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2022 - Draft Final - Butte Reduction Works (BRW) Smelter Area Mine Waste Remediation and Contaminated Groundwater Hydraulic Control Site Phase III Quality Assurance Project Plan (QAPP)

Pioneer Technical Services, Inc.

SILVER BOW CREEK/BUTTE AREA NPL SITE
BUTTE PRIORITY SOILS OPERABLE UNIT

2022

Draft Final

Butte Reduction Works (BRW) Smelter Area Mine Waste Remediation and Contaminated Groundwater Hydraulic Control Site Phase III Quality Assurance Project Plan (QAPP)

Atlantic Richfield Company
317 Anaconda Road
Butte, Montana 59701

Revision 1. June 2022

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Prepared for:

Atlantic Richfield Company
317 Anaconda Road
Butte, Montana 59701

Prepared by:

Pioneer Technical Services, Inc.
1101 S. Montana Street
Butte, Montana 59701

Revision 1. June 2022

APPROVAL PAGE

Silver Bow Creek/Butte Area NPL Site
Butte Reduction Works Smelter Area Mine Waste Remediation and Contaminated Groundwater Hydraulic Control Site Phase III Quality Assurance Project Plan

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

Approved: ______________________________ Date: ____________
Daryl Reed, Project Officer, Montana DEQ

Approved: ______________________________ Date: ____________
Josh Bryson, Liability Manager
Atlantic Richfield Company

Approved: ______________________________ Date: ____________
David Gratson, Quality Assurance Manager
Environmental Standards, Inc.

Plan is effective on date of approval.

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Silver Bow Creek/Butte Area NPL Site
Butte Reduction Works Smelter Area Mine Waste Remediation and Contaminated Groundwater Hydraulic Control Site
Phase III Quality Assurance Project Plan

Key Personnel Recipients	Title	Organization	Telephone Number	E-mail Address
Nikia Greene	Remedial Project Manager	EPA	(406) 457-5019	Nikia.Greene@epa.gov
Erin Agee	Legal Counsel	EPA	(303) 312-6374	Erin.Agee@epa.gov
Daryl Reed	State Project Officer	DEQ	(406) 444-6433	dreed@mt.gov
Jonathan Morgan	Legal Counsel	DEQ	(406) 444-6589	JMorgan3@mt.gov
Josh Bryson	Liability Manager	Atlantic Richfield	(406) 782-9964	josh.bryson@bp.com
Irene Montero	Senior Technologist - RET Lead	Atlantic Richfield	(713) 538-0875	irene.montero@bp.com
David Gratson	Atlantic Richfield Quality Assurance Manager	Environmental Standards	(505) 660-8521	dgratson@envstd.com
David Shanight	EPA Contractor	CDM Smith	(406) 441-1400	ShanightDT@cdmsmith.com
Eric Hassler	Director, Department of Reclamation and Environmental Services	Butte-Silver Bow	(406) 497-5042	ehassler@bsb.mt.gov
Julia Crain	Assistant Director, Department of Reclamation and Environmental Services / Quality Assurance Manager	Butte-Silver Bow	(406) 497-6264	jcrain@bsb.mt.gov
Abigail Peltomaa	Manager, Data Management Division/Quality Assurance Officer	Butte-Silver Bow	(406) 497-5045	apeltoma@bsb.mt.gov
Chad Anderson	Manager, Human Health/RMAP Division	Butte-Silver Bow	(406) 497-6278	canderson@bsb.mt.gov
Brandon Warner	Manager, Environmental Division	Butte-Silver Bow	(406) 497-5022	bwarner@bsb.mt.gov
Jeremy Grotbo	GIS Data Specialist	Butte-Silver Bow	(406) 497-6261	jgrotbo@bsb.mt.gov
Pat Sampson	Atlantic Richfield Contractor – Project Oversight	Pioneer Technical Services, Inc.	(406) 490-0706	psampson@pioneer-technical.com

For Information Only Recipients	Organization	E-mail Address
Joe Vranka	EPA	vranka.joe@epa.gov
Jean Martin	Atlantic Richfield	jean.martin@bp.com
Brianne McClafferty	Holland & Hart	bcmcclafferty@hollandhart.com
Mave Gasaway	Davis, Graham & Stubbs, LLP	Mave.Gasaway@dgslaw.com
Patricia Gallery	Atlantic Richfield	patricia.gallery@bp.com
Loren Burmeister	Atlantic Richfield	loren.burmeister@bp.com
Irene Montero	Atlantic Richfield	irene.montero@bp.com
Chris Greco	Atlantic Richfield	chris.greco@bp.com
Dave Griffis	Atlantic Richfield	dave.griffis@bp.com
Mike Mc Anulty	Atlantic Richfield	mcanumc@bp.com
Curt Coover	CDM	CooverCA@cdmsmith.com
James Freeman	DOJ	james.freemen2@usdoj.gov
John Sither	DOJ	john.sither@usdoj.gov
Dave Bowers	DEQ	dbowers@mt.gov
Carolina Balliew	DEQ	carolina.balliew@mt.gov
Matthew Dorrington	DEQ	Matthew.Dorrington@mt.gov
Wil George	DEQ	william.george@mt.gov
John Gilmour	KelleyDrye	jgilmour@kelleydrye.com
Jim Ford	NRDP	jford@mt.gov
Pat Cunneen	NRDP	pcunneen@mt.gov
Harley Harris	NRDP	harleyharris@mt.gov
Katherine Hausrath	NRDP	KHausrath@mt.gov
Meranda Flugge	NRDP	nrdp@mt.gov
Ted Duaime	MBMG	TDuaime@mtech.edu
Gary Icopini	MBMG	gicopini@mtech.edu
Robert Bylsma	Union Pacific	rcbylsma@up.com
Kristen Stevens	Union Pacific	kmsteven@up.com
Leo Berry	BNSF	leo@bkbh.com
Robert Lowry	BNSF	rlowry@kelrun.com
Brooke Kuhl	BNSF	brooke.kuhl@bnsf.com
Lauren Knickrehm	BNSF	lauren.knickrehm@bnsf.com
Jeremie Maehr	Kennedy/Jenks	jeremiemaehr@kennedyjenks.com
Annika Silverman	Kennedy/Jenks	annikasilverman@kennedyjenks.com
Matthew Mavrinac	RARUS	Matthew.Mavrinac@patriotrail.com
Harrison Roughton	RARUS	harrison.roughton@patriotrail.com
Brad Gordon	RARUS	Brad.Gordon@Patriotrail.com
Becky Summerville	MR	bsummerville@mtresourcesinc.com
Mark Neary	BSB	mneary@bsb.mt.gov
Jeremy Grotbo	BSB	jgrotbo@bsb.mt.gov
Eileen Joyce	BSB	ejoyce@bsb.mt.gov
Sean Peterson	BSB	speterson@bsb.mt.gov
Gordon Hart	BSB	gordonhart@paulhastings.com
Josh Vincent	WET	jvincent@waterenvtech.com
Craig Deeney	TREC	cdeeney@woodardcurran.com
Scott Bradshaw	TREC	sbradshaw@woodardcurran.com
Brad Archibald	Pioneer Technical Services, Inc.	barchibald@pioneer-technical.com
Joe McElroy	Pioneer Technical Services, Inc.	jmcelroy@pioneer-technical.com

For Information Only Recipients	Organization	E-mail Address
Andy Dare	Pioneer Technical Services, Inc.	adare@pioneer-technical.com
Karen Helfrich	Pioneer Technical Services, Inc.	khelfrich@pioneer-technical.com
Leesla Jonart	Pioneer Technical Services, Inc.	ljonart@pioneer-technical.com
Randa Colling	Pioneer Technical Services, Inc.	rcolling@pioneer-technical.com
Ian Magruder	Citizen's Environmental Technical Committee	ian_magruder@wwcengineering.com
CTEC of Butte	Citizen's Environmental Technical Committee	BUTTECTEC@hotmail.com
Montana Tech Library	Montana Tech	sjuskiewicz@mtech.edu
Mining SharePoint	Atlantic Richfield	MiningSharePoint@bp.com

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ACRONYMS

Acronym	Definition	Acronym	Definition
%D	Percent Difference	**MS**	Matrix Spike
%R	Percent Recovery	**MSD**	Matrix Spike Duplicate
°C	Degree Celsius	**NRDP**	Natural Resource Damage Program
pCi/L	picocurie per liter	**NTU**	Nephelometric Turbidity Unit
ARAR	Applicable or Relevant and Appropriate Requirement	**O'Keefe**	O'Keefe Drilling Company
Atlantic Richfield	Atlantic Richfield Company	**PARCCS**	Precision, Accuracy, Representativeness, Completeness, Comparability, and Sensitivity
bgs	Below Ground Surface	**PAH**	Polycyclic Aromatic Hydrocarbons
BH	Borehole (for sample identification)	**PCB**	Polychlorinated Biphenyl
BMP	Best Management Practices	**PCP**	Pentachlorophenol
BNSF	Burlington Northern Santa Fe Railway	**PDI**	Pre-Design Investigation
BPSOU	Butte Priority Soils Operable Unit	**PDS**	Post Digestion Spike
BRW	Butte Reduction Works	**PID**	Photoionization Detector
BSB	Butte-Silver Bow	**Pioneer**	Pioneer Technical Services, Inc.
CAR	Corrective Action Report	**PM**	Project Manager
CECRA	Comprehensive Environmental Cleanup and Responsibility Act	**PPE**	Personal Protective Equipment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act	**PVC**	Polyvinyl Chloride
CFRSSI	Clark Fork River Superfund Site Investigation	**PZ**	Piezometer (for sample identification)
cfs	cubic feet per second	**QA**	Quality Assurance
CLP	Contract Laboratory Program	**QAM**	Quality Assurance Manager
COC	Contaminant of Concern	**QAO**	Quality Assurance Officer
CPM	Contractor Project Manager	**QAPP**	Quality Assurance Project Plan
		QC	Quality Control
DEQ	Montana Department of Environmental Quality	**RA**	Remedial Action
DI	Deionized	**RCRA**	Resource Conservation and Recovery Act
DM/DV	Data Management/Data Validation	**RD**	Remedial Design
DQA	Data Quality Assessment	**RDWP**	Remedial Design Work Plan
		REW	Right Edge of Water
DQO	Data Quality Objective	**RFC**	Request for Change
EDD	Electronic Data Deliverable	**RL**	Reporting Limit
EPA	Environmental Protection Agency	**RPD**	Relative Percent Difference
EPH	Extractable Petroleum Hydrocarbon	**SC**	Specific Conductance
EWI	Equal Width Increment	**SiO2**	Silicon Dioxide
GPS	Global Positioning System	**SOP**	Standard Operating Procedure
Hunter	Hunter Brothers Construction	**SOW**	Statement of Work
ICP-MS	Inductively Coupled Plasma Mass Spectrometry	**SPLP**	Synthetic Precipitation Leaching Procedure
LAO	Lower Area One	**SRM**	Standard Reference Material
LCS	Laboratory Control Sample	**SS**	Sample Station
LCSD	Laboratory Control Sample Duplicate	**SSHASP**	Site-Specific Health and Safety Plan
LDS	Laboratory Duplicate Sample	**SPT**	Standard Penetration Test

Acronym	Definition	Acronym	Definition
LEW	Left Edge of Water	**T**	Duplicate Identification for Field Samples
LMS	Laboratory Matrix Spike	**USCS**	Unified Soil Classification System
LNAPL	Light Non-Aqueous Phase Liquid	**USGS**	US Geological Survey
MB	Method Blank	**VOC**	Volatile Organic Compound
MBMG	Montana Bureau of Mines and Geology	**VPH**	Volatile Petroleum Hydrocarbon
MPTP	Montana Pole and Treating Plant	**XRF**	X-Ray Fluorescence

1.0 INTRODUCTION

This site-specific Butte Reduction Works (BRW) Phase III Quality Assurance Project Plan (QAPP) (BRW Phase III QAPP) provides the procedures and protocols necessary to conduct a Phase III Site Investigation as a part of the overall remedial design (RD) effort for the BRW Smelter Area Mine Waste Remediation and Contaminated Groundwater Hydraulic Control Site (Site).

The Site is within the Butte Priority Soils Operable Unit (BPSOU) located within the city of Butte, Montana (Figure 1). The Site is located within Lower Area One (LAO), which has a history of multiple industrial uses (Figure 2). As a result, there are accumulations of slag, tailings, demolition debris, and other impacted materials that may be sources of contaminants of concern (COCs) (i.e., arsenic, cadmium, copper, mercury, lead, and zinc) and additional constituents of concern (e.g., manganese, trace elements, organic pollutants, etc.) to the underlying groundwater.

Multiple investigations have been completed at the Site, including recent investigations completed as part of the RD to fill data gaps identified by the design team (Table 1). From August 2018 through June 2021, the Phase I Site Investigation took place according to the Phase I QAPP (Atlantic Richfield Company, 2021a). Additionally, a Phase II Site Investigation began in June 2020 and concluded in March 2021 (following guidelines in a corresponding Phase II QAPP; Atlantic Richfield Company, 2021b). Based on results of the Phase I Site Investigation and preliminary results from the Phase II Site Investigation, an additional investigation is needed to fill the remaining data gaps identified in Table 1.

The Phase III Site Investigation will include additional solid material characterization, a geotechnical investigation, Silver Bow Creek sediment sampling and particle analysis, groundwater analysis during a representative range of seasonal groundwater and surface water conditions (such as high- and low-groundwater and surface water conditions), and an analysis of COCs loading to Silver Bow Creek. Since the objectives of this investigation are slightly different than previous investigations, this BRW Phase III QAPP provides new Data Quality Objectives (DQOs) specific to the Phase III Site Investigation. The DQOs were identified according to U.S. Environmental Protection Agency (EPA) *Guidance on Systematic Planning Using the Data Quality Objectives Process* (EPA, 2006).

Prior to the approval of the BRW Phase III QAPP, Agencies approved two Requests for Change (RFCs) to the BRW Phase II QAPP (RFC-BRW-2021-01 and RFC BRW-2021-02), which enabled a supplemental groundwater and surface water sampling event to occur during low-groundwater conditions. To allow the sampling event to occur during low-groundwater conditions, Agencies approved the data collection (i.e., sampling) as part of the BRW Phase II QAPP while the BRW Phase III QAPP was being finalized. However, the DQOs detailed in this BRW Phase III QAPP cover the supplemental sampling event; therefore, the data validation and interpretation associated with the supplemental sampling event will be included with the additional data collected during the Phase III Site Investigation.

1.1 Purpose of the Phase III Site Investigation

The Phase I Site Investigation included an initial data collection effort to help refine the characterization of solid materials and groundwater within the Site. That investigation took place from August 2018 through February 2020, with the exception of groundwater level measurements which continued through June 2021, and included the investigation activities detailed in the BRW Phase I QAPP and associated RFC documents (Atlantic Richfield Company, 2021a). The Phase II Site Investigation began in June 2020 and concluded in March 2021 and addressed additional design-related data gaps associated with future hydraulic control and construction dewatering and included additional data related to the characterization of solid materials, particularly slag, and groundwater within the Site (Table 1).

The Phase III Site Investigation aims to address the remaining data gaps and conclude data collection so that the design team can finalize the Site characterization and proceed with RD. Remaining design-related data gaps consist of solid materials characterization, geotechnical considerations, Silver Bow Creek realignment and sediment transport capacity, groundwater characterization, and COCs loading to Silver Bow Creek (Table 1). Additional soil data will be collected to further define the nature and extents of the COCs present within the Site, which will aid the BRW hydraulic control design and assist in determining the extent of waste removal within the removal corridor (using the waste identification criteria listed in Table 1 in Appendix 1 of Attachment C of Appendix D of the BPSOU Consent Decree [CD] [EPA, 2020a]). A geotechnical investigation will characterize the geotechnical properties of subsurface materials to remain in place in areas of potential structural features that will be constructed as part of the Site's end land use. The geotechnical investigation will also gather data to supplement the excavation surface design to ensure stable slopes adjacent to existing features on and off the Site. Sediment samples collected from Silver Bow Creek will be analyzed to determine sediment particle size distribution, which will be used to calculate the required sediment transport capacity through the Site to assist in designing the realigned Silver Bow Creek and 100-year floodplain. Finally, a primary goal of the Phase III Site Investigation is to assess the effects of a range of seasonal groundwater and surface water conditions. The chemical and spatial variability of groundwater within the Site, as well as the COCs loading to Silver Bow Creek, will aid in optimizing and designing the realigned Silver Bow Creek and BRW hydraulic control.

To support the Phase III Site Investigation, this document includes the following information:

1. Site Background (Section 2.0).
2. DQOs (Section 3.0).
3. Sampling Process and Design (Section 4.0).
4. Assessment and Oversight (Section 5.0).
5. Health and Safety (Section 6.0).
6. Project Organization and Responsibilities (Section 7.0).
7. Data Validation and Usability (Section 8.0).

This document references Pioneer Technical Services, Inc. (Pioneer) Standard Operating Procedures (SOPs) for activities that outline specific procedures to safely complete tasks included in the Phase III Site Investigation. Table 2 lists the applicable SOPs.

1.2 Objectives of the Phase III Site Investigation

The main purpose of the Phase III Site Investigation is to collect additional data to support the RD for the Site. The conceptual RD is shown on Figure 3. The specific objectives of the investigation include the following:

- Additional Solid Material Characterization:
    - Collect additional information to refine the volume and location of waste materials within the removal corridor and obtain additional information on the chemical stability/leachability of solid materials to integrate the waste removal design with the effectiveness of the hydraulic control.
    - Collect additional information to refine the extents of the soil impacted with organic pollutants and the concentrations of organic pollutants within the soil to help define appropriate Site-specific action levels and develop the proper management plan for soil impacted with organic pollutants both inside and outside the removal corridor.
- Geotechnical Investigation: Collect data regarding the physical properties of the soil within the Site to inform the designs of structural features planned as part of the end land use and the design of the excavation surface.
- Silver Bow Creek Sediment Sampling: Collect data representing the stream sediment particle size distribution along the current alignment of Silver Bow Creek to guide the design of the realigned Silver Bow Creek.
- Groundwater Characterization: To guide the designs for the BRW hydraulic control and realigned Silver Bow Creek and collect additional physical and chemical data at specific locations during a representative range of seasonal groundwater and surface water conditions, such as low- and high-groundwater and surface water conditions, to provide finer detail on the nature and extent of COC-impacted groundwater in addition to groundwater impacted with organic pollutants (hydrocarbon compounds, polychlorinated biphenyl [PCB], pentachlorophenol [PCP], and/or dioxins) within the Site. An additional objective is to establish a baseline for groundwater conditions (hydraulic gradient and chemistry) between the Montana Pole and Treating Plant (MPTP) site and the Site to inform the design of the future BRW hydraulic control and/or construction dewatering efforts that will take place during the Remedial Action (RA). The new piezometers to be installed, along with the existing piezometer and monitoring wells, will help establish an "early detection network." The "early detection network" will monitor water levels and PCP concentrations to ensure that the hydraulic gradient between the MPTP Site and the Site does not significantly change and that notable concentrations of PCP do not migrate during construction dewatering and/or as a result of implementing the BRW hydraulic control.
- Silver Bow Creek Loading Analysis: Collect additional information needed to determine the nature, extent, and source of the COCs loading to Silver Bow Creek from the area

between sample station (SS) SS-05B and SS-06A (Figure 2) during a representative range of seasonal groundwater and surface water conditions, such as low- and high-groundwater and surface water conditions.

To meet the objectives above, the following activities will be completed as part of the Phase III Site Investigation:

- Continue to collect solid material data to further define the nature and extent of the COCs and organic pollutants within the Site. This will aid the BRW hydraulic control design, help determine the appropriate waste removal depth within the removal corridor for the RA, and help develop a management plan for the soil within the Site impacted by organic pollutants including development of Site-specific action levels.
    - Drill the Waste Characterization Boreholes at identified data gap locations, collect soil samples from lithological layers, and analyze for COCs, hydrocarbon compounds, and chemical stability/leachability. The analyses will be used to determine the extent of waste material within the removal corridor, to inform the BRW hydraulic control design, and to help develop a management plan for the soil impacted with organic pollutants above Site-specific action levels within the Site.
    - Drill the Phase III Piezometers at the identified locations, collect soil samples from lithological layers, and analyze for COCs, hydrocarbon compounds, and chemical stability/leachability. The analyses will be used to inform the hydraulic control design and to help develop a management plan for the soil impacted with organic pollutants above Site-specific action levels within the Site.
    - Collect samples from soil cores that were retrieved from the Site during the Phase I Site Investigation activities and archived at the Pioneer field office at 244 Anaconda Road in Butte, Montana. Analyze the samples for COCs and chemical stability/leachability. These analyses will be used to refine the estimate of chemical leachability of slag within the Site and the extents of a potential highly leachable soil layer near piezometer BRW18-PZ08 (Figure 4).
- Complete a geotechnical analysis of Site conditions and soil that will be encountered during RA activities and that may remain in place after the RA is complete. The data and construction recommendations obtained will support the excavation design and future Site design, which is expected to include a parking lot, walking trails, a potential amphitheater[1], support utilities, and other infrastructure.
    - Drill boreholes at select locations identified based on the conceptual removal corridor and preliminary end land use design. Additional boreholes may be required once the Intermediate 60% RD documents are reviewed by Agencies as the design will include details regarding the end land use plan. If additional boreholes are required, an RFC to this QAPP will be submitted for Agency review and approval prior to completing the additional boreholes.

[1] Design, construction, and operation and maintenance of the amphitheater requires mutual agreement of Atlantic Richfield Company and Butte-Silver Bow, and identification and commitment of a third-party investor and operator.

- Complete Standard Penetration Tests (SPTs) and collect soil samples, possibly including Shelby tube samples, for specified analysis from each borehole.

- Collect Silver Bow Creek sediment samples for particle size distribution near the upstream and downstream tie in locations of the realigned stream and 100-year floodplain. The sediment sample particle size distribution will support the stream design.
- Collect groundwater data during a representative range of seasonal groundwater and surface water conditions, such as high- and low-groundwater and surface water conditions, to further define the characterization of groundwater and aid in the optimization and design of the BRW hydraulic control.
  - Install the Phase III Piezometers, collect groundwater samples, then analyze the samples for specified analytes to establish a baseline for groundwater conditions (i.e., chemistry and hydraulic gradient) between the MPTP Site and the Site. Groundwater conditions between the MPTP Site and the Site will be monitored to avoid migration of organic pollutants during construction dewatering and/or as a result of implementing the BRW hydraulic control.
  - Collect groundwater samples from existing monitoring wells and piezometers during a representative range of seasonal groundwater and surface water conditions, then analyze for specified analytes to further define the nature and extent of the areas within the groundwater aquifer within the Site that have been impacted with dissolved COCs and organic pollutants (hydrocarbon compounds, PCBs, PCP, and dioxins).
  - Continue to collect groundwater and surface water level data to observe seasonal elevation changes and possible direction of flow changes.

- Complete a loading analysis for Silver Bow Creek from the area between SS-05B and SS-06A (Figure 2) during a representative range of seasonal groundwater and surface water conditions, such as high- and low-groundwater and surface water conditions, to aid the BRW hydraulic control design.
  - Collect groundwater and surface water samples from existing monitoring wells / piezometers and staff gages, respectively, and analyze for specified analytes to determine changes in chemical concentration and loading to Silver Bow Creek during a representative range of seasonal groundwater and surface water conditions.

2.0 BACKGROUND

Details of the Site, its history, and previous investigations are included in the BRW RD Work Plan (RDWP) (Atlantic Richfield Company, 2021c) and the corresponding Pre-Design Investigation (PDI) Work Plan included as an attachment to the RDWP. These documents are working documents and will be updated as needed. Summaries relevant to the Phase III Site Investigation are included in the sections below.

2.1 Site Description

The Site is in Butte, Montana, covers approximately 24 acres, and is located immediately west of Montana Street between Silver Bow Creek and the Burlington Northern Santa Fe (BNSF)

Railway line (Figure 1 and Figure 2). Currently, Butte-Silver Bow uses the Site to store materials.

The Site is located within an urban area and adjacent to other impacted areas. To the south and west of the Site, the MPTP Site (Figure 2) treats extracted groundwater impacted by nearly 40 years of uncontrolled releases of a solution of approximately 5% PCP mixed with a petroleum carrier oil that was used to preserve poles, posts, and bridge timbers from 1946 to 1984 (EPA, 2017). NorthWestern Energy (NWE) has a storage yard and operating center immediately south of the Site (Figure 2). The storage yard has been there since 1899 and is a Comprehensive Environmental Cleanup and Responsibility Act (CECRA) site. Underground storage tanks and on-site use or disposal of various substances such as paints, solvents, mercury, Fuller's earth, wood-treating compounds, and transformer oil containing PCBs have resulted in on-site soil contamination and possibly localized groundwater contamination (DEQ, 2002).

2.2 Site History

Beginning in 1885 to the time of this writing, the Site has been the location of multiple industrial operations including a copper smelter and a zinc concentrator, and it was also used by the Domestic Manganese and Development Company (Sanborn, 1943) and Rocky Mountain Phosphates, Inc. (GCM Services, Inc., 1991). This complex history of activities has resulted in a complex distribution of materials within the Site (including slag, tailings, manganese waste, demolition debris, foundations, and other historic structures) as well as impacted soil and groundwater (Atlantic Richfield Company, 2021c).

2.3 Relevant Previous Investigations

2.3.1 Preliminary Results from Phase I Site Investigation

The Phase I Site Investigation began in 2018 and concluded in 2020, with the exception of groundwater level measurements which continued through June 2021. The PDI Evaluation Report (Atlantic Richfield Company, 2021d) listed results from field activities conducted as specified in the BRW Phase I QAPP (Atlantic Richfield Company, 2021a). The PDI Evaluation Report identified remaining data gaps to be addressed in Phase II and Phase III Site Investigations. The report called for the installation of five additional boreholes, referred to as the Waste Characterization Boreholes, to collect the remaining data needed to identify the waste material within the Site (defined by the BPSOU CD Waste Identification Screening Criteria [EPA, 2020a]). Using Leapfrog Works, a geological modeling software, locations were found where additional data would refine waste volumes. The PDI Evaluation Report also highlighted the need for a geotechnical analysis.

Additionally, Atlantic Richfield Company (Atlantic Richfield) has identified the need to collect additional samples for Synthetic Precipitation Leaching Procedure (SPLP) analysis based on the sample results from the Phase I Site Investigation (Atlantic Richfield Company, 2021d). These additional samples are necessary to refine the estimated chemical leachability of slag within the Site and refine the extents of a potential highly leachable soil layer near piezometer BRW18-PZ08 (Figure 4).

2.3.2 Preliminary Results from Phase II Site Investigation

The Phase II Site Investigation, which began in March 2020 and concluded in March 2021, focused on collecting additional design data related to the groundwater and aquifer within the Site. The Site activities and data collection for the Phase II Site Investigation are detailed in the BRW Phase II QAPP (Atlantic Richfield Company, 2021b). Once site investigation activities are complete, including data validation, the results from the Phase II Site Investigation will be incorporated into the PDI Evaluation Report and submitted for Agencies review.

2.4 BRW Remedial Action

The BRW RA will include removing tailings, waste, COC-impacted soil, and slag within the Silver Bow Creek 100-year floodplain reconstruction area to a depth to be determined during the RD activities. The conceptual RD, shown on Figure 3, will include the following elements:

- Waste removal (as defined by the BPSOU CD Waste Identification Screening Criteria [EPA, 2020a]) from the Site in a corridor that will contain a new channel for Silver Bow Creek to a depth determined during the RD.
- Management of soil and groundwater within the Site impacted by organic pollutants, as appropriate, and in a manner that is complementary with the remedy. Organic pollutants (hydrocarbon compounds, PCBs, PCPs, and dioxins) are secondary concerns for the Site. Soil and groundwater within the Site that have been impacted by these pollutants above Site-specific action levels will be addressed/managed as necessary to implement the remedy, but the long-term management and remediation of soil and groundwater impacted with organic pollutants (i.e., treatment of organic pollutant sources) is not required by the BPSOU CD.
- Realign Silver Bow Creek and construct the bank-full channel and 100-year floodplain.
- Regrade and construct caps over the tailings, waste, impacted soil, and slag left in place.
- Hydraulically manage COC-impacted groundwater at the Site to control discharge of COC-impacted groundwater to surface water and sediment in the BPSOU generally and within the Site specifically.

All COC-impacted soil and slag will be removed within a corridor having an average width of 275 feet from the toe of the BNSF Railway embankment extending north (Figure 3). The removal corridor will include the alignment of Silver Bow Creek and the 100-year floodplain. Areas where slag and COC-impacted soil are left in place will be appropriately capped to ensure protectiveness of human health and surface water. The entire Site will be regraded to produce a land surface that will facilitate future end land uses and account for geotechnical considerations related to constructing future structures.

To remove material from the Site, heavy construction equipment will need to travel on the material at the bottom of the excavation safely and effectively. Initial reconnaissance suggests that most of the area within the removal area boundary may require at least nominal construction dewatering while deeper portions of the area may require that the water table be lowered up to

16.5 feet below the current water table elevation (a maximum of approximately 14.5 feet to bottom of waste, plus an additional 2 feet is anticipated for safe equipment access) (Atlantic Richfield Company, 2021e).

As part of the RA, COC-impacted groundwater from the Site must be hydraulically managed to control COC-impacted groundwater discharge to the newly constructed and existing portions of Silver Bow Creek that would lead to violations of surface water Applicable or Relevant and Appropriate Requirements (ARARs) for the BPSOU, to prevent degradation of groundwater that exceeds current standards, and to comply with the Surface Water Management Plan (EPA, 2020a).

3.0 DATA QUALITY OBJECTIVES

The DQOs are statements that define the type, quality, quantity, purpose, and use of data to be collected. EPA developed a seven-step process for establishing DQOs to help ensure that data collected during a field sampling program will be adequate to support reliable site-specific decision making or estimation, whichever is appropriate (EPA, 2006). The following DQOs were developed for the Phase III Site Investigation according to the EPA process. The DQOs are also detailed in Table 3:

- Solid Material Characterization.
- Geotechnical Investigation.
- Silver Bow Creek Sediment Sampling.
- Groundwater Characterization.
- Silver Bow Creek Loading Analysis.

The project schedule is included as Table 4.

3.1 Measurement Performance Criteria for Data

Specific data validation processes ensure that analytical results are within acceptable limits. For work completed under this BRW Phase III QAPP, all data gathered will be checked to ensure they are usable for their intended purposes. Analytical control limits and the precision, accuracy, representativeness, completeness, comparability, and sensitivity (PARCCS) parameters of the data will be analyzed. If significant issues with any data are found, results will be discussed with EPA and Montana Department of Environmental Quality (DEQ) project managers. EPA, in consultation with Montana DEQ, will then decide if the total study error could cause them to make an incorrect decision. Using this approach, the probability of making an incorrect decision (i.e., either a false negative or positive) based on the information collected is considered small.

The PARCCS definitions are provided below along with the acceptance criteria for data collected. Equations for calculating precision, accuracy, and completeness are provided in Table 5.

Precision

Precision is the amount of scatter or variance that occurs in repeated measurements of a particular analyte. Acceptance or rejection of precision measurements is based on the relative percent difference (RPD) of the laboratory and field duplicates. For example, perfect precision would be a 0 percent RPD between duplicate samples (both samples have the same analytical result). For groundwater samples, the control limit of a RPD less than 20 percent will be used when sample results are greater than 5 times the laboratory Reporting Limit (RL). If either of the sample results are less than 5 times the RL, the control limit used will be a difference between sample results less than the RL. For soil samples, the control limit of an RPD less than 35 percent will be used when sample results are greater than 5 times the RL. If either of the sample results are less than 5 times the RL, the control limit used will be a difference between sample results less than 2 times the RL. This precision requirement is derived from the *Clark Fork River Superfund Site Investigation* (CFRSSI), *Laboratory Analytical Protocol* (ARCO, 1992a), the National Functional Guidelines for Inorganic Superfund Methods Data Review (EPA, 2020b), and the *CFRSSI QAPP* (ARCO, 1992b).

Accuracy

Accuracy is the ability of the analytical procedure to determine the actual or known quantity of a particular substance in a sample. Accuracy is assessed based on the percent recovery (%R) and percent difference (%D) of various laboratory quality control (QC) samples. Perfect %R is 100% and perfect %D is 0% (the analysis result is exactly the known concentration of the QC sample). The laboratory control sample (LCS) and laboratory matrix spike (LMS) are used to measure accuracy, based on the %R of the LMS and LCS. An acceptable accuracy range for the %R of LMS and LCS is 80% to 120% in groundwater samples and 75% to 125% for soil samples. Additional laboratory QC samples may be used to assess accuracy as appropriate to the analytical method. Accuracy requirements for this project are derived from the CFRSSI QAPP (ARCO, 1992b).

Representativeness

Representativeness is a qualitative parameter that is addressed through proper design of the sampling program. The sampling program is designed to obtain a sufficient number of samples that adequately represents the range of conditions present in the medium being sampled and specify suitable sampling methods and procedures.

For this Phase III Investigation, the Contractor Project Manager (CPM) will review the BRW Phase III QAPP to ensure that it is designed to collect the data and information necessary to meet the purpose of the investigation. The review will consider the volume, variability, and intended use of the data to ensure proper sampling methods and adequate spatial distribution of samples.

After the data have been collected and analyzed, the Field Team Leader or CPM will review the data and qualitatively assess whether the data adequately represent the Site conditions and intended purpose of the investigation. Sample representativeness may also be evaluated using the RPDs for field duplicate sample results, if applicable.

Completeness
Completeness determines if enough valid data have been collected to meet the investigation needs. Completeness is assessed by comparing the number of valid sample results to the number of sample results planned for the investigation. Although not all the analytes measured in this sampling effort have completeness objectives outlined in the CFRSSI QAPP (ARCO, 1992b), the completeness target for this investigation is 95.0% or greater as designated in the CFRSSI QAPP.

Comparability
Comparability determines if one set of data can be compared to another set of data. Comparability will be assessed by determining if an EPA-approved analysis method was used, if values and units are sufficient for the database, if specific sampling points can be established and documented, and if field collection methods are similar. All SOPs for this investigation are included in Appendix A. Analysis methods for each analytical group are listed in Table 6. The applicable analytical group for each sampling location is listed in Table 7.

Completeness
Completeness determines if enough valid data have been collected to meet the investigation needs. Completeness is assessed by comparing the number of valid sample results to the number of sample results planned for the investigation. Although not all the analytes measured in this sampling effort have completeness objectives outlined in the CFRSSI QAPP (ARCO, 1992b), the completeness target for this investigation is 95.0% or greater as designated in the CFRSSI QAPP.

Method Sensitivity
Method sensitivity is related to the method detection limits. The method sensitivity or lower limit of detection depends on several factors, including the analyte of interest, the method used, the type of detector used, matrix effects, etc. Appropriate methods must be selected with sufficient method sensitivity to accomplish the project's goals. Two methods are listed below.

> **X-Ray Fluorescence (XRF) Analysis:** The method sensitivity or lower limit of detection for XRF analysis depends on several factors, including the analyte of interest, the type of detector used, the type of excitation source, the strength of the excitation source, count times used to irradiate the sample, physical matrix effects, chemical matrix effects, and interelement spectral interferences. Example lower limits of detection for analytes of interest in environmental applications are listed in Table 8. These limits apply to a clean, spiked matrix of quartz sand (silicon dioxide) free of interelement-spectral interferences using long (100 - 600 second) count times. These sensitivity values are given for guidance only and may not always be achievable, because they will vary depending on the sample matrix, which instrument is used, and operating conditions.
>
> **Modern Water RaPID Assay PCP Screening Kit (PCP Screening Kit):** The method sensitivity or lower limit of detection for the PCP Screening Kit is 0.1 parts per billion for water samples. Also, the PCP Screening Kit does not differentiate between PCP and other organochlorines. Therefore, laboratory samples will also be collected and analyzed for PCP and other organochlorines to evaluate any cross reactivity.

Laboratory Analysis: The method sensitivity for laboratory analyses is determined as part of the laboratory's SOPs. The laboratory RL for each analyte is listed in Table 6. These detection limits will be reviewed as part of the data validation process (Section 8.0).

4.0 SAMPLING PROCESS AND DESIGN

The Phase III Site Investigation will include soil sampling, a geotechnical investigation, groundwater sampling, a COC loading analysis, and sediment sampling along Silver Bow Creek during a representative range of seasonal groundwater and surface water conditions, such as high- and low-groundwater and surface water conditions. The following subsections provide the procedures and protocols necessary to complete these tasks.

4.1 Preparation for Fieldwork

The following tasks will be completed prior to conducting field activities.

4.1.1 Training

All field personnel will have a current certification for the 40-hour Occupational Safety and Health Administration Hazardous Waste Site and Emergency Response Training. Current certification records will be maintained at Pioneer's headquarters at 1101 S. Montana Street in Butte, Montana.

In a project meeting held prior to fieldwork, all field personnel will review this BRW Phase III QAPP and receive any specified training. Field personnel will review sampling and monitoring procedures and requirements prior to field activities to ensure collecting and handling methods are completed according to the BRW Phase III QAPP requirements. Field personnel will be trained in how to properly use field equipment and complete activities according to field data collection SOPs in Appendix A.

The Field Team Leader will review the internal BRW Site-Specific Health and Safety Plan (SSHASP) with all field personnel prior to fieldwork to assess the Site's specific hazards and the control measurements put in place to mitigate these hazards. The BRW SSHASP review will cover all other safety aspects related to the Site including personnel responsibilities and contact information, additional safety requirements and procedures, and the emergency response plan.

The Field Team Leader will be responsible for training field personnel on how to calibrate field measurement instruments. The Field Team Leader will be experienced in the use and calibration of the equipment that will be used and responsible for training and overseeing the support staff. One hard copy of the current approved version of the BRW Phase III QAPP will be maintained for reference purposes in the field vehicle and/or field office. All field team personnel will have access to electronic PDF format files of all documents pertaining to fieldwork.

4.1.2 Property Access

Atlantic Richfield, BNSF Railway Line, Montana DEQ, and NWE own the property where the field activities will be performed. Atlantic Richfield currently has an access agreement with NWE to sample monitoring well MW-03-MPC and an access agreement with Montana DEQ to sample monitoring wells MW-O-01 and MW-I-96 on the MPTP Site. Atlantic Richfield is in the process of obtaining a property access agreement with BNSF Railway Line to sample monitoring wells GW-13 and GW-17. Copies of the access agreements will be placed in the field binder to have on hand during the field activities.

Atlantic Richfield is currently completing the process to gain access to the BNSF property; however, it is anticipated that this process may take months based on communication with BNSF and may not be timely for the groundwater sampling event. Montana DEQ has offered to sample the wells on behalf of Atlantic Richfield. As part of the 1996 CD for the MPTP Site (information available on the Montana DEQ Superfund site at https://deq.mt.gov/cleanupandrec/Programs/superfundfed), EPA and DEQ (and EPA and DEQ contractors) have access at all reasonable times to the MPTP Site and any other property to which access is required for implementing the MPTP CD, which includes monitoring wells GW-13 and GW-17. DEQ views the data collected from GW-13 and GW-17 as mutually beneficial to both DEQ and Atlantic Richfield. Particularly, DEQ agrees with Atlantic Richfield that data are needed to establish a baseline of groundwater conditions between the BRW Site and the MPTP Site to avoid any potential impacts to the MPTP Site groundwater remedy by future remedial activities at the BRW Site, such as construction dewatering and hydraulic control.

In the event that Atlantic Richfield is unable to obtain access to the BNSF property in a timely manner, Tetra Tech (Tom Bowler), contractor and representative to DEQ, will collect the groundwater samples from monitoring wells GW-17 and GW-13 following the protocols and procedures identified in this QAPP. Mr. Bowler will collect the samples and then hand them over to Atlantic Richfield to submit to the laboratory for analyses.

4.1.3 Utility Locates

There is a possibility that investigation points could shift once underground utilities are located throughout the Site. Utility locates will be performed prior to any fieldwork and will follow BP Remediation Management Defined Procedures for ground disturbance in addition to applicable control measures addressed in the internal BRW SSHASP. Final utility locates for the work area will be completed by the performing authority prior to any ground disturbance activities.

4.1.4 Best Management Practices

Although a Joint Application for Proposed Work in Montana's Streams, Wetlands, Floodplains, and other Water Bodies (Joint Application) is not required for Superfund related activities, Atlantic Richfield has identified measures that will be taken to ensure that the substantive requirements of the Joint Application and applicable requirements are met during the field activities. Protection of the environment during field activities will be addressed through implementation of short-term construction Best Management Practices (BMPs). General descriptions of the BMPs to be implemented to minimize the project impacts to the floodplain/wetland area within the Site are provided in the sections below.

4.1.4.1 Minimize Project Impacts to Floodplain/Wetland

During the Phase III Site Investigation, work may be performed within the floodplain/wetland area on the west side of the Site. Specifics of the work activities are detailed below and throughout this document. To minimize project impacts to the floodplain/wetland area, the following measures will be taken:

- The access road used to access the floodplain/wetland area and the drill pad were installed during the Phase II Investigation and were designed to limit the amount of disturbance in the floodplain/wetland area.
- Equipment must stay on the access road or drill pad while work is completed in the floodplain/wetland area, except for the Geoprobe® unit, which will be used to install piezometers and drill boreholes within the floodplain/wetland area.
- Material and supplies will be transported to and stored on the drill pad in appropriate containers. No hazardous materials or liquids will be stored on the drill pad and/or within the floodplain/wetland area.

4.1.4.2 In-Stream Turbidity Control

During the Phase III Site Investigation, some work must be performed within close proximity to the stream channel under flowing conditions with the potential to release sediments into the active watercourse. This work includes drilling boreholes within close proximity to the stream. The following construction BMPs will be implemented for work along Silver Bow Creek to reduce sediment loading and excessive turbidity:

- Geoprobe work will be set back from Silver Bow Creek to provide a protective vegetative buffer between the Geoprobe unit and the Silver Bow Creek channel.
- If the Geoprobe unit must work in close proximity to the stream channel, it will be required to track perpendicularly to the streambank to prevent bank collapse or damage, prevent excessive impact to existing vegetation, and prevent equipment falling into the stream.
- The Geoprobe unit will not be allowed to enter the active stream channel.

4.1.4.3 Stormwater Management

During Site work activities, standard BMPs will be followed/installed, as appropriate, to minimize off-Site sediment tracking and to prevent stormwater runoff from transporting sediments and/or pollutants (e.g., construction related oils, fuels, and other materials) downgradient into Silver Bow Creek. These BMPs may include, but are not limited to, the following:

- A vegetative buffer of native soil/vegetation will help attenuate any sediments and/or pollutants in stormwater flowing from the access road and drill pad to Silver Bow Creek.
- Spillguard® secondary containment systems (or equivalent) will be used, as necessary, to contain any inadvertent spills or leaks.
- Sediment cores from every borehole drilled during this project will be stored in their entirety (in increments) at the Pioneer field office at 244 Anaconda Road in Butte, Montana, or an alternate suitable location.
- Sediments, drill cuttings, materials from potholing, etc. that are not sent to a laboratory will be stockpiled on the Site for disposal during the RA, disposal at the Mine Waste Repository, or other viable option at the discretion of the CPM.
- Development water will be transported to a holding tank and sampled for hydrocarbon compounds prior to management/disposal. The need for management/disposal options, if necessary, will be determined based on the laboratory results.
- General good housekeeping practices.

The Field Team Leader will be responsible for ensuring BMPs are installed properly at appropriate locations. Additionally, the Field Team Leader will be responsible for initiating corrective actions, as necessary.

4.1.5 Site-Specific Borehole Installation Concerns

Past drilling and probing at the Site found heaving sands to be a concern. Therefore, potable water may be added to the drill and/or probe strings as they are advanced to prevent formation heave inside the drill and/or probe rod. The added water provides a positive pressure inside the sample string, minimizing the amount of water and soil invading the drill and/or probe rod as the core sample is retrieved. Water will be added only when needed and not on a routine basis.

Additionally, depending on the drilling conditions, water may be added to help the drill rig progress through tougher material (i.e., slag and demolition debris). Any recovered water will be contained within a specified containment area. Based on field observations, if the recovered water appears to contain hydrocarbon compounds, the recovered water will be sampled for hydrocarbon compounds prior to management/disposal. The need for management/disposal options, if necessary, will be determined based on the laboratory results.

4.2 Solid Material Characterization

Up to 19 boreholes will be drilled as part of the solid material characterization component of the Phase III Site Investigation (Figure 4).

- Waste Characterization Boreholes: Up to 5 boreholes will be drilled and sampled to fill the data gaps related to the distribution of waste materials within the Site. These 5 locations were identified during the evaluation of data from the Phase I Site Investigation.

Additional details are in the PDI Evaluation Report (Atlantic Richfield Company, 2021d).

- Phase III Piezometers: 2 additional boreholes will be drilled (and piezometers installed) as part of the baseline monitoring and early detection system that will be located between the Site and the MPTP Site (Figure 4).
- Geotech Analysis Boreholes: 12 boreholes will be drilled as part of the geotechnical investigation. *In-situ* field tests will be conducted to determine the strength of the soil at 5-foot interval depths and soil samples will be collected from the boreholes and analyzed for geotechnical properties listed in Table 6 (Analytical Group 14). This information will be used to fill the data gaps related to designing the excavation surface and end land use features.

The number and location of the boreholes may be modified as determined by the Field Team Leader and/or CPM in consultation with the Contractor Quality Assurance Officer (QAO) (Section 7.0). Drilling and sampling are to be conducted as per all relevant and applicable SOPs in Appendix A. Specific to this investigation, certain modifications to the SOP are provided in this section.

4.2.1 Waste Characterization and Piezometer Boreholes

4.2.1.1 Drilling Equipment

It is anticipated that the collection of high-quality core samples will be accomplished by either a sonic drilling rig or Geoprobe unit, as appropriate. Only the Geoprobe unit will be used to drill the boreholes in the floodplain. Core samples will be examined to produce a detailed lithologic characterization log of the subsurface materials at each borehole location. The following paragraphs include output details and general practices for each instrument.

Sonic Drilling Rig
The sonic drilling rig will provide continuous core samples, which are anticipated to be 5 feet in length by 4 inches in diameter. To temporarily store the sediment core, polyethylene sleeves designed to fit over the core barrels will be used. Each 5-foot length will be properly labeled to split the core into manageable units for storage.

Geoprobe
The Geoprobe unit will provide continuous core samples using the dual tube soil sampling system. These core samples are anticipated to be up to 5 feet in length by 2 inches in diameter. To temporarily store the sediment core from the Geoprobe unit, plastic liners will be used within the inner core barrel to collect the core samples. Each 5-foot length will be properly labeled for storage.

4.2.1.2 General Procedures

The following general procedures will be performed at each proposed Waste Characterization Borehole and proposed Phase III Piezometer location identified in Table 7. Note that this list is not intended to be a complete list.

- Prepare drill equipment for operation. This includes, but is not limited to, decontaminating drilling tools and sampling equipment, leveling the rig, preparing the down-hole tool, and establishing the drill location.
- Begin advancing the core barrel. Advance the core barrel to collect the core sample, then retrieve the inner core barrel to recover the core sample.
- Classification and lithology of the core from each borehole will be logged and sampled following the general procedures listed below.
- Continue adding core barrel segments and collecting core samples until desired depth has been reached.
- Decontaminate the drill rig core barrel(s) between samples by rinsing with tap water and/or using a high-pressure washer.
- Backfill Waste Characterization Boreholes with bentonite hole plug.
- Record location of each borehole with the Global Positioning System (GPS) unit and/or survey.

The general depth of each borehole is specified in Table 7 and may be limited or increased based on field personnel observations.

Equipment
Equipment used to collect core samples will include, but not be limited to, the following:

- Field logbook and pens.
- Measuring tape.
- Unified Soil Classification System (USCS) chart (ASTM D-2488) (Appendix B).
- Munsell color chart (Munsell, 2009).
- Field XRF unit.
- Sieve.
- Portable heater or oven.
- Two photoionization detectors (PIDs) (9.8 eV and 10.6 eV lamps) with humidity filter.
- Sample containers and labels.
- Chain of custody forms.
- Coolers.

- Decontamination equipment (pressure washer, tap water, dilute nitric acid, liquinox soap, decontamination containers, paper towels, scrub brushes, and spray bottles) (refer to SOP-DE-02 in Appendix A).
- Camera and film, digital camera, and/or digital video camera.
- Survey-grade GPS unit.
- Appropriate safety personal protective equipment (PPE).

Logging
The classification and lithology of the core will be logged and photographed. This will include a soil log of the borehole that lists USCS classification (Appendix B); visual estimate of rock content (2-inch plus fraction); angularity of the grains (when feasible); color (as per Munsell color chart [Munsell, 2009]); depth to top and bottom of each stratigraphic unit; presence or absence of soil staining, odors, nodules, organic matter, and/or groundwater; percent recovery; type of drilling equipment; and bedrock depth (if encountered). All relevant observations will be recorded in a bound field logbook or on the designated field form (Appendix B).

PID Screening Analysis
Prior to drilling each borehole, visual observations (sight and/or smell) and a PID will be used to identify sources of hydrocarbon compounds on the surface. Any findings will be recorded in the field logbook. The procedures for using the PID are detailed in Section 4.8.2. If the presence of hydrocarbon compounds is detected (via sight and/or smell or detection with a PID) on the surface, a surface sample may be collected for hydrocarbon analyses as determined by the Field Team Leader.

Sampling and Analysis Procedures
Core samples will be collected from the Waste Characterization Boreholes and Phase III Piezometer locations shown on Figure 4 using a sonic drilling rig or Geoprobe® unit. Core samples will be collected according to all applicable SOPs in Appendix A. Soil samples will be collected at the locations listed in Table 7 and analyzed for analytes specified in Table 6. The required samples for each location are identified in the "Solid Material Characterization (Analytical Group From Table 6)" column in Table 7 and correspond to the "Analytical Group" identified in Table 6.

The following general procedures will be performed at each location (at the depth intervals). Note that this is not intended to be a complete list.

1. Prior to use, and between samples, wash all utensils with a detergent solution, followed by a tap water rinse, a diluted acid rinse (if necessary), and a final rinse with deionized (DI) water.
2. Open the core sleeve and lay out the core samples in order on strips of visqueen or other appropriate material where the boring depth footage has been pre-labeled.
3. Split any non-slag material within the core lengthwise using a plastic spatula and/or stainless-steel blades.

4. Use two PIDs to immediately screen for any hydrocarbon compounds (Section 4.8.2). If the presence of hydrocarbon compounds is detected (via sight, smell, and/or detection with a PID), complete the following:
   - Confirm all visual and olfactory observations of suspected hydrocarbon compounds with a PID prior to collecting a sample.
   - Immediately collect samples for headspace detection method (Section 4.8.2) and laboratory hydrocarbon analyses (Table 6).
   - A soil sample may be collected near the top of the saturated layer (in the capillary fringe) for hydrocarbon analyses (Table 6 and Table 7) if determined necessary by the Field Team Leader or CPM.
5. Photograph the complete length of the core in 2-foot segments from directly overhead using parallel camera movement and a high-resolution setting.
   - Take additional photographs of subsamples for documentation, as necessary.
6. Conduct field XRF analysis for specified analytes for each material horizon via the XRF unit, unless determined otherwise by field personnel. The field XRF analysis results will be used to estimate the first lithological layer in each boring that passes the Waste Identification Screening Criteria (EPA, 2020a).
   - Based on the field XRF analyses, up to two samples will be collected for each borehole and submitted for Synthetic Precipitation Leaching Procedure (SPLP) analysis, unless determined otherwise by field personnel. Samples will be collected from up to two distinct lithological layers with field XRF analysis values of COC concentrations that suggest notable concentrations of leachable COCs as determined by the CPM and Contractor QAO. At the discretion of the CPM and Contractor QAO, the analytical approach may be altered based on field observations or analytical results. Agency personnel will be notified prior to implementing a new analytical approach.
   - A sample will be collected from each lithological layer in each boring and submitted for metals analysis via inductively coupled plasma mass spectrometry (ICP-MS) (Table 6), unless the lithological layer is too thin and there is not enough soil to fulfill the required sample volume. In this instance, a sample will be collected and prepped for official XRF analysis (Section 4.8.1).
   - Samples will be collected as per SOP-S-12 or SOP-S-13 included in Appendix A.
7. Place the core samples in properly labeled sample core boxes for transport (the labels will include location, depth interval, and core orientation). It is imperative that the core sample is marked clearly and is carefully transported horizontally, as it will be used for further observation, sample selection, and analysis.

Sediment cores from every borehole drilled during this project will be stored in their entirety (in increments) at the Pioneer field office at 244 Anaconda Road in Butte, Montana, or an alternate suitable location. When it has been determined that enough sample is present for design-related purposes, additional samples will be shared with other parties, transferred from Pioneer’s field office, or disposed of appropriately. Sediments, drill cuttings, materials from potholing, etc. that are not sent to a laboratory will be stockpiled on the Site for disposal during the RA, disposal at the Mine Waste Repository, or other viable option at the discretion of the CPM.

4.2.2 Phase III Piezometers

The field team will install 2 additional piezometers to determine the baseline groundwater conditions between the Site and MPTP Site (Figure 4 and Table 7). The number and location of the piezometers may be modified as determined by the Field Team Leader and/or CPM in consultation with the Contractor QAO. Field personnel will record survey-grade GPS location coordinates for all piezometer locations.

4.2.2.1 Installing Piezometers

Piezometers will be installed as best suits the field conditions.

All piezometers will be installed in general accordance with the SOP-GW-11 included in Appendix A. Specific details for the piezometer construction are provided on Figure 5. The procedures below assume that either a vibratory roto-sonic drilling rig or Geoprobe unit will be used to install the piezometers. These procedures may change based on field conditions and equipment availability.

The general depth of each borehole and the general target depth for the piezometer screen are specified in Table 7 and may be limited or increased based on field personnel observations as determined by the Field Team Leader and CPM in consultation with the Contractor QAO. Equipment, materials, and supplies used to install the piezometer will include, but is not limited to, the following:

- 1.5 inch by 5- or 10-foot Schedule 40 polyvinyl chloride (PVC) (flush-threaded) casing (number to vary per piezometer) (Figure 5).
- One 1.5-inch by 5-foot Schedule 40 PVC pre-packed screen 0.010 slot (flush-threaded) per piezometer.
- One 1.5-inch PVC bottom cap.
- One 1.5-inch slip cap.
- Field logbook and pens.
- Measuring tape.
- Sharpie marker.
- Water level probe.
- Metal tag with the identification.
- Camera and film, digital camera, or digital video camera.
- Appropriate safety PPE.

The following procedures will be performed at each new piezometer location. Construction details are provided on Figure 5.

- Once the target depth is reached (Table 7), the well screen interval will be installed in the shallowest conductive unit as determined by the Field Team Leader and CPM in consultation with the Contractor QAO.
- Backfill any over-drilled boring with hydrated bentonite chips or bentonite pellets to a depth of 2 feet or greater below the expected total depth of the well, and transition to building filter pack (10-20 Mesh Colorado Silica Sand). This will help ensure that bentonite does not swell into the screened zone.
    - Alternatively, field personnel may elect to backfill the original borehole with bentonite, drill an adjacent borehole to the desired bottom depth of the piezometer, and install the piezometer in this second borehole.
- For the Screen and Riser:
    - Each piezometer will consist of 5 feet of 1.5-inch nominal diameter schedule 40 flush-threaded PVC well screen with a slot size of 0.010-inches, with 1.5-inch nominal diameter schedule 40 flush-threaded PVC blank casing extending to approximately 2.5 feet to 3 feet above the ground surface or finished as a flush-mount at locations where an aboveground surface finish is not possible (e.g., access roads, etc.).
    - Install an appropriately sized schedule 40 slip-fit cap on top of the PVC blank casing before installing the filter pack and other components described below.
- For the Filter Pack:
    - Install the filter pack to at least 2 feet above the top of the screen.
    - Install the annular seal of hydrated bentonite chips from the top of the filter pack to 6 to 12 inches below ground surface (bgs). For shallower completions of piezometers, the thickness of the seal and/or filter pack above the piezometer screen may be reduced by field personnel, as necessary.
- For the Casing:
    - Install a 4-to-6 inch by 5-foot steel surface casing from approximately 2.5 feet bgs to approximately 2.5 feet above ground surface.
    - If the location is anticipated to be subject to frost-heave, such as in the western portion of the Site, install a longer steel surface casing that extends below the frost line.
    - In areas susceptible to flooding, the protective casing should extend high enough to be above flood level (OhioEPA, 2008).
    - In high traffic areas, 3 bollards should be installed around the piezometer.
    - Install 10-20 mesh Colorado Silica Sand from 6 inches bgs to approximately 2 inches below the top of the 1.5-inch diameter PVC.

- Mark a measuring point on the north side of the inner casing using permanent marker.
- Install a concrete pad around the surface casing.
- Provide a locking steel cap for each piezometer.
- Write the piezometer name, depth, and installation data on the underside of the locking steel cap.

Pioneer will prepare a piezometer completion log for the location and, at a minimum, it will contain the following:

- Time and date installed.
- Borehole, casing, and screen diameters.
- Bottom cap length.
- Boring depth (plus or minus 0.1 foot) in relation to the ground surface.
- Well depth (plus or minus 0.1 foot) in relation to the ground and final measuring point.
- Lithology logs.
- Casing materials.
- Screen size, length, and depth to top and bottom of screen from ground surface.
- Filter pack material, size, and thickness in relation to the ground surface.
- Seal thickness and depth below ground in relation to the ground surface.
- Depth to groundwater at time of completion, in relation to the ground and final measuring point.
- Survey-grade X and Y coordinates and elevations for the measuring point (marked on the north side of the PVC), top of protective casing, and ground surface.

All drilling equipment and accessories will be decontaminated at the completion of the piezometer installation.

4.2.2.2 Development

The piezometers will be developed following the general procedures detailed in SOP-GW-12 in Appendix A. The piezometer will be considered developed when 3 consecutive readings for turbidity are below 5 Nephelometric Turbidity Units (NTUs) or are within 10% of each other and the water quality parameters are stable, or the piezometer has been developed for 4 hours. The water quality parameters are considered stable when three consecutive readings are as follows:

- Temperature range is no more than plus or minus 1 degree Celsius (°C).
- pH varies by no more than 0.1 pH units.
- Specific Conductance (SC) readings are within 3% of the average.

If a light non-aqueous phase liquid (LNAPL) layer is detected on the groundwater table using an interface probe, the piezometer will not be developed.

Development water will be contained within a specified containment area and/or holding tank. Based on field observations, if the development water appears to contain hydrocarbon compounds, the water will be sampled for hydrocarbon compounds prior to management/disposal. The need for management/disposal options, if necessary, will be determined based on the laboratory results.

4.2.3 Geotechnical Analysis Boreholes

4.2.3.1 Drilling Equipment

Based on field conditions and recommendations from the geotechnical engineer, an appropriate drill rig will be used to log and sample solids for field testing and laboratory analysis. The Geoprobe unit will be used to drill the 2 boreholes located in the floodplain to minimize the impact to the floodplain and Silver Bow Creek (Figure 4). The drilling methods available for the 10 boreholes located on the main Site outside the floodplain (Figure 4) include the sonic drilling rig and the hollow stem auger. While the hollow stem auger is the preferred method for collecting geotechnical data on the alluvial material beneath the slag and demolition debris at the Site, the sonic rig may also be used and will provide data that meets the DQOs. The hollow stem auger will be limited to areas without slag or other hard materials. Therefore, the sonic rig may be used to drill through tougher materials (i.e., demolition debris or slag), if needed. Core samples will be examined to produce a detailed lithologic characterization log of the subsurface materials at each borehole location.

The following paragraphs include output details and general practices for each instrument as they apply to the geotechnical investigation.

Hollow Stem Auger
Where appropriate, a hollow stem auger will be used for the geotechnical investigation. Drilling will be conducted using a 6-to-8-inch outer-diameter hollow stem auger system. To temporarily store the sediment core, polyethylene sleeves designed to fit over the core barrels will be used. Each 5-foot length will be properly labeled to split the core into manageable units for storage.

Sonic Drilling Rig
Where appropriate, the sonic drilling rig will provide continuous core samples, which are anticipated to be 5 feet in length by 4 inches in diameter. To temporarily store the sediment core, polyethylene sleeves designed to fit over the core barrels will be used. Each 5-foot length will be properly labeled to split the core into manageable units for storage.

Geoprobe
The Geoprobe unit will provide continuous core samples using the dual tube soil sampling system. These core samples are anticipated to be up to 5 feet in length. The Geoprobe unit is equipped with 2 sampling systems, one that collects 2-inch core and one that collects 3-inch core, which will allow collection of Shelby tube samples. Using either of the systems will be determined by the Field Team Leader and CPM in consultation with the geotechnical engineer. To temporarily store the sediment core from the Geoprobe unit, plastic liners will be used within

the inner core barrel to collect the core samples. Each 5-foot length will be properly labeled for storage.

All three drill rigs will be equipped with the appropriate system to conduct SPTs. The SPTs will be conducted with a split spoon sampler using the hammer to drive the sampler to the ground in a minimum of three 6-inch increments. The drill rigs (auger, sonic, and Geoprobe unit) will also be equipped to take standard Shelby tube samples. Based on field conditions, the Field Team Leader and CPM in consultation with the geotechnical engineer will determine the appropriate drilling equipment to use.

4.2.3.2 General Procedures

The following general procedures will be performed at each Geotech Analysis Borehole (Figure 4) location (at the depth intervals). Note that this list is not intended to be a complete list.

- Prepare drill equipment for operation. This includes, but is not limited to, decontaminating drilling tools and sampling equipment, leveling the rig, preparing the down-hole tool, and establishing the drill location.
- Perform SPTs starting at ground surface and continuing in approximately 5-foot intervals in general accordance with the *Standard Method for Standard Penetration Test and Split-Barrel Sampling of Soils* (ASTM D1586; ASTM, 2017a included in Appendix C). Note that the SPTs will be performed by a subcontractor. The geotechnical engineer or Field Team Leader will log the number of blow counts for each test.
- Advance the auger barrel segment (anticipated to be 5 feet) to complete field testing and collect samples. Boreholes will be advanced at the direction of the Field Team Leader, CPM, or the geotechnical engineer.
- Shelby tube samples will be collected to obtain samples of clay or silt, at the discretion of the Field Team Leader or geotechnical engineer, in accordance with the *Standard Practice for Thin-Walled Tube Sampling of Fine-Grained Soils for Geotechnical Purposes* (ASTM D1587; ASTM, 2017b included in Appendix C).
- Classification and lithology of the core from each borehole will be logged and sampled following the general procedures listed below.
- Continue adding auger barrel segments and collecting samples until desired depth has been reached.
- Decontaminate the drill equipment between investigation locations by rinsing with tap water and/or using a high-pressure washer.
- Backfill borehole with bentonite hole plug.

The general depth of each borehole is specified in Table 7 and may be limited or increased based on field personnel observations.

Equipment
Equipment used to collect core samples will include, but not be limited to, the following:

- Field logbook and pens.
- Measuring tape.
- Ziplock bags.
- Chain of custody forms.
- 5-gallon buckets.
- Large brush to remove soil from split spoon sampler.
- Duct tape.
- Shelby tubes and plastic end caps.
- Decontamination equipment (pressure washer, tap water, dilute nitric acid, liquinox soap, decontamination containers, paper towels, scrub brushes, and spray bottles) (refer to SOP-DE-02 in Appendix A).
- Camera and film, digital camera, and/or digital video camera.
- GPS unit.
- Appropriate safety PPE.

Logging
A geotechnical engineer will log the number of blow counts during the SPT, log soil lithology, collect soil samples for field and laboratory testing, observe existing groundwater conditions (where encountered), inform the driller when to take Shelby tube samples, note the ease or difficulty of drilling, and record any other notable features.

Sampling and Analysis Procedures
The following general procedures will be performed at each location at the discretion of the geotechnical engineer, Field Team Leader, or CPM:

- Between boreholes, wash all utensils and drilling equipment with a detergent solution, followed by a tap water rinse, a diluted acid rinse, and a final rinse with DI water.
- Upon receiving the split spoon from the driller, open the split spoon, measure the length of recovered material, take a photograph from directly overhead, log the soil, and place in a ziplock bag labeled with the location name, soil depth interval, and date.
- Upon receiving the 5-foot core from the driller, open the bag, take a photograph from directly overhead, and log the soil. Samples may be collected at the discretion of the geotechnical engineer, Field Team Leader, or CPM.
- Upon receiving a Shelby tube from the driller, keep the Shelby tube in an upright position, place the plastic caps over the top and bottom of the Shelby tube and use duct tape or a similar material to secure and seal the caps to the Shelby tube. Place the Shelby tube in a location where it will remain upright and will be subject to minimal movement.
- Select samples may be analyzed at Pioneer’s Material Testing Laboratories for moisture content, resistivity, pH, sulfate, particle size distribution, Atterberg Limits, standard

proctor, California bearing ratio, triaxial shear strength, and consolidation (Table 6) depending on borehole location and the potential infrastructure that might be located in that area.

- Place the core samples in properly labeled sample core boxes for transport (the labels will include location, depth interval, and core orientation). It is imperative that the core sample is marked clearly and is carefully transported horizontally, as it will be used for further observation, sample selection, and analysis.

Sediment cores from every borehole drilled during this project will be stored in their entirety (in increments) at the Pioneer field office at 244 Anaconda Road in Butte, Montana, or an alternate suitable location. When it has been determined that enough sample is present for design-related purposes, additional samples will be shared with other parties, transferred from Pioneer’s field office, or disposed of appropriately. Sediments, drill cuttings, materials from potholing, etc. that are not sent to a laboratory will be stockpiled on the Site for disposal during the RA, disposal at the Mine Waste Repository, or other viable option at the discretion of the CPM.

4.2.4 Additional SPLP Samples

Based on the sample results from the Phase I Site Investigation (Atlantic Richfield Company, 2021d), Atlantic Richfield has identified the need to collect additional samples for SPLP analysis. These additional samples are necessary to refine the estimate of chemical leachability of slag within the Site and the extents of a potential highly leachable soil layer near piezometer BRW18-PZ08 (Figure 4). To expedite sampling and not delay the RD for the Site, Atlantic Richfield is proposing that these additional SPLP samples be collected from soil cores that were retrieved from the Site during the Phase I Site Investigation activities and archived at the Pioneer field office at 244 Anaconda Road in Butte, Montana.

While the holding time for the samples will have been exceeded, it is believed this will have little effect on the quality of the data for the COCs (arsenic, cadmium, copper, lead, and zinc) because the borehole cores have been stored under Atlantic Richfield control since they were originally removed from the ground (as early as 2018) and the COCs are relatively stable (i.e., do not easily degrade). Based on a previous agreement with Agencies (via email correspondence on March 25, 2020, and April 14, 2020), the samples will be qualified during the data validation process since they are outside the specified holding time. Atlantic Richfield recommends flagging detects as J and non-detects as UJ based on a previous agreement with Agencies. Based on these qualifications, the data will meet screening quality criteria (assuming no other issues are found during the data validation process), and per the *CFRSSI Data Management/Data Validation* (DM/DV) *Plan* (ARCO, 1992c), screening quality data is acceptable for engineering studies and engineering design (i.e., remedial design).

Figure 6 details the proposed additional samples for SPLP analysis and the following paragraphs detail the logic for identifying the additional samples.

Monolithic Slag:
It has been observed that SPLP test results can be greatly influenced by the degree of freshly fractured material that is included in the sample. Because monolithic slag is a form of glass, *in-situ* slag essentially encapsulates reactive material and prevents it from

weathering and is typically inert. Freshly fractured slag exposes fresh reactive material; therefore, laboratory SPLP testing on freshly fractured slag has the potential to overestimate the leachability of the *in-situ* weathered slag found at the Site. To determine a more representative SPLP result for *in-situ* weathered slag, the following procedures were completed for the slag samples collected and submitted for SPLP analysis during the Phase I Site Investigation:

- Slag samples were selected to include the smaller pieces of slag from the archived core; however, pieces were not crushed or ground prior to analysis.
- For each slag sample, an SPLP test was run twice:
    - The first SPLP test was anticipated to be representative of COC concentrations leaching from freshly fractured slag.
    - The second SPLP test (using the same sample material from the first SPLP test) was anticipated to be representative of COC concentrations leaching from *in-situ* weathered slag.

Based on the sample results from the Phase I Site Investigation, there were a number of samples where results from the second SPLP test were similar to or higher than the results from the first SPLP test indicating that the results were not yet representative of COC concentrations leaching from *in-situ* weathered slag (Atlantic Richfield Company, 2021d). Additionally, the higher SPLP results were typically from samples with solids: copper concentrations ranging from around 4,000 to 5,000 milligrams per kilogram (mg/kg). Therefore, the additional SPLP sample locations were selected based on slag samples with total copper concentrations ranging from 4,000 to 5,000 mg/kg and distributed across the Site.

Leachable Soil Layer near Piezometer BRW18-PZ08:
Based on the sample results from the Phase I Site Investigation, there was a sample collected from piezometer BRW18-PZ08 from 6.6 feet to 7.2 feet bgs that had significantly higher SPLP results than the other samples collected. Based on the lithology log for that location, this layer was soft, wet-moist, dark brown/black, medium plasticity, fines-clay/silt. Due to the anomalously high SPLP results from this location, it is warranted to further investigate and confirm these results by collecting and analyzing samples from nearby locations with similar material types. Additionally, samples will be collected above and below the lithological layer with high SPLP results (i.e., above 6.6 feet bgs and below 7.2 feet bgs) to evaluate the leachability in saturated and unsaturated conditions within these lithological layers.

All samples will be collected from the archived cores following the SOPs in the Phase III QAPP. Atlantic Richfield has retrieved the samples from the archived cores to verify there is sufficient material for analysis. The samples will be submitted to Eurofins TestAmerica for SPLP analysis (Analytical Group 13 in Table 6).

In order to obtain a representative SPLP result for *in-situ* weathered slag, Atlantic Richfield proposes to conduct multiple SPLP tests on the same material until results demonstrate that they are representative of *in-situ* weathered slag. Each sample will initially be leached using the SPLP procedure for a total of 11 times. Leachate from each cycle will be collected and preserved; leachate from the 1st, 2nd, 3rd, 5th, 7th, 9th, and 11th leaching cycle will be analyzed. These data will be used to determine if COC concentrations leached from each slag sample are decreasing with additional leaching cycles and if the concentrations tail off and stabilize around a specific concentration (i.e., asymptotic response). The following approach will be applied to the data set for each sample:

1. No notable reduction in concentrations is observed: The SPLP concentrations for 1st leaching cycle will be used for these samples.
2. Asymptotic response is observed: If an asymptotic response is noted with the additional leaches, the data will be used to determine if the concentrations have stabilized around a specific concentration. Additional leachate cycles may be necessary.
3. A continued linear decrease in concentration is observed: If a linear decrease is observed, additional leachate cycles may be necessary until an asymptotic response is observed.

4.3 Groundwater Characterization

Note: Prior to the approval of the BRW Phase III QAPP, Agencies approved two RFCs to the BRW Phase II QAPP (RFC-BRW-2021-01 and RFC-BRW-2021-02) which enabled a supplemental groundwater and surface water sampling event to occur during low-groundwater conditions and within the allotted timeframe of the Site Investigation schedule. The DQOs detailed in this BRW Phase III QAPP cover the supplemental sampling event; however, the protocols and procedures for the supplemental groundwater sampling event are contained in the BRW Phase II QAPP, RFC-BRW-2021-01, and RFC-BRW-2021-02 (Atlantic Richfield Company, 2021b).

The following actions will be completed as part of the remaining groundwater characterization for the Phase III Site Investigation:

1. Use U.S. Geological Survey (USGS) streamflow data from USGS station 12323250, or other appropriate location, during spring months (i.e., higher flow periods) as an analog for high-groundwater conditions. Silver Bow Creek flow generally corresponds to groundwater levels and the data will provide an appropriate estimation to target the seasonally higher groundwater conditions. Based on the streamflow data, the Field Team Leader and CPM in consultation with the Contractor QAO will determine when sampling takes place. Based on historical data, it is anticipated that sampling for high-flow conditions will occur between May and June 2021. Agencies will be notified at least 24 hours prior to start of sampling.

2. Use USGS streamflow data, historical records, and other appropriate sources to determine when to conduct seasonal groundwater sampling events, besides during high- and low- groundwater and surface water conditions, to provide a representative sample of seasonal groundwater and surface water conditions, if determined to be necessary. The Field Team Leader and CPM in consultation with the Contractor QAO will determine if additional sampling is needed and when it will take place. Agencies will be notified at least 24 hours prior to start of sampling.

3. Continue to gather continuous groundwater level readings implemented under the BRW Phase I QAPP (Atlantic Richfield Company, 2021a).
4. Complete a synoptic water level measurement at all the locations to be sampled prior to the day of sampling for groundwater sampling events as deemed appropriate by the Field Team Leader and CPM in consultation with the Contractor QAO. A synoptic event consists of measuring groundwater elevations from piezometers and monitoring wells that will be sampled the following day. Water levels will be recorded as a parameter during the sampling event.
5. Record field parameters, collect groundwater and surface water samples, and analyze for specified analytes.
    - Field personnel will collect a water sample and record field parameters from each piezometer and monitoring well identified in Table 7 following the identified procedures in Section 4.4.2 and associated Standard Operating Procedures. In the “Groundwater Characterization and Loading Analysis, Analytical Group from Table 6” column in Table 7, the required samples for each location are identified and correspond to the “Analytical Group” identified in Table 6. Groundwater samples will be collected from 51 groundwater monitoring wells and piezometers (shown on Figure 7).
    - At each surface water location identified in Table 7, field personnel will collect a water sample, record field parameters, and collect flow measurements following the identified procedures in Section 4.4 and associated Standard Operating Procedures. In the “Groundwater Characterization and Loading Analysis, Analytical Group from Table 6” column in Table 7, the required samples for each location are identified and correspond to the “Analytical Group” identified in Table 6. To provide data for a future COC loading analysis, select piezometers/wells will be sampled on the same day as surface water samples are collected. These locations are identified with the superscript “4” in Table 7 and shown on Figure 8.
    - The field parameters identified in Table 6 (Group 1 and Group 2) will be recorded at each location, with the exception of concentrations using the PCP Screening Kit. The PCP Screening Kit will be used to identify any pre-existing concentrations of PCP in select wells. These wells are indicated with “2b” in the “Groundwater Characterization and Loading Analysis, Analytical Group from Table 6” column in Table 7. The samples will be analyzed in the field following the procedures in the user manual.
    - The samples will be submitted to the laboratory for the specified analyses identified in Table 6.
    - The selected groundwater and surface water sampling and/or flow measurement locations may be changed, increased, or decreased as determined by the Field Team Leader and CPM in consultation with the Contractor QAO.

The Phase I Site Investigation schedule for continuous monthly groundwater monitoring concluded in June 2021. The Phase III Site Investigation groundwater monitoring schedule will extend the Phase I Site Investigation continuous monitoring locations through at least the conclusion of all Phase III groundwater sampling events. However, the Field Team Leader and CPM in consultation with the Contractor QAO may decide to continue the monthly groundwater monitoring past the conclusion of the Phase III groundwater sampling events.

4.3.1 Water Level Measurements

Continuous Groundwater Level Measurements

Continual water level recorders (transducers) will be monitored at the piezometer locations listed in Table 7 and set to collect a data point every 15 minutes, in a linear mode. The Phase III Site Investigation will use the transducer arrangement specified in the Phase I QAPP (Atlantic Richfield Company, 2021a) and extend the projected data collection completion date from January 2021 to the conclusion of all groundwater sampling events for Phase III. Transducers will be installed and monitored in accordance with SOP-GW-15 included in Appendix A. The proposed locations may be modified based on field observations and as approved by the Field Team Leader and CPM in consultation with the Contractor QAO.

Data from transducers will be downloaded monthly (unless needed for more frequent analysis during sampling events) and concurrently with synoptic monthly water level measurements. At the time the data from the transducers are downloaded, the transducers will be checked for proper functionality and visually inspected for fouling. If the transducer is becoming fouled, it will be rinsed with tap water. When removing transducers from piezometers, care will be taken to avoid contacting the transducer and any suspension cables with the ground surface. Should contact with the ground surface occur, the transducer and suspension cable will be rinsed with tap water to remove all foreign material.

Manual Groundwater Level Measurements

Manual water levels will be collected monthly (unless needed for more frequent analysis during sampling events) until the conclusion of Phase III groundwater sampling events from the identified locations in Table 7 using a dedicated electronic depth to water indicator tape (E-tape), unless the location must be removed or an alternate location is designated. The proposed locations may be modified based on field observations and as approved by the Field Team Leader and CPM in consultation with the Contractor QAO.

Manual water levels will be measured from the measuring point as indicated on the inner PVC well or piezometer casing, typically located on the north side of the inner PVC casing. Measuring point locations and elevations of all monitoring wells and piezometers identified in Table 7 have been or will be surveyed using a survey-grade GPS unit.

4.3.2 Groundwater Sampling

Groundwater samples will be collected from 51 groundwater monitoring wells and piezometers (shown on Figure 7) during a representative range of seasonal groundwater and surface water conditions, such as high- and low-groundwater conditions; the Field Team Leader and CPM, in consultation with the Contractor QAO, will assess if additional sampling is needed. Groundwater samples will be collected from the 51 groundwater monitoring wells and piezometers and will be submitted to be tested for varying analytical groups, as appropriate, to support the Phase III DQOs (Table 3). Groundwater samples will be collected from the locations listed in Table 7 and analyzed for analytes specified in Table 6. The "Analytical Group" values (1 through 8 for groundwater and surface water) of the first column in Table 6 correspond to the values listed for each location under the column heading "Groundwater Characterization and Loading Analysis, Analytical Group From Table 6" in Table 7. For example, in Table 7, the first piezometer listed under the 2018 and 2019 Piezometer group, BRW18-PZ03D, is scheduled for analytical groups 1, 2a, 3, and 8 (superscript 1) specified in Table 6. These analytical groups denote the following parameters: a water level measurement (analytical group 1); temperature, specific conductance, etc. (analytical group 2a); total recoverable and dissolved metals, total recoverable phosphate, and nitrate and nitrite (analytical group 3); and LNAPL samples (analytical group 8). Note that superscript values are specific to the table in which they are listed.

The samples will be taken following the general procedures below and SOPs in Appendix A. The selected groundwater sampling locations may be changed, increased, or decreased as determined by the Field Team Leader and CPM in consultation with the Contractor QAO. Field personnel will collect a water sample using the appropriate sampling equipment (e.g., peristaltic pump, submersible pump, or bladder pump) in conjunction with a low-flow sampling methodology approved by the Field Team Leader and CPM in consultation with the Contractor QAO. All water sampling results will be recorded in a bound field logbook.

Prior to groundwater sampling, depth-to-groundwater will be measured at each piezometer / monitoring well location in accordance with SOP-GW-03 in Appendix A. After water levels have been collected, the piezometers will be purged with the appropriate sampling equipment (e.g., peristaltic pump, submersible pump, or bladder pump; corresponding SOPs are in Appendix A) until the water quality parameters (turbidity, temperature, SC, and pH) and water level have stabilized. Water quality measurements will be collected at 3- to 5-minute intervals to monitor stabilized water quality parameters. Water quality parameters will be collected in accordance with the applicable and relevant SOPs. The piezometer will be considered stable when 3 consecutive readings for turbidity are below 5 NTUs or are within 10% of each other and the water quality parameters are stable. The water quality parameters are considered stable when 3 consecutive readings are as follows:

- Temperature range is no more than plus or minus 1 °C.
- pH varies by no more than 0.1 pH units.
- SC readings are within 3% of the average.

Once the water quality parameters stabilize, samplers will collect the groundwater sample directly from the sampling equipment and place it into appropriate sample containers. The sampling procedures will follow the applicable SOPs in Appendix A, which adhere to or expand upon the *CFRSSI SOPs* (ARCO, 1992d). Table 6 lists the detailed procedures for sample collection and handling.

4.4 Silver Bow Creek Loading Analysis

The purpose of the Silver Bow Creek loading analysis is to determine the changes in chemical concentrations and load in Silver Bow Creek from the area between SS-05B and SS-06A (Figure 2) during a representative range of seasonal groundwater and surface water conditions to guide the remedy design and implementation. The loading analysis will use a combination of manual flow measurements and radon tracing methodology to locate sub-reaches along Silver Bow Creek where impacted groundwater is upwelling and quantify the load to Silver Bow Creek.

4.4.1 Flow Measurements and Surface Water Sampling

Flow measurements and samples will occur during a representative range of seasonal surface water conditions, such as low- and high-flow conditions in Silver Bow Creek. It is anticipated that peak high groundwater loading from groundwater to surface water will occur on the declining limb of peak seasonal streamflow. These conditions will be targeted by this data collection effort, if possible. Streamflow data will be monitored as described in Section 4.3 to determine when sampling will occur. When taking flow measurements and samples, the field team will attempt to identify a day of favorable weather conditions, then start at the downstream-most sampling location and move upstream. Flow data and samples will be collected from the existing staff gage locations within Silver Bow Creek (Figure 8). Staff gages installed in the Hydraulic Control Channel (HCC) will provide water level data but will not function as sample locations for the Phase III Site Investigation, as shown in Table 7. The number and location of the staff gages may be modified as determined by the Field Team Leader and/or CPM in consultation with the Contractor QAO.

It is anticipated that the field team will be able to collect flow measurements and samples by wading. Stream flow measurements will be conducted using a cross section of the stream channel. Field personnel will use a FlowTracker2 following the SOPs in Appendix A. *Streamflow Measurement with Marsh McBirney or FlowTracker2 Flow Meter* (SOP-WFM-05) is based on the FlowTracker2 flow meter User's Manual, which states the measurement interval is dependent on width of the creek section and no interval size shall have greater than 5% of total flow.

Staff gages will be read to an accuracy of 0.01 feet before and after flow measurements are taken. The Field Team Leader will identify any change in flow over the duration of each sampling event using the nearby USGS station 12323250 or other appropriate location. The Field Team Leader will coordinate with other activities occurring in the Silver Bow Creek corridor that may affect sampling and stream flow measurement results.

The Silver Bow Creek Loading Analysis will likely consist of seven groundwater sample locations and seven surface water sample locations (indicated by superscript 4 in Table 7). The number and location of samples may be modified as determined by the Field Team Leader and/or CPM in consultation with the Contractor QAO. Groundwater and surface water samples analyzed for radon are represented by analytical group 7, listed under the "Groundwater Characterization and Loading Analysis, Analytical Group From Table 6" in Table 7. The superscript 4 in Table 7 denotes groundwater sample locations, surface water sample locations, and staff gage measurement locations to be collected within one day for the Silver Bow Creek Loading Analysis.

Samples will be collected per SOP-SW-01 in Appendix A. Samples will be collected using equal width increment (EWI) sampling technique (Atlantic Richfield Company, 2018). To use the EWI method, the sampler starts at the right edge of water (REW), collects a small portion of water into the sample container while avoiding touching the bottom of the streambed so that sediment is not stirred up during sample collection, steps towards the left side of the stream, and collects a second portion of water into the sample container. The sampler continues in this manner until the sample container is filled and the left edge of water (LEW) is reached. The field team will use common sense dividing the stream reach into equal increments.

4.4.2 Data Analysis

Data collected from specified monitoring wells and piezometers (Table 7) during the groundwater sampling (Section 4.3.2) and from the surface water sampling (Section 4.4.1) will be used to complete the loading analysis. The analysis of the data collected from the field activities will be similar to the radon tracing methodology described in the *Final Revised 2011 Blacktail Creek and Silver Bow Creek Radon Tracing and Thermal Imaging Survey Technical Memorandum* (Radon Tracing Memo) (Atlantic Richfield Company, 2016). That methodology is described below.

Estimation of Surface Water Gain using Radon Concentrations
Results from the radon analysis combined with surface water flow monitoring will help define locations where groundwater is upwelling into surface water. The relationship between surface water and groundwater is defined by the mass balance equation:

$$(Q_{us} * C_{us}) + (Q_{gw} * C_{gw}) = (Q_s * C_s) \qquad \text{(Equation 1)}$$

Where:
Q_{us} = Flow rate of stream at upstream sample location in cubic feet per second (cfs)
C_{us} = Concentration of radon at upstream sample location in picocurie per liter (pCi/L)
Q_{gw} = Groundwater inflow or gain (cfs)
C_{gw} = Concentration of radon in groundwater (pCi/L)
Q_s = Flow rate of stream at sample location (cfs)
C_s = Concentration of radon at sample location (pCi/L)

With stream flow and radon measurements known, the groundwater discharge between two locations in the stream is determined by rewriting Equation 1:

$$Q_{gw} = \frac{(Q_s * C_s) - (Q_{us} * C_{us})}{C_{gw}} \qquad \text{(Equation 2)}$$

It is necessary to use only the upstream discharge measurement of flow (Q_{us}) in the calculation to determine the total flow downstream rather than the measured flow downstream in case there is both a loss and a gain in the stream reach. This is accomplished by substituting for Q_s in Equation 2 using the following:

$$Q_s = Q_{us} + Q_{gw} \qquad \text{(Equation 3)}$$

Using the product from Equation 3 and substituting it back into Equation 2, the resulting equation through algebraic manipulation becomes:

$$Q_{gw} = Q_{us} * \frac{(C_s - C_{us})}{(C_{gw} - C_s)} \qquad \text{(Equation 4)}$$

Equation 4 allows calculation of the total groundwater discharged into a specific surface water reach. To account for the natural off-gassing of radon, each downgradient station will be adjusted individually using the procedures and results in the Radon Tracing Memo (Atlantic Richfield Company, 2016).

This methodology will be adjusted as needed to meet the requirements of the Site.

4.5 Silver Bow Creek Sediment Sampling

Two Silver Bow Creek locations will be sampled as part of the Silver Bow Creek Sediment Sampling (sediment sampling) component of the Phase III Site Investigation (Figure 4). The purpose of the sediment sampling is to determine sediment particle size distribution. Sediment particle size distribution will be analyzed at Pioneer's Materials Testing Laboratory (Analytical Group 14 from Table 6). The stream sediment sample particle size distribution will guide calculations to determine the sediment transport capacity through the Site and assist in the design of the realigned Silver Bow Creek and 100-year floodplain.

Stream sediment sampling will be conducted according to all relevant and applicable SOPs in Appendix A, particularly SOP-S-03. The field team will attempt to identify a day of favorable weather conditions to collect sediment samples. Sediment samples will be collected from the locations within Silver Bow Creek as indicated on Figure 4, and enough sample volume will be collected to adequately characterize the sediment at each location. It is anticipated that the field team will be able to collect stream sediment samples by wading and using a clean shovel. Sediment samples will be collected and placed directly into clean 5-gallon buckets. Sample location, depth, and range will be determined in the field using professional judgement based on field conditions. Sampling methods will be adjusted as needed to meet the requirements of the particle size distribution analysis (ASTM D6913).

Sample locations will be recorded with the GPS. All relevant observations will be recorded in a field logbook if applicable. Sediment samples will be transported directly to Pioneer's Materials Testing Laboratory for analysis. Pioneer's Materials Testing Laboratory will analyze the sediment samples as detailed in Table 6 (Analytical Group 14) and Section 4.6.

The number and general location of the sediment sampling may be modified as determined by the Field Team Leader and/or CPM in consultation with the Contractor Quality Assurance Officer (QAO) (Section 7.0).

4.6 Standard Operating Procedures

This BRW Phase III QAPP includes SOPs that apply to particular field activities, and the SOPs are referenced in the appropriate sections throughout this report and are included in Appendix A. Depending on circumstances and needs, it may not be possible or appropriate to follow the SOPs exactly in all situations due to Site conditions, equipment limitations, and limitations of the standard procedures. When necessary to perform an activity that does not have a specific SOP, or when the SOP cannot be followed, existing SOPs may be used as a general guidance or similar SOPs (not listed in this report) may be adopted if they meet the project DQOs. All modifications or adoptions will be approved by the Field Team Leader, CPM, and Contractor QAO and documented in the field logbook and/or the final project report, as appropriate.

4.7 Documents and Records

4.7.1 Sample Labeling and Identification

Soil Samples

A sample number system will be used to uniquely identify the project site, the sample medium, and the specific sample location and depth interval. The sample identification number will be derived from the borehole number with the Site Name followed by the sample interval enclosed in parentheses. For example, a sample designated BRW21-BH32(1.6-3.1) describes a sample from borehole BRW21-BH32 taken from a depth of 1.6-3.1 feet below existing grade. All measurements will be decimal feet. There will be no blank spaces permitted in the identification. The following is an example of the sample numbering system:

Sample Number: **BRW21-BH02(1.6-3.1)-04192021**

Location/Year:	*"BRW21"* - BRW project area, installed in 2021.
Type:	*"BH"* – Borehole *"PZ"* – Piezometer *"SBC"* – Silver Bow Creek
Location/Number:	*"02"* - Sample Location (corresponds with Borehole ID No.). All sample locations will be plotted on the sampling maps.
Depth Interval:	*"(1.6-3.1)"* (upper limit-lower limit). If sample is a duplicate, label the interval "T." Do not use specific intervals. Intervals and duplicates will be recorded in the field log or logbook.
Date:	*"04192021"* - sample collected on April 19, 2021.

For field duplicates, the depth interval will be replaced by "(T)." For example, a duplicate of BRW21-BH02(1.6-3.1)-04192021 would be BRW21-BH02(T)-04192021. Field duplicate samples will be recorded in the log or logbook, and the primary sample will be clearly indicated.

All subsample locations and depths will be described in the data log. All samples will be labeled in the field with documentation of the date and time of sample collection, the sample number, sample container type, analyses requested, and the sampler's initials. A permanent marker will be used for labeling.

All soil samples will be collected in the proper sample container. The sample ID, date, and depth interval of the sample will be written on the sample container with an indelible marker. Samples will be stored, handled, and packaged as described in Section 4.7.3 and Table 6. A copy of the chain of custody record will accompany the samples during shipment and will serve as the laboratory request form. The chain of custody form will specify the type of analysis requested for each individual sample. The original form will be maintained with the field notes and in the project records.

Groundwater and Surface Water Samples
As with soil sampling, a sample number system will be used to uniquely identify the project site, the sample type, and the specific sample location. The following is an example of the sample numbering system:

Sample Number: **BRW21-PZ02T-04192021**

Location/Year:	*"BRW21"* - BRW project area, installed or recorded in 2021. For groundwater samples, the location/year label *"BRW21"* refers to piezometers installed in 2021. For surface water samples, the location/year label *"BRW21"* refers to a 2021 sampling event.
Type:	"*PZ*" – Piezometer
Location/Number:	"*02*" – Piezometer location.
Duplicates:	"T" – Duplicates or "Twin" samples will be recorded on the field log or logbook.
Date:	*"04192021"* - sample collected on April 19, 2021.

All samples will be labeled in the field with documentation of the date and time of sample collection, the sample number, sample container type, analyses requested, and the sampler's initials. A permanent marker will be used for labeling. All groundwater and surface water samples will be collected in the appropriate sample container, with preservative in place from the laboratory (if necessary). Samples will be taken or shipped to the identified laboratory for analyses. Samples will be stored, handled, and packaged as described in Section 4.7.3 and Table 6. A copy of the chain of custody record will accompany the samples during shipment and will serve as the laboratory request form. A chain of custody form will be completed that specifies the type of analysis requested for each individual sample. The original form will be maintained with the field notes and in the project records.

4.7.2 Field Documentation

4.7.2.1 Field Logbook

To provide a permanent record of all field activities, field personnel will document all activities in a bound field logbook (refer to field SOPs in Appendix A). This will include a description of conditions during sampling activities. When field logbooks are used, each logbook will have a unique document control number, be bound, and have consecutively numbered pages. All entries will be in waterproof ink, and any mistakes will be lined out with a single line and initialed by the person making the correction. Whenever a sample is collected or a measurement is made, a detailed description of the sample location and any additional observations will be recorded. The GPS coordinates will be recorded when appropriate. Individual field team members may be responsible for required documentation based on specific tasks assigned by the Field Team Leader or CPM.

All significant observations, measurements, relevant data, and results will be clearly documented in the data log or the field logbook. At a minimum, the following will be recorded:

- A description of the field task.
- Time and date fieldwork started.
- Location and description of the work area including sketches if possible, map references, and references to photographs collected.
- Names and titles of field personnel.
- Name, address, and phone number of any field contacts or Site visitors (e.g., Agency representatives, auditors, etc.).
- Meteorological conditions at the beginning of fieldwork and any ensuing changes in the weather conditions.
- Details of the fieldwork performed and the field data sheets used.
- All field measurements made.
- Any field analysis results.
- Personnel and equipment decontamination procedures.
- Deviations from the BRW Phase III QAPP or applicable field SOPs (Appendix A).

For boreholes, the following entries will be made:

- Lithologic log of the boring indicating material types, from and to depths, rock content, color, presence of water, etc.
- Depth intervals from the ground surface for each soil horizon and total depth of the boring.
- Photograph or video of each boring with a staff gage or tape measure for scale to document existing conditions. Include Site name ID in photograph using a white board or note pad.
- Abnormal occurrences, deviations from the BRW Phase III QAPP, or other relevant observations.

For any field sampling work the following entries will be made:

- Sample location and ID number.
- Sample type collected.

- Date and time of sample collection.
- Sample location descriptions and designations, soil type and texture (e.g., sand, silt, etc.), grain-size, and color (in the field). Further sample information will be included with the laboratory results.
- Split samples taken by other parties (note the type of sample, sample location, time/date, name of individual, individual's company, and any other pertinent information).
- Sampling method, particularly any deviations from the field SOPs (Appendix A).
- 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).
- Sample preservation (if used).
- Decontamination procedure (if used).
- Sample custody.

The lithologic information for boreholes will be transcribed into a spreadsheet or database that can be used with Strater® or other appropriate lithologic log software.

4.7.2.2 Field Photographs

Photographs will be taken of sampling locations and field activities using a digital camera. When practical, photographs should include a scale in the picture as well as a white board with relevant information (e.g., time, date, location, sample number, etc.). Additional photographs documenting Site conditions will be taken, as necessary. Documentation of all photographs taken during sampling activities will be recorded in the bound field logbook or appropriate field data sheets (refer to field SOPs in Appendix A), and will specifically include the following for each photograph taken:

- Time, date, and location.
- Photograph or video number from the camera or video recorder.
- The identity of the person taking the photograph/video.
- Direction that the photograph was taken and description of the subject photographed.

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

4.7.3 Sample Handling, Documentation, and Shipping

As applicable, samples will be either hand delivered or shipped via Federal Express or UPS to the appropriate laboratory under strict EPA chain of custody procedures. Samples will be shipped in appropriate containers that will prevent detrimental effects to the sample.

Sample containers and holding times are listed in Table 6. All procedures will strictly follow appropriate protocols and field SOPs in Appendix A. Chain of custody records will be kept with the samples and custody seals will be placed on the sample storage containers (coolers).

All samples not submitted to the laboratory will be archived. When it is determined that the samples are no longer needed, they will be disposed of at the Mine Waste Repository.

4.7.4 Chain of Custody

The SOP for chain of custody (SOP-SA-04) is in Appendix A. Maintaining the integrity of the sample from collection through data reporting is critical to the sampling and analytical program. This process includes the ability to trace the possession and handling of samples from the time of collection through analysis and final disposition. This documentation of the sample's history is referred to as chain of custody. A sample is considered to be under an individual's custody if it is in that individual's physical possession, in view of the individual after taking possession, or secured by that individual so that no one can tamper with the sample.

The components of the field chain of custody (chain of custody form, labels, and custody seals) and laboratory chain of custody (chain of custody form, custody seals, and laboratory custody) are described in this section.

4.7.4.1 Chain of Custody Form

A chain of custody form will be completed and will accompany samples as appropriate. A standard form will be provided from each laboratory. The form will include the following information:

- Project code.
- Project name.
- Sampler’s signature.
- Sample identification.
- Date sampled.
- Time sampled.
- Analysis requested.
- Remarks.
- Relinquishing signature, data, and time.
- Receiving signature, date, and time.

4.7.4.2 Custody Seals

Custody seals are used to detect unauthorized tampering with samples following sample collection up to the time of analysis. Custody seals will be applied to the shipping containers when the samples are not in the sampler's custody.

4.7.4.3 Laboratory Custody

Laboratory custody procedures will generally conform to procedures established for the EPA Contract Laboratory Program (CLP) Statement of Work (SOW) for Superfund Analytical Methods SFAM01.1 (EPA, 2020a). These procedures include the following:

- Designation of sample custodian.
- Correct completion of the chain of custody form, recording of sample identification numbers, and documentation of sample condition upon receipt.
- Laboratory sample tracking and documentation procedures.
- Secure sample storage.

The samples will be delivered to the laboratory for analysis in a timely manner to ensure the requested analyses can be performed within the specified allowable holding times. The sample will be hand delivered or addressed to a person in the laboratory who is authorized to receive samples (laboratory sample custodian).

4.8 Field Analysis Methods

This section describes field analysis methods, including XRF analysis and PID screening.

4.8.1 XRF Analysis

Field XRF Analysis

Field XRF analysis will be used mainly as a guide to estimate the first lithological layer in each boring which passes the Waste Identification Screening Criteria (EPA, 2020a) and to identify materials from borings that are to be submitted to the laboratory for SPLP (Section 4.2), and as deemed necessary based on field observations.

The XRF analysis will be conducted using a Niton™ XL3 XRF Analyzer (XL3) and following the procedures outlined in SOP-SFM-02 in Appendix A as well as the XL3 user manual to ensure that the techniques employed are appropriate for the analytes of interest. Samples will be collected in a ziplock bag and mixed. Samples will be dried if conditions require and are deemed necessary by field personnel. If a portable heater or oven is used to dry samples, the sample will be dried while maintaining a temperature that does not exceed the boiling point of water (100 °C).

Official XRF Analysis

Limited XRF analysis will be conducted in the event a lithological layer is too thin and there is not enough soil to fulfill the required sample volume required for laboratory metals analysis. In this instance, a sample will be collected and prepped for XRF analysis at Pioneer's field office at 244 Anaconda Road in Butte, Montana, after sampling activities have finished.

The XRF analysis will be conducted using a XL3 and following the procedures outlined in SOP-SFM-02 in Appendix A as well as the XL3 user manual to ensure that the techniques employed are appropriate for the analytes of interest. Prior to completing analysis with the XRF, any large aggregate will be removed from the sample. For gravel or rocky soil, a sieve may be used to remove the large aggregates. Samples will be dried prior to analysis. Samples will be collected in a ziplock bag and mixed. The samples will then be placed in a small plastic cup with a mylar film cover for analysis.

4.8.2 PID Screening Analysis

Screening for hydrocarbon compounds will be conducted using two PIDs, one with a 9.8 eV lamp and another with a 10.6 eV lamp. The procedures for using the PID unit are summarized below and additional detail is included in applicable user manuals It is anticipated that a MiniRae 3000 unit and a UltraRAE 3000+ unit will be used, or equivalent.

Initially, the PIDs will be used to detect hydrocarbon compounds from soil with visual evidence of soil staining or if an odor is detected. A slow sweeping motion will be used to detect hydrocarbon compounds with the PID for soil from borehole cores, immediately after they are split.

Once it has been determined that volatile petroleum hydrocarbon (VPH) might be present, a combustible gas meter will be used to monitor the atmosphere for hazardous conditions. The combustible gas meter will be mounted on or near the drill rig to monitor conditions near the drill hole. If hazardous conditions are present, appropriate action will be taken by safety personnel.

If hazardous conditions are not present, a portion of the sample will immediately be collected in the appropriate sample container (Table 6) and the remainder placed in a ziplock bag with air space at the top above the sample (headspace) to allow testing using the headspace screening method. For the headspace screening method, the sample is brought to room temperature, the sample is mixed or shaken depending on soil type to allow the contaminants to volatilize, and then the PID probe is inserted into the bag and the headspace concentration is measured and recorded.

4.9 Laboratory Analysis Methods

The anticipated laboratory analytical methods to be used are detailed below. Laboratory analysis of samples collected during the course of this study will be performed by laboratories with established protocols and quality assurance (QA) procedures that meet or exceed EPA guidelines. EPA-approved methods will be used for all applicable equipment (refer to Table 6). Standard laboratory turnaround times will be requested.

4.9.1 Total Metals

Samples collected from boreholes will be sent for laboratory metals analysis analyzed by ICP-MS. Table 6 includes the analyte list and a description of the analytical technique. The ICP-MS laboratory sample results will be used to better determine the total mass of COCs and other constituents currently present within waste materials and the alluvial aquifer system at the Site.

4.9.2 Hydrocarbon Compounds

Soil that appears to contain hydrocarbon compounds (via sight and/or smell or detection with a PID) may be analyzed for VPH, extractable petroleum hydrocarbon (EPH) fractionation with polycyclic aromatic hydrocarbons (PAH), and lead scavengers (Table 6). All visual and olfactory observations of suspected hydrocarbon compounds will be confirmed with a PID prior to collecting a sample.

4.9.3 LNAPL Samples

If the interface probe indicates there is an LNAPL layer on the surface of the groundwater, a sample will be collected. If an LNAPL layer is present, a pure LNAPL sample will be collected, if possible. If a pure sample is not possible, a mixed sample of LNAPL and groundwater will be collected. The analytical procedures and proper preservation methods are detailed in Table 6.

4.9.4 Groundwater Analysis

Groundwater samples will be collected at the locations listed in Table 7 and analyzed for analytes specified in Table 6. The "Analytical Group" values (1 through 8 for groundwater and surface water) of the first column in Table 6 correspond to the values listed for each location under the column heading "Groundwater Characterization and Loading Analysis, Analytical Group From Table 6" in Table 7. The analytical procedures for these analytes are identified in Table 6. Note that superscript values are specific to the table in which they are listed. Low-flow sampling parameters will be used to estimate the hydraulic conductivity of the screened aquifer interval (Robbins et al., 2009).

4.9.5 Geotechnical Samples

Geotechnical samples will be analyzed for the parameters specified in Table 6 and Table 7. These samples will be sent to Pioneer's Material Testing Laboratories for analysis.

4.9.6 SPLP Samples

The BRW soil and slag samples will be collected and analyzed for parameters specified in Table 6, Analytical Group 13. Table 6 includes the analyte list and a description of the analytical technique. The sample results will be used to evaluate the leachability of *in-situ* waste at BRW and refine the Leapfrog model waste removal boundary to target materials with a higher potential to leach metals and impact groundwater quality, which will potentially reduce the volume of groundwater within the Site that must be hydraulically controlled per the BPSOU CD.

4.9.7 Silver Bow Creek Sediment Samples

Sediment samples will be analyzed for particle size distribution as detailed in Table 6, Analytical Group 14. These samples will be sent to Pioneer's Material Testing Laboratories for analysis.

4.10 Quality Assurance/Quality Control Samples

4.10.1 Field Quality Control Samples

Field QC samples are used to identify any biases from transportation, storage, and field handling processes during sample collection and to determine sampling precision. All field QC samples will be shipped with field samples to the laboratory per SOP-SA-01 in Appendix A. Brief descriptions of the field QC samples are below along with when and how many are to be collected.

Field Duplicate

Field duplicates will be collected for the soil, groundwater, and surface water sampling. A field duplicate is an identical, second sample collected from the same location, in immediate succession of the primary sample, using identical techniques. This applies to all surface water, groundwater, and soil sampling procedures including instream grab samples, pumps, and other water sampling devices. The duplicate sample will have its own sample number. Duplicate samples will be sealed, handled, stored, shipped, and analyzed in the same manner as the primary sample. Both the primary sample and duplicate sample will be analyzed for identical chemical parameters by the laboratory. The analytical results of the primary and duplicate sample will be compared to determine sampling precision. Field duplicate samples will be collected at a frequency of at least 1 per 20 samples (5%) (for all soil, groundwater, and surface water samples) or once per sampling event, whichever is more frequent.

Equipment, Cross Contamination, or Rinsate Blank

Equipment contamination blanks will be collected for the groundwater sampling effort. No equipment contamination blanks will be collected for the core collection sampling effort or for surface water sampling. All soil and surface water sampling equipment is anticipated to be *one-time use*. The drilling augers, casing, drill rods, and samplers will be properly decontaminated between boreholes. Therefore, no equipment, cross contamination, or rinsate blank samples will be submitted for soil or surface water sampling unless the equipment must be decontaminated and used between samples.

If equipment, cross contamination, or rinsate blank samples are necessary, they will be collected after sampling equipment is decontaminated or prior to sampling activities. An equipment blank is prepared by running distilled, DI, or analyte-free water through or over the cleaned, decontaminated sampling equipment; gathering the water in a sample collection bottle; and adding the appropriate chemical preservatives. Analysis on the equipment blanks will assess the adequacy of the decontamination process as well as the potential contamination of samples by the containers, preservatives, and filters. The appropriate sample number will be placed on the collection bottle and recorded in the project logbook as an equipment blank. The equipment blank will be analyzed for identical chemical parameters by the laboratory as a natural sample collected from the equipment. A minimum of 1 equipment blank is required for every 20 natural samples collected.

Field Blank
Field blanks will be collected for the groundwater and surface water sampling effort. A field blank is a sample bottle containing DI or analyte-free water and appropriate preservatives and is prepared in the field. A sample bottle is randomly chosen from bottles received by the contract laboratory or supplier, and DI or analyte-free water is poured directly into the sample bottle while in the field and the bottle is preserved and shipped to the laboratory with the field samples. Field blanks must be prepared in the field and help evaluate the potential for possible contamination from the sampling environment. The field blank will have its own unique sample number and will be recorded in the project logbook as a field blank or bottle blank. Field blanks will be prepared at a frequency of at least 1 field blank per 20 natural samples collected.

Temperature Blank
A temperature blank is a vial of water that accompanies the samples that will be opened and tested upon arrival at the laboratory to ensure that the temperature of the shipping container was less than 6 °C. One temperature blank is required for each cooler shipped to the laboratory.

Trip Blank
One trip blank is required per sampling event when volatile organic compound (VOC) samples are collected. Trip blanks are used to determine if samples were contaminated during storage and/or transportation back to the laboratory. A trip blank is only required for VOC sampling. A trip blank is prepared for field personnel by the contract laboratory staff prior to the sampling event and is shipped and stored in the same cooler with the investigative VOC samples throughout the sampling event. At no time after their preparation are trip blanks to be opened before they reach the laboratory. Trip blanks should be kept on ice in the cooler, along with the VOC samples during the entire sampling run. They must be stored in an iced cooler from the time of collection, while they are in the sampling vehicle, until they arrive at the laboratory.

4.10.2 XRF Quality Control Samples

The XRF QC samples will be collected and used to assess the accuracy and precision of the XRF data. The XRF QC samples required are described below.

Energy Calibration Check
Field personnel will run a preprogrammed energy calibration check on the equipment at the beginning of each working day. If the individual believes that drift is occurring during analysis, that individual will run the energy calibration check. The energy calibration check determines whether the characteristic X-ray lines are shifting, which would indicate drift within the instrument.

Silicon Dioxide Standard
The silicon dioxide (SiO2) sample, as provided by Niton, is a "clean" quartz or silicon dioxide matrix that contains concentrations of selected analytes near or below the machine's lower limit of detection. These samples are used to monitor for cross contamination. Field personnel will analyze this sample at the beginning of each day, once per every 20 samples, and at the end of each day's analysis. The sample information will be recorded as "SIO2" on XRF field data sheets. This sample will also be analyzed whenever field personnel suspect contamination of the

XRF aperture. Any elements with concentrations above the established lower limit of detection will be evaluated for potential contamination. If it is determined that the concentration is higher than that recorded at the start of the day, the probe window and the silicon dioxide sample will be checked for contamination. If it is determined that contamination is not a problem, and the concentration is significantly above the limit of detection, the sample result will be qualified by the XRF operator as ‘J’ estimated, and the problem recorded on the XRF field data sheet and in the logbook. If the problem persists, the XRF will be returned to Niton for calibration.

Calibration Verification Check Samples (Standards)

Calibration verification check samples help check the accuracy of the XL3 and assess the stability and consistency of the analysis for the analytes of interest. One to 3 (preferably) of the check samples will be analyzed at the start of each day, once per every 20 samples, and as the last analysis. Results for the check sample (standard reference material [SRM]) will be recorded on the individual XRF field data sheets and identified as a check sample. There are 3 Niton-provided SRM check samples: NIST 2709a- Joaquin Soil (2709), USGS SdAR-M2 (SRM created by the USGS), and a Resource Conservation and Recovery Act (RCRA) sample. There are also Niton-provided, machine-specific expected results for several elements for the check samples. Pioneer has refined the range of expected results for each SRM standard for each of the field XRF units in use. The measured values of a standard will be compared to the expected results. If a measured value falls outside this range, then the check sample will be reanalyzed. If the value continues to fall outside the acceptance range, this information will be noted on the XRF log. If any of the check sample results indicate that the XRF is not analyzing accurately, the XRF will be cleaned, turned off, and the energy calibration rerun. This information will be noted in the logbook and on the XRF field data sheet. The batch of samples analyzed prior to the unacceptable calibration verification check samples will be reanalyzed. If 1 standard continues to be outside of the expected range, it may indicate that the standard has been contaminated and needs replacing. If more than 1 standard is falling outside of the expected range, Niton will be contacted and the machine may be returned for calibration.

Duplicate Samples

The XRF duplicate samples will be analyzed to assess reproducibility of field procedures and soil heterogeneity. To run an XRF duplicate sample on the Niton XL3, field personnel will remove the sample cup/ziplock from the analytical stand, knead the ziplock bag once or twice/rotate the sample cup, and replace it in the stand to be analyzed a second time. XRF duplicate samples will be recorded on the XRF field data form with a D designator in the sample identification number. A XRF duplicate sample will be analyzed at the rate of at least 1 per 20 natural samples.

Replicate Samples

Field personnel will analyze an XRF replicate sample at the rate of at least 1 per 20 XRF samples. To run a XRF replicate sample on the Niton XL3, once the primary sample analysis has been completed, the XRF is restarted to analyze the same sample a second time with the same soil in the XRF aperture. XRF replicate samples help in assessing the stability and consistency of the XRF analysis. XRF replicate sample results will be recorded on the XRF field data form and designated with an R in the sample identification number.

4.10.3 Laboratory Quality Control Samples

Laboratory QC samples are introduced into the measurement process to evaluate laboratory performance and sample measurement bias. Laboratory QC samples can be prepared from environmental samples or generated from standard materials in the laboratory per the internal laboratory SOPs. Standard laboratory QC sample information is listed below.

Method Blank

The method blank (MB) samples will be prepared and analyzed for every 20 samples analyzed. The MB is laboratory DI water that has gone through the applicable sample preparation and analysis procedure. Control limits vary based on the laboratory method performed (Table 6) and are contained in the applicable laboratory method and SOP. Failure will trigger corrective action and the blanks will be reanalyzed. All samples affected will be footnoted with the appropriate flag to document contamination in the blank.

Laboratory Control Sample

The LCS will be prepared and analyzed for every 20 samples analyzed. Control limits vary based on the laboratory method performed (Table 6) and are contained in the applicable laboratory method and SOP. Failure will trigger corrective action and the analysis will be terminated, the problem corrected, and the samples associated with that LCS reanalyzed. If reanalysis of the samples fails, the samples affected by the failing LCS elements need to be re-digested and reanalyzed.

Matrix Spike/Matrix Spike Duplicate

The matrix spike (MS) and matrix spike duplicate (MSD) samples will be prepared and analyzed at different frequencies based on the laboratory method performed. The control limits also depend on the method used (Table 6) and are contained in the applicable laboratory method and SOP. If the %R for the MS and MSD falls outside the control limits, the results are flagged as outside acceptance criteria along with the parent sample. If the RPD exceeds the acceptance criteria, the MSD sample and associated parent sample will be flagged.

Post Digestion Spike

Post digestion spikes (PDS) will be prepared and analyzed at different frequencies based on the laboratory method performed. The control limits also depend on the method used (Table 6) and are contained in the applicable laboratory method and SOP.

Laboratory Duplicate Sample

The laboratory duplicate sample (LDS) will be prepared and analyzed for every 20 samples analyzed. An LCS and laboratory control sample duplicate (LCSD) pair or an MS and MSD sample pair may be used as the LDS. Control limits will vary based on the QC sample used. Failure will trigger corrective action and a single reanalysis of the respective failing QC sample is allowed. If the reanalysis is outside the acceptance criteria, the analysis must be terminated, the problem corrected, the instrument recalibrated, and the calibration re-verified.

4.11 Instrument/Equipment Testing, Inspection, Maintenance and Calibration

To ensure continual quality performance of all instruments and equipment, testing, inspection, and maintenance will be performed and recorded as described in this section. All field and laboratory equipment will be operated, maintained, calibrated, and standardized in accordance with all EPA and manufacturer's recommended procedures.

4.11.1 Field Equipment

Field equipment will be examined to verify that it is in proper operating order prior to its first use. Equipment, instruments, tools, gages, and other items requiring preventative maintenance will be serviced and/or calibrated in accordance with the manufacturer’s specified recommendations, as necessary. Field equipment will be cleaned (decontaminated) and safely stored between each use. Any routine maintenance recommended by the equipment manufacturer will also be performed and documented in field logbooks. Calibration of field equipment will be completed in the field at the beginning of each day and recorded in the field logbooks. Any equipment deficiencies or malfunctions during fieldwork will be recorded as appropriate in the field logbooks. The SOPs for the field equipment are in Appendix A.

Groundwater Meter - Multi-Parameter Probe
The multi-parameter probe will be used to record parameters during purging to ensure field measurements have stabilized as defined in previous sections and in the field equipment SOPs (Appendix A). To accommodate field meters, discharge from the sampling pump will be directed through a flow-through cell for the multi-parameter probe so that parameters can be measured until stabilized. Once parameters have stabilized, the flow-through cell will be disconnected and samples for field and laboratory analysis will be collected directly from the tubing. This will ensure that the tubing has acclimated to the water chemistry and the water being sampled is represented by the stabilized field parameters.

Modern Water RaPID Assay PCP Screening Kit
If available, the PCP screening kit will be used to identify any pre-existing concentrations of PCPs in the Phase III Piezometers. Samples will be collected while analyzing the physiochemical properties of the groundwater. The samples will be analyzed following the procedures in the user manual. Due to limitations regarding the manufacturing of the PCP screening kit (i.e., extended lead time required and limited production due to Covid-19 pandemic), the PCP screening kit may not be available for use for the Phase III Site Investigation. Since all locations where the PCP screening kit is intended to be used will also have samples collected for PCP laboratory analysis, the DQOs for the project will not be affected if the PCP screening kit is unavailable.

XRF Unit
The XRF analysis will be conducted using a Niton™ XL3 XRF Analyzer (XL3) and following the procedures outlined in SOP-SFM-02 in Appendix A as well as the XL3 user manual to ensure that the techniques employed are appropriate for the analytes of interest. Additional details on the operation of the XRF are included in Section 4.8.1.

PID Unit
Screening for hydrocarbon compounds will be conducted using two PIDs, one with a 9.8 eV lamp and another with a 10.6 eV lamp. The procedures for using the PID unit are included in Section 4.8.2 as well as in the applicable user manual. It is anticipated that a MiniRae 3000 unit and an UltraRAE 3000+ unit will be used, or equivalent.

Transducers
Transducers will be installed and programmed in accordance with SOP-GW-15 in Appendix A. Transducers will be maintained per manufacture specifications. Table 7 provides the specific details including the locations where transducers will be installed.

The following data screening steps will be taken to ensure the water level measuring device data accurately represents field conditions.

> **Compensation:** Raw water level data will be barometrically compensated and manually adjusted in a Microsoft Excel spreadsheet to match acceptable manual water level measurements recorded in the field notes. The compensated data will then be downloaded into the project database and plotted and analyzed for abnormalities (e.g., spikes, drops, inconsistencies, fluctuations, etc.).
>
> **Comparison:**
> a. To justify atypical water level fluctuations, water level data will be compared to precipitation events at Bert Mooney Airport in Butte, Montana.
> b. Trends in water levels will also be compared between nearby monitoring wells and piezometers.
> c. Any discrepancies will be flagged in the data.

4.11.2 Lab Equipment

Instruments used by the laboratory will be maintained in accordance with the laboratory QA plan requirements and analytical method requirements. All analytical measurement instruments and equipment used by the laboratory will be controlled by a formal calibration and preventive maintenance program. The laboratory will keep maintenance records and make them available for review, if requested. Laboratory preventive maintenance will include routine equipment inspection and calibration at the beginning of each day or each analytical batch, per the laboratory internal SOPs and method requirements.

4.12 Inspection/Acceptance of Supplies and Consumables

All supplies and consumables received for the project (e.g., sampling equipment, calibration standards, etc.) will be checked to ensure their condition is satisfactory, such as free of defects that would affect performance. The types of equipment needed to complete sampling activities are described in the relevant field SOPs (Appendix A). 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 inspecting laboratory supplies in accordance with the laboratory QA program.

4.13 Data Management Procedures

This section describes how the data for the project will be managed, including field and laboratory data. Data will be managed in accordance with the *BPSOU Data Management Plan* (Atlantic Richfield Company, 2017).

The BRW Phase III QAPP quality records will be maintained by Atlantic Richfield Company. These records, in either electronic or hard copy form, may include the following:

- Project work plans with any approved modifications, updates, and addenda.
- Project QAPP with any approved modifications, updates, addenda, and any approved corrective or preventative actions.
- Field documentation (including logbooks, data sheets, and photographs) in accordance with SOP-SA-05 in Appendix A.
- Chain of custody records in accordance with SOP-SA-04 in Appendix A.
- Field forms, which are provided in Appendix B.
- Laboratory documentation (results received from the laboratory will be documented in hard copy and in an electronic format).
- PDI Evaluation Report.

Hard copy field and laboratory records will be maintained in the project's central data file, where original field and laboratory documents are filed chronologically for future reference. These records will also be scanned to produce electronic copies. The electronic versions of these records will be maintained on a central Microsoft structured query language (SQL) server system that is backed up regularly. The data will be stored on the SQL server and a Microsoft Access database will be set up to access the data, which can then be exported to Excel, if necessary, for further graphing and interpretive analysis. Using a Microsoft-based software configuration is widely accepted with support from Microsoft and allows for easy data sharing with most hardware configurations.

All field and laboratory data and supporting documentation will be subject to appropriate review to ensure the accuracy and completeness of original data records prior to uploading into the project database. Field data that have been reviewed and approved in a hard copy format will be entered into an electronic system to be uploaded to the project database. Laboratory electronic data deliverables (EDDs) provided in Microsoft Excel format and correlating PDF full data packages will be reviewed as part of the internal data review process. Following these review steps, field and laboratory electronic data files will be imported to the project database.

Standardized data import formats and procedures will be used to upload both field and laboratory data into the electronic database. Standardized parameter names, numerical formats, and units of measure will be applied to the original information to facilitate comparability across all data sets and within the database. Using these standardized formats will allow for quick and easy querying to retrieve data. Data can be retrieved by exporting into an Excel file and, because the data will be formatted with parameter names, easily made into a pivot table for data processing.

5.0 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 BRW Phase III QAPP. The audits of field and laboratory activities include two independent parts: internal and external audits. Internal audits will be performed by Atlantic Richfield, their contractor, or a contracted laboratory consultant, as necessary. External audits will be performed by EPA, as necessary. Performance and systems audits of field and laboratory data collection and reporting procedures are described in this section.

5.1 Field Activities Oversight

Oversight personnel will have the ability to inspect each soil boring and determine the appropriateness of the recorded data and ensure that the appropriate samples are collected. Copies of field logbook pages will be provided to oversight personnel as part of the PDI Evaluation Report.

Any deviations from this BRW Phase III QAPP will be brought to the attention of oversight personnel. If the deviation is first determined by oversight personnel, Atlantic Richfield and/or field representatives will be immediately notified. Reasons for such deviations will be recorded in the field logbook along with corrective actions to be implemented, if required. If oversight personnel request a deviation from the BRW Phase III QAPP, the deviation and the reasons for the deviation will be noted and then signed by the agency personnel.

5.2 Corrective Action Procedures

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.

Non-conforming 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. For the BRW Phase III QAPP, a non-conformance 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 actions implemented by field personnel will follow appropriate field SOPs (Appendix A), as necessary.

Corrective action in the laboratory may occur prior to, during, and after initial analyses. A number of conditions such as broken sample containers, preservation or holding-time issues, and potentially high-concentration samples may be identified during sample log in or just prior to analyses. Corrective actions to address these conditions will be taken in consultation with the CPM (Section 7.0) and reported on a Corrective Action Report (CAR) form included in

Appendix D, as necessary. In the event that 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.

If during sample analyses, the associated laboratory QC results fall outside of the project's performance criteria, the laboratory should initiate corrective actions immediately. If laboratory QC results are outside of the project specifications, the laboratory should take the appropriate corrective actions for the specific analytical method. Following consultation with laboratory analysts and section leaders, it may be necessary for the CPM to approve implementing a corrective action. These conditions may include dilution of samples, additional sample extract cleanup, or automatic reanalysis when certain QC criteria are not met. If the laboratory cannot correct the situation that caused the non-conformance and an out-of-control situation continues to occur or is expected to occur, then the laboratory will immediately contact the CPM 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 CPM and Field Team Leader in consultation with the Contractor QAO to assess whether reanalysis 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 Field Team Leader and CPM. In the event that 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 with the QAPP records.

5.3 Corrective Action During Data Assessment

During data assessment, the Contractor QAO could identify the need for corrective action. Potential types of corrective action include re-sampling by the field team, reanalyzing samples by the laboratory, or resubmitting full data packages with corrected clerical errors. The appropriate and feasible corrective actions will depend on the ability to mobilize the field team and whether the data to be collected are 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, EPA will be consulted and concurrence will be obtained before the change is implemented. Corrective actions of this type will be documented by the Contractor QAO on a CAR and will be included in any subsequent reports.

5.4 Quality Assurance Reports to Management

After the investigation is complete, the Atlantic Richfield contractor will incorporate the results into the BRW PDI Evaluation Report summarizing and interpreting the sampling activities. The report will include the following:

- Summary of the investigations performed.

- Summary of investigation results.
- Summary of validated data (i.e., tables and graphics).
- Data validation reports and laboratory data reports.
- Narrative interpretation of data and results.
- Results of statistical and modeling analyses.
- Photographs documenting the work conducted.
- Conclusions and recommendations for RD, including design parameters and criteria.
- Recommendations for an additional phase(s) (if necessary).

The CPM and Contractor QAO are responsible for preparing the PDI Evaluation Report. All Site investigations will be incorporated into the report as the design progresses, and the report will be submitted in draft final form to EPA and Montana DEQ for review approximately 30 days prior to the Intermediate 60% RD Report for the Site.

6.0 HEALTH AND SAFETY

All work completed by Pioneer and its subcontractor during execution of the Phase III Site Investigation will be performed in accordance with all procedures outlined in the BRW Site-SSHASP. Planned field activity for Phase III maintains the same types of activity in Phase II; therefore, the BRW SSHASP currently contains applicable hazards for Phase III. The BRW SSHASP may be updated to include unique hazards that materialize during field activities for the Phase III Site Investigation.

7.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

The roles, duties, and responsibilities of personnel assigned to the Phase III Site Investigation are provided below. An organizational chart showing the overall organization of the project team is detailed on Figure 9.

Atlantic Richfield Company Liability/Project Manager (PM) – Josh Bryson

The Atlantic Richfield Operations PM communicates directly to the Agencies on project matters, monitors the performance of the contractor(s), consults with the CPM and Contractor QAO on deficiencies and helps finalize resolution actions.

Atlantic Richfield Company Quality Assurance Manager (QAM) – David Gratson

The Atlantic Richfield QAM interfaces with the Atlantic Richfield Operations PM on company policies regarding quality and has the authority and responsibility to approve specific QA documents including this BRW Phase III QAPP.

Contractor

Pioneer is the Contractor responsible for conducting the elements of the Phase III Site Investigation under the direction of Atlantic Richfield.

Pioneer Contractor Project Manager (CPM) – Karen Helfrich

The CPM is responsible for scheduling all testing and sampling work to be completed and ensuring that the work is performed in accordance with the requirements contained herein. The CPM, or designated alternate, is also responsible for consulting with the specific project QA personnel regarding any deficiencies and finalizing resolution actions, maintaining the BRW Phase III QAPP, and verifying effective implementation of BRW Phase III QAPP requirements and procedures, including RFCs. This includes reviewing field and laboratory data and evaluating data quality.

Contractor Quality Assurance Officer (QAO) – Thomas Brown

The Contractor QAO is responsible for verifying effective implementation of BRW Phase III QAPP requirements and procedures, including reviewing field and laboratory data, and evaluating data quality. The Contractor QAO may conduct Site reviews and prepare Site review reports for the QAM. The Contractor QAO will have a direct line of communication to the QAM to ensure issues related to project QA are resolved.

The Contractor QAO is also authorized to stop work if, in the judgment of that individual, the work is performed contrary to or in the absence of prescribed QCs or approved methods and further work would make it difficult or impossible to obtain acceptable results.

Pioneer Field Team Leader – Kendra Jackson

The Field Team Leader ensures that the BRW Phase III QAPP and associated RFCs have been reviewed by all members of the field team and the BRW Phase III QAPP procedures are properly followed during field activities. The Field Team Leader will conduct daily safety meetings, assist in field activities, and document activities in the field logbook. The Field Team Leader is responsible for facilitating field activities and managing equipment and is responsible for coordinating with the CPM and Contractor QAO regarding problem solving and decision making in the field. The Field Team Leader is responsible for technical aspects of the project and providing “on-the-ground” overviews of project implementation by observing Site activities to ensure compliance with technical project requirements and the BRW SSHASP. The Field Team Leader is responsible for identifying potential Integrity Management issues during field activities and reporting any issues to the Contractor QAO.

Safety and Health Manager – Tara Schleeman

The Safety and Health Manager is responsible for reviewing the BRW SSHASP with all members of the field team and updating it if necessary. The Safety and Health Manager will lead applicable Task Risk Assessments and conduct the initial safety meeting prior to starting fieldwork. The Safety and Health Manager will monitor work crews’ compliance with all Site safety and health requirements.

7.1.1 Subcontractors

Multiple contractors will assist with the BRW Phase III Site Investigation activities. These companies will subcontract to Pioneer and follow all health and safety protocols established by Pioneer to work on the Site. These subcontractors have been selected due to their unique skillset and specialized equipment.

O'Keefe Drilling (O'Keefe) or an equivalent contractor. O'Keefe, or an equivalent contractor approved by Atlantic Richfield, will supply the rotary sonic drill rig, hollow stem auger rig, and personnel to drill select boreholes (Table 7).

Hunter Brothers Construction (Hunter) or an equivalent contractor. Hunter, or an equivalent contractor approved by Atlantic Richfield, will provide general services for Site investigation activities, such as handling hydrocarbon-impacted soil and water and identifying the location of utilities prior to ground disturbance activities.

7.1.2 Laboratory

The laboratories selected to analyze the soil and groundwater samples will be Atlantic Richfield-approved laboratories that are in general accordance with EPA CLP SOW for Superfund Analytical Methods SFAM01.1 (EPA, 2020b). Eurofins TestAmerica and the Montana Bureau of Mines and Geology (MBMG) were selected to provide analytical services. The MBMG will only provide analysis for radon samples, whereas Eurofins TestAmerica will provide analysis for all other applicable groups in Table 6. Eurofins TestAmerica is required to generate and report high quality data that identify and define the physical and chemical characteristics of soil and groundwater for environmental investigations, remediation activities, long-term monitoring programs, discharge compliance monitoring, and waste characterization under the purview of RCRA and Comprehensive Environmental Response, Compensation & Liability Act (CERCLA), referred to as Superfund. As such, analytical data must be accurately and precisely generated and reported in conformance with the applicable method "best industry standards."

Geotechnical samples for moisture content, resistivity, pH, sulfate, particle size distribution, Atterberg Limits, standard proctor and/or California Bearing Ration will be analyzed by Pioneer's Material Testing Laboratories.

The selected laboratories will have QA personnel familiar with the approved QAPP and be responsible for reviewing final analytical reports, scheduling analyses, and supervising in-house custody procedures.

8.0 DATA VALIDATION AND USABILITY

This section addresses 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 for the express purposes of achieving the stated DQOs (Section 3.0). Based on a review of EPA guidance, the analytical data (not including any geotechnical data) collected will undergo Stage 2A data validation as defined in EPA *Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use* (EPA, 2009). Official XRF analysis data as described in Section 4.8.1 will undergo Stage 2B data validation (EPA, 2009).

8.1 Data Review, Verification, and Validation

This section describes the review, verification, and validation process for field data and laboratory data. The section also details laboratory data reporting requirements, which describe how results are conveyed to data users.

8.1.1 Data Review Requirements

Data review is performed by the data producer to ensure that the data have been recorded, transmitted, and processed correctly.

8.1.1.1 Field Data Review

Raw field data will be entered in field logbooks and/or field data sheets per appropriate field SOPs (Appendix A), and the data will be reviewed for accuracy and completeness by the Field Team Leader before the records are considered final. The overall quality of the field data from any given sampling round will be further evaluated during the process of data reduction and reporting.

Field data reduction 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, if necessary, are recorded properly in the field logbooks and/or data sheets and that any necessary and appropriate corrective actions were implemented and recorded. Such data will be written into the field logbook and/or data sheets immediately after measurements are taken. If errors are made, results will be legibly crossed out, initialed, and dated by the field member, and corrected in a space adjacent to the original (erroneous) entry. Later, the Field Team Leader will proof the field logbooks and/or data sheets 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.

If appropriate, field measurement data will be entered into electronic files for import to the project database. Data entries will be made from the reviewed field data sheets or logbooks, and all data entries will be reviewed for accuracy and completeness before the electronic file is provided to the database manager. Electronic files of field measurement data will be maintained as part of the project's quality records.

8.1.1.2 Laboratory Data Review

Internal laboratory data reduction procedures will be according to each laboratory's quality management plan. At a minimum, paper records will be maintained by the analysts to document sample identification number and the sample tag 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 will be signed and dated by the analyst. Secondary review of these records by laboratory personnel will take place prior to final data reporting to Atlantic Richfield. The laboratory will appropriately flag unacceptable data in the data package.

8.1.2 Data Verification Requirements

Data verification is the process for evaluating the completeness, correctness, and conformance/compliance of a specific data set against the method, procedural, or contractual specifications.

8.1.2.1 Field Data Verification

The Level A/B review, as described in the CFRSSI DM/DV Plan (ARCO, 1992c) and the *CFRSSI DM/DV Plan Addendum* (AERL, 2000), will be used in the verification process for field documentation related to samples collected for laboratory analysis.

The Level A criteria are:

- Sampling date.
- Sample team and/or leader.
- Physical description of sample location.
- Sample depth (soil).
- Sample collection technique.
- Field preservation technique.
- Sample preservation technique.
- Sample shipping records.

The Level B criteria are:

- Field instrumentation methods and standardization complete.
- Sample containers preparations.
- Collection of field duplicates.
- Proper and decontaminated sampling equipment.
- Field custody documentation.
- Shipping custody documentation.
- Traceable sample designation number.
- Field notebook(s), custody records in secure repository.
- Complete field forms.

8.1.2.2 Laboratory Data Verification

The laboratory will prepare standard data packages for transmittal of results and associated QC information to Atlantic Richfield or its designee within a standard turnaround time, unless otherwise required.

The laboratory will prepare standard data packages in general accordance with the EPA CLP SOW for Superfund Analytical Methods SFAM01.1 (EPA, 2020b). Deviations from these specifications should be acceptable provided the report presents all the requested types of information in an organized, consistent, and readily reviewable format.

Each data package, as described above, will be accompanied by an EDD prepared by the laboratory. Additional laboratory QC data can be included in the EDD. The 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 verification process.

The data packages from the laboratory will contain the following minimum information:

- A narrative addressing any anomalies encountered during sample analysis, and a discussion of any exceedances in the laboratory QC sample results.
- Analytical method references.
- Definition of any data flags or qualifiers used.
- Chain of custody documentation signed and dated by the laboratory to indicate sample receipt.
- Method detection limits and reporting limits.
- Analytical results for each field sample.
- QC sample results (as applicable).

8.1.2.3 Resolution of Deficiencies

Any deficiencies found during the verification process will be discussed with the data producer and may be resolved with a revised data package.

8.1.3 Data Validation Requirements

Data validation is the process of ensuring data are correct and useful. Data validation will be performed by qualified, independent data validation personnel, who are not associated with data collection or sampling responsibilities, and that have applicable training. The QC criteria used during the data validation process will follow the *National Functional Guidelines for Inorganic Superfund Methods Data Review* (EPA, 2020c), the *National Functional Guidelines for Organic Superfund Methods Data Review* (EPA, 2020d), the *National Functional Guidelines for High Resolution Superfund Methods Data Review* (EPA, 2020e), the CFRSSI QAPP (ARCO, 1992b), the CFRSSI DM/DV Plan (ARCO, 1992c), the CFRSSI DM/DV Plan Addendum (AERL, 2000), laboratory-specific QC criteria, and/or method-specific criteria where applicable.

8.2 Verification and Validation Methods

The Level A/B Assessment checklists included in Appendix E are based on the CFRSSI DM/DV Plan Addendum (AERL, 2000) guidance.

Stage 2A Verification and Validation checks include an evaluation of the following, as applicable for each analytical method:

- Completeness of laboratory data package
- Requested analytical methods performed
- Holding times
- Reported detection limits
- Dilution factors
- MBs
- LCS and LCSD
- MS samples and MSDs
- PDSs (as required by the analytical method)
- LDSs
- Field blanks
- Field duplicates
- Serial Dilution (when provided in the laboratory report)

Data qualifiers will follow those used in the National Functional Guidelines for Inorganic Superfund Methods Data Review (EPA, 2020c), the National Functional Guidelines for Organic Superfund Methods Data Review (EPA, 2020d), and the National Functional Guidelines for High Resolution Superfund Methods Data Review (EPA, 2020e). Data validation for each laboratory data package will be documented on the data validation checklists in Appendix E.

The Data Validator will be responsible for reviewing field documentation associated with sample collection, conducting the verification and validation of laboratory-produced data, and completing a data validation report, which will be reviewed by the CPM.

8.3 Reconciliation and User Requirements

The Data Quality Assessment (DQA) process described in the CFRSSI DM/DV Plan Addendum (AERL, 2000) and the Guidance for Data Quality Assessment EPA QA/G-9 (EPA, 2000) will be performed to determine whether project-specific DQOs have been satisfied. The DQA process 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: Select statistical test(s), as appropriate, to evaluate data quality.
Step 4: Verify assumptions.
Step 5: Draw conclusions about the quality of the data (data report will not include interpterion of results but will state conclusions regarding the quality of the results).

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. 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.

The PARCCS data quality indicators (Section 3.1) will be used when conducting the DQA. If the PARCCS assessment satisfies the project DQOs, then usability of the data will follow the enforcement/screening/unusable data categories as described in the CFRSSI DM/DV (ARCO, 1992c):

1. Enforcement Quality (Unrestricted Use) Data

   Enforcement quality data may be used for all purposes under the Superfund program including the following: site characterization, health and safety, Environmental Evaluation/Cost Analysis, remedial investigation/feasibility study, alternatives evaluation, confirmational purpose, risk assessment, and engineering design.

2. Screening Quality (Restricted Use) Data

   Potential uses of screening quality data, depending upon their quality, include site characterization, determining the presence or absence of contaminants, developing or refining sampling and analysis techniques, determining relative concentrations, scoping and planning for future studies, engineering studies and engineering design, and monitoring during implementation of the response action.

3. Unusable Data

   These data are not useable for Superfund-related activities.

Data that meet the Level A and Level B criteria and are not qualified as estimated or rejected during the data validation process are assessed as enforcement quality data and can be used for all Superfund purposes and activities. Data that meet only the Level A criteria and are not rejected during the data validation process can be assessed as screening quality data. Screening quality data can be used only for certain activities, which include engineering studies and design. Data that do not meet the Level A and/or B criteria and/or are rejected during the data validation process are designated as unusable. The data are assigned one of the following qualifiers:

E = Enforcement quality. No qualifiers or U qualifier and meets Level A and B criteria.
S = Screening quality. J or UJ qualifier and/or meets only Level A criteria.
R = Unusable. R qualifier and/or does not meet Level A or B requirements.

Enforcement/Screening Designation

	Meets Level A and B	Meets Level A	Does not meet Level A or B
No qualifier, A, or U	E	S	R
J, J+, J-, or UJ	S	S	R
R	R	R	R

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FIGURES

TABLES

Appendix A.
Standard Operating Procedures

Appendix B.
Field Forms and Tables

Appendix C.
Geotechnical Investigation Reference Documents

Appendix D.
Corrective Action Report

Appendix E.
Data Validation