Fall 11-23-2021

Silver Bow Creek Butte Area NPL Site 2022 Draft Butte Priority Soils Operable Unit Interim Site-Wide Groundwater Monitoring QAPP. Consent Decree- Civil Action No. CV 89-039-BU-SHE

Josh Bryson

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November 23, 2021

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RE: Silver Bow Creek Butte Area NPL Site 2022 Draft Butte Priority Soils Operable Unit Interim Site-Wide Groundwater Monitoring QAPP. Consent Decree- Civil Action No. CV 89-039-BU-SHE

Agency Representatives:

I am writing to you on behalf of Atlantic Richfield Company to submit the Silver Bow Creek/Butte Area NPL Site 2022 Draft BPSOU Interim Site-Wide Groundwater Monitoring Quality Assurance Project Plan for your review and approval. The plan summarizes the proposed site-wide groundwater data collection to be conducted during the 2022 monitoring period. The 2022 GW QAPP is similar to the approved Final 2021 BPSOU Groundwater QAPP, but minor changes to the monitoring network have been made. Four water level monitoring sites, BMW-04B, MSD-01A, MW2-CGSB3, and RLP-W and two water quality sites, MSD-01B and MSD-01C, have been eliminated for safety concerns.

- BMW-04B is both a water level monitoring point and a 5-year water quality site. This well is located on the southwest corner of the D4 pond. A dredge access ramp was added to the pond in 2020 and this created a drop of at least six feet within two feet of the well. This creates a working at heights and engulfment hazard for personnel monitoring the well.
- MW2-CGSB3 is a water level site. This well is located on the southwest corner of Front Street and Kaw Avenue. The well is located very near the intersection of these two streets which have relatively heavy traffic. This creates a traffic hazard and struck-by-vehicle risks for personnel monitoring this well.
- MSD-01A is a continual water level monitoring point and a five-year water quality site. MSD-01B and MSD-01C are continual water level sites and semi-annual water quality sites. These flush mount wells are within an earthen triangle at the intersections of South Warren Avenue, Olympia Avenue, and a third street which connects Warren Avenue and Olympia Way. The intersection of the three streets, combined with the fact that these are flush mount wells, creates a traffic hazard and struck-by-vehicle risks for personnel monitoring these wells.

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- RLP-W is a staff gage in the Ranchland Packing surface water pond at the west end of Lower Area One. The staff gage cannot be reached without stepping into the pond, limiting the ability of field personnel to obtain a reliable reading. This pond appears to be impacted by biological matter; thus, creating a potential biohazard to field personnel. Additionally, the pond freezes throughout the winter, so the usefulness of water level readings at this site is limited.

The 2022 Draft BPSOU Interim Site-Wide Groundwater Monitoring Quality Assurance Project Plan, along with the crosswalk, has been attached. The report and appendices may be downloaded at the following link:

2022 Draft BPSOU Interim Site-Wide Groundwater Monitoring QAPP

If you have any questions or comments, please call me at (406) 723-1834.

Sincerely,

Josh Bryson, PE, PMP
Liability Manager
Remediation Management Services Company
An affiliate of **Atlantic Richfield Company**

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EPA REGION 8 QA DOCUMENT REVIEW CROSSWALK

QAPP/FSP/SAP for: *(check appropriate box)*		**Entity** *(grantee, contract, EPA AO, EPA Program, Other)*	**Regulatory Authority and/or Funding Mechanism**	**___ 2 CFR 1500 for Grantee/Cooperative Agreements** **___ 48 CFR 46 for Contracts** **___ Interagency Agreement (FFA, USGS,)** **___ EPA/Court Order** **___ EPA Program Funding** **___ EPA Program Regulation** **___ EPA CIO 2105**
	GRANTEE	Atlantic Richfield		
	CONTRACTOR			
	EPA			
	Other			
Document Title ***[Note: Title will be repeated in Header]***		Draft Final Butte Priority Soils Operable Unit 2022 Interim Site-Wide Groundwater Monitoring Quality Assurance Project Plan		
QAPP/FSP/SAP Preparer		TREC, Inc.		
Period of Performance *(of QAPP/FSP/SAP)*		**2022**	**Date Submitted for Review**	
EPA Project Officer **EPA Project Manager**		Nikia Greene	**PO Phone #** **PM Phone #**	(406) 457-5019
QA Program Reviewer or Approving Official		Nikia Greene	**Date of Review**	

Documents Submitted for QAPP Review (QA Reviewer must complete):

1. QA Document(s) submitted for review:

QA Document	Document Date	Document Stand-alone	Document with QAPP
QAPP		Yes / No	
FSP		Yes / No	Yes / No
SAP		Yes / No	Yes / No
SOP(s)			Yes / No

2. WP/SOW/TO/PP/RP Date _____
WP/SOW/TO/RP Performance Period _____

3. QA document consistent with the:
WP/SOW/PP for grants? Yes / No
SOW/TO for contracts? Yes / No

4. QARF signed by R8 QAM Yes / No / NA
Funding Mechanism IA / contract / grant / NA
Amount _____

Notes for Document Submittals:

1. A QAPP written by a Grantee, EPA, or Federal Partner must include for review: Work Plan(WP) / Statement of Work (SOW) / Program Plan (PP) / Research Proposal (RP) and funding mechanism

2. A QAPP written by Contractor must include for review:
- **a)** Copy of Task Order Work Assignment/SOW
- **b)** Reference to a hard or electronic copy of the contractor's approved QMP
- **c)** Copy of Contract SOW if no QMP has been approved
- **d)** Copy of EPA/Court Order, if applicable
- **e)** The QA Review must determine (with the EPA CO or PO) if a QARF was completed for the environmental data activity described in the QAPP.

3. a. Field Sampling Plan (FSP) and/or Sampling & Analyses Plan (SAP) must include the Project QAPP ***or*** must be a stand-alone QA document that contain all QAPP required elements (Project Management, Data Generation/Acquisition, Assessment and Oversight, and Data Validation and Usability).

b. SOPs must be submitted with a QA document that contains all QAPP required elements.

Summary of Comments *(highlight significant concerns/issues)***:**
1. Comment #1

2. Comment #2
3. Comment #3
4. **The** Atlantic Richfield **must address the comments in the Summary of Comments, as well as those identified in the Comment section(s) that includes a "Response (date)" and Resolved (date)".**

Element	**Acceptable** *Yes/No/NA*	**Page/ Section**	**Comments**
A. Project Management			
A1. Title and Approval Sheet			
a. Contains project title		1st page	
b. Date and revision number line (for when needed)		2nd title page & page viii	
c. Indicates organization=s name		Cover page	
d. Date and signature line for organization=s project manager		i	
e. Date and signature line for organization=s QA manager		i	
f. Other date and signatures lines, as needed		i	
A2. Table of Contents			
a. Lists QA Project Plan information sections		v-vii	
b. Document control information indicated		v-viii	
A3. Distribution List			
Includes all individuals who are to receive a copy of the QA Project Plan and identifies their organization		ii-iv	
A4. Project/Task Organization			
a. Identifies key individuals involved in all major aspects of the project, including contractors		2.1	
b. Discusses their responsibilities		2.1	
c. Project QA Manager position indicates independence from unit generating data		2.1	
d. Identifies individual responsible for maintaining the official, approved QA Project Plan		2.1	
e. Organizational chart shows lines of authority and reporting responsibilities		Figure 1	
A5. Problem Definition/Background			
a. States decision(s) to be made, actions to be taken, or outcomes expected from the information to be obtained		2.2	

b. Clearly explains the reason (site background or historical context) for initiating this project		2.2	
c. Identifies regulatory information, applicable criteria, action limits, etc. necessary to the project		2.4.1, Table 6	
A6. Project/Task Description			
a. Summarizes work to be performed, for example, measurements to be made, data files to be obtained, etc., that support the project=s goals		2.3	
b. Provides work schedule indicating critical project points, e.g., start and completion dates for activities such as sampling, analysis, data or file reviews, and assessments		2.3, Table 1	
c. Details geographical locations to be studied, including maps where possible		2.4.1, Step 4, Figures 2, 3 & 4, Tables 3, 4, & 5	
d. Discusses resource and time constraints, if applicable		2.4.1, Step 4	
A7. Quality Objectives and Criteria			
a. Identifies - performance/measurement criteria for all information to be collected and acceptance criteria for information obtained from previous studies, - including project action limits and laboratory detection limits and - range of anticipated concentrations of each parameter of interest	Y	2.4.1 Table 2 2.4.2 Concentration range: 2.4.1, step 1	
b. Discusses precision	Y	2.4.2, Precision	
c. Addresses bias	Y	2.4.2, Accuracy/Bias	
d. Discusses representativeness	Y	2.4.2, Representatives	
e. Identifies the need for completeness	Y	2.4.2	
f. Describes the need for comparability	Y	2.4.2	
g. Discusses desired method sensitivity	Y	2.4.2	
A8. Special Training/Certifications			

a. Identifies any project personnel specialized training or certifications	Y	2.5	
b. Discusses how this training will be provided	Y	2.5	
c. Indicates personnel responsible for assuring training/certifications are satisfied	Y	2.5	
d. identifies where this information is documented	Y	2.5	
A9. Documentation and Records			
a. Identifies report format and summarizes all data report package information	Y	2.6.5, 2.6.6, & 4.3	
b. Lists all other project documents, records, and electronic files that will be produced	Y	2.6	
c. Identifies where project information should be kept and for how long	Y	2.6, 3.9	
d. Discusses back up plans for records stored electronically	Y	2.6, 3.9	
e. States how individuals identified in A3 will receive the most current copy of the approved QA Project Plan, identifying the individual responsible for this	Y	2.1	
B. Data Generation/Acquisition			
B1. Sampling Process Design (Experimental Design)			
a. Describes and justifies design strategy, indicating size of the area, volume, or time period to be represented by a sample	Y	3.1	
b. Details the type and total number of sample types/matrix or test runs/trials expected and needed	Y	3.1	
c. Indicates where samples should be taken, how sites will be identified/located	Y	Figures 3 & 4, Tables 3 & 4	
d. Discusses what to do if sampling sites become inaccessible	NA	NA	
e. Identifies project activity schedules such as each sampling event, times samples should be sent to the laboratory, etc.	Y	3.1.2, Tables 3 & 4 3.3	
f. Specifies what information is critical and what is for informational purposes only	Y	3.1.2	
g. Identifies sources of variability and how this variability should be reconciled with project information	Y	2.4.2, 3.1.2	
B2. Sampling Methods			

a. Identifies all sampling SOPs by number, date, and regulatory citation, indicating sampling options or modifications to be taken	Y	3.2.1, Table 10	
b. Indicates how each sample/matrix type should be collected	Y	3.2.2	
c. If in situ monitoring, indicates how instruments should be deployed and operated to avoid contamination and ensure maintenance of proper data	Y	3.2.2	
d. If continuous monitoring, indicates averaging time and how instruments should store and maintain raw data, or data averages	Y	3.3.1	
e. Indicates how samples are to be homogenized, composited, split, or filtered, if needed	Y	3.2.1 SOPS	
f. Indicates what sample containers and sample volumes should be used	Y	3.2.3 Table 11	
g. Identifies whether samples should be preserved and indicates methods that should be followed	Y	Table 11	
h. Indicates whether sampling equipment and samplers should be cleaned and/or decontaminated, identifying how this should be done and by-products disposed of	Y	3.2	
i. Identifies any equipment and support facilities needed	Y	3.2.3	
j. Addresses actions to be taken when problems occur, identifying individual(s) responsible for corrective action and how this should be documented	Y	3.2.3	
B3. Sample Handling and Custody			
a. States maximum holding times allowed from sample collection to extraction and/or analysis for each sample type and, for in-situ or continuous monitoring, the maximum time before retrieval of information	Y	3.3.1, Table 2	
b. Identifies how samples or information should be physically handled, transported, and then received and held in the laboratory or office (including temperature upon receipt)	Y	3.3.2	
c. Indicates how sample or information handling and custody information should be documented, such as in field notebooks and forms, identifying individual responsible	Y	3.3.3	

d. Discusses system for identifying samples, for example, numbering system, sample tags and labels, and attaches forms to the plan	Y	3.3.4	
e. Identifies chain-of-custody procedures and includes form to track custody	Y	3.3.2, 3.3.5, Appendix C	
B4. Analytical Methods			
a. Identifies all analytical SOPs (field, laboratory and/or office) that should be followed by number, date, and regulatory citation, indicating options or modifications to be taken, such as sub-sampling and extraction procedures	Y	3.4	
b. Identifies equipment or instrumentation needed	Y	3.4.3	
c. Specifies any specific method performance criteria	N/A	NA	
d. Identifies procedures to follow when failures occur, identifying individual responsible for corrective action and appropriate documentation	Y	3.5.2, Tables 7 and 9 4.1	
e. Identifies sample disposal procedures	Y	3.4.4	
f. Specifies laboratory turnaround times needed	Y	5.1.3	
g. Provides method validation information and SOPs for nonstandard methods	N/A	N/A	
B5. Quality Control			
a. For each type of sampling, analysis, or measurement technique, identifies QC activities which should be used, for example, blanks, spikes, duplicates, etc., and at what frequency	Y	3.5.1, 3.5.2	
b. Details what should be done when control limits are exceeded, and how effectiveness of control actions will be determined and documented	Y	3.5.2, Tables 7 & 9	
c. Identifies procedures and formulas for calculating applicable QC statistics, for example, for precision, bias, outliers and missing data	Y	2.4.2, Table 8	
B6. Instrument/Equipment Testing, Inspection, and Maintenance			
a. Identifies field and laboratory equipment needing periodic maintenance, and the schedule for this	Y	3.6.1, 3.6.2	
b. Identifies testing criteria	Y	3.6.1, 3.6.2	
c. Notes availability and location of spare parts	Y	3.2.3	
d. Indicates procedures in place for inspecting equipment before usage	Y	3.6.1, 3.6.2	

e. Identifies individual(s) responsible for testing, inspection and maintenance	Y	3.6.1, 3.6.2	
f. Indicates how deficiencies found should be resolved, re-inspections performed, and effectiveness of corrective action determined and documented	Y	3.2.3, 3.6.1, 3.6.2, 4.1	
B7. Instrument/Equipment Calibration and Frequency			
a. Identifies equipment, tools, and instruments that should be calibrated and the frequency for this calibration	Y	3.7	
b. Describes how calibrations should be performed and documented, indicating test criteria and standards or certified equipment	Y	3.7	
c. Identifies how deficiencies should be resolved and documented	Y	3.6.1, 3.7, 4.1	
B8. Inspection/Acceptance for Supplies and Consumables			
a. Identifies critical supplies and consumables for field and laboratory, noting supply source, acceptance criteria, and procedures for tracking, storing and retrieving these materials	Y	3.8	
b. Identifies the individual(s) responsible for this	Y	3.8	
B9. Use of Existing Data (Non-direct Measurements)			
a. Identifies data sources, for example, computer databases or literature files, or models that should be accessed and used	N/A	N/A	
b. Describes the intended use of this information and the rationale for their selection, i.e., its relevance to project	N/A	N/A	
c. Indicates the acceptance criteria for these data sources and/or models	N/A	N/A	
d. Identifies key resources/support facilities needed	N/A	N/A	
e. Describes how limits to validity and operating conditions should be determined, for example, internal checks of the program and Beta testing	N/A	N/A	
B10. Data Management			
a. Describes data management scheme from field to final use and storage	Y	3.9	
b. Discusses standard record-keeping and tracking practices, and the document control system or cites other written documentation such as SOPs	Y	3.9	

c. Identifies data handling equipment/procedures that should be used to process, compile, analyze, and transmit data reliably and accurately	Y	3.9	
d. Identifies individual(s) responsible for this	Y	3.9	
e. Describes the process for data archival and retrieval	Y	3.9	
f. Describes procedures to demonstrate acceptability of hardware and software configurations	N/A	N/A	
g. Attaches checklists and forms that should be used	N/A	N/A	
C. Assessment and Oversight			
C1. Assessments and Response Actions			
a. Lists the number, frequency, and type of assessment activities that should be conducted, with the approximate dates	Y	4.0	
b. Identifies individual(s) responsible for conducting assessments, indicating their authority to issue stop work orders, and any other possible participants in the assessment process	Y	4.0, 4.1, 4.2	
c. Describes how and to whom assessment information should be reported	Y	4.0, 4.1, 4.2	
d. Identifies how corrective actions should be addressed and by whom, and how they should be verified and documented	Y	4.1, 4.2	
C2. Reports to Management			
a. Identifies what project QA status reports are needed and how frequently	Y	4.3	
b. Identifies who should write these reports and who should receive this information	Y	4.3	
D. Data Validation and Usability			
D1. Data Review, Verification, and Validation			
Describes criteria that should be used for accepting, rejecting, or qualifying project data	Y	5.2.2, Table 12, Table 13	
D2. Verification and Validation Methods			
a. Describes process for data verification and validation, providing SOPs and indicating what data validation software should be used, if any	Y	5.2.2	

b. Identifies who is responsible for verifying and validating different components of the project data/information, for example, chain-of-custody forms, receipt logs, calibration information, etc.	Y	5.1.1, 5.1.2, 5.2.2	
c. Identifies issue resolution process, and method and individual responsible for conveying these results to data users	Y	5.1.1, 5.1.2	
d. Attaches checklists, forms, and calculations	Y	Appendix F	
D3. Reconciliation with User Requirements			
a. Describes procedures to evaluate the uncertainty of the validated data	Y	5.2.2	
b. Describes how limitations on data use should be reported to the data users	Y	5.2.1 5.2.2	

SILVER BOW CREEK/BUTTE AREA NPL SITE

2022 Draft Butte Priority Soils Operable Unit Interim Site-Wide Groundwater Monitoring Quality Assurance Project Plan (QAPP)

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November 2021

SILVER BOW CREEK/BUTTE AREA NPL SITE

2022 Draft Butte Priority Soils Operable Unit Interim Site-Wide Groundwater Monitoring Quality Assurance Project Plan (QAPP)

Prepared for:

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Prepared by:

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November 23, 2021

APPROVAL PAGE

SAMPLING AND ANALYSIS PLAN FOR
BUTTE PRIORITY SOILS OPERABLE UNIT GROUNDWATER MONITORING
SILVER BOW CREEK/BUTTE AREA NPL SITE

Approved: _____ Date: _____
Nikia Greene, Site Project Manager, EPA, Region 8

Approved: _____ Date: _____
Daryl Reed, Project Officer, Montana DEQ

Approved: _____ Date: _____
David Gratson, Quality Assurance Manager, Environmental Standards

Approved: _____ Date: _____
Josh Bryson, Liability Manager, Atlantic Richfield Company

Plan is effective on date of last signature above.

DISTRIBUTION LIST

Silver Bow Creek/Butte Area NPL Site
Butte Priority Soils Operable Unit Groundwater Monitoring Quality Assurance Project Plan (QAPP) Rev 1
Butte, Silver Bow County, Montana

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REVISION SUMMARY

Revision No.	Author	Version	Description	Date
NA	TREC, Inc.	1	Draft Final 2022 BPSOU GW QAPP	11/23/21

LIST OF ACRONYMS AND ABBREVIATIONS

AR	Atlantic Richfield
ARAR	Applicable Relevant and Appropriate Requirements
ARCO	Atlantic Richfield Company
ASTM	American Society of Testing and Materials
BDMS	Butte Data Management System
BMFOU	Butte Mine Flooding Operable Unit
BNSF	Burlington Northern Santa Fe
BPSOU	Butte Priority Soils Operable Unit
BRW	Butte Reduction Works
BTC	Blacktail Creek
BTL	Butte Treatment Lagoons
$CaCO_3$	Calcium Carbonate
CAP	Corrective Action Plan
CAR	Corrective Action Report
CCB	Continuing Contamination Blank
CCV	Continuing Calibration Verification
CFR	Code of Federal Regulations
CFRSSI	Clark Fork River Superfund Site Investigations
CGWA	Controlled Ground Water Area
COC	Contaminant of Concern
CPM	Contractor Project Manager
CTEC	Citizens Technical Environmental Committee
D	Percent Difference
DEQ	Department of Environmental Quality
DI	Deionized Water
DMP	Data Management Plan
DO	Dissolved Oxygen
DOJ	Department of Justice
DPHHS	Department of Public Health and Human Services
DQA	Data Quality Assessment
DQO	Data Quality Objectives
DSR	Data Summary Report
dtw	depth to water
E	Enforcement Status
EDD	Electronic Data Deliverable
EPA	U.S. Environmental Protection Agency
EQuIS	Environmental Quality Information System
FB	Field Blank
GW	groundwater
HAZWOPER	Hazardous Waste Operations and Emergency Response
HCC	Hydraulic Control Channel

LIST OF ACRONYMS AND ABBREVIATIONS

HSP	Health and Safety Plan
HSSE	Health Safety Security and Environment
ICB	Initial Contamination Blank
ICP	Inductively Coupled Plasma
ICS	Interference Check Sample
ICV	Initial Calibration Verification
IM	Integrity Management
LaMP	Laboratory Management Program
LAO	Lower Area One
LAP	Laboratory Analytical Protocol
LCS	Laboratory Control Spike
LCSD	Laboratory Control Spike Duplicate
LD	Laboratory Duplicate
LM	Atlantic Richfield Liability Manager
MB	Method Blank
MBMG	Montana Bureau of Mines and Geology
MDL	Method Detection Limit
MS	Matrix Spike
MS	Microsoft
MSD	Matrix Spike Duplicate
MSD	Metro Storm Drain
mV	millivolt
NELAP	National Environmental Laboratory Accreditation Program
NPL	National Priorities List
NRDP	Montana Natural Resource Damage Program
ORP	Oxidation-Reduction Potential
OSHA	Occupational Safety & Health Administration
pH	negative logarithm of the hydrogen ion concentration
POC	Point of Compliance
PPE	Personal Protective Equipment
QA	Quality Assurance
QAM	Quality Assurance Manager
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QC	Quality Control
QSR	Quality System Review
R	Rejected Status
RA	Remedial Action
RG	Remedial Goal
RL	Reporting Limit
ROD	Record of Decision

LIST OF ACRONYMS AND ABBREVIATIONS

RODA	Record of Decision Amendment
RPD	Relative Percent Difference
RSD	Relative Standard Deviation
S	Screening Status
SA	Spike Added
SBC	Silver Bow Creek
SC	Specific Conductivity
SD	Serial Dilution
SM	Standard Method
SOP	Standard Operating Procedure
SQL	Structured Query Language
SR	Sample Result
SSR	Spiked Sample Result
SU	Standard Unit
SW	Surface Water
TDS	Total Dissolved Solids
TI	Technical Impracticability
UAO	Unilateral Administrative Order
WET	Water and Environmental Technology

1.0 INTRODUCTION

The purposes of this Quality Assurance Project Plan (QAPP) are to provide guidance for collecting enforcement quality data for groundwater monitoring activities at the Butte Priority Soils Operable Unit within the Silver Bow Creek/Butte Area National Priorities List (NPL) Site, ensure that data quality will meet the decision needs, and to reference the documents necessary to describe the quality assurance and quality control (QA/QC) policies and procedures to be used during data collection and analysis. This QAPP was prepared in a manner consistent with the *EPA Requirements for Quality Assurance Project Plans, EPA QA/R-5* (EPA, 2001a), the *Guidance on Systematic Planning Using the Data Quality Objectives Process, EPA QA/G4* (EPA, 2006b), and the *EPA Region 8 Quality Assurance Document Review Crosswalk* checklist (EPA, 2017). The following four basic element groups are included:

- Project Management and Objectives;
- Measurement and Data Acquisition;
- Assessment and Oversight; and
- Data Review.

The four sections below provide these project plan elements and include the appropriate content needed for planning the sampling and analysis within the site. The sections in this framework QAPP expand and reference information in other site wide documents to present project specific requirements.

2.0 PROJECT MANAGEMENT

This section addresses project concerns, goals and approaches to be followed during sampling activities on the site.

2.1 Project Organization and Responsibilities

An example organizational chart showing the overall organization of the project team is provided in Figure 1. Responsibilities of key individuals comprising a project team are described below.

Atlantic Richfield Liability Manager (LM) – Josh Bryson (Atlantic Richfield Company)

The Liability Manager monitors the performance of the contractor(s). The LM consults with the Contractor Quality Assurance Officer and Contractor Project Manager on deficiencies and aids in finalizing resolution actions. The Atlantic Richfield LM, or their designee, will be responsible for distributing this QAPP. If requested, select individuals may receive a hard copy of the QAPP by certified mail (as well as an electronic copy), while all recipients will receive an electronic copy of the QAPP.

Environmental Protection Agency Project Manager – Nikia Greene (EPA)

The EPA Project Manager is responsible for communicating and coordinating EPA requirements with the Atlantic Richfield LM, such that Agency requirements are met. The EPA Project Manager must also coordinate with the Montana DEQ Project Manager to ensure that the state's concerns and requirements are addressed.

Montana Department of Environmental Quality Project Manager – Daryl Reed (DEQ)

The Montana DEQ Project Manager is responsible for communicating and coordinating with the Atlantic Richfield LM and the EPA Project Manager such that the state's requirements are addressed.

Atlantic Richfield Quality Assurance Manager (QAM) – David Gratson (Environmental Standards)

The Atlantic Richfield QAM interfaces with the Atlantic Richfield LM for company policies regarding quality and has the authority and responsibility to approve QA documents specific to the project including this QAPP.

Contractor Project Manager (CPM) – Scott Bradshaw (TREC, Inc.)

The CPM is responsible for scheduling all sampling work to be completed and ensuring that the work is performed in accordance with the requirements contained herein. The CPM is also responsible for consulting with the quality assurance personnel identified for the project regarding any deficiencies and finalizing resolution actions.

Field Team Leader – Alice Drew-Davies (TREC, Inc.)

The Field Team Leader ensures that the QAPP has been reviewed by all members of the field team and is properly followed when implementing field activities. The Field Team Leader will conduct daily safety meetings, assist in field activities and document activities in the logbook. The Field Team Leader is responsible for equipment, problem solving and decision making in the field, and for technical aspects of the project. In addition, the field team leader provides "on-the-ground" overview of project implementation by observing site activities to ensure compliance with technical project requirements, Health Safety Security and Environment (HSSE) requirements, and the Site Specific Health and Safety Plan. Finally, the field team leader identifies potential Integrity Management (IM) issues, as appropriate, and prepares required project documentation.

Contractor Quality Assurance Officer (QAO) – Tina Donovan (TREC, Inc.)

The QAO is responsible for field and laboratory data review and evaluation of data quality, including conducting on-site reviews and preparing site review reports for the QAM.

The QAO represents their assigned projects as the primary spokesperson on matters relating to quality management system implementation. In matters of project quality assurance (QA), this individual will have a direct line of communication to the QAM to ensure issues are resolved.

The QAO is authorized to stop work if, in the judgment of that individual, the work is performed contrary to or in the absence of prescribed quality controls, or approved methods, and further work would make it difficult or impossible to obtain acceptable results. The QAO may also stop work if completion of quality corrective actions is not acceptable.

The QAO is responsible for carrying out field audits to ensure the integrity of field measurements, sample collection, and documentation.

QAOs are responsible for evaluating data and information from instances of nonconformance, inspection reports, surveillance reports, audit and assessment reports, quality system reviews (QSRs), corrective action reports (CARs), corrective action plans (CAPs), stop work orders, and other sources. These data should be used to identify trends or conditions averse to quality, which shall be brought to the attention of the QAM. The QAO is also responsible for maintaining this QAPP.

Project Safety and Health Manager – Nicole Santifer (TREC, Inc.)

The Project Safety and Health Manager will conduct the initial safety meeting prior to starting fieldwork for the QAPP. The Safety and Health Manager will ensure that work crews comply with all site health and safety requirements and will revise the Health and Safety Plan (HSP), if necessary.

Contract Laboratory (Pace Analytical)

Pace Analytical Laboratory of Minneapolis, Minnesota will be the contract laboratory for BPSOU groundwater monitoring for the 2022 monitoring period. The Minnesota laboratory can be contacted at (612) 607-1700. Pace's QA personnel are familiar with the approved QAPP and are available to perform the work as specified. Contract Laboratory personnel are responsible for reviewing final analytical reports produced by the laboratory, coordinating scheduling of laboratory analyses and supervising in-house chain-of-custody procedures. Pace Analytical is accredited under the National Environmental Laboratory Accreditation Program (NELAP) and is certified under the Montana Department of Public Health and Human Services (DPHHS) public water supply laboratory certification program to perform organic and inorganic analyses. In addition, Pace is in Atlantic Richfield's Laboratory Management Program, thus is subject to annual auditing. Prior to making any changes in the contract laboratory, potential laboratories will review the QAPP to ensure analytical criteria can be met.

2.2 Problem Definition and Background

The alluvial aquifer underlying the Butte Priority Soils Operable Unit (BPSOU) has been impacted by over 100 years of mining, milling, and smelting in the Butte area. The extent and nature of groundwater contamination in portions of both the bedrock and alluvial aquifers have resulted in issuance of a Technical Impracticability (TI) waiver of groundwater standards and adoption of a Controlled Groundwater Area (CGWA) for portions of the aquifer. Systems are in place to capture and treat contaminated groundwater; and to minimize the volume of contaminated groundwater leaving the TI Zone or contributing to exceedances of surface water standards. Interim groundwater monitoring commenced in December 2007, and that monitoring enabled further characterization and enhancement of the conceptual site model for the alluvial aquifer. Monitoring of the alluvial aquifer will continue to assess performance of the groundwater capture systems as defined in the Record of Decision (ROD) (EPA, 2006d) and the 2020 ROD Amendment (RODA) (EPA, 2020a). This QAPP will define data quality objectives for BPSOU site-wide groundwater monitoring and present the monitoring plan in detail. The monitoring plan for the BPSOU alluvial aquifer has been designed to ensure groundwater capture systems are effective, ensure that contaminated groundwater is not leaving the TI zone or discharging to surface water at volumes/concentrations that would result in exceedance of standards, and to provide data for review of the remedy.

The ROD specifies

> *"A comprehensive groundwater monitoring plan shall be prepared and implemented for the entire alluvial aquifer to ensure that groundwater capture systems are effective; to determine that contaminated groundwater is not leaving the TI Zone or discharging to surface water; to provide additional information as necessary on the movement, quality, and quantity* of *groundwater; and to provide data for review of the groundwater remedy. The groundwater monitoring program will include installing additional monitoring wells, regular measurement of water quality and water levels in a monitoring network, and shall provide thorough monitoring that includes, but is not limited to, groundwater in upper and lower MSD, groundwater near the southern extent of the TI zone, between the MSD and LAO groundwater capture systems, and in the area adjacent to, and downgradient of the lagoon treatment system."* (EPA, 2006d)

The monitoring program described in this QAPP will meet the groundwater monitoring requirements specified in Section 12.1.2 of the ROD.

2.3 Project Description and Schedule

The purpose of this Groundwater Monitoring QAPP is to ensure the data quality necessary for determination of compliance with performance standards, where applicable, and assessment of remedy effectiveness and

protectiveness. The ROD/RODA specifies that the remedy is to prevent groundwater discharge that would lead to violations of surface water Applicable or Relevant and Appropriate Requirements (ARARs). It is outside of the scope of this QAPP to determine if surface water ARARs are met; however, the information gathered under this QAPP will be used in conjunction with information gathered under the BPSOU Interim Surface Water Monitoring QAPP to ascertain groundwater impacts to any potential violations of surface water ARARs. This QAPP will be limited in scope to the monitoring of groundwater to provide data with sufficient quality to evaluate points of compliance (POCs) and the effectiveness and protectiveness of remedies. Specific QAPP objectives are to:

1. Provide a sampling and analysis program which establishes the groundwater monitoring network, monitoring schedule, and analytical parameters for groundwater monitoring, that will provide data for:
    a. Monitoring POCs in order to determine compliance with performance standards,
    b. Evaluate the effectiveness and protectiveness of the Remedies.
2. Describe specific requirements for collecting and analyzing groundwater data.

The monitoring network specifically targets the following groundwater areas of concern, shown in Figure 2, to meet these objectives:

- The Area outside of the TI zone at POCs,
- The BPSOU sub-drain alluvial aquifer capture system,
- The Lower Area One (LAO) capture system, and
- The area between the BPSOU subdrain and LAO capture systems.

A summary of the project tasks to be completed under this QAPP is provided in Table 1 below. Additional detail on these tasks is provided in Section 3.0 – Measurement and Data Acquisition.

Table 1 - Summary of Project Tasks

1. **Sampling Tasks:**
    a. Measure groundwater elevations on a monthly basis, towards the end of each month, using the method described in Section 3.2.2.1.
    b. Collect water quality samples semi-annually, commencing in late spring/early summer and late summer/early fall of each year, using the method described in Section 3.2.2.2.
2. **Analysis Tasks:**
    a. Laboratory analysis for water quality parameters following guidelines in the *CFRSSI LAP*; or
    b. Analysis for dissolved metals and metalloids, in accordance with EPA approved test methods for inorganic contaminants, as listed in Table 2.
3. **Quality Control Tasks:**
    a. Verify all laboratory analytical matrices have the following QC samples analyzed: 1 field duplicate for every 20 primary samples, and if sampling equipment is reused across sample locations, 1 field blank collected for every 20 primary samples.
    b. Verify method blanks, laboratory control samples, laboratory duplicate samples, and matrix spike samples have been analyzed as applicable to the analytical method and that results of these laboratory quality control samples are included in all data packages. Verify that Full data packages include results of serial dilution samples, calibration verification samples, calibration blank samples, interference check samples, internal response standards, and contract required detection limit standards, as applicable to the analytical method. Refer to Section 3.5.2 for applicability of laboratory quality control and calibration samples to analytical methods.
4. **Data Management Tasks:**

a. Review analytical data and evaluate for quality (by the project's Quality Assurance Officer) and place in the site database.

5. **Documentation and Records:**
   a. Verify all samples collected have surveyed locations, records of each sample collected, and all field measurements appropriately documented.
6. **Data Packages:**
   a. Verify Full data packages are provided for samples from wells outside of the TI Zone and that Limited (standard) data packages are provided for all other samples; and, that data packages include results in mg/L, or other applicable units, of all constituents analyzed.

2.4 Quality Objectives and Criteria

This section discusses the internal quality control (QC) and review procedures used to ensure that all data collected for this project are of a known quality.

2.4.1 Data Quality Objectives

The DQO process is used to establish performance or acceptance criteria, which serve as the basis for designing a plan for collecting data of sufficient quality and quantity to support the goals of a study. Each step of the DQO process defines criteria that will be used to establish the final data collection design following the Guidance on Systematic Planning Using the Data Quality Objectives Process (EPA, 2006c)

The EPA DQO process consists of seven steps, as follows:

Step 1: State the Problem;

Step 2: Identify the Goals of the Study;

Step 3: Identify Information Inputs;

Step 4: Define the Boundaries of the Study;

Step 5: Develop the Analytic Approach;

Step 6: Specify Performance and Acceptance Criteria; and

Step 7: Develop the Plan for Obtaining Data.

The DQOs, which will be used to guide the data collection and analysis activities, are as follows:

Step 1: State the Problem.

- Both the alluvial and bedrock aquifers underlying the Butte Hill have been impacted by past mining. The bedrock aquifer is predominately characterized and monitored under the Butte Mine Flooding Operable Unit (BMFOU), while the alluvial aquifer primarily is characterized and monitored under the BPSOU, thus this QAPP focuses on the alluvial aquifer but covers monitoring of some bedrock wells. Contaminants of concern (COCs) within the BPSOU groundwater system are arsenic, cadmium, copper, lead, mercury, and zinc. Post-ROD historical concentration ranges for wells within the proposed water quality monitoring network for each of these constituents in mg/L are: arsenic less than the method detection limit (< MDL) to 4.41, cadmium < MDL to 4.23, copper 0.002 to 2100, mercury < MDL to 0.0058, lead < MDL to 1.8, and zinc 0.0002 to 4440. In 2006, the EPA deemed it was technically impracticable to remediate the alluvial aquifer to the point that groundwater met ARARs; thus, a TI waiver of groundwater standards was granted for the

BPSOU alluvial aquifer (EPA 2006d). Alluvial groundwater may discharge to Blacktail Creek (BTC) and Silver Bow Creek (SBC); therefore, groundwater capture and treatment systems are in place to minimize discharge of contaminated groundwater to BTC and SBC and prevent exceedances of surface water ARARs. This requires development of a groundwater monitoring plan that will ensure data is of adequate quality and is usable to assure the groundwater capture systems are operating effectively and preventing surface water standard exceedances. Components of this plan must include an assessment of groundwater quality trends (spatially and temporally), as well as groundwater/surface water elevation relationships that can be used to evaluate groundwater capture.

- The basis of the BPSOU alluvial aquifer TI waiver issued by the Agencies in 2006 aptly describes the setting of the aquifer. The TI waiver was based on widely scattered primary source areas (mine waste), widely distributed secondary sources which consist of "adsorbed and precipitated metals phases" (EPA, 2006b), heterogeneous physical and chemical properties within the alluvial aquifer which limit determination of aquifer hydraulic properties, and the fact that the aquifer is in an urban area, thus overlain by infrastructure and municipal, commercial, and residential structures. The COCs within the alluvial aquifer are defined as arsenic, cadmium, copper, lead, mercury, and zinc. The impacted area extends from the Montana Resources mine property on the east end, to the western boundary of Lower Area One (LAO) near the Interstate 90 westbound overpass. Regions of elevated metals concentrations are generally confined to a narrow (~1500 feet width) region paralleling the BPSOU subdrain and hydraulic control channel (HCC). As described in the ROD, aquifer thickness is approximately 200 feet at the eastern boundary and thins to approximately 30 feet at the western boundary due to structural controls and faulting.

Surface water features potentially impacted by alluvial groundwater include BTC and SBC. BTC enters the operable unit from the southeast, and perennial SBC begins at the ephemeral upper portion of the creek's confluence with BTC. Formerly a surface water feature, in 2003, upper SBC was underlain with a perforated polyvinylchloride pipe from Harrison Avenue to east of Kaw Avenue to separate groundwater from surface water. This subdrain capture system collects groundwater from one of the Operable Unit's most heavily impacted areas. The collected groundwater is piped from the BPSOU subdrain to the Butte Treatment Lagoons (BTL) (western portion of BPSOU) for treatment.

The objectives of groundwater monitoring as described in Appendix E (BPSOU Revised Interim Ground Water Monitoring Plan) of the Unilateral Administrative Order (UAO) (EPA, 2011b) are to:

- *"Ensure that existing ground water capture and treatment systems are effective.*
- *Determine that contaminated ground water is not leaving the TI Zone or discharging to surface water.*
- *Provide additional information as necessary on the movement, quality, and quantity of ground water to assure that ground water contamination plumes are not spreading and ground water quality is not degrading and that surface water is not threatened.*
- *Provide data for review of the ground water remedy"*

These UAO monitoring objectives assure that the remedial action objectives from the ROD (EPA, 2006b), as provided below, will be met.

- *"Prevent ingestion of or direct contact with contaminated ground water that would result in unacceptable risk to human health*
- *Prevent ground water discharge that would lead to violations of surface water ARARs and RGs for the BPSOU*
- *Prevent degradation of ground water that exceeds current standards"*

This BPSOU Interim Site-Wide Groundwater Monitoring QAPP (GW QAPP) addresses the objectives outlined in the UAO and in the ROD/RODA. These same objectives will be addressed as monitoring moves into the compliance determination period, after the BPSOU remedial action construction, and into compliance monitoring, although the monitoring network and frequency may need to be modified for those periods.

Step 2: Identify the Goal of the Study.

This step identifies what questions the study will attempt to resolve. The key questions may be stated as follows.

1. Are the groundwater performance standards being met for the ARARs at POC groundwater monitoring wells?
    a. Will data collection efforts provide sufficient spatial and temporal coverage to answer Questions 1?
2. Are statistically significant upward trends occurring in COC concentrations at groundwater monitoring wells outside of the TI Zone?
    a. Will data collection efforts provide sufficient spatial and temporal coverage to answer Questions 2?
3. Are current capture systems preventing impacted groundwater from discharging to surface water in amounts or concentrations that lead to exceedances of surface water ARARs?
    a. Will data collection efforts provide sufficient spatial and temporal coverage to answer Question 3?

Questions1 and 2 will be answered by collecting water quality samples at the network defined in Table 3 (provided at the end of this document), which also specifies the monitoring frequency. The water quality network has been designed to ensure sufficient spatial and temporal coverage to fully answer Questions 1 and 2. Analytical data produced from the Table 3 network must be of sufficient quality to meet the performance criteria specified in Section 3.5 of this QAPP. Development and adherence to project and laboratory standard operating procedures (SOPs) will ensure that groundwater sample collection and subsequent laboratory analysis maintains the required data integrity. Project SOPs and analytical methods are discussed in Section 3. Note that several wells in the 2011 UAO monitoring network have been abandoned due to the Parrot Tailings removal. These are BPS11-20, GS-09-01, GS-09-02, GS-09-03, GS-41S&D, GS-42S&D, and GS-45. Replacement wells are planned for these sites once the Parrot Tailings Removal site becomes accessible. Also scheduled for abandonment and replacement due to the Parrot Tailings removal is AMW-08. These wells may become inaccessible during the 2021 monitoring period.

Questions 3 will be answered by measuring groundwater and surface water elevations at the network specified in Table 4 (provided at the end of the document), which also specifies water level monitoring frequency. In addition to water elevation data, groundwater and normal flow surface water analytical data is needed to answer Question 3. Surface water data collection is discussed in *Silver Bow Creek/Butte Area Final BPSOU 2022 Monitoring Period Interim Site-Wide Surface Water Monitoring Quality Assurance Project Plan (QAPP)* (SW QAPP) (Atlantic Richfield, 2021). The water elevation monitoring network defined in Table 4 provides sufficient spatial and temporal coverage to assist in answering Question 3. Development and adherence to project SOPs, which are discussed in Section 3, will maintain data integrity.

Note that Table 5, which can be found at the end of this document, provides coordinates for all sites in the water level and water quality network.

Step 3: Identify Information Inputs.

The following data will be collected to supplement existing data to address the goals of the groundwater monitoring program:

- Groundwater water level monitoring data

    - Field measurements of depth-to-groundwater (wells) and flow rate (where possible from springs/seeps).
- Groundwater water quality monitoring data
    - Laboratory analyses for COC metals.
    - Field measurements of pH, specific conductance (SC), dissolved oxygen (DO), oxidation-reduction potential (ORP), and temperature.

Data will be obtained from sampling as described in Section 3.0: Measurement and Data Acquisition. The data will be used with previously collected data to assess water quality trends in POC wells and wells within the TI Zone. The media to be sampled, analytical parameters, and laboratory methods, detection limits, reporting limits, and hold times are provided in Table 2; while Table 6 provides COC performance standards for the alluvial aquifer outside of the TI Zone listed in the BPSOU ROD. There are no numeric groundwater standards within the TI Zone.

Table 2 - Analytical Methods, Approximate Detection Limits, Maximum Analytical Holding Times, and Field Parameter Specifications

Analyte	Method	MDL[1] (mg/L)	Reporting Limit (mg/L)	Holding Time (Days)
Semi-Annual Parameters				
Dissolved Arsenic	EPA 200.8	0.000083	0.00050	180
Dissolved Cadmium	EPA 200.8	0.000016	0.000080	180
Dissolved Copper	EPA 200.8	0.00050	0.0010	180
Dissolved Lead	EPA 200.8	0.000028	0.00010	180
Dissolved Mercury	EPA 245.1	0.000045	0.00020	28
Dissolved Zinc	EPA 200.8	0.0020	0.0050	180
Additional Five-Year Parameters				
Dissolved Calcium	EPA 200.8	0.018	0.040	180
Dissolved Iron	EPA 200.8	0.012	0.050	180
Dissolved Magnesium	EPA 200.8	0.0034	0.010	180
Dissolved Manganese	EPA 200.8	0.00020	0.00050	180
Dissolved Potassium	EPA 200.8	0.019	0.10	180
Dissolved Sodium	EPA 200.8	0.020	0.050	180
Hardness (as $CaCO_3$)	SM2340B, online edition, 1997	0.060	0.14	180
Alkalinity (as $CaCO_3$)	SM2320, online edition, 1997	1.8	5.000	14
Chloride	EPA 300.0	0.39	1.2	28
Sulfate	EPA 300.0	0.34	1.2	28
TDS	SM2540C, online edition, 1997	5	10	7
Field Parameters Measured with YSI Professional Plus				
Parameter	**Accuracy**		**Resolution**	
DO (mg/L)	Greater of ± 2% or reading or 0.2 mg/L		0.01 mg/L	
ORP (mV)	± 20 mV		0.1 mV	
pH (SU)	± 0.2		0.01 SU	
SC (µS/cm or mS/cm)	Greater of 0.001 mS/cm or ± 0.5% of reading		0 to 0.500 mS/cm: 0.001 mS/cm 0.501 to 50.00 mS/cm: 0.01 mS/cm 50.01 to 200 mS/cm: 0.1 mS/cm	
Temperature (°C)	0.2 °C		0.1 °C	

[1]The MDLs presented represent 2021 values. MDLs are determined annually and may fluctuate.

Table 3 - BPSOU 2022 Water Quality Monitoring Network - see Tables section

Table 4 - BPSOU 2022 Water Level Monitoring Network - see Tables section

Table 5 - BPSOU 2022 Groundwater Monitoring Network - Coordinates - see Tables section

Table 6 – 2006 ROD Based Groundwater Standards

Constituent of Concern	Performance Standard Identified in the 2006 ROD (Dissolved mg/L)
Arsenic	0.010
Cadmium	0.005
Copper	1.30
Lead	0.015
Mercury	0.002
Zinc	2.00

Step 4: Define the Boundaries of the Study.

The study area is limited to the groundwater monitoring network shown in Figures 3 and 4. Groundwater elevations will be measured monthly, towards the end of each month, using the method described in Section 3.2.2.1. Water quality samples will be collected semi-annually, commencing in late spring/early summer and late summer/early fall of each year.

Potential constraints that could delay fieldwork include adverse weather conditions, fires, closed roads, the inability to obtain property access for sampling, and stop work orders due to health or safety concerns. Major project delays resulting from these constraints will be reported and recorded in the field logbooks.

Step 5: Develop the Analytic Approach.

This step develops an approach that guides how study results are interpreted and how conclusions are drawn from the study results. The approach in this section corresponds with the information inputs defined in Step 3.

Information inputs are groundwater level and groundwater quality data. Groundwater level measurements will be made with an electronic depth to water tape which measures to 0.01 feet. It is believed that three hydrogeological units exist within the BPSOU, the shallow alluvial aquifer, a mid-level alluvial aquifer, and a deep alluvial aquifer. The water level monitoring network specified in Table 4 encompasses all three units and provides spatial coverage from the eastern boundary of the OU to the western boundary of the OU; thus, the network accurately represents the alluvial aquifer. Water level measurements will be checked for comparability with historical data, and all suspect measurements will be verified. There may be times when sites within the water level network cannot be accessed (i.e. staff gages submerged because of high streamflow, ice blockage in shallow wells, stop work orders due to health concerns). The QAPP completeness goal for water level measurements is 95%.

Water quality samples will be analyzed by the EPA approved methods listed in Table 2. Table 2 also identifies field parameters which will be measured on all water quality samples and lists the precision for each parameter. Analytical precision and accuracy are provided in Table 7. The QAPP completeness goal for water quality sampling is 95%.

Table 7 - Summary of Laboratory Quality Control Checks (see Tables section)

Step 6: Specify Performance or Acceptance Criteria.

General acceptance criteria for analytical data are detailed in Section 2.4.2 and Section 3.5.2 provides even greater detail. Briefly, analytical data must be of screening or enforcement quality to be deemed usable. Data usability will be determined through the data validation process which will follow the TREC Data Validation Guidelines for Inorganic Chemistry Data (TREC, 2021) (TREC Data Validation Guidelines). The TREC Data Validation Guidelines, provided as Appendix A, aligns with the National Functional Guidelines for Inorganic Superfund Methods Data Review (EPA, 2020b), but relies on method specific control limits.

Step 7: Develop the Plan for Obtaining Data.

The purpose of this step is to identify a resource-effective data collection design for generating data that are expected to satisfy the DQOs.

The data collection plan detailed in the following sections is designed to ensure that the data will be of sufficient quality and quantity to assess groundwater quality trends, groundwater flow direction, and groundwater/surface water elevation relationships. Data from the previous and current investigations will be comparable due to compatible approaches. The QAPP data collection design (sampling program) is fully described in Section 3.0.

Water level data is needed to generate potentiometric surface maps; thus, one component of this QAPP will be water level sampling. The target frequency for water levels measurements is monthly; however, health and safety concerns may prevent this frequency from being met. The water level network, which includes wells, subdrain manholes, and surface water sites, is specified in Table 4, and displayed on Figure 3, both of which are provided following the text of this document. Synoptic water level measurements will be made towards the end of the month. By staying with a consistent water level monitoring schedule, data collection bias will be eliminated. Water level data will be converted to elevation data and mapped to create a potentiometric surface.

Synoptic water quality data will be collected semi-annually in April/May and September/October, at the wells specified in Table 3, and displayed on Figure 4. Water quality sampling will include both field parameter measurements and laboratory analyses. Field measured data will include depth to water, water temperature, pH, specific conductivity, oxidation-reduction potential, and dissolved oxygen. Typical laboratory analyses will include dissolved arsenic, cadmium, copper, lead, mercury, and zinc. Every five years, commencing in 2023, the April/May round of sampling will include the Five-Year analyses listed in Table 2.

2.4.2 Measurement Performance Criteria for Data

All data collection will be conducted under CFRSSI or other applicable SOPs to maintain consistent techniques. Sample analysis will be performed by an approved laboratory which holds NELAP accreditation, is certified under the Montana DPHHS public water supply laboratory certification program to perform inorganic analyses, and is in Atlantic Richfield's Laboratory Management Program. Additionally, the analytical laboratory will adhere to the appropriate protocols specified in the *Clark Fork River Superfund Site Investigations Laboratory Analytical Protocol* (LAP), (ARCO, 1992a).

Measurement performance criteria are established by defining acceptance criteria and quantitative or qualitative goals (e.g., control limits) for accuracy, precision, representativeness, comparability, completeness, and sensitivity of measurement data. The definitions of precision, accuracy, representativeness, comparability, completeness, and sensitivity are provided below along with the acceptance criteria for data collected. Equations for calculation of precision, accuracy and completeness are provided in Table 8.

Table 8 - Precision, Accuracy and Completeness Calculations Equations

Characteristic	Formula	Symbols
Precision (as relative percent difference, RPD)	$RPD = \frac{(x_i - x_j)}{\left(\frac{x_i + x_j}{2}\right)} \times 100$	x_i, x_j: replicate values of x
Precision (as relative standard deviation, RSD, otherwise known as coefficient of variation)	$RSD = \frac{\sigma}{\bar{x}} \times 100$	σ: sample standard deviation $\bar{x}$: sample mean
Accuracy (as percent recovery, R, for samples without a background level of the analyte, such as reference materials, laboratory control samples and performance evaluation samples)	$R = \frac{x}{t} \times 100$	x: sample value t: true or assumed value
Accuracy (as percent recovery, R, for samples with a background level of the analyte, such as matrix spikes)	$R = \frac{SSR - SR}{SA} \times 100$	SSR: spiked sample result SR: sample result SA: spike added
Accuracy (as percent difference, D, for samples > 50X the MDL, which have undergone at least a five-fold dilution, with the result, S, corrected for the dilution)	$D = \frac{\lvert I - S \rvert}{I} \times 100$	I: initial sample result S: serial dilution result
Completeness (as a percentage, C)	$C = \frac{n}{N} \times 100$	n: number of valid data points produced N: total number of samples taken

Precision

Precision is the level of agreement among repeated measurements of the same characteristic. There are two general forms of uncertainty. The first is the random error component of the data collection process. The second is inherent stochastic variability, which cannot be eliminated but can be described.

Data precision is assessed by determining the agreement between replicate measurements of the same sample and/or measurements of duplicate samples. The overall random error component of precision is a function of the sampling. The analytical precision is determined by the analysis of field duplicates by laboratories and by replicate analyses of the same sample. An analytical duplicate is the preferred measure of analytical method precision. When analytes are present in samples at concentrations below or near the quantitation limit, precision may be evaluated using duplicate analyses of laboratory prepared samples such as duplicate laboratory matrix spike samples (MS/MSD), duplicate laboratory control spike samples (LCS/LCSD), and/or laboratory duplicate (LD) samples. Precision can be measured as relative percent difference (RPD) or as relative standard deviation (RSD) (also known as a coefficient of variation). Formulae for both are presented in Table 8.

For this QAPP, precision shall be determined by the analysis of field and laboratory duplicates and the evaluation of the RPD for the paired measurements. The RPD goals for measures of analytical precision are provided in Table 7, which can be found in the Tables section.

The RPD precision goal for aqueous field duplicates will be 20 percent for sample pairs with both sample results being greater than five times the reporting limit (RL). For field duplicate pairs with one or both sample results less than five times the RL, a difference of less than or equal to the RL (difference ≤ RL)

will be used as the precision goal. For analytical duplicates, the acceptable RPD varies from 5-20%, depending on the analysis. Table 7 summarize analytical RPD requirements.

Accuracy/Bias

Accuracy is the degree of difference between the measured or calculated value and the true value. It is a measure of the bias or systematic error of the entire data collection process. Potential sources of systematic errors include:

- sample collection methods;
- physical or chemical instability of the samples;
- interference effects during sample analysis;
- calibration of the measurement system; and
- contamination.

Field blanks and laboratory method blanks (MB) may be analyzed to assess artifacts introduced during sampling, transport and/or analysis that may affect the accuracy of the data. In addition, initial calibration verifications (ICVs), continuing calibration verifications (CCVs), initial calibration blanks (ICBs), continuing calibration blanks (CCBs), laboratory control samples (LCS), matrix spike samples (MS), serial dilution samples (SD), interference check samples (ICS), contract required detection limit (CRDL) check samples, and the intensity of internal standards relative to the intensity of that standard in the laboratory blank (%RI) are used to verify that sample concentrations are accurately measured by the analytical instrument throughout the analytical run. Note that MB, LCS, and MS results are reported in Limited and Full data packages, while ICV, CCV, ICB, CCB, SD, ICS, CRDL, and %RI results are reported only in Full data packages. Also, SD, ICS, and %RI are applicable only to inductively coupled plasma mass spectrometry analyses.

Bias in field activities shall be determined by the collection and analysis of field blanks, as described in Section 3.5.1. Field blank accuracy goals are target analyte concentrations less than the method detection limit. Laboratory accuracy and bias will be determined by the analysis of calibration verification samples, laboratory control samples, matrix spike samples, laboratory blank samples, serial dilution samples, interference check samples, CRDL samples, and %RI, as applicable to the analytical method. Accuracy/Bias goals for specific analytical methods are summarized in Section 5 and detailed in Table 7 and Table 9.

Table 9 – Summary of Laboratory Calibration Checks (See Tables Section)

Representativeness

Data representativeness is defined as the degree to which data accurately and precisely represents a characteristic of a population, parameter variations at a sampling point or environmental conditions. Representativeness is a qualitative parameter that is most concerned with the proper design of the sampling program. Representativeness of samples shall be achieved through the careful selection of sampling locations and methods. This QAPP has been designed to provide samples that are representative of the medium being sampled as well as a sufficient number of samples to meet the project DQOs, which are described in Section 2.4.1. Sample representativeness may also be evaluated using the RPDs for field duplicate results, as well as field blank results. Agreement between duplicate samples is applicable to representativeness of individual sampling points, not the overall sampling program. If agreement between field duplicates is acceptable (≤ 20% RPD for sample concentrations greater than five times the reporting limit, and a delta < the RL for samples less than five times the reporting limit), it can be assured that the reported concentration is a valid representative measure of near-aquifer conditions. If agreement between duplicate samples is not acceptable, the reported concentration must be considered an estimation of near-aquifer conditions. If field blanks fail acceptance criteria by a large margin (> 1.5X the MDL), and sample

concentrations are near the field blank concentration result (near FB result is defined as < ten times the FB result), it may be an indication that all associated samples are biased high due to equipment contamination.

Comparability

Data comparability is defined as the measure of the confidence with which one data set can be compared to another. Comparability is a qualitative parameter but must be considered in the design of the sampling plan and selection of analytical methods, quality control protocols, and data reporting requirements. Comparability shall be ensured by analyzing samples obtained in accordance with appropriate SOPs. The results of analyses collected under this QAPP will be compared with previously collected water quality data for the sites in the groundwater monitoring plan. All analytical data should be calculated and reported in units consistent with standard reporting procedures so that the results of the analyses can be compared with those of other laboratories, if necessary. Aqueous data should be reported in mg/L.

Completeness

Completeness refers to the amount of usable data produced during a sampling and analysis program. The procedures established in this QAPP are designed to ensure, to the extent possible, that data shall be valid and usable. To achieve this objective, every effort shall be made to collect each required sample and to avoid sample loss. The QAPP completeness goal is 95 percent for each matrix.

Sensitivity

Sensitivity refers to the capability to quantify an analyte at a given concentration, and this parameter is associated with the instrument and method detection limits, and the project reporting limits. The desired analytical sensitivity is method detection limits less than the applicable water quality standards specified in the BPSOU ROD/RODA. Table 2 displays the analytical sensitivity.

2.5 Special Training

All personnel engaged in on-site activities are required to have proper health and safety training as required by the Occupational Safety & Health Administration (OSHA) Regulation 29 CFR 1910.120 (HAZWOPER). Personnel who completed their initial HAZWOPER training more than 12 months prior to the start of the project must have completed an 8-hour refresher course within the appropriate time frame relative to their duties. The Project Safety and Health Manager is responsible for ensuring the field crews are compliant with HAZWOPER training.

Field personnel shall be trained in the requirements of this QAPP in a project meeting held prior to the initiation of any field activity. All personnel shall read the QAPP document prior to the start of fieldwork and shall acknowledge that they have read the document at the time of the project meeting. In addition, field procedures and sampling requirements shall be reviewed by the CPM, or designee, in order to better ensure that samples are collected and handled according to the QAPP requirements.

Field personnel will also be trained in the use of field equipment, decontamination procedures and chain-of-custody procedures in accordance with field data collection SOPs used for the sampling event, and this training will be documented within the appropriate section of each SOP. The CPM will be responsible for ensuring that training requirements are fulfilled.

One hard copy of the current approved version of this QAPP shall be maintained for ready reference purposes in the field vehicle or field office. All field team members shall have access to pdf files of the complete QAPP.

Laboratories providing analytical services will have a documented quality system that complies with EPA *Requirements for Quality Management Plans (QA/R-2) (EPA, 2001b)*. The Laboratory Quality Manager will be responsible for ensuring that all personnel have been properly trained and are qualified to perform assigned tasks.

2.6 Documents and Records

This section briefly describes the procedures for management of project documentation and records for this QAPP from initial generation of the data to its final use and storage in the project files.

2.6.1 Property Access Agreements

Atlantic Richfield will request that property owners grant access for monitoring related activities which may occur on private property. The CPM or their designee will manage requests for access, track the status of access requests and maintain copies of completed agreements received from property owners.

Completed agreements will be scanned and stored on a server with other project records.

2.6.2 Field Logbooks/Data Sheets

Documentation of observations in the field provides information on conditions at the time of sampling and a permanent record of field activities. Field records will be kept in a bound field logbook or in electronic field forms, or both. The logbook may reference more detailed records found in the electronic field forms, and vice versa. Each logbook shall have a unique document control number, and the logbooks will be bound and have consecutively numbered pages. The information recorded in these logbooks shall be written in black indelible ink. Whenever a sample is collected, or a measurement is made, the sample site identification and any additional observations will be recorded in the field book. Electronic forms for tasks associated with the QAPP have been developed, and these forms are available on digital tablets. Each field-completed form will have a unique document control number, and prior to upload, the forms will be checked for accuracy and completeness, and saved. Daily, the forms will be uploaded to a main server.

Field logbooks and electronic field forms will include the information listed below, at a minimum:

- Date of the field work
- Names and titles of field personnel;
- Meteorological conditions at the beginning of field work and any ensuing changes in the weather conditions;
- A description of the field task;
- Time field work started;
- All field measurements made;
- Any field analysis results; and
- Personnel and equipment decontamination procedures.

In addition to the items listed above, field logbooks will also include

- Name and affiliation of any field contacts or site visitors (e.g., agency representatives, auditors, etc.);
- Details of the field work performed and the field forms used, with special attention to any deviation from the QAPP or applicable SOPs.

For any water quality sample collection, the following entries will also be made in field books and/or electronic field forms:

- Calibration of any field equipment;
- Identification of field equipment, including make, model, and serial number if available;
- Sample location and ID number;
- Depth to water at beginning of purge process;
- Volume of three well casings;
- Depth at which pump/tubing is set, as measured from the marked measuring point;
- Date and time of sample collection;

- Sample type collected;
- Sample field preparation;
- Sample preservative;
- Final field parameters (temperature, pH, SC, ORP, DO);
- Split samples taken by other parties (note the type of sample, sample location, time/date, name of person, person's affiliation and any other pertinent information);
- Sampling method, particularly any deviations from the SOPs;
- Documentation or reference of preparation procedures for reagents or supplies that will become an integral part of the sample (if any used in the field).

Changes or deletions in the field logbook will be recorded with a single strike mark through the changed entry, with the sampler's initials and the date recording the new entry. All entries must remain legible. Sufficient information should be recorded to allow the sampling event to be reconstructed without having to rely on the sampler's memory.

Completed field logbooks will be scanned and stored on a server. No bound field logbooks will be destroyed or thrown away, even if they are illegible or contain inaccuracies that require a replacement document. Completed field data forms will be stored electronically on a main server, using a file structure that separates forms by project and date. Servers will be backed up daily. No electronic field forms will be deleted, even if they contain inaccuracies that require a replacement document.

2.6.3 Field Photographs

When photographs of field activities are taken, a digital camera will be used. Specifically, photographs should be taken of unexpected circumstances (i.e. a damaged well casing). Photographs should include a scale in the picture when practical.

The following items shall be recorded on the electronic field record for each photograph taken:

- The photographer's name, date, time, and the general direction faced;
- A brief description of the subject and the fieldwork portrayed in the picture; and
- Sequential number of the photograph.

The digital files shall be placed in project files with copies of supporting documentation from the bound field logbooks.

2.6.4 Chain of Custody Records

After samples have been collected, they will be maintained under strict chain-of-custody protocols in accordance with CFRSSI SOP G-7. The field sampling personnel will complete a chain-of-custody form for each sample shipment (e.g., batch of coolers) delivered to the laboratory for analysis. The sampler is responsible for ensuring that the chain-of-custody is initiated and filled out. The chain-of-custody for a sample shipment will list only the samples in that shipment.

Information contained on the chain-of-custody will include the following:

- Project name and identification number;
- Sampler's signature and affiliation;
- Date and time of collection;
- Sample identification number and matrix;
- Analyses requested;
- Preservative used;
- Remarks such as any additional notes to laboratory personnel (e.g., filter in lab);
- Signature of persons relinquishing custody, dates and times; and
- Signature of persons accepting custody, dates and times.

Any documentation, including chain-of-custody forms, placed inside the cooler during sample shipment should be placed inside a re-closeable plastic bag.

The sampler whose signature appears on the chain-of-custody is responsible for the custody of the samples from the time of sample collection until custody of the sample is transferred to a designated laboratory, a courier, or another project employee for the purpose of transporting the samples to the designated laboratory. The sample is considered to be in custody when the sample is: (1) in the responsible individual's physical possession; (2) in the responsible individual's visual range after having taken possession; (3) secured by the responsible individual so that no tampering can occur, (4) secured or locked by the responsible individual in an area in which access is restricted to authorized personnel; or (5) transferred to authorized personnel.

An electronic copy of each transmitted chain-of-custody will be stored on a main server, within project record files.

2.6.5 Analytical Laboratory Records

Results received from the laboratories will be documented both in report form and in an electronic format. Laboratory documentation includes copies of the signed chain-of-custody forms, laboratory confirmation reports including information on how samples have been batched and the analyses requested, data packages including the lab report and the electronic data deliverable (EDD), and any change requests or corrective action requests. Section 5.1.3 presents the project's laboratory reporting requirements in detail. Electronic report deliverables ("data package" or "report") issued by the laboratories will include data necessary to complete validation of laboratory results in accordance with specifications included in Section 5.2.2.

Original hard copy deliverables and electronic files received from laboratories will be maintained with the project quality records.

2.6.6 Project Data Reports

A Data Summary Report (DSR) will be prepared based on guidelines in the CFRSSI Pilot Data Report Addendum (ARCO, 2000b) following each year of data collection and evaluation. The DSR will describe the field activities performed during implementation of the QAPP and the physical characteristics of the study area. The DSR will include field documentation, documentation of field QC procedures, and results of all field and laboratory measurements and analyses. A detailed listing of any deviations from the approved QAPP will also be provided, with an explanation for each deviation and a description of the effect on data quality and usability, if any. A discussion of the data quality assessment, which is discussed in greater detail in Section 5.0 , will be included in the DSR.

Annually with the DSR submittal, technical recommendations for revisions to the BPSOU Site-Wide groundwater monitoring program will be proposed in a Recommendation Report. Additionally, COC data from POC wells outside of the TI Zone will be compared to the Performance Standards presented in Table 6 and presented in an annual Compliance Comparison Report.

The CPM is responsible for preparation of the DSR, the Recommendations Report, and the Compliance Comparison Report, all of which will be submitted in draft form to the EPA for review. The DSR will be submitted annually, by May 31 of the year following monitoring. The Recommendation Report will be submitted no later than May 31 of each year, and the Compliance Comparison Report will be submitted no later than June 30 of each year. Upon receipt of Agency comments, these draft reports will be revised to address the comments and resubmitted to the EPA for final approval. Numerical data presented in DSRs will be stored in the Butte Data Management System (BDMS). Finalized reports will reside on the BPSOU Document Sharepoint Site. Data management is fully described in the Final Data Management Plan (DMP) (Atlantic Richfield, 2020b)

2.6.7 Program Quality Records

Program quality records are defined as completed, legible documents that furnish objective evidence of the quality of items or services, activities affecting quality, or the completeness of data. These records shall be organized and managed by the Remedial Action (RA) entity and shall include, at a minimum:

- This QAPP and any approved revisions or addenda;
- Approved versions of the Health and Safety Plan (HSP) and any addenda;
- Copies of SOPs for field data collection, with any updates, revisions or addenda to those SOPs;
- Electronic field forms;
- Electronic copies of completed sample chain-of-custody forms;
- Copies of all laboratory agreements and amendments;
- As-received laboratory data packages;
- Documentation of field and/or laboratory audit findings and any corrective actions; and
- Draft and final delivered versions of all reports and supporting procedures such as statistical analyses, numerical models, etc.

3.0 MEASUREMENT AND DATA ACQUISITION

The elements in this section address all aspects of project design and implementation for the generation and acquisition of data. Implementation of these elements ensure that appropriate methods for sampling, sample handling, laboratory analysis, field and laboratory QC, instrument/equipment testing, inspection, and maintenance, instrument/equipment calibration, data management and data security are used for all phases of the investigation.

3.1 Sampling Process and Design

This QAPP has been developed to define the requirements for groundwater monitoring within the BPSOU. Groundwater monitoring performed under this QAPP includes water level measurements, field parameter measurements, and collecting water quality samples for laboratory analysis of six metals/metalloids at the monitoring networks specified in Table 3 and Table 4. One hundred eight sites will be sampled semi-annually and five sites will be sampled annually, for a total of 221 primary samples, resulting in 1326 analyses. The water quality frequency can also be found on Table 3 and the water level frequency for each site can be found on Table 4. Figure 3 displays the water level monitoring network, while the groundwater quality monitoring network is displayed on Figure 4.

3.1.1 Groundwater Monitoring Objectives

The objectives of groundwater monitoring as described in Appendix E (BPSOU Revised Interim Ground Water Monitoring Plan) of the Unilateral Administrative Order (UAO) (EPA, 2011b) are to:

- *"Ensure that existing ground water capture and treatment systems are effective.*
- *Determine that contaminated ground water is not leaving the TI Zone or discharging to surface water.*
- *Provide additional information as necessary on the movement, quality, and quantity of ground water to assure that ground water contamination plumes are not spreading and ground water quality is not degrading and that surface water is not threatened.*
- *Provide data for review of the ground water remedy"*

3.1.2 Groundwater Monitoring Network, Frequencies, and Analytes

Groundwater monitoring performed under this QAPP includes water level measurements at the sites defined in Table 4, as well as measuring field parameter and collecting water quality samples at the sites specified in Table 3. These tables also specify the monitoring frequency. Figure 3 displays the water level monitoring network, while the groundwater quality monitoring network is displayed on Figure 4.

Water quality samples, including measurement of field parameters, will be collected at the frequency specified on Table 3. Analytical results of water quality samples will be used in statistical evaluations to discern increasing, or decreasing, trends of contaminants of concern in monitoring wells. The water quality network specified in Table 3 will provide adequate data to assess the effectiveness of capture systems, to determine if impacted groundwater is leaving the TI zone or discharging to surface water in concentrations or volumes that adversely impact surface water quality, and to determine if groundwater quality within the TI zone is degrading.

Table 2 specifies both the field parameters that will be collected and the laboratory analysis that will be completed for all samples. Groundwater samples will be submitted to the analytical laboratory on no greater than a ten-day basis. In monitoring periods that five-year review analyses are performed samples will be submitted to the analytical laboratory at least every two days.

Contaminants of concern, dissolved arsenic, cadmium, copper, lead, mercury, and zinc, are critical information; while field parameters, temperature, pH, SC, ORP, and DO, as well as the additional five-year constituents, are considered informational data.

Variability with respect to historical data may occur in both water level and water quality data. Water level variability may be in response to nearby dewatering, in stream beaver dams, breaching of in-stream beaver dams, precipitation or snow melt events, and/or human error. Water level data will be collected using applicable SOPs, thus limiting human error. Significantly variable water level data will result in verifying suspect data points upon their discovery by checking all field notes, and if necessary, re-measuring the water level. Field personnel will note any non-routine occurrences (ponded water around a well, significant precipitation event, nearby dewatering, etc.) at the time they make the original and any follow-up water level measurement.

Water quality variability may occur in response to water table fluctuations, nearby dewatering, changes in sampling method, or changes in analytical method. To limit variability due to sampling and analysis, consistent sampling and analytical methods will be used according to applicable SOPs. Variability due to changes in the water table, whether those emanate from climatic conditions or man-made sources, cannot necessarily be controlled. Field documentation will occur during water quality monitoring, and should significant variability be found in water quality results, this documentation, along with climatic records, will be consulted.

3.2 Sampling Methods

This section details methods that will be used to obtain water level measurements and water quality samples.

3.2.1 Applicable Standard Operating Procedures (SOPs)

A list of the SOPs used for the site investigation are listed below in Table 10. The full text of each SOP can be found in Appendix B.

Table 10 – Project Sampling SOP References

Reference Number	Title and Revision Date	Originating Organization
G-4	Field Logbook/Photographs, April 2, 1992	ARCO
G-5	Sample Packaging and Shipping, 1992	ARCO
G-6	Field Quality Control Samples, September 1992	ARCO
G-7	Sample Custody, 1992	ARCO
SOP-GW-01	Ground Water Level Measurement, Rev. 3, January 23, 2019	TREC, Inc.
SOP-GW-02	Ground Water Sampling of Monitoring Wells with Submersible Pump, Rev. 5, May 12, 2021	TREC, Inc.
SOP-GW-03	Ground Water Sampling of Monitoring Wells with Geotech or ISCO Peristaltic Pump, Grundfos Pump, and Geotech Bladder Pump, Rev. 5, May 12, 2021	TREC, Inc.
SOP-H-01	Water Sampling Equipment Decontamination, Rev. 3, April 13, 2020	TREC, Inc.
SOP-H-02	Downloading Transducers, Rev. 2, April 13, 2020	TREC, Inc.
SOP-H-05	Calibrate YSI Professional Plus Multi-Meter, Rev. 3, February 23, 2019	TREC, Inc.
SOP-H-07	Transducer Compensation and File Submittal, Rev. 1, July 24, 2018	TREC, Inc.
SOP-H-08	Deployment of Ground Water Level Monitoring Equipment, Rev. 1, December 1, 2020	TREC, Inc.
SOP-SW-06	Read Staff Gage, Rev. 3, September 2, 2021	TREC, Inc.

3.2.2 Data Collection Method

3.2.2.1 Groundwater Level Measurements

Groundwater level measurements will be performed on each monitoring well identified in Table 4 according to the frequency identified therein. Water levels will be measured from the surveyed point on the casing, using the general procedures outlined in TREC SOP GW-01. Below is a summary of TREC SOP GW-01, while the SOP itself, which is available in Appendix B, provides greater detail. The water level tape will be lowered into the well casing until the tape sounds. The depth to water (DTW) will be read from the measuring point on the well casing. Water levels for several identified wells will be monitored continuously, following the procedures outlined in TREC SOP-H-08. Pressure transducers will be downloaded to a manufacturer specific device, a laptop computer, or a tablet, using the appropriate communication cable and software. Groundwater level measurement of wells that are covered under other monitoring programs (identified in the 2nd and 4th columns of Table 4) will be coordinated to limit duplication of effort.

Continual water level recorders (transducers) will be installed in the wells identified in Table 4. Transducers deployed by Atlantic Richfield will be set to collect a data point every 15 minutes, in linear mode. Transducers deployed by MBMG will be set to record on hourly intervals, in linear mode. Transducers will be site dedicated preventing potential cross-contamination. At the time the transducers are downloaded, they will be checked for proper function and annually, at a minimum, they will be visually inspected for fouling. If the transducer is becoming fouled, it will be rinsed with tap water. When removing transducers from wells, care will be taken to avoid contacting the transducer and any suspension cables with the ground surface. Should ground surface contact occur, the transducer and suspension cable will be rinsed with tap water to remove all foreign material.

3.2.2.2 Groundwater Sample Collection

Monitoring well sampling and sample handling, preservation, custody, and other associated activities will be performed according to the TREC and CFRSSI SOPs (ARCO 1992d) for groundwater sampling and sample water filtration which are listed in Table 10 above. Groundwater sampling is to be conducted with equipment consistent with CFRSSI SOPs (ARCO 1992d). Below is a summary of the Table 10 SOPs, while the SOPs themselves, which are available in Appendix B, provide greater detail. Table 3 identifies the wells for which groundwater samples will be collected along with the frequency. Sample collection in wells that are covered under other monitoring programs will be coordinated to limit duplication of effort.

The groundwater sampling procedure will include the basic steps summarized below. Detailed descriptions of groundwater sample collection can be found in TREC SOPs GW-02 and GW-03. Decontamination procedures are detailed in TREC SOP H-01.

1) Depth to water will be measured from the marked reference point on the well casing using an electronic depth to water meter, consistent with the method described in Section 3.2.2.1.
2) From the total well depth and depth to water, the length of the water column will be determined, and the column length and casing diameter will enable determination of a casing volume. The pump (or tubing if a peristaltic pump is used) will be lowered to the mid-point of the water column.
3) A minimum of three casing volumes will be purged from each well and field parameters will be measured throughout the purging process. If the pump flow rate is sufficiently low (0.5 gpm or less), parameters may be measured utilizing a flow-through cell. Field parameters will be recorded at least once per well volume. The well will continue to be purged until field parameter readings are stabilized and three casing volumes have been evacuated. Stabilization is reached when changes between two successive well volumes are: pH - <0.1 SU, SC – <10%, ORP – <10 mV.
4) Once field parameters have stabilized, and three casing volumes have been evacuated, the sample will be collected. Any non-filtered sample aliquot will be collected first, by decanting the well water directly from the tubing into a rinsed 500 mL (or larger) HDPE sample bottle. The bottle will be filled with no head space, and then capped. To collect the dissolved metals aliquot of the sample, a 0.45-micron disposable filter will be placed on the tubing outlet. The bottle will be rinsed with source water unless it is pre-preserved. The 250 mL, or larger, HDPE sample bottle will be filled, leaving sufficient space for sample preservative. The sample will be acidified, either previously by the bottle supplier, or in the field by the sampling team, to pH < 2 with nitric acid, and then capped.
5) All reusable equipment (submersible pumps and tubing) will be thoroughly decontaminated between each sampling site, following TREC SOP-H-01. Decontamination water will be containerized, along with purge water, and disposed of in the Butte Reduction Works (BRW) drying beds.

3.2.3 Sampling Equipment

Groundwater level measurements will be made with an electronic water level meter that makes measurements to the 0.01 foot. Continual water level measurements will be made with down-well pressure transducers. Transducers will be downloaded with a laptop computer, an electronic tablet, or a hand-held field device specific to the transducer type, and appropriate communication cables. Field parameters will

be measured using a hand-held field meter(s) which measures DO, ORP, pH, SC, and temperature, at a minimum. Field parameter measurement units and precision are specified in Table 2 above.

Water quality samples will be collected with a submersible, or peristaltic pump, whichever is applicable for the situation. Samples will be drawn to the surface through polyvinyl chloride or polyethylene tubing. When a peristaltic pump is used, silicon tubing will be mated to the polyethylene tubing to allow for the flexibility needed to pass the tubing through the pump rollers. Samples to be analyzed for dissolved metals will be field filtered through 0.45-micron disposable filters into clean laboratory bottles. Appropriate preservative (nitric acid for metals) will be added to the sample bottle, as indicated in Table 11.

Table 11 – Analytical Bottle Count and Preservation

Analytes	Sampling Container	Preservative	Filter	Comments
General Laboratory				
Alkalinity (as CaCO3)	Polyethylene, 1 x 1 L	None, refrigerate 0°C-6°C	None	Only one container for all analyses
Anions (Sulfate & Chloride)	Polyethylene, 1 x 1 L	None, refrigerate 0°C-6°C	None	
Total Dissolved Solids	Polyethylene, 1 x 1 L	None, refrigerate 0°C-6°C	None	
Metals				
Dissolved Metals[1]	Polyethylene, 1 x 250 mL	pH < 2 nitric acid, refrigerate 0°C-6°C	0.45-micron filter	Only one bottle for both analyses
Dissolved Mercury	Polyethylene, 1 x 250 mL	pH < 2 nitric acid, refrigerate 0°C-6°C	0.45-micron filter	

[1]Hardness determined by SM2340B; calculation using dissolved Calcium and Magnesium concentrations.

The complete field equipment needs for groundwater sampling are:

- Electronic copy of the QAPP;
- Electronic field tablet, which is loaded with appropriate sampling forms;
- Padlock keys;
- Electronic depth to water meter;
- Laptop computer;
- Leveloader or Bluetooth® device (for Solinst transducers);
- Communication cables;
- Multi-meter, or individual DO, ORP, pH, SC, and temperature meters;
- Submersible and/or peristaltic pump;
- Appropriate tubing;
- Sample bottles;
- 0.45-micron disposable filters;
- Nitric acid;
- Decontamination water, decontamination solutions, decontamination vessel;
- Sample labels and waterproof marker;
- Sample coolers and ice;

- Purge water tank
- Required Level D Personal Protective Equipment (PPE) including hard hat, safety glasses with side shields, high visibility vest (or shirt), long-sleeved shirt, and safety-toed boots.

Unexpected problems relating to data collection may include samples being spilled and equipment failures. In the event of a sample spill, either in the field or en route to the laboratory, the groundwater site will be re-sampled. To minimize the chance of spills during shipping, coolers will be packed in a manner which eliminates void spaces. Equipment failures may occur with sampling pumps, batteries, field meters, water level tapes, laptop computers, communication cables, or manufacturer specific download devices. Spare pumps, batteries, water level tapes, laptop computers, and communication cables will be kept on hand. Two field meters will be available, and spare probes will be kept on hand for the meters. However, there may be meter failures which require factory repair, in which case a rental meter will be obtained. Transducers are downloaded with manufacturer specific download devices (Leveloader or Bluetooth® device); however, a laptop computer can be used in the event of Leveloader/Bluetooth® failure.

The Field Team Leader will be responsible for maintaining an inventory of spare equipment, as well as ordering replacement or rental equipment. Field team members will be responsible for resampling groundwater sites when sample spills occur in the field. The Field Team Leader will be informed of sample spills which occur during storage or shipment and will assign team members to resample the associated groundwater site.

3.2.4 Sample Disposal

Disposable equipment and all other solid waste associated with sample collection will be immediately placed in trash bags to avoid cross-contamination and to maintain an orderly work environment. The bagged trash will be disposed of at a waste disposal facility. Purge water will be containerized and disposed of at the Butte Reduction Works drying beds.

3.3 Sample Handling and Custody

3.3.1 Sample Holding Time

Every five years, commencing in 2023, the April/May round of sampling will include dissolved metals, dissolved mercury, anions sulfate and chloride, alkalinity, and TDS analysis. As Table 2 shows, the minimal holding time for five-year analytes is seven days for TDS. In sampling rounds that only semi-annual parameters are measured, holding times are 28 days (mercury) and 180 days (metals). The mercury and metals holding times assume the samples are preserved at collection time.

Continual recorders at the BPSOU site are set at varying sampling frequencies, with many set to record data on 15-minute intervals; thus after 90 days, 32,400 data points will be stored. Transducers deployed at BPSOU sites can store 40,000 data points. The target download frequency for continual recorders is monthly. However, health and safety concerns may interrupt this frequency resulting in lengthier intervals between downloads. Every attempt will be made to prevent data loss; however, this may be unavoidable due to restrictions on field work beyond the control of Atlantic Richfield.

3.3.2 Sample Handling and Storage

After collection and labeling, the groundwater samples will be placed in coolers and kept between 0 and 6°C. The samples will be maintained under strict chain-of-custody protocols. The field sampling personnel will complete a chain-of-custody form for each laboratory delivery/shipment. The chain-of-custody form(s) will be placed in a re-sealable plastic bag and placed in the cooler with the samples. Sample shipment is controlled by the analyte with the shortest holding time, which is seven days for five-year cycles and 28 days for all other sampling rounds. Groundwater sampling is anticipated to occur on consecutive days; thus, in five-year sampling rounds samples will be shipped every two days at a minimum and in all other sampling

rounds samples will be shipped at least every ten days. Samples will be placed in coolers, along with a sufficient volume of double-bagged ice to maintain a sample temperature of 0 to 6°C up until the time of sample receipt by the laboratory. Should void spaces exist in the coolers, these spaces will be filled with non-contaminating packing material to prevent samples from shifting, and possibly spilling, during shipment. Coolers which are to be shipped will be custody sealed, securely taped shut, and have a shipping label securely adhered to the cooler. Sample containers hand delivered to the laboratory do not need to be prepared for shipping, but sample temperature must be maintained between 0 and 6 °C.

3.3.3 Field Documentation

All field entries will be recorded in a bound logbook and on electronic field forms. Logbook entries and the electronic form will be completed prior to proceeding to the next sample location. All field logbook and electronic form entries will be consistent with CFRSSI SOP G-4, which is provided in Appendix B. Specific entries will include, but are not necessarily limited to the following: sample location (well ID); sample date and time; depth to water prior to purging, volume of three well casings, depth at which pump/tubing is set, sample identification number; sample analysis, sample field preparation, sample preservative, final field parameters, sampling equipment decontamination, weather conditions, personnel present and affiliation of personnel, and any deviations from the SOP or QAPP protocols.

3.3.4 Sample Identification and Labeling

All groundwater samples collected will have a unique sample ID that follows an alpha-numeric code. The sample ID will follow the pattern "GW####-MMDDYY". Numbers will be sequential starting at 0001 with the first sample collected for each semi-annual monitoring event, and advancing by 1 with each subsequent sample, through the end of the semi-annual event. For example, the first sample collected for the first sampling event of the year on April 20, 2022 would be GW0001-042022. The first sample collected for the second semi-annual sampling event of the year on September 12, 2022 would be GW0001-091222. A label will be placed on each sample bottle, and every label will contain the following information: sample ID, sample date, sample time, requested analysis, preservative added, and samplers' initials. The same information will be recorded on the field form, along with the sample site. The sample ID on the bottle will exactly match the sample ID on the field form and on the chain-of-custody.

3.3.5 Sample Chain of Custody

The sampler is responsible for initiating and filling out the chain-of-custody in a manner consistent with CFRSSI SOP G-7. General chain of custody procedures are detailed here, while CFRSSI SOP G-7 provides greater detail. Each sample in the shipment will be listed on the chain-of-custody, and the chain will contain the project code, the project name, sample IDs, sample dates, samples times, analyses requested, preservative used for each sample analysis, any remarks, name and signature of person relinquishing samples, date and time samples were relinquished, name and signature of sample recipient, date and time samples were received. An example chain of custody can be found in Appendix C.

3.4 Laboratory Methods

Samples will be analyzed using methods consistent with the CFRSSI LAP, (ARCO, 1992a) and the EPA approved methods listed in Table 2 above. The analytical method and detection limit requirements will be updated as required by the governing regulatory agency.

3.4.1 Sample Preparation Methods

Groundwater samples will be prepared for analysis as the EPA approved methods dictate.

3.4.2 Sample Analysis Methods

Groundwater samples will be analyzed in accordance with the appropriate EPA approved method. A summary of sample analyses and methods is provided in Table 2 above. Table 2 includes current detection and reporting limits for each analyte but these are determined on an annual basis; thus, they will fluctuate.

3.4.3 Laboratory Equipment

Required laboratory equipment are an inductively coupled plasma mass spectrometer and an analytical balance for metals/metalloids analysis by EPA 200.8. Mercury analysis requires a cold vapor atomic adsorption analyzer, an autosampler, a block digester, and an analytical balance. Anion analysis requires an ion chromatograph, and H_2O scrubber, and a CO_2 scrubber. Alkalinity analysis requires a pH meter, magnetic stir plates and magnetic stir bars, an autotitrator system, a hot plate, and an analytical balance. Gravimetric samples require an analytical balance, drying ovens, a muffle furnace, a vacuum filtration system, and a desiccator.

3.4.4 Sample Disposal

Disposable equipment and all other solid waste associated with laboratory analysis will be immediately discarded to avoid cross-contamination and to maintain an orderly work environment. The discarded material will be disposed of at a waste disposal facility. Samples which are shipped to the laboratory will be archived for six months, and after that time the laboratory is responsible for sample disposal.

3.5 Quality control

Sample QC protocols will be consistent with CFRSSI SOP G-6 and will include 1 field duplicate for every 20 primary samples and, if sampling equipment is reused across sample locations, 1 field blank collected for every 20 primary samples. Any deviation from the CFRSSI or other SOPs, or this QAPP, will be identified in the logbook and discussed in a data summary report, or similar, if required.

3.5.1 Field Quality Control Samples

Field quality control samples are introduced into the measurement process to provide information on transport, storage and field handling biases, and field sampling precision. The QC samples that follow will be collected for analysis identical to that which is required on primary samples. Brief descriptions of the QC samples to be utilized during groundwater sampling are provided below, along with instructions for their frequencies of collection and analyses.

Field Duplicate

A field duplicate is a second sample collected from the same location in immediate succession to the primary sample, using identical techniques. The duplicate sample will have its own unique sample identification number, but will be sealed, handled, shipped, and analyzed in the same manner as the primary sample. Analysis will be identical for the primary and duplicate sample. The analytical results of the duplicate sample will be compared to determine sampling precision, with a target precision of $\leq$ 20% RPD. Field duplicate samples will be collected at a frequency of one per 20 samples or once per sampling event, whichever is more frequent.

Field Blank

Field Blanks will be used to help identify possible contamination from the sampling environment, from sampling equipment, or from sample handling. A Field Blank (FB) is a sample of deionized water and appropriate preservatives prepared in the field. The FB is contained in a sample bottle randomly chosen from each lot of bottles received from the supplier. Field blanks will be collected by pouring water into a single-use plastic vessel, placing the submersible pump (or tubing if using a peristaltic pump) in the vessel of water, and pumping the water from that vessel. First, approximately two gallons of tap water containing

laboratory grade detergent will be pumped through the pump and tubing, followed by a rinse of two gallons of tap water only. Nearly five gallons of American Society for Testing and Materials (ASTM) Type II DI water will then be pumped through the sampling apparatus, with the blank sample being collected at the end of the flushing process. A new vessel will be used for collecting each blank, and this vessel will be decontaminated in a field laboratory setting prior to use. Decontamination will consist of rinsing the container with 5% nitric acid, followed by a triple rinse with ASTM Type II DI water. The vessel will then be stored in a clean, plastic bag until the time of use. The FB sample will be given its own sample identification, but will be sealed, handled, shipped, and analyzed in the same manner as the primary samples. Field Blanks will be prepared at a frequency of one per 20 samples collected, or one per sampling event, whichever is more frequent. The target is to achieve concentrations < the method detection limit (MDL) in field blanks.

3.5.2 Laboratory Calibration and Quality Control Samples

Laboratory QC samples are introduced into the measurement process to evaluate laboratory performance and sample measurement bias. Control samples may be prepared from environmental samples or generated from standard materials in the laboratory. The appropriate type and frequency of laboratory QC samples are described in the associated method. Examples of typical laboratory QC Samples are listed in Table 7. Analytical calibration check samples can be found in Table 9 These tables can be found following the text of this document.

Initial Calibration Verification/Continuing Calibration Verification

Initial calibration verification (ICV) must be performed immediately after instrument calibration, and after a continuing calibration failure. Continuing calibration verification (CCV) shall be performed every 10 analyses and at the end of the analytical run. Control limits are ± 10% of the reference value for the majority of analyses. In the case of a QC failure, the analysis must be terminated and the problem corrected. The instrument should then be recalibrated, and all samples analyzed since the last in-compliance CCV must be reanalyzed. This is summarized in Table 9.

Initial Calibration Blank/Continuing Calibration Blank

An initial calibration blank (ICB) must be analyzed immediately after the ICV, and a continuing calibration blank (CCB) must be analyzed immediately after every CCV. Neither the ICB nor the CCB should exceed one-half of the reporting limit of any analyte for which analysis was performed. As summarized in Table 9, failure will trigger corrective actions similar to those for an ICV/CCV failure.

Interference Check Sample

Interference Check Samples (ICS) are applicable to inductively coupled plasma (ICP) analyses. ICS samples consist of two solutions, Solution A and Solution AB. Solution A is made up of interferents, while Solution AB consists of analytes mixed with the interferents. Both solutions should be run consecutively (first ICSA and then ICSAB) early in the analytical sequence prior to samples. Control limits for both the ICSA and ICSAB are 80-120% of the true value for analytes included in the solution, or < the RL for analytes which are not included in the solution. As Table 9 explains, if the ICS fails to meet acceptance criteria, analysis should be terminated, the problem corrected, the machine recalibrated, and the calibration verified. Any samples that were run since the previous in-control ICS must be reanalyzed.

Method Blank

Method blanks should be prepared and analyzed for every 20 samples analyzed. The method blank is laboratory DI water which has gone through the applicable sample preparation and analysis procedure. Control limits are a concentration < ½ the RL. Control limits and corrective actions for control limit failures are outlined in Table 7.

Laboratory Control Spike

A laboratory control spike (LCS) consists of a laboratory sample which is spiked so that each of the target analytes are contained in the final digestate at two time the RL (or greater) for the associated matrix. The purpose of the LCS is to validate the analytical results, based on the recovery of the LCS. One LCS should be analyzed for every 20 samples analyzed. Control limits are specified in Table 7. If the LCS fails to meet the specified control limit, the analysis must be terminated, the problem corrected, and samples which fell in the failed LCS batch must be re-analyzed.

Laboratory Duplicates

Laboratory duplicate (LD) samples test laboratory precision, and one LD sample should be analyzed for every 10 to 20 samples, as indicated in Table 7. For metals analysis by EPA 200.8, mercury analysis by EPA 245.1, and anion analysis by EPA 300 the matrix spike duplicate (MSD) sample typically serves as the LD. Samples which are known to be field blanks cannot be used for LD samples. Control limits for LD samples can be found in Table 7. The relative percent differences (RPD) between the sample and duplicate that are specified in Table 7 are applicable if both the sample and duplicate are $\geq$ five times the RL. If either the sample or duplicate is < five times the RL, the control limit is an absolute difference between the sample and duplicate no greater than the RL. Should LD samples fail to meet control limits, and the samples in the associated batch are of a similar matrix, then associated sample results should be flagged. If samples in the associated batch are not similar to the parent sample used for the LD, then only the parent sample used to prepare the duplicate should be flagged.

Matrix Spike/ Matrix Spike Duplicate

Matrix spike (MS) samples evaluate the effect of the sample matrix on sample preparation and measurement methodology. MS/MSD frequency varies, but is generally one MS/MSD per 10 to 20 samples. The frequency requirements and control limits for MS recovery are detailed in Table 7. MS recovery criteria are applicable for situations where the parent sample concentration is less than four times the spike concentration. If the parent sample concentration is ≥ four times the spike added, the criteria are waived. Samples which are known to be field blanks cannot be used for MS samples. Corrective actions are described in Table 7.

As indicated above, one matrix spike duplicate (MSD) is often analyzed to serve as the laboratory duplicate sample. The purpose and criteria of the MSD is identical to the purpose of the previously described laboratory duplicate sample. Refer to Table 7 for MSD RPD criteria and corrective actions in the event of failing to meet criteria.

Serial Dilution

Serial dilution (SD) samples are applicable to ICP analyses. One SD sample is required for each group of samples of a similar matrix, or each group of up to 20 samples, whichever is more frequent. The SD checks for significant physical or chemical interferences from the sample matrix. The control limits for the SD sample is $\leq$ 10% difference between the serial dilution analysis, after correction for dilution, and the original sample result for samples that are > 50X the MDL. As Table 7 indicates, SD samples which meet the concentration criteria, but fail the 10% difference criteria should be qualified as estimated, and all samples in that group of a similar matrix should be qualified as estimated. Samples which are known to be field blanks cannot be used for the SD sample.

3.6 Instrument/Equipment Testing, Inspection and Maintenance

To ensure continual quality performance of any instruments or equipment, testing, inspection and maintenance shall be performed and recorded as described in this section.

3.6.1 Field Equipment

Field equipment will be examined to certify that it is in proper operating order prior to its first use. Equipment, instruments, tools, gauges and other items requiring preventative maintenance will be serviced in accordance with the manufacturer's specified recommendations. An electronic Equipment Log shall be stored on a server within project files. Field equipment will be cleaned and safely stored between each use. Any routine maintenance recommended by the equipment manufacturer will also be performed and documented in field logbooks or appropriate data sheets. Equipment will be inspected and the calibration checked, if applicable, before it is transported to a field setting for use. Should equipment deficiencies be found, including calibration failures, the equipment will be immediately removed from service and repaired. Once equipment failures have been resolved and testing/calibration demonstrates proper equipment function, it will be returned to service. The field team leader, or their designee, will be responsible for field equipment checks and maintaining the Equipment Log.

3.6.2 Laboratory Equipment

Instruments used by the laboratories will be maintained in accordance with each laboratory's Quality Assurance Plan and analytical method requirements. All analytical measurement instruments and equipment used by the laboratory shall be controlled by a formal calibration and preventive maintenance program.

The laboratories will keep maintenance records and make them available for review, if requested, during laboratory audits. Laboratory preventive maintenance will include routine equipment inspection and calibration at the beginning of each day or each analytical batch, per the laboratory's internal SOPs and method requirements.

3.7 Instrument/Equipment Calibrations and Frequency

Field multi-meters will be calibrated prior to each use, as necessary. Meters will be calibrated following manufacturer's instructions, and using manufacturer recommended calibration solutions. Calibration logs will be stored electronically, within project files. Calibration failures will result in meters being immediately removed from service. Once repaired, and successfully calibrated, meters will be returned to service.

3.8 Inspection/Acceptance of Supplies and Consumables

All supplies and consumables received for the project (e.g., sampling equipment, calibration standards, etc.) will be checked for damage and other deficiencies that would affect their performance. The types of equipment that will be needed to complete sampling activities are described in the relevant SOPs. Inspections of field supplies will be performed by the Field Team Leader or Field Team Members.

The personnel at each laboratory will be responsible for performing inspections of laboratory supplies in accordance with their QA program.

3.9 Data Management Procedures

This section describes the management of data for the project including field and laboratory data. The program quality records will be maintained by Atlantic Richfield. These records, either electronic or hard copy in form, may include:

- Project work plans with any approved modifications, updates, and addenda;
- Project QAPP, including this QAPP, with any approved modifications, updates, addenda, and any approved corrective or preventative actions;
- Field documentation;
- Chain-of-custody records;

- Laboratory documentation (results received from the laboratory will be documented both in report form and in an electronic data deliverable format); and
- DSRs.

Hard-copy field and laboratory records shall be maintained in the project's central data file, where original field and laboratory documents are filed chronologically for future reference. These records are also scanned to produce electronic copies. These electronic copies, along with all electronic field and laboratory records, are maintained on a central server system with backup scheduled daily, as described in the *BPSOU Final Data Management Plan* (DMP) (Atlantic Richfield, 2020b). The Server Administrator is responsible for data backups, and potential data restoration.

Before field and laboratory data are incorporated into the project database, the data and supporting documentation shall be subject to appropriate review to ensure the accuracy and completeness of original data records. Field data that has been reviewed in a hard-copy format will be entered into electronic data files for upload to the project database. All manual data entry into an electronic format will be reviewed by a separate party before such data are incorporated into the database. Laboratory EDDs and related data packages will be reviewed as part of the internal data review process. The Data Base Coordinator will be responsible for ensuring data integrity prior to database uploads. Following these review steps, field and laboratory electronic data files will be imported to the project database. Procedures for data storage, archival, and retrieval are fully explained in the DMP (Atlantic Richfield, 2020b).

The DMP fully describes the data flow process, from data acquisition, to data production, storage, and retrieval. Data collectors (acquisition) collect data, and provide documentation in logbooks and electronic field forms, in conformance with this QAPP. Laboratories (data producers) typically provide analytical data to the entity which has collected the data, and to the Environmental Quality Information System (EQuIS) data management system. For data collected under this QAPP, laboratories will provide data directly to the BPSOU database coordinator or to Atlantic Richfield's EQuIS data management system. Once analytical data is submitted, the data undergoes QA/QC, to verify the data was collected and produced in accordance with specific Work Plans or QAPPs, and once verified, the data is incorporated into the database or EQuIS data management system. Data submitted directly to the BPSOU database coordinator will be submitted to the EQuIS system once review is complete. QA/QC checks are in place to ensure that data upload is successful, and that data quality is preserved. Once data has been uploaded to the database, only the data management system coordinator has access to perform any edits. Data can be retrieved through on-line portals, through the EQuIS system, or by written request to the database coordinator.

Currently geospatial data is stored in a Geodatabase, non-geospatial data is stored in Microsoft (MS) Structured Query Language (SQL) databases or MS Access databases that can be accessed by an on-line portal or the EQuIS system. This SQL/Geodatabase combination allows integration of spatial data (site locations, property information, geographic place names, site features, topography, and aerial collected imagery) with non-spatial information (analytical data) to provide a comprehensive database that contains all relevant site information.

As part of the duties of operating and maintaining the database, the Database Coordinator, including the EQuIS system administrator, shall develop specific procedures, forms, and systems for accurate import and export of data. For instance, the Database coordinator shall work with Data Collectors or Data Producers to identify appropriate formats and procedures for receiving data into the system. Part of these formats will include a confirmation that the data was collected following the correct standardized procedure. This may mean that Data Producers supply laboratory data in standard, approved electronic data deliverables (EDDs). The Database Coordinator shall verify the accurate import of data supplied by Data Collectors and Data Producers. This shall include working with Data Collectors/Producers to perform appropriate QA and input of appropriate supplemental information (e.g., metadata) to document and describe the receipt and handling of the data. The Database Coordinator will also develop standard request forms or procedures by which Data Users may request data to be exported from the database.

4.0 ASSESSMENT AND OVERSIGHT

Assessment and oversight of data collection and reporting activities are designed to verify that sampling and analyses are performed in accordance with the procedures established in this QAPP. The audits of field and laboratory activities include two independent parts: internal and external audits. Internal audits will be performed by the QAO and/or QAM as necessary, and audit reports would be submitted to the CPM. External audits will be performed by the EPA as necessary.

Performance and systems audits of field and laboratory data collection and reporting procedures are described in this section.

4.1 Corrective Actions

Corrective action is the process of identifying, recommending, approving and implementing measures to counter unacceptable procedures or out-of-QC performance which can affect data quality. Corrective action can occur during field activities, laboratory analyses, and data assessment.

Nonconforming equipment, items, activities, conditions, and unusual incidents that could affect data quality and attainment of the project's quality objectives will be identified, controlled, and reported in a timely manner. The person finding the nonconformity is responsible for reporting to the field team leader and ensuring that the condition is reported to the project manager. In regard to equipment nonconformity, the field team leader, or their designee is responsible for recording the nonconformity in the electronic equipment log, and for ensuring that the nonconformity is corrected. In regard to conditions that are not equipment related, the person finding the irregular condition is responsible for providing documentation in the field book and the electronic field form. The field book entry may reference a more thorough entry on the electronic form, or vice versa, but the cross-reference must be provided. For this QAPP, a nonconformance is defined as a malfunction, failure, deficiency, or deviation that renders the quality of an item unacceptable or indeterminate in meeting the project's quality objectives.

Corrective action in the laboratory may occur prior to, during and after initial analyses and will be reported to the LM and QAO. Several conditions such as broken sample containers, preservation or holding-time issues and potentially high-concentration samples may be identified during sample log-in, just prior to analysis, or during analysis. Corrective actions to address these conditions will be taken in consultation with the LM and QAO and reported on a Corrective Action Report, an example of which is included in Appendix D. If corrective action requests are not in complete accordance with approved project planning documents, the LM will consult with EPA, and concurrence will be obtained before the change is implemented.

If during analyses of the samples, the associated laboratory QC results fall outside of the project's performance criteria, the laboratory should initiate corrective actions immediately. Table 7 and Table 9 indicate the performance criteria for specific analytical methods and the appropriate corrective actions to be completed if QC results are outside of the project specifications. Following consultation with lab analysts and section leaders, it may be necessary for the Laboratory Quality Manager to approve the implementation of a corrective action. These conditions may include dilution of samples, additional sample extract cleanup, automatic re-analysis when certain QC criteria are not met, etc. If the laboratory cannot correct the situation that caused the nonconformance and an out-of-control situation continues to occur, or is expected to occur, then the laboratory will immediately contact the QAO and request instructions regarding how to proceed with sample analyses.

Completion of any corrective action should be evidenced by data once again falling within the project's performance criteria. If this is not the case, and an error in laboratory procedures or sample collection and handling procedures cannot be found, the results will be reviewed by the LM with input from others to assess whether re-analysis or re-sampling is required.

All corrective actions taken by the laboratory will be documented in writing by the Laboratory Project Manager and reported to the CPM and QAO. If corrective action requests are not in complete accordance with approved project planning documents, EPA will be consulted, and concurrence will be obtained before the change is implemented. All corrective action records will be included in the program's quality records.

4.2 Corrective Action during Data Assessment

The QAO may identify the need for corrective action during data assessment. Potential types of corrective action may include re-sampling by the field team, re-analysis of samples by the laboratory or re-submission of data packages with corrected clerical errors. The appropriate and feasible corrective actions are dependent upon the ability to mobilize the field team and whether the data to be collected is necessary to meet the required QA objectives (e.g., the holding time for samples is not exceeded, etc.). If corrective action requests are not in complete accordance with approved project planning documents, the EPA will be consulted by the LM and QAM and concurrence will be obtained before the change is implemented. Corrective actions of this type will be documented by the QAO on a CAR and will be included in any subsequent reports.

4.3 Quality Assurance Reports to Management

Quality Assurance Reports to management will include Field Audit Reports, CARs, and Data Assessment Reports (within DSRs). After the investigation is complete, Atlantic Richfield will prepare a DSR for the sampling activities described in this QAPP. The DSR will contain a discussion of the data quality assessment. The data quality discussions will contain, on a routine basis, the results of any associated field and laboratory measurements and analyses, information generated on the achievement of specific DQOs, and a summary of any corrective actions that were implemented and their immediate results on the project. The CPM and QAO are responsible for preparation of the DSR. The DSR will be submitted in draft form to the EPA for review by the first day of the second quarter of the year following data acquisition. Upon receipt of comments, the draft DSR will be revised to address the comments and resubmitted to the EPA for final approval.

Any Field Audit Reports and CARs associated with the project will be submitted to management on a quarterly basis.

5.0 DATA REVIEW AND USABILITY

The following sections address the final project checks conducted after the data collection phase of the project is completed to confirm that the data obtained meet the project objectives and to estimate the effect of any deviations on data usability.

5.1 Data Review and Verification

The process to be used for reviewing and verifying field data and the internal laboratory data review and reporting process are described in the following sections. Laboratory data reporting requirements, which describe how results are conveyed to data validators, are also discussed.

5.1.1 Field Data Review

Raw field data shall be entered in field logbooks and on electronic field forms, which shall be reviewed for accuracy and completeness by the Field Team Leader, or their designee, before those records are considered final. The overall quality of the field data from any given sampling round shall be further evaluated during the process of data review and reporting.

Field data review and reporting procedures will be minimal in scope compared to those implemented in the laboratory setting. Field data review will include verification that any QC checks and calibrations are

recorded properly in the field logbooks and/or on electronic forms and that any necessary and appropriate corrective actions were implemented and recorded. QC checks, calibrations, and any corrective actions will be written into field logbooks and/or recorded on electronic forms immediately after they occur. If errors are made in logbooks, results will be legibly crossed out, initialed, and dated by the field team member, and corrected in a space adjacent to the original (erroneous) entry. If mistakes are made in electronic forms, the original form and output file are preserved, a revised output file is developed, and the data in the replacement file is entered into the database. In a reasonable time frame, the Field Team Leader, or designee, will proof the field logbooks and electronic field forms to determine whether any transcription errors have been made by the field crew. If transcription errors have been made, the Field Team Leader and field crew will address the errors to provide resolution.

Appropriate field measurement data will be uploaded from electronic field forms for project database entry. Data entries will be made directly from electronic field forms which have been reviewed for accuracy and completeness by a separate party, prior to submittal to the database manager. Electronic files of field measurement data will be maintained as part of the project's quality records.

Should the database manager, or a data user, find suspect data, the suspect data point will be investigated. If the data point is found to be in error, it will be corrected in the database, and the database manager will be responsible for any necessary notifications of the data revision or redistributions of the data.

5.1.2 Laboratory Data Review

Internal laboratory data review and reporting procedures will be per each laboratory's Quality Management Plan. At a minimum, records shall be maintained by the analysts to document sample identification number with sample results and other details, such as the analytical method used (e.g., method SOP #), name of analyst, the date of analysis, matrix sampled, reagent concentrations, instrument settings, and the raw data. These records shall be signed and dated by the analyst. Secondary review of these records by the Laboratory Supervisor (or designee) shall take place prior to final data reporting to Atlantic Richfield. The laboratory shall appropriately qualify unacceptable data in the data package. Shall any deficiencies with the potential to change analytical results be found during laboratory review of previously reported data, Atlantic Richfield, or their representative, will be immediately notified, and a revised report and EDD will be issued.

5.1.3 Laboratory Data Reporting Requirements

The laboratory shall prepare electronic data packages for transmittal of results and associated QC information to Atlantic Richfield or their designee. Analytical data will undergo Level 2b validation for wells outside of the TI Zone and Level 2a validation for all other groundwater sampling sites. A Limited data package (Level 2a validation) shall include at a minimum, the case narrative, all sample results, units, and quality control sample results. Limited data packages shall be transmitted to Atlantic Richfield or their designee within 14 days of laboratory sample receipt. Full (Level 2b validation) data packages shall be transmitted to Atlantic Richfield or their designee within 28 days of sample receipt. Refer to Appendix E for the components which shall be included in Limited and Full data packages.

The laboratory shall prepare electronic data packages for transmittal of results and associated QC information to Atlantic Richfield, or their designee, in a format compatible with contractor database and EQuIS requirements. Deviations from these specifications may be acceptable provided the electronic report presents all requested types of information in an organized, consistent, and readily reviewable format.

5.1.4 Laboratory Electronic Data Deliverable

Each electronic data package, as described above, shall be accompanied by an EDD prepared by the laboratory. Additional laboratory QC data can be included in the EDD. EDDs will be cross checked against corresponding data reports to confirm consistency in results reported in these two separate formats. This cross check will take place as part of the data review process.

5.1.5 Specific Quality Control/Assessment Procedures

The accuracy, precision, completeness, representativeness, and sensitivity of analytical data will be described relative to the project's control limits through a process of field and laboratory data quality review. Results from these reviews will be documented in a Data Quality Assessment Report prepared for all data users. Any qualification of the data resulting from that review will also be incorporated into the project's electronic database so that all data users are aware of any uncertainties associated with individual results.

5.2 Internal Data Review

Data review is the process of verifying that information generated relative to a given sample is complete and accurate. Data review involves examining each data point to see that it meets frequency, accuracy, and precision criteria. Data review procedures shall be performed for both field and laboratory operations as described below and in accordance with the criteria in Table 12. A thorough review of data enables the subsequent data assessment, which is further described below.

Table 12 – Validation Criteria for Laboratory and Field Quality Control Samples (see Tables section)

5.2.1 Field Quality Control Data

The results of field quality control sample analyses associated with each laboratory data package will be reviewed to allow for evaluation of field blanks and other field QC samples and further indications of the data quality. If a problem is identified through the review of field QC data, all associated field samples will be identified, and if possible, corrective actions can be instituted and documented on a CAR. If corrective action requests are not in complete accordance with approved project planning documents, the EPA will be consulted, and concurrence will be obtained before the change is implemented. If data are compromised due to a problem identified via field QC sample review, appropriate data qualifications will be used to identify the data for future data users. These qualifiers will be included with tabulated data presented in the Data Assessment section of DSRs.

The handling, preservation and storage of samples collected during the sampling program will be monitored on an on-going basis. The project laboratories will document sample receipt including proper containers and preservation at the time samples are logged in by the laboratory. The sample receipt records (a required data package deliverable), as well as the chain-of-custody documentation, will also be assessed during data review.

5.2.2 Laboratory Chemistry Data

The second level of review will be performed by the QAO, or their designee, and will include a review of laboratory performance criteria and sample-specific criteria. One hundred percent of project data will be reviewed and validated. Data validation will follow the TREC Data Validation Guidelines which incorporate validation guidelines from the *National Functional Guidelines for Inorganic Superfund Methods Data Review* (EPA, 2020b), but align with method-specific criteria. Validation will also align with procedures in the CFRSSI Data Management/Data Validation Plan (ARCO, 1992c) and the CFRSSI Data Management/Data Validation Plan Addendum (ARCO, 2000a). An additional responsibility of the QAO will be to determine whether the DQOs have been met and calculate the data completeness for the project.

Data quality review is a process to determine if the data meet project DQOs. Level 2a and Level 2b data quality review will include verification of the following:

- Compliance with the QAPP,
- Proper sample collection and handling procedures,

- Holding times,
- Field QC results,
- Laboratory blank analysis,
- LCS percent recovery,
- Detection limits,
- Laboratory duplicate relative percent differences,
- MS/MSD percent recoveries and relative percent differences,
- Data completeness and format, and
- Data qualifiers assigned by the laboratory.

Level 2b data quality review will include verification of the following additional items as applicable to the analytical method:

- Instrument tuning
- Instrument calibration
- Initial and continuing calibration verification
- Initial and continuing calibration blanks
- Contract required detection limit check standard
- Internal standards relative response
- Interference check sample recovery
- Serial dilution percent difference
- Correct laboratory sample sequence
- Correct laboratory QC sample frequency

Refer to Appendix F, Exhibit 1 for components of Level 2a data quality review and Appendix F, Exhibit 2 for components of Level 2b data quality review. Qualifiers that may be applied to the data include the following:

U The analyte was analyzed for but was not detected above the reporting limit.

J The analyte was positively identified; the associated numerical value is an estimate of the concentration of the analyte in the sample.

UJ The analyte was not detected above the sample reporting limit. However, the reporting limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.

R The sample results are rejected due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the analyte cannot be verified.

Additional qualifiers can be found in Appendix F, Exhibit 5. Data that are only qualified as a result of the value reported between the laboratory reporting and the detection limit are also considered enforcement quality.

A Data Quality Assessment (DQA) will be performed to determine whether the project-specific DQOs have been satisfied. The DQA consists of five steps that relate the quality of the results to the intended use of the data:

Step 1: Review DQOs and sampling design

Step 2: Conduct preliminary data review

Step 3: Apply Statistical test(s) as described in this QAPP to the data set

Step 4: Verify assumptions

Step 5: Draw conclusions about the quality of the data (data report will not include interpretation of results, but will state conclusions regarding the quality of the results).

Data points may be assigned a qualifier during data review based on a failure to meet frequency, accuracy, or precision criteria. Appendix F, Exhibit 5 provides a description of data validation qualifiers. Data assessment involves assigning a status of Enforcement (E), Screening (S), or Rejected (R) to each data point. Table 13 provides a summary of status assignment. Enforcement quality data meet all QA/QC and documentation requirements. Screening quality data do not meet the applicable QA/QC requirements and/or documentation requirements. Unusable data (R) may result from inappropriate sampling, analysis, or documentation procedures. In reviewing documentation requirements, a Level A/B checklist is completed. This checklist is provided as Exhibit 4 in Appendix F. Level A data partially meets documentation requirements; while level B data meets all documentation requirements. Level A/B status is not assigned to individual data points, but rather to samples (all data points for an individual sample).

Table 13 – Summary of Status Assignment (Enforcement/Screening/Unusable)

Data Validation Qualifier	Level A/B Designation		
	Level B	Level A	Rejected
U	Enforcement	Screening	Unusable
J or UJ	Screening	Screening	Unusable
R	Unusable	Unusable	Unusable

If, as a result of the DQA process, it is determined that data do not satisfy all DQOs, then corrective action(s) should be recommended and documented in the data report. Corrective actions include, but are not limited to, revision of the DQOs, based on the results of the investigation, or collection of more information or data. It may be determined that corrective actions are not required, or the decision process may continue with the existing data, with recognition of the limitations of the data.

Level 2a and 2b laboratory data validation checklists are included in Appendix F, Exhibit 1 and 2, respectively. A field checklist is provided as Exhibit 3. A level A/B criteria screening checklist is included as Exhibit 4.

Results of the QA review and/or validation will be included in any subsequent report, which will provide a basis for meaningful interpretation of the data quality and evaluate the need for corrective actions. The QAO is responsible for review of project QA and/or validation.

6.0 REFERENCES

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TABLES

Table 1 - Summary of Project Tasks

1. **Sampling Tasks:**
    a. Measure groundwater elevations on a monthly basis, towards the end of each month, using the method described in Section 3.2.2.1.
    b. Collect water quality samples semi-annually, commencing in late spring/early summer and late summer/early fall of each year, using the method described in Section 3.2.2.2.
2. **Analysis Tasks:**
    a. Laboratory analysis for water quality parameters following guidelines in the *CFRSSI LAP*; or
    b. Analysis for dissolved metals and metalloids, in accordance with EPA approved test methods for inorganic contaminants, as listed in Table 2.
3. **Quality Control Tasks:**
    a. Verify all laboratory analytical matrices have the following QC samples analyzed: 1 field duplicate for every 20 primary samples, and if sampling equipment is reused across sample locations, 1 field blank collected for every 20 primary samples.
    b. Verify method blanks, laboratory control samples, laboratory duplicate samples, and matrix spike samples have been analyzed as applicable to the analytical method and that results of these laboratory quality control samples are included in all data packages. Verify that full data packages include results of serial dilution samples, calibration verification samples, calibration blank samples, interference check samples, internal response standards, and contract required detection limit standards, as applicable to the analytical method. Refer to Section 3.5.2 for applicability of laboratory quality control and calibration samples to analytical methods.
4. **Data Management Tasks:**
    a. Review analytical data and evaluate for quality (by the project's Quality Assurance Officer) and place in the site database.
5. **Documentation and Records:**
    a. Verify all samples collected have surveyed locations, records of each sample collected, and all field measurements appropriately documented.
6. **Data Packages:**
    a. Verify Full data packages are provided for samples from wells outside of the TI Zone and that Limited (standard) data packages are provided for all other samples; and, that data packages include results in mg/L, or other applicable units, of all constituents analyzed.

Table 2 – Analytical Methods, Approximate Detection Limits, Maximum Analytical Holding Times, and Field Parameter Specifications

Analyte	Method	MDL[1] (mg/L)	Reporting Limit (mg/L)	Holding Time (Days)
Semi-Annual Parameters				
Dissolved Arsenic	EPA 200.8	0.000083	0.00050	180
Dissolved Cadmium	EPA 200.8	0.000016	0.000080	180
Dissolved Copper	EPA 200.8	0.00050	0.0010	180
Dissolved Lead	EPA 200.8	0.000028	0.00010	180
Dissolved Mercury	EPA 245.1	0.000045	0.00020	28
Dissolved Zinc	EPA 200.8	0.0020	0.0050	180
Additional Five-Year Parameters				
Dissolved Calcium	EPA 200.8	0.018	0.040	180
Dissolved Iron	EPA 200.8	0.012	0.050	180
Dissolved Magnesium	EPA 200.8	0.0034	0.010	180
Dissolved Manganese	EPA 200.8	0.00020	0.00050	180
Dissolved Potassium	EPA 200.8	0.019	0.10	180
Dissolved Sodium	EPA 200.8	0.020	0.050	180
Hardness (as $CaCO_3$)	SM2340B, online edition, 1997	0.060	0.14	180
Alkalinity (as $CaCO_3$)	SM2320, online edition, 1997	1.8	5.000	14
Chloride	EPA 300.0	0.39	1.2	28
Sulfate	EPA 300.0	0.34	1.2	28
TDS	SM2540C, online edition, 1997	5	10	7

Field Parameters		
Parameter	**Accuracy**	**Resolution**
DO (mg/L)	Greater of ± 2% or reading or	0.01 mg/L
ORP (mV)	± 20 mV	0.1 mV
pH (SU)	± 0.2	0.01 SU
SC (µS/cm or mS/cm)	Greater of 0.001 mS/cm or ± 0.5% of reading	0 to 0.500 mS/cm: 0.001 mS/cm 0.501 to 50.00 mS/cm: 0.01 mS/cm 50.01 to 200 mS/cm: 0.1 mS/cm
Temperature (°C)	0.2 °C	0.1 °C

[1]The MDLs presented represent 2021 values. MDLs are determined annually and may fluctuate.

Table 3 - BPSOU 2022 Water Quality Monitoring Network

Well ID	2021 Monitoring Frequency	Date Added to Water Quality Network	Comment
Point of Compliance (POC) Wells[1]			
AMW-13	Semi-Annual		
AMW-13B	Semi-Annual		
AMW-13B2	Semi-Annual	Feb-12	Well drilled Feb-12
AMW-13C	Semi-Annual	May-11	Well drilled May-11
BPS07-01A	Semi-Annual		
BPS07-01B	Semi-Annual		
BPS07-05A[2]	Semi-Annual		
BPS07-05B	Semi-Annual		
BPS07-16A	Semi-Annual	Jul-08	Well drilled Jul-08
BPS07-16B	Semi-Annual	Jul-08	Well drilled Jul-08
BPS11-11A1	Semi-Annual	Dec-11	Well drilled Dec-11
BPS11-11A2	Semi-Annual	Dec-11	Well drilled Dec-11
BPS11-11B	Semi-Annual	Jan-12	Well drilled Jan-12
BPS11-11C	Semi-Annual	Dec-11	Well drilled Dec-11
Performance Monitoring Network Outside of Technical Impracticability (TI) Zone[1]			
AMW-11	5-year	2018	Added to network 2018 in response to Agency request
BPS11-12A	Semi-Annual	2012	Well drilled Jan-12
BPS11-15	Semi-Annual	2012	Well drilled Jan-12
BPS11-16	Semi-Annual	2012	Well drilled Jan-12
BPS11-19A2	Semi-Annual	2012	Well drilled Jan-12
BPS11-19B	Semi-Annual	2012	Well drilled Feb-12
BT-98-02	Semi-Annual		
BT98-02B	Semi-Annual		
GS-28	5-year	2018	Added to network 2018 in response to Agency request
BPSOU Subdrain Capture System Monitoring Network			
AMC-12	Semi-Annual		
AMC-13	Semi-Annual		
AMC-23B	Semi-Annual	2012	Well drilled Dec-11
AMC-24	Semi-Annual		
AMC-24B	Semi-Annual		
AMC-24C	Semi-Annual	2010	Well drilled May-10
AMW-01A	Semi-Annual		
AMW-01B	Semi-Annual		
AMW-01C	Semi-Annual		
AMW-08	Semi-Annual		Parrot Tailings Removal: Scheduled to be abandoned
AMW-12	Semi-Annual		
AMW-20	Semi-Annual		
BPS07-03A	Semi-Annual		
BPS07-07	Semi-Annual		
BPS07-11A	Semi-Annual		
BPS07-11B	Semi-Annual		
BPS07-21	Semi-Annual		
BPS07-21B	Semi-Annual	2010	Well drilled Jan-10
BPS07-21C	Semi-Annual	2010	Well drilled Aug-10
BPS07-22R	Semi-Annual	2012	Well drilled December 2011, Replaced BPS07-22
BPS07-22B	Semi-Annual	2012	Well drilled Dec-11
BPS07-22C	Semi-Annual	2012	Well drilled Dec-11

Table 3 - BPSOU 2022 Water Quality Monitoring Network

Well ID	2021 Monitoring Frequency	Date Added to Water Quality Network	Comment
BPS07-23	Semi-Annual		
BPS07-24	Semi-Annual		
BPS11-10A	Semi-Annual	2012	Well drilled Dec-11
BPS11-10B	Semi-Annual	2012	Well drilled Jan-12
BPS11-10C	Semi-Annual	2012	Well drilled Dec-11
BPS11-13B	Semi-Annual	2012	Well drilled Jan-12
BPS11-14A	Semi-Annual	2012	Well drilled Jan-12
BPS11-14B	Semi-Annual	2012	Well drilled Dec-11
BPS11-17C	Semi-Annual	2012	Well drilled Dec-11
BPS11-18B	Semi-Annual	2012	Well drilled Dec-11
BPS11-18C	Semi-Annual	2012	Well drilled Feb-12
BPS11-20	NA	2012	Drilled Feb-12 Parrot Tailings Removal: Abandoned 2018
GS-08R	Semi-Annual	2012	Drilled Jan-12, replaced GS-08
GS-09R	Semi-Annual	2012	Drilled Jan-12, replaced GS-09
GS-09-01	NA		Parrot Tailings Removal: Abandoned 2018
GS-09-02	NA		Parrot Tailings Removal: Abandoned 2018
GS-09-03	NA		Parrot Tailings Removal: Abandoned 2018
GS-11R	Semi-Annual	2012	Drilled Jan-12, replaced GS-11
GS-30D	Semi-Annual		
GS-30S	Semi-Annual		
GS-31D	Semi-Annual		
GS-31S	Semi-Annual		
GS-32D	Semi-Annual		
GS-32S	Semi-Annual		
GS-40R	Semi-Annual	2012	Added in 2011 Agency GWMP
GS-41D	NA		Parrot Tailings Removal: Abandoned 2018
GS-41S	NA		Parrot Tailings Removal: Abandoned 2018
GS-44D	Semi-Annual		
GS-44S	Semi-Annual		
GS-45	NA		Parrot Tailings Removal: Abandoned 2018
GS-46D	Semi-Annual		
GS-46S	Semi-Annual		
MF-07	Semi-Annual		
MF-08	Semi-Annual		
MF-09	Semi-Annual		
MF-10	Semi-Annual		
MF-11	Semi-Annual		
MSD-02A	Semi-Annual		
MSD-02B	Semi-Annual		
MSD-03	Semi-Annual		
MSD-04	Semi-Annual		
MSD-05	Semi-Annual		
BPSOU Subdrain Manholes	Annual		Manholes replaced clean-outs
Monitor Area Between Ground Water Capture Zones			
AMW-02	Semi-Annual		
BPS07-08A	Semi-Annual		

Table 3 - BPSOU 2022 Water Quality Monitoring Network

Well ID	2021 Monitoring Frequency	Date Added to Water Quality Network	Comment
BPS07-13A	Semi-Annual		
BPS07-13B	Semi-Annual	2012	Well drilled Dec-11
BPS07-14A	Semi-Annual		
BPS07-15A	Semi-Annual		
BPS07-25	Semi-Annual	2010	Well drilled Oct-10, replacement for BPS07-09A
BPS11-01	Semi-Annual	2012	Well drilled Dec-11
BPS11-02	Semi-Annual	2012	Well drilled Dec-11
BPS11-03	Semi-Annual	2012	Well drilled Dec-11
BPS11-04	Semi-Annual	2012	Well drilled Dec-11
BPS11-05A1	Semi-Annual	2012	Well drilled Dec-11
BPS11-05A2	Semi-Annual	2012	Well drilled Dec-11
BPS11-06	Semi-Annual	2012	Well drilled Dec-11
BPS11-07	Semi-Annual	2012	Well drilled Dec-11
BPS11-08	Semi-Annual	2012	Well drilled Nov-11
BPS11-09	Semi-Annual	2012	Well drilled Nov-11
BPSPZ-07	5-year	2018	Lizac property piezometer, added to network 2018 in response to Agency request
FP98-1	Semi-Annual		
FP98-1B	Semi-Annual	2012	Well drilled Nov-11
FP98-2	Semi-Annual		
FP98-3	Semi-Annual		
GS-13A	Semi-Annual	2008	GS-13B mistaken for GS-13A during initial sampling round in 2007.
Lower Area One Capture System Monitoring Network			
BMW-03A	Semi-Annual		
BMW-03B	Semi-Annual		
BMW-06B	5-year		
BPS07-17A	Semi-Annual		
BPS07-18A	Semi-Annual		
BPS07-18B	Semi-Annual		
CT-NW-3	5-year		
FP98-4	5-year	2018	Added to network 2018 in response to Agency request
FP98-5	5-year	2018	Added to network 2018 in response to Agency request
FP98-6	Semi-Annual		
FP98-7	5-year		
GS-26	5-year		
HCA-B1	Semi-Annual		
HCA-B2	Semi-Annual		

Impacted by Parrot Tailings removal.

[1]Full data package will be provided

[2]Arsenic concentration excluded for POC purposes

Table 4 - BPSOU 2022 Water Level Monitoring Network

Well ID	Target Frequency[1]	Date Added to Water Level Network	Comment	Date Continuous Monitoring Began	Reason Added for Continuous Monitoring
AMC-06	Continuous MBMG	Mar-08	Well not located until March 2008		
AMC-12	Continuous MBMG	Dec. 2007/Jan. 2008			
AMC-13	Monthly MBMG	Dec. 2007/Jan. 2008			
AMC-23	Continuous MBMG	Dec. 2007/Jan. 2008			
AMC-23B	Monthly	Dec-11	Well drilled December 2011		
AMC-24	Continuous MBMG	Dec. 2007/Jan. 2008			
AMC-24B	Continuous	Dec. 2007/Jan. 2008		1/22/2010	Continuous added for BPSOU subdrain pump test
AMC-24C	Continuous	May-10	Well drilled May 2010	7/19/2010	Continuous added for BPSOU subdrain Isolation study
AMW-01A	Continuous	Dec. 2007/Jan. 2008		2/22/2010	Continuous originally added for MSD Isolation study
AMW-01B	Continuous	Dec. 2007/Jan. 2008		7/9/2009	Continuous originally added to monitor effects of MSD sub-drain cleaning
AMW-01C	Continuous	Dec. 2007/Jan. 2008		1/22/2010	Continuous added for BPSOU subdrain pump test
AMW-02	Continuous	Dec. 2007/Jan. 2008		2/26/2010	Continuous added for BPSOU subdrain Isolation study, continued for BRW effectiveness study
AMW-08	Continuous MBMG until inaccessible	Dec. 2007/Jan. 2008	Parrot Tailings Removal: Scheduled to be abandoned		
AMW-11	Monthly	Dec. 2007/Jan. 2008			
AMW-12	Monthly	Dec. 2007/Jan. 2008			
AMW-13	Continuous	Dec. 2007/Jan. 2008		8/13/2010	Continuous originally added for MSD isolation study
AMW-13B	Continuous	Dec. 2007/Jan. 2008		8/13/2010	Continuous originally added for MSD isolation study
AMW-13B2	Monthly	Feb-12	Well drilled February 2012		
AMW-13C	Continuous	May-11	Well drilled May 2011	7/19/2010	Continuous originally added for MSD Isolation study
AMW-20	Continuous MBMG	Dec. 2007/Jan. 2008			
BMF96-02	Continuous MBMG	Dec. 2007/Jan. 2008			
BMF96-03	Continuous MBMG	Dec. 2007/Jan. 2008			
BMF96-04	Continuous MBMG	Dec. 2007/Jan. 2008			
BMW-01A	Monthly	Dec. 2007/Jan. 2008			
BMW-01B	Monthly	Dec-09	Added as courtesy to MDEQ		
BMW-01C	Monthly	Dec-09	Added as courtesy to MDEQ		
BMW-02A	Monthly	Dec. 2007/Jan. 2008			
BMW-02B	Monthly	Dec. 2007/Jan. 2008			
BMW-02D	Monthly	Feb-08			
BMW-03A	Continuous	Dec. 2007/Jan. 2008		2/8/2012	Continuous required under Agency 2011 GWMP
BMW-03B	Continuous	Dec. 2007/Jan. 2008		2/22/2012	Continuous required under Agency 2011 GWMP. Transducer non-functioning until 2/22/12.
BMW-05A	Monthly	Dec. 2007/Jan. 2008			
BMW-05B	Monthly	Dec. 2007/Jan. 2008			
BMW-06B	Continuous	Dec. 2007/Jan. 2008		2/22/2012	Continuous required under Agency 2011 GWMP
BMW-08A	Monthly	Dec. 2007/Jan. 2008			
BMW-09A	Monthly	Dec. 2007/Jan. 2008			
BMW-09B	Monthly	Dec. 2007/Jan. 2008			
BMW-11B	Monthly	Dec-09	Added as courtesy to MDEQ		
BMW-13B	Monthly	Feb-08	WA-LEV-2 listed as site in LAO in Agency 2007 GWMP. This site could not be located, and believed to be synonymous with GS-13B.		
BPS07-01A	Monthly	Dec. 2007/Jan. 2008			
BPS07-01B	Monthly	Dec. 2007/Jan. 2008			
BPS07-03A	Continuous	Dec. 2007/Jan. 2008		4/1/2008	Continuous added to monitor impacts from pumping vault.
BPS07-05A	Monthly	Jul-08	Well drilled July 2008		

Table 4 - BPSOU 2022 Water Level Monitoring Network

Well ID	Target Frequency[1]	Date Added to Water Level Network	Comment	Date Continuous Monitoring Began	Reason Added for Continuous Monitoring
BPS07-05B	Monthly	Jul-08	Well drilled July 2008		
BPS07-07	Continuous	Jul-08	Well drilled July 2008	2/19/2010	Continuous originally added for MSD Isolation study, also required under 2011 GWMP
BPS07-08A	Continuous	Dec. 2007/Jan. 2008		11/18/2010	Continuous added for BRW effectiveness study
BPS07-11A	Continuous	Dec. 2007/Jan. 2008		1/22/2010	Continuous added for BPSOU subdrain pump test
BPS07-11B	Continuous	Dec. 2007/Jan. 2008		1/22/2010	Continuous added for BPSOU subdrain pump test
BPS07-13A	Monthly	Dec. 2007/Jan. 2008			
BPS07-13B	Monthly	Dec-11	Well drilled December 2011		
BPS07-14A	Monthly	Jul-08	Well drilled July 2008		
BPS07-15A	Monthly	Jul-08	Well drilled July 2008		
BPS07-16A	Monthly	Jul-08	Well drilled July 2008		
BPS07-16B	Monthly	Jul-08	Well drilled July 2008		
BPS07-17A	Continuous	Jul-08	Well drilled July 2008	2/22/2012	Continuous required under Agency 2011 GWMP
BPS07-18A	Continuous	Jul-08	Well drilled July 2008	2/22/2012	Continuous required under Agency 2011 GWMP
BPS07-18B	Continuous	Jul-08	Well drilled July 2008	2/22/2012	Continuous required under Agency 2011 GWMP
BPS07-21	Continuous	Jul-08	Well drilled July 2008	2/24/2010	Continuous originally added for MSD Isolation study
BPS07-21B	Continuous	Jan-10	Well drilled January 2010	2/4/2010	Continuous originally added for MSD Isolation study
BPS07-21C	Continuous	Aug-10	Well drilled August 2010	8/16/2010	Continuous originally added for MSD Isolation study
BPS07-22	Monthly	Jul-08	Well drilled July 2008		
BPS07-22B	Continuous	Dec-11	Well drilled December 2011	2/23/2012	Continuous required under Agency 2011 GWMP
BPS07-22C	Continuous	Dec-11	Well drilled December 2011	2/23/2012	Continuous required under Agency 2011 GWMP
BPS07-22R	Continuous	Dec-11	Well drilled December 2011	2/23/2012	Continuous added to BPS07-22 for MSD Isolation study. When BPS07-22R was drilled, transducer was transferred from BPS07-22 to BPS07-22R.
BPS07-23	Continuous	Jul-08	Well drilled July 2008	2/22/2010	Continuous originally added for MSD Isolation study
BPS07-24	Continuous	Sep-10	Well drilled September 2010	8/16/2010	Continuous originally added for MSD Isolation study
BPS07-25	Continuous	Oct-10	Well drilled October 2010, replacement for BPS07-09A	10/18/2010	Continuous originally added to BPS07-09A for BRW drawdown study which commenced in July 2008. When BPS07-09A was abandoned, BPS07-25 was drilled as a replacement well, and transducer was installed.
BPS11-01	Monthly	Dec-11	Well drilled December 2011		
BPS11-02	Monthly	Dec-11	Well drilled December 2011		
BPS11-03	Monthly	Dec-11	Well drilled December 2011		
BPS11-04	Monthly	Dec-11	Well drilled December 2011		
BPS11-05A1	Monthly	Dec-11	Well drilled December 2011		
BPS11-05A2	Monthly	Dec-11	Well drilled December 2011		
BPS11-06	Monthly	Dec-11	Well drilled December 2011		
BPS11-07	Continuous	Dec-11	Well drilled December 2011	Dec-11	Continuous for BRW effectiveness study
BPS11-08	Monthly	Dec-11	Well drilled November 2011		
BPS11-09	Monthly	Dec-11	Well drilled November 2011		
BPS11-10A	Continuous	Dec-11	Well drilled December 2011	Feb-12	Continuous required under Agency 2011 GWMP
BPS11-10B	Continuous	Jan-12	Well drilled January 2012	Mar-12	Continuous required under Agency 2011 GWMP. Transducer non-functioning until 3/27/12.

Table 4 - BPSOU 2022 Water Level Monitoring Network

Well ID	Target Frequency[1]	Date Added to Water Level Network	Comment	Date Continuous Monitoring Began	Reason Added for Continuous Monitoring
BPS11-10C	Continuous	Dec-11	Well drilled December 2011	Feb-12	Continuous required under Agency 2011 GWMP
BPS11-11A1	Monthly	Dec-11	Well drilled December 2011		
BPS11-11A2	Monthly	Dec-11	Well drilled December 2011		
BPS11-11B	Monthly	Jan-12	Well drilled January 2012		
BPS11-11C	Monthly	Dec-11	Well drilled December 2011		
BPS11-12A	Monthly	Dec-11	Well drilled December 2011		
BPS11-13B	Monthly	Jan-12	Well drilled January 2012		
BPS11-14A	Monthly	Jan-12	Well drilled January 2012		
BPS11-14B	Monthly	Dec-11	Well drilled December 2011		
BPS11-15	Monthly	Jan-12	Well drilled January 2012		
BPS11-16	Monthly	Jan-12	Well drilled January 2012		
BPS11-17C	Monthly	Dec-11	Well drilled December 2011		
BPS11-18B	Monthly	Dec-11	Well drilled December 2011		
BPS11-18C	Monthly	Feb-12	Well drilled February 2012		
BPS11-19A2	Monthly	Jan-12	Well drilled January 2012		
BPS11-19B	Monthly	Feb-12	Well drilled February 2012		
BPS11-20	NA	Feb-12	Well drilled February 2012 Parrot Tailings Removal: Abandoned 2018		
BRW-00 OS	Continuous	May-11	Added for BRW effectiveness study	1/6/11	Continuous for BRW effectiveness study, maintained as courtesy to PTS
BT-98-02	Monthly	Dec. 2007/Jan. 2008			
BT-98-02B	Monthly	Dec. 2007/Jan. 2008			
CT NE-2	Monthly	Dec. 2007/Jan. 2008			
CT NW-3	Continuous	Dec. 2007/Jan. 2008		2/22/2012	Continuous required under Agency 2011 GWMP
CT NW-4	Monthly	Dec. 2007/Jan. 2008			
CT S-2	Monthly	Mar-08	Well not located until March 2008.		
CT S-5	Monthly	Dec. 2007/Jan. 2008			
CT SW-4	Monthly	Dec. 2007/Jan. 2008			
CT-84-01	Monthly	Dec. 2007/Jan. 2008			
CT-94-1	Monthly	Dec. 2007/Jan. 2008			
FP98-1	Monthly	Dec. 2007/Jan. 2008			
FP98-1B	Monthly	Jan-12	Well drilled December January 2012		
FP98-2	Monthly	Dec. 2007/Jan. 2008			
FP98-3	Monthly	Dec. 2007/Jan. 2008			
FP98-4	Monthly	Dec. 2007/Jan. 2008			
FP98-5	Monthly	Dec. 2007/Jan. 2008			
FP98-6	Continuous	Dec. 2007/Jan. 2008		2/23/2012	Continuous required under Agency 2011 GWMP
FP98-7	Continuous	Dec. 2007/Jan. 2008		2/23/2012	Continuous required under Agency 2011 GWMP
FP98-8	Monthly	Dec. 2007/Jan. 2008			
FP98-9	Monthly	Dec. 2007/Jan. 2008			
GS-08	Monthly	Dec. 2007/Jan. 2008			Replaced by GS-08R, transducer originally added for MSD pump test
GS-08R	Continuous	Jan-12	Well drilled December 2011/January 2012	2/23/12	Continuous required under Agency 2011 GWMP

Table 4 - BPSOU 2022 Water Level Monitoring Network

Well ID	Target Frequency[1]	Date Added to Water Level Network	Comment	Date Continuous Monitoring Began	Reason Added for Continuous Monitoring
GS-09	Monthly	Dec. 2007/Jan. 2008			Replaced by GS-09R, transducer originally added for MSD pump test
GS-09R	Continuous	Jan-12	Well drilled December 2011/January 2012	2/23/12	Continuous required under Agency 2011 GWMP
GS-09-01	NA		Parrot Tailings Removal: Abandoned 2018		
GS-09-02	NA		Parrot Tailings Removal: Abandoned 2018		
GS-09-03	NA		Parrot Tailings Removal: Abandoned 2018		
GS-11	Monthly	Dec. 2007/Jan. 2008			Replaced by GS-11R, transducer originally added for MSD pump test
GS-11R	Continuous	Jan-12	Well drilled December 2011/January 2012	2/23/12	Continuous required under Agency 2011 GWMP
GS-12	Monthly	Dec. 2007/Jan. 2008			
GS-13A	Continuous	Mar-08	Neither GS-13A nor GS-13B were marked, and GS-13B was mistaken for GS-13A	2/22/2012	Continuous required under Agency 2011 GWMP
GS-13B	Monthly	Dec-07	Neither GS-13A nor GS-13B were marked, and GS-13B was mistaken for GS-13A		
GS-17DR	Monthly	Dec. 2007/Jan. 2008			
GS-18R	Monthly	Dec. 2007/Jan. 2008			
GS-19	Monthly	Dec. 2007/Jan. 2008			
GS-20	Monthly	Dec. 2007/Jan. 2008			
GS-22	Monthly	Dec. 2007/Jan. 2008			
GS-23	Monthly	Dec. 2007/Jan. 2008			
GS-25	Monthly	Dec. 2007/Jan. 2008			
GS-25C	Monthly	Dec. 2007/Jan. 2008			
GS-25D	Monthly	Dec. 2007/Jan. 2008			
GS-26	Continuous	Dec. 2007/Jan. 2008		2/22/2012	Continuous required under Agency 2011 GWMP
GS-28	Monthly	Dec. 2007/Jan. 2008			
GS-29D	Continuous	Mar-10	Believed to be added for MSD Isolation Study	7/19/10	Continuous believed to have been added for MSD Isolation Study
GS-29SR	Monthly	Dec. 2007/Jan. 2008			
GS-30D	Continuous	Dec. 2007/Jan. 2008		1/22/2010	Continuous added for BPSOU subdrain pump test
GS-30S	Continuous	Dec. 2007/Jan. 2008		1/22/2010	Continuous originally added for MSD pump test
GS-31D	Monthly	Dec. 2007/Jan. 2008			
GS-31S	Continuous	Dec. 2007/Jan. 2008		2/23/2012	Continuous required under Agency 2011 GWMP
GS-32D	Continuous	Dec. 2007/Jan. 2008		1/22/2010	Continuous added for BPSOU subdrain pump test
GS-32S	Continuous	Dec. 2007/Jan. 2008		1/22/2010	Continuous added for BPSOU subdrain pump test
GS-34D	Monthly	Dec-09	Added as courtesy to MDEQ		
GS-34S	Monthly	Dec. 2007/Jan. 2008			
GS-40R	Monthly	Dec. 2007/Jan. 2008			
GS-41D	NA	Dec. 2007/Jan. 2008	Parrot Tailings Removal: Abandoned 2018		
GS-41S	NA	Dec. 2007/Jan. 2008	Parrot Tailings Removal: Abandoned 2018		
GS-42D	NA	Dec. 2007/Jan. 2008	Parrot Tailings Removal: Abandoned 2021		
GS-42S	NA	Dec. 2007/Jan. 2008	Parrot Tailings Removal: Abandoned 2021		
GS-44D	Continuous MBMG	Dec. 2007/Jan. 2008			Formerly referred to as GS-44DR, GS-44D is consistent with MBMG terminology

Table 4 - BPSOU 2022 Water Level Monitoring Network

Well ID	Target Frequency[1]	Date Added to Water Level Network	Comment	Date Continuous Monitoring Began	Reason Added for Continuous Monitoring
GS-44S	Continuous MBMG	Dec. 2007/Jan. 2008			
GS-45	NA	Jan-13	Inadvertently omitted from wl network until Jan. 2013. Parrot Tailings Removal: Abandoned 2018		
GS-46D	Continuous MBMG	Dec. 2007/Jan. 2008			
GS-46S	Continuous MBMG	Dec. 2007/Jan. 2008			
GW-06R	Monthly	Dec. 2007/Jan. 2008			
HCA-B1	Continuous	Dec. 2007/Jan. 2008		3/6/2012	Continuous required under Agency 2011 GWMP. Transducer non-functioning until 3/6/12.
HCA-B2	Continuous	Dec. 2007/Jan. 2008		2/22/2012	Continuous required under Agency 2011 GWMP
HCA-MG1	Monthly	Dec. 2007/Jan. 2008			
HCA-MG3	Monthly	Dec-11	Added as courtesy to PTS		
M-01	Monthly	Dec. 2007/Jan. 2008			
M-03-87	Monthly	Mar-08	Well not located until March 2008. Identified as MW-3 in Agency 2011 GWMP Table 2-1.		
MF-01	Continuous MBMG	Dec. 2007/Jan. 2008			
MF-03	Monthly	Dec. 2007/Jan. 2008	Listed for semi-annual wl monitoring under 2007 Agency GWMP, monitored on a monthly frequency for simplicity[1.]		
MF-05	Monthly	Dec. 2007/Jan. 2008			
MF-07	Continuous	Dec. 2007/Jan. 2008		4/1/2008	Continuous originally added to monitor impacts from pumping vault.
MF-08	Continuous	Dec. 2007/Jan. 2008		11/19/2009	Listed in BPSOU subdrain pump test work plan, continuous likely added for BPSOU subdrain pump test
MF-09	Monthly	Dec. 2007/Jan. 2008			
MF-10	Continuous	Dec. 2007/Jan. 2008		2/26/2010	Continuous originally added for MSD Isolation study
MF-11	Monthly	Dec. 2007/Jan. 2008			
MSD-02A	Continuous	Dec. 2007/Jan. 2008		1/22/2010	Continuous originally added for MSD pump test
MSD-02B	Continuous	Dec. 2007/Jan. 2008		11/19/2009	Listed in BPSOU subdrain pump test work plan, continuous likely added for BPSOU subdrain pump test
MSD-03	Monthly	Dec. 2007/Jan. 2008			
MSD-04	Monthly	Dec. 2007/Jan. 2008			
MSD-05	Monthly	Dec. 2007/Jan. 2008			
MW-G-96	Monthly	Dec. 2007/Jan. 2008			
MW-H-96	Monthly	Dec. 2007/Jan. 2008			
MH-MSD106	Monthly	Apr-11	Manholes replaced cleanouts		
MH-MSD108	Monthly	Apr-11	Manholes replaced cleanouts		
MH-MSD110	Monthly	Apr-11	Manholes replaced cleanouts		
MH-MSD113	Continuous	Apr-11	Manholes replaced cleanouts	11/20/2009	MH-MSD113 replaced MSDCL-04. Transducer originally installed in MSDCL-04 on 11/20/09 to monitor effects of sub-drain cleaning.
MH-MSD116	Continuous	Jan-11		11/19/2009	Likely that transducer was installed to monitor effects of MSD sub-drain cleaning.
BTL Cells					
A1	Monthly	Apr-08	Likely inadvertently overlooked until April 2008		Data transmitted electronically on a continual basis to Copper Environmental Consulting
A2	Monthly	Apr-08	Likely inadvertently overlooked until April 2008		Data transmitted electronically on a continual basis to Copper Environmental Consulting

Table 4 - BPSOU 2022 Water Level Monitoring Network

Well ID	Target Frequency[1]	Date Added to Water Level Network	Comment	Date Continuous Monitoring Began	Reason Added for Continuous Monitoring
A3	Monthly	Apr-08	Likely inadvertently overlooked until April 2008		Data transmitted electronically on a continual basis to Copper Environmental Consulting
B1	Monthly	Apr-08	Likely inadvertently overlooked until April 2008		Data transmitted electronically on a continual basis to Copper Environmental Consulting
B3	Monthly	Apr-08	Likely inadvertently overlooked until April 2008		Data transmitted electronically on a continual basis to Copper Environmental Consulting
C1	Monthly	Apr-08	Likely inadvertently overlooked until April 2008		Data transmitted electronically on a continual basis to Copper Environmental Consulting
C3	Monthly	Apr-08	Likely inadvertently overlooked until April 2008		Data transmitted electronically on a continual basis to Copper Environmental Consulting
D2	Monthly	Apr-08	Likely inadvertently overlooked until April 2008		Data transmitted electronically on a continual basis to Copper Environmental Consulting
D3	Monthly	Apr-08	Likely inadvertently overlooked until April 2008		Data transmitted electronically on a continual basis to Copper Environmental Consulting
D4	Monthly	Apr-08	Likely inadvertently overlooked until April 2008		Data transmitted electronically on a continual basis to Copper Environmental Consulting
Staff Gages					
HCC-01	Monthly	Dec. 2007/Jan. 2008			
HCC-01A	Monthly	Dec. 2007/Jan. 2008			
HCC-01B	Monthly	Dec. 2007/Jan. 2008			
HCC-02A	Monthly	May-08	Added to network in May 2008, specific SGs not specified in Agency plan.		
HCC-03	Monthly	Dec. 2007/Jan. 2008			
HCC-03A	Monthly	Dec. 2007/Jan. 2008			
HCC-04	Monthly	Dec. 2007/Jan. 2008			
HCC-04A	Monthly	Dec. 2007/Jan. 2008			
HCC-05	Monthly	Dec. 2007/Jan. 2008			
HCC-05A	Monthly	Dec. 2007/Jan. 2008			
HCC-06	Monthly	Dec. 2007/Jan. 2008			
HCC-06A	Monthly	Dec. 2007/Jan. 2008			
HCC-07	Monthly	Dec. 2007/Jan. 2008			
MSD-3A	Monthly	Feb-08			
MSD-HAB	Monthly	Feb-08			
MSDSG-02	Monthly	Jan-18			
MSDSG-03	Monthly	Jan-18			
MSDSG-04	Monthly	Jan-18			
MSDSG-05	Monthly			4/5/2018	Continuous added Apr-18 to provide continuous record for SW monitoring. MSDSG-05 serves as the stage reading for surface water site SS-01.6, and continuous record is identified as SS-01.6.
SBC Sed B-8	Continuous	Dec-10	SG installed December 2010	12/1/10	Site & continuous monitoring added for BRW effectiveness study. Site currently monitored as courtesy to PTS.
SS-01	Monthly	Jan-08			
SS-01.35	Continuous	Feb-20	SG installed February 2020		
SS-04	Monthly	Jan-08			
SS-05	Continuous	Jan-08			

Table 4 - BPSOU 2022 Water Level Monitoring Network

Well ID	Target Frequency[1]	Date Added to Water Level Network	Comment	Date Continuous Monitoring Began	Reason Added for Continuous Monitoring
SS-05.6	Monthly	12/28/2010			Site added for SBC seep investigation, continuous monitoring added 12/1/10-5/30/12 for BRW effectiveness study. Site no longer monitored continuously.
SS-05.7	Continuous	Jan-08		1/22/2010	Continuous added for BPSOU subdrain pump test
SS-05.9R1	Continuous	Mar-12	Replaced SS-05.9R	12/1/10-5/30/12	Continuous added for BRW effectiveness study. Continuous monitored as courtesy to PTS.
SS-05A	Continuous	Jan-08		7/16/2013	Continuous added for BRW effectiveness study. Continuous currently monitored as courtesy to PTS.
SS-05B	Continuous	Jan-08		7/18/2013	Continuous added for BRW effectiveness study. Continuous monitored as courtesy to PTS.
SS-06A	Monthly	Jan-08			
SS-06F	Monthly	May-10	Site established at request of Agencies. Intent was to use this site as a replacement base flow streamflow measurement site for SS-06G because gradient and streambed at SS-06G create poor flow measurement conditions.		
SS-06G	Monthly	Jan-08			Identified as SS-06GR2
SS-06H	Monthly	May-10	Site established at request of Agencies. Intent was to add this site to base flow monitoring in order to capture potential HCC inputs to SBC.		
SS-07	Monthly	Jan-08			

Impacted by Parrot Tailings removal.

[1]Health and safety concerns may periodically interupt field work, preventing the target frequency from being achieved.

Table 5. BPSOU 2022 Ground Water Monitoring Network - Coordinates

Well ID	Easting (NAD83FT)	Northing (NAD83FT)	Measuring Point (NAVD88FT)	Screened Interval for WQ Wells (ft)	WL Frequency	WQ Chemistry Frequency	Location
Point of Compliance (POC) Wells							
AMW-13	1198109.21	650633.10	5454.99	5-15	Continuous	Semi-Annual	Visitor Center
AMW-13B	1198101.02	650648.42	5454.97	26-35	Continuous	Semi-Annual	Visitor Center
AMW-13B2	1198104.51	650653.86	5456.12	41-46	Monthly	Semi-Annual	Visitor Center
AMW-13C	1198095.00	650657.30	5454.17	72-82	Continuous	Semi-Annual	Visitor Center
BPS07-01A	1203623.03	651666.82	5479.33	13-23	Monthly	Semi-Annual	Clark Park
BPS07-01B	1203623.38	651679.74	5479.18	29-39	Monthly	Semi-Annual	Clark Park
BPS07-05A[1]	1201799.84	649886.89	5463.12	25-35	Monthly	Semi-Annual	Southwest of Clark Park
BPS07-05B	1201788.65	649887.39	5462.50	69-79	Monthly	Semi-Annual	Southwest of Clark Park
BPS07-16A	1200085.64	650004.05	5456.26	10-20	Monthly	Semi-Annual	Majors and Nevada Streets
BPS07-16B	1200086.26	650019.68	5456.53	30-40	Monthly	Semi-Annual	Majors and Nevada Streets
BPS11-11A1	1199028.43	650425.25	5451.90	9-14	Monthly	Semi-Annual	Southeast corner of KOA
BPS11-11A2	1199021.53	650418.03	5451.92	23-33	Monthly	Semi-Annual	Southeast corner of KOA
BPS11-11B	1199021.25	650423.62	5452.06	63-73	Monthly	Semi-Annual	Southeast corner of KOA
BPS11-11C	1199028.61	650418.85	5451.65	141-151	Monthly	Semi-Annual	Southeast corner of KOA
Performance Monitoring Network Outside of Technical Impracticability (TI) Zone							
AMW-11	1197599.51	650816.81	5449.60	4-14	Monthly	5-Year	west of Visitors Center
BPS11-12A	1197056.64	650631.21	5452.35	24-34	Monthly	Semi-Annual	SW of MSD Vault, south of George St & BPS11-09
BPS11-15	1196666.00	650420.89	5453.52	27-37	Monthly	Semi-Annual	Montana St, at I-90 eastbound entrance ramp
BPS11-16	1196698.91	650110.41	5455.88	63-73	Monthly	Semi-Annual	Montana St, at I-90 westbound exit ramp
BPS11-19A2	1198941.73	650608.89	5449.98	33-43	Monthly	Semi-Annual	KOA, north of BPS11-11 well group
BPS11-19B	1198940.87	650603.02	5449.98	52-67	Monthly	Semi-Annual	KOA, north of BPS11-11 well group
BT-98-02	1200254.43	650476.15	5461.01	14-19	Monthly	Semi-Annual	Cobban St, near Wyoming
BT-98-02B	1200136.18	650484.20	5459.20	29-39	Monthly	Semi-Annual	Cobban St, near Nevada
GS-28	1198607.15	650317.44	5450.45	6-11	Monthly	5-Year	South of KOA

Table 5. BPSOU 2022 Ground Water Monitoring Network - Coordinates

Well ID	Easting (NAD83FT)	Northing (NAD83FT)	Measuring Point (NAVD88FT)	Screened Interval for WQ Wells (ft)	WL Frequency	WQ Chemistry Frequency	Location
BPSOU Subdrain Capture System							
AMC-06	1205161.09	654385.06	5493.83	53-63	Monthly	WL Only	East of Parrott Tailings
AMC-12	1203350.12	653445.14	5483.93	35-45	Continuous	Semi-Annual	East of Parrott Tailings
AMC-13	1203026.63	652054.00	5479.72	47-55	Monthly	Semi-Annual	Clark Park
AMC-23	1198900.93	651533.24	5452.52	19-29	Continuous	WL Only	East of Kaw Ave., north of MSD
AMC-23B	1198903.75	651526.71	5452.88	97-107	Monthly	Semi-Annual	East of Kaw Ave., north of MSD
AMC-24	1198981.74	650908.24	5456.29	13-23	Continuous	Semi-Annual	East of Kaw Ave., south of MSD
AMC-24B	1198991.33	650911.36	5455.95	39-49	Continuous	Semi-Annual	East of Kaw Ave., south of MSD
AMC-24C	1198984.00	650920.10	5454.63	69-79	Continuous	Semi-Annual	East of Kaw Ave., south of MSD
AMW-01A	1201806.63	653285.10	5469.49	3-13	Continuous	Semi-Annual	Civic Center
AMW-01B	1201821.65	653300.93	5469.60	33-43	Continuous	Semi-Annual	Civic Center
AMW-01C	1201813.77	653292.62	5469.60	87-97	Continuous	Semi-Annual	Civic Center
AMW-08	1203321.25	654315.14	5500.52	30-45	Monthly	Semi-Annual	Shields Ave., North of Parrot tailings
AMW-12	1200738.80	651119.45	5464.82	7-22	Monthly	Semi-Annual	Utah St
AMW-20	1204162.12	654737.04	5491.63	24-39	Continuous	Semi-Annual	MRI, Ecology Ponds
BPS07-03A	1198230.63	651153.04	5452.69	9-19	Continuous	Semi-Annual	Southeast of Pump Vault
BPS07-07	1197529.13	651175.82	5448.51	7-17	Continuous	Semi-Annual	MSD Vault Area, W of Vault
BPS07-11A	1202374.92	652882.17	5473.00	14-24	Continuous	Semi-Annual	Between Parrott Tailings & Clark Park
BPS07-11B	1202363.34	652882.70	5472.78	35-45	Continuous	Semi-Annual	Between Parrott Tailings & Clark Park
BPS07-21	1197903.44	651092.08	5457.29	13-21	Continuous	Semi-Annual	MSD Vault Area, SE of Vault
BPS07-21B	1197902.91	651101.47	5456.61	36-46	Continuous	Semi-Annual	MSD Vault Area, SE of Vault
BPS07-21C	1197908.20	651098.03	5456.94	65-81	Continuous	Semi-Annual	MSD Vault Area, SE of Vault
BPS07-22B	1197819.72	651283.60	5451.45	21-31	Continuous	Semi-Annual	MSD Vault Area, NE of Vault
BPS07-22C	1197817.10	651291.22	5451.24	89-99	Continuous	Semi-Annual	MSD Vault Area, NE of Vault

Table 5. BPSOU 2022 Ground Water Monitoring Network - Coordinates

Well ID	Easting (NAD83FT)	Northing (NAD83FT)	Measuring Point (NAVD88FT)	Screened Interval for WQ Wells (ft)	WL Frequency	WQ Chemistry Frequency	Location
BPS07-22R	1197812.39	651285.02	5451.39	4-14	Continuous	Semi-Annual	MSD Vault Area, NE of Vault
BPS07-23	1197539.74	651326.38	5450.83	7-17	Continuous	Semi-Annual	MSD Vault Area, NW of Vault
BPS07-24	1199800.19	651380.30	5456.13	60-70	Continuous	Semi-Annual	Diggings East
BPS11-10A	1198834.70	651083.58	5456.10	11-21	Continuous	Semi-Annual	SE Corner Kaw and George Streets
BPS11-10B	1198828.24	651083.02	5455.75	36-46	Continuous	Semi-Annual	SE Corner Kaw and George Streets
BPS11-10C	1198830.83	651077.65	5455.91	110-120	Continuous	Semi-Annual	SE Corner Kaw and George Streets
BPS11-13B	1199360.63	650787.52	5459.98	43-53	Monthly	Semi-Annual	Diggings East, East of AMC-24
BPS11-14A	1199858.66	651156.02	5457.11	17-22	Monthly	Semi-Annual	Diggings East, SE of MF-10
BPS11-14B	1199860.85	651148.52	5457.02	60-65	Monthly	Semi-Annual	Diggings East, SE of MF-10
BPS11-17C	1200805.66	652442.30	5461.64	56-66	Monthly	Semi-Annual	Casey St. at MSD, near MF-07
BPS11-18B	1201018.92	652457.57	5463.59	36-46	Monthly	Semi-Annual	Casey St. east of MSD
BPS11-18C	1201022.06	652461.18	5463.72	55-65	Monthly	Semi-Annual	Casey St. east of MSD
GS-08	1200371.05	651618.73	5461.57	127-145	Monthly	WL Only	Diggings East
GS-08R	1200387.64	651630.75	5463.56	168-178	Continuous	Semi-Annual	Diggings East
GS-09	1200378.85	651614.20	5461.92	61-76	Monthly	WL Only	Diggings East
GS-09R	1200383.54	651638.44	5463.46	49-59	Continuous	Semi-Annual	Diggings East
GS-11	1200372.68	651610.43	5461.63	8-18	Monthly	WL Only	Diggings East
GS-11R	1200392.40	651637.80	5463.39	8-18	Continuous	Semi-Annual	Diggings East
GS-30D	1200331.53	651783.14	5460.25	29-39	Continuous	Semi-Annual	Diggings East
GS-30S	1200332.60	651778.78	5460.81	14-20	Continuous	Semi-Annual	Diggings East
GS-31D	1200400.37	651284.18	5456.02	29-39	Monthly	Semi-Annual	Diggings East
GS-31S	1200397.37	651287.03	5455.92	15-20	Continuous	Semi-Annual	Diggings East
GS-32D	1200208.19	651936.94	5454.95	27-37	Continuous	Semi-Annual	Northside Tailings
GS-32S	1200205.06	651939.33	5454.49	6-11	Continuous	Semi-Annual	Northside Tailings
GS-40R	1203900.82	654152.35	5485.61	52-62	Monthly	Semi-Annual	Continental and Texas
GS-44D	1203257.03	652518.10	5482.63	50-60	Continuous	Semi-Annual	Clark Park
GS-44S	1203244.27	652515.25	5482.60	20-25	Continuous	Semi-Annual	Clark Park

Table 5. BPSOU 2022 Ground Water Monitoring Network - Coordinates

Well ID	Easting (NAD83FT)	Northing (NAD83FT)	Measuring Point (NAVD88FT)	Screened Interval for WQ Wells (ft)	WL Frequency	WQ Chemistry Frequency	Location
GS-46D	1204594.55	652828.63	5490.40	51-61	Continuous	Semi-Annual	East of Clark Park
GS-46S	1204593.29	652819.61	5490.48	25-30	Continuous	Semi-Annual	East of Clark Park
MF-01	1196922.01	651209.99	5447.66		Continuous	WL Only	George St. and Montana St.
MF-03	1198486.69	651631.50	5452.99	13-18	Monthly	WL Only	East of Kaw Ave., north of MSD
MF-05	1200865.51	653019.18	5471.50	12-17	Monthly	WL Only	Northside Tailings
MF-07	1200839.99	652461.32	5463.13	13-18	Continuous	Semi-Annual	Casey St. at MSD
MF-08	1199558.75	651492.48	5453.86	9-14	Continuous	Semi-Annual	Delaware St. at MSD
MF-09	1200554.69	651543.07	5461.60	11-16	Monthly	Semi-Annual	Diggings East
MF-10	1199601.25	651174.66	5456.48	12-17	Continuous	Semi-Annual	Diggings East
MF-11	1201144.01	651754.15	5463.60	10-15	Monthly	Semi-Annual	Oregon and George
MSD-02A	1201167.94	652538.92	5462.58	4-14	Continuous	Semi-Annual	Casey St. at MSD
MSD-02B	1201168.06	652542.21	5465.55	35-45	Continuous	Semi-Annual	Casey St. at MSD
MSD-03	1200702.84	651964.12	5461.30	40-50	Monthly	Semi-Annual	NE of Diggings
MSD-04	1201143.89	651764.54	5463.63	45-55	Monthly	Semi-Annual	Oregon and George
MSD-05	1200320.35	651780.39	5461.28	50-55	Monthly	Semi-Annual	Diggings East
MH-MSD106	1197905.45	651208.71	5442.67	NA	Monthly	Annual	MSD Subdrain
MH-MSD108	1198781.11	651266.63	5445.55	NA	Monthly	Annual	MSD Subdrain
MH-MSD110	1199848.94	651504.02	5449.75	NA	Monthly	Annual	MSD Subdrain
MH-MSD113	1200906.38	652414.03	5455.75	NA	Continuous	Annual	MSD Subdrain
MH-MSD116	1201857.26	653235.97	5459.93	NA	Continuous	Annual	MSD Subdrain
Area Between Ground Water Capture Zones							
AMW-02	1196999.20	651600.32	5452.54	10-20	Continuous	Semi-Annual	Buffalo Gulch - Mouth
BMF96-02	1196120.24	652792.29	5477.61	149-169	Continuous	WL Only	Community Health Center
BMF96-03	1197301.04	652749.96	5472.02	145-165	Continuous	WL Only	BSB Health Department
BMF96-04	1198386.04	653202.73	5493.56	167-187	Continuous	WL Only	Charlie Judd Park
BPS07-08A	1196286.30	651929.32	5450.47	8-17	Continuous	Semi-Annual	Montana St., north of SBC
BPS07-13A	1196257.93	651644.07	5463.58	20-30	Monthly	Semi-Annual	BSB Asphalt Plant
BPS07-13B	1196252.70	651647.09	5464.70	33-43	Monthly	Semi-Annual	BSB Asphalt Plant
BPS07-14A	1195646.00	651801.25	5459.52	16-26	Monthly	Semi-Annual	BSB Asphalt Plant

Table 5. BPSOU 2022 Ground Water Monitoring Network - Coordinates

Well ID	Easting (NAD83FT)	Northing (NAD83FT)	Measuring Point (NAVD88FT)	Screened Interval for WQ Wells (ft)	WL Frequency	WQ Chemistry Frequency	Location
BPS07-15A	1195953.51	651691.02	5459.33	15-35	Monthly	Semi-Annual	BSB Asphalt Plant
BPS07-25	1195699.87	651930.29	5449.08	15-25	Continuous	Semi-Annual	BRW-near slag wall
BPS11-01	1196519.82	652032.37	5450.08	15-25	Monthly	Semi-Annual	Montana St., north of SBC
BPS11-02	1196542.27	651688.16	5447.27	19-29	Monthly	Semi-Annual	Montana St., north of SBC
BPS11-03	1197338.96	651577.36	5447.98	16-26	Monthly	Semi-Annual	West of vault, south of RR bed
BPS11-04	1197357.49	650891.75	5452.09	44-54	Monthly	Semi-Annual	West of Visitors Center, SW of Blacktail Creek
BPS11-05A1	1196512.37	651319.58	5449.38	6-11	Monthly	Semi-Annual	BSB Asphalt Plant
BPS11-05A2	1196521.57	651322.72	5449.46	23-28	Monthly	Semi-Annual	BSB Asphalt Plant
BPS11-06	1196042.03	651447.56	5452.05	19-29	Monthly	Semi-Annual	BSB Asphalt Plant
BPS11-07	1195871.59	652017.09	5455.46	26-36	Continuous	Semi-Annual	East of BRW, north of SBC
BPS11-08	1196084.17	652318.31	5456.82	13-23	Monthly	Semi-Annual	East of BRW, north of SBC
BPS11-09	1197015.15	651018.77	5448.20	24-34	Monthly	Semi-Annual	George St, west of Visitor's Center
BPSPZ07	1197256.00	651803.20	Not Surveyed	6-16	WQ Only	5-year	Base of Buffalo Gulch
FP98-1	1195210.87	651477.17	5442.51	4-6	Monthly	Semi-Annual	LAO, SBC floodplain
FP98-1B	1195275.85	651510.42	5461.32	38-48	Monthly	Semi-Annual	LAO, SBC floodplain
FP98-2	1195030.65	651577.81	5441.49	5-15	Monthly	Semi-Annual	LAO, SBC floodplain
FP98-3	1195161.74	651126.85	5445.89	3-5	Monthly	Semi-Annual	LAO, SBC floodplain
GS-12	1194639.22	651905.13	5446.91	20-30	Monthly	WL Only	BRW
GS-13A	1195561.75	651974.41	5443.81	13-14	Continuous	Semi-Annual	East end BRW
GS-19	1194388.23	651485.11	5445.99	14-19	Monthly	WL Only	BRW
GS-20	1194568.24	652213.18	5454.88	18-23	Monthly	WL Only	BRW
GS-29D	1196893.68	651275.12	5448.00	177-178	Continuous	WL Only	George St. and Montana St.
GS-29SR	1196900.37	651277.68	5448.85	14-24	Monthly	WL Only	George St. and Montana St.
HCA-MG1	1194628.42	652219.46	5460.99	6-11	Monthly	WL Only	BRW
HCA-MG3	1194778.68	652262.56	5460.35	15-25	Monthly	WL Only	BRW
LAO Capture System Monitoring Network							
BMW-01A	1192708.51	650962.24	5434.40	22-32	Monthly	WL Only	LAO, SBC floodplain
BMW-01B	1192725.08	650961.76	5433.62	39-29	Monthly	WL Only	LAO, SBC floodplain
BMW-01C	1192722.87	650976.61	5434.60		Monthly	WL Only	LAO, SBC floodplain

Table 5. BPSOU 2022 Ground Water Monitoring Network - Coordinates

Well ID	Easting (NAD83FT)	Northing (NAD83FT)	Measuring Point (NAVD88FT)	Screened Interval for WQ Wells (ft)	WL Frequency	WQ Chemistry Frequency	Location
BMW-02A	1191161.21	651944.37	5427.69	14-19	Monthly	WL Only	LAO
BMW-02B	1191145.43	651939.95	5427.31	45-55	Monthly	WL Only	LAO
BMW-02D	1191156.14	651912.62	5427.14	186-196	Monthly	WL Only	LAO
BMW-03A	1190747.07	651983.43	5422.80	15-19	Continuous	Semi-Annual	LAO, SBC floodplain
BMW-03B	1190742.86	651999.05	5423.19	36-50	Continuous	Semi-Annual	LAO, SBC floodplain
BMW-05A	1191763.28	651119.09	5439.29	5-8	Monthly	WL Only	South of LAO/SBC
BMW-05B	1191741.67	651127.15	5440.45	38-57	Monthly	WL Only	South of LAO/SBC
BMW-06B	1190865.38	652470.53	5430.35	59-79	Continuous	5-Year	West end HCC
BMW-08A	1194702.45	652063.17	5449.66	5-11	Monthly	WL Only	BRW
BMW-09A	1193534.81	651143.19	5436.47	16-26	Monthly	WL Only	LAO, SBC floodplain
BMW-09B	1193537.71	651136.63	5436.18	44-54	Monthly	WL Only	LAO, SBC floodplain
BMW-11B	1192280.53	652255.55	5435.54	55-75	Monthly	WL Only	North of LAO/Centennial Ave.
BMW-13B	1192899.90	651414.76	5432.98	45-65	Monthly	WL Only	LAO
BPS07-17A	1190554.33	652094.41	5429.62	8-18	Continuous	Semi-Annual	West end HCC
BPS07-18A	1190449.98	652112.47	5430.10	8-20	Continuous	Semi-Annual	West end HCC
BPS07-18B	1190433.80	652115.36	5430.32	30-40	Continuous	Semi-Annual	West end HCC
CT NE-2	1192181.07	652292.01	5436.50	15-20	Monthly	WL Only	North of LAO/Centennial Ave.
CT NW-3	1190875.69	652414.56	5429.82	9-14	Continuous	5-Year	West end HCC
CT NW-4	1190925.34	652298.35	5426.35	19-28	Monthly	WL Only	West end of LAO
CT S-2	1192063.70	651030.94	5440.11	25-28	Monthly	WL Only	South of LAO/SBC
CT S-5	1191254.12	651410.96	5441.44	16-23	Monthly	WL Only	South of LAO/SBC
CT SW-4	1190818.11	651950.59	5424.02	19-28	Monthly	WL Only	LAO, SBC floodplain
CT-84-01	1193702.57	651695.69	5444.77	11-16	Monthly	WL Only	LAO, east of Metro Sewer
CT-94-1	1192381.39	651130.75	5432.05	11-24	Monthly	WL Only	LAO, SBC floodplain
FP98-4	1194513.33	651067.43	5441.50	5-15	Monthly	5-Year	LAO, SBC floodplain
FP98-5	1194489.87	651316.64	5439.44	5-15	Monthly	5-Year	LAO, SBC floodplain
FP98-6	1191612.29	651621.71	5429.83	5-17	Continuous	Semi-Annual	LAO, SBC floodplain
FP98-7	1191595.27	651420.13	5432.13	5-15	Continuous	5-Year	LAO, SBC floodplain
FP98-8	1191051.41	651664.24	5430.77	2-4	Monthly	WL Only	LAO, SBC floodplain
FP98-9	1191127.93	651848.04	5426.98	3-17	Monthly	WL Only	LAO, SBC floodplain

Table 5. BPSOU 2022 Ground Water Monitoring Network - Coordinates

Well ID	Easting (NAD83FT)	Northing (NAD83FT)	Measuring Point (NAVD88FT)	Screened Interval for WQ Wells (ft)	WL Frequency	WQ Chemistry Frequency	Location
GS-13B	1195542.63	651978.13	5441.89	24-32	Monthly	WL Only	East end BRW
GS-17DR	1194113.84	651319.22	5444.18	20-30	Monthly	WL Only	LAO
GS-18R	1193548.92	651008.44	5436.78	5-15	Monthly	WL Only	LAO, SBC floodplain
GS-22	1192836.87	650753.30	5440.17	5-15	Monthly	WL Only	South of LAO/SBC
GS-23	1191657.15	651200.90	5441.36	15-20	Monthly	WL Only	South of LAO/SBC
GS-25	1192708.45	651658.59	5432.05	5-10	Monthly	WL Only	LAO near HCC
GS-25C	1192726.41	651650.09	5433.75	84-94	Monthly	WL Only	LAO near HCC
GS-25D	1192714.75	651670.29	5432.95	166-176	Monthly	WL Only	LAO near HCC
GS-26	1190772.52	652249.24	5422.79	10-15	Continuous	5-Year	West end HCC
GS-34D	1193374.75	651348.12	5438.42	21-31	Monthly	WL Only	LAO near HCC
GS-34S	1193377.72	651341.78	5437.59	12-17	Monthly	WL Only	LAO near HCC
GW-06R	1192715.55	651250.10	5435.38	10-20	Monthly	WL Only	LAO, SBC floodplain
HCA-B1	1190745.01	652241.64	5427.49	40-50	Continuous	Semi-Annual	West end HCC
HCA-B2	1190557.49	652105.11	5429.96	25-35	Continuous	Semi-Annual	West end HCC
M-01	1192749.22	651948.73	5433.52	5-8	Monthly	WL Only	BSB sewer treatment plant
M-03-87	1193441.69	650907.58	5441.61	5-15	Monthly	WL Only	North of Motana Pole
Colorado Smelter Repository							
MW-G-96	1193255.17	649618.96	5480.05	19-29	Monthly	WL Only	East of CO Smelter Repository
MW-H-96	1193198.14	650026.30	5462.71	17-27	Monthly	WL Only	NE of CO Smelter Repository
BRW Cell							
BRW-00	1195013.05	651764.72	5436.89		Continuous	WL Only	LAO-BRW
BTL Cells							
A1	1192164.94	651838.45	5400.00		Continuous		BTL
A2	1191690.21	651931.23	5400.00		Continuous		BTL
A3	1191180.80	652055.47	5400.00		Continuous		BTL
B3	1192096.79	651702.08	5400.00		Continuous		BTL
C3	1192046.18	651541.57	5400.00		Continuous		BTL
D2	1191570.06	651758.10	5400.00		Continuous		BTL
D3	1191135.20	651962.46	5400.00		Continuous		BTL
D4	1190838.38	652104.78	5400.00		Continuous		BTL

Table 5. BPSOU 2022 Ground Water Monitoring Network - Coordinates

Well ID	Easting (NAD83FT)	Northing (NAD83FT)	Measuring Point (NAVD88FT)	Screened Interval for WQ Wells (ft)	WL Frequency	WQ Chemistry Frequency	Location
Staff Gages							
HCC-01	1193749.26	651325.00	5430.38		Monthly		HCC
HCC-02A	1192780.84	651364.64	5421.29		Monthly		HCC
HCC-04	1191792.43	652072.94	5422.04		Monthly		HCC
HCC-06	1191051.80	652343.18	5419.37		Monthly		HCC
HCC-07	1190724.00	652188.07	5417.60		Monthly		HCC
MSD-3A	1198752.76	651259.34	5444.36		Monthly		uSBC
MSD-HAB	1201768.66	653181.90	5459.31		Monthly		uSBC
MSDSG-02	1198679.23	650307.25	5444.37		Monthly		Wetlands
MSDSG-03	1199309.57	649942.12	5444.24		Monthly		Wetlands
MSDSG-04	1198374.72	649221.21	5445.86		Monthly		Wetlands
MSDSG-05	1199016.35	650053.49	5441.98		Monthly		Wetlands
SS-01	1204425.04	647354.69	5451.88		Monthly		BTC
SS-01.35	1199562.17	649682.70	5443.71		Continuous		BTC
SS-04	1197358.41	651043.32	5441.22		Monthly		BTC
SS-05	1196597.16	651486.68	5440.64		Continuous		SBC
SS-05.6	1195726.02	651869.30	5437.82		Monthly		SBC
SS-05.7	1195681.57	651873.93	5437.38		Continuous		SBC
SS-05.9R1	1195583.75	651836.33	5437.45		Continuous		SBC
SS-05A	1195315.54	651699.09	5436.41		Continuous		SBC
SS-06A	1193386.54	651142.65	5431.00		Monthly		SBC
SS-06G	1190609.83	651954.81	5417.55		Monthly		SBC
SS-07	1190397.41	652040.79	5415.14		Monthly		SBC

[1]Arsenic concentration excluded for POC purposes

Table 6 - 2006 ROD Based Groundwater Standards

Contaminants of Concern	Performance Standard Identified in the 2006 ROD (Dissolved mg/L)
Arsenic	0.010
Cadmium	0.005
Copper	1.30
Lead	0.015
Mercury	0.002
Zinc	2.00

Table 7 - Summary of Laboratory Quality Control Checks

Laboratory QC	Analysis	Method	Frequency[1]	Control Limits[1]	Laboratory Corrective Action[2]
Method Blank (MB)	Metals	EPA 200.8	One in every 20 samples	1/2 RL	Re-analyze associated samples unless: sample results are non-detect, sample results are >10X the MB result. If this is not true, all associated samples > MDL & < 10X MB result should be redigested (if applicable) and reanalyzed. If insufficient sample for re-analysis, report results with qualifier.
	Mercury	EPA 245.1			
	Alkalinity	SM2320B			
	Anions	EPA 300.0			
	TDS	SM 2540C			
Laboratory Control Spike (LCS)	Metals	EPA 200.8	One in every 20 samples	85-115% of true value	Terminate analysis, correct problem, redigest (if applicable) and reanalyze all samples prepared with non-compliant LCS.
	Mercury	EPA 245.1			
	Alkalinity	SM2320B		90-110% of true value	
	Anions	EPA 300.0			
	TDS	SM 2540C		80-120% of true value	
Laboratory Control Spike Duplicate (LCSD)	Alkalinity	SM2320B	One in every 10 samples	≤ 20% RPD	Terminate analysis, correct problem, redigest (if applicable) and reanalyze all samples prepared with non-compliant LCS.
Laboratory Duplicate Sample (LDS)	Metals	EPA 200.8	One in every 20 samples (MSD serves as LDS)	≤ 20% RPD	Should LDS samples fail to meet control limits, and the samples in the associated batch are of a similar matrix, then associated sample results should be flagged. If samples in the associated batch are not similar to the parent sample used for the LDS, then only the parent sample used to prepare the duplicate should be flagged.
	Mercury	EPA 245.1			
	Alkalinity	SM2320B	One in every 10 samples (MSD serves as LDS)		
	Anions	EPA 300.0			
	TDS	SM2540C	One in every 10 samples	≤ 5% RPD	Qualify data. If RPD > 50% reanalyze parent sample in duplicate to confirm results.

Table 7 - Summary of Laboratory Quality Control Checks

Laboratory QC	Analysis	Method	Frequency[1]	Control Limits[1]	Laboratory Corrective Action[2]
Matrix Spike (MS)/Matrix Spike Duplicate (MSD)	Metals	EPA 200.8	One in every 10 samples MSD one in every 20 samples	70-130% of true value ≤ 20% RPD	Should MS/MSD samples fail to meet control limits, and the samples in the associated batch are of a similar matrix, then associated sample results should be flagged. If samples in the associated batch are not similar to the parent sample used for the MS/MSD, then only the parent sample used to prepare the spike should be flagged. MS/MSD% recovery criteria are waived if parent sample concentration is > 4X spike concentration.
	Mercury	EPA 245.1	1 per batch & if > 11 samples in a batch, an additional MS is required.	70-130% of true value ≤ 20% RPD	
	Alkalinity	SM2320B	One in every 10 samples	80-120% of true value ≤ 20% RPD	
	Anions	EPA 300.0			
Serial Dilution (SD)	Metals	EPA 200.8	One in every 20 samples	1:5 dilution 10% difference of original result when original sample is ≥ 50X the MDL	Should SD fail to meet control limits, and the samples in the associated batch are of a similar matrix, then associated sample results should be flagged. If samples in the associated batch are not similar to the parent sample used for the SD, then only the parent sample used to prepare the duplicate should be flagged.

[1]Frequency and control limits are based on EPA Methods. For analyses performed by standard methods frequency and control limits are based on Pace Analytical SOPs.
[2]Corrective actions are sequential for cases indicating multiple corrective actions. If the first corrective action is not sufficient to bring analysis back into control, the second action noted will be implemented.

Table 8 - Precision, Accuracy and Completeness Calculation Equations

Characteristic	Formula	Symbols
Precision (as relative percent difference, RPD)	$RPD = \frac{(x_i - x_j)}{\left(\frac{x_i + x_j}{2}\right)} \times 100$	x_i, x_j: replicate values of x
Precision (as relative standard deviation, RSD, otherwise known as coefficient of variation)	$RSD = \frac{\sigma}{\bar{x}} \times 100$	σ: sample standard deviation $\bar{x}$: sample mean
Accuracy (as percent recovery, R, for samples without a background level of the analyte, such as reference materials, laboratory control samples and performance evaluation samples)	$R = \frac{x}{t} \times 100$	x: sample value t: true or assumed value
Accuracy (as percent recovery, R, for samples with a background level of the analyte, such as matrix spikes)	$R = \frac{SSR - SR}{SA} \times 100$	SSR: spiked sample result SR: sample result SA: spike added
Accuracy (as percent difference, D, for samples > 50X the MDL, which have undergone at least a five-fold dilution, with the result, S, corrected for the dilution)	$D = \frac{\lvert I - S \rvert}{I} \times 100$	I: initial sample result S: serial dilution result
Completeness (as a percentage, C)	$C = \frac{n}{N} \times 100$	n: number of valid data points produced N: total number of samples taken

Table 9 - Summary of Laboratory Calibration Checks

Laboratory QC	Analysis	Method	Frequency[1]	Control Limits[1]	Corrective Action[2]
Initial Calibration Verification (ICV)	Mercury	EPA 245.1	At beginning of analytical run, immediately after ICV	95-105% of true value	
	Metals	EPA 200.8		90-110% of true value	
	Alkalinity	SM2320B			
	Anions	EPA 300.0			
Initial Calibration Blank/Continuing Calibration Blank (ICB/CCB)	Metals	EPA 200.8	At beginning of analytical run, immediately after ICV	< 1/2 RL	Terminate analysis, correct problem, recalibrate instrument. If all associated samples are ≥ 10X the ICB result, the data can be accepted.
	Mercury	EPA 245.1			
	Alkalinity	SM2320B			
	Anions	EPA 300.0			
Contract Required Detection Limit (CRDL)	Metals	EPA 200.8	At the beginning of each run for every analyte of interest	60-140%	Evaluate standard preparation and re-prepare if preparation is suspect. If CRDL is biased high, non-detects can be reported & samples > CCV may be reported. If CRDL is biased low, terminate analysis, correct problem, and recalibrate instrument
	Mercury	EPA 245.1	At the beginning of each run.	70-130%	Qualifiy associated samples
Interference Check Sample (ICS)	Metals	EPA 200.8	At the beginning of each analytical sequence, or a minimum of twice per 8-hour shift, whichever is more frequent.	80-120% R for analytes included in the ICS, <RL for analytes not included in the ICS	Terminate analysis, correct the problem, recalibrate instrument, verify calibration, reanalyze all samples since last compliant ICS.
Continuing Calibration Verification (CCV)	Metals	EPA 200.8	One in every ten samples, and after the last analytical sample	90-110% of true value	Terminate analysis, correct the problem, recalibrate instrument, reanalyze all samples not bracketed by compliant CCVs.
	Mercury	EPA 245.1			
	Alkalinity	SM2320B			
	Anions	EPA 300.0			

Table 9 - Summary of Laboratory Calibration Checks

Laboratory QC	Analysis	Method	Frequency[1]	Control Limits[1]	Corrective Action[2]
Internal Standard Response	Metals	EPA 200.8	Monitor signal intensity throughout the analytical run.	EPA 200.8 - 60-125%	Flush the instrument with the rinse blank, re-analyze the calibration blank, and examine the internal standard intensities with the following actions. If the internal standards intensities are acceptable, dilute a fresh sample aliquot & re-analyze. If the internal standards are still out-of-limits, terminate analysis & determine the cause of the drift. Perform sampling interface maintenance or re-tune the mass spectrometer as required. Re-calibrate & re-analyze any samples not bordered by acceptable ICV/CCV results.

[1]Frequency and control limits are based on EPA Methods. For analyses performed by standard methods frequency and control limits are based on Pace Analytical SOPs.
[2]Corrective actions are sequential for cases indicating multiple corrective actions. If the first corrective action is not sufficient to bring analysis back into control, the second action noted will be implemented.

Table 10 - Project Sampling SOP References

Reference Number	Title and Revision Date	Originating Organization
G-4	Field Logbook/Photographs, April 2, 1992	ARCO
G-5	Sample Packaging and Shipping, 1992	ARCO
G-6	Field Quality Control Samples, September 1992	ARCO
G-7	Sample Custody, 1992	ARCO
SOP-GW-01	Ground Water Level Measurement, Rev. 3, January 23, 2019	TREC, Inc.
SOP-GW-02	Ground Water Sampling of Monitoring Wells with Submersible Pump, Rev. 5, May 12, 2021	TREC, Inc.
SOP-GW-03	Ground Water Sampling of Monitoring Wells with Geotech or ISCO Peristaltic Pump, Grundfos Pump, and Geotech Bladder Pump, Rev. 5, May 12, 2021	TREC, Inc.
SOP-H-01	Water Sampling Equipment Decontamination, Rev. 3, April 13, 2020	TREC, Inc.
SOP-H-02	Downloading Transducers, Rev. 2, April 13, 2020	TREC, Inc.
SOP-H-05	Calibrate YSI Professional Plus Multi-Meter, Rev. 3, February 23, 2019	TREC, Inc.
SOP-H-07	Transducer Compensation and File Submittal, Rev. 1, July 24, 2018	TREC, Inc.
SOP-H-08	Deployment of Ground Water Level Monitoring Equipment, Rev. 1, December 1, 2020	TREC, Inc.
SOP-SW-06	Read Staff Gage, Rev. 3, September 2, 2021	TREC, Inc.

Table 11 – Analytical Bottle Count and Preservation

Analytes	Sampling Container	Preservative	Filter	Comments
General Laboratory				
Alkalinity (as CaCO3)	Polyethylene, 1 x 1 L	None, refrigerate 0°C-6°C	None	Only one container for all four analyses
Anions	Polyethylene, 1 x 1 L	None, refrigerate 0°C-6°C	None	
Total Dissolved Solids	Polyethylene, 1 x 1 L	None, refrigerate 0°C-6°C	None	
Metals				
Dissolved Metals[1]	Polyethylene, 1 x 250 mL	pH < 2 nitric acid, refrigerate 0°C-6°C	0.45-micron filter	Only one bottle for both analyses
Dissolved Mercury	Polyethylene, 1 x 250 mL	pH < 2 nitric acid, refrigerate 0°C-6°C	0.45-micron filter	

[1]Hardness determined by SM2340B; calculation using dissolved Calcium and Magnesium concentrations.

Table 12 - Validation Criteria for Laboratory and Field Quality Control Samples

Laboratory QC	Analysis	Method	Frequency[1,2]	Validation Criteria[1]	QC Sample Result	Action for Non-Detect Sample Result	Action for Detect Sample Result
Method Blank (MB)	Metals	EPA 200.8	One in every 20 samples	≤ 1.5X MDL	< MDL	No action	No action
	Mercury	EPA 245.1			≥ MDL but ≤ 1.5X MDL	No action	No action
	Alkalinity	SM2320B			> 1.5X MDL	No action	if ≥ MDL but ≤ RL UJ
	Anions	EPA 300.0					if > RL but ≤ 10X MB J+
	TDS	SM 2540C					if > 10X MB No action
Laboratory Control Spike (LCS) Recovery Criteria	Metals	EPA 200.8	One in every 20 samples	85-115% of true value	<40%	R	J-
	Mercury	EPA 245.1			40% to lower limit	UJ	J-
	Alkalinity	SM2320B		90-110% of true value	Between lower limit and upper limit	No action	No action
	Anions	EPA 300.0			Upper limit to 150%	No action	J+
	TDS	SM 2540C		80-120% of true value	> 150%	No action	R
Laboratory Duplicate Sample (LDS) Laboratory Control Spike Duplicate (LCSD) Matrix Spike Duplicate (MSD) Precision Criteria	Metals	EPA 200.8	One in every 20 samples (MSD serves as LDS)	≤ 20% RPD or Delta < RL	Both original and duplicate result ≥ 5X RL and RPD ≤ method criteria	No action	No action
	Mercury	EPA 245.1			Both original and duplicate result ≥ 5X RL and RPD > method criteria	UJ	J
	Alkalinity	SM2320B	One in every 10 samples (MSD serves as LDS)		Original or duplicate result, or both, < 5X RL and the absolute difference between the two results is < RL	No action	No action
	Anions	EPA 300.0			Original or duplicate result, or both, < 5X RL and the absolute difference between the two results is ≥ RL	UJ	J
	TDS	SM2540C	One in every 10 samples	≤ 10% RPD or Delta < RL			
Matrix Spike (MS)/Matrix Spike Duplicate (MSD) Recovery Criteria[3]	Metals	EPA 200.8	One in every 10 samples MSD one in every 20 samples	70-130% of true value ≤ 20% RPD	< 30%	R	J-
	Mercury	EPA 245.1	1 per batch & if > 11 samples in a batch, an additional MS is required.	70-130% of true value ≤ 20% RPD	30% to lower limit	UJ	J-
	Alkalinity	SM2320B	One in every 10 samples	80-120% of true value ≤ 20% RPD	Lower limit to upper limit	No action	No action
	Anions	EPA 300.0		80-120% of true value, ≤ 20% RPD	> Upper limit	No action	J+
Serial Dilution (SD)	Metals	EPA 200.8	One in every 20 samples	1:5 dilution 10% difference of original result when original sample is ≥ 50X the MDL	< 10% Difference	No action	No action
					> 10% Difference and original sample concentration is < 50X MDL	No action	No action
					> 10% Difference and original sample concentration is ≥ 50X MDL	UJ	J

Table 12 - Validation Criteria for Laboratory and Field Quality Control Samples

Laboratory QC	Analysis	Method	Frequency[1,2]	Validation Criteria[1]	QC Sample Result	Action for Non-Detect Sample Result	Action for Detect Sample Result
Field Quality Control Samples							
Field Blank	All Analyses	All Methods	A minimum of 1 per 20 primary samples collected or 1 per sampling event, whichever is more frequent	≤ 1.5X MDL	< MDL	No action	No action
					≥ MDL but ≤ 1.5X MDL	No action	No action
					> 1.5X MDL	No action	if ≥ MDL but ≤ RL UJ
							if > RL but ≤ 10X MB J+
							if > 10X MB No action
Field Duplicate	All Analyses	All Methods	A minimum of 1 per 20 primary samples collected or 1 per sampling event, whichever is more frequent	≤ 20% RPD or Delta < RL	Both original and duplicate result ≥ 5X RL and RPD ≤ method criteria	No action	No action
					Both original and duplicate result ≥ 5X RL and RPD > method criteria	UJ	J
					Original or duplicate result, or both, < 5X RL and the absolute difference between the two results is < RL	No action	No action
					Original or duplicate result, or both, < 5X RL and the absolute difference between the two results is ≥ RL	UJ	J

[1]Laboratory Frequency and control limits are based on EPA Methods. For analyses performed by standard methods frequency and control limits are based on Pace Analytical SOPs.

[2]If frequency is not met, professional judgement is used. The validator investigates why the frequency criteria was not met and the impact on the sample results.

[3]MS/MSD recovery criteria is waived if the parent sample concentration is ≥ 4X she spike concentration.

Table 13 - Summary of Status Assignment
(Enforcement/Screening/Unusable)

Data Validation Qualifier	**Level A/B Designation**		
	Level B	*Level A*	*Rejected*
No Qualifier or U	Enforcement	Screening	Unusable
J or UJ	Screening	Screening	Unusable
R	Unusable	Unusable	Unusable

FIGURES

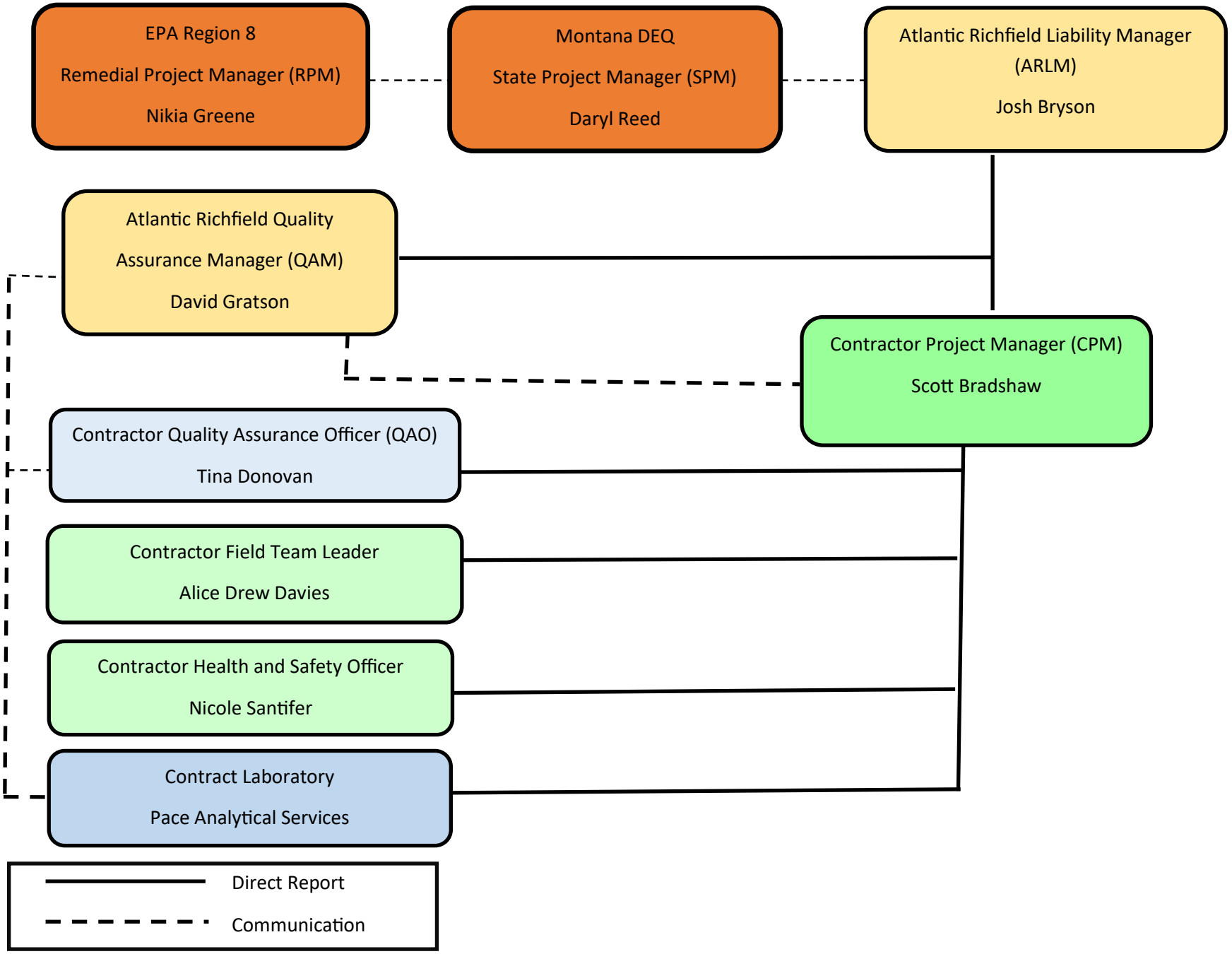

Figure 1—BPSOU Groundwater Monitoring Team Organization

Atlantic Richfield Company
A BP affiliated company

2022 Groundwater Quality Assurance Project Plan

Butte Priority Soils Operable Unit

Groundwater Quality Monitoring Areas Of Concern - Figure 2

N

Legend

Points of Compliance
- Semi-Annual Well - POC

LAO Capture System
- Semi-Annual Well
- Five Year Well

Area Between Capture Systems
- Semi-Annual Well
- Five Year Well

BPSOU Subdrain Capture System
- Semi-Annual Well
- Annual Well
- Five Year Well

- Wells Impacted by Parrot Tailings Removal
- Alluvial Potentiometric Surface September 2020 (NAVD88)
- BPSOU Boundary
- Alluvial TI Zone - ROD
- Controlled Groundwater Area Boundary - CGWA

250 125 0 250 500 750 Feet

TREC, Inc.
Engineering & Environmental Management
A Woodard & Curran Company

Project #: 0231348.02
Map Created: November 2021

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A BP affiliated company

2022 Groundwater Quality Assurance Project Plan

Butte Priority Soils Operable Unit

Groundwater Level Monitoring Network - Figure 3

N

Legend

- Monthly Monitoring
- Continuous Monitoring
- MBMG BMFOU Monitoring
- Wells impacted by Parrott Tailings Removal
- Alluvial Potentiometric Surface September 2020 (NAVD88)
- Alluvial TI Zone - ROD
- Controlled Groundwater Area Boundary - CGWA
- BPSOU Boundary

250 125 0 250 500 750 Feet

TREC, Inc.
Engineering & Environmental Management
A Woodard & Curran Company

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Map Created: Nov 2021

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2022 Groundwater Quality Assurance Project Plan

Butte Priority Soils Operable Unit

Groundwater Quality Monitoring Network - Figure 4

N

Legend

- Semi-Annual Well
- Annual Well
- Five Year Well
- Wells impacted by Parrott Tailings Removal
- Alluvial Potentiometric Surface September 2020 (NAVD88)
- Alluvial TI Zone - ROD
- Controlled Groundwater Area Boundary - CGWA
- BPSOU Boundary

250 125 0 250 500 750 Feet

TREC, Inc.
Engineering & Environmental Management
A Woodard & Curran Company

Project #: 0231348.02
Map Created: November 2021

APPENDICES

APPENDIX A

TREC, Inc. Data Validation Guidelines for Inorganic Chemistry

DATA VALIDAITON GUIDELINES FOR

INORGANIC CHEMISTRY

TREC, Inc.
A WOODARD & CURRAN COMPANY

July 2021

SIGN-OFF PAGE

TREC, Inc. Standard Operating Procedure for Validation of Inorganic Analytical Data
Revision 1

Accepted: Date:
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Accepted: Date:
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Accepted: Date:
Nadia Reed, TREC, Inc.

Accepted: Date:
Wayne Cummings, TREC, Inc.

Accepted: Date:

Accepted: Date:

Accepted: Date:

Accepted: Date:

DISTRIBUTION LIST

Data Validation Guidelines for Inorganic Chemistry, July 2021

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REVISION SUMMARY

Revision No.	Author	Version	Description	Date
0	TREC, Inc., JJ	1	SOP Validation of Inorganic Chemistry Data for CFRSSI 2014, aligns with Jan 2010 NFG	1st QTR 2014
1	TREC, Inc., JJ	2	SOP Validation of Inorganic Chemistry Data for CFRSSI 2015, aligns with Jan 2010 NFG	1st QTR 2015
2	TREC, Inc., JJ	3	SOP Validation of Inorganic Chemistry Data for CFRSSI 2016, aligns with Aug 2014 NFG	1st QTR 2016
3	TREC, Inc., JJ	4	SOP Validation of Inorganic Chemistry Data for CFRSSI 2017, aligns with Jan 2017 NFG	1st QTR 2017
4	TREC, Inc., JG	5	SOP Validation of Inorganic Chemistry Data for CFRSSI 2018, aligns with Jan 2017 NFG	1st QTR 2018
5	TREC, Inc. TD	6	SOP for Inorganic Chemistry Data Validation Aligns with method requirements, generally follows 2017 NFG guidance	March 2019
6	TREC, Inc. TD	7	Same as above, found mistakes in several tables, corrected and re-distributed	October 2019
7	TREC, Inc. TD	8	Corrected editorial mistakes, renamed the document as “Guidelines” rather than an SOP	February 2020
8	TREC, Inc. TD	8	Removed sections referencing project QAPP locations Removed detailed instructions on setting up field QC files Revised links to DV checklists and removed all but two of the links Changed MS/MSD acceptance criteria for EPA 300.0 from 90-110% to 80-120%. Added detail about assessing matrix similarity for lab duplicates and lab MS/MSD samples Added detail about assessing matrix similarity for field duplicate qualifications. Revised guidelines for assessing FB detections compared to MB detections. Revised to state that when there is both a FB and MB detection, and the FB detection is > the MB detection, the FB should be qualified for the	January 2021

Revision No.	Author	Version	Description	Date
			MB detection. Professional judgement should be used in qualifying the FB for a MB detection if the FB result is significantly higher than the MB result and the MB result is ≤ 2X MDL. Added a section about checking for obvious mis-labeling (poor duplicate precision, FB parameters all have detections, other sample all non-detects). Added several checks to final review	
9	TREC Inc, TD	9	Based on Nov 2020 revision of NFG. ion of NFG. Lab blanks, changed blank result <(-2XMDL) to blank result ≤ (-RL). Changed sample result to non-detect qualify UJ, detect qualify J- Changed temperature criteria. Analyses with temperature criteria, samples received >6ºC but <10ºC qualify J or UJ (non-detects). Samples received >10ºC qualify J- or UJ (non-detects). Changed EPA 300.0 MS recovery criteria to 80-120% Added LCS, MS, duplicate criteria for EPA 300.1, Rev 1, 1999	

LIST OF ACRONYMS AND ABBREVIATIONS

% D	percent difference
% R	percent recovery
°C	degrees Celsius
1.5X	1.5 times
10X	10 times
2X	2 times
5X	5 times
ACM	Anaconda Mining Company
AES	atomic emission spectrometry
AMU	atomic mass unit
As	arsenic
ASTM	American Society of Testing and Materials
Ba	barium
BP	British Petroleum
BPSOU	Butte Priority Soils Operable Unit
CCB	cross contamination blank
CCB	continuing calibration blank
CCV	continuing calibration verification
Cd	cadmium
Cl	chloride
COC	chain of custody
COD	chemical oxygen demand
Cr	chromium
CRDL	contract required detection limit
Cs	cesium
Cu	copper
CVAA	cold vapor atomic absorption
D	duplicate sample
DAR	data assessment report
DF	dilution factor
DI	deionized water
DM	data management
DOC	dissolved organic carbon
DSR	data summary report
DST	data summary table
DV	data validation
DVS	data validation spreadsheet
ECB	equipment contamination blank
F	fluoride
FB	field blank
Full	Full data package

LIST OF ACRONYMS AND ABBREVIATIONS

GW	groundwater
GWQC	groundwater quality control sample
HNO3	nitric acid
HT	holding time
I	initial sample result
ICB	initial calibration blank
ICP	inductively coupled plasma
ICV	initial calibration verification
ID	identification
ISC	interference check sample
J	estimated
J-	estimated low
J+	estimated high
L	Limited data package
L+	Limited plus data package
LaMP	laboratory management program
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
LDS	laboratory duplicate sample
LFB	laboratory fortified blank
LIMS	laboratory information management system
MB	method blank
MDL	method detection limit
Mn	manganese
Mo	molybdenum
MS	matrix spike
MSD	matrix spike duplicate
NH3	ammonia
Ni	nickel
NO2	nitrite
NO3	nitrate
ORP	oxidation reduction potential
Pb	lead
PDS	post digestion spike
QAPP	quality assurance project plan
QC	quality control
R	rejected
Rb	rubidium
RB	rinsate blank
RL	reporting level
RSD	relative standard deviation

LIST OF ACRONYMS AND ABBREVIATIONS

S	serial dilution result
S	primary sample
SA	spike added
Sb	antimony
SC	specific conductivity
SD	serial dilution
SDG	sample delivery group
SM	standard method
SO4	sulfate
SOP	standard operating procedure
SR	sample result
SSR	spiked sample result
SW	surface water
SWQC	surface water quality control sample
TB	trip blank
TDS	total dissolved solids
TKN	total Kjeldahl nitrogen
TOC	total organic carbon
TSS	total suspended solids
U	non-detect
U	uranium
UJ	estimated non-detect
USEPA	United States Environmental Protection Agency
WO	work order
Zn	zinc
SA	spike added
Sb	antimony
SC	specific conductivity
SD	serial dilution
SDG	sample delivery group
SM	standard method
SO4	sulfate
SOP	standard operating procedure
SR	sample result
SSR	spiked sample result
SW	surface water
SWQC	surface water quality control sample
TB	trip blank
TDS	total dissolved solids
TKN	total Kjeldahl nitrogen
TOC	total organic carbon

LIST OF ACRONYMS AND ABBREVIATIONS

TSS	total suspended solids
U	non-detect
U	uranium
UJ	estimated non-detect
USEPA	United States Environmental Protection Agency
WO	work order
Zn	zinc

1.0 PREPARATION

1.1 Review Guidance Documents

The main document that will guide project specific data validation is the applicable project QAPP. Each QAPP contains a table(s) of required laboratory calibration and quality control limits. Determine which QAPP applies and review it.

In addition to the QAPPs, general validation guidance documents can be consulted. Either print a copy of each guidance document listed below or open the documents and refer to an electronic version. Find digital copies of each of these documents here:

Location:
\\woodardcurran.net\shared\Offices\Bozeman\BUTTE\TREC\ARCO\DataValidation\Docs\
CFRSSI Data Validation/Data Management (DV/DM) Plan
File:
CFRSS DVDM Rev2.pdf
CFRSSI DV/DM Plan Addendum

File:
DVDM Plan Addendum.PDF

The USEPA National Functional Guidelines (NFGs) can be used as a general guidance document; but, be aware that the limits within the NFGs are not necessarily applicable to the analytical methods used for the data that is being validated. This is only a general guidance document. Also note that NFGs are periodically updated (every 1-4 years) and the most recent version of NFGs should be referenced.

USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Superfund Data Review (November 2020):

File:
\\woodardcurran.net\shared\Offices\Bozeman\BUTTE\TREC\ARCO\DataValidation\Docs\Guidance Docs\nfg_for_inorganic_superfund_methods_data_review_november_2020.pdf

BP Laboratory Management Program (LaMP) Technical Requirements (serves as the Statement of Work for BP contract laboratories). This data validation SOP has been written to be in compliance with BP's LaMP Technical Requirements. The BP LaMP Technical Requirements are applicable only to Atlantic Richfield, or BP, data.

File:

BP_LaMP Tech Requirements2017.pdf

1.2 File Set-up

Open the laboratory report, which is a PDF file that the analytical laboratory provides to the client, or the client's contractor. A Limited (L) laboratory package includes a cover letter, sample summary, lab case

narrative, sample report forms, lab quality control (QC) results, chain-of-custody, sample receipt forms, and any additional custody documentation (i.e. emails between samplers and the lab). Note that Limited data packages may also be referred to as standard data packages. A Limited Plus (L+) package contains laboratory calibration data and laboratory quality control sample results, as well as preparation logs and analysis run logs. Full laboratory packages contain all elements of Limited Plus packages and the full analytical run. The name of the laboratory report file matches that of the Sample Delivery Group (SDG) or work order (WO) number. SDG is a unit used to identify groups of samples inclusive under one (or more) Chain-of-Custody (COC). One Data Validation Checklist will be completed for each SDG. Checklists may be Level 2a (L package), Level 2b (Full package), Level 3 (Full package), or Level 4 (Full package). Project-specific checklist templates have been created.

Retrieve the data set to be validated using the appropriate Data Validation (DV) entry template. Immediately rename the template using the proper naming convention, then populate the file.

The data validation checklist guides the validation process and these checklists are completed as the validator goes through the data packages. Open the appropriate data validation checklist template and save it to the appropriate folder using an intuitive file naming convention.

2.0 HOLDING TIME AND SAMPLE PREPARATION

2.1 Check Holding Times

Check the holding time for each data point. This is performed in Excel by subtracting the sample collection date/time from the sample analysis date/time. Use the values in the DV entry file. The narrative within the laboratory report will also note any holding time violations and a laboratory qualifier will be applied.

Method specific holding times are listed below in Table 1– Holding Times and Preservation Requirements for typical analyses. A more thorough list of holding times can be found in Appendix B of these guidelines. Note: Because HTs are analyte and method specific, the method of sample analysis must match that listed in the raw data deliverable. If the methods differ, and it is not listed in Table 1, look it up for that specified method Analytical method descriptions are found here:

Location:

\\woodardcurran.net\shared\Offices\Bozeman\TREC Files\Reference_Regs_Specs\EnvironmtlMonitoring\Methods_InorgChem\

Holding times can be found within the methods, and within Pace analytical SOPS, which are located here:

Location:

\\woodardcurran.net\shared\Offices\Bozeman\BUTTE\TREC\ARCO\PaceLabs\Pace SOPs_2018_09\

The file at the link below is a comprehensive list of holding times.

File:

Preservation_Holding_Time.pdf

Location:

\\woodardcurran.net\shared\Offices\Bozeman\BUTTE\TREC\ARCO\DataValidation\Docs\Methods\

Table 1– Holding Times and Preservation Requirements

Analyte	Method	Holding Time	Preservative
Alkalinity: Total, Carbonate, Bicarbonate, & Hydroxide	SM 2320B	14 days	Raw 0-6°C
Anions by Chromatography (bromide, chloride, fluoride, sulfate)	EPA 300.0	28 days	Raw 0-6°C
Anions by Chromatography (orthophosphate-P, nitrate, nitrite)	EPA 300.0	48 hours	Raw 0-6°C
Chloride	SM4500-Cl C	28 days	Raw 0-6°C
Sulfate	ASTMD 516	28 days	Raw 0-6°C
Dissolved Organic Carbon/Total Organic Carbon (DOC/TOC)	SM 5310 C	28 days	H_2SO_4 < pH 2 0-6°C
Hardness[1]	SM 2340B	180 days	HNO_3 < pH 2
Mercury (aqueous) total and dissolved by CVAA	EPA 245.1, SW846 7470	28 days	HNO_3 < pH 2
Metals (aqueous) total and dissolved by ICP-AES	EPA 200.7, SW846 6010	180 days	HNO_3 < pH 2
Metals (aqueous) total and dissolved by ICP-MS	EPA 200.8, SW846 6020, 6020A, 6020B,	180 days	HNO_3 < pH 2
Metals (aqueous) - Dissolved Exotic by ICP-MS (Cs & Rb)	SW6020A_E	180 days	HNO_3 < pH 2
Nitrogen - Ammonia	**EPA 350.1** SM 4500-NH3 B/C	28 days	H_2SO_4 < pH 2 0-6°C
Nitrogen - NO_2/NO_3	**SM 4500-NO3 H** SM 4500-NO3 E SM 4500-NO2 B	28 days	H_2SO_4 < pH 2 0-6°C
Nitrogen - Total Kjeldahl Nitrogen	**EPA 351.2** SM 4500-Norg B	28 days	H_2SO_4 < pH 2 0-6°C

Analyte	Method	Holding Time	Preservative
pH	EPA 150.1	24 hours	Raw 0-6°C
Solids - Total Dissolved Solids	SM 2540C	7 days	Raw 0-6°C
Solids - Total Suspended Solids	SM 2540D	7 days	Raw 0-6°C
Specific Conductivity	SM 2510B	28 days	Raw 0-6°C
Total Metals in Solids by ICP-MS (Sb, As, Ba, Cd, Cr, Cu, Pb, Mn, Mo, Ni, U, & Zn)	SW6020	180 days	None 0-6°C
Mercury in solids	SW846 7471B	28 days	None 0-6°C
Phosphorus - Total/Dissolved	**SM 4500P-B**/E	28 days	H_2SO_4 < pH 2 0-6°C

2.2 Assign Data Qualifiers for Exceeded Holding Times

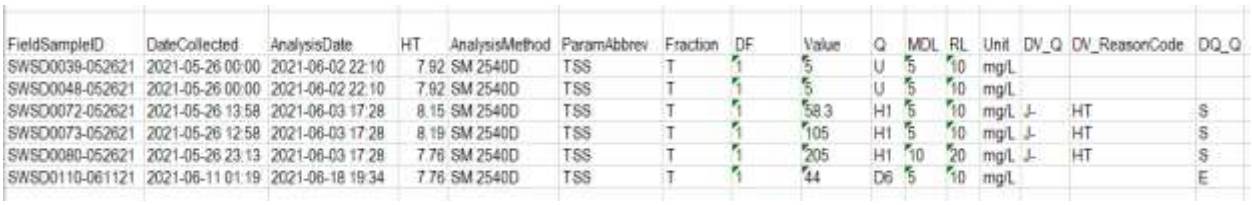
Assign data qualifiers for exceeding holding times using Table 2. With each data qualifier assigned, include reason code "HT" (see narrative below as well as Figure 1). When using the calculation within the DV entry file, be aware that holding time is not exceeded at 0.1 days past holding time. For example, holding time for total dissolved solids (TDS) is 7 days. A sample that is analyzed at 7.1 days has not exceeded holding time. A sample that is analyzed at 8.00 days has exceeded holding time. Both collection data and time need to be considered.

Use "professional judgment" when assigning data qualifiers based on holding time exceedances. The interpretation of "professional judgment" for the purpose of this SOP is that before a data point is rejected (R), there must be substantial evidence supporting the rejection. For holding times ≤ 14 days, a 2x the recommended holding time limit may be applied. For example, pH (24-hour holding time) analyzed at 47 hours warrants a J- qualifier where pH analyzed at 49 hours warrants an R qualifier. For analyses with 28 – 180 day holding times, the 2x recommended holding time limit is not applicable. You would instead research as to why the holding times were exceeded (sometimes in the case narrative or sample receipt forms) and how the analyte concentration might be affected outside of holding time. If there is no explanation for a holding time exceedance, analyses 10 days to two weeks past the recommended holding time may warrant rejection. For example, total mercury analyzed at 35 days warrants a J- qualifier where total mercury analyzed at 45-days warrants an R qualifier.

Table 2 - Holding Time Action

Holding Time (HT) Result	Action for Samples
< Recommended HT	No Action
> Recommended HT	Qualify results that are ≥ MDL as estimated low (J-) Qualify non-detects as estimated (UJ)
>2X HT	Qualify all results unusable (R)

Figure 1 Holding Time Action Example



FieldSampleID	DateCollected	AnalysisDate	HT	AnalysisMethod	ParamAbbrev	Fraction	DF	Value	Q	MDL	RL	Unit	DV_Q	DV_ReasonCode	DQ_Q
SWSD0039-052621	2021-05-26 00:00	2021-06-02 22:10	7.92	SM 2540D	TSS	T	1	5	U	5	10	mg/L			
SWSD0048-052621	2021-05-26 00:00	2021-06-02 22:10	7.92	SM 2540D	TSS	T	1	5	U	5	10	mg/L			
SWSD0072-052621	2021-05-26 13:58	2021-06-03 17:28	8.15	SM 2540D	TSS	T	1	58.3	H1	5	10	mg/L	J-	HT	S
SWSD0073-052621	2021-05-26 12:58	2021-06-03 17:28	8.19	SM 2540D	TSS	T	1	105	H1	5	10	mg/L	J-	HT	S
SWSD0080-052621	2021-05-26 23:13	2021-06-03 17:28	7.76	SM 2540D	TSS	T	1	205	H1	10	20	mg/L	J-	HT	S
SWSD0110-061121	2021-06-11 01:19	2021-06-18 19:34	7.76	SM 2540D	TSS	T	1	44	D6	5	10	mg/L			E

2.3 Verify Proper Sample Preservation

Verify that samples were properly preserved, received at the proper temperature, and filtered as required. You can find this information in the sample condition upon receipt (SCUR) form that follows the chain of custody within the laboratory report. Note that dissolved metals, mercury, and dissolved organic carbon samples must be field filtered with a 0.45 µm filter. If field filtering is not possible, preservative should not be added to the sample until it has been filtered.

2.4 Assign Data Qualifiers for Incorrect Sample Preservation

Assign data qualifiers for incorrect sample preservation using Table 3 - and applying reason code "IP". The actions apply to samples that have preservative and temperature criteria.

Table 3 - Preservation Action

Result	Action for Samples
Aqueous samples received with pH > 2 and pH not adjusted	Qualify results that are ≥ MDL as estimated low **(J-)** Qualify non-detects as estimated (UJ)
Aqueous or soil/sediment samples that are received >6ºC but ≤ 10ºC	Qualify results that are ≥ MDL as estimated **(J)** Qualify non-detects as estimated (UJ)
Aqueous or soil/sediment samples that are received >10ºC	Qualify results that are ≥ MDL as estimated low **(J-)** Qualify non-detects as estimated (UJ)

3.0 LABORATORY DATA VALIDATION

3.1 Read Laboratory Case Narrative

Read the laboratory cover letter and case narrative found in the (pdf) raw data deliverable. The case narrative will give insight to problems the laboratory had when running analyses (or lack thereof).

3.2 Check Sample ID Numbers

Upon database import, sample ID numbers, sample dates, and sample times in the laboratory EDD are checked for consistency with what is listed on the chain-of-custody. If there is a discrepancy, the laboratory is notified and must submit a revised report with correct sample IDs. The data team performs this task.

3.3 Verify Laboratory Quality Control (QC) Parameters.

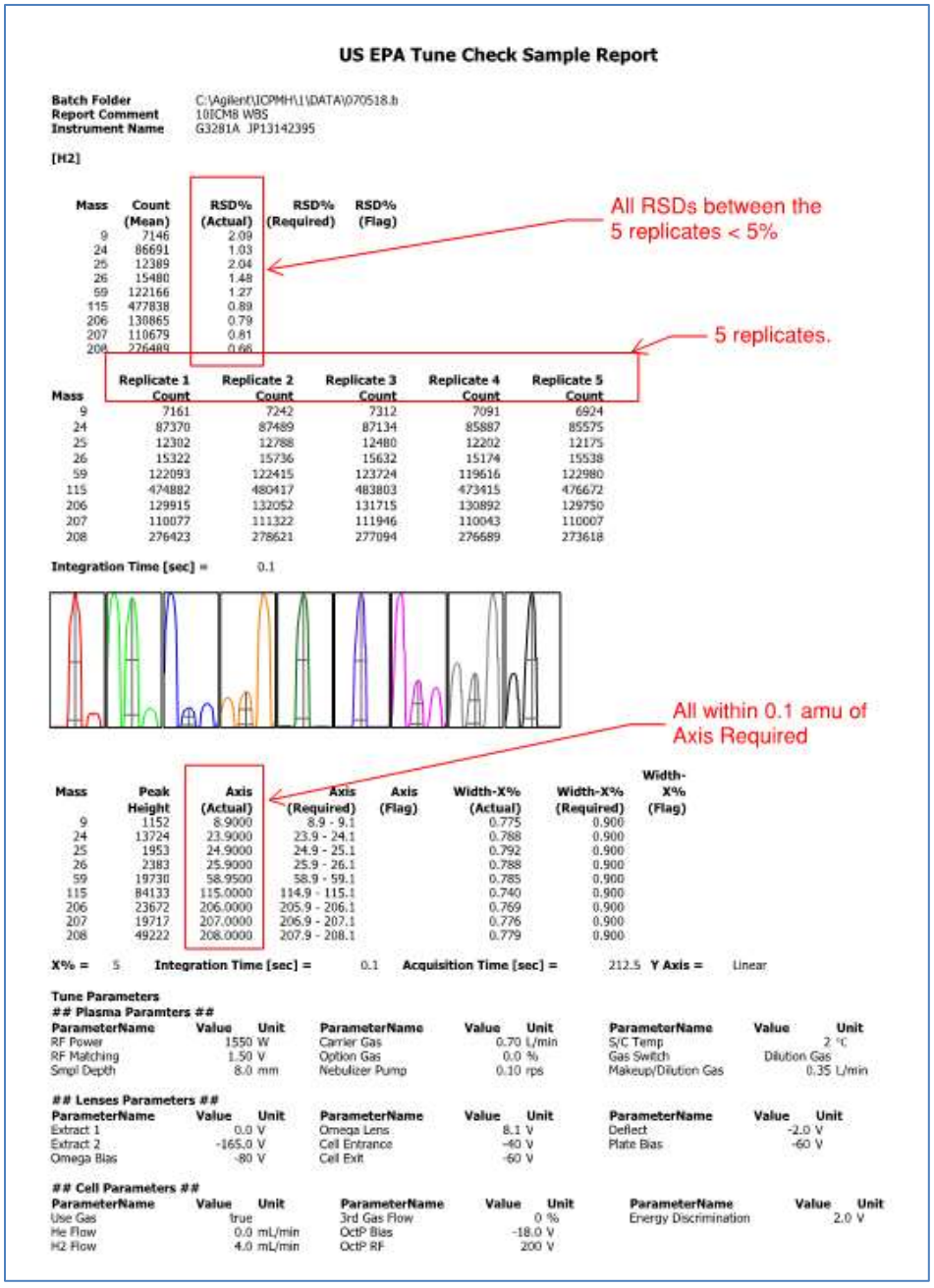
The laboratory must adhere to method requirements for all calibrations and quality control (QC) samples. Calibration steps, calibration limits, and QC sample frequency and limits vary depending on the method. This section first explains laboratory calibration and QC samples and then explains the actions for out-of-compliance calibration or QC samples. Next calibration and QC sample control limits for individual analyses are provided. Several parameters can be analyzed by more than one analytical method, and it is not uncommon for differing methods to have different limits. Thus, within each analytical parameter listed below, more than one method may be listed. The information provided in laboratory reports differs depending on the report level. The tables below indicate which data are reported in Limited, Limited Plus, and Full laboratory packages.

Be aware that samples within a sample delivery group are not necessarily analyzed in a single batch. A laboratory QC batch can consist of up to 20 samples, thus, if more than 20 samples are submitted, samples will be associated with more than one QC batch. Samples within a single SDG may also be broken into more than one batch when fewer than 20 samples are submitted. This is common with total dissolved solids (TDS) and total suspended solids (TSS) analyses. Be certain that validation qualifiers are applied only to samples in the QC batch that is associated with the qualifier.

3.3.1 Instrument Tune

Instrument tuning is applicable only to ICP-MS analyses (SW846 6020 series and EPA 200.8). Prior to calibration, the ICP-MS tuning solution is analyzed. The tune solution contains a range of isotope masses and it establishes instrument accuracy, resolution, and precision prior to calibration. The tune solution must be analyzed five times, consecutively. Any necessary adjustments are made to bring the peak width within the manufacturer's specifications and to adjust the resolution of the mass calibration to within 0.1 atomic mass unit (amu) over a specified amu range. The percent relative standard deviation (RSD) of the absolute signals for all target analytes in the tuning solution must but be ≤ 5%. An example tune report is presented in Figure 2. Tune criteria and corrective actions can be found in Table 4 and Table 5, respectively.

Figure 2 – Example Tune Report



US EPA Tune Check Sample Report

Batch Folder C:\Agilent\ICPMH\1\DATA\070518.b
Report Comment 10ICM8 WBS
Instrument Name G3281A JP13142395

[H2]

Mass	Count (Mean)	RSD% (Actual)	RSD% (Required)	RSD% (Flag)
9	7146	2.09		
24	86691	1.03		
25	12389	2.04		
26	15480	1.48		
59	122166	1.27		
115	477838	0.89		
206	130865	0.79		
207	110679	0.81		
208	276489	0.66		

All RSDs between the 5 replicates < 5%

5 replicates.

Mass	Replicate 1 Count	Replicate 2 Count	Replicate 3 Count	Replicate 4 Count	Replicate 5 Count
9	7161	7242	7312	7091	6924
24	87370	87489	87134	85887	85575
25	12302	12788	12480	12202	12175
26	15322	15736	15632	15174	15538
59	122093	122415	123724	119616	122980
115	474882	480417	483803	473415	476672
206	129915	132052	131715	130892	129750
207	110077	111322	111946	110043	110007
208	276423	278621	277094	276689	273618

Integration Time [sec] = 0.1

All within 0.1 amu of Axis Required

Mass	Peak Height	Axis (Actual)	Axis (Required)	Axis (Flag)	Width-X% (Actual)	Width-X% (Required)	Width-X% (Flag)
9	1152	8.9000	8.9 - 9.1		0.775	0.900	
24	13724	23.9000	23.9 - 24.1		0.788	0.900	
25	1953	24.9000	24.9 - 25.1		0.792	0.900	
26	2383	25.9000	25.9 - 26.1		0.788	0.900	
59	19730	58.9500	58.9 - 59.1		0.785	0.900	
115	84133	115.0000	114.9 - 115.1		0.740	0.900	
206	23672	206.0000	205.9 - 206.1		0.769	0.900	
207	19717	207.0000	206.9 - 207.1		0.776	0.900	
208	49222	208.0000	207.9 - 208.1		0.779	0.900	

X% = 5 **Integration Time [sec] =** 0.1 **Acquisition Time [sec] =** 212.5 **Y Axis =** Linear

Tune Parameters

Plasma Paramters

ParameterName	Value	Unit	ParameterName	Value	Unit	ParameterName	Value	Unit
RF Power	1550	W	Carrier Gas	0.70	L/min	S/C Temp	2	°C
RF Matching	1.50	V	Option Gas	0.0	%	Gas Switch	Dilution Gas	
Smpl Depth	8.0	mm	Nebulizer Pump	0.10	rps	Makeup/Dilution Gas	0.35	L/min

Lenses Parameters

ParameterName	Value	Unit	ParameterName	Value	Unit	ParameterName	Value	Unit
Extract 1	0.0	V	Omega Lens	8.1	V	Deflect	-2.0	V
Extract 2	-165.0	V	Cell Entrance	-40	V	Plate Bias	-60	V
Omega Bias	-80	V	Cell Exit	-60	V			

Cell Parameters

ParameterName	Value	Unit	ParameterName	Value	Unit	ParameterName	Value	Unit
Use Gas	true		3rd Gas Flow	0	%	Energy Discrimination	2.0	V
He Flow	0.0	mL/min	OctP Bias	-18.0	V			
H2 Flow	4.0	mL/min	OctP RF	200	V			

Table 4 – ICP MS Tune Criteria

Calibration Step[1]	Method	Frequency	Control Limits
Tune	SW846 6020 SW846 6020A SW846 6020B EPA 200.8	Prior to calibration	Tune solution analyzed five times, consecutively Mass calibration within 0.1 amu % RSD of absolute signals < 5%

[1]Reported in Full packages

Table 5 – ICP MS Tune Actions

Calibration Step[1]	Method	Tune Result	Action for Samples	Qualifier Code
Instrument Tune	SW846 6020 SW846 6020A SW846 6020B EPA 200.8	Not performed	Qualify all data as unusable (R)	Tune
		5 consecutive analyses of tune solution not performed	Use professional judgement. At a minimum qualify detects as estimated (J) and non-detects as estimated non-detect (UJ)	Tune
		Mass calibration resolution not within 0.1 amu	Qualify detects as estimated (J) Qualify non-detects as estimated non-detect (UJ)	Tune
		> 5% RSD	Qualify detects as estimated (J) Qualify non-detects as estimated non-detect (UJ)	Tune

3.3.2 Laboratory Calibration Data

Calibration data are provided in L+ and Full laboratory reports. A calibration curve is established with a blank and various standards. The calibration curve fit is a linear regression of results for the blank and calibration standards. The calibration curve fit can be found at the beginning of the raw data in Full laboratory reports only. Table 6 specifies criteria for calibration curves, while Table 7 details corrective actions for out of compliance calibration curves.

Initial calibration verification (ICV) and continuing calibration verification (CCV) results are reported as percent recoveries (%R). These are determined by:

$$\%R = \frac{Found\ Value}{True\ Value}\ x\ 100$$

Figure 3 provides an example of ICV/CCV data reported by the laboratory. Note that several CCVs have > 110% recovery for Ca, Mg, Si, Na, and Zn. If this occurs, consult the analysis run log, which is provided in Figure 4. The out of compliance CCV is highlighted in Figure 4. Five samples were run between the out of compliance CCV and the next in compliance CCV. However, Ca, Mg, Si, Na, and Zn results were not reported from that run sequence, but from a later run sequence. Thus, these sample results should not be qualified.

Figure 3 - ICV/CCV Example from Full Laboratory Package

FORM II INORGANIC-2
INITIAL AND CONTINUING CALIBRATION VERIFICATION

Lab Name: Pace Analytical - Minnesota SDG No. : 10443691 Contract: Rocker

Initial Calibration Verification Source:

Continuing Calibration Verification Source: 174801

Concentration Units: ug/L Instrument ID: 10ICM3

	Continuing Calibration Verification									
	09/05/2018 00:10			09/05/2018 00:50			09/05/2018 01:29			Control Limit
Analyte	True	Found	%R	True	Found	%R	True	Found	%R	
Arsenic	80	86.8	108.6	80	86.7	108.4	80	86.2	107.8	90-110
Cadmium	80	84.6	105.8	80	84.1	105.1	80	84.0	105.0	90-110
Calcium	1000	1180	117.7	1000	1180	117.5	1000	1130	112.9	90-110
Copper	80	87.0	108.8	80	87.8	109.8	80	86.7	108.4	90-110
Iron	1000	1100	109.5	1000	1070	107.2	1000	1080	107.8	90-110
Lead	80	84.9	106.1	80	84.0	105.0	80	84.0	105.1	90-110
Magnesium	1000	1140	113.7	1000	1110	110.6	1000	1130	112.6	90-110
Manganese	80	87.2	109.0	80	85.8	107.2	80	85.7	107.2	90-110
Potassium	1000	1090	109.3	1000	1080	107.7	1000	1060	106.4	90-110
Silicon	1000	1170	117.4	1000	1100	110.3	1000	1120	112.2	90-110
Sodium	1000	1100	110.5	1000	1100	110.4	1000	1070	107.4	90-110
Zinc	80	88.5	110.6	80	87.9	109.9	80	87.5	109.4	90-110

Figure 4 – Analysis Run Log Example from Full Laboratory Package

FORM XIII INORGANIC-1
ANALYSIS RUN LOG

Lab Name: Pace Analytical - Minnesota SDG No. : 10443691 Contract: Rocker

Instrument ID: 10ICM3 Analysis Method: EPA 200.8

Start Date: 09/04/2018 22:03 End Date: 09/05/2018 02:17

Sample Name	Lab Sample ID	D/F	Date	Time	As	Ca	Cd	Cu	Fe	K	Mg	Mn	Na	Pb	Si	Zn
20496315CAL0	20496315CAL0	1	09/04/2018	22:03	X	X	X	X	X	X	X	X	X	X	X	X
20496316CAL1	20496316CAL1	1	09/04/2018	22:06	X	X	X	X	X	X	X	X	X	X	X	X
20496317CAL4	20496317CAL4	1	09/04/2018	22:10	X	X	X	X	X	X	X	X	X	X	X	X
20496318CAL5	20496318CAL5	1	09/04/2018	22:13	X	X	X	X	X	X	X	X	X	X	X	X
20496319CAL6	20496319CAL6	1	09/04/2018	22:17	X	X	X	X	X	X	X	X	X	X	X	X
20496320CAL2	20496320CAL2	1	09/04/2018	22:20	X	X	X	X	X	X	X	X	X	X	X	X
20496321CAL3	20496321CAL3	1	09/04/2018	22:24	X	X	X	X	X	X	X	X	X	X	X	X
20496322ICV	20496322ICV	1	09/04/2018	22:27	X	X	X	X	X	X	X	X	X	X	X	X
20496323ICB	20496323ICB	1	09/04/2018	22:34	X	X	X	X	X	X	X	X	X	X	X	X
20496326ICSA	20496326ICSA	1	09/04/2018	22:44	X	X	X	X	X	X	X	X	X	X	X	X
20496327ICSAB	20496327ICSAB	1	09/04/2018	22:48	X	X	X	X	X	X	X	X	X	X	X	X
20496328CCV	20496328CCV	1	09/04/2018	22:51	X	X	X	X	X	X	X	X	X	X	X	X
20496329CCB	20496329CCB	1	09/04/2018	22:58	X	X	X	X	X	X	X	X	X	X	X	X
20496330CCV	20496330CCV	1	09/04/2018	23:25	X	X	X	X	X	X	X	X	X	X	X	X
20496331CCB	20496331CCB	1	09/04/2018	23:29	X	X	X	X	X	X	X	X	X	X	X	X
20496332CRDL	20496332CRDL	1	09/04/2018	23:32	X	X	X	X	X	X	X	X	X	X	X	X
3028525BLANK	3028525	1	09/04/2018	23:36	X	X	X	X	X	X	X	X	X	X	X	X
PALMER-081318	10443691001	1	09/04/2018	23:39	X		X	X	X	X		X		X		
3038257SD	3038257	5	09/04/2018	23:42	X		X	X	X	X		X		X		
3028527MS	3028527	1	09/04/2018	23:49	X		X	X	X	X		X		X		
3028528MSD	3028528	1	09/04/2018	23:53	X		X	X	X	X		X		X		
3028526LCS	3028526	1	09/05/2018	00:07	X		X	X	X	X		X		X		
20496333CCV	20496333CCV	1	09/05/2018	00:10	X	X	X	X	X	X	X	X	X	X	X	X
20496334CCB	20496334CCB	1	09/05/2018	00:14	X	X	X	X	X	X	X	X	X	X	X	X
RH-06-081418	10443691008	1	09/05/2018	00:17	X		X	X	X	X		X		X		
RH-05-081418	10443691009	1	09/05/2018	00:20			X	X	X	X				X		
RH-47-081418	10443691010	1	09/05/2018	00:24	X		X	X	X	X				X		
RH-47D-081418	10443691011	1	09/05/2018	00:27	X		X	X	X	X				X		
3028529MS	3028529	1	09/05/2018	00:30	X		X	X	X	X				X		
MW-01-081418	10443691007	1	09/05/2018	00:44	X		X	X	X	X		X		X		
20496335CCV	20496335CCV	1	09/05/2018	00:50	X	X	X	X	X	X	X	X	X	X	X	X
20496336CCB	20496336CCB	1	09/05/2018	00:54	X	X	X	X	X	X	X	X	X	X	X	X
20496337CCV	20496337CCV	1	09/05/2018	01:29	X	X	X	X	X	X	X	X	X	X	X	X
20496338CCB	20496338CCB	1	09/05/2018	01:33	X	X	X	X	X	X	X	X	X	X	X	X
20496339CRDL	20496339CRDL	1	09/05/2018	01:36	X	X	X	X	X	X	X	X	X	X	X	X
20496340CCV	20496340CCV	1	09/05/2018	02:14	X	X	X	X	X	X	X	X	X	X	X	X
20496341CCB	20496341CCB	1	09/05/2018	02:17	X	X	X	X	X	X	X	X	X	X	X	X

No sample result should be reported between ICVs or CCVs which do not meet criteria, but before qualifying data based on ICV/CCV recoveries, consult the analysis run log to verify that sample results were reported between the out-of-control calibration standards. Table 6 provides calibration curve correlation requirements, as wells as ICV and CCV percent recovery criteria for differing analyses. Both

recovery and frequency criteria must be met. If frequency criteria were not met, qualify all affected results as estimated (J). Apply corrective actions in accordance with the rules in Table 7.

Table 6 – Calibration Criteria

Calibration Step	Analysis	Method	Frequency	Control Limits
Calibration Curve Fit	Mercury	SW846 7470 SW846 7470A EPA 245.1	At beginning of run	r ≥ 0.995
ICV			Immediately after instrument calibration and after a continuing calibration failure	90-110% of true value EPA 245.1 - 95-105%
CCV			Every ten samples, and after the last analytical sample	90-110% of true value
Calibration Curve Fit	Metals	SW846 6020 SW846 6020A SW846 6020B EPA 200.8	At beginning of run	r ≥ 0.998
ICV			Immediately after instrument calibration and after a continuing calibration failure	90-110% of true value
CCV			Every ten samples, and after the last analytical sample	90-110% of true value
Calibration Curve Fit	Metals	SW846 6010B SW846 6010C SW846 6010D EPA 200.7	At beginning of run	r ≥ 0.995
ICV			Immediately after instrument calibration and after a continuing calibration failure	90-110% of true value EPA 200.7 - 95-105%
CCV			Every ten samples, and after the last analytical sample	90-110% of true value SW846 6010B - The RSD of the CCV must be < 5%
Calibration Curve Fit	Alkalinity	SM 2320B	At beginning of run	slope 96-106% of true value
pH Calibration Check			Immediately after calibration of pH probe	± 0.10 pH units
ICV			Immediately after instrument calibration and after a continuing calibration failure	90-110% of true value

Calibration Step	Analysis	Method	Frequency	Control Limits
CCV			Every ten samples, and after the last analytical sample	90-110% of true value
Calibration Curve Fit	NH_3	EPA 350.1	At beginning of run	$r \geq 0.995$
ICV			Immediately after instrument calibration and after a continuing calibration failure	90-110% of true value
CCV			Every ten samples, and after the last analytical sample	90-110% of true value
Calibration Curve Fit	NO_2/NO_3	SM 4500 NO_3-H	At beginning of run	$r \geq 0.995$
ICV			Immediately after instrument calibration and after a continuing calibration failure	90-110% of true value
CCV			Every ten samples, and after the last analytical sample	90-110% of true value
Calibration Curve Fit	TKN	EPA 351.2	At beginning of run	$r \geq 0.995$
ICV			Immediately after instrument calibration and after a continuing calibration failure	90-110% of true value
CCV			Every ten samples, and after the last analytical sample	90-110% of true value
Calibration Curve Fit	DOC/TOC	SM 5310C	At beginning of run	$r \geq 0.995$
ICV			Immediately after instrument calibration and after a continuing calibration failure DOC/TOC analysis by SM 5310C calibration frequency is every six months or as needed. Thus ICV frequency may be six months.	90-110% of true value
High and Low Check Standards			Daily prior to sample analysis unless ICV is run that day.	90-110% of true value

Calibration Step	Analysis	Method	Frequency	Control Limits
CCV			Every ten samples, and after the last analytical sample	90-110% of true value
Calibration Curve Fit	Sulfate	ASTM D516-90	At beginning of run	r ≥ 0.990 Standard at or below RL must recover within 60-140% of true value
ICV			Immediately after instrument calibration and after a continuing calibration failure	80-120% of true value
CCV			Every ten samples, and after the last analytical sample	80-120% of true value
Calibration Curve Fit	Chloride	SM 4500-Cl E	At beginning of run	r ≥ 0.995
ICV			Immediately after instrument calibration and after a continuing calibration failure	90-110% of true value
CCV			Every ten samples, and after the last analytical sample	90-110% of true value
Calibration Curve Fit	Anions (Bromide, chloride, fluoride, sulfate)	EPA 300	At beginning of run	r ≥ 0.990 for each analyte
ICV			Immediately after instrument calibration and after a continuing calibration failure	90-110% of true value
CCV			Every ten samples, and after the last analytical sample	90-110% of true value
Calibration Curve Fit	Fluoride	SM 4500-F-C	At beginning of run	slope 90-110%
ICV			Immediately after instrument calibration and after a continuing calibration failure	90-110% of true value
CCV			Every ten samples, and after the last analytical sample	90-110% of true value
Calibration Curve Fit	Total Phosphorus	SM4500P-F	At beginning of run	r ≥ 0.995

Calibration Step	Analysis	Method	Frequency	Control Limits
ICV			Immediately after instrument calibration and after a continuing calibration failure	90-110% of true value
CCV			Every ten samples, and after the last analytical sample	90-110% of true value
Calibration Curve Fit	Chemical Oxygen Demand (COD)	SM 5220D EPA 410.4	At beginning of run	$r \geq 0.995$
ICV			Immediately after instrument calibration and after a continuing calibration failure	SM5220D - 95-105% EPA 410.4 - 90-10%
CCV			Every ten samples, and after the last analytical sample	SM5220D - 95-105% EPA 410.4 - 90-10%
Calibration Curve Fit	Orthophosphate-P	SM4500-P B/E	At beginning of run	$r \geq 0.995$
ICV			Immediately after instrument calibration and after a continuing calibration failure	90-110% of true value
CCV			Every ten samples, and after the last analytical sample	90-110% of true value
Calibration Curve Fit	Sulfide	SM4500-S^{2-}D	At beginning of run	$r \geq 0.995$
ICV			Immediately after instrument calibration and after a continuing calibration failure Sulfide analysis by SM4500-S^{2-}D calibration frequency is every six months or as needed. Thus ICV frequency may be six months.	90-110% of true value
High and Low calibration checks			Daily prior to sample analysis unless ICV is run that day.	90-110% of true value
CCV			Every ten samples, and after the last analytical sample	90-110% of true value

Table 7 - Calibration Action

Calibration Results	Calibration Criteria	Action for Samples	Qualifier Code
Calibration not performed		Qualify all results unusable **(R)**	CQ
Correlation coefficient < the method requirement	See Section 3.4 Tables	Qualify results that are ≥ MDL as estimated **(J)** Qualify non-detects as estimated (UJ)	CR
ICV/CCV %R < 67%	80-120%	Qualify results that are ≥ MDL as estimated low **(J**-) or unusable (R) Qualify non-detects as unusable (R) For both detects and non-detects use professional judgement	ICV/CCV
ICV/CCV %R < 75%	90-110%		
ICV/CCV %R < 79%	95-105%		
ICV/CCV %R 67-79%	80-120%	Qualify results that are ≥ MDL as estimated low **(J-)** Qualify non-detects as estimated (UJ)	ICV/CCV
ICV/CCV %R 75-89%	90-110%		
ICV/CCV %R 79-104%	95-105%		
ICV/CCV %R 121-	80-120%	Qualify results that are ≥ MDL as estimated high **(J+)** No action for non-detects	ICV/CCV
ICV/CCV %R 111-	90-110%		
ICV/CCV %R 106-119%	95-105%		
ICV/CCV %R > 136%	80-120%	Qualify results that are ≥ MDL as estimated high **(J+)** or unusable (R). Use professional judgement. No action for non-detects	ICV/CCV
ICV/CCV %R > 125%	90-110%		
ICV/CCV %R > 119%	95-105%		
ICV/CCV %R > 175%	80-120%	Qualify results that are ≥ MDL as unusable **(R)** No action for non-detects	ICV/CCV
ICV/CCV %R > 160%	90-110%		
ICV/CCV %R > 153%	95-105%		

3.3.3 Laboratory Blank Data

Ideally, all laboratory blanks including initial calibration blanks (ICBs), continuing calibration blanks (CCBs), method blanks (MBs) or preparation blanks (PBs), should be non-detect (U-flagged by the laboratory) or have a reported value ≤ MDL. MDL values are statistically calculated every 13 months at a minimum, and these may change year to year. When referencing laboratory QC requirements in project QAPPs, be aware that validation criteria for blanks differs from laboratory blank criteria. The validator assesses blanks to the MDL; whereas the laboratory blank criteria is a value < the RL or ≤ ½ the RL. Atlantic Richfield criteria is a value ≤ ½ RL. Were the laboratory to repeat an analysis until all blank results were non-detect, they could consume the entire client sample volume and be unable to perform laboratory QCs such as a matrix spike or duplicate sample.

All laboratory analyses require a MB (can also be identified as a preparation blank) at a frequency of one MB per batch of 20 or fewer samples. All analyses which require calibrations (calibration samples are not applicable to solids determinations, i.e. TDS and TSS) the laboratory must analyze an ICB at the beginning of the analytical run, immediately after the ICV, and a CCB every ten samples, immediately after the CCV. Ensure that the required frequency was met when assessing laboratory blank results; and qualify affected data as estimated (J) if the frequency was not met.

Where there are positive and negative blank detections, qualification is assigned based on the highest absolute blank value. Once a data validation qualifier has been applied, add reason code "ICB", "CCB", or "MB" as appropriate. For laboratory ICB/CCB results > than laboratory criteria, analysis should have been terminated, and the contamination source determined and corrected. If necessary, the instrument should have been recalibrated and any sample analyzed since the last in-control blank should have been re-analyzed. When assessing ICB/CCB results, ensure that sample results were reported between out of control blank detections. For method blank detections > criteria, each sample result <10x the blank value should have been re-digested (if applicable) and reanalyzed. If sample results are non-detect, this is not required. If re-analysis was not possible (sample volume was consumed), the sample results should be qualified. To assign qualification to sample results based on a laboratory blank detection, the instrument value must be used. The instrument value is calculated by dividing the sample result by the dilution factor.

Although sample results are assessed in comparison to laboratory blank results, a laboratory blank result should never be substituted for the MDL. A laboratory blank result is a single result at a single point in time; whereas MDLs are determined by a statistical process every thirteen months, at a minimum. MDLs are determined by analyzing a minimum of seven spiked samples and seven blank samples in at least three batches on three separate calendar days, with the analyses spread across all instruments to which the MDL will be applied. Statistical analysis is then applied to the sample results to determine the MDL.

Table 8 – Laboratory Blank Action

Lab Blank Result	Sample Results	Action for Samples
≥ MDL, but ≤ 1.5x MDL	Non-detect (< MDL)	No action
	> MDL, but ≤ RL	No action
	> RL	No action
> 1.5x MDL	Non-detect (< MDL)	No action
	≥ MDL, but ≤ RL	Qualify results as estimated non-detect (UJ)
	> RL, but ≤ 10x blank	Qualify results as estimated high (J+)
	>10x blank value	No action
> RL	See action above for 1.5x MDL value. If any sample results are > MDL and < 10x the blank value, note in the Data Validation Summary that the laboratory failed to re-digest (if applicable) and reanalyze the affected samples. Reanalysis is not required for sample results < MDL or > 10X the blank detection.	
≤ (-RL)	Non-detect (< MDL)	Qualify results as estimated (UJ)
	Detect <10x RL	Qualify results as estimated low (J-)

Lab Blank Result Lab Sample	Sample Results Report Level	Action for Samples Frequency[1]
ICB	L+, Full	At beginning of analytical run, immediately after ICV
CCB	L+, Full	One in every 10 samples, immediately after CCV
MB	L, L+, Full	One per batch of 20 or fewer samples

[1]ICB/CCB samples not applicable to gravimetric (solids) analyses

3.3.4 Contract Required Detection Limit (CRDL)

Not all analyses include a contract required detection limit (CRDL) sample. These samples simply check the recoveries of standards which have analyte present at the CRDL. Recoveries are calculated by:

$$\%R = \frac{Found\ Value}{True\ Value}\ x\ 100$$

Frequency and recovery requirements for CRDL samples are detailed below in **Table 9**. Note that these laboratory samples will only be reported in L+ or Full packages. Corrective actions for out of control CRDL samples are presented in **Table 10**

Table 9 - Contract Required Detection Limit/Reporting Limit Criteria

Calibration Step[1]	Analysis	Method	Frequency	Control Limits
Contract Required Detection Limit (CRDL)	Mercury	SW846 7470 SW846 7470A EPA 245.1	At the beginning of each run.	70-130%
	Metals	SW846 6020 SW846 6020A SW846 6020B EPA 200.8	At the beginning of each run for every analyte of interest 6020A - at the beginning of each run and at the end of each analytical batch	6020/200.8 - 60-140% 6020A - 70-130% 6020B - 80-120%
	Metals	SW846 6010B EPA 200.7	At the beginning of each run for every analyte of interest	60-140%

[1]Reported only in Limited Plus and Full packages

Table 10 – CRDL Action

Calibration Criteria	Action for Samples	Qualifier Code
CRDL < method criteria	J-	CRQL
CRDL > method criteria	J+	CRQL

3.3.5 Interference Check Sample (ISC) Results

An interference check sample (ICS) is applicable to ICP-MS and ICP-AES analyses, and the purpose is to determine the instrument's capability to overcome common interferences. These samples will be reported only in L+ or Full packages. The ICS consists of two solutions, solution A and solution AB. Solution A contains high concentrations of interferents, while solution AB contains the interferents and mid-range concentrations of the target analytes. The two solutions are run consecutively, at the beginning of the analytical sequence, but not before the ICV. The ICSA is run first, followed by the ICSAB, which is immediately followed by a CCV. ICS recovery are calculated by:

$$\%R = \frac{Found\ Value}{True\ Value}\ x\ 100$$

Table 11 states ICS criteria; while corrective actions for out of control results can be found in Table 12. Should data be qualified for out of control ICS recoveries, assign reason code "ICS".

Table 11 – Interference Check Sample Criteria

Calibration Step[1]	Analysis	Method	Frequency	Control Limits
Interference Check Sample (ICS)	Metals	SW846 6020 SW846 6020A SW846 6020B EPA 200.8	At the beginning of each analytical sequence, or a minimum of twice per 8-hour shift, whichever is more frequent.	80-120% R for analytes included in the ICS Greater of ±2XRL for analytes not included in the ICS
	Metals	SW846 6010B SW846 6010C SW846 6010D EPA 200.7		80-120% R for analytes included in the ICS, ± RL for analytes not included in the ICS

[1]Reported only in Limited Plus and Full packages

Table 12 – Interference Check Sample Action

ICS Results	Action for Samples
ICS not analyzed at required frequency	Qualify all results as unusable **(R)**
ICS not analyzed in proper sequence	Use professional judgment
ICS %R <50%	Qualify results ≥ MDL as estimated low (J-) Qualify non-detects as unusable **(R)**
ICS %R 50-79% [or for 6020 and 200.8 ICS found value is < (true value – 2xRL), for 6010 and 200.7	Qualify results ≥ MDL as estimated low (J-) Qualify non-detects as estimated **(UJ)**

ICS Results	Action for Samples
found value is < (true value – RL), whichever is lower]	
ICS %R >120% [or for 6020 and 200.8 ICS found value is > (true value + 2xRL), for 6010 and 200.7 found value is < (true value + RL whichever is greater]	Qualify results ≥ MDL as estimated high (J+) No action for non-detects
Apply to analyte results ≥ MDLs if samples have detections of analytes not present in ICS. Samples with level of interferents comparable to or higher than interferent levels in the ICS and analyte concentration near the ICS level	Qualify results ≥ MDL as estimated high (J+) No action for non-detects
Apply to negative sample results (but absolute value is ≥ MDL) for analytes that are not present in the ICS solution. Samples with level of interferents comparable to or higher than interferent levels in the ICS	Qualify detects < 10x the |negative result| as estimated low **(J-)** Qualify non-detects as estimated (UJ)

3.3.6 Internal Standards Relative Intensity

Internal standards are applicable to ICP analyses, and these are reported only in L+ and Full packages. An internal standard is added to each client sample and the response is monitored throughout the run. The internal standard is made up of analytes which are not typically seen in environmental samples, such as thorium, germanium, scandium, or indium[115], among others. The purpose is to detect instrument drift. The internal standard response is compared to the standard's initial response in the calibration blank. Control limits for internal standards are presented in Table 13, while Table 14 presents actions for out of control responses. Qualified data should be given the validation code "IS". Each internal standard has specific analytes associated to it; thus, only analytes associated with an out-of-compliance internal standard response should be qualified. Consult the analytical laboratory to determine which analyte is associated with each internal standard.

Table 13 – Internal Standards Relative Response Criteria

Calibration Step[1]	Analysis	Method	Frequency	Control Limits
Internal Standard Response	Metals	SW846 6020 SW846 6020A SW846 6020B EPA 200.8	Monitor signal intensity throughout the analytical run.	**6020** - Any one internal standard's absolute intensity in ICB/CCB and ISCAB must be within 80-120% of original intensity in associated calibration blank. The absolute intensity of any one standard in samples and remaining QC samples must be within 30-120% of original intensity in associated calibration blank. **6020A/6020B** - Response in standards and samples 70-125% of response in associated blank **EPA 200.8** - Response in standards and samples 60-125% of response in associated blank
		SW846 6010B SW846 6010C SW846 6010D EPA 200.7		Response in standards and samples 70-130% of response in associated blank

[1]Reported in Limited Plus and Full packages

Table 14 – Internal Standards Response Action

Calibration Criteria	Action for Samples	Qualifier Code
Internal standard response < or > method criteria and sample was re-analyzed at 2-fold dilution	J for associated detected analytes UJ for associated non-detect analytes	IS
Internal standard response < or > method criteria and sample was not diluted and re-analyzed	Use professional judgement J or R for associated detected analytes UJ or R for associated non-detect analytes	IS

3.3.7 Laboratory Control Sample (LCS) Result

A laboratory control sample (LCS) is required for nearly all analyses. The LCS is DI water spiked with known concentrations of all target analytes. For soils analyses, the LCS is a spiked non-metal containing matrix. The LCS may also be referred to as a laboratory fortified blank (LFB). The LCS is assessed on percent recovery:

$$\%R = \frac{Found\ Value}{True\ Value}\ x\ 100$$

If the LCS recovery does not fall within control limits, the analysis should be terminated, the problem corrected, and associated samples reanalyzed. Occasionally, an LCS result is not within criteria, and analysis proceeds. This may occur if all client sample volume has been consumed. Frequency and control limits for the LCS are provided in Table 15, while Table 16 provides corrective actions.

Several analyses require a laboratory control sample duplicate. This is a separate sample from the laboratory duplicate. The LCSD is a duplicate sample of the LCS. The LCSD percent recovery is assessed identically to the LCS; and in addition, the LCS/LCSD are assessed in terms of relative percent difference (RPD) between the two sample results. This tests the laboratory's repeatability, or precision. The LCS/LCSD RPD is determined by:

$$RPD\% = \frac{|LCS - LCSD|}{\frac{LCS + LCSD}{2}} \times 100$$

Like the LCS, if the LCSD recovery does not fall within the control limits specified in Table 15, analysis should be terminated, the problem corrected, and affected samples re-analyzed. If LCS/LCSD precision (RPD) is outside of control limits, analysis should be terminated, the problem corrected, and affected samples re-analyzed. The frequency and control limits for the few samples which required LCSDs are included in Table 15, and the corrective action for unacceptable RPDs is at the end of Table 16.

Table 15 - Laboratory Control Sample/Laboratory Control Sample Duplicate Criteria

Calibration Step[1]	Analysis	Method	Frequency	Control Limits
Laboratory Control Spike (LCS)	Mercury	SW846 7470 SW846 7470A EPA 245.1	One in every 20 samples	80-120% of true value **EPA 245.1** - 85-115% of true value
	Metals	SW846 6020 SW846 6020A SW846 6020B EPA 200.8		80-120% of true value **EPA 200.8** - 85-115% of true value
	Metals	SW846 6010B SW846 6010C SW846 6010D EPA 200.7		80-120% **EPA 200.7** - 85-115% of true value

Calibration Step[1]	Analysis	Method	Frequency	Control Limits
	Alkalinity (LCS & LCSD)	SM 2320B		90-110% of true value RPD ≤ 20%
	TDS/TSS (LCS & LCSD)[2]	SM 2540C/2540D		80-120% of true value RPD ≤ 10%
	NH_3	EPA 350.1		90-110% of true value
	NO_2/NO_3	SM 4500 NO_3-H		
	TKN	EPA 351.2		
	DOC/TOC	SM 5310C		80-120% of true value RPD ≤ 20%
	Sulfate (LCS & LCSD)	ASTM D516-90		
	Anions	EPA 300.1		Conc from RL to 10xRL 75-125% of true value Conc > 10x RL 85-115% of true value
	Chloride	SM 4500-Cl E		90-110% of true value
	Anions	EPA 300.0		
	Fluoride	SM 4500-F-C		
	Total Phosphorus	SM4500P F		
	COD	SM 5220D EPA 410.4		
	Sulfide	SM4500-S^{2-}D		80-120% of true value
	Orthophosphate-P	SM4500-P B/E		90-110% of true value

[1]Reported in Limited, Limited Plus, and Full packages

[2]TDS/TSS – LCSD sample may be analyzed in place of laboratory duplicate at the analyst's discretion. TDS/TSS duplicate sample frequency criteria of 1 in 10 samples must be met.

Table 16 – Laboratory Control Sample/Lab Control Sample Duplicate Action

Calibration Results[1]	Calibration Criteria	Action for Samples	Qualifier Code
LCS not performed at required frequency	1 per batch of 20 or fewer samples	Use professional judgement. Investigate why LCS was not performed. At a minimum, qualify detects as estimated (J) and non-detects as estimated non-detect (UJ)	LCS
LCS %R < 40%	70-130% 80-120% 85-115% 90-110%	Qualify results that are ≥ MDL as estimated low **(J-)** Qualify non-detects rejected (R)	LCS
LCS %R 40-69%	70-130%	Qualify results that are ≥ MDL as estimated low **(J-)** Qualify non-detects as estimated non-detect (UJ)	LCS
LCS %R 40-79%	80-120%		
LCS %R 40-84%	85-115%		
LCS %R 40-89%	90-110%		
LCS %R 131-150%	70-130%	Qualify results that are ≥ MDL as estimated high **(J+)** No action for non-detects	LCS
LCS %R 121-150%	80-120%		
LCS %R 116-150%	85-115%		
LCS %R 111-150%	90-110%		
LCS %R >150%	70-130% 80-120% 85-115% 90-110%	Qualify results that are ≥ MDL Rejected **(R)** No action for non-detects	LCS
LCS/LCSD RPD > criteria (10%, 20%)	≤ 10% RPD ≤ 20% RPD	Qualify affected results as estimated (J) Qualify non-detects as estimated non-detect (UJ)	RPD

[1]LCS results are reported in Limited, Limited Plus, and Full laboratory packages

3.3.8 Laboratory Duplicate Sample (LDS) Results

The purpose of the laboratory duplicate sample is to assess the laboratory and method precision. The LDS is a second aliquot of a client sample that is treated identically to the primary aliquot. Known field blanks should not be used for the LDS. LDS frequency and acceptance criteria are provided in Table 17. In many cases, the matrix spike duplicate (MSD) is used as the LDS. Refer to Section 3.3.9 for a discussion of

MSD samples. As Table 17 indicates, the LDS is assessed on the RPD between the primary and duplicate sample. The RPD is determined by:

$$\boldsymbol{RPD\%} = \frac{\left|\boldsymbol{S-D}\right|}{\frac{\boldsymbol{S+D}}{\boldsymbol{2}}} \times \boldsymbol{100}$$

Where S = sample

D = duplicate

Table 18 provides corrective actions for LDS RPDs greater than criteria. The criteria in Table 18 are applicable when both the primary and duplicate sample concentrations are ≥ 5X the RL. If either the primary or duplicate sample result is < 5X the RL, a difference ≤ the RL between the two results is acceptable. Several analyses require more than one LDS; thus, two LDS samples are analyzed per QC batch. If only one of the RPDs exceeds criteria, qualifications result. Data qualified for LDS precision is given the reason code "RPD".

In assessing LDS RPDs, the sample matrix should be considered. If the parent sample used for the laboratory duplicate sample is dissimilar from other samples in the laboratory quality control (QC) batch, then only the parent sample and samples similar to the parent should be qualified. Sample similarity can be assessed by considering sample field data (pH, SC, ORP), site and sampling documentation (sample location, soil moisture, soil type) and laboratory data such as TSS, TDS, alkalinity, reactive sulfide, and anions. The sample data itself can also be used, such as very high analyte concentrations compared to all other samples in the laboratory QC batch. If a project-associated sample was not used for the LDS parent, matrix dissimilarity can be assumed and professional judgement can be used in declining to qualify associated results. In using professional judgement consider if analytical results were within historical ranges. Provide an explanation of the decision in the checklist. Since the sample matrix is considered, any field collected blank which consists of DI water should not be qualified because of LDS RPDs that exceed acceptance criteria. Known field blank samples should not be used as the LDS primary sample; but given that the analyst may not be aware of which samples are blanks, there are times that this occurs. Should LDS RPDs be greater than acceptance criteria, and the parent sample was a blank (DI water), the blank, along with all other samples in the QC batch, would be qualified. Although the blank matrix is dissimilar to the other samples, a duplicate sample of DI water with an RPD > acceptance criteria indicates a problem; thus, all associated data should be qualified.

Greater variability is expected in solid samples (soil) than in aqueous samples; thus, LDS criteria for solid samples is ≤ 35% RPD. For solid sample results < 5X the RL, a difference ≤ 2XRL between the primary and duplicate result is acceptable.

Table 17 – Laboratory Duplicate Sample Criteria

Calibration Step[1]	Analysis	Method	Frequency	Control Limits
Laboratory Duplicate Sample (LDS) LDS	Mercury (MSD)	SW846 7470 SW846 7470A EPA 245.1	One in every 20 samples	≤ 20% RPD
	Metals (MSD)	SW846 6020 SW846 6020A SW846 6020B EPA 200.8	One in every 20 samples	≤ 20% RPD
	Metals (MSD)	SW846 6010B SW846 6010C SW846 6010D EPA 200.7	One in every 20 samples	≤ 20% RPD
	Alkalinity (MSD)	SM2320B	One in every 10 samples	≤ 20% RPD
	NH_3 (MSD)	EPA 350.1	One in every 10 samples	≤ 20% RPD
	NO2/NO3 (MSD)	SM 4500 NO_3-H	One in every 10 samples	≤ 30% RPD
	TKN (MSD or alternate)	EPA 351.2	One in every 20 samples	≤ 10% RPD
	TDS/TSS	SM 2540C/2540D	One in every 10 samples	≤ 10 % RPD
	DOC/TOC	SM 5310C	One in every 20 samples	≤ 25% RPD
	Sulfate (MSD)	ASTM D516-90	One in every 10 samples	≤ 30% RPD
	Chloride (MSD)	SM 4500-Cl E	One in every 10 samples	≤ 20% RPD
	Anions (MSD)	EPA 300.0	One in every 10 samples	≤ 20% RPD
	Anions (MSD)	EPA 300.1	One in every 10 samples	RL -10xRL ≤ 20% RPD >10x RL ≤ 10% RPD
	Fluoride (MSD)	SM 4500-F-C	One in every 10 samples	≤ 20% RPD

Calibration Step[1]	Analysis	Method	Frequency	Control Limits
	Total Phosphorus (MSD)	SM4500P F	One in every 10 samples	≤ 30% RPD
	COD (MSD or alternate)	SM 5220D EPA 410.4	One in every 10 samples	≤ 20% RPD
	Sulfide	SM4500-S^{2-}D	One in every 20 samples	≤ 20% RPD
	Orthophosphate-P (MSD)	SM4500-P B/E	One in every 10 samples	≤ 30% RPD
LDS	Metals (soils/solids)[2]	Above applicable analyses	One in every 20 samples	≤ 35% RPD

[1]Reported in Limited, Limited Plus, and Full laboratory packages

Table 18 – Laboratory Duplicate Sample Action

Duplicate Sample Results[1]	Action for Samples
LDS not performed at required frequency	Use professional judgement. Investigate why LDS was not analyzed. At a minimum, qualify detects as estimated (J) and non-detects as estimated (UJ)
Both original and duplicate sample results ≥ 5X RL and RPD > Table 17 criteria	Qualify results that are ≥ MDL as estimated **(J)** Qualify non-detects as estimated non-detect (UJ)
Original sample or duplicate sample < 5X the RL (including non-detects) and absolute difference between sample and duplicate > RL	Qualify results that are ≥ MDL as estimated **(J)** Qualify non-detects as estimated non-detect (UJ)
Both original and duplicate sample results ≥ 5X RL and RPD < Table 17 criteria	No action
Original sample or duplicate sample < 5X the RL (including non-detects) and absolute difference between sample and duplicate < RL	No action

[1]Reported in Limited, Limited +, and Full packages

3.3.9 Matrix Spike (MS) Results

The matrix spike (MS) sample is a client sample spiked with a known amount of analyte. The purpose of the MS is to assess the effect of the sample matrix on the preparation and measurement methods. Often,

the laboratory duplicate sample (LDS) requirement is met by analyzing a matrix spike duplicate (MSD) sample. The MSD is a duplicate of the MS, that is, the same parent sample that is used for the MS is used for the MSD. The spike concentration(s) of the MSD is identical to the concentration(s) used for the MS. MS/MSD frequency and acceptance criteria vary with analysis, and these can be found in Table 19. As Table 19 indicates, MS/MSD samples are assessed on recovery and, when an MSD is used as the LDS, the RPD between the two samples is assessed for laboratory precision. Since an MSD can serve as the LDS, the RPD assessment is identical to that for laboratory duplicate samples, which is discussed in Section 3.3.8. MS/MSD recoveries are assessed as:

$$\%\boldsymbol{R} = \frac{\boldsymbol{SSR - SR}}{\boldsymbol{SA}} \times \mathbf{100}$$

Where SSR = spiked sample result

SR = sample result

SA = spike added

When the sample result (SR) is < the MDL, use a value of zero for SR when calculating the recovery.

Table 20 provides corrective actions for out of control MS/MSD recoveries. Corrective actions for MS/MSD RPDs are discussed in Section 3.3.8. An exception to the qualification criteria in Table 20 is when the parent sample concentration is ≥ 4X the spike concentration. If this is the case, the recovery criteria are waived.

Many analyses require a matrix spike sample at a 10% frequency; thus, two MS samples, and possibly two MSDs are analyzed per QC batch. If only one of the spiked sample recoveries does not meet criteria, qualifications result. Data qualified for MS or MSD recoveries is given the reason code “MS”.

In assessing MS/MSD recoveries, the sample matrix should be considered. If the parent sample used for the MS/MSD is dissimilar from other samples in the laboratory quality control (QC) batch, then only the parent sample and samples similar to the parent should be qualified. Sample similarity can be assessed by considering sample field data (pH, SC, ORP, soil type for solid samples) and laboratory data such as TSS, TDS, alkalinity, reactive sulfide, and anions. The sample data itself can also be used, such as very high analyte concentrations compared to all other samples in the laboratory QC batch. If a project-associated sample was not used for the LDS parent, matrix dissimilarity can be assumed and professional judgement can be used in declining to qualify associated results. In using professional judgement consider if analytical results were within historical ranges. Provide an explanation of the decision in the checklist. Since the sample matrix is considered, any field collected blank which consists of DI water should not be qualified because of MS/MSD recoveries that do not meet acceptance criteria. Known field blank samples should not be used as the MS parent sample; but given that the analyst may not be aware of which samples are blanks, there are times that this occurs. Should MS/MSD recoveries fall outside of acceptance criteria, and the parent sample was a blank (DI water), the blank, along with all other samples in the QC batch, would be qualified. Although the blank matrix is dissimilar to the other samples, out of control recoveries of spiked DI water indicate a problem; thus, all associated data should be qualified.

Table 19 – Matrix Spike/Matrix Spike Duplicate Criteria

Calibration Step[1]	Analysis	Method	Frequency	Control Limits
Matrix Spike (MS)/Matrix Spike Duplicate (MSD)	Mercury	SW846 7470 SW846 7470A EPA 245.1	One per batch of 20 samples **EPA 245.1** - 1 per batch & if > 11 samples in a batch, an additional MS is required.	80-120% of true value EPA 245.1 - 70-130% of true value ≤ 20% RPD
	Metals	SW846 6020 SW846 6020A SW846 6020B EPA 200.8	MS One in every 20 samples **EPA 200.8** MS - One in every 10 samples MSD one in every 20 samples	75-125% of true value EPA 200.8 - 70-130% of true value ≤ 20% RPD
	Metals	SW846 6010B SW846 6010C SW846 6010D EPA 200.7	MS One in every 20 samples **EPA 200.7** - 1 MS per 10 samples MSD 1 in 20	75-125% of true value EPA 200.7 - 70-130% of true value ≤ 20% RPD
	Alkalinity	SM2320B	One in every 10 samples	80-120% of true value ≤ 20% RPD
	NH_3 (MSD)	EPA 350.1		90-110% of true value ≤ 20% RPD
	NO_2/NO_3	SM 4500 NO_3-H		80-120% of true value ≤ 30% RPD
	TKN	EPA 351.2	MS 1 in 10 MSD 1 in 20	90-110% of true value ≤ 20% RPD

Calibration Step[1]	Analysis	Method	Frequency	Control Limits
MS	DOC/TOC	SM 5310C	One in every 20 samples No MSD	80-120% of true value
MS/MSD	Sulfate	ASTM D516-90	One in every 10 samples	80-120% of true value ≤ 30% RPD
	Chloride	SM 4500-Cl E		80-120% of true value ≤ 20% RPD
	Anions	EPA 300.0	More frequent of 1 per batch or 1 per 10 samples	80-120% of true value ≤ 20% RPD
	Anions	EPA 300.1	More frequent of 1 per batch or 1 per 10 samples	75-125% of true value ≤ 20% RPD for results between RL and 10x RL ≤ 10% RPD for results >10x RL
	Fluoride	SM 4500-F-C	One in every 10 samples	80-120% of true value ≤ 20% RPD
	Total Phosphorus	SM4500P F		80-120% of true value ≤ 30% RPD
MS/MSD (or alternate duplicate sample)	COD	SM 5220D EPA 410.4		SM 5220D 80-120% EPA 410.4 90-110% ≤ 20% RPD
MS	Sulfide	SM4500-S^{2-}D	One in every 20 samples No MSD	75-125% of true value

Calibration Step[1]	Analysis	Method	Frequency	Control Limits
MS/MSD	Orthophosphate-P	SM4500-P B/E	One in 10 with a max of 2 MS/MSD pairs per batch of 20	80-120% ≤ 30% RPD

[1]Reported in Limited, Limited +, and Full packages

Table 20 - Matrix Spike/Matrix Spike Duplicate Recovery Action

MS Sample Results[1]	Calibration Criteria	Action for Samples	Qualifier Code
MS not performed at required frequency	As specified in Table 15	Use professional judgement. Investigate why MS was not performed. At a minimum, qualify detects as estimated (J) and non-detects as estimated (UJ)	MS
MS/MSD %R < 30%	70-130%	Qualify results that are ≥ MDL as estimated low **(J-)** Qualify non-detects rejected (R)	MS
	75-125%		
	80-120%		
	90-110%		
MS/MSD %R 30-69%	70-130%	Qualify results that are ≥ MDL as estimated low **(J-)** Qualify non-detects as estimated (**UJ**)	MS
MS/MSD %R 30-74%	75-125%		
MS/MSD %R 30-79%	80-120%		
MS/MSD %R 30-89%	90-110%		
MS/MSD %R >130%	70-130%	Qualify results that are ≥ MDL as estimated high (**J+)** No action for non-detects	MS
MS/MSD %R > 125%	75-125%		
MS/MSD %R >120%	80-120%		
MS/MSD %R >110%	90-110%		

[1]MS/MSD results are reported in Limited, Limited +, and Full packages

3.3.9.1 Post digestion spike

Post-digestion spike (PDS) samples are applicable to ICP data and are required for the analytical methods listed in Table 21 when the MS recovery falls outside of criteria, and the parent sample concentration is < 4X the spike concentration. The PDS must be assessed only for the analytes that did not meet MS criteria. A matrix spike sample is spiked at the beginning of the sample preparation process, while the PDS is spiked after the sample has gone through preparation. Table 21 provides PDS criteria, while Table 22 provides corrective actions for samples that do not meet MS and PDS criteria. If a PDS is analyzed, the results are reported only in L+ and Full packages. When assessing PDS recoveries consider sample similarity in the manner described in Section 3.3.9 Matrix Spike (MS) Results. Since a PDS sample is analyzed only when there is an MS result which does not meet criteria, the code "MS,PDS" should be used when samples are qualified for MS and PDS results.

Table 21– Post Digestion Spike Criteria

Laboratory QC[1]	Analysis	Method	Frequency	Control Limits[2]
Post digestion spike	Metals	SW846 6020 SW846 6020A SW846 6020B	One per QC batch if MS/MSD recovery outside of 75-125%	6020/6020A 80-120% of true value 6020B 75-125% of true value
	Metals	SW846 6010B SW846 6010C SW846 6010D	One per QC batch if MS/MSD recovery outside of 75-125%	6010B 85-120% of true value 6010C 80-120% of true value 6010D 75-125% of true value

[1]Reported in Limited Plus and Full packages

[2]Post digestion spike assessment is required only for elements failing MS recovery criteria

Table 22 – Post Digestion Spike Action

Spiked Sample Results	Applicable Method	Action for Samples
MS %R < 30% PDS %R < 75%	6020B 6010D	Qualify results that are ≥ MDL as estimated low **(J-)** Qualify non-detects as rejected (R)
MS %R < 30% PDS %R < 80%	6020 6020A 6010C	Qualify results that are ≥ MDL as estimated low **(J-)** Qualify non-detects as rejected (R)
MS %R < 30% PDS %R < 85%	6010B	Qualify results that are ≥ MDL as estimated low **(J-)** Qualify non-detects as rejected (R)
MS %R < 30% PDS %R ≥ 75%	6020B 6010D	Qualify results that are ≥ MDL as estimated **(J)** Qualify non-detects as estimated (UJ)
MS %R < 30% PDS %R ≥ 80%	6020 6020A 6010C	Qualify results that are ≥ MDL as estimated **(J)** Qualify non-detects as estimated (UJ)
MS %R < 30% PDS %R ≥ 85%	6010B	Qualify results that are ≥ MDL as estimated **(J)** Qualify non-detects as estimated (UJ)
MS %R 30-74% PDS %R < 75%	6020B 6010D	Qualify results that are ≥ MDL as estimated low **(J-)** Qualify non-detects as estimated (UJ)
MS %R 30-74% PDS %R < 80%	6020 6020A 6010C	Qualify results that are ≥ MDL as estimated low **(J-)** Qualify non-detects as estimated (UJ)
MS %R 30-74% PDS %R < 85%	6010B	Qualify results that are ≥ MDL as estimated low **(J-)** Qualify non-detects as estimated (UJ)
MS %R > 125% PDS %R > 125%	6020B 6010D	Qualify results that are ≥ MDL as estimated high **(J+)** No action for non-detects
MS %R > 125% PDS %R > 120%	6020 6020A 6010B	Qualify results that are ≥ MDL as estimated high **(J+)** No action for non-detects

Spiked Sample Results	Applicable Method	Action for Samples
	6010C	
MS %R > 125% PDS %R ≤ 125%	6020B 6010D	Qualify results that are ≥ MDL as estimated **(J)** No action for non-detects
MS %R > 125% PDS %R ≤ 120%	6020 6020A 6010B 6010C	Qualify results that are ≥ MDL as estimated **(J)** No action for non-detects
MS %R < 30% No PDS performed	All	Qualify results that are ≥ MDL as estimated low **(J-)** Qualify non-detects as rejected (R)
MS %R 30-74% No PDS performed	All	Qualify results that are ≥ MDL as estimated low **(J-)** Qualify non-detects as estimated (UJ)
MS %R 75-125% No PDS is required	All	No action
MS %R > 125% No PDS performed	All	Qualify results that are ≥ MDL as estimated high **(J+)** No action for non-detects

[1]Reported in Limited Plus and Full packages

[2]Post digestion spike assessment is required only for elements failing MS recovery criteria

3.3.10 Serial Dilution Sample Results

Serial dilution (SD) samples are applicable to ICP data. The SD is a client sample which is diluted by a factor of five. The dilution corrected result (SD result x 5) should be within a specific percent difference of the original sample result, for samples in which the original concentration is sufficiently high. The SD sample is an indication of physical or chemical interferences within the sample matrix. Serial dilution % difference is determined by:

$$\%Difference = \frac{|I - S|}{I} \times 100$$

Where I = initial sample result

S = serial dilution result

Since SD samples assess matrix interference, field blank samples should not be used for the initial sample. Additionally, as with LDS, MS, and PDS samples, sample similarity should be considered when assessing SD results; and since field blank samples are of a differing matrix, they are not qualified for SD samples which do not meet criteria. Serial dilution results are reported only in L+ and Full packages. Table 23 specifies analyses for which SD samples are applicable, and acceptance criteria; while, Table 24 presents actions for non-compliant SD results. The code "SD" should be used for samples qualified for serial dilution results which do not meet criteria.

Table 23 – Serial Dilution Criteria

Laboratory QC[1]	Analysis	Method	Frequency	Control Limits
Serial Dilution (SD)	Metals	SW846 6020 SW846 6020A SW846 6020B EPA 200.8	One in every batch of 20 or fewer samples	6020/6020A/EPA 200.8 - 1:5 dilution 10% difference of original result when original sample is ≥ 50X the MDL 6020B - 20% difference of 1:5 dilution of MS or samples with concentration 25X the lower limit of quantification in parent sample
Serial Dilution (SD)	Metals	SW846 6010B SW846 6010C SW846 6010D EPA 200.7	One in every batch of 20 or fewer samples	6010B, 6010C - 10% difference of original result when original sample is > 10X the RL. 6010D - 20% difference of 1:5 dilution of MS or samples with concentration 25X the lower limit of quantification in parent sample EPA 200.7 - 10% difference for original samples ≥ 50X the MDL

[1]Reported in Limited Plus and Full packages

Table 24 – Serial Dilution Action

SD Result[1]	Applicable Method	Original Sample Concentration	Action for Samples	Qualifier Code
SD not performed at required frequency	One per batch of 20 or fewer samples	NA	Use professional judgement. Investigate why MS was not performed. At a minimum, qualify detects as estimated (J) and non-detects as estimated (UJ)	SD
SD %Difference (%D) > 10%	SW846 6020 SW846 6020A EPS 200.8 SW846 6010B SW846 6010C EPA 200.7	≥ 50X MDL	Qualify results that are ≥ MDL as estimated **(J)** Qualify non-detects as estimated non-detect (UJ)	SD
SD %D > 10%	SW8466020 SW846 6020A EPA 200.8 SW846 6010B SW846 6010C EPA 200.7	< 50X MDL	No Qualification	
SD %D > 20%	SW846 6020B SW846 6010D	> 25X lower limit of quantification or 1:5 dilution of MS	Qualify results that are ≥ MDL as estimated (J) Qualify non-detects as estimated non-detect (UJ)	SD
SD %D > 20%	SW846 6020B SW846 6010D	< 25X lower limit of quantification	No Qualification	

[1]Serial dilution results are reported in Limited Plus and Full packages

3.4 Data Validation Process for Analytical Parameters

This section outlines validation steps by analytical parameter (mercury, metals, alkalinity, etc.). Since laboratory packages present calibration and QC results by parameter, the most efficient way to assess data is by parameter, rather than by QC sample. That is, assess all mercury calibration and QC sample results, next assess all ICP calibration and QC sample results, and so on, rather than assessing blank results for all analyses, assess LCS results for all analyses, etcetera. In assessing laboratory data for each parameter, use the limits and corrective actions provided in Section 3.3.

3.4.1 Mercury Assessment

Mercury analyses are assessed for the calibration and QC samples found in Table 25.

3.4.2 Metals Assessment

Metals analyses are assessed for the calibration and QC samples found in Table 26.

3.4.3 Alkalinity Assessment

Alkalinity analyses are assessed for the calibration and QC samples found in Table 27

3.4.4 Solids (TDS/TSS) Assessment

Solids (TSS, TDS, etc.) analyses are assessed for the calibration and QC samples found in Table 38.

3.4.5 Nitrate +Nitrite Assessment

Nitrate + nitrite analyses are assessed for the calibration and QC samples found in Table 29

3.4.6 Ammonia Assessment

Ammonia analyses are assessed for the calibration and QC samples found in Table 30.

3.4.7 Total Kjeldahl Nitrogen (TKN) Assessment

TKN analyses are assessed for the calibration and QC samples found in Table 31.

3.4.8 Dissolved/Total Organic Carbon (DOC/TOC) Assessment

DOC and TOC analyses are assessed for the calibration and QC samples found in Table 32. The analytical method for DOC and TOC is identical, the difference is that a sample to be analyzed for DOC is field filtered.

3.4.9 Sulfate Analysis by ASTMD 516-90 Assessment

Sulfate analyses by ASTMD 516-90 are assessed for the calibration and QC samples found in Table 33.

3.4.10 Total Phosphorus Assessment

Total phosphorus analyses are assessed for the calibration and QC samples found in Table 34

3.4.11 Chloride Analysis by SM4500-Cl E Assessment

Chloride analyses by SM4500-CL E are assessed for the calibration and QC samples found in Table 35.

3.4.12 Anion Analysis (Bromide, Chloride, Fluoride, and Sulfate) by EPA 300 Assessment

Anion analyses (bromide, chloride, fluoride, and sulfate) by EPA Method 300 are assessed for the calibration and QC samples found in Table 36.

3.4.13 Fluoride Assessment

Fluoride analyses by SM4500-F-C analyses are assessed for the calibration and QC samples found in Table 37.

3.4.14 Sulfide Assessment

Sulfide analyses are assessed for the calibration and QC samples found in Table 38.

3.4.15 Chemical Oxygen Demand (COD) Assessment

Chemical oxygen demand (COD) analyses are assessed for the calibration and QC samples found in Table 39**.**

3.4.16 Orthophosphate Assessment

Orthophosphate analyses are assessed for the calibration and QC samples found in Table 40.

Table 25 - Mercury Calibration and Laboratory QC Sample Requirements

Laboratory Calibration/ QC Sample	Method	Frequency	Control Limits	Action Table	L Report	L+ Report	Full Report
Calibration Curve Fit	SW846 7470 SW846 7470A EPA 245.1	Once in 24 hours or each time the instrument is set up	r ≥ 0.995	Table 7	No	Yes	Yes
ICV	SW846 7470 SW846 7470A EPA 245.1	Immediately after instrument calibration and after a continuing calibration failure	90-110% of true value EPA 245.1 - 95-105%R	Table 7	No	Yes	Yes
CCV	SW846 7470 SW846 7470A EPA 245.1	1 in 10 samples, and after the last analytical sample	90-110% of true value	Table 7	No	Yes	Yes
CRDL	SW846 7470 SW846 7470A EPA 245.1	At the beginning of each run.	SW846 7470/7470A 80-120%R 245.1 70-130%R	Table 9	No	Yes	Yes
ICB	SW846 7470 SW846 7470A EPA 245.1	Immediately after instrument calibration, following the CCV	< MDL	Table 8	No	Yes	Yes
CCB	SW846 7470 SW846 7470A EPA 245.1	1 in 10 samples and after the last analytical sample, following CCVs	< MDL	Table 8	No	Yes	Yes
MB	SW846 7470 SW846 7470A EPA 245.1	1 per batch of ≤ 20 samples	< MDL	Table 8	Yes	Yes	Yes

Laboratory Calibration/ QC Sample	Method	Frequency	Control Limits	Action Table	L Report	L+ Report	Full Report
LCS	SW846 7470 SW846 7470A EPA 245.1	1 per batch of ≤ 20 samples	80-120% R EPA 245.1 - 85-115%R	Table 16	Yes	Yes	Yes
LDS (MSD suffices as LDS)	SW846 7470 SW846 7470A EPA 245.1	1 per batch of ≤ 20 samples	≤ 20% RPD	Table 18	Yes	Yes	Yes
MS/MSD	SW846 7470 SW846 7470A EPA 245.1	1 per batch of ≤ 20 Samples EPA 245.1 - 1 per batch & if > 11 samples in a batch, an additional MS is required.	80-120%R EPA 245.1 - 70-130%R ≤ 20% RPD	Table 20	Yes	Yes	Yes

Table 26 – Metals Calibration and Laboratory QC Sample Requirements

Laboratory QC	Method	Frequency[1]	Control Limits[1]	Action Table	L Report	L+ Report	Full Report
Tuning	SW846 6020 SW846 6020A SW846 6020B EPA 200.8	Prior to calibration Tune solution analyzed five times, consecutively	mass calibration within 0.1 amu % RSD of absolute signals < 5%	Table 5	No	Yes	Yes
Calibration Curve Fit	SW846 6020 SW846 6020A SW846 6020B EPA 200.8	Once in 24 hours or each time the instrument is set up	$r \geq 0.998$	Table 7	No	Yes	Yes
Calibration Curve Fit	SW846 6010B SW846 6010C SW846 6010D EPA 200.7	Once in 24 hours or each time the instrument is set up	$r \geq 0.995$	Table 7	No	Yes	Yes
ICV	SW846 6020 SW846 6020A SW846 6020B EPA 200.8	Immediately after instrument calibration and after a continuing calibration failure	90-110% of true value	Table 7	No	Yes	Yes
ICV	SW846 6010B SW846 6010C SW846 6010D EPA 200.7	Immediately after instrument calibration and after a continuing calibration failure	90-110% R EPA 200.7 - 95-105%R	Table 7	No	Yes	Yes
CCV	SW846 6020 SW846 6020A SW846 6020B EPA 200.8	1 in every 10 samples, and after the last analytical sample	90-110% R	Table 7	No	Yes	Yes
CCV	SW846 6010B SW846 6010C SW846 6010D EPA 200.7	1 in every 10 samples, and after the last analytical sample	90-110% R SW846 6010B - The RSD of the CCV must be < 5%	Table 7	No	Yes	Yes

Laboratory QC	Method	Frequency[1]	Control Limits[1]	Action Table	L Report	L+ Report	Full Report
CRDL	SW846 6020 SW846 6020A SW846 6020B EPA 200.8	At the beginning of each run for every analyte of interest	6020/200.8 - 60-140% R 6020A - 70-130% R 6020B - 80-120% R	Table 10	No	Yes	Yes
CRDL	SW846 6010B EPA 200.7	At the beginning of each run for every analyte of interest	60-140% R	Table 10	No	Yes	Yes
ICB	SW846 6020 SW846 6020A SW846 6020B EPA 200.8	At beginning of analytical run, immediately after CCV	< MDL	Table 8	No	Yes	Yes
ICB	SW846 6010B SW846 6010C SW846 6010D EPA 200.7	At beginning of analytical run, immediately after ICV	< MDL	Table 8	No	Yes	Yes
CCB	SW846 6020 SW846 6020A SW846 6020B EPA 200.8	1 in every 10 samples, immediately after CCV	< MDL	Table 8	No	Yes	Yes
CCB	SW846 6010B SW846 6010C SW846 6010D EPA 200.7	1 in every 10 samples, immediately after CCV	< MDL	Table 8	No	Yes	Yes
MB	SW846 6020 SW846 6020A SW846 6020B EPA 200.8	1 in every 20 samples	< MDL	Table 8	Yes	Yes	Yes
MB	SW846 6010B SW846 6010C SW846 6010D EPA 200.7	1 in every 20 samples	< MDL	Table 8	Yes	Yes	Yes

Laboratory QC	Method	Frequency[1]	Control Limits[1]	Action Table	L Report	L+ Report	Full Report
ICS	SW846 6020 SW846 6020A SW846 6020B EPA 200.8	At the beginning of each analytical sequence, or a minimum of twice per 8-hour shift, whichever is more frequent.	80-120% R for analytes included in the ICS, < RL for analytes not included in the ICS	Table 12	No	Yes	Yes
ICS	SW846 6010B SW846 6010C SW846 6010D EPA 200.7	At the beginning of each analytical sequence, or a minimum of twice per 8-hour shift, whichever is more frequent.	80-120% R for analytes included in the ICS, < RL for analytes not included in the ICS	Table 12	No	Yes	Yes
Internal Standard Response	SW846 6020 SW846 6020A SW846 6020B EPA 200.8	Monitor signal intensity throughout the analytical run.	6020 - absolute intensity in ICB/CCB and ISCAB 80-120% of original intensity in associated calibration blank, absolute intensity in samples and remaining QC samples 30-120% of original intensity in associated calibration blank. 6020A/6020B - 70-125% EPA 200.8 - 60-125%	Table 14			
Internal Standard Response	SW846 6010B SW846 6010C SW846 6010D EPA 200.7	Monitor signal intensity throughout the analytical run.	70-130% R	Table 14	No	Yes	Yes

Laboratory QC	Method	Frequency[1]	Control Limits[1]	Action Table	L Report	L+ Report	Full Report
LCS	SW846 6020 SW846 6020A SW846 6020B EPA 200.8	1 in every 20 samples	80-120% R EPA 200.8 - 85-115% R	Table 16	Yes	Yes	Yes
LCS	SW846 6010B SW846 6010C SW846 6010D EPA 200.7	1 in every 20 samples	80-120% R EPA 200.7 - 85-115% R	Table 16	Yes	Yes	Yes
LDS	SW846 6020 SW846 6020A SW846 6020B EPA 200.8	1 in every 20 samples MSD suffices as LDS	20% RPD	Table 18	Yes	Yes	Yes
LDS	SW846 6010B SW846 6010C SW846 6010D EPA 200.7	1 in every 20 samples MSD suffices as LDS	20% RPD	Table 18	Yes	Yes	Yes
MS/MSD	SW846 6020 SW846 6020A SW846 6020B EPA 200.8	MS One in every 20 samples EPA 200.8 MS - One in every 10 samples MSD one in every 20 samples	25-125% R EPA 200.8 - 70-130% R ≤ 20% RPD	Table 20	Yes	Yes	Yes
MS/MSD	SW846 6010B SW846 6010C SW846 6010D EPA 200.7	MS One in every 20 samples EPA 200.7 - 1 MS per 10 samples MSD 1 in 20	75-125% R EPA 200.7 - 70-130% R 20% RPD	Table 20	Yes	Yes	Yes
PDS	SW846 6020 SW846 6020A SW846 6020B	1 per QC batch if MS/MSD recovery outside of 75-125%	6020/6020A 80-120% R 6020B 75-125% of true value	Table 22	No	Yes	Yes
PDS	SW846 6010B SW846 6010C SW846 6010D	1 per QC batch if MS/MSD recovery outside of 75-125%	6010B 85-120% R 6010C 80-120% R 6010D 75-125% R	Table 22	No	Yes	Yes

Laboratory QC	Method	Frequency[1]	Control Limits[1]	Action Table	L Report	L+ Report	Full Report
SD	SW846 6020 SW846 6020A SW846 6020B EPA 200.8	1 in every 20 samples	6020/6020A/EPA 200.8 - 1:5 dilution 10% D of original result when original sample is ≥ 50X the MDL 6020B - 20% D of 1:5 dilution of MS or samples with concentration 25X the lower limit of quantification in parent sample	Table 24	No	Yes	Yes
SD	SW846 6010B SW846 6010C SW846 6010D EPA 200.7	1 in every 20 samples	6010B, 6010C - 10% D of original result when original sample is > 10X the RL. 6010D - 20% D of 1:5 dilution of MS or samples with concentration 25X the lower limit of quantification in parent sample EPA 200.7 - 10% D for original samples ≥ 50X the MDL	Table 24	No	Yes	Yes

Table 27 – Alkalinity Calibration and Laboratory QC Requirements

Laboratory QC	Method	Frequency	Control Limits	Action Table	L Report	L+ Report	Full Report
Calibration Curve Fit	SM 2320B	At the beginning of run	slope 96-106% of true value	Table 7	No	Yes	Yes

Laboratory QC	Method	Frequency	Control Limits	Action Table	L Report	L+ Report	Full Report
pH Calibration Check	SM 2320B	Immediately after pH probe calibration	± 0.10 pH units	Table 7	No	Yes	Yes
ICV	SM 2320B	Immediately after instrument calibration and after a continuing calibration failure	90-110% R	Table 7	No	Yes	Yes
CCV	SM 2320B	1 in every ten samples, and after the last analytical sample	90-110% R	Table 7	No	Yes	Yes
ICB	SM 2320B	Immediately after instrument calibration, following the ICV	< MDL	Table 8	No	Yes	Yes
CCB	SM 2320B	One in every 10 samples	< MDL	Table 8	No	Yes	Yes
MB	SM 2320B	1 in every 20 samples	< MDL	Table 8	Yes	Yes	Yes
LCS	SM 2320B	1 in every 20 samples	90-110% R	Table 16	Yes	Yes	Yes
LCSD	SM 2320B	1 in every 20 samples	20% RPD	Table 16	Yes	Yes	Yes
LDS	SM 2320B	1 in every 10 samples MSD suffices for LDS	20% RPD	Table 18	Yes	Yes	Yes
MS/MSD	SM2320B	One in every 10 samples	80-120% R 20% RPD	Table 20	Yes	Yes	Yes

Table 28 – TDS/TSS Laboratory QC Requirements

Laboratory QC	Method	Frequency	Control Limits	Action Table	L Report	L+ Report	Full Report
MB	SM 2540C/D	1 in every 20 samples	< MDL	Table 8	Yes	Yes	Yes
LCS	SM 2540C/D	1 in every 20 samples	80-120% R	Table 16	Yes	Yes	Yes
LCSD	SM 2540C/D	1 in every 20 samples (if analyzed)	10% RPD	Table 16	Yes	Yes	Yes
LDS	SM 2540C/D	1 in every 10 samples	10% RPD	Table 18	Yes	Yes	Yes

Table 29 – Nitrate + Nitrite Calibration and Laboratory QC Requirements

Laboratory QC	Method	Frequency	Control Limits	Action Table	L Report	L+ Report	Full Report
Calibration Curve Fit	SM 4500 NO_3-H	At the beginning of run	$r \geq 0.995$	Table 7	No	Yes	Yes
ICV	SM 4500 NO_3-H	Immediately after instrument calibration and after a continuing calibration failure	90-110% R	Table 7	No	Yes	Yes
CCV	SM 4500 NO_3-H	One in every ten samples, and after the last analytical sample	90-110% R	Table 7	No	Yes	Yes
ICB	SM 4500 NO_3-H	Immediately after instrument calibration, immediately following ICV	< MDL	Table 8	No	Yes	Yes
CCB	SM 4500 NO_3-H	1 in every 10 samples	< MDL	Table 8	No	Yes	Yes
MB	SM 4500 NO_3-H	1 in every 20 samples	< MDL	Table 8	Yes	Yes	Yes
LCS	SM 4500 NO_3-H	1 in every 20 samples	90-110% R	Table 16	Yes	Yes	Yes

Laboratory QC	Method	Frequency	Control Limits	Action Table	L Report	L+ Report	Full Report
LDS	SM 4500 NO_3-H	1 in every 10 samples MSD suffices as LDS	≤ 30% RPD	Table 18	Yes	Yes	Yes
MS/MSD	SM 4500 NO_3-H	1 in every 10 samples	80-120% R ≤ 30% RPD	Table 20	Yes	Yes	Yes

Table 30 – Ammonia Calibration and Laboratory QC Sample Requirements

Laboratory QC	Method	Frequency	Control Limits	Action Table	L Report	L+ Report	Full Report
Calibration Curve Fit	EPA 350.1	At the beginning of run	$r \geq 0.995$	Table 7	No	Yes	Yes
ICV	EPA 350.1	Immediately after instrument calibration and after a continuing calibration failure	90-110% R	Table 7	No	Yes	Yes
CCV	EPA 350.1	1 in every ten samples, and after the last analytical sample	90-110% R	Table 7	No	Yes	Yes
ICB	EPA 350.1	Immediately after instrument calibration, immediately following ICV	< MDL	Table 8	No	Yes	Yes
CCB	EPA 350.1	1 in every ten samples, and after the last analytical sample	< MDL	Table 8	No	Yes	Yes
MB	EPA 350.1	1 in every 20 samples	< MDL	Table 8	Yes	Yes	Yes
LCS	EPA 350.1	1 in every 20 samples	90-110% R	Table 16	Yes	Yes	Yes
LDS	EPA 350.1	1 in every 10 samples MSD suffices as LDS	≤ 20% RPD	Table 18	Yes	Yes	Yes
MS/MSD	EPA 350.1	1 in every 10 samples	90-110% R 20% RPD	Table 20	Yes	Yes	Yes

Table 31 – TKN Calibration and Laboratory QC Samples Requirements

Laboratory QC	Method	Frequency	Control Limits	Action Table	L Report	L+ Report	Full Report
Calibration Curve Fit	EPA 351.121	At the beginning of run	$r \geq 0.995$	Table 7	No	Yes	Yes
ICV	EPA 351.2	Immediately after instrument calibration and after a continuing calibration failure	90-110% R	Table 7	No	Yes	Yes
CCV	EPA 351.2	1 in every 10 samples, and after the last analytical sample	90-110% R	Table 7	No	Yes	Yes
ICB	EPA 351.2	At beginning of analytical run, immediately after CCV	< MDL	Table 8	No	Yes	Yes
CCB	EPA 351.2	1 in every 10 samples, and after the last analytical sample	< MDL	Table 8	No	Yes	Yes
MB	EPA 351.2	1 in every 20 samples	< MDL	Table 8	Yes	Yes	Yes
LCS	EPA 351.2	1 in every 20 samples	90-110% R	Table 16	Yes	Yes	Yes
LDS	EPA 351.2	1 in every 20 samples (MSD or alternate)	≤ 10% RPD	Table 18	Yes	Yes	Yes
MS/MSD	EPA 351.2	MS 1 in every 10 samples MSD 1 in 20	90-110% R	Table 20	Yes	Yes	Yes

Table 32 – DOC/TOC Calibration and Laboratory QC Samples Requirements

Laboratory QC	Method	Frequency	Control Limits	Action Table	L Report	L+ Report	Full Report
Calibration Curve Fit	SM 5310C	At the beginning of run	$r \geq 0.995$	Table 7	No	Yes	Yes
ICV	SM 5310C	Immediately after instrument calibration and after a continuing calibration failure DOC/TOC analysis by SM 5310C calibration frequency is every six months or as needed. Thus, ICV frequency may be six months.	90-110% R	Table 7	No	Yes	Yes
High and Low Standard Check	SM 5310C	Daily prior to sample analysis unless ICV is run that day		Table 7			
CCV	SM5310 C	One in every ten samples, and after the last analytical sample	90-110% R	Table 7	No	Yes	Yes
ICB	SM5310 C	At beginning of analytical run, immediately after CCV	< MDL	Table 8	No	Yes	Yes
CCB	SM5310 C	1 in every 10 samples, and after the last analytical sample	< MDL	Table 8	No	Yes	Yes
MB	SM5310 C	1 in every 20 samples	< MDL	Table 8	Yes	Yes	Yes
LCS	SM5310 C	1 in every 20 samples	80-120% R	Table 16	Yes	Yes	Yes
LDS	SM5310 C	1 in every 20 samples	≤ 25% RPD	Table 18	Yes	Yes	Yes
MS	SM5310 C	MS 1 in every 20 samples	80-120% R	Table 20	Yes	Yes	Yes

Table 33 – Sulfate by ASTM D516-90 Calibration and Laboratory QC Sample Requirements

Laboratory QC	Method	Frequency	Control Limits	Action Table	L Report	L+ Report	Full Report
Calibration Curve Fit	ASTM D516-90	At the beginning of run	$r \geq 0.990$	Table 7	No	Yes	Yes
ICV	ASTM D516-90	Immediately after instrument calibration and after a continuing calibration failure	80-120% R	Table 7	No	Yes	Yes
CCV	ASTM D516-90	1 in every 10 samples, and after the last analytical sample	80-120% R	Table 7	No	Yes	Yes
ICB	ASTM D516-90	At beginning of analytical run, immediately after CCV	< MDL	Table 8	No	Yes	Yes
CCB	ASTM D516-90	1 in every 10 samples, and after the last analytical sample	< MDL	Table 8	No	Yes	Yes
MB	ASTM D516-90	1 in every 20 samples	< MDL	Table 8	Yes	Yes	Yes
LCS	ASTM D516-90	1 in every 20 samples	80-120% R	Table 16	Yes	Yes	Yes
LCSD	ASTM D516-90	1 in every 20 samples	≤ 20% RPD	Table 16	Yes	Yes	Yes
LDS	ASTM D516-90	1 in every 10 samples MSD suffices as LDS	≤ 30% RPD	Table 18	Yes	Yes	Yes
MS/MSD	ASTM D516-90	1 in every 10 samples	80-120% R 30% RPD	Table 20	Yes	Yes	Yes

Table 34 - Total Phosphate by SM4500P-E Calibration and Laboratory QC Sample Requirements

Laboratory QC	Method	Frequency	Control Limits	Action Table	L Report	L+ Report	Full Report
Calibration Curve Fit	SM4500P-E	At the beginning of run	$r \geq 0.995$	Table 7	No	Yes	Yes
ICV	SM4500P-E	Immediately after instrument calibration and after a continuing calibration failure	90-110% R	Table 7	No	Yes	Yes
CCV	SM4500P E	1 in every 10 samples, and after the last analytical sample	90-110% R	Table 7	No	Yes	Yes
ICB	SM4500P E	At beginning of analytical run, immediately after CCV	< MDL	Table 8	No	Yes	Yes
CCB	SM4500P E	1 in every 10 samples, and after the last analytical sample	< MDL	Table 8	No	Yes	Yes
MB	SM4500P E	One in every 20 samples	< MDL	Table 8	Yes	Yes	Yes
LCS	SM4500P E	One in every 20 samples	90-110% R	Table 16	Yes	Yes	Yes
LDS	SM4500P E	One in every 10 samples MSD suffices as LDS	30% RPD	Table 18	Yes	Yes	Yes
MS/MSD	SM4500P E	One in every 10 samples	80-120% R	Table 20	Yes	Yes	Yes

Table 35 – Chloride by SM4500-Cl E Calibration and Laboratory QC Sample Requirements

Laboratory QC	Method	Frequency	Control Limits	Action Table	L Report	L+ Report	Full Report
Calibration Curve Fit	SM 4500-Cl E	At the beginning of run	$r \geq 0.995$	Table 7	No	Yes	Yes
ICV	SM 4500-Cl E	Immediately after instrument calibration and after a continuing calibration failure	90-110% R	Table 7	No	Yes	Yes
CCV	SM 4500-Cl E	1 in every 10 samples, and after the last analytical sample	90-110% R	Table 7	No	Yes	Yes
ICB	SM 4500-Cl E	At beginning of analytical run, immediately after CCV	< 1/2 RL	Table 8	No	Yes	Yes
CCB	SM 4500-Cl E	1 in every 10 samples, and after the last analytical sample	< 1/2 RL	Table 8	No	Yes	Yes
MB	SM 4500-Cl E	1 in every 20 samples	< 1/2 RL	Table 8	Yes	Yes	Yes
LCS	SM 4500-Cl E	1 in every 20 samples	90-110% R	Table 16	Yes	Yes	Yes
LDS	SM 4500-Cl E	1 in every 10 samples MSD suffices as LDS	≤ 20% RPD	Table 18	Yes	Yes	Yes
MS/MSD	SM 4500-Cl E	1 in every 10 samples	80-120% R	Table 20	Yes	Yes	Yes

Table 36 – Anion (Bromide, chloride, fluoride, sulfate) Analysis by EPA 300.0 Calibration and Laboratory QC Sample Requirements

Laboratory QC	Method	Frequency	Control Limits	Action Table	L Report	L+ Report	Full Report
Calibration Curve Fit	EPA 300.0	At the beginning of run	$r \geq 0.990$	Table 7	No	Yes	Yes
ICV	EPA 300.0	Immediately after instrument calibration and after a continuing calibration failure	90-110% R	Table 7	No	Yes	Yes
CCV	EPA 300.0	1 in every 10 samples, and after the last analytical sample	90-110% R	Table 7	No	Yes	Yes
ICB	EPA 300.0	At beginning of analytical run, immediately after CCV	< MDL	Table 8	No	Yes	Yes
CCB	EPA 300.0	1 in every 10 samples, and after the last analytical sample	< MDL	Table 8	No	Yes	Yes
MB	EPA 300.0	1 in every 20 samples	< MDL	Table 8	Yes	Yes	Yes
LCS	EPA 300.0	1 in every 20 samples	90-110% R	Table 16	Yes	Yes	Yes
LDS	EPA 300.0	1 in every 10 samples MSD suffices as LDS	≤ 20% RPD	Table 18	Yes	Yes	Yes
MS/MSD	EPA 300.0	1 in every 10 samples	80-120% R	Table 20	Yes	Yes	Yes

Table 37 - Fluoride Analysis by SM4500-F-C Calibration and Laboratory QC Sample Requirements

Laboratory QC	Method	Frequency	Control Limits	Action Table	L Report	L+ Report	Full Report
Calibration Curve	SM 4500-F-C	Daily, prior to analysis	Slope=90-110%	Table 7	No	Yes	Yes
ICV	SM 4500-F-C	Immediately after instrument calibration and after a continuing calibration failure Sulfide analysis by SM4500-S^{2-}D calibration frequency is every six months or as needed. Thus, ICV frequency may be six months.	90-110% R	Table 7	No	Yes	Yes
CCV	SM 4500-F-C	1 in every 10 samples, and after the last analytical sample	90-110% R	Table 7	No	Yes	Yes
ICB	SM 4500-F-C	At beginning of analytical run, immediately after CCV	< MDL	Table 8	No	Yes	Yes
CCB	SM 4500-F-C	1 in every 10 samples, and after the last analytical sample	< MDL	Table 8	No	Yes	Yes
MB	SM 4500-F-C	One in every 20 samples	< MDL	Table 8	Yes	Yes	Yes
LCS	SM 4500-F-C	One in every 20 samples	90-110% R	Table 16	Yes	Yes	Yes
LDS	SM 4500-F-C	One in every 10 samples	20% RPD	Table 18	Yes	Yes	Yes
MS/MSD	SM 4500-F-C	One in every 10 samples	80-120% R	Table 20	Yes	Yes	Yes

Table 38 - Sulfide Analysis by SM4500-S^{2-}-D Calibration and Laboratory QC Sample Requirements

Laboratory QC	Method	Frequency	Control Limits	Action Table	L Report	L+ Report	Full Report
Calibration Curve Fit	SM4500-S^{2-}D	At the beginning of run	$r \geq 0.995$	Table 7	No	Yes	Yes
ICV	SM4500-S^{2-}D	Immediately after instrument calibration and after a continuing calibration failure Sulfide analysis by SM4500-S^{2-}D calibration frequency is every six months or as needed. Thus ICV frequency may be six months.	90-110% R	Table 7	No	Yes	Yes
High calibration check	SM4500-S^{2-}D	Daily prior to sample analysis unless ICV is run that day.	90-110% R	Table 7	No	Yes	Yes
Low calibration check	SM4500-S^{2-}D	Daily prior to sample analysis unless ICV is run that day.	90-110% R	Table 7	No	Yes	Yes
CCV	SM4500-S^{2-}D	One in every ten samples, and after the last analytical sample	90-110% R	Table 7	No	Yes	Yes
ICB	SM4500-S^{2-}D	At beginning of analytical run, immediately after CCV	< MDL	Table 8	No	Yes	Yes
CCB	SM4500-S^{2-}D	1 in every 10 samples, and after the last analytical sample	90-110% R	Table 8	No	Yes	Yes
MB	SM4500-S^{2-}D	One in every 20 samples	< MDL	Table 8	Yes	Yes	Yes
LCS	SM4500-S^{2-}D	One in every 20 samples	80-120% R	Table 16	Yes	Yes	Yes
LDS	SM4500-S^{2-}D	One in every 20 samples	20% RPD	Table 18	Yes	Yes	Yes
MS	SM4500-S^{2-}D	One in every 20 samples	75-125% of true value	Table 20	Yes	Yes	Yes

Table 39 – COD Analysis by SM5220D and EPA 410.4 Calibration and Laboratory QC Sample Requirements

Laboratory QC	Method	Frequency	Control Limits	Action Table	L Report	L+ Report	Full Report
Calibration Curve Fit	SM 5220D EPA 410.4	At the beginning of run	$r \geq 0.995$	Table 7	No	Yes	Yes
ICV	SM 5220D EPA 410.4	Immediately after instrument calibration and after a continuing calibration failure	SM5220D - 95-105% EPA 410.4 - 90-10%	Table 7	No	Yes	Yes
CCV	SM 5220D EPA 410.4	One in every ten samples, and after the last analytical sample	SM5220D - 95-105% EPA 410.4 - 90-10%	Table 7	No	Yes	Yes
ICB	SM 5220D EPA 410.4	At beginning of analytical run, immediately after CCV	< MDL	Table 8	No	Yes	Yes
CCB	SM 5220D EPA 410.4	1 in every 10 samples, and after the last analytical sample	< MDL	Table 8	No	Yes	Yes
MB	SM 5220D EPA 410.4	One in every 20 samples	< MDL	Table 8	Yes	Yes	Yes
LCS	SM 5220D EPA 410.4	One in every 20 samples	90-110% R	Table 16	Yes	Yes	Yes
LDS	SM 5220D EPA 410.4	One in every 10 samples MSD suffices as LDS	20% RPD	Table 18	Yes	Yes	Yes
MS	SM 5220D EPA 410.4	One in every 10 samples	SM 5220D 80-120% EPA 410.4 90-110%	Table 20	Yes	Yes	Yes

Table 40 – Ortho Phosphate Analysis by SM4500P-G Calibration and Laboratory QC Sample Requirements

Laboratory QC	Method	Frequency	Control Limits	Action Table	L Report	L+ Report	Full Report
Calibration Curve Fit	SM4500P-G	At the beginning of run	r ≥ 0.995	Table 7	No	Yes	Yes
ICV	SM4500P-G	Immediately after instrument calibration and after a continuing calibration failure	90-110% R	Table 7	No	Yes	Yes
CCV	SM4500P-G	1 in every 10 samples, and after the last analytical sample	90-110% R	Table 7	No	Yes	Yes
ICB	SM4500P-G	At beginning of analytical run, immediately after CCV	< MDL	Table 8	No	Yes	Yes
CCB	SM4500P-G	1 in every 10 samples, and after the last analytical sample	< MDL	Table 8	No	Yes	Yes
MB	SM4500P-G	One in every 20 samples	< MDL	Table 8	Yes	Yes	Yes
LCS	SM4500P-G	One in every 20 samples	90-110% R	Table 16	Yes	Yes	Yes
LDS	SM4500P-G	One in every 10 samples MSD suffices as LDS	30% RPD	Table 18	Yes	Yes	Yes
MS/MSD	SM4500P-G	One in every 10 samples	80-120% R	Table 20	Yes	Yes	Yes

3.5 Reported Results Authentication

Compare at least 10% of the reported results to the raw data results. This will be possible only with Full reports. When comparing results, correct for sample volumes, dilution factors, and units. The results should be confirmed randomly (i.e. do not pick the first 10% of results reported.) If there is a discrepancy, the laboratory needs to be notified and to submit a report revision with correct results included.

One of the initial steps in Level 2b data validation is confirming that all laboratory calibration and QC samples, as well as all client samples, appear in the raw data. Reported concentrations can be checked when confirming calibration and sample presence in the raw data. Figure 5 below shows the reported results for a client sample which has been assigned laboratory ID 10455965003. Figure 6 displays the Analysis Run Log. From the log, the analysis time and dilution factor can be determined. Note that sample -003 was run at 1X, 10X, and 100X dilutions and different parameters were reported from each of these analyses. Figure 7 shows the sample -003 raw data for the 1X dilution; while Figure 8 shows the raw data for the 10X and 100X dilutions. Note that in the examples below, results from the raw data are in ppb, while the reported values are in ppm. When corrected for units and dilutions, the raw data agrees with the reported values.

3.5.1 Check Laboratory Reported Sample Concentrations

For metals and mercury analyses in which both total and dissolved analyses have been performed, compare the laboratory reported total concentrations to the dissolved concentrations. For projects which report both total and dissolved concentrations, there is a worksheet which performs this comparison within the DV spreadsheet. The calculation (Total Result – Dissolved Result) is used; thus, the difference should be positive. Check for negative differences. In the case where numerous dissolved concentrations exceed total concentrations for the same sample, a switch (either by the laboratory or sampling team) is likely. Notify the laboratory of the results and ask for a sample confirmation or rerun if possible.

For projects in which total Kjeldahl nitrogen (TKN) and ammonia analyses have been performed, TKN results should always be greater than ammonia results. This check is performed automatically when the EDD is imported to the database. TKN is the sum of organic and ammonia nitrogen; thus, a TKN result significantly lower than an ammonia result is suspect. Discretion should be used in comparing TKN concentrations near the reporting limit.

Figure 5 – Reported Results for Client Sample with Laboratory ID 10455965003

ANALYTICAL RESULTS

Project: Rocker
Pace Project No.: 10455965

Sample: [redacted] **Lab ID:** 10455965003 Collected: 11/15/18 10:26 Received: 11/17/18 10:00 Matrix: Water

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
200.8 MET ICPMS, Dissolved	Analytical Method: EPA 200.8 Preparation Method: EPA 200.8								
Arsenic, Dissolved	**0.73**	mg/L	0.00050	0.00011	1	11/28/18 08:59	12/06/18 23:22	7440-38-2	
Cadmium, Dissolved	**0.0011**	mg/L	0.000080	0.000027	1	11/28/18 08:59	12/06/18 23:22	7440-43-9	
Calcium, Dissolved	**88.1**	mg/L	0.40	0.14	10	11/28/18 08:59	12/06/18 23:25	7440-70-2	
Copper, Dissolved	**0.0011**	mg/L	0.0010	0.00022	1	11/28/18 08:59	12/06/18 23:22	7440-50-8	
Iron, Dissolved	**0.26**	mg/L	0.050	0.0054	1	11/28/18 08:59	12/06/18 23:22	7439-89-6	
Lead, Dissolved	**0.000067J**	mg/L	0.00010	0.000039	1	11/28/18 08:59	12/06/18 23:22	7439-92-1	
Magnesium, Dissolved	**22.7**	mg/L	0.010	0.0050	1	11/28/18 08:59	12/06/18 23:22	7439-95-4	
Manganese, Dissolved	**27.8**	mg/L	0.050	0.024	100	11/28/18 08:59	12/06/18 23:28	7439-96-5	
Potassium, Dissolved	**4.6**	mg/L	0.10	0.018	1	11/28/18 08:59	12/06/18 23:22	7440-09-7	
Silicon, Dissolved	**19.5**	mg/L	0.50	0.16	10	11/28/18 08:59	12/06/18 23:25	7440-21-3	
Sodium, Dissolved	**29.3**	mg/L	0.050	0.018	1	11/28/18 08:59	12/06/18 23:22	7440-23-5	
Zinc, Dissolved	**0.0033J**	mg/L	0.0050	0.0019	1	11/28/18 08:59	12/06/18 23:22	7440-66-6	
2320B Alkalinity	Analytical Method: SM 2320B								
Alkalinity, Hydroxide (CaCO3)	ND	mg/L	5.0	1.0	1		11/28/18 08:18		
Alkalinity, Total as CaCO3	**226**	mg/L	5.0	1.0	1		11/28/18 08:18		
Alkalinity,Bicarbonate (CaCO3)	**226**	mg/L	5.0	1.0	1		11/28/18 08:18		
Alkalinity,Carbonate (CaCO3)	ND	mg/L	5.0	1.0	1		11/28/18 08:18		
2540C Total Dissolved Solids	Analytical Method: SM 2540C								
Total Dissolved Solids	**514**	mg/L	20.0	10.0	1		11/21/18 10:57		
ASTM D516 Sulfate Water	Analytical Method: ASTM D516								
Sulfate	**182**	mg/L	25.0	12.0	10		11/30/18 12:31	14808-79-8	
SM4500Cl-E Chloride	Analytical Method: SM 4500-Cl E								
Chloride	**20.1**	mg/L	2.0	0.59	1		11/27/18 11:32	16887-00-6	

Figure 6 – Analysis Run Log Showing Sample 10455965003. Log provides analysis time and dilution factors.

FORM XIII INORGANIC-1
ANALYSIS RUN LOG

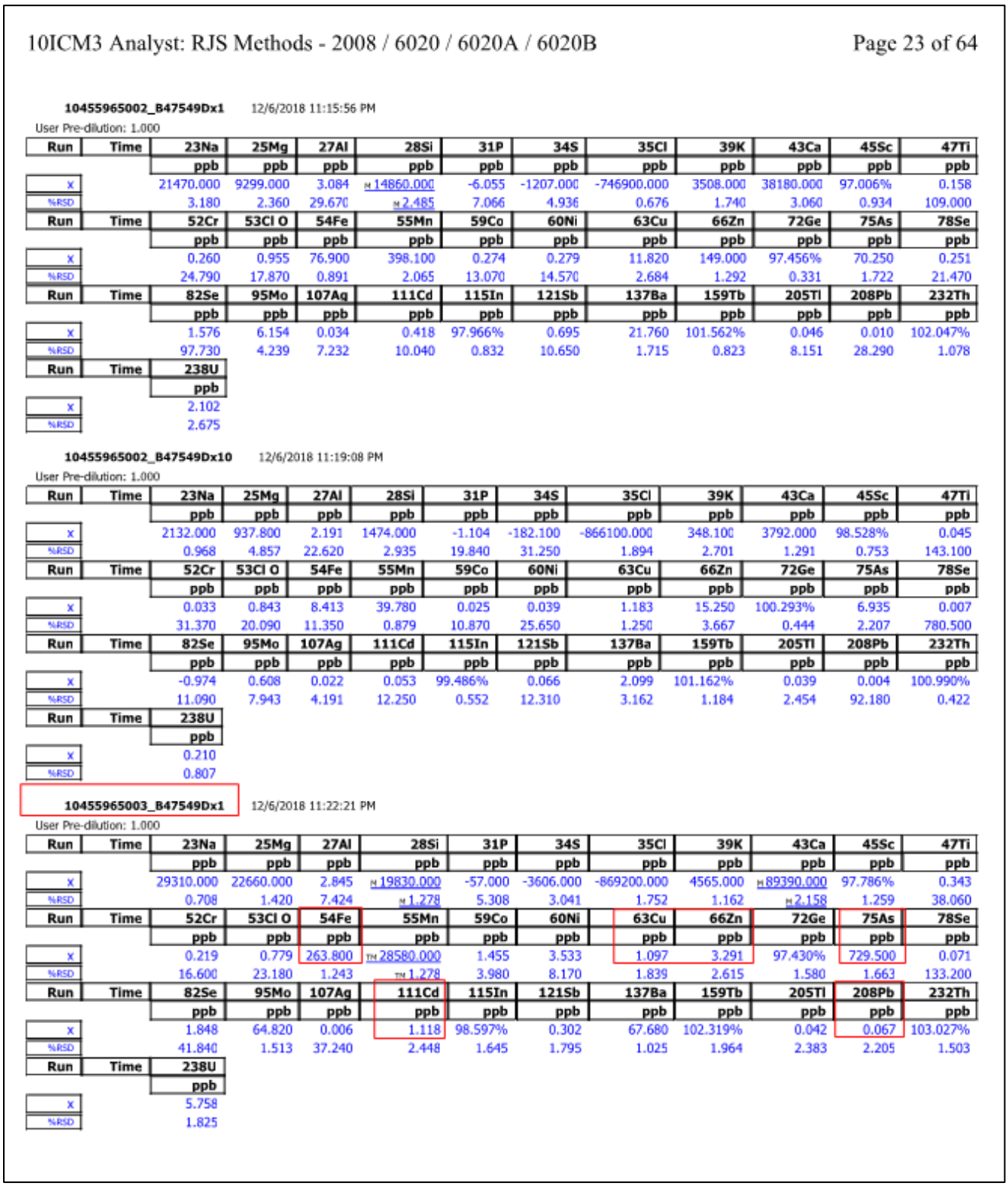
Lab: Pace Analytical - Minnesota SDG No. : 10455965 Contract: Rocker

Instrument: 10ICM3 Analysis: EPA 200.8

Start: 12/06/2018 21:42 End Date: 12/07/2018 02:12

Sample Name	Lab Sample ID	D/F	Date	Time	As	Ca	Cd	Cu	Fe	K	Mg	Mn	Na	Pb	Si	Zn
21235421CAL0	21235421CAL0	1	12/06/2018	21:42	X	X	X	X	X	X	X	X	X	X	X	X
21235422CAL1	21235422CAL1	1	12/06/2018	21:45	X	X	X	X	X	X	X	X	X	X	X	X
21235423CAL4	21235423CAL4	1	12/06/2018	21:48	X	X	X	X	X	X	X	X	X	X	X	X
21235424CAL5	21235424CAL5	1	12/06/2018	21:52	X	X	X	X	X	X	X	X	X	X	X	X
21235425CAL6	21235425CAL6	1	12/06/2018	21:55	X	X	X	X	X	X	X	X	X	X	X	X
21235426CAL2	21235426CAL2	1	12/06/2018	21:58	X	X	X	X	X	X	X	X	X	X	X	X
21235427CAL3	21235427CAL3	1	12/06/2018	22:02	X	X	X	X	X	X	X	X	X	X	X	X
21235428ICV	21235428ICV	1	12/06/2018	22:05	X	X	X	X	X	X	X	X	X	X	X	X
21235429ICB	21235429ICB	1	12/06/2018	22:12	X	X	X	X	X	X	X	X	X	X	X	X
21235430CRDL	21235430CRDL	1	12/06/2018	22:15	X	X	X	X	X	X	X	X	X	X	X	X
21235431ICSA	21235431ICSA	1	12/06/2018	22:19	X	X	X	X	X	X	X	X	X	X	X	X
21235432ICSAB	21235432ICSAB	1	12/06/2018	22:22	X	X	X	X	X	X	X	X	X	X	X	X
21235433CCV	21235433CCV	1	12/06/2018	22:25	X	X	X	X	X	X	X	X	X	X	X	X
21235434CCB	21235434CCB	1	12/06/2018	22:32	X	X	X	X	X	X	X	X	X	X	X	X
3127538BLANK	3127538	1	12/06/2018	22:35	X	X	X	X	X	X	X	X	X	X	X	X
3127539LCS	3127539	1	12/06/2018	22:38	X	X	X	X	X	X	X	X	X	X	X	X
[redacted]	10455965001	1	12/06/2018	22:42	X	X	X	X	X	X	X	X	X	X		X
3139123SD	3139123	5	12/06/2018	22:45	X	X	X	X	X	X	X	X	X	X		X
3127540MS	3127540	1	12/06/2018	22:52	X	X	X	X	X	X	X	X	X	X	X	X
3127541MSD	3127541	1	12/06/2018	22:55	X	X	X	X	X	X	X	X	X	X	X	X
[redacted]	10455965001	10	12/06/2018	22:59											X	
3139123SD	3139123	50	12/06/2018	23:06											X	
21235435CCV	21235435CCV	1	12/06/2018	23:09	X	X	X	X	X	X	X	X	X	X	X	X
21235436CCB	21235436CCB	1	12/06/2018	23:12	X	X	X	X	X	X	X	X	X	X	X	X
[redacted]	10455965002	1	12/06/2018	23:15	X	X	X	X	X	X	X	X	X	X		X
[redacted]	10455965002	10	12/06/2018	23:19											X	
[redacted]	10455965003	1	12/06/2018	23:22	X		X	X	X	X	X		X	X		X
[redacted]	10455965003	10	12/06/2018	23:25		X									X	
[redacted]	10455965003	100	12/06/2018	23:28								X				
[redacted]	10455965008	1	12/06/2018	23:32			X	X	X	X	X	X	X	X		X
[redacted]	10455965008	10	12/06/2018	23:35	X	X									X	

Figure 7 – ICP Raw Data Showing Sample 10455965002 Run at a 1X Dilution



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User Pre-dilution: 1.000

Run	Time	23Na	25Mg	27Al	28Si	31P	34S	35Cl	39K	43Ca	45Sc	47Ti
		ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb
x		21470.000	9299.000	3.084	M 14860.000	-6.055	-1207.000	-746900.000	3508.000	38180.000	97.006%	0.158
%RSD		3.180	2.360	29.670	M 2.485	7.066	4.936	0.676	1.740	3.060	0.934	109.000

Run	Time	52Cr	53Cl O	54Fe	55Mn	59Co	60Ni	63Cu	66Zn	72Ge	75As	78Se
		ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb
x		0.260	0.955	76.900	398.100	0.274	0.279	11.820	149.000	97.456%	70.250	0.251
%RSD		24.790	17.870	0.891	2.065	13.070	14.570	2.684	1.292	0.331	1.722	21.470

Run	Time	82Se	95Mo	107Ag	111Cd	115In	121Sb	137Ba	159Tb	205Tl	208Pb	232Th
		ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb
x		1.576	6.154	0.034	0.418	97.966%	0.695	21.760	101.562%	0.046	0.010	102.047%
%RSD		97.730	4.239	7.232	10.040	0.832	10.650	1.715	0.823	8.151	28.290	1.078

Run	Time	238U
		ppb
x		2.102
%RSD		2.675

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User Pre-dilution: 1.000

Run	Time	23Na	25Mg	27Al	28Si	31P	34S	35Cl	39K	43Ca	45Sc	47Ti
		ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb
x		2132.000	937.800	2.191	1474.000	-1.104	-182.100	-866100.000	348.100	3792.000	98.528%	0.045
%RSD		0.968	4.857	22.620	2.935	19.840	31.250	1.894	2.701	1.291	0.753	143.100

Run	Time	52Cr	53Cl O	54Fe	55Mn	59Co	60Ni	63Cu	66Zn	72Ge	75As	78Se
		ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb
x		0.033	0.843	8.413	39.780	0.025	0.039	1.183	15.250	100.293%	6.935	0.007
%RSD		31.370	20.090	11.350	0.879	10.870	25.650	1.250	3.667	0.444	2.207	780.500

Run	Time	82Se	95Mo	107Ag	111Cd	115In	121Sb	137Ba	159Tb	205Tl	208Pb	232Th
		ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb
x		-0.974	0.608	0.022	0.053	99.486%	0.066	2.099	101.162%	0.039	0.004	100.990%
%RSD		11.090	7.943	4.191	12.250	0.552	12.310	3.162	1.184	2.454	92.180	0.422

Run	Time	238U
		ppb
x		0.210
%RSD		0.807

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User Pre-dilution: 1.000

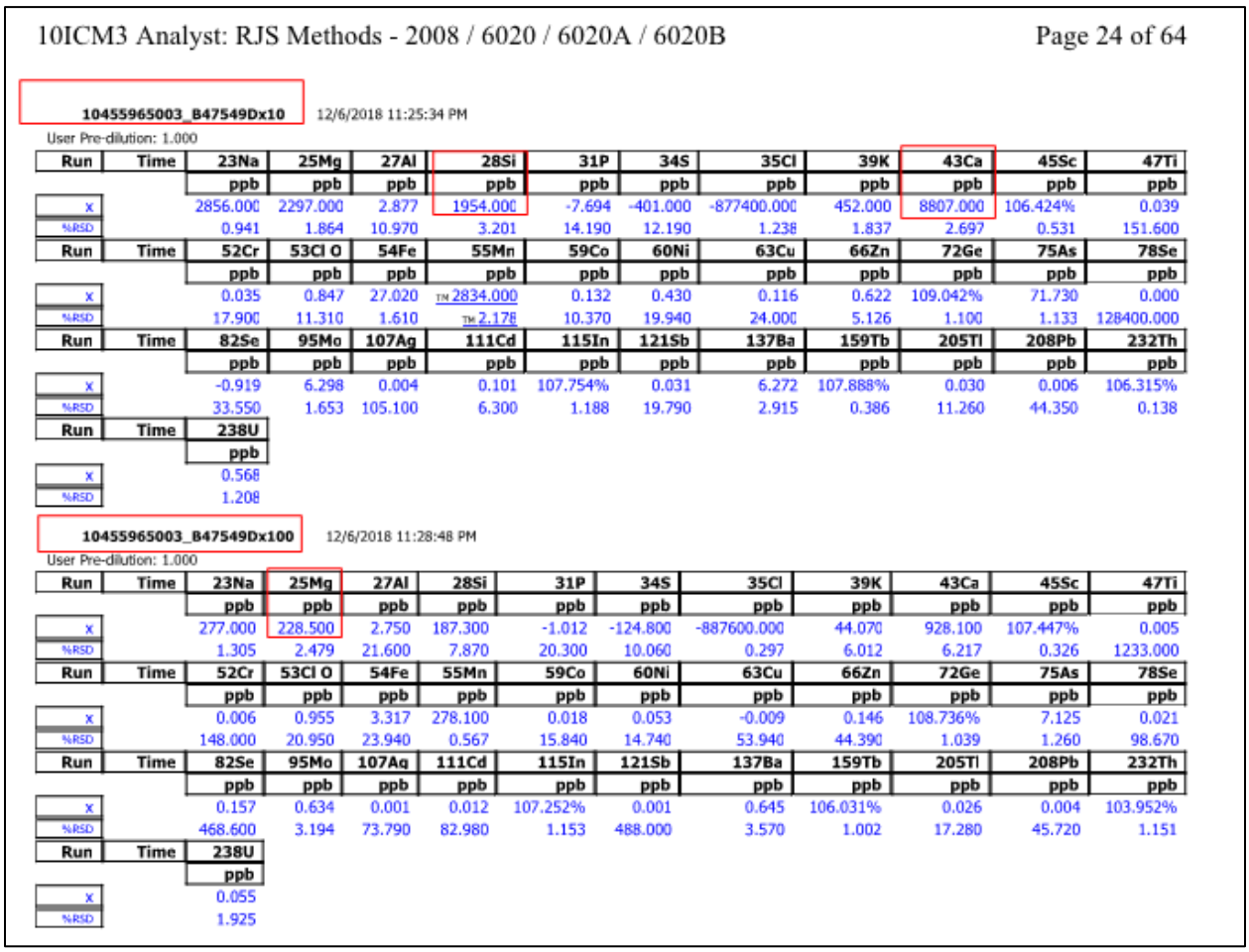
Run	Time	23Na	25Mg	27Al	28Si	31P	34S	35Cl	39K	43Ca	45Sc	47Ti
		ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb
x		29310.000	22660.000	2.845	N 19830.000	-57.000	-3606.000	-869200.000	4565.000	M 89390.000	97.786%	0.343
%RSD		0.708	1.420	7.424	N 1.278	5.308	3.041	1.752	1.162	M 2.158	1.259	38.060

Run	Time	52Cr	53Cl O	54Fe	55Mn	59Co	60Ni	63Cu	66Zn	72Ge	75As	78Se
		ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb
x		0.219	0.779	263.800	TN 28580.000	1.455	3.533	1.097	3.291	97.430%	729.500	0.071
%RSD		16.600	23.180	1.243	TN 1.278	3.980	8.170	1.839	2.615	1.580	1.663	133.200

Run	Time	82Se	95Mo	107Ag	111Cd	115In	121Sb	137Ba	159Tb	205Tl	208Pb	232Th
		ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb
x		1.848	64.820	0.006	1.118	98.597%	0.302	67.680	102.319%	0.042	0.067	103.027%
%RSD		41.840	1.513	37.240	2.448	1.645	1.795	1.025	1.964	2.383	2.205	1.503

Run	Time	238U
		ppb
x		5.758
%RSD		1.825

Figure 8 – Raw Data Showing Sample 10455965002 Run at a 10X and 100X Dilutions



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10455965003_B47549Dx10 12/6/2018 11:25:34 PM

User Pre-dilution: 1.000

Run	Time	23Na	25Mg	27Al	28Si	31P	34S	35Cl	39K	43Ca	45Sc	47Ti
		ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb
x		2856.000	2297.000	2.877	1954.000	-7.694	-401.000	-877400.000	452.000	8807.000	106.424%	0.039
%RSD		0.941	1.864	10.970	3.201	14.190	12.190	1.238	1.837	2.697	0.531	151.600

Run	Time	52Cr	53Cl O	54Fe	55Mn	59Co	60Ni	63Cu	66Zn	72Ge	75As	78Se
		ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb
x		0.035	0.847	27.020	TM 2834.000	0.132	0.430	0.116	0.622	109.042%	71.730	0.000
%RSD		17.900	11.310	1.610	TM 2.178	10.370	19.940	24.000	5.126	1.100	1.133	128400.000

Run	Time	82Se	95Mo	107Ag	111Cd	115In	121Sb	137Ba	159Tb	205Tl	208Pb	232Th
		ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb
x		-0.919	6.298	0.004	0.101	107.754%	0.031	6.272	107.888%	0.030	0.006	106.315%
%RSD		33.550	1.653	105.100	6.300	1.188	19.790	2.915	0.386	11.260	44.350	0.138

Run	Time	238U
		ppb
x		0.568
%RSD		1.208

10455965003_B47549Dx100 12/6/2018 11:28:48 PM

User Pre-dilution: 1.000

Run	Time	23Na	25Mg	27Al	28Si	31P	34S	35Cl	39K	43Ca	45Sc	47Ti
		ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb
x		277.000	228.500	2.750	187.300	-1.012	-124.800	-887600.000	44.070	928.100	107.447%	0.005
%RSD		1.305	2.479	21.600	7.870	20.300	10.060	0.297	6.012	6.217	0.326	1233.000

Run	Time	52Cr	53Cl O	54Fe	55Mn	59Co	60Ni	63Cu	66Zn	72Ge	75As	78Se
		ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb
x		0.006	0.955	3.317	278.100	0.018	0.053	-0.009	0.146	108.736%	7.125	0.021
%RSD		148.000	20.950	23.940	0.567	15.840	14.740	53.940	44.390	1.039	1.260	98.670

Run	Time	82Se	95Mo	107Ag	111Cd	115In	121Sb	137Ba	159Tb	205Tl	208Pb	232Th
		ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb
x		0.157	0.634	0.001	0.012	107.252%	0.001	0.645	106.031%	0.026	0.004	103.952%
%RSD		468.600	3.194	73.790	82.980	1.153	488.000	3.570	1.002	17.280	45.720	1.151

Run	Time	238U
		ppb
x		0.055
%RSD		1.925

3.6 Data Validation Notes to Remember

In addition to the general guidance and method specific guidance discussed above, the validator should keep the items discussed in Section 3.6 in mind.

3.6.1 Laboratory Qualifiers

Sample results come with laboratory qualifiers. The Laboratory Information Management System (LIMS)) automatically qualifies unrounded results lower than the MDL, "U" or "non-detect". Laboratory QC anomalies are also automatically qualified, although the results may meet QC criteria. A common example is a qualifier being applied to the parent sample used for the MS. Very often, the parent sample concentration is greater than 4X the spike concentration; therefore, recovery criteria are waived. Although the LIMS system has applied a qualifier, the validator will not necessarily apply a qualifier. It is very common to see laboratory data with a J qualifier. A laboratory J qualifier indicates the sample result was between the MDL and the RL. Just like the case narrative, use the laboratory qualifier flags as a tool; do not rely on these flags, as they may be inconsistent with guidance used to assign validation qualifiers.

3.6.2 Laboratory Control Limits

The LIMS may use control limits which differ from those specified in this SOP, or the project QAPP, and control limits may differ among labs. There may be instances when data are/are not flagged by the laboratory, and these data will not/will warrant a data validation qualifier. When assessing data, with the exception of laboratory blanks, the control limits within project QAPPS are the most pertinent reference. The limits tabulated in project QAPPs are the limits laboratories are required to meet; and generally, these limits align with method limits. Aside from laboratory blank criteria, the limits within this SOP also align with method limits. Laboratory blanks are assessed to the MDL during validation, but it is not reasonable to require laboratories to achieve blank results < the MDL.

3.6.3 Multiple Data Qualifiers and DV Reason Codes

In the data assessment process, a data point may be qualified for more than one QC deficiency. For example, a sample result less than the MB result may receive a UJ qualification. This same data point may be qualified because the laboratory duplicate precision was greater than the acceptable RPD, warranting a J qualification. Each data point is assigned only one qualifier, so an overall qualifier would be applied (see Table 41).

Unlike qualifiers, multiple reason codes may be applied, and these are listed in Table 42 below. If multiple reason codes are used, always list these codes in alphabetical order. For example, if a data point is qualified for matrix spike recovery (MS), laboratory duplicate precision (RPD), and a field blank detection (FB), the codes should be listed as "FB,MS,RPD". All analytical results, data validation qualifiers, and reason codes are stored in a database. A database recognizes "FB,MS,RPD" and "MS,FB,RPD" as two different reason codes. Multiple reason codes must be separated by commas, without any spaces in the text string. Ideally, only one and no more than two reason codes are applied. It is permissible to use more than one reason code; but use discretion in applying codes. For example, if an associated laboratory blank has a detection 10 parts per trillion (ppt) above the MDL and a field blank has a detection 10X the MDL, the FB detection would override the MB detection and only a FB code would be applied.

Table 41 – Multiple Data Qualifiers

Multiple Qualifiers	Overall Qualifier
Data point qualified (UJ) and either (J), (J+), or (J-)	Qualify result as estimated non-detect (UJ)
Data point qualified a combination of (J) and (J+) or (J) and (J-)	Qualify result as estimated high (J+) or estimated low (J-), respectively
Data point qualified as (J+) and (J-)	Qualify result as estimated (J)
Data point qualified (R) and any other qualifier	Qualify result as rejected (R)

Table 42 – Data Validation Reason Codes

Code[1]	Definition
A	Laboratory is not accredited for associated analyses
AB	Did not meet level A/B criteria
CC	Correlation coefficient less than 0.995 for instrument calibration
CCB	Continuing calibration blank contamination
CCV	Continuing calibration verification outside limits
COM	Result is not comparable to historical data
CQ	No calibration performed
CRQL	Contract required quantitation limit (CRDL) standard recovery outside quality control limits
DNR	Do not report. An alternate, acceptable result is available.
EB	Equipment blank contamination
ECR	Reported concentration exceeds instrument calibration range
FB	Field blank contamination
FD	Field duplicate RPD outside limits
HT	Holding time exceeded
ICB	Initial calibration blank contamination
ICS	Interference check standard recovery outside limits
ICV	Initial calibration verification outside limits
IP	Incorrect sample preservation
IS	Internal standard recovery outside limits
LCS	Lab control spike recovery is outside quality control limits
MB	Method blank contamination
MDL	Non-detect at MDL value
MI	Matrix interference with analyte quantitation
MS	Matrix spike recovery is outside quality control limits
PDS	Post digestion spike recovery is outside control limits
RB	Equipment rinse blank contamination
RPD	Duplicate sample relative percent difference exceeds QC limits
SD	ICP serial dilution percent difference outside QC limits
SUR	Surrogate recovery is outside QC limits
TB	Trip blank contamination
TIC	Compound was tentatively identified by GC/MS search
[1]Always list reason codes in alphabetical order, separated by commas, no spaces	

3.6.4 Labeling Errors

Occasionally sample bottles are mislabeled in the field, and this is most likely to happen when the field QC set is being collected. On many projects the entire QC set is collected at a single site, in the order: primary sample, duplicate sample, blank sample. When reviewing results, if the precision between the primary and duplicate sample is very poor for nearly all parameters and the blank sample has a detection for nearly every parameter, it is likely that the bottles were mis-labeled. Use professional judgement in re-assigning sample types. For example if RPDs between the primary sample and the sample identified as a blank is very good and the sample identified as a duplicate is non-detect for nearly every parameter, it is

likely the field duplicate and field blank labels were switched. If this occurs, the database manager for instructions on how to remedy the mix-up. Also notify the field team leader and the quality assurance officer. Detail the mistake and resolution within the checklist.

4.0 FIELD DATA VALIDATION

Field data validation includes an assessment of QC samples collected by the sampling team, and a review of sampling documentation and record keeping. Field QC sample assessment is discussed first. Refer to the project QAPP to determine the type and frequency of field QC samples. Some projects require only field duplicates, others require field duplicates and field blanks, and more than one type of field blank may be required. Generally, field QC sample frequency is one field QC sample or sample set (duplicate and blank), per 20 primary samples; however, there may be projects which require one field QC set per day. The project QAPP will provide this information.

Data for the majority of TREC projects is managed by the in-house data management team. The team has developed macro-enabled spreadsheets specifically for data validation (referred to as Data Validation Spreadsheet-DVS- below). Spreadsheet format may differ slightly across projects. In the examples within this section, spreadsheets developed for BPSOU are used in examples.

4.1 Data Summary Table Setup

Field QC files have been developed for BPSOU projects, and these can be found in the project specific folders within the data validation folder. Open the field QC template, immediately save it to the appropriate folder with an intuitive file name. Within the files there are worksheets for field blanks and field duplicate sets. Populate these worksheets by copying the appropriate results from the DV spreadsheet. Within the field duplicate worksheet be certain duplicate sets are aligning and analytical parameters are aligning. When copying data into the worksheets, do not paste over columns containing formulas. Once data is pasted into the correct worksheet, use “convert to number” to assure results are expressed as number values, not text values. If results are not expressed as number values, the formulas will not work.

The Blank worksheet checks for field blank results which do not meet criteria, and if criteria are not met (≤ 1.5X the MDL), the blank result is multiplied by 10. The worksheet titled Dup calculates the RPD for duplicate pairs. The Dup worksheet also checks sample and duplicate results to see if there is > a 20% RPD between results, if results are ≥ 5X the RL, and if not, the spreadsheet checks the difference between the duplicate pair results. All field blank samples will be listed in the Blank worksheet and all field duplicate samples will be listed in the DUP worksheet. Data can be copied directly from the DVS into the QC templates.

To find field QC samples within the DVS, filter the data to isolate field duplicate and field blank samples. In the sample type column, field duplicates will be have a suffix of “-D” (FG-D, IS-D, or AS-D). The primary sample for each duplicate will have suffix of “-N” as in “FG-N”). Field blanks will be sample types such as FB, RB, TB, ECB, CCB, and in the location column any field collected blank will be identified as SWQC or GWQC. In the ensuing discussion, this field QC worksheet will be referred to as the Field QC Summary file (FQC).

4.1.1 Group Samples in Field QC Batches

As previously discussed, the field QC frequency for most projects is one field duplicate and one field blank per 20 primary samples. This is an overall rate; thus, if a project consists of 21-40 primary samples, two of each required QC samples could be collected on a single day. Ideally, field QC samples will be collected at a rate of one duplicate, one blank (as appropriate) within the first 20 primary samples collected. The second duplicate and blank will be collected between primary sample 21 and 40, the third QC sample set will be collected between primary sample 41 and 60, and so on. Results of the first duplicate and field blank will be used to assess primary samples 1-20, results of the second duplicate and field blank will be used to assess primary samples 21-40, etc. If all field QC samples were collected on a single day, the results of all field QC samples would be applied to all of the samples. By spacing QC samples out, the QC sample results can be applied to fewer samples. This is advantageous when field blank or duplicate sample results prompt qualifications. The primary sample counts (groups of 20) includes only primary samples; field QC samples are not included in the count.

Often project sampling is not completed in a single day and as an example, field QC samples may have been collected on two days of a three-day sampling event. Try to group primary samples/QC samples by SDG to simplify the validation process. In order to batch field QC samples with laboratory SDGs, it is allowable to group primary samples in groups of up to 22 primary samples (assuming the QC sample rate is 5% of primary samples). If this is done, some groups will have fewer than 20 samples. No matter how samples are batched, the overall field QC rate must have been met.

When validating samples collected in automatic samplers which collect multiple samples, try to avoid breaking up the sampler group. For example, if Samplers A, B, C, D, E, and F each collect four there would be 24 primary samples among the four samplers. If possible don't assign QC set 1 to the samples from samplers A, B, C, D, and two of the samples in Samper E and QC set 2 to the two remaining samples in Sampler E and the four samples from Sampler F. Rather, keep all samples in Sampler E with the same QC set.

4.2 Verify Field QC Parameters

Required field QC sample frequency and sample type is indicated in project QAPPs. Verify that QC sample type and frequency were met. All field QC samples must be analyzed for the same parameters analyzed in primary samples. If field QC sample type, frequency, or analyses did not meet the criteria specified in the project QAPP, this will be indicated on the field checklist, which is discussed in Section 5.1

4.3 Field Blank Results

Field collected blanks may be identified as field blanks, "trip" blanks, rinsate blanks, equipment contamination blanks, or cross contamination blanks. In this discussion, all of these will be referred to as FBs, and ideally all of these should have results less than the MDL. Any BP LaMP approved laboratory should report results to the MDL; thus, results below the detection limit will be reported as "< MDL" "ND" (non-detect), or as a value at the MDL accompanied by a "U" qualifier. If a result is reported at the MDL with no "U" qualifier, then the result was a detection at the MDL. Unless indicated in the project QAPP, laboratories not in the LaMP program may not report to the MDL, but to the reporting limit (RL). If this occurs, field blank results should be < RL.

Field collected blank results may be influenced by laboratory blank results; but, use discretion in qualifying field collected blank results based on laboratory blank detections. While the majority of projects do assess field collected blank results based on laboratory blank results, there are projects which assess the two types of blanks separately. Check with the project manager or quality assurance officer to determine which practice is followed for the analytical results being validated.

If FB results will be assessed against laboratory blanks, determine if it is likely that the FB result was influenced by laboratory contamination. With L+ and Full packages, ICB and CCB detections should be applied to FB results only if the FB was analyzed between out of control ICB/CCB samples. Since MBs apply to entire laboratory QC batches, FB results should be assessed against MB results, assuming the FB was analyzed in the same laboratory QC batch which had MB detections. There will be instances when FB results apply to samples which were analyzed in two or more laboratory QC batches. Table 43 provides guidance on assessing sample results when this occurs. Table 44 provides guidance for qualifying data based on FB detections. Table 43 and Table 44 should be used together. First determine which situation in Table 43 applies, then apply qualifiers as indicated in Table 44. If a data validation qualifier is assigned for the FB detection, add reason code "FB". Refer to Section 3.3.3 Laboratory Blank Data for guidance in qualifying data for laboratory blank detections.

Unlike laboratory blanks, the laboratory instrument value is not used in assessing FB detections. Use the reported result of the FBs and associated samples in assessing FB detections.

Table 43 – Field Blank Assessment in Relation to Laboratory Blanks

FB/MB/Samples all in same lab QC batch			
FB Result	**Lab Blank > MDL**	**FB Qualification**	**Associated Sample Qualification**
FB < MDL	MB > FB	No qualification for FB	Qualify samples based on lab blank
FB > MDL	MB > FB	Qualify FB for MB detection	Qualify samples based on lab blank detection
FB > MDL	FB > MB	Qualify FB for MB detection but use professional judgement. If the FB is >> MB and MB detection is ≤ 2X MDL it is doubtful the MB detection had an impact on the FB result.	Qualify samples based on FB detection
FB/MB in same lab QC batch, FB associated samples in two or more lab QC batches			
FB Result	**Lab Blank > MDL**	**FB Qualification**	**Sample Qualification**
FB < MDL	MB > FB	No qualification for FB	Qualify samples based on lab blank
FB > MDL	MB > FB	Qualify FB for lab blank detection	Determine which samples were in impacted lab QC batch, if the MB

FB > MDL	FB > MB	Qualify FB for MB detection but use professional judgement. If the FB is >> MB and MB detection is ≤ 2X MDL it is doubtful the MB detection had an impact on the FB result.	was > FB, qualify the samples in that lab batch for lab blank detection. Samples which were in a lab QC batch with in-control lab blanks, qualify for FB detection.

Table 44 – Field Blank Action

Field Blank Result	Sample Results	Action for Samples
FB < Lab Blank	Any	No action for FB detection. Data assessed based on lab blank results
> MDL, but ≤ 1.5X MDL	Non-detect (< MDL) ≥ MDL	No action No action
> 1.5X MDL	Non-detect (< MDL) ≥ MDL, but ≤ RL > RL but ≤ 10X blank value > 10X blank value	No action Qualify results as estimated non-detect (UJ) Qualify results as estimated high (J+) No action
< 2X |-MDL|	Non-detect (< MDL) ≤ 5x absolute blank value	Qualify results as estimated (UJ) Qualify results as estimated low (J-)

4.4 Field Duplicate Results

Check the RPDs between primary and duplicate samples and assign data qualifiers as indicated in Table 45. The RPD is determined by:

$$\boldsymbol{RPD}\% = \frac{|\boldsymbol{S-D}|}{\frac{\boldsymbol{S+D}}{\boldsymbol{2}}} \times \boldsymbol{100}$$

Where S = primary sample

D = duplicate sample

Acceptable RPDs are ≤ 20% for aqueous samples and ≤ 35% for solid samples. The 20%/35% limits are applicable when both the primary and duplicate sample are ≥ 5X the RL. If either the primary or duplicate sample are < 5X the RL, an acceptable RPD is < RL for aqueous samples or < 2X the RL for solid samples. When qualifying data based on field precision, consider matrix similarity in the same manner that it is assessed for laboratory duplicates and laboratory MS/MSD samples. TDS, TSS, sulfate, and alkalinity will likely be the simplest parameters to assess, but also consider trace metal results. Qualify results only from samples that are of a similar matrix to that of the duplicate sample set. For example, the matrix of a sample collected upstream of a point-source discharge may be dissimilar to the matrix of water collected downstream of the discharge. Qualifications based on FD RPDs are not applied to field collected

blanks since they are made up of DI water, and the sample matrix differs from that which makes up the primary and duplicate sample.

When assessing RPDs, round to the whole number, with values < 20.5/35.5 rounded down and values ≥ 20.5/35.5 rounded up. Assign code "FD" to results qualified for field precision.

Table 45 – Field Duplicate Action

Duplicate Sample Results	Action for Samples
Both primary and duplicate sample ≥ 5X RL & RPD > 20%/35%	Qualify results ≥ MDL as estimated (J) Qualify non-detects as estimated non-detect (UJ)
Primary or duplicate sample result < 5X RL & absolute difference between sample and duplicate > RL (2X RL for solids)	Qualify results ≥ MDL as estimated (J) Qualify non-detects as estimated non-detect (UJ)
Primary or duplicate sample result < 5X RL & absolute difference between sample and duplicate ≤ RL (2X RL for solids)	No action

5.0 QUALITY DESIGNATION

Data quality is assessed by assigning each data point a quality of Enforcement (E), Screening (S), or Rejected (R). Before assigning quality, the Field Checklist must be completed, and samples must be designated as meeting Level A or Level B criteria. Note that only primary samples are assigned a quality status. A quality status is not applicable to field QC samples.

5.1 Level A/B Assessment

Note that Level A/B applies to entire samples, not individual data points. Figure 9 presents an example Field Checklist. The checklist may differ slightly across projects. The Figure 9 example was developed for Clark Fork River Superfund Site Investigations (CFRSSI) projects; and for those projects, the checklist is often referred to as the Level A/B checklist. The checklist is fairly self-explanatory. The checklist information can be found in field logbooks or on electronic field forms. If this information is not found in the logbooks or forms, within reason, it can be discerned through conversation with the sampling team. However, if conversations are necessary, the sampling team should be instructed to document the missing information for all future field efforts.

Based on the checklist review, all samples (primary samples and field QC samples) are designated as Level A, Level B, or Unusable. If a sample receives Level A or Unusable designation, all results for that sample would be qualified as estimated (J), and the reason code AB would be assigned. It is possible for a sample to be designated as Level B, but individual data points for that sample to be qualified as estimated and coded AB. This would only happen if the field QC samples associated with that sample did not undergo the full analysis the sample underwent. For example, if manganese analysis was requested for two primary samples, but the field duplicate did not undergo manganese analysis, the field QC requirements (item III.3 in Figure 9) would not be complete for manganese analysis. In such a case, the

sample would be considered Level B, but the manganese results for the two samples would be qualified J, and an AB reason code applied.

A Level A/B checklists is attached as an appendix to this SOP, and they can also be found at the link below.

\\woodardcurran.net\shared\Offices\Bozeman\BUTTE\TREC\ARCO\DataValidation\AB_Checklists

Figure 9 – Example Field Checklist

Level A/B Screening Checklist			
I.	General Information		II. Screening Results
	Site:	SITE NAME	Data are:
	Project:	SITE NAME/LAB SDG #	1) Unusable _____
	Client:		2) Level A YES or NO
	Sample Matrix:		3) Level B YES or NO
II.	Level A Screening		
			Yes/No
1.	Sampling date		
2.	Sample team/or leader		
3.	Physical description of sample location		
4.	Sample depth (soils)		
5.	Sample collection technique		
6.	Field preparation technique		
7.	Sample preservation technique		
8.	Sample shipping records		
III.	Level B Screening		
1.	Field instrumentation methods and standardization complete		
2.	Sample container preparation		
3.	Collection of field replicates (insert QAPP requirement)		
4.	Proper and decontaminated sampling equipment		
5.	Field custody documentation		
6.	Shipping custody documentation		
7.	Traceable sample designation number		
8.	Field notebook(s), custody records in secure repository		
9.	Completed field forms		

5.2 Quality Designation

Each primary sample data point is assigned a quality, Enforcement, Screening, or Rejected. Field QC samples do not receive a data quality designation. Enforcement quality data meet all QA/QC and documentation requirements and can be categorized as definitive data with unrestricted use. Screening

quality data do not meet the applicable QA/QC requirements and/or documentation requirements and can be categorized as data whose associated numerical values are estimated. Unusable data may result from inappropriate sampling, analysis, or documentation procedures; or from field or laboratory calibration and/or QC sample results which are far outside of acceptable criteria. Unusable data is given a qualifier and a quality of R, rejected and these data cannot be used. Table 46 provides a matrix for determining data quality assignment. Note that the J qualifiers in Table 46 refer to those applied during validation, not J qualifiers applied by the laboratory. Laboratory J qualifiers indicate that the sample result was between the MDL and the RL. Data J qualified by the laboratory may receive an enforcement status.

Table 46 – Data Quality Matrix

Data Validation Qualifier	Level A/B Designation		
	Level B	Level A	Rejected
No qualifier or U	Enforcement (E)	Screening (S)	Unusable (R)
J, J+, J- or UJ	Screening (S)	Screening (S)	Unusable (R)
R	Unusable (R)	Unusable (R)	Unusable (R)

6.0 DATA VALIDATION SUMMARY

6.1 Data Validation Summary

The data validation checklist that is compiled throughout the validation process is one portion of the data validation summary. A second component is a short write-up which summarizes the outcome of data validation. The summary should state the number of primary sample data points, the number (and percentage) of data points which were assessed as enforcement quality, the number (and percentage) of data points assessed as screening quality, and the number (and percentage) that were rejected. The summary should also state the reason data points did not meet enforcement quality. Refer to the checklists in Appendix D for examples of data validation summaries.

6.2 Data Assessment Report (DAR.)

The frequency that data assessment reports (DARs) must be compiled differs among projects. For BPSOU projects, the DAR is compiled annually, and submitted as an appendix to annual Data Summary Reports. Rocker OU DARs are compiled quarterly and submitted as an appendix to quarterly Operations and Monitoring Reports. The details, table formats, and checklists included in DARs differs among projects. Generally, the depth of detail is driven by the project manager in conference with the project quality assurance officer, as well as the Agency reviewer. DARs include a write-up of data validation results of all analytical data for the reporting period, several tables, and checklists. Example DARs can be found at the links below.

BPSOU surface water DAR

\\woodardcurran.net\shared\Projects\TREC\9208_AR_MT_BPSOU\9208 - 2009 BPSOU\9208-003_SW-GW_Monitoring\01_SurfaceWater\03_DSRs\2019\BF&WW\2-Submittal\Agency submittal 4-10-2020\Attachments\Appendix B Data Validation\2019_BPSOU_AppendixB_DQA_SW.pdf

Rocker Groundwater DAR

..\..\Rocker\2017Rpts\Qtr4\AppG_DatValidation4QTR17.pdf

6.2.1 Review the DV spreadsheet.

Once the data validation spreadsheet, the data validation checklist, and the data validation summary are compiled, a competent person should review the spreadsheet, the checklist, and the summary report. Use the following items as a guide.

1. Ensure that all requested analyses have been reported. This can be done by performing a total count of data points. For example, a BPSOU storm drain package containing 16 samples (each analyzed for TSS, and total and dissolved (As, Cd, Cu, Fe, Hg, Pb, and Zn) should contain 240 data points (ie. 15 (analytes) X 16 (samples) = 240). If the count does not equal the expected count, first review the chain of custody. For BPSOU wet weather and storm drain samples, it is not unusual that analyses will be missing due to inadequate sample volume. The COC will indicate the requested analysis for each sample. If there is nothing unexpected on the COC, consult the sample receipt form which follows the COC in the laboratory data package. This form will indicate if samples spilled en route to the lab, or at the lab. If the sample receipt form cannot explain the missing analyses, consult sample preparation records, and finally contact the laboratory project manager.
2. Make sure all required fields are populated in the DV file: validator qualifier, qualifier code, quality designation, validator, validation date, validation level, Level A/B designation (AB designation is on a separate worksheet within the DV file).
3. Perform filter checks within the distribution file to check for the following mistakes:
   a. No Non-Detects were qualified J and No detects were qualified UJ (unless the data point was qualified as “UJ” during laboratory blank or FB assessment.)
   b. No FB samples were qualified due to MS, MSD, LDS, SD, FD, or FB codes. Exceptions would be if the FB sample was used as the parent sample for the MS or LDS. (Note that if the FB was used as the parent for the MS, by default, it is the parent for the MSD; and, if the FB was used as the parent for the SD, then the parent sample result should be < 50X the MDL, thus the SD was not assessed for percent difference.)
   c. Any result assigned an E quality does not have a corresponding qualifier or code. Any results assigned an S quality has a corresponding qualifier and code. Any result assigned an R quality has a R qualifier.
   d. No FD or FB results have been assigned a quality.
   e. All primary sample results have been assigned a quality.
4. Double check the totals vs dissolved metals concentration comparison. This is performed within the distribution file under the tab “DisTR_DBLinked”. If there are numerous dissolved concentrations > total concentrations for a sample, it is likely that the two sample aliquots were mislabeled in the field, or a mix-up occurred at the lab.
5. Ensure that laboratory QC batches have been applied properly within the checklist.
6. Ensure sample and analysis dates are correct within the checklist.
7. Review the checklist and compare qualifications within the checklist to qualifications in the DV file to make sure that they agree.

8. Make sure all results are unfiltered prior to submittal.

6.3 Submit the Distribution File to the Data Team.

For BPSOU projects, data tracking should be performed within the DV Index Excel sheet. Completion, reviews, any rejected results or special cases (ie. switched sample results) should be documented in the Notes section of the DV Index file. This will be useful when compiling Data Assessment Reports. Once review and any necessary revisions are made, send the distribution file with the pre-assigned naming convention to: Donna Hawley, Jonathan Longden, and the appropriate project email address:

mailto:jlongden@woodardcurran.com

BPSOU and Rocker data: bpsoudata@woodardcurran.com
Great Falls Data: TrecDataGF@woodardcurran.com

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APPENDICES

Appendix A Measurement Performance Criteria for Data

Appendix B Comprehensive Holding Time Table

Appendix C Level A/B Checklist

Appendix D Data Validation Checklists

Appendix A Measurement Performance Criteria for Data

Measurement performance criteria are established by defining acceptance criteria and quantitative or qualitative goals (e.g., control limits) for accuracy, precision, representativeness, comparability and completeness of measurement data. The definitions of precision, accuracy, representativeness, comparability and completeness are provided below along with the acceptance criteria for data collected. Equations for calculation of precision, accuracy and completeness are provided in Table 1– Holding Times and Preservation Requirements.

Table A1 Precision, Accuracy and Completeness Calculations Equations

Characteristic	Formula	Symbols
Precision (as relative percent difference, RPD)	$RPD = \frac{(x_i - x_j)}{\left(\frac{x_i + x_j}{2}\right)} \times 100$	x_i, x_j: replicate values of x
Precision (as relative standard deviation, RSD, otherwise known as coefficient of variation)	$RSD = \frac{\sigma}{\bar{x}} \times 100$	σ: sample standard deviation $\bar{x}$: sample mean
Accuracy (as percent recovery, R, for samples without a background level of the analyte, such as reference materials, laboratory control samples and performance evaluation samples)	$R = \frac{x}{t} \times 100$	x: sample value t: true or assumed value
Accuracy (as percent recovery, R, for samples with a background level of the analyte, such as matrix spikes)	$R = \frac{SSR - SR}{SA} \times 100$	SSR: spiked sample result SR: sample result SA: spike added
Accuracy (as percent difference, D, for samples > 50X the MDL, which have undergone at least a five-fold dilution, with the result, S, corrected for the dilution)	$D = \frac{\lvert I - S \rvert}{I} \times 100$	I: initial sample result S: serial dilution result
Completeness (as a percentage, C)	$C = \frac{n}{N} \times 100$	n: number of valid data points produced N: total number of samples taken

Precision

Precision is the level of agreement among repeated measurements of the same characteristic. There are two general forms of uncertainty. The first is the random error component of the data collection process. The second is inherent stochastic variability, which cannot be eliminated but can be described.

Data precision is assessed by determining the agreement between replicate measurements of the same sample and/or measurements of duplicate samples. The overall random error component of precision is a function of the sampling. The analytical precision is determined by the analysis of field duplicates by laboratories and by replicate analyses of the same sample. An analytical duplicate is the preferred measure of analytical method precision. When analytes are present in samples at concentrations below or near the quantitation limit, precision may be evaluated using duplicate analyses of laboratory prepared samples such as duplicate laboratory matrix spike samples (MS/MSD), duplicate laboratory control spike samples

(LCS/LCSD), and/or laboratory duplicate (LD) samples. Precision can be measured as relative percent difference (RPD) or as relative standard deviation (RSD) (also known as a coefficient of variation). Formulae for both are presented in Table A1.

Accuracy/Bias

Accuracy is the degree of difference between the measured or calculated value and the true value. It is a measure of the bias or systematic error of the entire data collection process. Potential sources of systematic errors include:

- sample collection methods;
- physical or chemical instability of the samples;
- interference effects during sample analysis;
- calibration of the measurement system; and
- contamination.

Field blanks and laboratory method blanks (MB) may be analyzed to assess artifacts introduced during sampling, transport and/or analysis that may affect the accuracy of the data. In addition, initial calibration verifications (ICVs), continuing calibration verifications (CCVs), initial calibration blanks (ICBs), and continuing calibration blanks (CCBs) are used to verify that sample concentrations are accurately measured by the analytical instrument throughout the analytical run. Note that ICV, CCV, ICB, and CCB results are reported only in Level III and IV data packages.

Representativeness

Data representativeness is defined as the degree to which data accurately and precisely represents a characteristic of a population, parameter variations at a sampling point or environmental conditions. Representativeness is a qualitative parameter that is most concerned with the proper design of the sampling program. Representativeness of samples shall be achieved through the careful selection of sampling locations and methods. Sample representativeness may also be evaluated using the RPDs for field duplicate results, as well as field blank results. Agreement between duplicate samples is applicable to representativeness of individual sampling points, not the overall sampling program. If agreement between field duplicates is acceptable ($\leq$ 20% RPD for sample concentrations greater than five times the reporting limit, and a delta < the RL for samples less than five times the reporting limit), it can be assured that the reported concentration is a valid representative measure of near-aquifer conditions. If agreement between duplicate samples is not acceptable, the reported concentration must be considered an estimation of conditions.

Comparability

Data comparability is defined as the measure of the confidence with which one data set can be compared to another. Comparability is a qualitative parameter but must be considered in the design of the sampling plan and selection of analytical methods, quality control protocols, and data reporting requirements. Comparability is ensured by analyzing samples obtained in accordance with appropriate SOPs. All analytical data should be calculated and reported in units consistent with standard reporting procedures so that the results of the analyses can be compared with those of other laboratories, if necessary.

Completeness

Completeness refers to the amount of usable data produced during a sampling and analysis program. When determining completeness, also consider the number of samples that were collected in terms of the number of samples that were anticipated to be collected.

Sensitivity

Sensitivity refers to the capability to quantify an analyte at a given concentration, and this parameter is associated with the instrument and method detection limits, and the project reporting limits. The desired analytical sensitivity are typically method detection limits less than the applicable water quality standards specified in Montana Circular DEQ-7, Montana Numeric Water Quality Standards and detection limits that will allow geochemical analysis.

Appendix B Comprehensive Holding Time Table

Table B1 – Expanded List of Holding Times and Preservation Requirements

Analyte	Method	Holding Time	Preservative	BPSOU BF	BPSOU WW	Diagnostic	Expanded	BPSOU GW	Rocker	Great Falls
Alkalinity: Total, Carbonate, Bicarbonate, & Hydroxide	SM 2320B	14 days	Raw 0-6°C	Total only	Total only			x	x	
Anions by Chromatography (bromide, chloride, fluoride, sulfate)	EPA 300.0	28 days	Raw 0-6°C				Cl, F, SO4	Cl, SO4		x
Anions by Chromatography (orthophosphate-P, nitrate, nitrite)	EPA 300.0	48 hours	Raw 0-6°C							
Chloride	SM4500-Cl C	28 days	Raw 0-6°C						X	
Fluoride	SM 4500-F− C	28 days	Raw 0-6°C							
Orthophosphate-P	SM4500-P B/E	48 hours	Raw 0-6°C							
Sulfate	ASTMD 516	28 days	Raw 0-6°C	x	x	x			x	
Dissolved Organic Carbon/Total Organic Carbon (DOC/TOC)	SM 5310 C	28 days	H_2SO_4 < pH 2 0-6°C	DOC	DOC		DOC			

Analyte	Method	Holding Time	Preservative	BPSOU BF	BPSOU WW	Diagnostic	Expanded	BPSOU GW	Rocker	Great Falls
Hardness[1]	SM 2340B	180 days	HNO_3 < pH 2	x	x					
Mercury (aqueous) total and dissolved by CVAA	EPA 245.1, SW846 7470	28 days	HNO_3 < pH 2	245.1	245.1			245.1		
Metals (aqueous) total and dissolved by ICP-AES	EPA 200.7, SW846 6010	180 days	HNO_3 < pH 2				SW846 6010B			
Metals (aqueous) total and dissolved by ICP-MS	EPA 200.8, SW846 6020, 6020A, 6020B,	180 days	HNO_3 < pH 2	200.8	200.8	200.8	SW846 6020A	200.8	200.8	
Metals (aqueous) - Dissolved Exotic by ICP-MS (Cs & Rb)	SW6020A_E	180 days	HNO_3 < pH 2				x			
Nitrogen - Ammonia	**EPA 350.1** SM 4500-NH3 B/C	28 days	H_2SO_4 < pH 2 0-6°C	x	x					
Nitrogen - NO_2/NO_3	**SM 4500-NO3 H** SM 4500-NO3 E SM 4500-NO2 B	28 days	H_2SO_4 < pH 2 0-6°C	x	x					

Analyte	Method	Holding Time	Preservative	BPSOU BF	BPSOU WW	Diagnostic	Expanded	BPSOU GW	Rocker	Great Falls
Nitrogen - Total Kjeldahl Nitrogen	**EPA 351.2** SM 4500-Norg B	28 days	H_2SO_4 < pH 2 0-6°C	x	x					
pH	EPA 150.1	24 hours	Raw 0-6°C				x	x		
Solids - Total Dissolved Solids	SM 2540C	7 days	Raw 0-6°C	x	x			x		
Solids - Total Suspended Solids	SM 2540D	7 days	Raw 0-6°C	x	x	x				
Solids, Total (TS)	SM 2540B	7 days	Raw 0-6°C							
Solids, Volatile (VS)	SM 2540 E / EPA 160.4	7 days	Raw 0-6°C							
Solids, Settleable (SS)	SM 2540 F	48 hours	Raw 0-6°C							
Solids, Volatile Suspended (VSS)	SM 2540 D / EPA 160.4	7 days	Raw 0-6°C							
Specific Conductivity	SM 2510B	28 days	Raw 0-6°C				x	x		

Analyte	Method	Holding Time	Preservative	BPSOU BF	BPSOU WW	Diagnostic	Expanded	BPSOU GW	Rocker	Great Falls
Total Metals in Solids by ICP-MS (Sb, As, Ba, Cd, Cr, Cu, Pb, Mn, Mo, Ni, U, & Zn)	SW6020	180 days	None				x			
Phosphorus - **Total**/Dissolved	**SM 4500P-B**/E	28 days	H_2SO_4 < pH 2 0-6°C	x	x					
Biochemical Oxygen Demand (BOD)	SM 5210 B	48 hours	Raw 0-6°C							
Chemical Oxygen Demand (COD)	SM 5220 D	28 days	H_2SO_4 < pH 2 0-6°C							
Sulfide, Soluble	SM 4500-S2− D	15 minutes	Raw 0-6°C							
Sulfide, Total	SM 4500-S2− D	7 days	ZnAc2 & NaOH pH > 9 0-6°C							

Appendix C Level A/B Checklist

Level A/B Screening Checklist

I.	General Information		II. Screening Results
	Site/BIF:	BPSOU	Data are:
	Project:	Base Flow SW Monitoring	1) Unusable _____
	Client:	Atlantic Richfield	2) Level A YES
	Sample Matrix:	Water	3) Level B YES

II. Level A Screening

		Yes/No
1.	Sampling date	Yes
2.	Sample team/or leader	Yes
3.	Physical description of sample location	Yes
4.	Sample depth (soils)	N/A
5.	Sample collection technique	Yes
6.	Field preparation technique	Yes
7.	Sample preservation technique	Yes
8.	Sample shipping records	Yes

III. Level B Screening

		Yes/No
1.	Field instrumentation methods and standardization complete	Yes
2.	Sample container preparation	Yes
3.	Collection of field replicates (1/20 minimum)	Yes
4.	Proper and decontaminated sampling equipment	Yes
5.	Field custody documentation	Yes
6.	Shipping custody documentation	Yes
7.	Traceable sample designation number	Yes
8.	Field notebook(s), custody records in secure repository	Yes
9.	Completed field forms (COC Record)	Yes

Appendix D Example Data Validation Checklists

Example BPSOU GW Level 2b Checklist

\\woodardcurran.net\shared\Offices\Bozeman\BUTTE\TREC\ARCO\DataValidation\2020\GW\CompletedReport\Fall\Level-IV_DV-Checklist_GW_10534245_093020.xlsx

Example BPSOU Normal Flow Level 2a Checklist

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APPENDIX B

Standard Operating Procedures

STANDARD OPERATING PROCEDURE G-4

FIELD LOGBOOK/PHOTOGRAPHS
SOP G-4

FIELD LOGBOOK

A separate field logbook will be used for each field task. Each logbook shall have a unique document control number. The logbooks will be bound and have consecutively numbered pages. The information recorded in these logbooks shall be written in indelible ink. The author will initial and date entries at the end of each day, and a line shall be drawn through the remainder of the page. All corrections will consist of a single line-out deletion in indelible ink, followed by the author's initials and the date. No bound field logbooks will be destroyed or thrown away, even if they are illegible or contain inaccuracies that require a replacement document. These bound logbooks, at a minimum, shall include the following entries:

1. A purpose and description of the proposed field task,
2. Time and date fieldwork started,
3. .Location and description of the work area, including sketches if possible, map references and photographs, and sketches of well construction details, soils, pits, etc.,
4. Names and titles of field personnel,
5. Name, address, and phone number of any field contacts,
6. Meteorological conditions at the beginning of fieldwork and any ensuing changes in these conditions,
7. Details of the fieldwork performed and field data sheets used (including document control numbers), with special attention to any deviations from the task-specific Sampling and Analysis Plan (SAP) or Standard Operating Procedures (SOPs),
8. All field measurements made,

STANDARD OPERATING PROCEDURE G-4

FIELD LOGBOOK/PHOTOGRAPHS
SOP G-4

FIELD LOGBOOK

A separate field logbook will be used for each field task. Each logbook shall have a unique document control number. The logbooks will be bound and have consecutively numbered pages. The information recorded in these logbooks shall be written in indelible ink. The author will initial and date entries at the end of each day, and a line shall be drawn through the remainder of the page. All corrections will consist of a single line-out deletion in indelible ink, followed by the author's initials and the date. No bound field logbooks will be destroyed or thrown away, even if they are illegible or contain inaccuracies that require a replacement document. These bound logbooks, at a minimum, shall include the following entries:

1. A purpose and description of the proposed field task,
2. Time and date fieldwork started,
3. .Location and description of the work area, including sketches if possible, map references and photographs, and sketches of well construction details, soils, pits, etc.,
4. Names and titles of field personnel,
5. Name, address, and phone number of any field contacts,
6. Meteorological conditions at the beginning of fieldwork and any ensuing changes in these conditions,
7. Details of the fieldwork performed and field data sheets used (including document control numbers), with special attention to any deviations from the task-specific Sampling and Analysis Plan (SAP) or Standard Operating Procedures (SOPs),
8. All field measurements made,

9. Any field laboratory analytical results, and
10. Personnel and equipment decontamination procedures.

For any field sampling work, at a minimum, the following entries should be made:

1. Sample location and number,
2. Sample type (eg, ground water) and amount collected,
3. Date and time of sample collection,
4. Split samples taken by other parties. Note the type of sample, sample location, time/date, name of person, person's company, any other pertinent information,
5. Sampling method, particularly any deviations from the SOP,
6. Suspected waste composition, including an estimate of the hazard level as being low or medium,
7. Documentation or reference of preparation procedures for reagents or supplies that will become an integral part of the sample (eg, filters and preserving reagents), and
8. Sample preservation, handling, packaging, labeling, shipping information (eg., weight), the shipping agent, and the laboratory where the samples will be sent.

After each day of fieldwork, all the bound logbooks will be locked up in a location accessible to the Quality Assurance Manager, such as the field office filing cabinet.

PHOTOGRAPHS

Photographs will be taken of field activities using a camera-lens system with a perspective similar to the naked eye. Photographs should include a measured scale in the picture, when practical. Telephoto or wide-angle shots will not be used, since they cannot be used in enforcement meetings. The following items shall be recorded in the bound field logbook for each photograph taken:

1. The photographer's name, the date, the time of the photograph, and the general direction faced,
2. A brief description of the subject and the fieldwork portrayed in the picture, and
3. Sequential number of the photograph and the roll number on which it is contained.

The slides or prints and associated negatives shall be placed in task files in the field office after the film is developed. Any supporting documentation from the bound field logbooks shall be photocopied and placed in the task files to accompany the particular slides or prints.

Figure G-4-1 provides a suggested photograph label format for attaching to photographs, or for a photograph logbook.

STANDARD OPERATING PROCEDURE G-5

SAMPLE PACKAGING AND SHIPPING
SOP G-5

Transportation regulations for shipping hazardous substances and dangerous goods are defined by the Department of Transportation (DOT) in 49 Code of Federal Regulations (CFR) Subchapter C, Part 171 (October 1, 1988); the International Air Transport Association (IATA); and the International Civil Aviation Organization (ICAO). A combination of IATA and ICAO shipment and packaging regulations shall be used. These regulations are the accepted protocols for shipping hazardous substances and dangerous goods by Federal Express and other ground or air carriers.

According to DOT regulations, environmental samples shall be classified as Other Regulated Substances (ORS). ORS are articles, samples, or materials that are suspected, or known, to contain contaminants and/or are capable of posing a risk to health, safety, or property when transported by ground or air.

The materials included under the proper shipping name of ORS must **not** meet any of the definitions for the following classes of material:

1. Class 1: Explosives,

2. Class 2: Gases - compressed, liquified, dissolved under pressure, or deeply refrigerated,

3. Class 3: Flammable liquids,

4. Class 4: Substances susceptible to spontaneous combustion,

5. Class 5: Oxidizing substances,

6. Class 6: Poisonous (toxic and infectious substances),

7. Class 7: Radioactive materials, or

8. Class 8: Corrosives.

ORS generated or handled by ARCO personnel shall be defined as samples, substances, or materials (environmental samples) **suspected** to contain contaminants.

Samples, substances, or materials from areas other than drums, leachate streams, sludges, noticeably discolored soils or waters, and lagoons shall be defined as ORS or environmental samples. In addition, any samples producing photoionization detector/organic vapor analyzer (PID/OVA) readings slightly above background shall be defined as ORS or environmental samples. Examples of environmental samples include most ground water and soil samples.

The following steps shall be followed when packaging and shipping environmental samples:

1. Collect the sample as stated in appropriate standard operating procedure (SOP).

2. Wipe the exterior of the sample container with appropriate decontamination solution while wearing the necessary personal protective equipment as specified in the site-specific Health and Safety Plan.

3. Attach the identification tag to the sample container. Place sample container in a 2-ml thick (or thicker) zip-lock polyethylene bag, one sample per bag. Position the sample container so the identification tag can be read through the bag, then seal the bag.

4. Place one or more bagged samples into a strong outside water-tight container, such as an ice chest or a DOT-approved fiberboard box.

5. Add ice and/or blue ice if required by the appropriate SOP.

6. Secure containers with noncombustible, absorbent, cushioning material such as vermiculite for stability (styrofoam peanuts are not acceptable).

7. Secure the properly completed chain-of-custody form (see SOP G-7) to the inside of the ice chest lid in a plastic bag. The chain-of-custody form shall list only those samples contained in the ice chest.

8. Tape ice chest drain and ice chest closed using fiberglass tape and seal with several chain-of-custody seals (Figure G-5-1).

9. Complete the air bill and Shipper's Certification for Restricted Articles/Dangerous Goods as shown on Figure G-5-2.

10. Label and address the ice chest as shown on Figures G-5-3 and G-5-4.

STANDARD OPERATING PROCEDURE G-6

FIELD QUALITY CONTROL SAMPLES
SOP G-6

Field Quality Control (QC) is a part of the project Quality Assurance/Quality Control program and is described in detail in the Clark Fork River Superfund Site Investigations Quality Assurance Project Plan (PTI, 1992). This Standard Operating Procedure (SOP) describes the purpose, preparation and collection frequency of field QC blanks, replicate and split samples, and reference materials samples for aqueous and solid matrices. Table G-6.1 summarizes the field QC sampling requirements described in this SOP.

At least one set of field QC samples will be prepared for each sampling event. An event is defined by any of the following conditions:

1. The beginning of a new sampling round,

2. A significant change in either the sample type, matrix, or location, or

3. A change in any sample analysis parameter.

If the number of field QC samples taken does not equal to an integer multiple of the interval specified in Table G-6.1, use the next higher multiple. For example, if a frequency of 1 in 20 is indicated and 28 field samples are collected, then two field QC samples will be prepared.

All field QC samples shall be packaged and shipped with field samples to the primary or referee laboratory in accordance to procedures outlined in SOP-G-5. Sample custody will be maintained according to procedures outlined in SOP-G-7. The text below describes the field QC samples for the aqueous and solid matrices.

FIELD QC SAMPLES - AQUEOUS

Trip Blank

A trip blank will be used to help identify cross contamination in a shipment of aqueous samples for analyzing volatile organic compounds (VOCs) only. Trip blanks will be prepared by the appropriate laboratory and in the appropriate containers using distilled/deionized (DS/DI) water. Trip blanks will be transported unopened to and from the field with field samples. One trip blank will be prepared for and sent with each shipment of samples for analyzing VOCs.

Cross-contamination Blank

Cross-contamination blanks will be used to help identify possible contamination from the sampling environment or from sampling equipment, such as a bailer, collection container, or filter apparatus. Cross-contamination blanks for field-filtered samples will be prepared by processing a representative amount of laboratory DS/DI water through the decontaminated sample collection equipment and filtering apparatus without a filter, then transferring the water to an appropriate sample container, and adding any necessary preservatives.

Cross-contamination blanks for non-field filtered samples will be prepared by processing a representative amount of laboratory DS/DI water through the decontaminated sample collection equipment, then transferring the water to an appropriate sample container, and adding any necessary preservatives. Cross-contamination blanks are required for all inorganic or organic constituents. Cross-contamination blanks will be prepared daily, or once for every 20 samples collected, whichever is more frequent.

External Contamination Blank

External contamination blanks are collected to ensure that contaminants are not originating from material used to collect cross-contamination blanks. External contamination blanks for field-filtered samples will be prepared by processing a representative amount of laboratory DS/DI water through the decontaminated sample collection equipment and filtering apparatus with a filter, then transferring the water to an appropriate sample container, and adding any necessary preservatives. No external contamination blanks will be used for non-field filtered samples because no external

materials, such as filter papers, are used. External contamination blanks will be prepared daily, or once for every 20 samples collected, whichever is more frequent.

Field Blank

Field blanks provide a measure a various cross-contamination sources, decontamination efficiency, and other potential errors that can be introduced from sources other than the sample. A field blank is prepared by the same protocols as a normal sample, but is not exposed to any sampling equipment. A field blank is prepared in the field and consists of a representative amount of laboratory DS/DI and/or reagent-grade (analyte-free) water and any necessary preservatives. A field blank is contained in a sample bottle randomly chosen from each lot of bottles received from the supplier. Field blanks are required for all inorganic or organic constituents. Field blanks will be collected for each type of sample bottle at a frequency of 1 per 20 samples or once per sampling event, whichever is more frequent.

Field Replicate

Field replicates are co-located samples collected identically and consecutively over a minimum period of time and provide a measure of the total analytical bias (field and laboratory variance), including bias resulting from the heterogeneity of the replicate sample set itself. Field replicates consist of two samples (one sample and one replicate) collected consecutively at the same location and placed in different bottles for separate analysis. Each replicate will have its own sample number. The two samples will be sent to the primary laboratory and analyzed for identical chemical parameters. Field replicate samples will be collected at a minimum frequency of 1 per 20 samples or once per sampling event, whichever is more frequent.

Reference Materials

Reference materials samples are materials of known composition that have been prepared by and obtained from U.S. Environmental Protection Agency (EPA) approved sources, and that have undergone multi-laboratory analyses using a standard method. Reference materials samples provide a measure of analytical performance and/or analytical method bias of both the primary and referee laboratories. Several reference materials samples may be required to cover all analytical parameters. Reference materials samples will be submitted to both the primary and referee

laboratories at a minimum frequency of 1 per 50 samples, or once per sampling event, whichever is more frequent.

Laboratory Split

A laboratory split consists of one well-mixed and homogenized natural sample, which is split in the field into two samples and placed in different bottles for separate analysis. One of the split samples will be sent to the primary laboratory and the other split sample will be sent to the referee laboratory. Each split will have its own sample number. Both split samples will be analyzed for identical chemical parameters. The results of the laboratory split from both laboratories will be compared to determine inter-laboratory precision. Laboratory split samples will be collected at a frequency of 1 per 20 samples or once per sampling event, whichever is more frequent.

FIELD QC SAMPLES - SOLIDS

Cross-contamination Blank

Cross-contamination blanks will be used to help identify possible contamination from the sampling environment or from sampling equipment, such as an auger or split-spoon sampler. Cross-contamination blanks for solid matrix samples will be prepared by wiping a surface of decontaminated sampling equipment with ashless filter paper and inserting the filter paper into an empty sample container. The sample is then sent to the primary laboratory where the filter paper is analyzed. Cross-contamination blanks are required for all inorganic or organic constituents. Cross-contamination blanks will be prepared daily or once for every 20 samples collected, whichever is more frequent.

External Contamination Blank

External contamination blanks are collected to ensure that contaminants are not originating from material used to collect cross-contamination blanks. External contamination blanks for solid matrix samples will be prepared by inserting a clean, unused ashless filter paper, from the same lot as the filter paper used to for the cross-contamination blank, into an appropriate, empty sample container. The sample is then sent to the primary laboratory where the filter paper is analyzed. External contamination blanks will be prepared daily or once for every 20 samples collected, whichever is more frequent.

Field Replicate

Field replicates are co-located samples collected identically and consecutively over a minimum period of time and provide a measure of the total analytical bias (field and laboratory variance), including bias resulting from the heterogeneity of the replicate sample set itself. Field replicates consist of two samples (one sample and one replicate) collected consecutively at the same location and placed in different sample containers for separate analysis. Each replicate will have its own sample number. The two samples will be sent to the primary laboratory and analyzed for identical chemical parameters. Field replicate samples will be collected at a minimum frequency of 1 per 20 samples or once per sampling event, whichever is more frequent.

Reference Materials

Reference materials samples are materials of known composition that have been prepared by and obtained from EPA-approved sources, and that have undergone multi-laboratory analyses using a standard method. Reference materials samples provide a measure of analytical performance and/or analytical method bias of both the primary and referee laboratories. Several reference materials samples may be required to cover all analytical parameters. Reference materials samples will be submitted to both the primary and referee laboratories at a minimum frequency of 1 per 50 samples or once per sampling event, whichever is more frequent.

Laboratory Split

A laboratory split consists of one well-mixed and homogenized sample, which is split in the field Yinto two samples and placed in different sample containers for separate analysis. One of the split samples will be sent to the primary laboratory and the other split sample will be sent to the referee laboratory. Each split will have its own sample number. Both split samples will be analyzed for identical chemical parameters. The results of the laboratory split from both laboratories will be compared to determine inter-laboratory precision. Laboratory split samples will be collected at a frequency of 1 per 20 samples or once per sampling event, whichever is more frequent.

References:

PTI Environmental Services, 1992, Clark Fork River Superfund Site Investigations Quality Assurance Project Plan, February, prepared for ARCO, Anaconda, Montana.

TABLE G-6.1
FIELD QC SAMPLING REQUIREMENTS

		Sample Preparation		Laboratory Frequency	
QC Sample	**Sample Matrix**	**Location**	**Method**	**Primary**	**Referee**
Cross-contamination blank	Aqueous	Field	DI/DS water through sampling equipment and preserved.	Daily or one every 20 samples.	Not required
Cross-contamination blank	Solid	Field	Wipe surface of sampling equipment with ashless filter paper.	Daily or one every 20 samples.	Not required
External contamination blank	Aqueous (filtered samples only)	Field	DI/DS water through filter apparatus with filter and preserved.	Daily or one every 20 samples.	Not required
External contamination blank	Solid	Field	Clean, unused ashless filter paper.	Daily or one every 20 samples.	Not required
Field blank	Aqueous	Field	DI/DS water not exposed to sampling equipment.	One per sampling event or one every 20 samples.	Not required
Field replicate	Aqueous and Solid	Field	Co-located samples collected identically and consecutively.	One per sampling event or one per 20 samples.	Not required
Laboratory split	Aqueous and Solid	Field	Splits of one well-mixed and homogenized sample.	One per sampling event or one per 20 samples.	One per sampling event or one per 20 samples
Reference materials	Aqueous and Solid	Laboratory	Prepared by and obtained from EPA-approved source.	One per sampling event or one per 50 samples.	One per sampling event or one per 50 samples
Trip blanks	Aqueous (VOCs only)	Laboratory	DI/DS water.	One per sample shipment.	One per sample shipment

STANDARD OPERATING PROCEDURE G-7

SAMPLE CUSTODY
SOP G-7

A stringent, established program of sample chain-of-custody procedures shall be followed during field sample collection and handling activities to account for each sample. Preprinted labels will be used to maintain the highest degree of control in sample handling. The preprinted labels (with spaces provided) will ensure that all necessary information is retained with the sample chain-of-custody records, and shipping manifests will be utilized to maintain control over access to the sample destination after shipment from the sample collection site.

SAMPLE CONTROL FORMS

Figures G-7-1, G-7-2, and G-7-3 show the sample label, the field sample data sheet, and the chain-of-custody record, respectively. The use of each of the forms is discussed below.

Sample Label

Each sample collected at the site shall be identified with a sample label. The following information shall be recorded on the label:

1. Project number,

2. Sample type (grab or composite, media sampled),

3. Sample identification (well number for ground water samples, soil boring number, sample number, and sample depth for soil samples, etc),

4. Date and time sample was taken,

5. Sampler's name,

6. Sample tag number (a unique serial number stamped or written on each sample label; duplicates and blanks shall be assigned separate sample numbers),

7. Preservative added, and

8. Remarks, including pertinent field observations.

Field Sample Data Sheet

The field sample data sheet is completed in the field and signed by the individual physically in charge of collecting the sample. The field sample data sheet correlates the assigned sample bottle designation to a specific well or sample location, or to other distinguishing features or attributes (i.e., dummy sample, replicate sample, purge evaluation sample, etc).

Chain-of-Custody Record

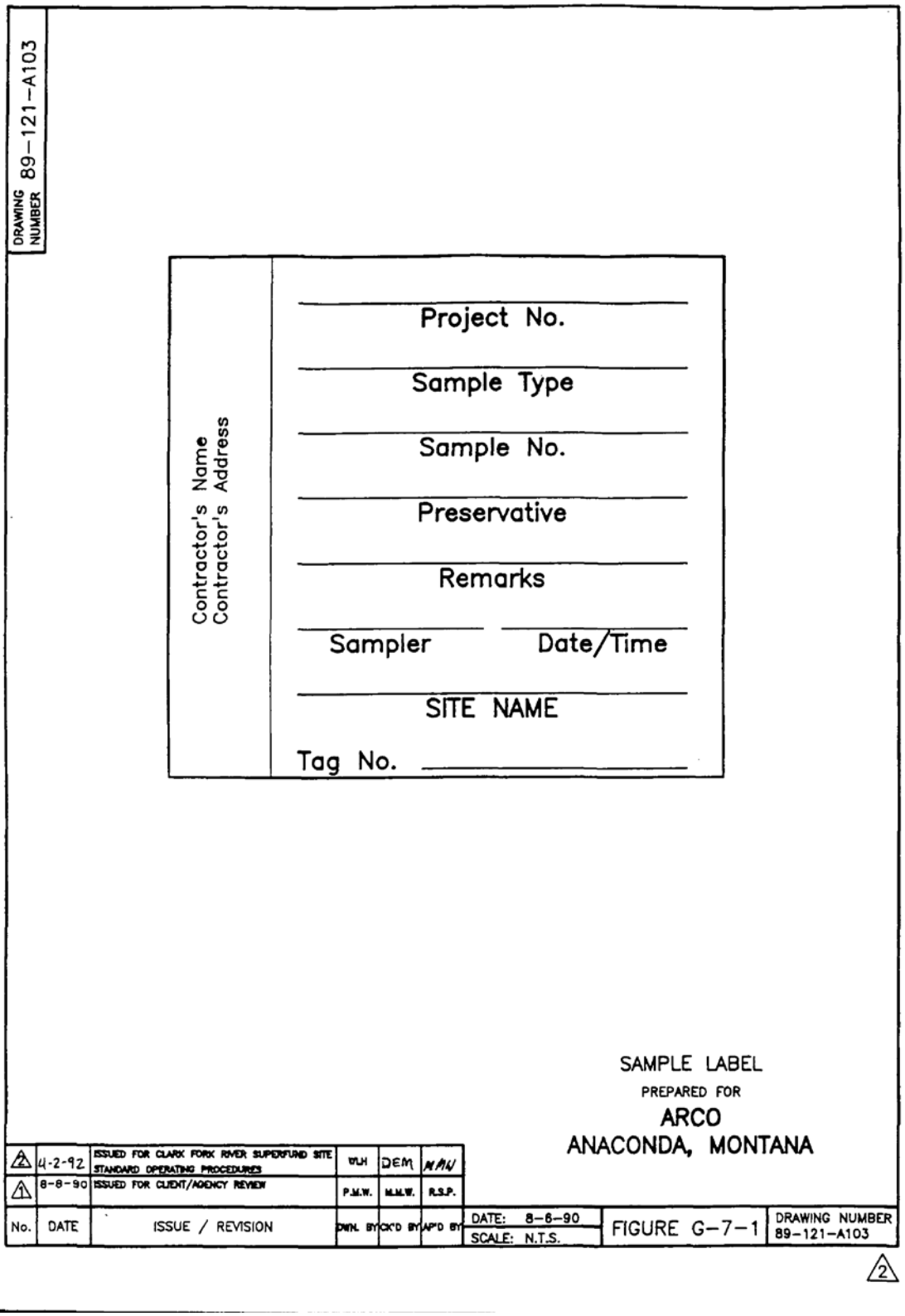
Chain-of-custody records ensure that samples are traceable from the time of collection until introduced as evidence in legal proceedings. A sample is in a person's custody if any of the following criteria are met:

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 has been locked up to prevent tampering after it was in the person's possession.
4. The sample was in the person's possession, then was transferred to a designated secure area.

The chain-of-custody record is completed in the field by the individual physically in charge of the sample collection. Figure G-7-4 provides an example of a completed chain-of-custody form. The chain-of-custody record may be completed concurrently with the field sample data sheet or before shipping samples to the laboratory. The sampler is personally responsible for the care and custody of the sample until it is shipped.

When transferring the sample possession, the individuals relinquishing and receiving the sample will sign, date, and write the time of day on the chain-of-custody record. The chain-of-custody record is enclosed with the sample after it has been signed by the sampler.

The chain-of-custody record also serves as the laboratory request form. As shown on Figure G-7-3, a space is included on the form to list the analyses requested for each set of samples.


DRAWING NUMBER 89-121-A103
Contractor's Name
Contractor's Address
Project No.
Sample Type
Sample No.
Preservative
Remarks
Sampler
Date/Time
SITE NAME
Tag No.
SAMPLE LABEL
PREPARED FOR
ARCO
ANACONDA, MONTANA
2 4-2-92 ISSUED FOR CLARK FORK RIVER SUPERFUND SITE STANDARD OPERATING PROCEDURES VLH DEM MAN
1 8-8-90 ISSUED FOR CLIENT/AGENCY REVIEW P.M.W. M.M.W. R.S.P.
No. DATE ISSUE / REVISION DWN. BY CK'D BY AP'D BY
DATE: 8-6-90
SCALE: N.T.S.
FIGURE G-7-1
DRAWING NUMBER 89-121-A103
2

Canonie

7-5

Field Sample Data

PROJECT No. _____
PAGE _____ OF _____

PROJECT NAME _____ SAMPLED BY _____
STATION No./LOCATION _____ DATE _____

SKETCH ON BACK YES ☐ NO ☐ PHOTOGRAPHS YES ☐ NO ☐ ROLL No./EXPOSURE No. _____

FIELD DATA

TIME _____ AIR TEMP. °F _____ WEATHER _____

WELL DEPTH _____ WATER DEPTH _____ SAMPLE DEPTH _____ SAMPLE METHOD _____

VOL. PURGED _____ SAMPLE TEMP. _____ °C ☐ IN SITU ☐ IN BOTTLE SP. COND. _____ / _____ AT 25° C ☐ IN SITU ☐ IN BOTTLE

pH _____ ☐ IN SITU ☐ IN BOTTLE Eh _____ ☐ IN SITU ☐ IN BOTTLE DISSOLVED O_2 _____ ppm ☐ IN SITU ☐ IN BOTTLE

BOTTLE ID	LAB ID	VOL	MATERIAL	FILTERED	PRES./VOL.	ANALYSIS REQUESTED

FIELD PARAMETERS:

_____ GALLON pH– _____ EH– _____ TEMP. _____

_____ GALLON pH– _____ EH– _____ TEMP. _____

_____ GALLON pH– _____ EH– _____ TEMP. _____

REMARKS: _____

FIELD EQUIPMENT QUALITY ASSURANCE CHECKLIST

pH METER BUFFER CHECK pH 4 _____ pH 7 _____ pH 10 _____

SP. COND. METER STANDARDS CHECK _____ Eh PROBE _____

PUMP TUBING RINSED _____ CHANGED _____ SAMPLER BLANK _____

FILTRATION BLANK WITH PRES. _____ FILTERS ACID WASHED _____

FIGURE 7-2

ENVIRONMENTAL PROTECTION AGENCY
Office of Enforcement

CHAIN OF CUSTODY RECORD

PROJ NO.	PROJECT NAME					NO OF CONTAINERS							REMARKS
SAMPLERS (Signature)													
STA NO.	DATE	TIME	COMP	GRAB	STATION LOCATION								

Relinquished by (Signature)	Date / Time	Received by: (Signature)	Relinquished by: (Signature)	Date / Time	Received by: (Signature)
Relinquished by (Signature)	Date / Time	Received by (Signature)	Relinquished by: (Signature)	Date / Time	Received by (Signature)
Relinquished by (Signature)	Date / Time	Received for Laboratory by: (Signature)	Date / Time	Remarks	

Distribution: Original Accompanies Shipment; Copy to Coordinator Field Files

CHAIN-OF-CUSTODY
RECORD FORM
FIGURE G-7-3

E ONMENTAL PROTECTION AGENCY
Office of Enforcement

CHAIN OF CUSTODY RECORD

PROJ. NO. 12-3456 | PROJECT NAME # 0123

SAMPLERS: (Signature) John Sampler

STA. NO.	DATE	TIME	COMP.	GRAB	STATION LOCATION	NO. OF CONTAINERS	Total Metals	Cyanide					REMARKS ITR	REMARKS Tag #
001	9/26	8:00		X	LOC-ST-010	2	X	X					ME1701	5-102501
													"	5-102502
002	9/26	11:00		X	LOC-ST-011	2	X	X					ME1702	5-102503
													"	5-102504
003	9/26	16:00		X	LOC-ST-012	2	X	X					ME1703	5-102505
													"	5-102506
004	9/26	17:00		X	LOC-ST-013	2	X	X					ME1704	5-102507
													"	5-102508
005	9/26	18:00		X	LOC-ST-014	2	X	X					ME1705	5-102509
													"	5-102510

Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Relinquished by: (Signature)	Date / Time	Received by: (Signature)
John Sampler	9/26 19:00				
Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Relinquished by: (Signature)	Date / Time	Received by: (Signature)

Relinquished by: (Signature)	Date / Time	Received for Laboratory by: (Signature)	Date / Time	Remarks
		Mary Sunshine	9/27 10:00	Case # 1000 Fed. Ex. # 123456789 Custody Seals # 31122 & 31123

Distribution: Original Accompanies Shipment; Copy to Coordinator Field Files

COMPLETED CHAIN-OF-CUSTODY RECORD FORM

FIGURE G-7-4

9. Any field laboratory analytical results, and
10. Personnel and equipment decontamination procedures.

For any field sampling work, at a minimum, the following entries should be made:

1. Sample location and number,
2. Sample type (eg, ground water) and amount collected,
3. Date and time of sample collection,
4. Split samples taken by other parties. Note the type of sample, sample location, time/date, name of person, person's company, any other pertinent information,
5. Sampling method, particularly any deviations from the SOP,
6. Suspected waste composition, including an estimate of the hazard level as being low or medium,
7. Documentation or reference of preparation procedures for reagents or supplies that will become an integral part of the sample (eg, filters and preserving reagents), and
8. Sample preservation, handling, packaging, labeling, shipping information (eg., weight), the shipping agent, and the laboratory where the samples will be sent.

After each day of fieldwork, all the bound logbooks will be locked up in a location accessible to the Quality Assurance Manager, such as the field office filing cabinet.

PHOTOGRAPHS

Photographs will be taken of field activities using a camera-lens system with a perspective similar to the naked eye. Photographs should include a measured scale in the picture, when practical. Telephoto or wide-angle shots will not be used, since they cannot be used in enforcement meetings. The following items shall be recorded in the bound field logbook for each photograph taken:

1. The photographer's name, the date, the time of the photograph, and the general direction faced,
2. A brief description of the subject and the fieldwork portrayed in the picture, and
3. Sequential number of the photograph and the roll number on which it is contained.

The slides or prints and associated negatives shall be placed in task files in the field office after the film is developed. Any supporting documentation from the bound field logbooks shall be photocopied and placed in the task files to accompany the particular slides or prints.

Figure G-4-1 provides a suggested photograph label format for attaching to photographs, or for a photograph logbook.

SOP – GW – 01

GROUND WATER LEVEL MEASUREMENT (Domestic & Non-Domestic)

Authorized for use: 01/23/2019
Revision 3

SCOPE	This SOP addresses the manual measurement of a water level in a well using an electronic water level tape.
TRA(s) Referenced/ Reviewed	TRA1-001: Common Hazards Driving Manual Handling TRA1-002: Water Levels TRA1-007: Download Transducers TRA1-028: SS-07
STOP WORK TRIGGERS	Lightning (30 second rule) Extreme wind Unsafe conditions Inadequate PPE or equipment Inability to access the work area safely Defective equipment Improper tools
MSDS	Arsenic Cadmium Copper Lead Manganese Mercury Zinc Nitric Acid Bleach Creosote PCB's Wasp Spray
PPE REQUIRED	Hard hat Safety toe boots Safety glasses High visibility shirt or vest Gloves (leather, impervious) Long sleeve shirt Long trousers
OTHER INSTRUCTIONS/SOPs	
REQUIRED TOOLS	Electronic water level tape Spray bottle containing tap water Spray bottle containing 5% HNO_3 (For domestic wells only) Spray bottle containing dilute bleach solution (For domestic wells only)
Trained, Competent and Authorized Employees in this SOP	Tina Donovan — Nicole Santifer Alice Drew-Davies — Joel Arbaugh Daniel Cass — Shyla Allred Caleb Arbaugh — Mat Erickson Michael Picker — Matt Kilsdonk

PROCEDURES

REMOVE WELL CAP

1. Wearing leather gloves unlock the steel well cap and remove it. On the domestic wells, the cap should have a sanitary seal, so a wrench may be required to access the well. This cap needs to remain clean so after removing it, place in a manner that will not get dirt or other contaminants on it.

MEASURING WATER LEVEL

1. Locate the marked measuring point on the well casing.
2. Lower the water level tape into the well until it sounds. When lowering the tape, lower it directly down the well. Do not run the tape along the side of the casing.
3. Raise the tape approximately one foot, taking care to not run the tape along the side of the casing. Slowly lower the again tape until it sounds.
4. From the bottom up, read the tape where it meets with the measuring point to the nearest 0.01 foot. It may be necessary to raise and slowly lower the tape more than once to get an accurate reading.
5. On the sheet, check to see what the level was last month. If there is a huge discrepancy between the current level measured and the previous measurement (greater than half a foot), ask the person measuring to check the level again. On the iPad and field reference sheet, record the date, time, measured depth to water. If the water is frozen or the well is dry, do not record in the DTW column. Use the comments column and add a comment such as "water frozen at 5.65 feet".
6. Rewind the water level tape. When rewinding, take care to not run the tape along the side of the casing. Also rewind the tape in a manner that the tape lays evenly and flatly on the reel.
7. Before and after water level measurement in domestic well, it is necessary to decontaminate the length of the tape which will enter the well. A 5% nitric solution is used to remove metal residuals from the tape

	and a bleach solution is used to remove any virus/bacteria from the tape. Follow the instructions described below for domestic and non-domestic wells. a) DOMESTIC WELLS: i. Spray the 5% Nitric Acid on the tape/paper towel and use the paper towel to wipe. **ii.** Spray water from the decontamination bottle on the tape. **It is important to clean the tape with water before using the bleach solution. Nitric Acid and Bleach can create a chlorine gas when mixed.** iii. Squirt the diluted bleach solution onto the tape/paper towel and wipe the tape. iv. Rinse with water from the decontamination bottle. b) NON-DOMESTIC WELLS: i. Decontaminate by squirting/spraying water from the decontamination bottle on the tape. In some instances, if the tape is visibly dirty. may be necessary to run the tape through a saturated paper towel as it is being reeled. 8. Replace the well cap and close the lock.
DOCUMENTATION	1. In the field book, at the beginning of the sampling job, record date, personnel involved, safety topics for the day, and weather conditions. Also indicate which iPad will be used to for the day so that records can be easily found if necessary. Complete a "Butte – GW WLs r0" doForm on the iPad that will be used to record field data. Follow **GW I-Pad Steps –gwl** located at a. **Butte –** https://woodardcurran.sharepoint.com/sites/trec/docs/DoForms/Butte%20-%20GW%20I-Pad%20Steps%20-gwl.aspx b. **Rocker –** https://woodardcurran.sharepoint.com/sites/trec/docs/DoForms/Rocker%20-%20GW%20I-Pad%20Steps%20-gwl.aspx Record any unusual circumstances in the notes of the doForm as well as the field book. At the end of the day record any applicable deviations from the Clark Fork River SOPs/Work Plan/Sampling Plan.
REPORTING	1. Download doForms, process files with transformer, and organize output forms: a. Download appropriate doForms by following **DoForms Online Download Steps** located at https://woodardcurran.sharepoint.com/sites/trec/docs/DoForms%20Online%20Download%20Step.aspx b. Follow **GWL Processing Steps** located at • **Butte –** https://woodardcurran.sharepoint.com/sites/docs/DoForms/Butte%20-%20GWL%20Processing%20Steps.aspx • **Rocker –** https://woodardcurran.sharepoint.com/sites/docs/DoForms/Rocker%20-%20GWL%20Processing%20Steps.aspx c. Ensure that all files are complete and organized as instructed in **GWL File Organization Details** located at • **Butte –** https://woodardcurran.sharepoint.com/sites/docs/DoForms/Butte%20-%20GWL%20File%20Organization%20Details.aspx • **Rocker –** https://woodardcurran.sharepoint.com/sites/docs/DoForms/Rocker%20-%20GWL%20File%20Organization%20Details.aspx 2. Editing and revisions: a. If missing data (date, time, units, etc.) or grammatical errors are discovered, corrections may be made to original doForms and re-import can be performed, or the original output file can also be edited. b. Before submitting the output file to the database, if there are found to be incorrect entries while checking the output file, save the output file as a revision with a date stamp (file-name_revised-mmddyy) and make the appropriate edits, but preserve the original raw doForms. c. After an output file is submitted to the database, and an error is found, save the submitted output file as a resubmit with a date stamp (file-name_resubmit-mmddyy) and make the appropriate edits, but preserve the original raw doForms. Resubmit the file to BPSOU DATA for re-import to database. d. Ensure that all revisions are saved to the submittal folder (monthly file) as well as the original file location.

SOP – GW – 02

GROUND WATER SAMPLING OF MONITORING WELLS WITH SUBMERSIBLE PUMP

Authorized for use: 04/22/2020
Revision 4

SCOPE	This procedure describes the steps required to safely Sample Groundwater from monitoring wells using a submersible pump. The method described in this SOP applies to wells which fall under the Clark Fork River Superfund Site (CFRSS).
TRA(s) Referenced/ Reviewed	TRA1-001: Common Hazards Driving Manual Handling TRA1-002: Water Levels TRA1-003: GW Sampling and Monitoring TRA1-022: Transport and Clean GW Tank TRA1-028: SS-07
STOP WORK TRIGGERS	Lightning (30 second rule) Extreme Wind Unsafe conditions Inadequate PPE or equipment Inability to access site safely
MSDS	Arsenic Cadmium Copper Lead Mercury Zinc HNO_3 HCl H_2SO_4 Battery Acid Laboratory Grade Detergent pH 4.00 s.u., 7.00 s.u. buffers <3.0 mmhos/cm conductivity standards ORP standard (<300mV)
PPE REQUIRED	Hard Hat Safety Toe Boots Safety Glasses High Visibility Shirt or Vest Gloves Long Sleeve Shirt Long Trousers
OTHER INSTRUCTIONS/SOPs	At the Rocker Ground Water OU, water can be purged to the ground surface except for MW-01, RH-05, RH-06, and RH-44. Also, when sampling at Rocker, instead of using the project Butte use Rocker and the form for sampling is the Rocker – GW Smpl Clctnr0.
REQUIRED TOOLS	Submersible pump 12-V battery Water quality meter Sample containers, Preservation acids, Filters, $^3/_8$ " ID clear vinyl tubing, Electronic water level tape, Bucket(s) Barrels for containerizing water Spring clamps Hose clamps Screwdriver Calculator Ratchet and ½", $^9/_{16}$" sockets (Flush Mount Wells) Hammer to loosen flush mount caps Scissors Pry tool for removing well caps Snow shovel (winter months) 2 Liter graduated cylinder Coolers Ice when temperature is above 40F Decontamination Water Laboratory Grade Detergent Field Sheet

	DI Water 5% Nitric Acid
Trained, Competent and Authorized Employees in this SOP	Tina Donovan Alice Drew-Davies Dan Cass Michael Picker Matt Kilsdonk Shyla Allred Joel Arbaugh
PROCEDURES	
PRE-PURGING CALCULATIONS	1. See "Butte – GW I-Pad Steps -smpl". Pump depth is automatically calculated in the "Butte– GW Smpl Clctn r2" doForm or the Rocker GW Smpl Clctn r0" doForm by entering the depth to water measurement. The other parameters used to calculate pump depth are already assigned to each site, but it may be necessary to ensure that they are correct before continuing. 2. If doForms are not being used: a. Begin filling out field sheet with applicable information. b. Measure the depth to water (dtw) in the well following procedures in SOP-GW-01_GW-Level Measurements. c. Based on the water level, total depth of the well, and the casing diameter, calculate the water volume, purge volume, and depth the pump should be placed at using the following equations: i. Water column = Total Depth - DTW ii. Purge volume = • 0.75" casing = 0.023*water column * 3 • 2" casing = 0.163 * water column * 3 • 4" casing = 0.652 * water column * 3 • 6" casing = 1.467 * water column * 3 d. Pump depth = (Water column/2) + DTW
PREPARING TO PURGE/SAMPLE WELL WITH SUBMERSIBLE PUMP	1. Confirm the name of the well to be sampled with name on the well. 2. If working in public areas, park vehicle so it is highly visible. Use orange candles and drums as traffic barriers (if necessary). Use flashing yellow light on top of vehicle (if required). 3. Attach an adequate length of tubing to the submersible pump with a hose clamp. Tubing is re-used, so check the depth of the pump for the next several wells before cutting. When determining the tubing length, allow length for the tubing to reach the area to which water will be purged. 4. Set up a garbage can when containerizing the discharge water. The garbage can should be positioned so the discharge water can be easily purged into the tank in the back of the truck. Use good housekeeping to avoid tripping hazards. 5. Using metal spring clamps, attach a small bucket (or 1000 mL sample bottle with top portion removed) to the inside of the purge barrel (garbage can). One clamp can hold the bucket to the barrel. The other clamp can be attached to the barrel, and the handle of the bucket can be hung over the clamp. Place the multi-meter into the bucket (or 1000 mL sample bottle with top portion removed). Water should flow into the bucket (or 1000 mL sample bottle) then out and into the barrel. 6. If water is not to be containerized, set up a bucket (if purge volume is very small, use a 2-3 gallon bucket) and place the multi-meter in the bucket. Water will be purged into this bucket, allowing field parameters to be measured. When setting up the purge bucket, set it in a spot so that water will flow away from the work area. 7. Lower the pump into the well to the determined depth. Be sure the depth is referenced to the measuring point on the casing. Clamp the tubing and pump wire to the casing so that the clamp supports the tubing and wire, being careful not to pinch the tubing. 8. Remove the protective cap from the YSI Pro Plus. Replace with the metal guard. Put the meter into the discharge bucket and turn the multi-meter on. (Be sure the stirrer is turned on if applicable).
PURGING WELL	1. Correctly connect the pump leads to the battery and begin pumping. Record all applicable data in the doForm. 2. Determine the purge rate by measuring the time it takes for purge water to fill a known volume. Record the purge rate in the doForm. 3. Continue purging and measure field parameters at appropriate intervals. Intervals should be volume based. For BPSOU, field parameters must be recorded at least five times. Thus, if the purge volume is 50 gallons, parameters should be recorded every ten gallons. For Rocker GW OU, field parameters must be recorded at least eight times, so for a 50-gallon purge volume, parameters would be recorded approximately every 6 gallons. 4. Continue purging until at least three casing volumes have been purged and field parameters have stabilized. Stabilization is defined as: a. pH: within 0.1 standard unit over one casing volume b. specific conductivity (SC) and temperature: within 10 % over one casing volume c. ORP, DO: should have changed minimally, but stabilization is not defined. If pH, SC, and temperature have stabilized, very likely that other parameters have stabilized. 5. After appropriate volume is purged and parameters have stabilized, the sample can be collected. 6. Reduce flow rate by pinching the tubing if necessary. 7. At Rocker Ground Water OU all the sixty series wells (RH-60, RH-61, etc.) the water level in the well needs to be monitored as the well is purged at a reduced pumping rate. Before purging begins, place a clamp on the pump discharge tubing limiting flow. Try to attain a rate of less than or equal to 1 liter per minute. Document initial DTW on field sheet. While purging, leave water level tape in the well and

	monitor water level continuously at the start of pumping and then every 30 seconds to 5 minutes to ensure that drawdown does not exceed 0.33 ft. Upon completion of sampling, record DTW at sampling on the field sheet. Collect samples as described below.
SAMPLE WELL	1. Collect samples. a. Wear clean impervious gloves to collect the sample. b. Be certain the tubing outlet is clean. c. If using pre-preserved bottles, a head space need not be left. If preservative must be added to bottle, leave a small head space. Do not leave head space on the general chemistry bottle. d. Do not overfill pre-preserved bottles, preservative will be lost. e. Collect the dissolved metals portion of the sample last. Sample order does not matter on other portions. f. To collect the dissolved metals portion of the sample, place a new 0.45-micron filter on the tubing outlet. Flush adequate water through the tubing to thoroughly rinse the filter. Fill the sample bottle. 2. While collecting samples, continue to purge excess water into containers if water is being containerized.
DECONTAMINATION	1. After sampling, measure water level. Turn off the pump by disconnecting the leads from the battery. 2. Pull pump and tubing from well, coiling it neatly. Do not let the pump or tubing touch the ground. 3. Prepare decontamination solution in a 2-liter graduated cylinder or similar container. Put a very small amount (a drop) of phosphate free detergent in the cylinder. Fill the cylinder ¾ full of tap water. 4. Place the pump in the cylinder. Have extra water at hand and ready to pour. Be certain that the tubing outlet is directed away from personnel and equipment. If water was containerized, containerize the decontamination water. 5. Reconnect the battery and flush the decontamination solution through the pump and tubing. As the water in the cylinder draws down, pour fresh water in, but no detergent. Continue to run water through the pump/tubing until the rinse water is free of soap.
WATER DISPOSAL	1. Before sampling, complete a ground water equipment checklist to ensure that there are no leaks, and everything is working properly. Document equipment inspections in doForms. Project: Butte – HSSE Form: Butte HSSE – GW Eq Insp. 2. Place a dedicated discharge pump into purge barrel. 3. Check to make sure hose is firmly attached to tank fitting. 4. Connect the pump leads to the battery (correctly) and begin pumping the discharge water into the tank in the back of the truck. 5. Upon emptying barrel, disconnect leads from the battery and remove pump from barrel. 6. Do not run pump dry, stop the pump when there is approximately 2” water left in the barrel. 7. When tank reaches maximum fill level, tanks are marked, carefully drive to the drying beds in LAO. 8. Upon arrival, park horizontal to the drying bed. 9. Unroll tank discharge hose. 10. Insert a pre-cut piece of PVC pipe into the discharge hose, allowing for unimpeded discharge of purge water. Direct discharge away from personnel and vehicle. 11. Open valve and allow tank to drain. 12. Close valve, remove PVC, roll up hose and replace. If overnight temperatures are expected to be below freezing, store the valve open to avoid it getting frozen shut. Simply roll up the hose and clamp it to prevent leakage.
DOCUMENTATION	1. In the field book, at the beginning of the sampling job, record date, personnel involved, safety topics for the day, and weather conditions. Also indicate which iPad and forms will be used for the day so that records can be easily found if necessary. Complete a “Butte – GW Smpl Clctn r2” doForm or a “Rocker – GW Smpl Clctn r0” doForm on the iPad during sampling to record field data. In the field book, enter the same pertinent information as the doForm. However, only the final set of parameters needs to be documented. Follow **GW I-Pad Steps –smpl** located at a. **Butte –** https://woodardcurran.sharepoint.com/sites/trec/docs/DoForms/Butte%20-%20GW%20I-Pad%20Steps%20-smpl.aspx b. **Rocker –** https://woodardcurran.sharepoint.com/sites/trec/docs/DoForms/Rocker%20-%20GW%20I-Pad%20Steps%20-smpl.aspx Record any unusual circumstances in the notes of the doForm as well as the field book. At the end of the day record any applicable deviations from the Clark Fork River SOPs/Work Plan/Sampling Plan. 2. Each sample shall be clearly labeled in waterproof ink with a unique sample ID, sample date, sample time, sample analysis, sample preparation (i.e. filtered, preservative used), and sampler’s initials.
REPORTING	1. Download doForms, process files with transformer, and organize output forms: a. Download appropriate doForms by following **DoForms Online Download Steps** located at https://woodardcurran.sharepoint.com/sites/trec/docs/DoForms%20Online%20Download%20Steps.aspx b. Follow **GW Processing Steps** located at • **Butte –** https://woodardcurran.sharepoint.com/sites/trec/docs/DoForms/Butte%20-%20GW%20Processing%20Steps.aspx • **Rocker –** https://woodardcurran.sharepoint.com/sites/trec/docs/DoForms/Rocker%20-%20GW%20Processing%20Steps.aspx c. Ensure that all files are complete and organized as instructed in **GW File Organization Details** located at

	• **Butte –** https://woodardcurran.sharepoint.com/sites/trec/docs/DoForms/Butte%20-%20GW%20File%20Organization%20Details.aspx • **Rocker –** https://woodardcurran.sharepoint.com/sites/trec/docs/DoForms/Rocker%20-%20GW%20File%20Organization%20Details.aspx 2. Editing and revisions: a. If missing data (date, time, units, etc.) or grammatical errors are discovered, corrections may be made to original doForms and re-import can be performed, or the original COC output file can also be edited. b. Before submitting the COC output file to the database, if there are found to be incorrect entries while checking the output file, save the output file as a revision with a date stamp (file-name_revised-mmddyy) and make the appropriate edits, but preserve the original raw doForms. c. After a COC output file is submitted to the database, and an error is found, save the submitted output file as a resubmit with a date stamp (file-name_resubmit-mmddyy) and make the appropriate edits, but preserve the original raw doForms. Resubmit the file to BPSOU DATA and request the replacement of the originally submitted file with the revised file. d. Ensure that all revisions are saved to the submittal folder (monthly file) as well as the original file location.

SOP – GW – 03

GROUND WATER SAMPLING OF MONITORING WELLS with GEOTECH or ISCO PERISTALTIC PUMP, GRUNDFOS PUMP, and GEOTECH BLADDER PUMP

Authorized for use: 04/23/2020
Revision 4

SCOPE	This procedure describes the steps required to safely Sample Groundwater from monitoring wells using an ISCO or Geotech peristaltic, Grundfos VFD, or bladder pump with generator and air compressor. The method described in this SOP applies to wells which are being sampled for metals.
TRA(s) Referenced/ Reviewed	TRA1-001: Common Hazards Driving Manual Handling TRA1-002: Water Levels TRA1-003: GW Sampling and Monitoring TRA1-022: Transport and Clean GW Tank
STOP WORK TRIGGERS	Lightning (30 second rule) Extreme wind Unsafe conditions Inadequate PPE or equipment Inability to access site safely
MSDS	Arsenic Cadmium Copper Lead Mercury Zinc HNO_3 HCl H_2SO_4 Laboratory Grade Detergent pH 4.00 s.u., 7.00 s.u. buffers <3 mmhos/cm conductivity standards ORP standard (<300 mV)
PPE REQUIRED	Hard Hat Safety Toe Boots Safety Glasses High Visibility Shirt or Vest Gloves (leather, impervious) Long Sleeve Shirt Long Trousers
OTHER INSTRUCTIONS/SOPs	At Rocker Ground Water OU, water can be purged to the ground surface, except MW-01, RH-05, RH-06, and RH-44.
REQUIRED TOOLS	Peristaltic pump 12-V peristaltic battery Grundfos pump Generator (Utility power supply if available) Geotech Bladder pump Compressor Water quality meter Sample containers Preservation acids Filters Vinyl or silicon tubing as applicable Electronic water level tape Flow cell end fittings (optional) Bucket(s) Barrels if containerizing water Spring clamps Field sheets Calculator Ratchet and ½", $^{9}/_{16}$" sockets (flush mount wells) Hammer to loosen flush mount caps Scissors Pry tool for removing well caps Snow shovel (winter months) 2 Liter graduated cylinder Decontamination Water Liquinox DI Water

	5% Nitric Acid
Trained, Competent and Authorized Employees in this SOP	Tina Donovan Alice Drew-Davies Shyla Allred Dan Cass Matt Kilsdonk Mat Erickson Michael Picker Joel Arbaugh
PROCEDURES	
PRE-PURGING CALCULATIONS	1. See "Butte – GW I-Pad Steps -smpl". Pump depth is automatically calculated in the "Butte– GW Smpl Clctn r2" doForm and the "Rocker GW Smpl Clctn r0" by entering the depth to water measurement. The other parameters used to calculate pump depth are already assigned to each site, but it may be necessary to ensure that they are correct before continuing. 2. If doForms are not being used: a. Begin filling out field sheet with applicable information. b. Measure the depth to water (dtw) in the well following procedures in the SOP-GW-1_GW-LevelMeasurement. c. Based on the water level, total depth of the well, and the casing diameter, calculate the water volume, purge volume, and depth the pump should be placed at using the following equations: i. Water column = Total Depth - DTW ii. Purge volume = • 2" casing = 0.163 * water column * 3 • 4" casing = 0.652 * water column * 3 • 6" casing = 1.467 * water column * 3 d. Pump depth = (Water column/2) + DTW
PREPARING TO PURGE/SAMPLE WELL WITH PERISTALTIC PUMP	1. Confirm the name of the well to be sampled with name on the well. 2. If working in public areas, park vehicle so it is highly visible. Use orange candles and drums as traffic barriers (if necessary). Use flashing yellow light on top of vehicle (if required).
IF USING ISCO PERISTALTIC PUMP	1. Insert an adequate length of Extra Silistic ® ½" tubing into the internal pump. This pump uses an ISCO Model 948 12-V battery for power. The battery should be in a power center casing that has a cord that screws onto the pump connection labeled for battery or power source. 2. Use Clearflo 0.375 x 0.500 PVC 3/8" tubing on either end of the internal tubing. Attach the appropriate calculated length of tubing to the internal tubing inlet by simply pushing the 3/8" tubing into the ½" tubing. When determining the tubing length, allow length for the tubing to travel from the peristaltic pump to the top of the well casing and down to the desired depth. If the well has a 4" casing, it may be difficult to lower the tubing into the well. Attach the end of the tubing onto a submersible pump using zip ties and lower to the desired level. 3. Attach the appropriate calculated length of tubing to the peristaltic pump outlet. Attach the outlet tubing in the same way that the inlet tubing was attached. Attach enough tubing so that the purge water will be able to be discharged away from the immediate work area or to the purge barrels if water is being containerized.
IF USING GEOTECH PERISTALTIC PUMP	1. Insert an adequate length of 3/16" x 3/8" silicon tubing into the internal pump. This pump uses a Geotech 12 V 8 AH, non-spillable AGM, sealed maintenance-free battery. The battery is connected to the pump by a separate cord. 2. Use New Age Industries 0.170 x 0.250 linear low-density polyethylene tubing for purging. Attach the appropriate calculated length polyethylene tubing to the internal tubing inlet by simply pushing the polyethylene tubing into the internal tubing. When determining the tubing length, allow length for the tubing to travel from the peristaltic pump to the top of the well casing and down to the desired depth. Run the outlet end of the silicon tubing into a 2-gallon bucket that the YSI will be placed in to take parameters. If containerizing, attach enough tubing to reach the discharge barrel.
IF USING GRUNDFOS VFD PUMP WITH GENERATOR	1. Attach an adequate length of tubing to the pump inlet and secure it with a hose clamp. Lower the pump into the well to the desired depth. The pump is extremely heavy if lowered >100 feet into the well and securing it at the top of the casing can be difficult. Attach multiple clamps to the tubing without compressing it. Do not pinch electrical lead with clamp as this might compromise it causing the pump to malfunction. 2. If using a generator, start the generator and allow enough time for it to warm up. Using the supplied cables, connect the motor lead to the VFD. Plug the VFD into the generator or utility power supply. The VFD will initialize and be ready to drive the motor. Press the FWD key to start the motor. Use the up and down arrows to increase or decrease pump speed to the desired pumping rate. If generator does not have a GFCI, do not use if raining, snowing, or there is the possibility of the generator getting wet.

If USING BLADDER PUMP WITH COMPRESSOR at SOUTHERN CROSS WELL.	1. Call Sun Rental and rent a 185-cfm compressor. It is rather large and will be towed behind the vehicle. Confirm with rental company which size ball you need for towing. 2. Bring dedicated tubing to site. Tubing is in a black garbage bag labeled with site name. If tubing is compromised, order two 250 feet sections of item # 87050502 (Item Description: TUBING,PE,1/4x3/8,FT POLYETHYLENE) from Geotech. 3. Two lines, one dedicated to air and one dedicated to water. 4. Upon arrival, start compressor and let it warm up 5 to 10 minutes. 5. While the compressor is warming up, attach the tubing to pump, assuring the water line is attached to water outlet on the pump and that the air from the compressor is attached to the air inlet on the pump. Also, attach one end of a length of cord to the pump and the other end securely fasted to the well casing or another stable surface, to be used in the event the pump disconnects from the tubing so you can recover it.
PREPARING TO PURGE/SAMPLE WELL	1. If containerizing purge water, complete a ground water equipment checklist to ensure that there are no leaks, and everything is working properly with the tank. Document equipment inspections in doForms. Project: Butte – HSSE Form: Butte HSSE – GW Eq Insp. 2. If water must be containerized: a. Place dedicated discharge pump into purge barrel. b. Check to make sure hose is firmly attached to tank fitting. 3. If not using the flow cell, using metal spring clamps, attach a small bucket or 1000 mL sample bottle with top removed, to the inside of one of the purge barrels. One clamp can hold the bucket to the barrel. The other clamp can be attached to the barrel, and the handle of the bucket can be hung over the clamp. Remove plastic guard from YSI Pro Plus. Put metal guard on meter. Place the multi-meter into the 3-gallon bucket or 1000 mL sample bottle. Water should flow into the bucket then out and into the barrel. 4. If containerizing water and using the flow cell, attach the flow cell to the outlet of the peristaltic pump, Grundfos, or bladder pump and attach an additional length of tubing to the outlet of the flow cell. When attaching the outlet tubing, attach enough tubing so the discharge water will reach the container. 5. If water is not to be containerized, remove plastic guard from YSI Pro Plus. Put metal guard on meter. Set up a bucket and place the multi-meter in the bucket. Water will be purged into this bucket, allowing field parameters to be measured. If using the flow cell, after removing plastic guard, insert meter into flow cell and turn clockwise to tighten down, attach the flow cell to the outlet of the peristaltic, Grundfos, or bladder pump, and then attach an additional length of tubing to the outlet of the flow cell. Whether purging into a bucket or through the flow cell, discharge the purge water so that it will flow away from the work area. 6. Lower the tubing into the well to the determined pumping depth. Be sure the depth is referenced to the measuring point on the casing. Clamp the tubing to the casing so that the clamp supports the tubing but does not pinch it. 7. Turn the multi-meter on. (Be sure the stirrer is turned on if applicable)
PURGING WELL	1. Be sure the pump is connected to the battery. 2. Begin purging and record all applicable data in the doForm and field book. At Southern Cross well, a paper field sheet replaces the doForm and a dedicated field book is used also. 3. Determine the purge rate by measuring the time it takes for purge water to fill a known volume. Record the purge rate in the doForm (field sheet if Southern Cross). 4. Continue purging and measure field parameters at appropriate intervals. Intervals should be volume based. For BPSOU, field parameters must be recorded at least five times. Thus, if the purge volume is 5 gallons, parameters should be recorded every gallon. For Rocker GW OU, field parameters must be recorded at least eight times, so for a 5-gallon purge volume, parameters would be recorded approximately every 0.6 gallons. 5. Continue purging until at least three casing volumes have been purged and field parameters have stabilized. Stabilization is defined as: a. pH: within 0.1 standard unit over one casing volume b. specific conductivity (SC) and temperature: within 10 % over one casing volume c. ORP, DO: should have changed minimally, but stabilization is not defined. If pH, SC, and temperature have stabilized, very likely that other parameters have stabilized. 6. After appropriate volume is purged and parameters have stabilized, sample can be collected. 7. At Sothern Cross well, turbidity must be less than 5 NTU's before sampling can occur.
SAMPLE WELL	1. Prior to collecting the sample, remove the flow cell (if applicable). 2. Flush source water through the pump/tubing for approximately one minute after removing flow cell. 3. Collect samples directly into sample bottles. a. Wear clean impervious gloves to collect the sample. b. Be certain the tubing outlet is clean. c. If using pre-preserved bottles, a head space need not be left. If preservative must be added to bottle, leave a small head space. Do not leave head space on the general chemistry bottle. d. Do not overfill pre-preserved bottles, preservative will be lost. e. Collect the dissolved metals portion of the sample last. Sample order does not matter on other portions. f. To collect the dissolved metals portion of the sample, place a new 0.45-micron filter on the tubing outlet. Flush adequate water through the tubing to thoroughly rinse the filter. Fill the sample bottle.

	4. While collecting samples, continue to purge excess water into containers if water is being containerized.
DECONTAMINATION	1. After sampling, measure water level if required. Stop the pump. 2. When using the Grundfos VFD pump, unplug the VFD from the generator BEFORE removing the motor lead from the VFD or turning off the generator. Also, the cable connecting the pump to the VFD must be removed from the pump before the pump can be raised from the well. 3. At Southern Cross well, if using the Grundfos, due to the PVC size and the type of pump, the pump may have to be removed before the water level can be measured. Removal of pump may require two people due to the weight of it (see TRA). If possible, refrain from lifting the pump by the electrical lead as this may cause irreparable damage. Sometimes, the level may be obtained before removing the pump if using the bladder pump at the Southern Cross well due to the smaller sized tubing employed. 4. Pull the tubing from well, coiling it neatly. Do not let the tubing touch the ground. At Southern Cross well, it may be necessary, due to the length of the tubing, to use a clean tarp to place the tubing on while removing it from the well. Mark the two sides of the tubing as air and water, before removing the pump from the tubing for reference next time the tubing is installed on the pump. Zip tying the coiled sections, as you remove the tubing from the well, is imperative to controlling the tubing, due to the length. 5. Prepare decontamination solution. Use a 2-liter graduated cylinder. Put a very small amount (a drop) of phosphate free detergent in the cylinder. Fill the cylinder ¾ full of tap water. 6. Place one end of the tubing in the cylinder. Have extra water at hand and ready to pour. Be certain that the tubing outlet is directed away from personnel and equipment. If water was containerized, containerize the decontamination water as well. 7. Restart the pump and flush the decontamination solution through the pump and tubing. As the water in the cylinder draws down, pour fresh water in, but no detergent. Continue to run water through the pump/tubing until the rinse water is free of soap. 8. Load equipment and proceed to the next site.
WATER DISPOSAL	1. Before sampling, complete a ground water equipment checklist to ensure that there are no leaks, and everything is working properly. Document equipment inspections in doForms. Project: Butte – HSSE Form: Butte HSSE – GW Eq Insp. 2. Place dedicated submersible pump into purge barrel. 3. Check to make sure hose is firmly attached to tank fitting. 4. Connect the pump leads to the battery (correctly) and begin pumping the discharge water into the tank in the back of the truck. 5. Upon emptying barrel, disconnect leads from the battery and remove pump from barrel. 6. Do not run pump dry, stop the pump when there is approximately 2” water left in the barrel. 7. When tank reaches maximum fill level, tanks are marked, carefully drive to the drying beds in LAO. 8. Upon arrival, park horizontal to the drying bed. 9. Unroll tank discharge hose. 10. Insert a pre-cut piece of PVC pipe into the discharge hose, allowing for unimpeded discharge of purge water. Direct discharge away from personnel and vehicle. 11. Open valve and allow tank to drain. 12. Close valve, remove PVC, roll up hose and replace. If overnight temperatures are expected to be below freezing, store the valve open to avoid it getting frozen shut. Simply roll up the hose and clamp it to prevent leakage.
DOCUMENTATION	1. In the field book, at the beginning of the sampling job, record date, personnel involved, safety topics for the day, and weather conditions. Also indicate which iPad and form will be used to for the day so that records can be easily found if necessary. Complete a “Butte – GW Smpl Clctn r2” or Rocker-GW-Smpl-Clctn-r0 doForm on the iPad that will be used to record field data. Follow **GW I-Pad Steps –smpl** located at a. **Butte –** https://woodardcurran.sharepoint.com/sites/trec/docs/DoForms/Butte%20-%20GW%20I-Pad%20Steps%20-smpl.aspx b. **Rocker –** https://woodardcurran.sharepoint.com/sites/trec/docs/DoForms/Rocker%20-%20GW%20I-Pad%20Steps%20-smpl.aspx Record any unusual circumstances in the notes of the doForm as well as the field book. At the end of the day record any applicable deviations from the Clark Fork River SOPs/Work Plan/Sampling Plan. 8. Each sample shall be clearly labeled in waterproof ink with a unique sample ID, sample date, sample time, sample analysis, sample preparation (i.e. filtered, preservative used), and sampler’s initials.
REPORTING	1. Download doForms, process files with transformer, and organize output forms: a. Download appropriate doForms by following **DoForms Online Download Steps** located at https://woodardcurran.sharepoint.com/sites/trec/docs/DoForms%20Online%20Download%20Steps.aspx b. Follow **GW Processing Steps** located at • **Butte –** https://woodardcurran.sharepoint.com/sites/trec/docs/DoForms/Butte%20-%20GW%20Processing%20Steps.aspx • **Rocker –** https://woodardcurran.sharepoint.com/sites/trec/docs/DoForms/Rocker%20-%20GW%20Processing%20Steps.aspx c. Ensure that all files are complete and organized as instructed in **GW File Organization Details** located at • **Butte –** https://woodardcurran.sharepoint.com/sites/trec/docs/DoForms/Butte%20-

	%20GW%20File%20Organization%20Details.aspx • **Rocker –** https://woodardcurran.sharepoint.com/sites/trec/docs/DoForms/Rocker%20-%20GW%20File%20Organization%20Details.aspx 2. Editing and revisions: a. If missing data (date, time, units, etc.) or grammatical errors are discovered, corrections may be made to original doForms and re-import can be performed, or the original output file can also be edited. b. Before submitting the output file to the database, if there are found to be incorrect entries while checking the output file, save the output file as a revision with a date stamp (file-name_revised-mmddyy) and make the appropriate edits, but preserve the original raw doForms. c. After an output file is submitted to the database, and an error is found, save the submitted output file as a resubmit with a date stamp (file-name_resubmit-mmddyy) and make the appropriate edits, but preserve the original raw doForms. Resubmit the revised form to BPSOU DATA and request that the revised form replace the originally submitted form. d. Ensure that all revisions are saved to the submittal folder (monthly file) as well as the original file location.

SOP – H – 01

WATER SAMPLING EQUIPMENT DECONTAMINATION

Authorized for use: 04/13/2020
Revision 3
Reviewed: 04/13/2020

SCOPE	This SOP addresses decontamination of water sampling equipment. Procedures for both surface water and ground water sampling equipment are included.
RTRA(s) Referenced/ Reviewed	TRA1-001: Common Hazards Driving Manual Handling TRA1-003: GW Sampling And Monitoring TRA1-005: Surface Water Sampling
STOP WORK TRIGGERS	Lightning (30 second rule) Extreme Wind Unsafe conditions Inadequate PPE or equipment
MSDS	Arsenic Cadmium Copper Lead Mercury Zinc Battery Acid 5% HNO_3 Laboratory grade detergent
PPE REQUIRED	If on site items: 1-7 are required. If off site: items 3, 5, 6 and 7 are required. 1. Hard Hat 2. Safety Toe Boots (if surface water sampling rubber (or comparable) soled waders 3. Safety Glasses 4. High Visibility Shirt/Vest 5. Clean Impervious Gloves 6. Long Sleeve Shirt 7. Long Trousers
OTHER INSTRUCTIONS/SOPs	
REQUIRED TOOLS	Laboratory grade detergent 5% Nitric acid Deionized/distilled/tap water Decontamination solution container
Trained, Competent and Authorized Employees in this SOP	Tina Donovan Alice Drew-Davies Shyla Allred Dan Cass Caleb Arbaugh Michael Picker Joel Arbaugh Mat Erickson
PROCEDURES	
PERISTALTIC PUMP DECONTAMINATION- IF PUMP HAS INTERNAL TUBING	1. Store decontamination solutions in clearly marked, dedicated containers. 2. Wear clean impervious gloves to avoid contamination of equipment/solutions. 3. Sampling in field with peristaltic pump with internal tubing: At each site place clean (new) tubing on the pump. Have pump situated so tubing does not touch the ground or other surfaces, such as the tailgate. If working off the tailgate, assure surface has been cleaned and situate pump at edge of tailgate so tubing does not touch the surface. 4. Attach filter to outlet end of tubing. 5. Rinse the end of inlet tubing with source water by pouring a small amount of water over tubing. 6. Place the decontaminated end of the pump tubing into the container of source water. 7. Pump source water through the new tubing with filter attached for at least 5 seconds after water begins to discharge from filter to thoroughly rinse line and filter before collecting filtered sample. 8. Dispose of decontamination solution to the ground surface unless the sampling/work plan states otherwise. 9. Sample preparation in lab: Add a generous quantity of 5% nitric acid to deionized water in a clean dedicated container. Internal tubing will be re-used for each site with adequate decontamination between

	all samples collected. 10. After prepping initial sample, use a dedicated squirt bottle of deionized water, rinse the end of the inlet tubing by squirting a small amount of water over tubing. 11. Place tubing end into decontamination solution and run decontamination solution through tubing. Run tap water in the sink during this step as a safety precaution. 12. Before collecting the filtered sample, attach filter to outlet end of tubing and rinse the tubing and filter with sample water to remove all traces of nitric acid. Repeat steps 9 through 11 for each time interval sample (3 Litres per each time collection) starting with last sample collected at the site and ending with first sample collected. 13. Remove and dispose of pump outlet tubing. 14. Cut a new length of pump outlet tubing in preparation for the next sample collection site. 15. If using peristaltic pump (modified Isco head) for ground water sampling, decontamination will be conducted using the technique described below in the Ground Water Sampling Pump Decontamination but the term tubing will replace pump.
FIELD DECONTAMINATION OF CHURN SPLITTER	1. Store decontamination solutions in clearly marked, dedicated containers 2. Wear clean impervious gloves to avoid contamination of equipment/solutions 3. Fill the churn splitter half-way full with deionized water and add approximately 1 cup of 5% HNO_3 to the water. 4. Swirl the water in the churn splitter, taking care to rinse all inside surfaces. Move the churn up and down. Dispense a portion of the water through the spigot, and pour the remaining water out of the top of the churn splitter. 5. Repeat steps 3 and 4 two times with deionized water only. 6. At the next site, rinse the churn splitter as described in steps 3 and 4 with source water.
OFFICE DECONTAMINATION OF CHURN SPLITTER	1. Store decontamination solutions in clearly marked, dedicated containers 2. Wear clean impervious gloves to avoid contamination of equipment/solutions 3. Fill the churn splitter half-way full with tap water and a small quantity (~1/8 teaspoon) of laboratory grade detergent 4. Swirl the water in the churn splitter, taking care to rinse all inside surfaces. Move the churn up and down. Use a clean dedicated brush with a handle (such as a bottle brush) to scrub inside seams and the spout. Use a small brush (toothbrush) to scrub the spigot. Dispense a portion of the water through the spigot. When dispensing water through spigot, rinse the lid. Unscrew spigot and brush threads. Pour the remaining water out of the opening where the spigot was removed and/or the top of the churn splitter. 5. Rinse the churn splitter three times with tap water. 6. Fill the churn splitter half-way full with deionized water and add approximately 1 cup of 5% HNO_3 to the water. 7. Swirl the water in the churn splitter, taking care to rinse all inside surfaces. Move the churn up and down. Dispense a portion of the water through the spigot, unscrew spigot and pour the remaining water out of the opening where the spigot was removed and the top of the churn splitter. When dispensing water out of the spigot, rinse the lid of the churn splitter. 8. Repeat steps 6 and 7 three times with deionized water only. 9. Immediately cover the spigot with lab wrap or comparable material. Place the decontaminated churn splitter in two plastic bags which can be pulled shut. 10. Label the bag that the churn splitter is being stored in, with the name of the dedicated site it is being used at. Store the churn splitter in a clean area until the next use.
GROUND WATER SAMPLING PUMP DECONTAMINATION	1. Store decontamination solutions in clearly marked, dedicated containers. 2. A tall, slender container is recommended for submersible pump decontamination. A plastic 2 liter volumetric cylinder works well. 3. Wear clean impervious gloves to avoid contamination of equipment/solutions. 4. Place a very small amount (one drop) of dilute laboratory grade detergent in the decontamination container. Review and follow all manufacture's instructions before dilution. 5. Fill the decontamination vessel with decontamination solution. For ground water monitoring, cleanliness of the source water along with the anticipated purge volume, can be considered when choosing a decontamination solution. a. If utilizing low flow sampling techniques, distilled or deionized water must be used. b. If utilizing the three casing volume technique, tap water can be used. i. If the total purge volume is small (< 3 gallons) and the source water is clean (expected to meet drinking water standards) distilled or deionized water shall be used for decontamination even when utilizing the three casing volume technique. 6. Ensure that the outlet end of the pump tubing is secured in the appropriate collection container before pumping commences. 7. Place pump (tubing if using modified ISCO head) into the decontamination solution. 8. Connect the pump to the power source and pump until the decontamination solution has purged through the entire tubing length. Add water to the decontamination vessel to ensure that the pump intake remains submerged. If sampling in BPSOU, all decontamination water will be containerized. Disconnect the pump power source before the level of the decontamination solution is below the pump intake. 9. Pour any soapy water out of the decontamination vessel. Rinse the vessel to remove all detergent

	residue. Place the pump back in the vessel and pour decontamination water into the vessel to the top of the pump. Do not add detergent. 10. Connect the pump to the power source and pump until the rinse water has purged through the entire tubing length. Add water to the decontamination vessel to ensure that the pump intake remains SUBMERGED. If sampling in BPSOU, all decontamination water will be containerized. Disconnect the pump power source before the level of the decontamination solution is below the pump intake. Place pump and tubing into dedicated bucket for storage between sampling sites.
DOCUMENTATION	1. Note in the field book that equipment has been decontaminated

SOP – H – 02

DOWNLOADING TRANSDUCERS

Authorized for use: 04/13/20
Revision 2

SCOPE	This SOP addresses downloading Solinst Transducers by various methods. A Depth to Water measurement or SG measurement must always be recorded when downloading data.
TRA(s) Referenced/ Reviewed	TRA1-001: Common Hazards Driving Manual Handling TRA1-007: Download Transducers
STOP WORK TRIGGERS	1. Lightning (30 second rule) 2. Extreme Wind 3. Unsafe conditions 4. Inadequate PPE or equipment 5. Inability to access the work area safely 6. Defective equipment 7. Improper tools
MSDS	1. Arsenic 2. Cadmium 3. Copper 4. Lead 5. Mercury 6. Zinc 7. Manganese 8. Iron 9. White Lithium 10. PCB's 11. Wasp Killer
PPE REQUIRED	1. Hard Hat 2. Safety Toe Boots 3. Safety Glasses 4. High Visibility Shirt/Vest 5. Gloves 6. Long Sleeve Shirt 7. Long Trousers
P&IDs/Other Relevant Drawings	1. N/A
OTHER INSTRUCTIONS/SOPs	1. Other applicable TRA's/SOPs: Water Level Measurement, Read Staff Gage, Remove Manhole Cover
REQUIRED TOOLS	1. Levelloader 2. Levelogger App Interface 3. Computer with Optical Reader 4. Water level tape (when applicable) 5. Decontamination equipment (when applicable) 6. Manhole Hook (MSD and sub drain sites) 7. Socket Wrench 8. Screw Driver 9. Hammer
Trained, Competent and Authorized Employees in this SOP	1. Tina Donovan 2. Alice Drew Davies 3. Dan Cass 4. Michael Picker 5. Shyla Allred 6. Nicole Santifer 7. Caleb Arbaugh 8. Joel Arbaugh
Lessons Learned (observations, near misses, etc.	

to be considered during 2-yr SOP review)	
PROCEDURES	
DOWNLOADING TRANSDUCERS WITH BLUETOOTH SOLINST LEVELOADER APP INTERFACE	1. Measure the depth to water in the well following SOP-GW-01_GW-LevelMeasurement when downloading transducers in wells. Record the water level on the field sheet and in the appropriate doForm. Read and record the water level of the staff gage according to SOP-SW-06_ReadStaffGauge when downloading surface water transducers. Record the water level on the field sheet and in the appropriate doForm. 2. If a direct read cable is deployed in the well or surface water, remove the cap from the direct read and screw the interface to the direct read cable. If a direct read is not deployed in the well or surface water, the transducer extension or direct read dongle is attached by screwing it directly onto the direct read port. Remove the transducer from the well and remove the cap. Use a paper towel to dry the transducer off, so the water will not run into the adapter or dongle. Also, take the time to visually inspect the transducer and then line up the eyes and pinhole of the transducer with the eyes and pin of the transducer extension port and firmly, but gently, push the transducer into the App Interface or screw onto the dongle. 3. Press the button on the interface until the light turns on. A green flashing light means the device is on. A blue flashing light means the Bluetooth is connected to your tablet. 4. Go into the settings of your tablet. Select the Bluetooth section. Your device will automatically be recognized. If there is only one Bluetooth interface device listed under “My Devices” and it is the serial number interface you possess, then no further action is required. If there are two serial devices listed under “My Devices” then you will have to remove the one that you are not using. Next to the status (Connected, Not Connected) of your Bluetooth, there is a blue circle with an “i” inside. Press that and an option to “Forget This Device” will show up. Two different serial numbers of the same type of device will cause conflict with connection. 5. Go into the Solinst app. If the device disconnects while opening this app, you will have to toggle back to the Settings and manually connect the device again. Otherwise, you can either give the app a few seconds to recognize the transducer you are connected to, or you can drag down the left menu until you see a loading bar and a message to refresh the attempt to connect to the transducer. The connected transducer should show up at the top of the left menu. If you receive communication error messages, you may have to try downloading with a Leveloader (next section of the SOP). 6. Once connected to the transducer, click the “All Data” button below the picture of the transducer. If a download progress bar does not show up below the picture of the transducer, then simply click on the picture of the transducer and it should show up. Pay attention to make sure that it fully downloads (100%). Once the download is complete, the App will play a little tune. 7. After all data has downloaded, click the “Start/Stop/Edit” button below the picture of the transducer. In the detail view to the right, under the Datalogger Sampling Mode section, there is a red “Stop Now” button, press it. Again, the App will alert you when the action is complete with a tune. Under the Datalogger Status section, the Status should now say “Stopped” in red. Press the “Start Now” button which appears in green. Again, the App Interface will play a little tune. Ensure that the Status says “Logging” in green before moving to the next well. 8. Disconnect from the transducer by removing the transducer from the extension port/dongle or unscrewing the direct read port. Replace cap on direct read end and return to well. 9. To remove downloaded data from the tablet to the computer, you must have iTunes. 10. Connect the iPad to your laptop via USB. Open iTunes. A popup may ask for permission to connect the device, and you will have to follow prompts on the tablet and computer to complete this step. 11. In the top right, there is a tablet icon, click on it. In the left menu, select “File Sharing.” Select Solinst in the Apps menu that shows up to the right. The downloaded files should show up to the right in the Solinst Documents menu. 12. Select all files and drag to the current month folder within \\woodardcurran.net\shared\Offices\Bozeman\BUTTE\TREC\ARCO\BPSOUGW\ContinuaIData\RawFiles

DOWNLOADING TRANSDUCERS WITH CORDED LEVELOADER	1. Measure the depth to water in the well following SOP-GW-01_GW-LevelMeasurement when downloading transducers in wells. Record the water level on the field sheet and in the appropriate doForm. Read and record the water level of the staff gage according to SOP-SW-06_ReadSG when downloading surface water transducers. Record the water level on the field sheet and in the appropriate doForm. 2. Turn Leveloader on by pressing the "ON" button in the top left corner of the device. 3. The Leveloader is emptied of all stored data prior to the next round of ground water levels. Check the "View Stored Data" by scrolling to it and pressing the button that points to the "OK" option on the screen. It will be empty if you are at your first download site. Check the last number in the log before downloading your current transducer; you may have to scroll down. Press the button that points to the "Menu" option on the screen. 4. Determine if there is a direct read cable or not, select the appropriate cord to plug into the Leveloader and connect the other end to the direct read or the transducer. A direct read requires the metal end and screws onto the metal direct read end of the transducer cord (the cap must be removed first). If attached to paracord, the transducer must be removed from the well, the cap unscrewed, and the transducer needs to be screwed onto the cord with the eyes and pin lined up correctly and attached to the transducer. Make sure the connection is tight on both ends. 5. Select Connect to Logger. If "Check Cable Communication Error" pops up, you will either need to check your connections or look for an alternative download method. If this message appears for a direct read, you can try to pull the transducer up and connect to it with the other cord. If that still doesn't work, try downloading with a laptop (next section of the SOP). 6. If there are no connection issues, scroll down to Data from Logger and press the OK button. Data points will show up on the screen, press the Save Log button. 7. The download process will begin; it is best to pay close attention and wait for a "Download Complete!" message to ensure that all data was successfully downloaded. If you lose track of this, the screen will return to the Levelogger Menu if all data was successfully downloaded. A communication error message will flash if anything went wrong during data download, in which you will have to navigate to the menu to start over. 8. When Download is complete, press the Return button. Go back to View Stored Data to ensure that there is an additional log in the list from when it was checked prior to download. Return to the main menu and disconnect from the transducer. 9. Turn the Leveloader off between sites to save on battery by holding the ON button until the screen goes blank. 10. To remove downloaded data from the Leveloader to the computer, you must have the appropriate version of Solinst software downloaded to your laptop. 11. Connect the Leveloader to your laptop via the correct cord. 12. Turn the Leveloader on and scroll to the "Data to PC" option and press OK. 13. Open the Solinst software on your laptop. Go to the last tab at the top labeled "Leveloader." It is very important to select the correct com port that you have the Leveloader plugged into or a connection error will appear. Press the top left icon of a Leveloader with a green arrow to a computer; this is "Retrieve Leveloader Settings." 14. Stored data will show in the left menu below. All the files will be selected to download. If you do not want to download all the files, unclick the box preceding that file. Press the icon with the arrow pointing down; this is "Download Data." A box will appear. Open Windows Explore. Find the path to \\woodardcurran.net\shared\Offices\Bozeman\BUTTE\TREC\ARCO\BPSOUGW\ContinuaIData\RawFiles and the folder named the month and the year (ex. 18-January) you have downloaded. Right click on the path and select Copy and save path as text. Paste the path you have copied as text into the line at the bottom of the box that appeared. Click okay. After the data is downloaded, a box will appear, click "finish".

DOWNLOADING TRANSDUCERS WITH A LAPTOP	1. Measure the depth to water in the well following SOP-GW-01_GW-LevelMeasurement when downloading transducers in wells. Record the water level on the field sheet and in the appropriate doForm. Read and record the water level of the staff gage according to SOP-SW-06_ReadSG when downloading surface water transducers. Record the water level on the field sheet and in the appropriate doForm. 2. Turn the laptop on and open the Solinst software. You can use either an optical reader (USB to "drop-in" transducer port) or the USB to direct read cord with transducer extension port. Select the appropriate cord for the connection type (direct read or transducer). 3. In the Solinst software on the laptop, make sure you are in the Datalogger Settings tab. Click the first icon in the top left, a transducer with a green arrow to a computer; this is "Retrieve Datalogger Settings." 4. Once connected, go to the Data Control tab. Click the first icon in the top left, a green arrow pointing down; this is "Download Data." Select "All Data" in the drop-down menu that pops up. If all three methods of connection fail, there may be an issue with the transducer; manufacturer maintenance or technical support should be sought and documented. 5. Once all data is downloaded, a graph will show the data. Go to File and select Save As. Make sure it is an XLE file and save it to the appropriate folder on the desktop. That data can then be transferred from the field laptop to an office laptop via thumb drive. If the field laptop has access to the server, it can be transferred to the current month folder within \\woodardcurran.net\shared\Offices\Bozeman\BUTTE\TREC\ARCO\BPSOUGW\ContinuaIData\RawFiles once you return to the office.
DOCUMENTATION	At each site, record the date and time, depth to water or staff gage measurement, and any comments or notes that affect the water level in the appropriate site fields in the ground water levels doForm and printed sheet. If the transducer cannot be downloaded, document in the field book and seek maintenance or technical support.

SOP – H – 05

Calibrate YSI Professional Plus Multi-Meter

Authorized for use: 02/23/19
Revision 2
Reviewed: 04/14/2020

SCOPE	This SOP addresses the manual calibration of YSI Professional Plus Multi-Meter.
TRA(s) Referenced and/or Reviewed	TRA041 – Equipment Calibration
STOP WORK TRIGGERS	Unsafe conditions Inadequate PPE or equipment Inability to access the work area safely Defective equipment Improper tools
MSDS	1413 µS/cm Conductivity Solution 447 µS/cm Conductivity Solution 84 µS/cm Conductivity Solution Buffer Solution pH 7.00 Buffer Solution pH 4.01 Buffer Solution pH 10.02 ORP Standard Solution
PPE REQUIRED	Closed-toe shoes Safety glasses Gloves (nitrile, impervious) Long sleeve shirt Long trousers
OTHER INSTRUCTIONS and/or SOPs	Refer to product manual for troubleshooting, maintenance, and further information.
REQUIRED TOOLS	Philips screwdriver to change batteries, if low (3 C Batteries)
Trained, Competent and Authorized Employees in this SOP	1. Tina Donovan 2. Alice Drew Davies 3. Dan Cass 4. Michael Picker 5. Shyla Allred 6. Joel Arbaugh 7. Mat Erickson
PROCEDURES	
Dissolved Oxygen (DO %)	1. Turn the meter ON. 2. Make sure that there is a good DO membrane tip with fresh electrolyte solution (there should be no air bubbles or wrinkles, also the tip should not be corroded). 3. Blot excess water from the DO probe and fill the calibration/storage cup with a small amount of water (the longest probe is the metal tip of the temperature/conductivity probe – it should be completely above the water surface). 4. Lightly screw on the calibration/storage cup, giving it two turns. 5. Press CAL, use the arrows to highlight DO (%) and press ENTER. Allow the DO% reading to stabilize (at minimum ten minutes, the numbers might bounce back and forth but you won't see a trend.) 6. From the calibration screen, record the barometer value. 7. After stabilization, press ENTER to accept calibration. Record the final calibration value (%) from the meter display.
pH (SU)	8. Always starting with neutral (pH 7.00), pour buffer solution rinse into the calibration/storage cup. Tighten cup and gently shake probes to rinse. Discard the rinse solution in the sink. 9. Fill cup with fresh buffer solution (from the gallon bottles). All the probes should be completely covered, including the conductivity orifice. 10. Press CAL, use the arrows to highlight pH (SU) and press ENTER. Allow the pH reading to stabilize by monitoring both the pH (SU) and voltage (mV) values (viewed in the calibration screen). Again, the numbers might bounce back and forth but you won't see a trend. 11. For pH, the temperature adjusted calibration value will automatically populate so you won't have to manually change it. Here is a calibration table showing what the temperature adjusted calibration values and voltage range should look like:

	pH 7.00	pH 4.00	pH 10.00

	Calibration Temperature (ºC)	voltage range (0 mV to 50 mV)	voltage range (+165 to +180 from buffer 7.)	voltage range (-165 to -180 from buffer 7.)
	10	7.07	4	10.19
	15	7.05	4	10.12
	20	7.02	4	10.06
	25	7	4	10
	12. After stabilization, record initial value (SU) and temperature (ºC) from meter display. Then, use arrows to highlight *accept calibration value* and press ENTER (only once!) At the very bottom of the calibration screen, you should see "Ready for Point 2". Record the final calibration value (SU). Note: for Point 1, there is typically no final value displayed for your first point (pH 7.) as you need two points to complete the line. 13. Repeat Steps 7-11 as necessary (pH 7. and 4. for groundwater and pH 7. and 10. for surface water.) Use a three-point calibration (pH 7., 4., and 10.) if the meter has been in long term storage or has been recently maintained (replacement or cleaning of probes), etc. 14. When you have accepted the final calibration value (second, or third point depending on what you are calibrating for) press CAL to complete pH calibration. Record the final pH calibration value.			
SC (µS/cm)	15. Pour the appropriate conductivity solution rinse (447 µS/cm for surface water, and 1413 µS/cm for groundwater) into the calibration/storage cup. Tighten cup and gently shake probes to rinse. Discard the rinse solution in the sink. 16. Fill cup with fresh conductivity solution (from the gallon bottles). All the probes should be completely covered, including the conductivity orifice. 17. Press CAL, use the arrows to highlight conductivity, then highlight specific conductance, press ENTER, then highlight µS/cm and press ENTER. Allow the SC reading to stabilize. 18. For SC, the default calibration value must be changed. Use the arrow keys to scroll up to the calibration value (it should read the same as the meter), press ENTER to edit, and use the arrow keys to backspace and edit the calibration value to the value of standard which you are using. Press ENTER to take you back to the calibration screen. 19. After stabilization, record the initial calibration value (µS/cm) and temperature (ºC) from meter display. Hit ENTER to accept value. 20. Press CAL to complete and record the final calibration value.			
ORP (mV) (Typically only calibrated for groundwater monitoring)	21. Pour ORP rinse solution into the calibration/storage cup. Tighten cup and gently shake probes to rinse. Discard the rinse solution into the sink. 22. Fill cup with fresh ORP solution (from the brown liter bottle). All the probes should be completely covered, including the conductivity orifice. 23. Press CAL, use the arrows to highlight ORP, then ENTER. 24. For ORP, the default calibration value must be changed. If the standard used is Geotech 220 mV +/-5 mV at 25ºC, use the following table to look up the ORP standard value to the nearest 5ºC.			
	Temperature (ºC)	Potential (mV)		
	0	237		
	5	232		
	10	230		
	15	227		
	20	223		
	25	220		
	30	216		
	25. Use the arrow keys to scroll up to the calibration value, press ENTER to edit, and use the arrow keys to backspace and edit the calibration value to the value of standard which you are using. Press ENTER to take you back to the calibration screen. 26. After stabilization, record the initial calibration value (mV) and temperature (ºC) from meter display. 27. Press CAL to complete and record the final calibration value.			
DOCUMENTATION	1. In the field book you will log the following fields: calibration standard (value and manufacturer for ORP standard as well as expiration date), initial value (except for DO), final value, and temperature (ºC). The field book information is also submitted electronically via a calibration doForm, under the correct project. 2. On the iPad, fill out an equipment calibration doForm (Butte/Rocker – Equip Calibr). Follow the steps located at a. Butte – https://woodardcurran.sharepoint.com/sites/trec/docs/DoForms/Butte%20-%20Equip%20Calibr%20I-Pad%20Steps.aspx b. Rocker – https://woodardcurran.sharepoint.com/sites/trec/docs/DoForms/Rocker%20-%20Equip%20Calibr%20I-Pad%20Steps.aspx			
REPORTING	1. Download the equipment calibration form and save it with the sampling event that it is associated with. a. Download instructions: https://woodardcurran.sharepoint.com/sites/trec/docs/DoForms/DoForms%20Online%20Download%20Steps.aspx b. File organization instructions: • Butte – https://woodardcurran.sharepoint.com/sites/trec/docs/DoForms/Butte%20-%20Equip%20Calibr%20File%20Organization%20Details.aspx			

	• Rocker – https://woodardcurran.sharepoint.com/sites/trec/docs/DoForms/Rocker%20-%20Equip%20Calibr%20File%20Organization%20Details.aspx

SOP-H-07

Transducer Compensation and File Submittal

Revision 1
Authorization for Use: 07/24/18

This SOP addresses compensating Solinst transducer files and preparing submittal files.

Required Tools: Field logbook, Completed doForm output files, Solinst software, Barologger

Compensating the File

1. Open the latest version of Levelogger software.
2. Go to the "Data Wizard" tab at the top.
3. Select "Advanced" and click "Next" at the bottom right.
4. Under "Choose Data Display Options" select "Depth to Water Level". The question "Are you compensating Levelogger data with a Barologger?" should be set to "Yes". If recording units have not been specified for a transducer (feet, meters, cm, etc.) select "Yes" for "Do You need to change any parameters?". If it is not known if units have been specified, choose Yes. When the transducer file opens, under "Units", "Level", question marks (???) will appear if units have not been specified. Click "Next" at the bottom right.
5. Click the folder icon with the green arrow at the top left to select the barometric file, which is located in the current month's folder at \\woodardcurran.net\shared\Offices\Bozeman\BUTTE\TREC\ARCO\BPSOUGW\Continual Data\RawFiles and titled with a "barologmmddyyyy" format. The file can be easily found by typing "baro" in the top right search box. Select the appropriate (most recent) baro file and click the "Open" button at the bottom right.
6. Click the icon at the top left again to select the file to be compensated, which will also be located in the current year-month folder within \\woodardcurran.net\shared\Offices\Bozeman\BUTTE\TREC\ARCO\BPSOUGW\Continual Data\RawFiles.The file can be found by typing in the site name in the top right search box. Select the appropriate file and click the "Open" button at the bottom right.
    a. Surface Water (SW) raw files can be found in the current year-month folder within \\woodardcurran.net\shared\Offices\Bozeman\BUTTE\TREC\ARCO\LAO\SW\Raw Files
7. If units have not been specified for the transducer, check "Apply all" and specify the correct measurement unit (typically feet) under Level. °C should be specified for Temp. It is not necessary to specify an offset or Logger elevation. Click "Next".
8. This brings up the Manual Data Compensation step. In this step an observed depth to water (stage for surface water) will be input at a specific time. Which time/data point you select for the manual data compensation depends on what the first few data points look like. The best way to choose a data point for compensation is to view the raw file. To view the raw data:

a. Go to the "Data Control" tab which appears across the top of the window.

b. Click the second icon at the top left (folder with green arrow).

c. Select the file you are compensating and click the "Open" button at the bottom right.

d. If the first few data points are in agreement, that data point can be used for compensation. If the first data point is significantly different, choose the next data point down or whichever data point resembles the subsequent data. The goal is to choose a stable data point. If you no longer need to view the data, you can press the "X" at the top right of the tab displaying the file.

e. Return to the "Data Wizard" tab.

9. Select the time that you wish to use for compensation and enter the observed depth to water for that time (or the nearest time) in the "A=Field Zero" box. Click the "Add" button. The depth to water can be obtained from the monthly water level sheet, other applicable data sheet such as a groundwater sampling form, or the DB continual level file for the site being compensated (see Step a). Groundwater depth to water values will be entered as positive values (Example: 26.32) and surface water stage values will be entered as negative values (-2.15).

a. A convenient source for the starting compensation point is the DB continual water level file for each continual level site. These are located at:
\\woodardcurran.net\shared\Offices\Bozeman\BUTTE\TREC\ARCO\BPSOUGW\ContinualData

Open the appropriate folder and file. Find the final observed water level (should be the last entry). This level will be input as the starting water level in the file currently being compensated.

b. If the compensation period includes times in which a change in the transducer level or a change in the reference measuring point, additional compensation points will be needed. If groundwater sampling has occurred in the compensation period, it may be necessary to add compensation points. Again, view the raw data file to choose the second, and if necessary subsequent, compensation points. If the transducer level or reference point has changed, there should be an obvious shift in the level. Use field notes to find the date and time at which the shift occurred. Use a time which follows the shift. If groundwater sampling has occurred, use an observed water level from a time in which the water level has stabilized. If recovery was very slow (over hours or days), there may not be an associated observed water level. In this case, one of the final data points can be used. This data point/'time will correspond with the field visit in which the transducer was last downloaded. As each subsequent water level is entered, the "Update" button must be clicked.

c. SW folders and their associated DB files are located at:
\\woodardcurran.net\shared\Offices\Bozeman\BUTTE\TREC\ARCO\LAO\SW

d. Remember, when the initial water level is entered, click "Add". As each subsequent water level is entered, click "Update".

10. Once all necessary water levels have been entered, click the "Next" button.

11. The file will be saved as a compensated file. It is often necessary to compensate a file more than one time. In this case, when the "Next" button is clicked, a window will come up asking "Do you want to overwrite file XXXX_Compensated.xle?" Choose "No" and rename the file in a simple manner such as XXXX_Compensated1.xle.

12. When the status reads "Success" and shows a green bar, you can open the compensated file by clicking the "Open" button next to "Success."

a. If the time period for the barologger file does not match the Levelogger file time period within three hours, the Status box will display "Warning" and the Reason box will display "Barologger Time and Levelogger Time must be within 3 hours. Complete compensation may not be possible." If this occurs, and barologger data is missing at the end of the file, the barologger should be downloaded again and the dataset should be re-compensated with that barologger

file. If barologger data is missing at the beginning of the file, and archived barologger file can be used to compensate only the beginning of the Levelogger file.

13. In step 12, the compensated file was opened by clicking on the Open button. A horizontally split screen will display the data in tabular and graphic form. Scroll to the bottom of the tabular data points. If the level at the bottom is within 0.05 feet of the level attained from monthly groundwater levels (on your sheet), then the file is good and can be exported. Sometimes the last level is very different from previous data points due to the transducer being out of the water while being downloaded and taking a reading then. If that is the case, see if the data point above it resembles the level attained from monthly groundwater levels. If so, the file is good and can be exported.

a. Several variables affect the degree of agreement between the transducer file and the observed level, such as the accuracy of the water level measurement, disturbances to the transducer during the recording period (sampling occurring, transducer being repositioned), extreme atmospheric conditions, and lengthiness of deployment time. A consistent method of measuring water levels, double-checking the water level at measurement time, maintaining the water level tape in good condition, and minimizing disturbance to the transducer will result in better agreement between observed levels and recorded levels.

b. If agreement between the observed level and the compensated level is poor (> 0.05 ft) another attempt should be made at compensation, using fewer or more compensation points. This is a trial and error process.

14. Once a satisfactorily compensated file is obtained, the file is exported. To export the file, go to the “File” drop-down at the top left, hover over the “Export File >” option, and select “Data.”

15. Select the appropriate site-specific folder within \\woodardcurran.net\shared\Offices\Bozeman\BUTTE\TREC\ARCO\BPSOUGW\ContinualData and save the file in the format of site_mmddyy-. with the date stamp on the file name being the last date associated with the data set (if the last data point is on 7/27/2017, your date stamp will be SiteID_072717; i.e. FP986_072717). Once the appropriate file location is selected and the file is appropriately named, press the “Save” button. The export takes several minutes (about 5).

a. SW files are to be saved in the same process and format, but to their appropriate folder located at \\woodardcurran.net\shared\Offices\Bozeman\BUTTE\TREC\ARCO\LAO\SW

16. •While the file is exporting, open the “Transducer_Template.xlsm – Shortcut” at \\woodardcurran.net\shared\Offices\Bozeman\BUTTE\TREC\ARCO\BPS-Storm\Monthly Downloads File, or in \\woodardcurran.net\shared\Offices\Bozeman\BUTTE\TREC\ARCO\LAO\SW if compensating a SW file.) Click the “Enable Editing” button in the yellow bar at the top of the file if it appears.

Processing file for Submittal

1. The compensated file will export as a .csv file (i.e. FP986_072717.csv). Once it has finished exporting, open the file. Right click on the tab at the bottom and select “Move or Copy. In the “To book:” drop-down menu, select “Transducer_Template,” highlight/select the “(move to end)” option, check the “Create a copy” box at the bottom, and press “OK.” An exact copy of the compensated csv file will be copied to “Transducer_Template” for record-keeping purposes.

2. A DB Excel file has been created for each site that is equipped with a continual recorder. These are located at \\woodardcurran.net\shared\Offices\Bozeman\BUTTE\TREC\ARCO\BPSOUGW\ContinualData Find the folder for the site that is being compensated, open the folder, and then open the DB

file. DB file names will contain the year to which the data applies. Once the file is open, go to the tab that contains the most recent data, and go to the last row of data.

3. Return to the compensated csv file. The first few rows in this file will contain information for the logger (Serial number, Project ID, Location, Level Unit, Offset, and Temperature Unit). There will then be a header row with Date, Time, ms, Level, and Temperature. Copy all data below the header row and paste it into the first empty row of the DB file. The first date and time values in the pasted data should be the next increment for the existing data. For example, the DB file ended 09/02/18 1100. The pasted data should begin at 09/02/18 1200 (assuming transducers are set on an hourly interval). Once the compensated data has been pasted into the Transducer_Template and the DB file, the csv file can be closed. If transducers are not set on hourly intervals, but rather on 15 minute intervals, and you notice an hour shift in time, ascertain if the file is in MDT or MST.

4. In the DB file, the pasted data will not align with the existing data. Typical column headings will be:

ColA	ColB	ColC	ColD	ColE	ColF	ColG	ColH	ColI
Date	Time	Date+Time	Level	WaterTemp	DTW	FG_DTW	Delta	Comment

When the CSV file is copied into the DB file, the Date and Time columns will align. Format the time column to military (24-hour) time. Zeros will be present in the Date+Time column (column C). Overwrite the zeros with the formula columnA + columnB (i.e. =A1+B1). Level will align with the Level column, and the WaterTemp column will align. The purpose of Column F is to round the depth to water to two significant figures (represents measurement accuracy). Use the formula [=round(D1,2)]. In the appropriate rows of Column G, enter the observed depth to water. Column H is the difference between the observed dtw and the transducer level (=G1-D1). Column I is for commenting the observed level, “Observed level = X.XX ft. Include any other pertinent comment such as, “Well being sampled”. Note that all formulas can be copied down from the previous entry, but be sure only formulas are copied (columns C and H).

5. In the first row of the current data set, copy columns G, H, and I (FG-DTW, Delta, and Comment) from the last row of the previous data set. Go to the last row of the current data set, and enter the observed dtw, the delta formula, and comment the dtw and any other pertinent comment.

a. If groundwater sampling has occurred at the site you are compensating during the month that you are working with, an observed value, difference, and comment will also need to be added to the dates and times associated with the sampling event.

b. With surface water transducers, any additional staff gage readings throughout the month may be added to the observed value, difference, and comment columns per the date and time the observations were made.

6. When all necessary data is entered into the DB file, check the chart tab for any anomalies in the graph. If there are anomalies not accounted for in comments, the suspect data points must be investigated. If an explanation cannot be provided comment the data point as suspect. Once satisfied with the data set, the current month’s data is pasted into the “DataForImport” tab in the “Transducer_Template” file.

7. Go to the Transducer_Template file. Go to the DataForImport tab. Select the appropriate “Equipment Type” and “Location”in the drop-down menu at the top of the sheet. This will auto-fill the serial number, and applicable units. It will also create headings in Row 11. Go back to the DB file for the Location selected. Copy all rows and columns of the most recent data set. Paste the selected data into the Transducer_Template using Paste Special, Values and Number

formats. If the correct Location has been selected, all data should align with column headings. Once this step is completed, the DB file can be saved and closed.

8. Go to the “File” tab at the top of the Transducer_Template file. Select “Save As” and rename the file in the format of site_mmddyy with the date stamp on the file name being the last date associated with the data set (same naming convention when exporting the compensated data from the Levelloger software). Save the renamed file in \\woodardcurran.net\shared\Offices\Bozeman\BUTTE\TREC\ARCO\BPSOUGW\ContinualData\Send.

SOP–H–08
Deployment of Water Level Monitoring Equipment

Authorized for use: 12/1/2020 Revision 1

SCOPE	This SOP covers the installation of a data logger and pressure transducer for continuous water level measurements in wells and surface water bodies.		
RTRA(s) Referenced/ Reviewed	TRA1-003 GW sampling and Monitoring TRA1-007 Download Transducers TRA1-002 Water Levels TRA1-008 SG readings, Download Sutron, ISCO, H350, weatherstation		
STOP WORK TRIGGERS	1. Lightning (30 second rule) 2. Extreme Wind 3. Unsafe conditions 4. Inadequate PPE or equipment 5. Other:		
MSDS	1. Arsenic 2. Cadmium 3. Copper 4. Lead	5. Mercury 6. Zinc 7. Manganese 8. Iron	9. White Lithium 10. PCB's 11. Wasp Spray
PPE REQUIRED	1. Hard Hat 2. Safety Toe Boots 3. Safety Glasses 4. High Visibility Shirt/Vest	5. Gloves 6. Long Sleeve Shirt 7. Long Trousers	
P&IDs/Other Relevant Drawings			
OTHER INSTRUCTIONS /SOPs	1. Other applicable TRAs/SOPs; Water Level Measurement, Read Staff Gage, Remove Manhole Cover		
REQUIRED TOOLS	1. Levelloader 2. Levelogger App Interface 3. Computer with Optical Reader 4. Water level tape (when applicable) 5. Decontamination equipment (when applicable)	6. Manhole Hook (MSD and sub drain sites) 7. Socket Wrench 8. Screwdriver 9. Hammer 10. Magnet	
Trained, Competent and Authorized Employees in this SOP	1. Tina Donovan 2. Alice Drew Davies		
Lessons Learned (observations, near misses, etc. to be considered			

PROCEDURES

Site evaluation

1. Selection of the transducer type is dependent on the maximum head of water above the transducer. The following table provides a list of transducer types and conditions for use. There are vented and non-vented units available.

Type of Transducer (psi)	Maximum Transducer Immersion (feet)	Accuracy (feet)
5	11.5	+/- 0.010
10	23	+/- 0.023
15	35	-
30	69	-
50	115	+/- 0.115
100	230	+/- 0.230

Solonist	Maximum Transducer Immersion (feet)	Accuracy (feet)
M5	16.4	+/- 0.010
M10	32.8	+/- 0.016
M20	65.6	+/- 0.32
M30	98.4	+/- .064
M100	328.1	+/- .164

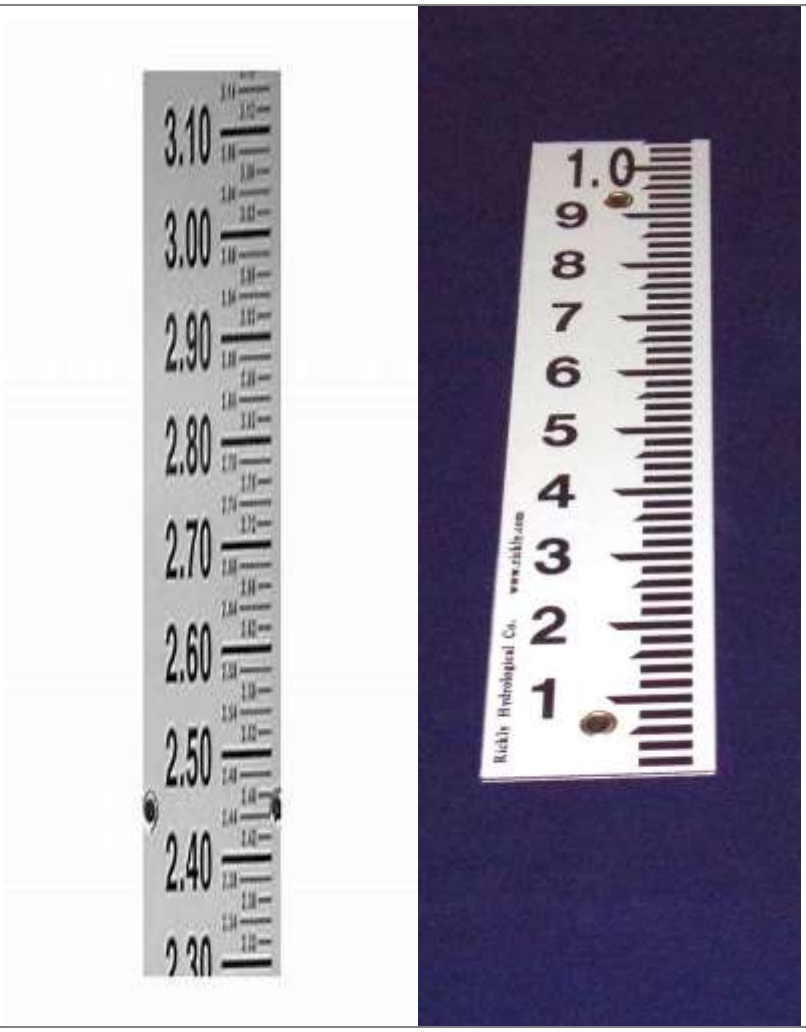
Installation Piezometers and Wells	1. Measure the depth to water from the top of the casing (TOC) or other established marking point such as top of PVC (TPVC), using a portable electric water-level indicator. Refer to SOP-GW-05. Make sure you properly estimate the maximum and minimum expected water levels during the monitoring period. The levelogger needs to be installed so it always remains submerged and so that its maximum submergence depth throughout the monitoring period remains within its specified range. The pressure transducer can be damaged if the datalogger is over-pressurized by submergence greater than its level range. The Levelogger Edge, Levelogger Junior Edge, and LTC Levelogger Edge are warranted to pressures up to 200% of their full scale level range (150% for the Levelogger Gold, Levelogger Junior and LTC Levelogger Junior Models), however accuracy cannot be guaranteed beyond its full scale. 2. Unroll suspension material (direct read, wire, or Kevlar cord) and mark the length equal to the depth to water plus about half of the maximum transducer immersion in feet. EXAMPLE, for the 50-psi transducer the suspension material should be marked at the length equal to the depth to water plus about 57 feet (115 feet divided by 2.) For wells with a shallower depth, place the transducer between the level of water and the bottom of the well (mid-point of the water column). Also allow for the amount of suspension material required for anchoring to the well. Regardless of the equation given here, under no circumstances should the transducer strike, or rest on the bottom of the casing due to the potential for damage as well as clogging by silt or sediment. 3. Securely anchor the suspension material (direct read cable, suspension wire, or cord) to the well casing or inner PVC casing, by means of a hole drilled in the PVC, or some manner of clamp. The Levelogger is to be pre-programmed and started using the appropriate software. Attach the suspension material (direct read cable, suspension cord, or wire) to the installation cap of the transducer. Slowly lower the transducer into the well to the full length of suspension material measured, or to the depth marked on the suspension material. Always be looking for knots or damage in the suspension material. 4. Connect the transducer to the data logger, to ensure proper logging. 5. If practical allow the cable to stretch in place for 1-2 days and then check the depth to water and download/restart the transducer verifying the readings. 6. For long term installations, quarterly at a minimum, verify the pressure transducer readings by measuring the depth to the water with a portable electric water-level indicator. At that time, download data from the data logger to a portable computer. The frequency of downloading the data depends on the data logger's storage capacity and the measurement frequency required. Reset the data logger by clearing the memory.

Installation Surface Water Bodies	1. Install a length of PVC at the chosen location and/or attach to a T-post for creek installations with hose clamps (ground disturbance permit required unless a T-post is already in place) (evaluate for catch basin applications). Choose a length of PVC that allows the transducer to be easily accessed. For example, an 8-foot length may be reasonable at a catch basin when the transducer is accessed from the deck of the discharge structure, but this length would not be reasonable in a creek setting where the transducer is accessed from the stream bank. When attaching the PVC to the post, discharge structure, etc., make sure the attachment prohibits movement of the PVC (vertical slipping). Leave a small (~1/2-1 inch) space between the bottom of the PVC pipe and the stream bed to allow water level to equilibrate within the PVC. 2. Determine the length of suspension material needed (calculate enough to compensate for the extra amount needed to secure to the top) based on the length of the PVC pipe. Measure suspension material so that the transducer sits between the ground and the upper level of the water. Use caution not to let the transducer sit on the ground or on the streambed. Also make sure the bottom of the transducer will remain submerged. Do not use direct read cables in creek installations. 3. Drill a hole on the side of the PVC near the top, or notch from the top but low enough that a cap may be used without pinching the suspension material. If using in a catch basin situation with a direct read cable, drill the hole completely through the PVC and run a solid material (wire) for direct read suspension. 4. Insert the suspension material through the hole in the top side of the PVC and firmly knot or secure the end with hose clamps if using a notch. With the transducer cap securely attached to the suspension material, lower the transducer to the measured monitoring depth. If using direct read in catch basin situations, insert a solid material, such as a dowel, wire, or Kevlar cord, through the holes and secure (bend over at both ends). Loop direct read cable and head over solid material support, lower the transducer into place and apply PVC cap. 5. Check that your transducer is sitting at the desired length following installation, ensuring that it is not sitting on the bottom or in silt. 6. Connect the transducer to the data logger, to ensure proper logging. 7. If practical allow the cable to stretch in place for 1-2 days and then check the depth to water and download/restart the transducer verifying the readings. 8. For long term installations, quarterly at a minimum, verify the pressure transducer readings by reading the staff gage. At that time, download data from the data logger to a portable computer. The frequency of downloading the data depends on the data logger's storage capacity and the measurement frequency required. Reset the data logger by clearing the memory.

‘SOP – SW – 06
READ STAFF GAGE

Authorized for use: 09/02/2021
Revision 3

SCOPE	This SOP addresses reading a staff gage in an open water body.
TRA(s) Referenced/ Reviewed	TRA1-001: Common hazards Driving Manual Handling TRA1-008: SG Readings Download Sutron ISCO H350 Weather Station
STOP WORK TRIGGERS	Lightning (30 second rule) Extreme Wind Unsafe conditions Inadequate PPE or equipment
MSDS	Arsenic Cadmium Copper Lead Mercury Zinc PCB’s
PPE REQUIRED	Hard Hat If in the water, rubber soled waders If not in the water, Safety Toe Boots Safety Glasses High Visibility Shirt or Vest Gloves Long Sleeve Shirt Long Trousers
OTHER INSTRUCTIONS/SOPs	
REQUIRED TOOLS	At times, steel bar for ice removal and brush for cleaning staff gage
Trained, Competent and Authorized Employees in this SOP	1. Tina Donovan 2. Alice Drew Davies 3. Mat Erickson 4. Caleb Arbaugh 5. Nicole Santifer 6. Kirsten Vose
PROCEDURES	
READ STAFF GAGE	1. Locate the staff gage 2. Remove any debris which has built up around/on the staff gage 3. Chip out any ice around the staff gage. Use an appropriate tool to chip ice and always wear heavy gloves. If ice is thin (< 0.5 inch) it can be removed with a shovel. If ice does not easily clear with a shovel or stick, use a steel bar. Hold the bar with both hands and very near the staff gage. 4. Wipe the staff gage clean so that markings can be clearly discerned (use brush, plastic or steel). 5. Read the staff gage to the nearest 0.01 foot. 6. If the type of staff gage pictured below left is utilized (standard USGS), each mark represents 0.02 feet. Therefore, values between marks are estimated as accurately as possible. On the staff gage pictured on the right, each mark is associated with 2 measurements. For example, the line that points toward the number 4 pictured below, the top of the line (pointed) would represent a stage of 0.40 feet. The lower part of the same line (indent), however, would represent 0.39 feet.



SS-05 USGS T-POST CURRENT CREEK STAGE READING	Note: **Do not use the USGS website to adjust the stage reading on the 4230 bubbler.** Note: Before arriving at SS-05, the field team needs to measure the distance from the water's surface to the top of one of the USGS T-posts, RP-3 and RP-4, at the confluence of Grove Gulch and Silver Bow Cr on the east side of Montana St. Park vehicles on the grassy area just north of the creek and turn on your vehicle's flashers. 1. Using your yardstick, measure the distance from the surface of the water to the top of the T-post. The RP-4 T-post is on shore and should only be used when the stage of the creek is higher than the bankfull height. The image of the T-posts are at the end of this SOP. 2. If your yardstick has increments in the standard 1/8 in., divide the distance measured by 12 to get your distance in 1/10 ft, e.g. 2 ÷ 12 = 0.16 2 in. is 0.16 ft. 3. If your yardstick is in 1/10 increments, you do not need to divide your distance by 12. 4. If the water's surface is above the top of T-post, the distance you measure will need to added to the datum of the T-post. If the water's surface is below the top of the T-post, the distance you measure will need to be subtracted from the datum of the T-post. 5. Enter the time and stage you calculated in the logbook and then go to SS-05. Manually purge the bubbler, check the stage the bubbler is reading, and adjust the stage if the difference between the observed stage and the bubbler's stage is > 0.02 ft.
DOCUMENTATION	6. In the field book, and on the field sheet, if required, record the time, site name, and staff gage reading. If comparing the open water staff gage reading to a site recorder, and recorder stage is adjusted to the observed, note in field book that the stage on the recorder was adjusted.
REPORTING	1. Enter site name, date, time, and staff gage reading in the appropriate spreadsheet. 2. Spreadsheet can be found at: \\woodardcurran.net\shared\Offices\Bozeman\BUTTE\TREC\ARCO\LAO\SW 3. File name: SGReadings_2018 (or appropriate year).

USGS T-POST IMAGE

APPENDIX C

Example Chain of Custody

Laboratory Management Program (LaMP) Chain of Custody Record
Soil, Sediment and Groundwater Samples

BP Site Node Path: _____ **Req Due Date (mm/dd/yy):** _____ Rush TAT Yes ____ No ____

BP/RM Facility No: _____ **Lab Work Order Number:** _____

Lab Name:	BP/ARC Facility Address:	Consultant/Contractor:
Lab Address:	City, State, ZIP Code:	Consultant/Contractor Project No:
Lab PM:	Lead Regulatory Agency:	Address:
Lab Phone:	California Global ID No.:	Consultant/Contractor PM:
Lab Shipping Accnt:	Enfos Proposal No:	Phone: Email:
Lab Bottle Order No:	Accounting Mode: Provision ____ OOC-BU _____ OOC-RM _____	Send/Submit EDD to:
Other Info:	Stage Activity	Invoice To: BP-RM ____ BP-Other _____
BP/RM PM:	**Sample Details**	**Requested Analyses**
PM Phone:		
PM Email:		

Report Type & QC Level

Limited (Standard) Package ____

Limited Plus Package ____

Full Package ____

Lab No.	Sample Description	Date	Time	Field Matrix	Start Depth	End Depth	Depth Unit	Grab (G) or Composite (C)	Total Number of Containers	Analysis	Filt	Pres														Comments

Sampler's Name:	**Relinquished By / Affiliation**	**Date**	**Time**	**Accepted By / Affiliation**	**Date**	**Time**
Sampler's Company:						
Ship Method:						
Shipment Tracking No:						

Special Instructions:

THIS LINE - LAB USE ONLY: Custody Seals In Place: Yes / No | Temp Blank: Yes / No | Cooler Temp on Receipt: _____°F/C | Trip Blank: Yes / No | MS/MSD Sample Submitted: Yes / No

APPENDIX D

Corrective Action Report

Corrective Action Report/ Corrective Action Plan

Project ID	Project Name	Document ID

Preparer's Signature/Submit Date	Submitted to:

Description of the requirement or specification	
Reason for the Corrective Action	
Location, affected sample, affected equipment, etc. requiring corrective action	
Suggested Corrective Action	(Continue on Back)
Corrective Action Plan	(Continue on Back) ☐ Approval signature/date:_____
	Approval of corrective actions required by EPA? ☐ Yes ☐ No ☐ EPA approval name/date:_____ ☐ Corrective actions completed name/date:_____
Preventative Action Plan	(Continue on Back) ☐ Preventative actions completed name/date:_____

Corrective Action Report/
Corrective Action Plan

Suggested Corrective Action (Continued)	
Corrective Action Plan (Continued)	
Preventative Action Plan (Continued)	

Corrective Action Report/ Corrective Action Plan

Project ID	Project Name	Document ID

Preparer's Signature/Submit Date	Submitted to:

Description of the requirement or specification	
Reason for the Corrective Action	
Location, affected sample, affected equipment, etc. requiring corrective action	
Suggested Corrective Action	(Continue on Back)
Corrective Action Plan	(Continue on Back) ☐ Approval signature/date:_____
	Approval of corrective actions required by EPA? ☐ Yes ☐ No ☐ EPA approval name/date:_____ ☐ Corrective actions completed name/date:_____
Preventative Action Plan	(Continue on Back) ☐ Preventative actions completed name/date:_____

Corrective Action Report/
Corrective Action Plan

Suggested Corrective Action (Continued)	
Corrective Action Plan (Continued)	
Preventative Action Plan (Continued)	

APPENDIX E

Laboratory Data Package Components

Limited (Level 2a validation) Data Package Deliverables

A Level 2 data package will include data for analyses of all samples in one Sample Delivery Group (SDG), including field samples, re-analyses, secondary dilutions, blanks, laboratory control samples (LCS), laboratory control sample duplicates (LCSD), matrix spikes (MSs), matrix spike duplicates (MSDs), and/or laboratory duplicates. The laboratory will report one single set of data representing the best of the results for each sample.

SDG General Information

Cover letter signed by Technical Project Manager or designee
Title page
Table of Contents
SDG narrative
References to preparation and analytical methods performed and applicable project documents
Field and Internal laboratory chain-of-custody records
Sample receipt information
Project correspondence

Metals Fraction (ICP, ICP/.MS, CVAA)

Analytical results summaries for samples
Analytical results summaries for preparation (method) blanks
Analytical results summaries for MS/MSD samples
Analytical results summaries for LCSs/LCSDs samples
Preparation (method) blank summaries
MS/MSD recovery and precision summaries
Post-digestion (when applicable) recovery summaries
Laboratory duplicate precision summaries
LCS/LCSD recovery and precision summaries
Sample preparation logs

General Chemistry

Analytical results summaries for samples
Analytical results summaries for preparation (method) blanks
Analytical results summaries for MS/MSD samples
Analytical results summaries for LCSs/LCSDs samples
Preparation (method) blank summaries
MS/MSD recovery and precision summaries
Laboratory duplicate precision summaries
LCS/LCSD recovery and precision summaries
Sample preparation logs

Radiological

Analytical results summaries for samples
Analytical results summaries for preparation (method) blanks
Analytical results summaries for MS/MSD samples
Analytical results summaries for LCS samples
Preparation (method) blank summaries
MS/MSD recovery and precision summaries
Laboratory duplicate precision summaries
LCS recovery and precision summaries
Chemical yield (tracer/carrier) recovery summaries
Sample preparation logs

Full (Level 2b validation) Data Package Deliverables

A Level 4 data package will include data for analyses of all samples in one Sample Delivery Group (SDG), including field samples, re-analyses, secondary dilutions, blanks, laboratory control samples (LCS), laboratory control sample duplicates (LCSD), matrix spikes (MSs), matrix spike duplicates (MSDs), and/or laboratory duplicates. The laboratory will report one single set of data representing the best of the results for each sample.

SDG General Information

Cover letter signed by Technical Project Manager or designee
Title page
Table of Contents
SDG narrative
References to preparation and analytical methods performed and applicable project documents
Field and Internal laboratory chain-of-custody records
Sample receipt information
Project correspondence

Metals Fraction (ICP, ICP/.MS, CVAA)

Analytical results summaries for samples
Analytical results summaries for preparation (method) blanks
Analytical results summaries for MS/MSD samples
Analytical results summaries for LCSs/LCSDs samples
Summaries include:

- SDG number
- Field sample ID
- Lab sample ID
- Field sample matrix
- Sample collection date
- Name and CAS number of each target analyte
- Concentration of positives and RL and MDL for each target analyte
- Applicable laboratory flags
- Concentration units

QC and quarterly verification of instrument parameter summaries
Initial calibration verification (ICV) and continuing calibration verification (CCV) summaries including

- SDG number
- Names of all target analytes
- Instrument identifier
- Start and end date of analytical sequence
- True concentrations of all target analytes for ICV and CCV standards
- Observed concentrations for all target analytes for each ICV/CCV analysis
- Calculated percent recoveries for all target analytes
- Control limits for ICV and CCV percent recoveries
- Concentration units

Reporting Limit (RL) standard or low-limit ICV summaries including

- SDG number
- Names of all target analytes
- Instrument identifier
- Dates and times for the RL standard analyses

True concentrations of all target analytes
Observed concentrations for all target analytes for each RL standard analysis
Calculated percent recoveries for all target analytes
Control limits for RL percent recoveries
Concentration units

Initial calibration blank (ICB) and continuing calibration blank (CCB) summaries including
SDG number
Names of all target analytes
Instrument identifier
Start and end date of analytical sequence
Observed concentration or MDL for each target analyte
Acceptance limits for ICB and CCB analyses
Concentration Units

Preparation (method) blank summaries including
SDG number
Names of all target analytes
Instrument identifier
Observed concentration or MDL for each target analyte

ICP or ICP/MS interference check sample (ICS) summaries including
SDG number
Names of all target analytes
Instrument identifier
Dates and times for the ICP interference check standard analyses
True concentrations of all target analytes
Observed concentrations for all target analytes in each ICS standard analysis. Aluminum, calcium, iron, and magnesium results must be reported even if they are not target analytes.
Calculated percent recoveries for all target analytes in each ICS standard analysis, including aluminum, calcium, iron, and magnesium results.
Control limits for ICS standard recoveries
Concentration units

MS/MSD recovery summaries including
SDG number
Field ID number for spiked sample
Names of all target analytes
Analyte concentration of non-spiked sample aliquot
True concentration for all target analytes in MS solution
Observed concentration for all target analytes in MS sample analysis
Calculated percent recoveries for all target analytes
Control limits for MS recoveries
Concentration units
MS/MSD precision summary including
MSD identifier
Observed concentration for all target analytes in MSD sample
RPD between MS and MSD results for all target analytes
RPD limit for each analyte

Post-digestion (when applicable) recovery summaries including

- SDG number
- Field ID number for post-spiked sample
- Names of all target analytes
- Analyte concentration of non-spiked sample aliquot
- True concentration for all target analytes in post-spike solution
- Observed concentration for all target analytes in post-spike sample analysis
- Calculated percent recoveries for all target analytes
- Control limits for post-spike recoveries
- Concentration units

Laboratory duplicate precision summaries including
- SDG number
- Field ID number for origianl sample
- Names of all target analytes
- Analyte concentration of original sample aliquot
- Observed concentration for all target analytes in the duplicate sample analysis
- Calculated RPD for all target analytes
- RPD limit for each analyte
- Concentration units

LCS/LCSD recovery summaries including
- SDG number
- LCS laboratory ID
- Names of all target analytes
- True concentration for all target analytes in LCS
- Observed concentration for all target analytes in LCS analysis
- Calculated percent recoveries for all target analytes
- Control limits for LCS recoveries
- Concentration units

ICP or ICP/MS serial dilution (SD) summaries including
- SDG number
- Field ID number for spiked sample
- Names of all target analytes
- Analyte concentration of original sample aliquot
- Observed concentration for all target analytes in the SD analysis
- Calculated percent difference for all target analytes
- Control limits percent difference
- Concentration units

RL and method detection limit (MDL) summaries
- SDG number
- Instrument identifier
- Date the MDL determination was made
- Names of all target analytes
- Determined MDL for all target analytes
- RL for all target analytes
- Concentration units

ICP interelement correction factor summaries
- SDG number

Instrument identifier
Date the ICP interelement correction factors determination was performed
Names of all target analytes
Determined ICP interelement correction factors concentration for all target analytes
Concentration units

ICP or ICP/MS linear range summaries including
SDG number
Instrument identifier
Date the ICP linear range determination was performed
Names of all target analytes
Determined ICP linear range concentrations for all target analytes
Concentration units

Analytical sequence Form including
SDG number
Instrument identifier
Field ID number associated with sequence
QC sample identifiers associated with sequence
Analysis date and time for each field and QC sample associated with sequence
Identification of all target analytes reported from each field and QC sample analysis
Dilution factor for each field and QC sample analysis
Start and end dates and times of sequence

ICP/MS tune summaries including
SDG number
Date and time of tune analysis
Tune intensities and acceptance limits

ICP or ICP/MS internal standard relative intensity summaries including
SDG number
Field IDs associated with sequence
QC sample identifiers associated with sequence
Internal standards intensities
Internal standards intensities acceptance limits

Raw Data
All raw data associated with each reported data, including field samples and laboratory samples, but excluding quarterly verification parameters. Raw data contains all instrument readouts.

Sample preparation summaries including Field and laboratory QC sample preparation logs

General Chemistry

Analytical results summaries for samples
Analytical results summaries for preparation (method) blanks
Analytical results summaries for MS/MSD samples
Analytical results summaries for LCSs/LCSDs samples
Summaries include
SDG number
Field sample ID

- Lab sample ID
- Field sample matrix
- Sample collection date
- Name and CAS number of each target analyte
- Concentration of positives and RL and MDL for each target analyte
- Applicable laboratory flags
- Concentration units

Initial calibration verification (ICV) and continuing calibration verification (CCV) summaries including

- SDG number
- Names of all target analytes
- Instrument identifier
- Start and end date of analytical sequence
- True concentrations of all target analytes for ICV and CCV standards
- Observed concentrations for all target analytes for each ICV/CCV analysis
- Calculated percent recoveries for all target analytes
- Control limits for ICV and CCV percent recoveries
- Concentration units

Initial calibration blank (ICB) and continuing calibration blank (CCB) summaries including

- SDG number
- Names of all target analytes
- Instrument identifier
- Start and end date of analytical sequence
- Observed concentration or MDL for each target analyte
- Acceptance limits for ICB and CCB analyses
- Concentration Units

Preparation (method) blank summaries including

- SDG number
- Names of all target analytes
- Instrument identifier
- Observed concentration or MDL for each target analyte

MS/MSD recovery summaries including

- SDG number
- Field ID number for spiked sample
- Names of all target analytes
- Analyte concentration of non-spiked sample aliquot
- True concentration for all target analytes in MS solution
- Observed concentration for all target analytes in MS sample analysis
- Calculated percent recoveries for all target analytes
- Control limits for MS recoveries
- Concentration units

MS/MSD precision summary including

- MSD identifier
- Observed concentration for all target analytes in MSD sample
- RPD between MS and MSD results for all target analytes
- RPD limit for each analyte

Laboratory duplicate precision summaries including

SDG number
Field ID number for original sample
Names of all target analytes
Analyte concentration of original sample aliquot
Observed concentration for all target analytes in the duplicate sample analysis
Calculated RPD for all target analytes
RPD limit for each analyte
Concentration units

LCS/LCSD recovery summaries including
SDG number
LCS laboratory ID
Names of all target analytes
True concentration for all target analytes in LCS
Observed concentration for all target analytes in LCS analysis
Calculated percent recoveries for all target analytes
Control limits for LCS recoveries
Concentration units

LCS/LCSD precision summary including
LCSD identifier
Observed concentration for all target analytes in LCSD sample
RPD between LCS and LCSD results for all target analytes
RPD limit for each analyte

Analytical sequence Form including
SDG number
Instrument identifier
Field ID number associated with sequence
QC sample identifiers associated with sequence
Analysis date and time for each field and QC sample associated with sequence
Identification of all target analytes reported from each field and QC sample analysis
Dilution factor for each field and QC sample analysis
Start and end dates and times of sequence

Raw Data
All raw data associated with each reported data, including field samples and laboratory samples, but excluding quarterly verification parameters. Raw data contains all instrument readouts.

Sample preparation summaries including Field and laboratory QC sample preparation logs

Radiological

Analytical results summaries for samples
Analytical results summaries for preparation (method) blanks
Analytical results summaries for MS/MSD samples
Analytical results summaries for LCSs/LCSDs samples
Summaries include
SDG number
Field sample ID
Lab sample ID
Field sample matrix
Sample collection date

Sample analysis date
Sample activity, uncertainty, and the sample-specific minimum detectable concentration (MDC). The sample specific MDC will be based on the background of the detector that the sample was counted on. The sample activity (positive or negative), uncertainty, and sample-specific MDC will be reported for positive and non-detect results.
- Any applicable flags
- Concentration units

Chemical yield (tracer/carrier) recovery summaries including
- SDG number
- Field ID number
- Laboratory QC sample numbers
- Percent recovery for all tracers/carriers
- Applicable recovery limits

Method blank (MB) summaries including
- SDG number
- Names for all target analytes
- Observed activity, uncertainty, and MDC for each target analyte for each MB analysis
- Concentration units

MS/MSD recovery and precision summaries including
- SDG number
- Field ID number for spiked sample
- Names of all target analytes
- Analyte concentration of non-spiked sample aliquot
- True concentration for all target analytes in MS solution
- Observed concentration for all target analytes in MS sample analysis
- Calculated percent recoveries for all target analytes
- Control limits for MS recoveries
- Concentration units

MS/MSD precision summary including
- MSD identifier
- Observed concentration for all target analytes in MSD sample
- RPD/Reliable Error Ration (RER) between MS and MSD results for all each analyte
- RPD/RER limit for each analyte

Laboratory duplicate precision summaries including
- SDG number
- Field ID number for original sample
- Names of all target analytes
- Analyte activity, uncertainty, and MDC observed in the original sample aliquot
- Observed activity, uncertainty, and MDC for all target analytes in the duplicate sample analysis
- Calculated RPD/RER for all target analytes
- RPD/RER limit for each analyte
- Concentration units

LCS recovery summaries including
- SDG number
- LCS laboratory ID
- Names of all target analytes
- True concentration for all target analytes in LCS

Observed concentration for all target analytes in LCS analysis
Calculated percent recoveries for all target analytes
Control limits for LCS recoveries
Concentration units

Calibration verification summaries including
SDG number
Names of all target analytes
Instrument identifier
Date calibration was performed for each method and analyte.
Acceptance limits for calibration verification
Efficiency checks
Background checks

Calibration verification summaries for Alpha Spectroscopy including
SDG number
Names of all target analytes
Instrument identifier
Date calibration was performed for each method and analyte.
Acceptance limits for calibration verification
Energy calibration checks
Efficiency checks
Background checks
Resolution checks

Calibration verification summaries for Alpha Scintillation Spectroscopy including
SDG number
Names of all target analytes
Instrument identifier
Date calibration was performed for each method and analyte.
Acceptance limits for calibration verification
Background checks

Raw Data
All raw data associated with each reported data, including field samples and laboratory samples.

Sample preparation logs including

Preparation logs by method
Traceability documents by method

APPENDIX F

Data Validation Checklists

Exhibit 1 –Example Level 2a Data Validation Checklist

Exhibit 2 - Example Level 2b Data Validation Checklist

Exhibit 3 – Field QC Checklist

Exhibit 4 - Level A/B Checklist

Exhibit 5 – Data Flags, Qualifiers and Descriptors

Exhibit 1 – Example Level 2a Data Validation Checklist

LEVEL 2a LABORATORY DATA VALIDATION CHECKLIST FOR ICPMS

Validation Criteria: CFRSSI Data Management/Data Validation Plan and Addendum (ARCO 1992 and ARCO 2000, respectively); Data Validation Guidelines for Inorganic Chemistry (TREC, July 2021); National Functional Guidelines for Inorganic Superfund Methods Data Review (USEPA, November 2020)			
Project QAPP: Silver Bow Creek/Butte Area NPL Site 2022 Butte Priority Soils Operable Unit Interim Site-Wide Groundwater Monitoring Quality Assurance Project Plan (QAPP), (Atlantic Richfield, November 2021)			
Site:	Butte Priority Soils Operable Unit	**Project:**	BPSOU GW Monitoring - 0231348
Laboratory:	Pace Analytical Services (Minneapolis, MN)	**Case Number:**	
Matrix:	Aqueous	**Analysis:**	Dissolved As, Cd, Cu, Pb, Zn
Sample Date(s):		**Analysis Date(s):**	
Data Validator:		**Validation Date:**	

Sample Delivery Group

Field Sample ID	Lab Sample ID	Lab QC Batch	Sample Type	Associated Fld QC	Abbreviated Field ID

1. Holding Times

Analyte	Matrix	Method	Collection Date	Analysis Date	Affected data flagged
Dissolved As, Cd, Cu, Pb, Zn	Aqueous	EPA 200.8			

Describe corrective actions taken because of holding time problems.

LEVEL 2a LABORATORY DATA VALIDATION CHECKLIST FOR ICPMS

2. Blanks

Were method blanks analyzed at the frequency of 1/20 samples?	Y____ N_____
Were MB results non-detects?	Y____ N_____
Were any data flagged because of blank problems?	Y____ N_____
Describe corrective actions taken because of blank problems.	

3. Laboratory Control Sample (LCS)

Was Laboratory Control Sample (LCS) analyzed at the frequency of 1/20 samples?	Y____ N_____
Was LCS within control window of 85-115% recovery?	Y____ N_____
Were any data flagged because of LCS problems?	Y____ N_____
Describe corrective actions taken because of LCS problems.	

4. Matrix Spike/Matrix Spike Duplicate Sample Results

Was Matrix Spike Sample (MS) analyzed at the frequency of 1/10 samples?	Y____ N_____
Was MS result within control window of 70-130% for samples in which the parent sample concentration was ≤ 4X the spike concentration?	Y____ N_____
Was the Matrix Spike Duplicate Sample (MSD) analyzed at the frequency of 1/20 samples?	Y____ N_____
For MS & MSD results > 5 times the RL, were results of the MSD ≤ 20% relative percent difference (RPD)? For MS & MSD results < 5 times the RL, were results of the MSD ≤ the RL?	Y____ N_____
Were any data flagged because of MS/MSD recovery problems?	Y____ N_____
Were any data flagged because of MS/MSD RPD problems?	Y____ N_____
Describe corrective actions taken because of MS problems.	

Are there any additional analytical limitations that users should be aware of?	Y____ N_____

Exhibit 2 – Example Level 2b Data Validation Checklist

LEVEL 2b LABORATORY DATA VALIDATION CHECKLIST FOR ICPMS

Validation Criteria: CFRSSI Data Management/Data Validation Plan and Addendum (ARCO 1992 and ARCO 2000, respectively); Data Validation Guidelines for Inorganic Chemistry (TREC, July 2021); National Functional Guidelines for Inorganic Superfund Methods Data Review (USEPA, November 2020)			
Project QAPP: Silver Bow Creek/Butte Area NPL Site 2022 Butte Priority Soils Operable Unit Interim Site-Wide Groundwater Monitoring Quality Assurance Project Plan (QAPP), (Atlantic Richfield, November 2021)			
Site:	Butte Priority Soils Operable Unit	**Project:**	BPSOU GW Monitoring - 0231348
Laboratory:	Pace Analytical Services (Minneapolis, MN)	**Case Number:**	
Matrix:	Aqueous	**Analysis:**	Dissolved As, Cd, Cu, Pb, Zn
Sample Date(s):		**Analysis Date(s):**	
Data Validator:		**Validation Date:**	

Sample Delivery Group

Field Sample ID	Lab Sample ID	Lab QC Batch	Sample Type	Associated Fld QC	Abbreviated Field ID

1. Holding Times

Analyte	Matrix	Method	Collection Date	Analysis Date	Affected data flagged
Dissolved As, Cd, Cu, Pb, Zn	Aqueous	EPA 200.8			

Describe corrective actions taken because of holding time problems.

LEVEL 2b LABORATORY DATA VALIDATION CHECKLIST FOR ICPMS

2. Instrument Tuning

Prior to calibration, was the ICP-MS tuning solution analyzed at least five times (5X) consecutively and necessary adjustments made to bring peak width within the instrument manufacturer's specifications and mass calibration to within 0.1 amu over the range of 9-208 amu?	Y____ N_____
Was the Percent Relative Standard Deviation (%RSD) of the absolute signals for all analytes (and for each isotope) in the tuning solution < 5%?	Y____ N_____

3. Instrument Calibration

Was instrument calibrated at the correct frequency (daily or once every 24 hours) with appropriate standards &	Y____ N_____
Did the calibration curve have an R value of ≥ 0.998?	Y____ N_____
Was the ICV performed immediately following calibration with results within criteria of 90-110%?	Y____ N_____
Were CCVs performed at a 10% frequency, with results within criteria of 90-110%?	Y____ N_____
Was a CCV performed at the end if the analytical run, with results within criteria of 90-110%?	Y____ N_____
Were any data flagged because of calibration problems?	Y____ N_____
Describe corrective actions taken because of calibration problems.	

4. CRDL Check Standard

Was the CRDL check standard performed with recoveries between 60 and 140%?	Y____ N_____

5. Internal Standards

Does the internal standard solution contain a minimum of five elements, and include elements from the following list? Li^{6}, Sc, Y, Rh, In^{115}, Tb, Ho, Lu, Bi?	Y____ N_____
	Y____ N_____
Is the Percent Relative Intensity (%RI) in the samples within 60-125% of the response in the calibation blank?	
If the %RI falls outside of 60-125%, are the affected samples re-analyzed at a 2X dilution until the Internal standards are within the criteria?	Y___ N___ NA __
Were any data flagged because of internal standard problems?	Y____ N_____
Describe corrective actions taken because of internal standard problems.	

LEVEL 2b LABORATORY DATA VALIDATION CHECKLIST FOR ICPMS

6. Blanks

Was Initial Calibration Blank (ICB) analyzed?	Y____ N_____
Was the ICB result > 0 and < the MDL?	Y____ N_____
Were Continuing Calibration Blanks (CCBs) analyzed at the frequency of 10%?	Y____ N_____
Were CCB results > 0 and < the MDL?	Y____ N_____
Were method blanks analyzed at the frequency of 1/20 samples?	Y____ N_____
Were MB results non-detects?	Y____ N_____
Were any data flagged because of blank problems?	Y____ N_____
Describe corrective actions taken because of blank problems.	

7. Interference Check Sample

Were the ICSA/ICSAB analyzed at the beginning of each run?	Y____ N_____
Were ICSA within control window of 80-120% recovery?	Y____ N_____
Were ICSAB within control window of 80-120% recovery?	Y____ N_____
Were any data flagged because of ICS problems?	Y____ N_____
Describe corrective actions taken because of ICS problems.	

8. Laboratory Control Sample

Was Laboratory Control Sample (LCS) analyzed at the frequency of 1/20 samples?	Y____ N_____
Was LCS within control window of 85-115% recovery?	Y____ N_____
Were any data flagged because of LCS problems?	Y____ N_____
Describe corrective actions taken because of LCS problems.	

10. Matrix Spike/Matrix Spike Duplicate Sample Results

Was Matrix Spike Sample (MS) analyzed at the frequency of 1/10 samples?	Y____ N_____
Was MS result within control window of 70-130% for samples in which the parent sample concentration was ≤ 4X the spike concentration?	Y____ N_____
Was the Matrix Spike Duplicate Sample (MSD) analyzed at the frequency of 1/20 samples?	Y____ N_____
For sample & duplicate values > 5 times the RL, were results of the MSD ≤ 20% relative percent difference (RPD)? For sample or duplicate values < 5 times the RL, is the absolute difference between the sample and duplicate values ≤ the RL?	Y____ N_____
Were the MS and MSD analyzed at the same dilution factor?	Y____ N_____
Were the parent sample, MS, and MSD analyzed at the same dilution factor?	Y____ N_____
Were any data flagged because of MS/MSD recovery problems?	Y____ N_____
Were any data flagged because of MS/MSD RPD problems?	Y____ N_____
Describe corrective actions taken because of MS problems.	

LEVEL 2b LABORATORY DATA VALIDATION CHECKLIST FOR ICPMS

11. Laboratory Post Digestion Spike Analysis	
Was the post digestion spike analyzed at a frequency of 1/20 samples?	Y____ N_____
Was post digestion spike recovery within control window of 75-125%?	Y___ N___ NA __
Were the sample and post digestion spike analyzed at the same dilution factor?	Y___ N___ NA __
Were any data flagged because of post digestion spike problems?	Y___ N___ NA __
Describe corrective actions taken because of post digestion spike problems.	
12. ICP Serial Dilution	
Was the laboratory serial dilution analyzed at the frequency of 1/20 samples	Y____ N_____
For sample concentrations >50 times the MDL, did the serial dilution agree within 10% of the original determination after correction for dilution?	Y____ N_____
Were any data flagged because of serial dilution problems?	Y____ N_____
Describe corrective actions taken because of serial dilution problems.	
Are there any additional analytical limitations that users should be aware of?	Y____ N_____

Exhibit 3 – Field QC Checklist

FIELD QUALITY CONTROL SAMPLE CHECKLIST

Validation Criteria: CFRSSI Data Management/Data Validation Plan and Addendum (ARCO 1992 and ARCO 2000, respectively); Data Validation Guidelines for Inorganic Chemistry (TREC, July 2021); National Functional Guidelines for Inorganic Superfund Methods Data Review (USEPA, November 2020)

Project QAPP: Silver Bow Creek/Butte Area NPL Site 2022 Butte Priority Soils Operable Unit Interim Site-Wide Groundwater Monitoring Quality Assurance Project Plan (QAPP), (Atlantic Richfield, November 2021)

Site:	Butte Priority Soils Operable Unit	**Project:**	BPSOU GW Monitoring - 0231348
Laboratory:	Pace Analytical Services (Minneapolis,	**Case Number:**	
Matrix:	Aqueous	**Analysis:**	Dissolved Mercury, Dissolved As, Cd, Cu, Pb, Zn
Sample Date(s):		**Analysis Date(s):**	
Data Validator:		**Validation Date:**	

Sample Delivery Group

Field Sample ID	Lab Sample ID	Sample Type	Associated Fld QC	Abbreviated Field ID

Analyte	Matrix	Method	Collection Date	Analysis Date
Dissolved Mercury	Aqueous	EPA 245.1		
Dissolved As, Cd, Cu, Pb, Zn	Aqueous	EPA 200.8		

FIELD QUALITY CONTROL SAMPLE CHECKLIST

Field QC Samples	
Field Blanks FB)	
Were FBs sumbitted as specified in the BPSOU GW QAPP (1 in 20)?	Y___ N___
Were results for FBs within the target control limits in the BPSOU GW QAPP (< MDL)?	Y___ N___
Were any data qualified because of FB problems?	Y___ N___
Field Replicates	
Were field duplicates (FD) submitted as specified in the BPSOU GW QAPP (1 in 20)?	Y___ N___
Were results for FDs within the target control limits in the BPSOU GW QAPP (< 20% RPD or Δ ≤ RL as applicable)?	
Were any data qualified because of FD results?	Y___ N___
Additional Comments	

Exhibit 4 – Level A/B Checklist

EXHIBIT 4 - Level A/B Screening Checklist

I. General Information		II. Screening Results
Site:	BPSOU/	Data are:
Project:	BPSOU GW Monitoring - 0231348.01	1) Unusable _____
Client:	Atlantic Richfield	2) Level A _____
Sample Matrix:	Water	3) Level B ___,___

II. Level A Screening

		Yes/No
1.	Sampling date	
2.	Sample team/or leader	
3.	Physical description of sample location	
4.	Sample depth (soils)	
5.	Sample collection technique	
6.	Field preparation technique	
7.	Sample preservation technique	
8.	Sample shipping records	

III. Level B Screening

		Yes/No
1.	Field instrumentation methods and standardization complete	
2.	Sample container preparation	
3.	Collection of field replicates (1/20 minimum)	
4.	Proper and decontaminated sampling equipment	
5.	Field custody documentation	
6.	Shipping custody documentation	
7.	Traceable sample designation number	
8.	Field notebook(s), custody records in secure repository	
9.	Completed field forms (COC Record)	

Exhibit 5 - Data Flags, Qualifiers and Descriptors

Exhibit 5 - Definitions of Data Flags, Data Qualifiers and Status Assessments

	Laboratory Flags[a]
AB	Analyte was detected in an associated instrument blank.
AD	Analyte was detected in the method blank at a concentration greater than 2.2 times the MDL.
B	Analyte was detected in the associated method blank.
BH	Analyte was detected in an instrument blank. The result may be biased high.
BL	Analyte was detected in an instrument blank at a negative value. The result may be biased low.
C0	Result confirmed by second analysis.
C1	Result could not be confirmed by second analysis.
C7	Analyte is a possible laboratory contaminant (not present in method blank).
C8	Result may be biased high due to carryover from previously analyzed sample.
C9	Common Laboratory Contaminant.
CC	The continuing calibration for this compound is outside of Pace Analytical acceptance limits. The result may be biased.
CH	The continuing calibration for this compound is outside of Pace Analytical acceptance limits. The results may be biased high.
CL	The continuing calibration for this compound is outside of Pace Analytical acceptance limits. The results may be biased low.
CR	The dissolved metal result was greater than the total metal result for this element. Results were confirmed by reanalysis.
CU	The continuing calibration for this compound is outside of Pace Analytical acceptance limits. Analyte presence below reporting limits in associated samples. Results unaffected by high bias.
D3	Sample was diluted due to the presence of high levels of non-target analytes or other matrix interference.
D4	Sample was diluted due to the presence of high levels of target analytes.
D6	The relative percent difference (RPD) between the sample and sample duplicate exceeded laboratory control limits.
D7	The sample and/or duplicate results for this parameter are less than the reporting limit, calculations are based on estimated values and may be statistically unreliable
D8	The sample and duplicate results for this parameter are less than 5 times the reporting limit, the RPD may not be statistically valid.
D9	Dissolved result is greater than the total. Data is within laboratory control limits.
E	Analyte concentration exceeded the calibration range. The reported result is estimated.
F5	The recovery of the analyte in the CRDL standard (also known as the reporting limit verification) did not meet the acceptance criteria.
FS	The sample was filtered in the laboratory prior to analysis.
H1	Analysis conducted outside the recognized method holding time.
H2	Extraction or preparation was conducted outside of the recognized method holding time.
H3	Sample was received or analysis requested beyond the recognized method holding time.
H5	Reanalysis conducted in excess of EPA method holding time. Results confirm original analysis performed in hold time.
IH	This analyte exceeded secondary source verification criteria high for the initial calibration. The reported results should be considered an estimated value.
IL	This analyte exceeded secondary source verification criteria low for the initial calibration. The reported results should be considered an estimated value.
IO	The internal standard response was outside the laboratory acceptance limits confirmed by reanalysis. The results reported are from the most QC compliant analysis.
IR	The internal standard recovery associated with this result exceeds the upper control limit. The reported result should be considered an estimated value.
IS	The internal standard response is below criteria. Results may be biased high.
IU	The internal standard recoveries associated with this sample exceed the upper control limit. The reported results should be considered estimated values.
J	Analyte detected below reporting limit, therefore result is an estimate
L0	Analyte recovery in the laboratory control sample (LCS) was outside QC limits.
L1	Analyte recovery in the laboratory control sample (LCS) was above QC limits. Results may be biased high.
L2	Analyte recovery in the laboratory control sample (LCS) was below QC limits. Results may be biased low.
L3	Analyte recovery in the laboratory control sample (LCS) exceeded QC limits. Analyte presence below reporting limits in associated samples. Results unaffected by high bias.
L5	LCS recovery exceeded QC limits. Batch accepted based on matrix spike recovery within LCS limits.
LS	Analyte recovery in the laboratory control sample (LCS) was outside QC limits for one or more of the constituent analytes used in the calculated result.
M0	Matrix spike recovery and/or matrix spike duplicate recovery was outside laboratory control limits.
M1	Matrix spike recovery exceeded QC limits. Batch accepted based on laboratory control sample (LCS) recovery.
M2	Matrix spike recovery was below QC limits due to sample dilution. Data acceptance based on laboratory control sample (LCS) recovery.
M3	Matrix spike recovery was outside laboratory control limits due to matrix interferences.
M4	A matrix spike/matrix spike duplicate was not performed for this batch due to sample dilution.
M5	A matrix spike/matrix spike duplicate was not performed for this batch due to insufficient sample volume.
M6	Matrix spike and Matrix spike duplicate recovery not evaluated against control limits due to sample dilution.
MA	Result determined by method of standard addition.
MH	Matrix spike recovery and/or matrix spike duplicate recovery was above laboratory control limits. Result may be biased high.
ML	Matrix spike recovery and/or matrix spike duplicate recovery was below laboratory control limits. Result may be biased low.
MS	Analyte recovery in the matrix spike was outside QC limits for one or more of the constituent analytes used in the calculated result.
P4	Sample field preservation does not meet EPA or method recommendations for this analysis.
P6	Matrix spike recovery was outside laboratory control limits due to a parent sample concentration notably higher than the spike level.
P7	This spike was performed as a post digestion spike.
P8	Analyte was detected in the method blank. All associated samples had concentrations of at least ten times greater than the blank or were below the reporting limit.
PI	The precision between the sample and the duplicate sample exceeded laboratory control limits.
R1	RPD value was outside control limits.
R2	RPD value was outside control limits due to matrix interference
R3	RPD value was outside control limits due to uncertainty of values at or near the PRL.
RS	The RPD value in one of the constituent analytes was outside the control limits.
SD	The serial dilution and the original analysis did not agree within ±10%. The concentration is estimated due to a suspected chemical or physical interference.
TP	The samples were received outside of required temperature range. Analysis was completed upon client approval.
TV	Analysis conducted outside EPA method holding time. Results may be biased low.

Exhibit 5 - Definitions of Data Flags, Data Qualifiers and Status Assessments

TW	Dissolved result is greater than the total. Data is within laboratory control limits, however the RPD between the total and dissolved result is >20%.
REV_X	Revision X - This report replaces the Month, DD, YYYY report. This project was revised on Month, DD, YYYY <REASON>. (Lab city, State)
SubCert	This report contains data that were produced by a subcontracted laboratory certified for the fields of testing performed.
TO	Samples requiring thermal preservation were received outside of recommended temperature limits of 0-6 degrees Celsius.
C0	Results confirmed by second analysis.
IQ	The internal standard recoveries associated with this sample exceed the lower control limit. The reported results should be considered estimated values.
IU	The internal standard recoveries associated with this sample exceed the upper control limit. The reported results should be considered estimated values.
sb	Client sample ID on container did not match COC; client was notified.
sd	date - Added 3ml HNO3 to Metals bottle prior to analysis. pH <2.
se	Sample collection dates and times were not present on the sample containers.
sf	Sample collection dates and times were not listed on the COC.
sg	Sample collection time on containers does not match COC; client was notified.
sh	The sampler's name and signature were not listed on the COC.
sl	Sample was received outside the recognized method holding time; client notified and approved.
sm	A Chain of Custody was not received with samples; client was contacted.
	Data Validation Qualifiers[b]
U	The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit.
J	The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.
J+	The result is an estimated quantity, but the result may be biased high.
J-	The result is an estimated quantity, but the result may be biased low.
R	The data are unusable. The sample results are rejected due to serious deficiencies in meeting Quality Control (QC) criteria. The analyte may or may not be present in the sample.
UJ	The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise.
	Data Validation Descriptors[c]
AB	Did not meet level A/B criteria
CC	Correlation coefficient less than 0.995 for instrument calibration
CCV	Continuing calibration verification outside limits
CCB	Continuing calibration blank contamination
CQ	No calibration performed
CRQL	Contract required quantitation limit standard recovery outside quality control limits
DNR	Do not report. An alternate, acceptable result is available.
ECR	Reported concentration exceeds instrument calibration range
FB	Field blank contamination
FD	Field duplicate RPD outside limits
HT	Holding time exceeded
ICB	Initial calibration blank contamination
ICS	Interference check standard recovery outside limits
ICV	Initial calibration verification outside limits
IP	Incorrect sample preservation
IS	Internal standard recovery outside limits
LCS	Lab control spike recovery is outside quality control limits
MB	Method blank contamination
MI	Matrix interference with analyte quantitation
MDL	Non-detect at MDL value
MS	Matrix spike recovery is outside quality control limits
RB	Equipment rinse blank contamination
RL	Laboratory detected result below reporting limit
RPD	Duplicate sample relative percent difference exceeds QC limits
SD	ICP serial dilution percent difference outside QC limits
SIC	Sample integrity compromised
SUR	Surrogate recovery is outside QC limits
TB	Trip blank contamination
	CFRSSI Status[d]
E	Enforcement quality data are data with unrestricted use, meet Level A/B criteria, and are NOT qualified during the data validation process
S	Screening quality data are data whose associated values are estimated or meet only Level A criteria
R	Unusable data are data whose associated numerical values are so questionable it is recommended that they not be used
	Level A/B Screening Results[d]
A	Meets only Level A Screening criteria, but does not meet Level B Screening criteria, including proper techniques
B	Meets both Level A and Level B criteria, including field replicates and proper documentation

[a] Assigned by Pace Analytical Services, Inc.
[b] Adapted from US EPA 2017. Laboratory Data Validation National Functional Guidelines for Inorganic Data Review; EPA, January, 2017)
[c] Assigned by TREC, Inc. during data validation
[d] Defined in Clark Fork River Superfund Site Investigations Data Management/Data Validation Plan; ARCO, May 1992)