and burials are protected in RCW

Chapter 27.44). A historic cemetery is defined in the statute as one established before November 1889. A historic grave is a grave or graves outside of a cemetery placed prior to June 1990.

2.4.4 RCW Chapter 43.21C, State Environmental Policy Act

This legislation directs state and local agencies in Washington to address environmental impacts of proposed projects. The implementing rules (WAC Chapter 197-11) require that impacts to historic and cultural resources are to be addressed in the State Environmental Policy Act process.

3 PROPOSED SAMPLING PROGRAM

A summary of the proposed sampling locations (coordinates) is provided with Table E3-1. A detailed description of sampling techniques is provided in the quality assurance project plan (QAPP). As indicated in the QAPP, sediment and porewater sampling activities will occur within the top 6 in. of sediment using one of several decontaminated samplers.

During this work, up to 88 sediment and 106 porewater samples for chemical analyses will be collected from the three areas of interest (AOIs) as indicated on Maps E3-2 through E3-4. In addition, the China Bend AOI also includes two judgmental samples at which sediment and porewater will be collected, as requested by EPA. If samples cannot be retrieved from a sampling area, an alternate sample location will be chosen from the designated alternate sample provided for each AOI. Regardless of whether sediment sampling is successful, porewater samples will be collected at all primary sediment sampling locations as well as six additional porewater-only locations for each AOI. Porewater samples will also be collected at any alternate locations where sediment samples are collected.

Collection of sediment from sediment sample locations will typically occur using one of three decontaminated grab samplers (Van Veen grab, Hamon grab, or freeze grab). If very shallow water (e.g., < 1 m) or dry conditions are encountered at a sample location, a handheld sediment sampling device may be deployed by wading. Although some sampling devices are capable of collecting up to 57 L (15 gal) of sample per grab, 25 L (6.5 gal) per grab is expected.

Collection of porewater from surface sediment will be conducted using a Trident probe. The Trident probe will be inserted into the sediment, and porewater collected by low-flow peristalic pump extraction, as described in QAPP Appendix A, Attachment 2, SOP-7. The sampling tube will be routed from the sediment floor to a glovebox on the sampling vessel, and 320 to 570 mL of porewater will be collected at each location if possible. The Trident probe will be deployed in one of several ways, depending on the water depth, current velocity, and substrate type at each sample location. For example, a pole-mounted Trident probe may be used in shallow areas with low water velocity and soft substrate, while a Trident probe with a weighed frame and pneumatic hammer may be used in deeper areas with higher flow and coarser substrate.

Prior to the collection of sediment or porewater samples, onsite cultural resources monitors may inspect the location via an underwater video camera mounted to each sampling device.

Sampling stations will be approached at slow boat speeds with minimal wake to minimize disturbance of bottom sediments prior to sampling, particularly in shallow sampling locations. Unless operating in shallow water, all vessel-based sampling devices will be deployed using a hydraulic winch and an overhead davit or boom at a controlled rate of speed of about 1 ft/sec.

Material in the sediment sampler will be photographed along with a small whiteboard, which will include the photograph's station location, date, and time of sample. Overlying water in the sediment sampler (if any) will be removed by siphoning.

Prior to manipulation of the bulk sediment sample, a subsample of fine sediment will be placed into a resealable plastic bag and provided to the cultural resources monitor for inspection. If the subsample passes cultural resources review, the sediment will be used to fill an 8 oz sample jar for analysis of acid volatile sulfide and simultaneously extracted metals. Excess sediment from the resealable plastic bag will then be returned to the sediment sampler.

All remaining sediment in the sampler will then be placed in a transparent Lexan tub for inspection by onsite cultural resources monitors. Following cultural inspection and clearance, a decontaminated Lexan sampling scoop or similar device (e.g., stainless-steel trowel or spoon) will be used to collect sediment for the remaining analytical and biological testing (bioassay and/or benthic macroinvertebrate enumeration) as specified in the QAPP.

4 COORDINATION PLAN

The objective of this CRCP is to ensure that implementation of the RI/FS and associated sampling activities does not adversely affect any cultural resources. The plan therefore defines a general process and describes specific procedures to meet this objective.

The two main challenges in meeting this objective are 1) the iterative process of remedial investigations; and 2) the high density of cultural resources in the study area. The iterative process is a challenge because there are likely to be several rounds of sampling (and associated actions) that extend over several years. Coordination and consultation must therefore also be an iterative process because methods and locations are defined for each round of sampling.

The high density of cultural resources is a challenge because it is highly likely that every round of intrusive sampling will occur at the identified location of one or more cultural resources. At the same time, the high density is potentially misleading by suggesting that all cultural resources in the UCR have been identified. Most—if not all—of the Lake Roosevelt lands have been surveyed for cultural resources in the past. Few of the surveys conducted prior to about 1975 are likely to have met current regulatory and professional standards. In addition, many of the previous surveys focused on archaeological resources to the exclusion of other types of cultural resources (and older archaeological surveys documented only evidence of prehistoric use or occupation). Finally, it is likely that there are some locations previously surveyed at which burials or buried archaeological resources are present, but not evident, and therefore not recorded at the time of the survey (many surveys in the past and in the present rely entirely or primarily on surface evidence of archaeological resources or burials).

This coordination plan therefore defines procedures that address sampling at known locations of cultural resources as well as locations where no cultural resources are currently recorded.

4.1 GENERAL CONSULTATION FRAMEWORK

Implementation of the RI/FS constitutes an "undertaking" as defined in the NHPA; therefore, complying with the NHPA requirements is the responsibility of EPA. EPA is the lead federal agency for cultural resources consultation and coordination for the Site. Any issues or concerns related to cultural resources during the planning and/or implementation of Site work shall be brought to the attention of EPA for consultation with the UCR Cultural Resources Working Group, as appropriate. Successful implementation of the RI/FS and of this

CRCP, given the issues defined above, will require ongoing consultation and coordination with the UCR Cultural Resources Working Group consisting of the NPS, USBR, CCT, STI, and the Washington SHPO (i.e., the consulting parties). Other consulting parties (as defined in 36 CFR 800.2(c)) may be recognized in the future, whose participation would be important for general consultation or coordination in the RI/FS process or for specific sampling locations. For the purposes of cultural resources coordination activities, the "consulting parties" referred to in this plan are distinguished from other "participating parties" to the RI/FS process.

4.2 CULTURAL RESOURCE PROCEDURES IN THE SAMPLING PROCESS

This section defines general procedures to be followed in the sampling process to minimize the potential for inadvertent disturbance of cultural resources. More specific protocols to respond to discoveries are defined in the following subsections.

In addition, the UCR Cultural Resources Working Group recommended to Teck American Incorporated (TAI) that it provide cultural awareness, avoidance, and sensitivity training or refresher programs to field personnel, as appropriate, prior to the commencement of field activities.

4.2.1 Archaeological Monitoring in the Sampling Program

To ensure compliance with the NHPA and the applicable requirements, procedures, and standards of the NPS, USBR, CCT, and STI, the following procedures have been developed to address potential discoveries, including inadvertent discoveries, of cultural materials and deposits (including sacred objects, funerary objects, and objects of cultural patrimony as defined in NAGPRA), as well as Indian burials and human remains (as defined in NAGPRA), during sediment and porewater sampling and associated activity that could result in ground disturbance.

4.2.1.1 Notification of Planned Sediment and Porewater Sampling

TAI shall notify EPA at least 15 days in advance of any sample collection activity, unless shorter notice is agreed to by EPA. Notification to EPA may be provided by email or by letter. As for all RI/FS activities at the Site involving ground penetration and disturbance, TAI shall work with potentially affected parties to assess the effects of the planned work and seek ways to avoid, minimize, or mitigate any adverse effects on historic properties. Further, sediment and porewater sampling cannot be performed at the Site without 1) clearance of proposed locations by tribal and federal/state cultural resources coordinators; 2) a cultural

resources monitor present on site with each field crew conducting sediment and porewater collection activities, unless otherwise indicated by the UCR Cultural Resources Working Group; and 3) approval by EPA.

The names and contact information for potentially affected parties (i.e., representatives of the federal land-managing agencies and tribes) are provided in Attachment E1 of this CRCP. TAI will work with EPA to establish a procedure for timely notification of these parties.

4.2.1.2 Professional Archaeologist and/or Tribal Cultural Monitor On Site

An archaeological monitor and/or Tribal representative will be present on-site when sampling or sampling-related activity occurs. The archaeological monitor and/or Tribal representative will visually examine all sediment samples to determine if evident or likely artifacts are present or if other deposits are present that are likely to be cultural in origin. At porewater sampling locations, porewater will be drawn from the sediment surface using a Trident probe; therefore, inspection for cultural resources will occur via an underwater video camera attached to the Trident probe. The archaeological monitor and/or Tribal representative will not make physical contact with the sediment sample unless artifacts or other cultural deposits are present. If artifacts or likely archaeological deposits are present, the archaeologist or Tribal representative will record the location of the materials and photograph the materials in place in such a manner to provide information on provenience. The artifacts and other archaeological materials will then be re-deposited at their original location.

The archaeological monitor and/or Tribal representative will document their observations on a daily basis, including field notes and photographs that record the location, character of the sampling or other ground-disturbing activity, any archaeological discoveries made, and any decisions made within the provisions of this plan by the archaeological monitor and Tribal representative in response to any archaeological discoveries. A standardized archaeological monitoring form may be substituted for the field notes referenced above.

All archaeological monitors and Tribal representatives will be required to have read the applicable health and safety plan and to have complete understanding of the archaeological monitoring provisions of this plan. The archaeological monitors will also be required to meet requirements for personal protective equipment. In addition, all onsite personnel are subject to the directions of the task field supervisor at all times.

4.2.1.3 Discoveries—Archaeolgical Monitors Present

At the discretion of the archaeological monitor or Tribal representative, ground-disturbing sampling or associated activity may be slowed or halted at any time that a suspected archaeological object or archaeological resource is encountered. The objective of this slowing or halting of ground-disturbing activity is to allow the archaeologist to confirm and/or make a preliminary assessment of the discovery. At the discretion of the archaeological monitor or Tribal representative, a specific sample may be relocated from the location of the discovery but at the sampling location. Such relocation will be coordinated with the onsite sampling manager or supervisor.

At the request of the archaeological monitor or Tribal representative, the sampling personnel will either:

- Assist in securing access to the location of the discovery and take appropriate measures to protect the location of the discovery from rain, stormwater, and other possible disturbances, or
- Assist in moving the artifacts to a protected and secure area of the site away from the immediate sampling area. Removal of artifacts from the discovery location will be undertaken only if leaving the artifacts in place would jeopardize their integrity due to erosion or collection by unauthorized individuals.

The archaeological monitor, Tribal representative, or a member of the TAI technical team will remain on site to ensure the security of the find until more extensive efforts can be made to secure the site from further disturbance or a more extensive evaluation and documentation of the discovery can be made.

Notification of any archaeological discoveries must be provided to EPA for further coordination with consulting parties within 24 hours of the discovery. All telephone notification of discoveries must be promptly followed by notification in writing (via email or conventional mail).

4.2.1.4 Discoveries—Archaeological Monitor Not Present

If suspected or evident artifacts or other archaeological deposits are encountered when an archaeological monitor or Tribal representative is not present, the immediate vicinity of the discovery will be secured. Notification of any archaeological discoveries must be provided to EPA for further coordination with consulting parties within 24 hours of the discovery. All telephone notification of discoveries must be promptly followed by notification in writing (via email or conventional mail).

The discovery will be mapped and photographed in place but will be otherwise left as found (other than appropriate measures to secure the find and maintain security). In consultation with the land-managing agency or appropriate tribe, as well as other interested parties, TAI will arrange for the location of the discovery to be examined by a professional archaeologist and Tribal representative in a timely manner. If the archaeologist/Tribal representative confirms the presence of artifacts or other archaeological deposits, the procedures defined above for discoveries made during ground-disturbing activity monitored by an archaeologist will be implemented. The archaeologist/Tribal representative will prepare appropriate State of Washington archaeological forms to document the find.

To ensure proper recognition of artifacts and other cultural items or deposits, all TAI field personnel will be provided with training in recognizing these materials by a professional archaeologist prior to the initiation of any sediment and porewater sampling.

4.2.1.5 Discovery of Human Remains

Native peoples in the study area consider the graves of their ancestors to be important in both their cultural identity and in defining their relationship with the land. These graves are therefore considered sacred and should be left undisturbed. Should inadvertent disturbance occur, the remains and associated materials (funerary objects) must be treated with respect and honor. All appropriate federal, tribal, and state laws, regulations, and procedures regarding burials should be rigorously enforced.

If likely or confirmed human remains are encountered, all further sampling or other ground-disturbing activity will cease immediately. To comply with 43 CFR 10.4(b), any discoveries of human remains must be reported to the NPS and USBR immediately by telephone, followed by written notification. Any discoveries within the boundaries of the CCT or the STI reservations must also be reported immediately to the respective tribe.

TAI will notify EPA for further coordination with consulting parties (consisting minimally of the NPS, USBR, CCT, STI, and the Washington SHPO). The TAI technical team will assist the archaeological monitor and Tribal representative in securing the location of the discovery.

If no archaeological monitor or Tribal representative is present, the TAI technical team will secure the location of the discovery in such a manner that both maintains the physical integrity of the remains and any associated objects and precludes further disturbance, or a member of the TAI technical team will remain on site until an archaeologist or Tribal representative can arrive to assess the find.

Other conditions for responses to discoveries of archaeological materials may be defined in the permits issued for the sampling program. Responses to any discoveries of burials must comply with provisions of NAGPRA and its implementing regulations (in addition to those referenced above), as well as the existing protocols of the NPS, USBR, CCT, and STI (copies of these protocols are provided in Attachment E1).

4.2.2 Curation

Artifacts and other cultural materials that may be recovered during the sampling program (with the exception of human remains and associated items subject to NAGPRA) will be curated at a facility that meets the standards of 36 CFR 79. The appropriate facility or facilities will be designated by the NPS and USBR in consultation with the tribes for items recovered from federal lands. The appropriate tribe will designate the curation facility for cultural materials recovered from tribal lands.

4.2.3 Reporting

Within 150 days of completion of each sampling activity that is covered under the QAPP,[4] if a discovery is made, a professional archaeologist will prepare a confidential[5] written report that presents the results of responses to any discoveries of archaeological resources or burials. The report will include 1) copies of field notes, descriptions, and maps of all locations at which sampling-related archaeological monitoring was conducted; 2) descriptions of any discoveries made and the outcome of the discoveries (including the rationale for the decisions for the disposition of any finds); 3) descriptions and maps of all nonmonitored locations at which inadvertent discoveries were made and the outcomes of those discoveries; and 4) recommendations for any changes in the monitoring protocol or coordination plan that may be appropriate to address results of the monitoring or how well existing coordination procedures worked. A standardized archaeological monitoring form may be substituted for the field notes referenced above.

The draft report will be provided to EPA for review and dissemination to the consulting parties for review and comment.

[4] Sampling or other RI/FS activities that do not require coordination under the QAPP will not result in generation of this reporting requirement.

[5] Refer to Section 4.3, Confidentiality.

4.3 CONFIDENTIALITY

TAI shall make its best efforts, in accordance with state and federal law, to ensure that its employees and contractors keep the discovery of any found or suspected human remains, other cultural items, and potential historic properties confidential. Pertinent TAI employees and contractors will be required to read and sign a confidentiality statement that specifies procedures to be followed in response to media and public contacts regarding archaeological and other cultural resources. To the extent permitted by law, prior to any release of information, EPA, TAI, and the other consulting parties shall concur on the amount of information, if any, to be released to the public, any third party, and the media, and the procedures for such a release.

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6 GLOSSARY OF TERMS

Burial—A burial is defined in NAGPRA as "[a]ny natural or prepared physical location, whether originally below, on, or above the surface of the earth, into which as part of the death rite or ceremony of a culture, individual human remains are deposited."

Curation—Long-term storage and preservation of archaeological collections. Archaeological collections from federal lands must be curated at facilities that meet the standards of 36 CFR 79.

Ethnohistoric—Information on Native peoples gathered from historical accounts.

Historic, historic-period, historical—The NHPA uses the term "historic" to refer to properties that are listed or have been determined eligible for listing on the National Register of Historic Places. To avoid confusion with this definition of "historic," "historic-period" or "historical" are used to reference resources, places, events, and people associated with the period since the appearance of Euroamericans and the beginning of written accounts (ca. 1780–1810 in the Pacific Northwest).

Protohistoric—The period of time transitional from prehistory to history. In the Pacific Northwest, protohistoric can be generally defined as from the late 1600s until late 1700s.

MAPS

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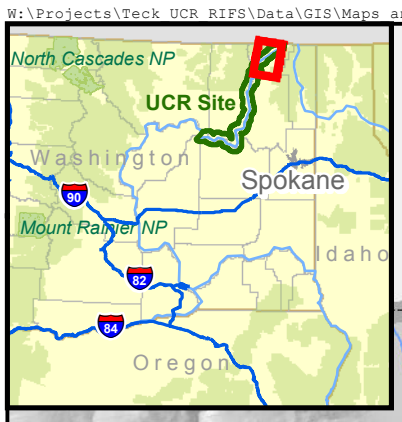

U.S. - Canada Border

RM 744

RM 740

Deadman's Eddy

Big Sheep Creek

Deadman's Eddy

North Fork Deep Creek

251

Northport

RM 730

Deep Creek

25

China Bend

China Bend

RM 720

South Fork Deep Creek

Cable Ferry Landing

Bossburg Flat Beach

Evans Campground

RM 710

Evans

South Fork Deep Creek

Legend

- Upper Reach OU AOI
- Upper Columbia River
- Stream
- Populated Places
- State Highway
- Railroad
- River Mile (USGS)

Windward environmental LLC

0 2 4 Km

0 1 2 Miles

N

Map E1. **Overview of Proposed UCR Sediment Sampling Locations**
Upper Columbia River, WA

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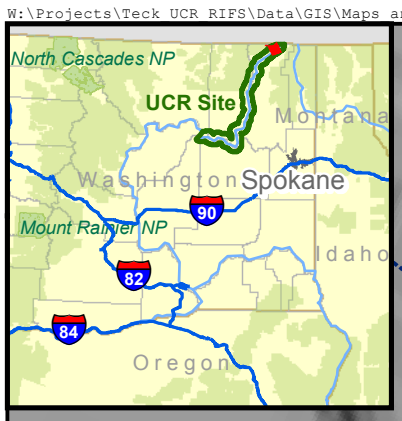

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Legend

Proposed Sampling Locations
- Sampleable Sand – Primary
- Sampleable Sand – Alternate
- Mixed Coarse – Primary
- Mixed Coarse – Alternate
- Coarse (Porewater Only) – Primary
- Coarse (Porewater Only) – Alternate
- Repeat Sampling Location

Sediment Facies (Area/Relative Abundance)
- Bedrock (0.04 sqkm/5.7%)
- Sand (S)(0.07 sqkm/10.5%)
- Mixed Fines, Predominantly Sand (mFs) (0.05 sqkm/8.6%)
- Mixed Coarse with Sand (mCs) (0.03 sqkm/4.7%)
- Mixed Boulder/Cobble with Sand (mBs) (0.03 sqkm/4.0%)
- Coarse (C)(0.42 sqkm/65.8%)
- Boulder/Cobble (B)(<0.01 sqkm/0.7%)

- Upper Reach OU AOI

UCR Riverbed Elevation
- 1,290 ft
- Historical Thalweg
- Major Road
- Railroad
- River Mile (USGS)

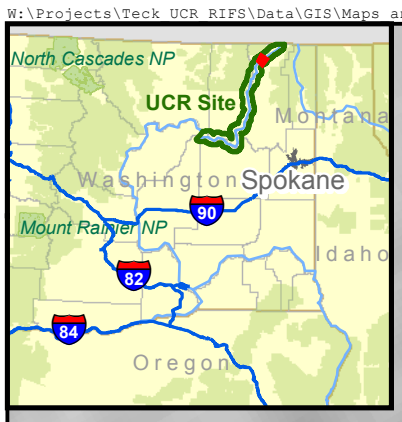
Windward environmental LLC

0 0.1 0.2 Km

0 0.05 0.1 Miles

Map E2. **Proposed Sampling Locations at Deadman's Eddy AOI**
Upper Columbia River, WA

W:\Projects\Teck UCR RIFS\Data\GIS\Maps and Analyses\Phase 3 Support\Sediment QAPP\Cultural Resources Coordination Plan\Map E3 7033 Sed facies and proposed smp locs - China Bend.mxd @ 08/19/2019



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CB002
CB001
JS001
JS002
JS003
JS004
3-R7-2019
3-R8-2019
25

Legend

Proposed Sampling Locations

- Sampleable Sand – Primary
- Sampleable Sand – Alternate
- Mixed Coarse – Primary
- Mixed Coarse – Alternate
- Mud – Primary
- Mud – Alternate
- Coarse (Porewater Only) – Primary
- Coarse (Porewater Only) – Alternate
- Judgmental Sampling Location - Primary
- Judgmental Sampling Location - Alternate
- Repeat Sampling Location

Sediment Facies (Area/Relative Abundance)

- Bedrock (0.05 sqkm/3.3%)
- Dense Vegetation (0.10 sqkm/6.8%)
- Gravel (G)(<0.01 sqkm/0.1%)
- Sand (S)(0.09 sqkm/6.3%)
- Mixed Fines, Predominantly Sand (mFs) (0.11 sqkm/7.7%)
- Mixed Coarse with Sand (mCs) (0.30 sqkm/21.1%)
- Mixed Boulder/Cobble with Sand (mBs) (0.17 sqkm/11.9%)
- Mud (M)(0.08 sqkm/5.9%)
- Mixed Fines, predominantly Mud (mFm) (0.02 sqkm/1.4%)
- Mixed Coarse with Mud (mCm) (0.01 sqkm/0.5%)
- Mixed Boulder/Cobble with Mud (mBm) (<0.01 sqkm/0.2%)
- Coarse (C)(0.45 sqkm/31.7%)
- Boulder/Cobble (B)(0.04 sqkm/3.2%)

- Upper Reach OU AOI

UCR Riverbed Elevation

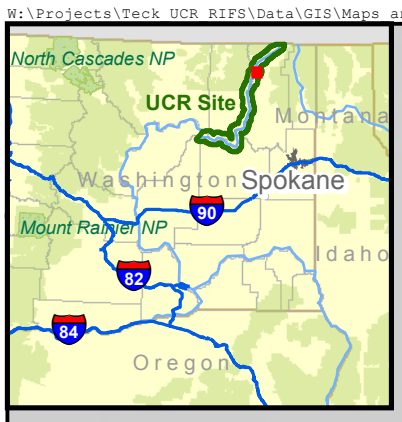
- 1,220 ft
- 1,250 ft
- Historical Thalweg
- Major Road
- Railroad
- River Mile (USGS)

Windward environmental LLC

Km 0 0.2 0.4
Miles 0 0.1 0.2
N

Map E3. **Proposed Sampling Locations at China Bend AOI**
Upper Columbia River, WA

W:\Projects\Teck UCR RIFS\Data\GIS\Maps and Analyses\Phase 3 Support\Sediment QAPP\Cultural Resources Coordination Plan\Map E4 7033 Sed facies and proposed smp locs - Evans.mxd @ 08/19/2019



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EV014
EV022
EV023
EV006
EV020
EV017
EV005
4-B6-2019
EV007
EV018
EV002
EV016
EV008
RM 708
EV013
EV015
EV009
EV012
EV001
EV010
EV003
EV011
25

Legend

Proposed Sampling Locations
- Sampleable Sand – Primary
- Sampleable Sand – Alternate
- Mixed Coarse – Primary
- Mixed Coarse – Alternate
- Mud – Primary
- Mud – Alternate
- Coarse (Porewater Only) – Primary
- Coarse (Porewater Only) – Alternate
- Repeat Sampling Location

Sediment Facies (Area/Relative Abundance)
- Bedrock (0.19 sqkm/5.2%)
- Dense Vegetation (0.27 sqkm/7.5%)
- Sand (S)(0.81 sqkm/22.2%)
- Mixed Fines, Predominantly Sand (mFs) (0.40 sqkm/11.1%)
- Mixed Coarse with Sand (mCs) (0.32 sqkm/8.9%)
- Mixed Boulder/Cobble with Sand (mBs) (0.31 sqkm/8.5%)
- Mud (M)(1.09 sqkm/30.0%)
- Mixed Fines, predominantly Mud (mFm) (0.06 sqkm/1.7%)
- Mixed Coarse with Mud (mCm) (0.02 sqkm/0.6%)
- Mixed Boulder/Cobble with Mud (mBm) (0.03 sqkm/0.8%)
- Coarse (C)(0.12 sqkm/3.4%)
- Boulder/Cobble (B)(0.01 sqkm/0.2%)

- Upper Reach OU AOI

UCR Riverbed Elevation
- 1,220 ft
- 1,250 ft
- Historical Thalweg
- Populated Places
- Major Road
- Railroad
- River Mile (USGS)

Windward environmental LLC

0 0.2 0.4 Km

0 0.1 0.2 Miles

N

Map E4. **Proposed Sampling Locations at Evans AOI**
Upper Columbia River, WA

TABLE

Table E3-1. Proposed UCR Sampling Locations

Area	Location ID	Primary, Alternate, or Repeat	Sample Type(s)	EPA Split Sample Type(s)	Target Stratum	Target Facies	Facies Elevation (ft amsl)	Elevation Class	X_UTM_11N (meters)	Y_UTM_11N (meters)
China Bend	CB001	A	PW	NS	coarse	B	1,209.6	< 1220	429350	5407271
China Bend	CB002	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,245.0	1220 to 1250	429476	5407452
China Bend	CB003	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,244.6	1220 to 1250	429512	5407456
China Bend	CB004	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,218.3	< 1220	429499	5407408
China Bend	CB005	P	SE, PW, BMI	SE, PW	mixed coarse	mCs	1,154.8	< 1220	429458	5407331
China Bend	CB006	P	SE, PW, TX, BMI	NS	sampleable sand	S	1,230.1	1220 to 1250	429540	5407412
China Bend	CB007	P	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,262.4	> 1250	429567	5407464
China Bend	CB008	P	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,241.3	1220 to 1250	429571	5407441
China Bend	CB009	P	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,259.0	> 1250	429612	5407449
China Bend	CB010	A	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,236.0	1220 to 1250	429625	5407436
China Bend	CB011	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,216.0	< 1220	429626	5407406
China Bend	CB012	P	SE, PW, TX, BMI	PW	sampleable sand	S	1,211.9	< 1220	429602	5407385
China Bend	CB013	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,167.6	< 1220	429563	5407352
China Bend	CB014	P	SE, PW, TX, BMI	TX	sampleable sand	S	1,165.0	< 1220	429614	5407338
China Bend	CB015	A	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,238.1	1220 to 1250	429682	5407421
China Bend	CB016	P	SE, PW, TX, BMI	PW	sampleable sand	mFs	1,218.9	< 1220	429676	5407402
China Bend	CB017	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,169.3	< 1220	429667	5407336
China Bend	CB018	P	SE, PW, TX, BMI	NS	sampleable sand	S	1,220.1	1220 to 1250	429706	5407381
China Bend	CB019	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,176.8	< 1220	429705	5407323
China Bend	CB020	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,219.2	< 1220	429734	5407361
China Bend	CB021	P	SE, PW, TX, BMI	NS	mud	M	1,243.9	1220 to 1250	429793	5407363
China Bend	CB022	P	SE, PW, TX, BMI	NS	sampleable sand	S	1,210.2	< 1220	429779	5407320
China Bend	CB023	A	SE, PW, TX, BMI	NS	mud	M	1,250.5	> 1250	429802	5407350
China Bend	CB024	P	SE, PW, TX, BMI	NS	mud	M	1,224.9	1220 to 1250	429796	5407334
China Bend	CB025	A	SE, PW, TX, BMI	NS	mud	M	1,261.7	> 1250	429813	5407352
China Bend	CB026	A	SE, PW, TX, BMI	NS	mud	M	1,228.8	1220 to 1250	429808	5407329
China Bend	CB027	P	SE, PW, TX, BMI	NS	mud	M	1,211.9	< 1220	429798	5407317
China Bend	CB028	A	SE, PW, TX, BMI	NS	mud	M	1,228.8	1220 to 1250	429805	5407315
China Bend	CB029	P	SE, PW, TX, BMI	TX	mud	M	1,252.5	> 1250	429831	5407316
China Bend	CB030	A	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,216.1	< 1220	429847	5407267
China Bend	CB031	P	SE, PW, TX, BMI	TX	sampleable sand	mFs	1,210.2	< 1220	429858	5407245
China Bend	CB032	P	SE, PW, BMI	NS	mixed coarse	mCs	1,230.9	1220 to 1250	430023	5407204
China Bend	CB033	A	PW	NS	coarse	B	1,198.8	< 1220	430005	5407105
China Bend	CB034	A	SE, PW, BMI	NS	mixed coarse	mCs	1,208.2	< 1220	430149	5407087
China Bend	CB035	P	SE, PW, BMI	NS	mixed coarse	mCs	1,219.8	< 1220	430354	5407156
China Bend	CB036	A	SE, PW, BMI	NS	mixed coarse	mCs	1,217.7	< 1220	430428	5407112
China Bend	CB037	A	SE, PW, BMI	NS	mixed coarse	mCs	1,221.2	1220 to 1250	430494	5407113
China Bend	CB038	P	SE, PW, BMI	NS	mixed coarse	mCs	1,222.0	1220 to 1250	430548	5407140

Table E3-1. Proposed UCR Sampling Locations

Area	Location ID	Primary, Alternate, or Repeat	Sample Type(s)	EPA Split Sample Type(s)	Target Stratum	Target Facies	Facies Elevation (ft amsl)	Elevation Class	X_UTM_11N (meters)	Y_UTM_11N (meters)
China Bend	CB039	P	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,223.1	1220 to 1250	430647	5407204
China Bend	CB040	A	SE, PW, BMI	NS	mixed coarse	mCs	1,217.4	< 1220	430614	5407244
China Bend	CB041	P	PW	PW	coarse	C	1,226.2	1220 to 1250	430770	5407127
China Bend	CB042	A	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,225.6	1220 to 1250	430687	5407216
China Bend	CB043	P	PW	NS	coarse	C	1,223.1	1220 to 1250	430661	5407260
China Bend	CB044	P	SE, PW, TX, BMI	NS	mud	M	1,260.0	> 1250	430625	5407342
China Bend	CB045	A	SE, PW, TX, BMI	NS	mud	M	1,260.0	> 1250	430633	5407349
China Bend	CB046	P	SE, PW, BMI	NS	mixed coarse	mCs	1,225.8	1220 to 1250	430802	5407336
China Bend	CB047	P	SE, PW, TX, BMI	SE, PW, TX	sampleable sand	mFs	1,234.5	1220 to 1250	431007	5407422
China Bend	CB048	P	PW	NS	coarse	C	1,232.4	1220 to 1250	431088	5407419
China Bend	CB049	P	PW	NS	coarse	C	1,229.9	1220 to 1250	431255	5407342
China Bend	CB050	P	SE, PW, BMI	NS	mixed coarse	mCs	1,219.1	< 1220	431274	5407406
China Bend	CB051	A	PW	NS	coarse	C	1,230.3	1220 to 1250	431430	5407509
China Bend	CB052	P	PW	NS	coarse	C	1,220.5	1220 to 1250	431601	5407515
China Bend	CB053	A	PW	NS	coarse	mBs	1,246.5	1220 to 1250	431803	5407542
China Bend	CB054	A	SE, PW, BMI	NS	mixed coarse	mCs	1,213.3	< 1220	431812	5407633
China Bend	CB055	P	PW	NS	coarse	C	1,226.8	1220 to 1250	431792	5407692
China Bend	CB056	A	SE, PW, BMI	NS	mixed coarse	mCs	1,226.2	1220 to 1250	432089	5407732
China Bend	CB057	A	PW	NS	coarse	mBs	1,224.2	1220 to 1250	432092	5407831
China Bend	CB058	A	PW	NS	coarse	C	1,232.7	1220 to 1250	432202	5408183
China Bend	JS001	P	SE, PW, BMI	NS	sampleable sand	S	1,238.7	1220 to 1250	430966	5407512
China Bend	JS002	P	SE, PW, BMI	NS	sampleable sand	S	1,248.1	1220 to 1250	431069	5407578
China Bend	JS003	A	SE, PW, BMI	NS	sampleable sand	S	1,245.2	1220 to 1250	431014	5407540
China Bend	JS004	A	SE, PW, BMI	NS	sampleable sand	S	1,242.3	1220 to 1250	430969	5407554
Deadman's Eddy	DM001	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,261.1	NA	445961	5421205
Deadman's Eddy	DM002	P	SE, PW, TX, BMI	NS	sampleable sand	S	1,261.1	NA	445978	5421211
Deadman's Eddy	DM004	A	SE, PW, BMI	NS	mixed coarse	mCs	1,259.7	NA	445998	5421196
Deadman's Eddy	DM005	A	SE, PW, BMI	NS	mixed coarse	mCs	1,257.9	NA	446028	5421170
Deadman's Eddy	DM006	A	SE, PW, BMI	NS	mixed coarse	mCs	1,257.1	NA	446038	5421153
Deadman's Eddy	DM007	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,257.9	NA	446069	5421183
Deadman's Eddy	DM008	P	SE, PW, TX, BMI	TX	sampleable sand	S	1,263.0	NA	446070	5421205
Deadman's Eddy	DM009	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,270.1	NA	446207	5421191
Deadman's Eddy	DM010	P	SE, PW, TX, BMI	SE, PW	sampleable sand	S	1,281.9	NA	446108	5421208
Deadman's Eddy	DM011	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,272.1	NA	446107	5421183
Deadman's Eddy	DM012	A	SE, PW, BMI	NS	mixed coarse	mCs	1,255.8	NA	446097	5421153
Deadman's Eddy	DM013	P	SE, PW, BMI	NS	mixed coarse	mCs	1,254.1	NA	446086	5421137
Deadman's Eddy	DM014	P	SE, PW, BMI	NS	mixed coarse	mCs	1,254.1	NA	446099	5421135
Deadman's Eddy	DM015	P	SE, PW, TX, BMI	NS	sampleable sand	S	1,280.4	NA	446155	5421228

Table E3-1. Proposed UCR Sampling Locations

Area	Location ID	Primary, Alternate, or Repeat	Sample Type(s)	EPA Split Sample Type(s)	Target Stratum	Target Facies	Facies Elevation (ft amsl)	Elevation Class	X_UTM_11N (meters)	Y_UTM_11N (meters)
Deadman's Eddy	DM016	P	SE, PW, TX, BMI	NS	sampleable sand	S	1,278.4	NA	446172	5421158
Deadman's Eddy	DM017	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,248.1	NA	446183	5421064
Deadman's Eddy	DM018	P	SE, PW, TX, BMI	NS	sampleable sand	S	1,276.7	NA	446198	5421144
Deadman's Eddy	DM019	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,277.1	NA	446207	5421191
Deadman's Eddy	DM020	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,277.1	NA	446222	5421213
Deadman's Eddy	DM021	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,270.9	NA	446243	5421224
Deadman's Eddy	DM022	P	SE, PW, TX, BMI	NS	sampleable sand	S	1,280.7	NA	446234	5421155
Deadman's Eddy	DM023	P	SE, PW, TX, BMI	NS	sampleable sand	S	1,279.4	NA	446259	5421166
Deadman's Eddy	DM024	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,279.5	NA	446251	5421110
Deadman's Eddy	DM025	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,276.7	NA	446314	5421101
Deadman's Eddy	DM026	P	SE, PW, TX, BMI	PW, TX	sampleable sand	S	1,280.4	NA	446283	5421071
Deadman's Eddy	DM027	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,271.4	NA	446313	5421058
Deadman's Eddy	DM028	P	PW	PW	coarse	C	1,268.9	NA	446224	5420934
Deadman's Eddy	DM029	P	PW	NS	coarse	C	1,256.3	NA	446384	5420813
Deadman's Eddy	DM030	A	PW	NS	coarse	C	1,280.2	NA	446701	5420788
Deadman's Eddy	DM031	A	SE, PW, BMI	NS	mixed coarse	mCs	1,249.4	NA	446661	5420526
Deadman's Eddy	DM032	P	SE, PW, BMI	NS	mixed coarse	mCs	1,249.7	NA	446682	5420529
Deadman's Eddy	DM033	P	SE, PW, TX, BMI	NS	sampleable sand	S	1,254.1	NA	446708	5420531
Deadman's Eddy	DM034	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,254.4	NA	446666	5420469
Deadman's Eddy	DM035	P	SE, PW, TX, BMI	TX	sampleable sand	S	1,253.3	NA	446680	5420451
Deadman's Eddy	DM036	P	SE, PW, BMI	SE, PW	mixed coarse	mCs	1,250.2	NA	446699	5420445
Deadman's Eddy	DM037	A	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,268.5	NA	446729	5420368
Deadman's Eddy	DM038	A	SE, PW, BMI	NS	mixed coarse	mCs	1,261.5	NA	446761	5420448
Deadman's Eddy	DM039	P	SE, PW, BMI	NS	mixed coarse	mCs	1,266.3	NA	446769	5420444
Deadman's Eddy	DM040	P	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,274.9	NA	446779	5420425
Deadman's Eddy	DM041	A	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,272.8	NA	446770	5420396
Deadman's Eddy	DM042	P	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,270.7	NA	446791	5420341
Deadman's Eddy	DM043	A	PW	NS	coarse	C	1,268.3	NA	446770	5420319
Deadman's Eddy	DM044	P	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,271.0	NA	446790	5420320
Deadman's Eddy	DM045	A	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,271.9	NA	446842	5420282
Deadman's Eddy	DM046	A	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,275.6	NA	446852	5420275
Deadman's Eddy	DM047	P	SE, PW, BMI	NS	mixed coarse	mCs	1,271.4	NA	446818	5420448
Deadman's Eddy	DM048	P	SE, PW, TX, BMI	TX	sampleable sand	mFs	1,271.1	NA	446869	5420366
Deadman's Eddy	DM049	A	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,263.6	NA	446884	5420360
Deadman's Eddy	DM050	P	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,265.3	NA	446892	5420322
Deadman's Eddy	DM051	P	SE, PW, TX, BMI	PW	sampleable sand	mFs	1,277.4	NA	446875	5420405
Deadman's Eddy	DM052	P	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,277.4	NA	446900	5420400
Deadman's Eddy	DM053	A	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,265.1	NA	446934	5420386

Table E3-1. Proposed UCR Sampling Locations

Area	Location ID	Primary, Alternate, or Repeat	Sample Type(s)	EPA Split Sample Type(s)	Target Stratum	Target Facies	Facies Elevation (ft amsl)	Elevation Class	X_UTM_11N (meters)	Y_UTM_11N (meters)
Deadman's Eddy	DM054	A	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,272.0	NA	446847	5420524
Deadman's Eddy	DM055	A	PW	NS	coarse	C	1,276.7	NA	446921	5420705
Deadman's Eddy	DM056	P	PW	NS	coarse	C	1,277.0	NA	446944	5420805
Deadman's Eddy	DM057	P	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,267.4	NA	447027	5420499
Deadman's Eddy	DM058	A	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,268.5	NA	447048	5420521
Deadman's Eddy	DM059	P	PW	NS	coarse	C	1,271.3	NA	447036	5420591
Deadman's Eddy	DM060	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,271.9	NA	447064	5420571
Deadman's Eddy	DM061	P	SE, PW, TX, BMI	NS	sampleable sand	S	1,276.4	NA	447098	5420650
Deadman's Eddy	DM062	P	PW	NS	coarse	C	1,279.8	NA	447178	5420949
Deadman's Eddy	DM063	P	PW	NS	coarse	C	1,280.6	NA	447314	5420971
Deadman's Eddy	DM064	A	PW	NS	coarse	C	1,264.6	NA	447310	5421145
Deadman's Eddy	DM065	A	PW	NS	coarse	C	1,254.0	NA	447367	5421140
Deadman's Eddy	DM066	P	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,256.2	NA	447409	5421290
Evans	EV001	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,202.5	< 1220	422463	5391534
Evans	EV002	P	SE, PW, TX, BMI	TX	sampleable sand	S	1,204.0	< 1220	422495	5391672
Evans	EV003	A	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,201.3	< 1220	422509	5391491
Evans	EV004	A	SE, PW, TX, BMI	NS	mud	M	1,255.9	> 1250	422575	5391868
Evans	EV005	P	SE, PW, TX, BMI	NS	sampleable sand	S	1,202.1	< 1220	422603	5391705
Evans	EV006	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,200.2	< 1220	422660	5391744
Evans	EV007	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,195.2	< 1220	422728	5391709
Evans	EV008	P	SE, PW, TX, BMI	NS	sampleable sand	S	1,198.4	< 1220	422708	5391653
Evans	EV009	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,201.7	< 1220	422679	5391573
Evans	EV010	P	SE, PW, TX, BMI	PW	sampleable sand	mFs	1,201.2	< 1220	422660	5391528
Evans	EV011	A	SE, PW, BMI	NS	mixed coarse	mCs	1,217.4	< 1220	422776	5391453
Evans	EV012	P	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,199.8	< 1220	422815	5391576
Evans	EV013	P	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,200.8	< 1220	422910	5391593
Evans	EV014	P	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,216.0	< 1220	422857	5391808
Evans	EV015	P	SE, PW, BMI	SE, PW	mixed coarse	mCs	1,201.2	< 1220	423086	5391612
Evans	EV016	A	SE, PW, BMI	NS	mixed coarse	mCs	1,203.4	< 1220	423197	5391663
Evans	EV017	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,201.4	< 1220	423187	5391741
Evans	EV018	P	PW	NS	coarse	mBs	1,205.9	< 1220	423341	5391692
Evans	EV019	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,199.7	< 1220	423420	5391883
Evans	EV020	A	SE, PW, BMI	NS	mixed coarse	mCs	1,207.3	< 1220	423492	5391761
Evans	EV021	P	PW	NS	coarse	mBs	1,208.0	< 1220	423640	5391827
Evans	EV022	P	SE, PW, BMI	NS	mixed coarse	mCs	1,208.0	< 1220	423655	5391802
Evans	EV023	P	PW	NS	coarse	mBs	1,238.0	1220 to 1250	423866	5391829
Evans	EV024	P	PW	NS	coarse	C	1,257.0	> 1250	423911	5391844
Evans	EV025	A	PW	NS	coarse	mBs	1,203.0	< 1220	423743	5392072

Table E3-1. Proposed UCR Sampling Locations

Area	Location ID	Primary, Alternate, or Repeat	Sample Type(s)	EPA Split Sample Type(s)	Target Stratum	Target Facies	Facies Elevation (ft amsl)	Elevation Class	X_UTM_11N (meters)	Y_UTM_11N (meters)
Evans	EV026	P	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,206.7	< 1220	423832	5392159
Evans	EV027	P	SE, PW, TX, BMI	TX	sampleable sand	mFs	1,201.6	< 1220	423866	5392028
Evans	EV028	A	SE, PW, BMI	NS	mixed coarse	mCs	1,200.9	< 1220	423968	5392005
Evans	EV029	P	PW	NS	coarse	mBs	1,197.4	< 1220	424041	5392086
Evans	EV030	A	PW	NS	coarse	mBs	1,195.7	< 1220	424077	5392080
Evans	EV031	A	SE, PW, BMI	NS	mixed coarse	mCs	1,201.9	< 1220	424127	5392055
Evans	EV032	A	PW	NS	coarse	C	1,253.1	> 1250	424207	5391990
Evans	EV033	A	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,192.3	< 1220	424117	5392138
Evans	EV034	P	SE, PW, BMI	NS	mixed coarse	mCs	1,232.0	1220 to 1250	424297	5392053
Evans	EV035	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,196.2	< 1220	424189	5392225
Evans	EV036	P	SE, PW, BMI	NS	mixed coarse	mCs	1,232.7	1220 to 1250	424415	5392111
Evans	EV037	P	SE, PW, TX, BMI	SE, PW	sampleable sand	S	1,204.9	< 1220	424273	5392314
Evans	EV038	A	PW	NS	coarse	C	1,232.8	1220 to 1250	424510	5392190
Evans	EV039	A	SE, PW, BMI	NS	mixed coarse	mCs	1,201.4	< 1220	424508	5392336
Evans	EV040	A	PW	NS	coarse	mBs	1,211.4	< 1220	424602	5392305
Evans	EV041	P	PW	NS	coarse	mBs	1,209.0	< 1220	424691	5392415
Evans	EV042	P	SE, PW, BMI	NS	mixed coarse	mCs	1,201.5	< 1220	424768	5392626
Evans	EV043	A	PW	NS	coarse	mBs	1,204.4	< 1220	424735	5392717
Evans	EV044	P	SE, PW, TX, BMI	TX	mud	M	1,258.0	> 1250	424998	5392740
Evans	EV045	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,199.0	< 1220	424714	5392805
Evans	EV046	P	SE, PW, TX, BMI	NS	sampleable sand	S	1,269.9	> 1250	425232	5392896
Evans	EV047	A	SE, PW, TX, BMI	NS	mud	M	1,257.2	> 1250	425146	5392954
Evans	EV048	P	SE, PW, TX, BMI	NS	sampleable sand	S	1,182.5	< 1220	424638	5392930
Evans	EV049	P	SE, PW, BMI	NS	mixed coarse	mCs	1,210.6	< 1220	424694	5392956
Evans	EV050	A	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,214.3	< 1220	424726	5393028
Evans	EV051	P	SE, PW, TX, BMI	NS	sampleable sand	S	1,205.3	< 1220	424659	5393066
Evans	EV052	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,207.1	< 1220	424623	5393169
Evans	EV053	P	SE, PW, TX, BMI	NS	sampleable sand	S	1,206.5	< 1220	424702	5393228
Evans	EV054	P	SE, PW, TX, BMI	NS	mud	M	1,259.9	> 1250	425060	5393189
Evans	EV055	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,203.0	< 1220	424633	5393349
Evans	EV056	A	SE, PW, TX, BMI	NS	mud	M	1,255.5	> 1250	424977	5393465
Evans	EV057	P	SE, PW, TX, BMI	NS	mud	M	1,258.0	> 1250	424823	5393493
Evans	EV058	P	SE, PW, TX, BMI	NS	sampleable sand	S	1,223.9	1220 to 1250	424681	5393481
Evans	EV059	P	SE, PW, TX, BMI	NS	sampleable sand	S	1,207.5	< 1220	424554	5393581
Evans	EV060	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,205.2	< 1220	424566	5393697
Evans	EV061	A	SE, PW, TX, BMI	NS	mud	M	1,256.6	> 1250	424911	5393737
Evans	EV062	P	SE, PW, TX, BMI	PW	sampleable sand	S	1,260.6	> 1250	425015	5393767
Evans	EV063	P	SE, PW, TX, BMI	PW	mud	M	1,256.1	> 1250	424892	5393901

Table E3-1. Proposed UCR Sampling Locations

Area	Location ID	Primary, Alternate, or Repeat	Sample Type(s)	EPA Split Sample Type(s)	Target Stratum	Target Facies	Facies Elevation (ft amsl)	Elevation Class	X_UTM_11N (meters)	Y_UTM_11N (meters)
Evans	EV064	P	SE, PW, TX, BMI	NS	mud	M	1,260.8	> 1250	424645	5393930
Evans	EV065	P	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,206.3	< 1220	424462	5393916
Evans	EV066	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,205.6	< 1220	424474	5393994
Evans	EV067	P	SE, PW, TX, BMI	NS	sampleable sand	S	1,211.6	< 1220	424537	5394017
Evans	EV068	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,216.5	< 1220	424557	5394086
Evans	EV069	P	SE, PW, TX, BMI	TX	sampleable sand	S	1,204.2	< 1220	424427	5394120
Evans	EV070	A	SE, PW, TX, BMI	NS	mud	M	1,260.2	> 1250	424984	5394215
Evans	EV071	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,197.3	< 1220	424445	5394262
Evans	EV072	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,204.7	< 1220	424378	5394308
Evans	EV073	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,204.4	< 1220	424343	5394388
Evans	EV074	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,224.5	1220 to 1250	424476	5394396
Evans	EV075	P	SE, PW, TX, BMI	NS	sampleable sand	mFs	1,204.6	< 1220	424385	5394453
Evans	EV076	A	SE, PW, TX, BMI	NS	sampleable sand	S	1,205.2	< 1220	424290	5394457
Deadman's Eddy	1-B5-NRT	R	SE, PW, TX, BMI	NS	NA	NA	NA	NA	446376	5421101
Deadman's Eddy	1-B6-NRT	R	SE, PW, TX, BMI	NS	NA	NA	NA	NA	446353	5421016
China Bend	3-R7-2019	R	SE, PW, TX, BMI	NS	NA	C	NA	NA	430299	5407152
China Bend	3-R8-2019	R	SE, PW, TX, BMI	NS	NA	B	NA	NA	429442	5407277
Evans	4-B1-2019	R	SE, PW, TX, BMI	NS	NA	S	NA	NA	424499	5393517
Evans	4-B6-2019	R	SE, PW, TX, BMI	NS	NA	bedrock	NA	NA	423102	5391739

Notes:

Primary judgmental (JS001 and JS002) and alternate judgmental (JS003 and JS004) sample locations were added to the China Bend area of interest (AOI) as requested by EPA.

A - alternate

BMI - benthic macroinvertebrate

NA - not applicable

NS - not specified as an EPA split location by EPA

P - primary

PW - porewater

R - repeat

SE - sediment

TX - potential toxicity testing

Facies

M - mud (silt and clay, < 0.063 mm)

S - sand (0.063 mm – 2 mm)

B - boulder/cobble (> 64 mm)

mFs - mixed finer-grained, predominantly sand

mCs - mixed coarse, with sand

mBs - mixed boulder/cobble, with sand

C - coarse

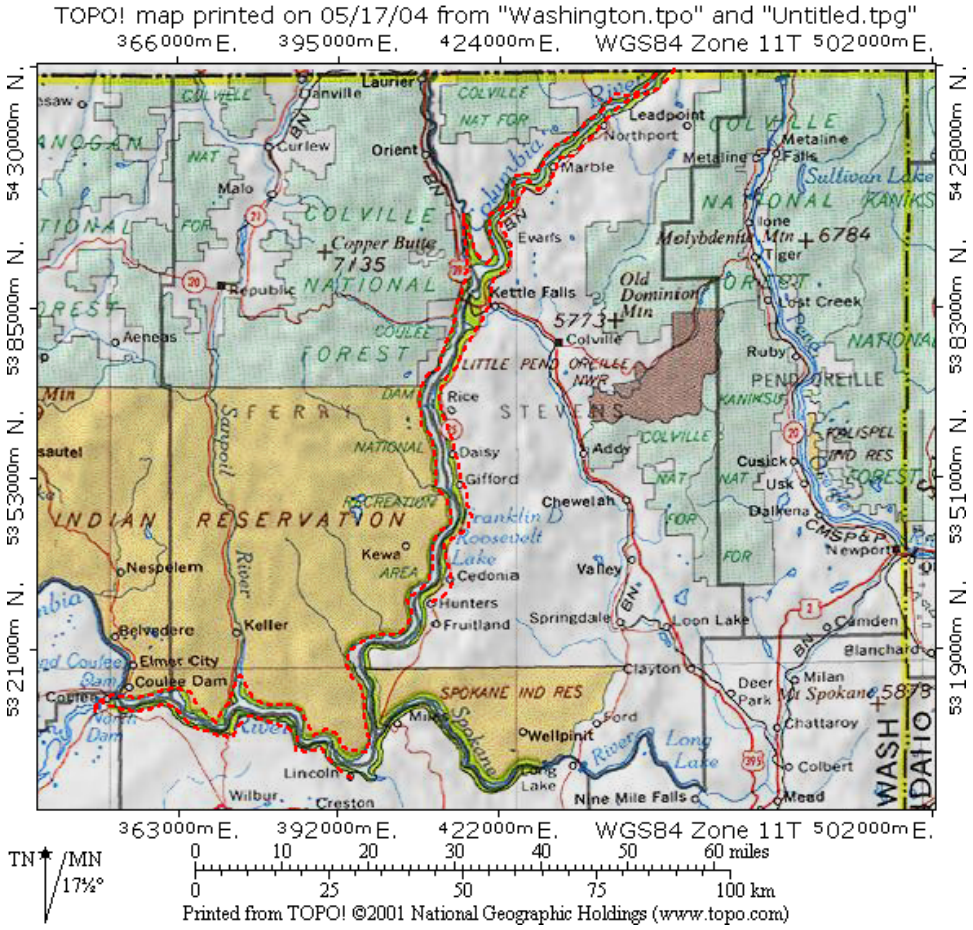
ATTACHMENT E1

PROTOCOLS FOR INADVERTENT DISCOVERIES

NAGPRA Inadvertent Discoveries or Intentional Excavations: Confederated Tribes of the Colville Reservation, National Park Service, and the Bureau of Reclamation

Lake Roosevelt Protocols for Native American Graves Protection and Repatriation Act (NAGPRA) Inadvertent Discoveries or Intentional Excavations: Confederated Tribes of the Colville Reservation, National Park Service, and the Bureau of Reclamation

This protocol is intended to cover NAGPRA items exposed by inadvertent discoveries or intentional excavations within the boundaries of lands managed by the National Park Service (NPS)/Lake Roosevelt National Recreation Area. The term "NAGPRA items" in this document refers to human NAGPRA items, associated funerary objects, and objects of cultural patrimony as they are defined in 25 USC 3001. This document does not address inadvertent discoveries on lands within reservation boundaries or trust land outside of the reservation boundaries of the Confederated Tribes of the Colville Reservation (CCT). Funding of actions is not covered under this protocol.



Map of Lake Roosevelt National Recreation Area

This protocol covers those areas highlighted in red within the recreation area, which is the yellow highlighted portion of the Lake Roosevelt shoreline.

1. If NAGPRA items that are potentially human are encountered, any activity in the vicinity of the discovery shall cease and all reasonable efforts shall be made to protect the NAGPRA items and all appropriate effort shall be made to determine if the NAGPRA items are human. The activity shall resume only when clearance to proceed is received by the CCT Tribal Historic Preservation Officer and the National Park Service's designated official.

2. If the NAGPRA items are determined to be human, the burial or location shall not be disturbed in any way. Any discovered human NAGPRA items and associated artifacts will be treated in a respectful manner.

3. In cases where a potential crime scene exists, *personnel except those necessary to protect the location will leave the immediate vicinity in order to prevent unintentional destruction of crime scene information.* A National Park Service law enforcement officer will be immediately notified.

4. The Colville Tribal Historic Preservation Officer and the archaeologists working for the Colville Tribes and the Park Service (numbers listed below) will also be contacted immediately after law enforcement. For NAGPRA discoveries associated with the Lake Roosevelt shoreline, the Reclamation archaeologist must also be contacted. Live phone contact is required; backup staff are identified if the primary contacts are unavailable. Phone contact will be followed up by written confirmation, e-mail is acceptable. E-mail should not include detailed (site specific information) for security reasons.

5. A professional archaeologist will assist law enforcement in determining if the NAGPRA items are archaeological in origin. If the crime scene is ARPA-related (i.e., there is evidence for intentional disturbance or looting of archaeological materials), an archaeologist shall assist law enforcement as needed in the collection of archeological data to support the ARPA case.

6. Guy Moura, CCT THPO and Program Manager of the CCT History/Archaeology Program is the primary contact for the CCT. Mr. Moura's phone number at the Program is (509) 634-2695 and email is guy.moura@colvilletribes.com. After hours, Mr. Moura can be contacted at (509) 631-1705 (cell). If Mr. Moura cannot be reached, then Jon Meyer, Tribal Archaeologist is the alternate contact at (509) 634-2691 (office) or (509) 631-2130 (cell) and at jon.meyer@colvilletribes.com. In the event that neither Mr. Moura or Mr. Meyer cannot be contacted, then Arrow Coyote, CCT Senior Archaeologist will be contacted at (509) 634-2736 (office) or (509) 634-1280 (cell) and at mailto: arrow.coyote@colvilletribes.com. Mr. Meyer or Ms. Coyote shall participate in the NAGPRA consultation process on Mr. Moura's behalf until his return. Jackie Cook, Repatriation Specialist will also participate in the NAGPRA consultation process. Ms. Cook's contact information

is (509) 634-2635 (office) or (509) 631-1176 (cell) and jackie.cook@colvilletribes.com. The CCT shall maintain a presence at the location of the discovery as needed until all contacts have been made and appropriate treatment of the NAGPRA items has been conducted.

Jon Edwards, NPS Project Manager for the Lake Roosevelt National Recreation Area, is the primary contact for the NPS. Mr. Edward's phone number is (509) 754-7876 or (509) 631-0103, and his FAX is (509) 633-3862, and internet address is jon_edwards@nps.gov.

Derek Beery, Power Office Archaeologist, is Reclamation's contact. His phone number is (509) 633-9233 [desk], (509) 237-4477 [cell phone] FAX 633-9138, and internet address is mailto: dbeery@usbr.gov. If Derek Beery is not available, contact Sean Hess, Regional Archaeologist (208) 378-5316, FAX (208) 378-5305, and internet address is shess@usbr.gov.

7. As soon as the NAGPRA items have been determined to be human, then all effort shall be made in the field to determine whether human NAGPRA items are Native American. If yes, skip steps 8 and 9 below and proceed to step 10.

8. If the NAGPRA items are determined not to be Native American, then Washington State laws apply and shall be followed (Title 68, Chapter 68.50 RCW HUMAN NAGPRA ITEMS).

9. If the NAGPRA items' affiliation cannot be determined in the field, further non-destructive analysis of human NAGPRA items and/or associated cultural materials may be required. The CCT, NPS, and Reclamation shall coordinate regarding the types of non-destructive analysis to be conducted.

10. Provenience information will be collected as specified by the written plan of action. The Reclamation contract language for burials recovered in the shoreline of the National Recreation Area will also apply and should agree with the written plan of action and these protocols.

11. Recording of provenience may include any or all of the following: documenting the location of the burial or scattered NAGPRA items and general site conditions on a site form or on an addendum to an existing form; describing the surface visible NAGPRA items to the degree that can be accomplished without causing additional disturbance to the grave; documenting the location of the burial on a USGS 7.5' topographic sheet and with a GPS unit.

12. If it is possible to rebury or cap the NAGPRA items in place, then that decision shall be documented in the written plan of action (see below).

13. If NAGPRA items must be excavated or removed, procedures will be specified by the written plan of action. The Reclamation contract language for burials recovered in the shoreline of the NRA will also apply and should agree with the written plan of action and these protocols. If NAGPRA items are to be excavated or removed by personnel other than those employed by the CCT or the U.S. government, an ARPA permit will be required from the NPS.

14. Excavation or removal procedures may include any or all of the following: NAGPRA items will be removed using standard professional archaeological practices in a culturally sensitive manner at the direction of a CCT History/Archaeology Department representative. Such practices may include collection of horizontal provenience data referenced to a site datum point; if excavation is required, vertical provenience data shall be tracked through the use of controlled 10-cm levels within a standard grid unit, screening of all excavated fill through 1/8-inch screen mesh, and photographic and to-scale plan map documentation of excavated features. All recovered items shall be listed in the field during collection to minimize handling after recovery.

15. Inadvertent discoveries that result from activities requiring easements or other non-ARPA permits (such as access, construction, etc.) shall be dealt with by the permitting agencies, which may be Reclamation or the NPS. This protocol document will be included with documents issued to permittees.

16. The written plans of action for individual discoveries will detail exact procedures for further implementation of NAGPRA. A sample written plan of action is attached.

Template NAGPRA Plan of Action for Lake Roosevelt

This plan of action shall comply with the requirements of the Native American Graves Protection and Repatriation Act (NAGPRA) (25 USC 3001 et seq.), its implementing regulations (43 CFR Part 10) and the Archaeological Resources Protection Act (ARPA) (16 USC 470 et seq.) with its implementing regulations (43 CFR Part 7).

1. The kinds of objects to be considered as cultural items as defined in Sec. 10.2 (b):
   - ✓ Human remains
   - ✓ Associated funerary objects
   - ✓ Unassociated funerary objects
   - ✓ Objects of cultural patrimony
   - ✓ Sacred objects

   These objects are cultural objects as defined under NAGPRA 43CFR Part 10.2 (d)

2. The specific information used to determine custody pursuant to Sec. 10.6:
   - ✓ Traditional association (this is where tribe's area of interest is cited with reference to Lake Roosevelt)
   - ✓ Cultural affiliation
   - ✓ Evidence: Geographical, archaeological, linguistic, folklore, oral tradition, historical

3. The planned treatment, care, and handling of human remains and other objects as defined in NAGPRA

4. The planned archaeological recording of the human remains and other objects as defined in NAGPRA

5. The kinds of analysis planned for each kind of object

6. Any steps to be followed to contact Indian tribe officials at the time of intentional excavation or inadvertent discovery of specific human remains and other objects as defined in NAGPRA

7. The kind of traditional treatment, if any, to be afforded the human remains and other objects as defined in NAGPRA by members of the Indian tribe

8. The nature of reports to be prepared

9. The planned disposition of human remains, and other objects as defined in NAGPRA.

NAGPRA Inadvertent Discoveries and Intentional Excavations on the Lake Roosevelt National Recreation Area: Spokane Tribe of Indians, National Park Service, and Bureau of Reclamation

Protocols for NAGPRA Inadvertent Discoveries and Intentional Excavations on the Lake Roosevelt National Recreation Area: Spokane Tribe of Indians, National Park Service, and Bureau of Reclamation

This protocol is intended to cover NAGPRA items exposed by inadvertent discoveries and intentional excavations within the boundaries of lands managed by the National Park Service/Lake Roosevelt National Recreation Area (Figure 1), excluding inadvertent discoveries on lands within reservation boundaries of the Spokane Tribe of Indians (STI) (Figure 2). For procedures within STI reservation boundaries (as shown in Figure 2 along the left bank [east side of the Columbia River], from the mouth of the Spokane River and north to the Spokane Reservation boundary) please see the Spokane Tribe's *Procedure for the Inadvertent Disturbance or Discovery of Spokane Human Remains and Cultural Resources*. Funding of actions is not covered under this protocol.

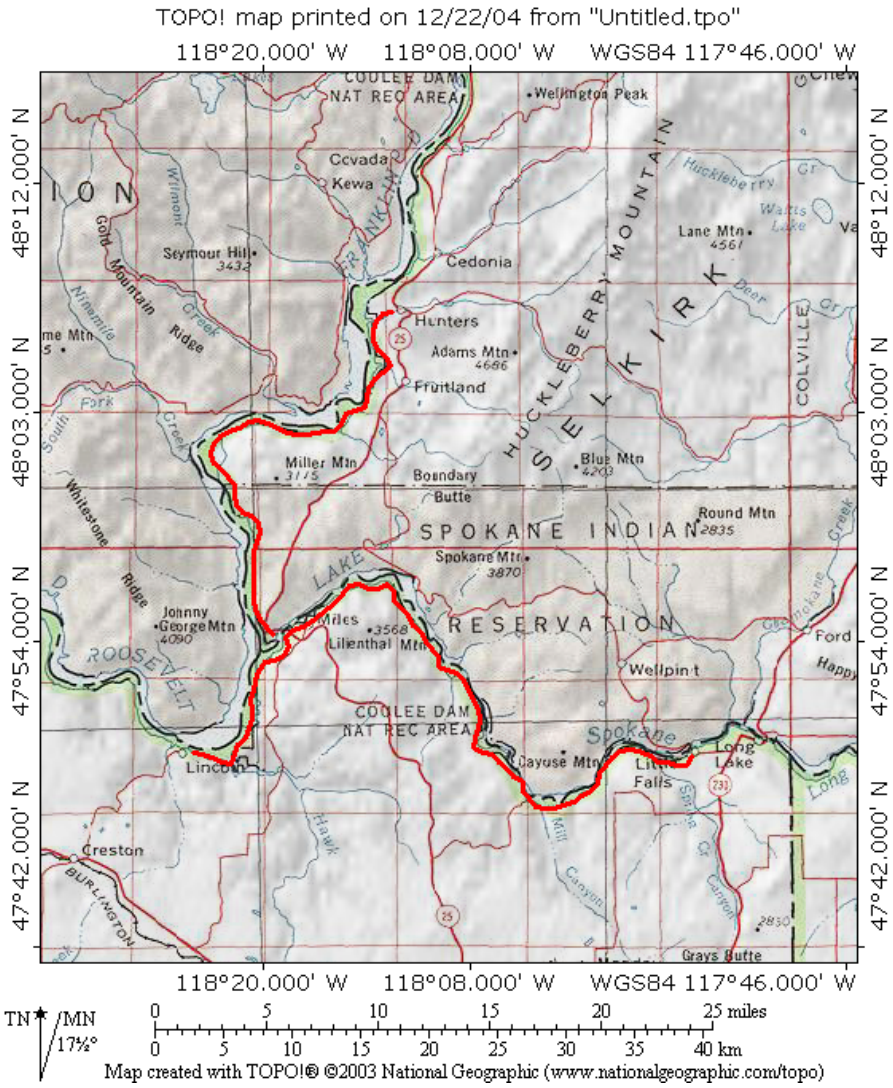


Figure 1. Lake Roosevelt National Recreation Area Shoreline Areas Managed by the National Park Service and Bureau of Reclamation

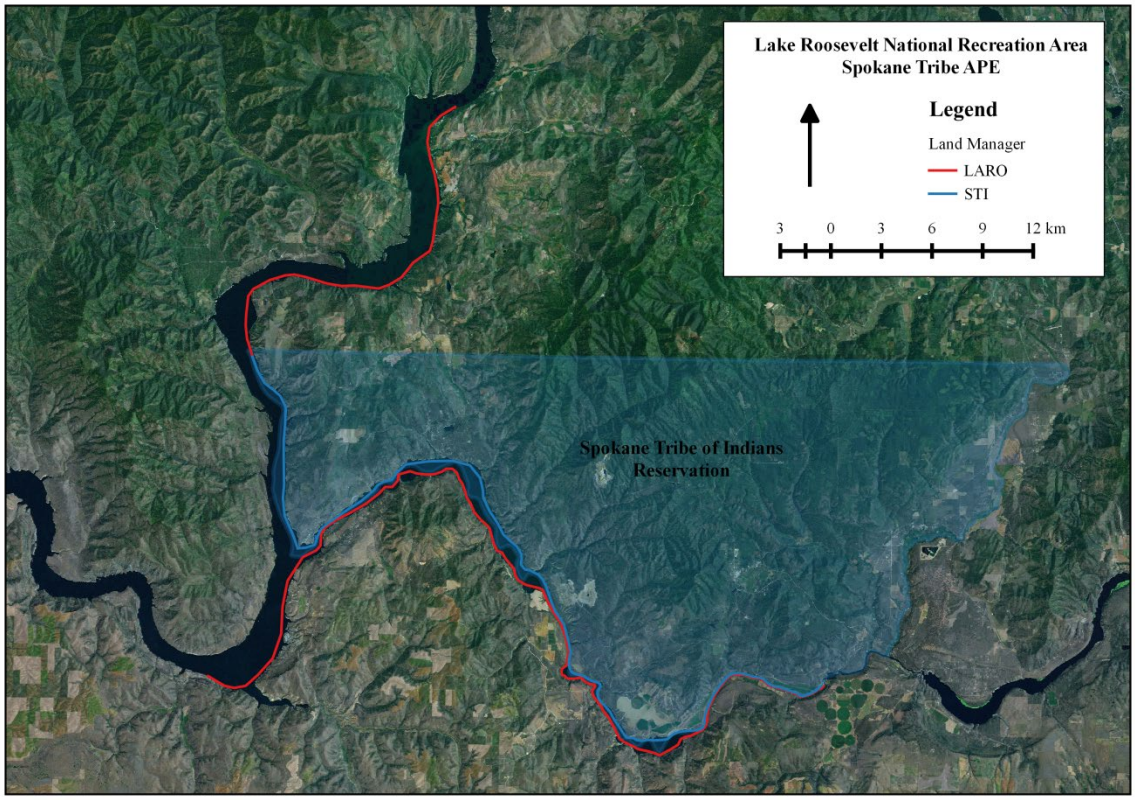


Figure 2. Spokane Tribe of Indians Reservation Land Not Covered by NPS Protocol

1. If remains that are potentially human are encountered, any activity in the vicinity of the discovery shall cease and all appropriate effort shall be made to determine if the remains are human. NAGPRA dictates that the 'stop work' order shall be for 30 days, but this period can be shortened in consultation between affected parties.

2. If the remains are determined to be human, the burial or location shall not be disturbed in any way. Any discovered human remains and associated artifacts will be treated in a respectful manner.

3. The person(s) making the discovery shall immediately notify NPS law enforcement. In cases where a potential crime scene exists, *personnel except those necessary to protect the location will leave the immediate vicinity in order to prevent unintentional destruction of crime scene information.*

4. The person(s) making the discovery shall immediately notify the Spokane Tribal Historic Preservation Officer (STI THPO), the Park Service archaeologist, and the Reclamation archaeologist (numbers are listed below) immediately after law enforcement.

   Live phone contact is required; backup staff are identified if the primary contacts are unavailable. Phone contact will be followed up by written confirmation, e-mail is acceptable.

5. **Notifications:**

   - Randy Abrahamson, STI THPO, is the primary contact for the STI. Mr. Abrahamson's phone number at the Department is (509) 258-4315, FAX (509) 258-6965, and his Internet address is randya@spokanetribe.com. After work hours, Mr. Abrahamson can generally be reached at (509) 951-0524 (cell). If Mr. Abrahamson cannot be reached, John Matt (Preservation Department Director), James Harrison (Principal Investigator), Jackie Corley(Tribal Archaeologist), Laura McCullough (Project Archaeologist), or Chris Casserino (Project Archaeologist) shall be contacted at (509) 258-4060. If none of the above people can be reached, then the on-site STI crew leader shall be presumed delegated as the primary STI representative and shall participate in the NAGPRA consultation process until Mr. Abrahamson's return. The STI shall maintain a presence at the location of the discovery as needed until all contacts have been made and appropriate treatment of the remains has been conducted.

   - Derek Beery, Power Office Archaeologist, is Reclamation's contact. His phone number is (509) 237-4477 [cell phone], (509) 633-9233 [desk] FAX 633-9138, and internet address is "dbeery@usbr.gov." If Derek Beery is not available, contact Sean Hess, Regional Archaeologist (208) 378-5316, FAX (208) 378-5305, and internet address is "shess@usbr.gov."

   - Jon Edwards, NPS Project Manager for the Lake Roosevelt National Recreation Area, is the primary contact for the NPS. Mr. Edward's phone number is (509) 754-7876 or (509) 631-0103, and his FAX is (509) 633-3862, and internet address is jon_edwards@nps.gov.

   - Spokane Tribal Law Enforcement can be reached at 1-888-258-6899 and/or 258-7766, and at (509) 633-9441, ext. 123. If Tribal Law Enforcement is not available, the North District Ranger number is (509) 738-6266 ext. 162 or cell (509) 631-4722.

6. A professional archaeologist will assist law enforcement in determining if the remains are archaeological in origin. If the discovery is determined to be a recent crime scene, field personnel shall follow direction from law enforcement officers.

7. If the discovery is determined to be an ARPA crime scene (i.e., there is evidence for intentional disturbance or looting of archaeological materials), an archaeologist shall assist law enforcement as needed in the collection of archeological data to support the ARPA case.

8. If the discovery is determined not to be a crime scene, an attempt will be made to determine whether the remains are human remains.

9. Documentation: If the remains are human, the location of the burial or scattered remains and general site conditions shall be documented. Documentation will include locating the burial on a USGS 7.5' topographic sheet and with a GPS unit, and recording the location on a site form or on an addendum to an existing form. Surface visible remains will be described to the degree that can be accomplished without causing any additional disturbance.

   If NAGPRA applies to the remains, a written plan of action will be drafted by the NPS and Reclamation archaeologists in coordination with the STI THPO. The party responsible for making the NAGPRA determination must document in writing the basis of that determination. Documentation methods will be described in the written plan of action for each discovery.

10. If possible and if agreed upon by all parties, human remains and associated objects shall be protected in place. If it is possible to rebury or cap the remains in place, then further actions under NAGPRA are not required. If the tribe prefers, protective actions can be conducted after locational information is collected.

11. If it is not possible to protect the remains in place, all efforts shall be made to determine in the field whether NAGPRA applies to the human remains. If NAGPRA does not pertain to the discovered remains, then WA state laws apply and shall be followed (Chapter 27.44 RCW: INDIAN GRAVES AND RECORDS, at http://www.oahp.wa.gov/rcw2744.htm).

12. Recovery: Remains or associated items that cannot be protected in place shall be recovered in a culturally sensitive manner according to the written plan of action developed by the STI, the NPS, and Reclamation. If remains are threatened and must be recovered before a written plan of action can be completed, the steps identified below shall be followed, at minimum:

    Collection of horizontal provenience data referenced to a site datum point; if excavation is required, vertical provenience data shall be tracked through the use of controlled 10-cm levels within a standard grid unit, screening of all excavated fill through 1/4-inch screen mesh (1/8-inch if sediments are sand), and (No photography, etc. if NAGPRA) of excavated features. Methods employed shall be designed to document information about burial practices and to recover any associated grave goods.

13. The NPS shall publish Notices of Intent to Make Disposition in local newspapers. The newspapers shall be named in the Written Plan of Action for each discovery.

14. After recovery and during the 30-day waiting period after newspaper notices are published by the NPS, NAGPRA items shall be stored and protected by the STI.

15. The written plans of action for individual discoveries within the Lake Roosevelt National Recreation Area will detail exact procedures for further implementation of NAGPRA.