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2023 Draft Final Butte Priority Soils Operable Unit Interim Site-Wide Groundwater Monitoring Quality Assurance Project Plan (QAPP)

Woodard & Curran

SILVER BOW CREEK/BUTTE AREA NPL SITE

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Atlantic Richfield Company
317 Anaconda Road
Butte, Montana 59701

November 2022

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November 29, 2022

APPROVAL PAGE

QUALITY ASSURANCE PROJECT PLAN FOR
BUTTE PRIORITY SOILS OPERABLE UNIT GROUNDWATER MONITORING
SILVER BOW CREEK/BUTTE AREA NPL SITE

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Daryl Reed, Project Officer, Montana DEQ

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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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TABLE OF CONTENTS

Page

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

REVISION SUMMARY

2023 Revision Number	Submittal Date	Previously Approved QAPP	Sections Revised	Changes/Comments	Signature Approval

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
W&C	Woodard & Curran
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 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 (Woodard & Curran)

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 (Woodard & Curran)

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 (Woodard & Curran)

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 (Woodard & Curran)

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 2023 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 at the frequency specified in Table 4, 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 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 calibration verification samples, calibration blank samples, interference check samples, internal response standards, and calibration check at the reporting 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 or their designee) 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 1.69, cadmium < MDL to 1.82, copper < MDL to 125, mercury < MDL to 0.00487, lead < MDL to 1.8, and zinc < MDL 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"*

Since the 2006 ROD was issued numerous studies have provided a more thorough understanding of groundwater movement, quality, and quantity. However, it is necessary to continue assessing capture system effectiveness. This BPSOU Interim Site-Wide Groundwater Monitoring QAPP (GW QAPP) focuses monitoring on the objectives outlined in the UAO and in the ROD/RODA; but also re-focuses the monitoring effort to provide data of greatest use. As monitoring moves into the compliance determination period, after the BPSOU remedial action construction, and into compliance monitoring, the monitoring network and frequency may need additional modifications.

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 Question 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 Question 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 provide 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. Additionally, AMW-02 will be abandoned as part of the Buffalo Gulch retention/detention pond construction scheduled to commence in 2023. BPS07-22B, BPS017-22C, and BPS07-22R will not be abandoned, but they are in the construction footprint. Should these wells become inaccessible during the 2023 monitoring period, monitoring will cease until they are once again accessible.

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 the *Silver Bow Creek/Butte Area Final BPSOU 2023 Monitoring Period Interim Site-Wide Surface Water Monitoring Quality Assurance Project Plan (QAPP)* (SW QAPP) (Atlantic Richfield, 2022b). 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)
- 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 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	0.000092	0.00050	180
Dissolved Cadmium	EPA 200.8	0.000022	0.000080	180
Dissolved Copper	EPA 200.8	0.00042	0.0010	180
Dissolved Lead	EPA 200.8	0.000056	0.00010	180
Dissolved Mercury	EPA 245.1	0.000072	0.00020	28
Dissolved Zinc	EPA 200.8	0.0019	0.0050	180
Additional Five-Year Parameters				
Dissolved Calcium	EPA 200.8	0.023	0.010	180
Dissolved Iron	EPA 200.8	0.011	0.050	180
Dissolved Magnesium	EPA 200.8	0.0071	0.030	180
Dissolved Manganese	EPA 200.8	0.00016	0.00050	180
Dissolved Potassium	EPA 200.8	0.016	0.10	180
Dissolved Sodium	EPA 200.8	0.017	0.050	180
Hardness (as $CaCO_3$)	SM2340B, online edition, 1997	0.086	0.14	180
Alkalinity (as $CaCO_3$)	SM2320, online edition, 1997	2.4	5.0	14
Chloride	EPA 300.0	0.39	1.2	28
Sulfate	EPA 300.0	0.43	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 2022 values. MDLs are determined annually and may fluctuate.

Table 3 - BPSOU 2023 Water Quality Monitoring Network - see Tables section

Table 4 - BPSOU 2023 Water Level Monitoring Network - see Tables section

Table 5 - BPSOU 2023 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 at the frequency specified in Table 4, using the method described in Section 3.2.2.1. Monthly water level measurements will be made towards the end of the month and quarterly measurements will be made in the last month of the quarter, synoptically with monthly water level measurements. Water quality samples will be collected semi-annually at the majority of sites, commencing in late spring/early summer and late summer/early fall of each year. Five-year wells will be sampled annually in the spring.

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 or safety 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 Data Validation Guidelines for Inorganic Chemistry Woodard & Curran Butte, MT (Woodard & Curran, 2022) (W&C Data Validation Guidelines). The W&C 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 or quarterly as defined in Table 4. 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 and quarterly measurements will be made in the last month of the quarter, synoptically with monthly water level measurements. 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. Five-year wells will be sampled annually in April/May. 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), calibration check at the reporting limit standards (CCRL), 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, CCRL, 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, CCRL 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 < five 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. This training will be documented and retained within the contractor's project files. 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 date, time, and the general direction faced when applicable;
- 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 deliverable 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, 2022a)

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 at the monitoring networks specified in Table 3 and Table 4. One hundred seven sites will be sampled semi-annually, five sites will be sampled annually, and nine sites due for 5-year sampling will be sampled in the spring only for a total of 228 primary samples. All sites sampled in the spring will undergo laboratory analysis for the six semi-annual parameters listed in Table 2, as well as the eleven 5-year parameters. The 107 sites sampled in the fall will undergo analysis for the six semi-annual metals/metalloids listed in Table 2. This results in a total of 2699 primary sample analyses for 2023 monitoring. The water quality frequency can 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 data; 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 by following applicable SOPs, to limit variability. 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	W&C
SOP-GW-02	Ground Water Sampling of Monitoring Wells with Submersible Pump, Rev. 6, October 26, 2022	W&C
SOP-GW-03	Ground Water Sampling of Monitoring Wells with Geotech or ISCO Peristaltic Pump, Grundfos Pump, and Geotech Bladder Pump, Rev. 6, October 26, 2022	W&C
SOP-H-01	Water Sampling Equipment Decontamination, Rev. 3, April 13, 2020	W&C
SOP-H-02	Downloading Transducers, Rev. 3, January 27, 2022	W&C
SOP-H-05	Calibrate YSI Professional Plus Multi-Meter, Rev. 5, August 4, 2022	W&C
SOP-H-07	Transducer Compensation and File Submittal, Rev. 1, July 24, 2018	W&C
SOP-H-08	Transducer Installation, Rev. 1, January 24, 2022	W&C
SOP-SW-06	Read Staff Gage, Rev. 3, September 2, 2021	W&C

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 W&C SOP GW-01. Below is a summary of W&C 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 W&C 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 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 Woodard & Curran 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 W&C SOPs GW-02 and GW-03. Decontamination procedures are detailed in W&C 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 W&C 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	No chemical, refrigerate 0°C-6°C	None	Only one container for all analyses
Anions (Sulfate & Chloride)	Polyethylene, 1 x 1 L	No chemical, refrigerate 0°C-6°C	None	
Total Dissolved Solids	Polyethylene, 1 x 1 L	No chemical, 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;
- 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 a manufacturer specific Bluetooth® device; however, a laptop computer can be used in the event of 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, 2023 would be GW0001-042023. The first sample collected for the second semi-annual sampling event of the year on September 12, 2023 would be GW0001-091223. A label will be placed on each sample bottle immediately following sample collection, 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 laboratory accreditation requirements.

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 H2O scrubber, and a CO2 scrubber. Alkalinity analysis requires a pH meter, magnetic stir plates and magnetic stir bars, an autotitrator system, 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 ≤ 20% RPD or a difference between the primary and duplicate sample ≤ the RL, as applicable. 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. Note that Tables 7 and 9 specify laboratory limits which may differ from validation limits, which can be found in Table 12.

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 ≥ 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 laboratory control limit for the SD sample is ≤ 10% difference (validation criteria is ≤ 20% 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 by the laboratory 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, 2022a). 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 flow process is described in greater detail below. 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, 2022a).

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. For data collected under this QAPP, laboratories will provide data directly to Atlantic Richfield's EQuIS data management system. Once the BDMS coordinator retrieves analytical data from EQuIS, 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. If problems are found with the data, the laboratory is notified, any errors corrected, and the data is re-submitted to EQuIS, and the BDMS coordinator retrieves the corrected data. Macro-enabled Excel spreadsheets have been developed to enable data retrieval from the BDMS for validation. These spreadsheets are populated during the data validation process and resubmitted to the data management team. The validated data, including associated validation qualifiers, codes, quality designation for each data point and Level A/B status for each sample, is then uploaded to the database. Once data review and validation is complete, the validated data is uploaded to EQuIS. 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 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 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, which is also referred to as a data validation report, as an appendix. The data quality discussions/data validation report 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 May 31 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 Stage 2b validation for wells outside of the TI Zone and Stage 2a validation for all other groundwater sampling sites. A Limited data package (Stage 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 (Stage 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 of 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 W&C 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. Stage 2a and Stage 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.

Stage 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
- Calibration check at the reporting limit 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 Stage 2a data quality review and Appendix F, Exhibit 2 for components of Stage 2b data quality review. Qualifiers that may be applied to the data include the following:

A The analyte concentration was between the method detection limit and the reporting limit.

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.

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
No Qualifier, A, or 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.

Stage 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

ARCO, 1992a. *Clark Fork River Superfund Site Investigations Laboratory Analytical Protocol*, ARCO April 1992.

ARCO, 1992b. *Clark Fork River Superfund Site Investigations Quality Assurance Project Plan*, ARCO May 1992.

ARCO, 1992c. *Clark Fork River Superfund Site Investigations Data Management/Data Validation Plan*, ARCO June 1992.

ARCO, 1992d. *Clark Fork River Superfund Site Investigations Standard Operating Procedures*, ARCO September 1992.

ARCO, 2000a. *Clark Fork River Superfund Site Investigations Data Management/Data Validation Plan Addendum*, ARCO June 2000.

ARCO, 2000b. *Clark Fork River Superfund Site Investigations Pilot Data Report Addendum*. ARCO July 2000.

Atlantic Richfield, 2017. Technical Requirements for Environmental Laboratory Analytical Services BP Laboratory Management Program (LaMP). Revision 12.1. Atlantic Richfield Company. March 2017.

Atlantic Richfield, 2020a. Butte Area NPL Site Butte Priority Soils Operable Unit (BPSOU) Final Quality Management Plan. Atlantic Richfield Company. September 2020.

Atlantic Richfield, 2022a. Butte Area NPL Site Butte Priority Soils Operable Unit (BPOSU) 2022 Data Management Plan. Atlantic Richfield Company. April 2022.

Atlantic Richfield, 2022b. Silver Bow Creek/Butte Area NPL Site Draft Butte Priority Soils Operable Unit 2023 Monitoring Period Interim Site Wide Surface Water Monitoring Quality Assurance Project Plan (QAPP). Atlantic Richfield Company. November 2022.

EPA (US Environmental Protection Agency). 2000. *Guidance on Technical Audits and Related Assessments for Environmental Data Operations* (QA/G-7). Washington DC: EPA, Office of Environmental Information. EPA/600/R-99/080. Available at https://www.epa.gov/sites/production/files/2015-07/documents/g7-final.pdf.

EPA (US Environmental Protection Agency). 2001a. *EPA Requirements for Quality Assurance Project Plans* (QA/R-5). Washington DC: EPA, Office of Environmental Information. EPA/240/B-01/003. Available at https://www.epa.gov/sites/production/files/2016-06/documents/r5-final_0.pdf .

EPA (US Environmental Protection Agency). 2001b. *EPA Requirements for Quality Management Plans* (QA/R-2). Washington DC: EPA, Office of Environmental Information. EPA/240/B-01/002. Available at https://www.epa.gov/sites/production/files/2016-06/documents/r2-final.pdf

EPA (US Environmental Protection Agency). 2002a. *Guidance for Quality Assurance Project Plans* (QA/G-5). Washington DC: EPA, Office of Environmental Information. EPA/240/R-02/009. Available at https://www.epa.gov/sites/production/files/2015-06/documents/g5-final.pdf .

EPA (US Environmental Protection Agency). 2002b. *Guidance on Environmental Data Verification and Data Validation* (QA/G-8). Washington DC: EPA, Office of Environmental Information. EPA/240/R-02/004. Available at https://www.epa.gov/sites/production/files/2015-06/documents/g8-final.pdf .

EPA (US Environmental Protection Agency). 2002c. *Guidance on Choosing a Sampling Design for Environmental Data Collection for Use in Developing a Quality Assurance Project Plan* (EPA QA/G-5S). Washington DC: EPA, Office of Environmental Information. EPA/240R/R-02/005. Available at https://www.epa.gov/sites/production/files/2015-06/documents/g5s-final.pdf

EPA (US Environmental Protection Agency). 2003. *Guidance on Assessing Quality Systems* (QA/G-3). Washington DC: EPA, Office of Environmental Information. EPA/240/R- 03/002. Available at https://www.epa.gov/sites/production/files/2015-06/documents/g3-final.pdf .

EPA (US Environmental Protection Agency). 2006a. *Data Quality Assessment: A Reviewer's Guide* (QA/G-9R). Washington DC: EPA, Office of Environmental Information. EPA/240/B-06/002. Available at https://www.epa.gov/sites/production/files/2015-08/documents/g9r-final.pdf .

EPA, (US Environmental Protection Agency). 2006b. *Final Technical Memorandum, Technical Impracticability Evaluation for Alluvial Ground Water, Silver Bow Creek/Butte Area NPL Site, Butte, Montana*. EPA April, 2006.

EPA (US Environmental Protection Agency). 2006c. *Guidance on Systematic Planning Using the Data Quality Objectives Process* (QA/G-4). Washington DC: EPA, Office of Environmental Information. EPA/240/B-06/001. Available at https://www.epa.gov/sites/production/files/2015-06/documents/g4-final.pdf .

EPA, (US Environmental Protection Agency). 2006d. *Record of Decision, Butte Priority Soils Operable Unit, Silver Bow Creek/Butte Area NPL Site*. EPA September 2006.

EPA, (US Environmental Protection Agency). 2011a. *Butte Priority Soils Operable Unit Revised Interim Ground Water Monitoring Plan Silver Bow Creek/Butte Area NPL Site Butte-Silver Bow County, Montana.* Helena, MT. July 21, 2011.

EPA, (US Environmental Protection Agency). 2011b. *Unilateral Administrative Order& Partial Remedy Work Plan for the BPSOU*. EPA July 21, 2011

EPA (US Environmental Protection Agency).2017. *EPA Region 8 Quality Assurance Document Review Crosswalk.* Available at https://www.epa.gov/quality/managing-quality-environmental-data-epa-region-8

EPA (US Environmental Protection Agency). *2020a. Record of Decision Amendment for the Butte Priority Soils Operable Unit of the Silver Bow Creek/Butte Area Site. Butte and Walkerville, Montana.* Appendix A to the Consent Decree. 100007296 – R8 SDMS. February 4, 2020.

EPA (US Environmental Protection Agency). 2020b. *National Functional Guidelines for Inorganic Superfund Methods Data Review*, Washington DC: EPA, Office of Superfund Remediation and Technology Innovation. OLEM 9240.1-66. EPA-542-R-20-006. November 2020. Available at

https://www.epa.gov/clp/national-functional-guidelines-inorganic-superfund-methods-data-review-sfam011

MDEQ (Montana Department of Environmental Quality). 2006. *Circular DEQ-7. Montana Numeric Water Quality Standards*. MDEQ February 2006.

United States of America and The State of Montana. 2020. United States of America and The State of Montana, Plaintiffs, v. Atlantic Richfield Company and the City and County of Butte-Silver Bow, a Municipal Corporation and Political Subdivision of the State of Montana, Defendants. Consent Decree for the Butte Priority Soils Operable Unit Partial Remedial Design/Remedial Action and Operation and Maintenance. Civil Action no. CV 89-039-BU-SEH. November 2020.

Woodard & Curran 2022. *Data Validation Guidelines for Inorganic Chemistry Woodard & Curran Butte, MT*. November 2022.

TABLES

FIGURES

APPENDICES

APPENDIX A

Data Validation Guidelines for Inorganic Chemistry Woodard & Curran Butte, MT

APPENDIX B

Standard Operating Procedures

APPENDIX C

Example Chain of Custody

APPENDIX D

Corrective Action Report

APPENDIX E

Laboratory Data Package Components

APPENDIX F

Data Validation Checklists

Exhibit 1 –Example Stage 2a Data Validation Checklist

Exhibit 2 - Example Stage 2b Data Validation Checklist

Exhibit 3 – Field QC Checklist

Exhibit 4 - Level A/B Checklist

Exhibit 5 – Data Flags, Qualifiers and Descriptors