Fall 11-2021

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

Atlantic Richfield Company

Atlantic Richfield Company

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November 23, 2021

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RE: Butte Reduction Works (BRW) Smelter Area Mine Waste Remediation and Contaminated Groundwater Hydraulic Control Site Quality Assurance Project Plan for Microbial Analysis and Biotreatability Study

Agency Representatives:

I am writing you on behalf of Atlantic Richfield Company to submit the *Final Butte Reduction Works (BRW) Smelter Area Mine Waste Remediation and Contaminated Groundwater Hydraulic Control Site Quality Assurance Project Plan (QAPP) for Microbial Analysis and Biotreatability* (BRW Biotreatability Study QAPP) for your review and approval. In short, the BRW Biotreatability Study QAPP provides the sampling and analytical procedures and protocols necessary to conduct a bench-scale biotreatability study, including microbial analysis, as part of the overall remedial design effort for the BRW Site. Fieldwork is anticipated to begin in January 2022, pending Agency approval. A proposed schedule is included in the BRW Biotreatability Study QAPP.

Included with the BRW Biotreatability Study QAPP is Atlantic Richfield's response to Agency comments received on September 27, 2021. Per Agency request, the *Draft Final BRW Smelter Area Mine Waste Remediation and Contaminated Groundwater Hydraulic Control Site Field Sampling Plan for Microbial Analysis and Biotreatability* was modified and reissued as a standalone QAPP (this document).

Per Agencies' request, the following documents are included with this submittal:

1. Word Document QAPP Crosswalk.
2. Word Document of BRW Biotreatability Study QAPP with redline text indicating edits from previous version submitted to Agencies.
3. Complete PDF of BRW Biotreatability Study QAPP.

Atlantic Richfield Company

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The documents may be downloaded at the following link:
https://pioneertechnicalservices.sharepoint.com/:f:/s/submitted/Eq8V299dd7NEo0pcXuehKI4B740IAVup9ddyY5RK5ktOAQ

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

Sincerely,

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

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

2021

Final

Butte Reduction Works (BRW) Smelter Area Mine Waste Remediation and Contaminated Groundwater Hydraulic Control Site Quality Assurance Project Plan (QAPP) for Microbial Analysis and Biotreatability Study

Atlantic Richfield Company

Revision 0. November 2021

RESPONSE TO AGENCY COMMENTS
FOR THE
BUTTE PRIORITY SOILS OPERABLE UNIT (BPSOU) BUTTE REDUCTION WORKS (BRW) SMELTER AREA MINE WASTE REMEDIATION AND CONTAMINATED GROUNDWATER HYDRAULIC CONTROL SITE
QUALITY ASSURANCE PROJET PLAN FOR MICROBIAL ANALYSIS AND BIOTREATABILITY STUDY
DATED AUGUST 3, 2021

General Document Comments

EPA General Comment 1: *After review of the data quality objectives in the BRW Phase III quality assurance project plan, EPA and DEQ believe that the existing data quality objectives (DQO) do not sufficiently describe the DQO steps that are necessary for this microbial analysis and biotreatability study. For example, the solid material characterization DQO section in the BRW phase III QAPP includes defining the extent of hydrocarbon contamination, but does not include anything on a hydrocarbon treatability study. Please revise the DQO section and Table 3, and provide an updated EPA crosswalk for the BRW Phase III QAPP to support this field sampling plan. Alternatively, this FSP could be converted to a QAPP (with DQOs sections) and a crosswalk to address this concern.*

Atlantic Richfield Company Response: The field sampling plan has been converted to a Quality Assurance Project Plan (QAPP) with data quality objectives and a crosswalk.

Specific Document Comments

EPA Specific Comment 1: <u>*Section 1.0 Introduction, Pg. 1:*</u> *The introduction should lay out why microbial analysis is required prior to the description of how the document is organized. Is land farming contemplated? In situ treatment? Chemical oxidation? It is unclear what exactly all of this work is for. Please add.*

Atlantic Richfield Company Response: Additional detail has been added to Section 1.0 to clarify why the bench-scale biotreatability study, including microbial analysis, is necessary.

EPA Specific Comment 2: <u>*Section 2.0 Site Background, Pg. 1-2:*</u> *This section is missing a description of the hydrocarbon related activities on the BRW site, including the above ground storage tank, and the hydrocarbon detections in soil. Please add.*

Atlantic Richfield Company Response: Additional detail has been added to Section 2.0 regarding the hydrocarbon related activities on the Site and results of previous Site investigations.

EPA Specific Comment 3: <u>*Section 2.0 Site Background, Pg. 2:*</u> *From the description it is unclear if the biotreatment is only for the soils within the removal corridor or if select areas north of the corridor will also be treated, for example in the above ground storage tank area.*

Figure 3 shows samples both inside and outside of the corridor. Please add the DQO section Step 1 (requested in the General Comments).

> **Atlantic Richfield Company Response:** Soil samples are necessary for both inside and outside the removal corridor since the removal corridor boundary is preliminary and since management of hydrocarbon-impacted soil may be necessary both inside and outside the removal corridor. Additional detail has been added to Section 2.0 on why samples must be collected inside and outside the removal corridor.

EPA Specific Comment 4: <u>Section 3.0, Pg. 2, last sentence:</u> *Please add "pyrite and other sulfide minerals" to the list (and on pg 26).*

> **Atlantic Richfield Company Response:** Text has been edited as requested.

EPA Specific Comment 5: <u>Section 4.4.2.4:</u> *In the third from the last paragraph, while it is acceptable to adjust sampling areas based on screening results, it is important to collect samples for laboratory analysis from each of the proposed sample areas. Please collect the appropriate samples.*

> **Atlantic Richfield Company Response:** Clarification has been added to Section 4.4.2.4 to state that at a minimum one sample will be collected from each sample area identified on Figure 3.

EPA Specific Comment 6: <u>Section 4.5.1:</u> *In the last paragraph it is mentioned that samples not sent to the lab will be disposed of at the Mine Waste Repository. With the hydrocarbon contamination present, do these samples need to be profiled before sending to the repository? This described action does not appear to be in accordance with Appendix A SOP-DE-03. Please revise as necessary.*

> **Atlantic Richfield Company Response:** Text in Section 4.5.1 has been edited to state that samples will either be archived or contained at the Site. Prior to disposal, soil will be sampled for proper disposal.

EPA Specific Comment 7: <u>Section 4.5.3, second paragraph:</u> *The text indicates that soil samples will be split 3 ways for analysis.*

- *This procedure was not clear in Section 4.4.2 Procedures. Please update Section 4.4.2 to clarify the splitting procedure.*
- *SOP-S-01 does not describe the method for splitting samples. Please either add SOP information or detail it in the text what the specific method is for splitting soil samples that may have volatile organic contaminants.*

> **Atlantic Richfield Company Response:** Some volatiles may be lost during the excavation of the test pits and mixing of the samples. To prevent the loss of volatiles during sampling, synthetic precipitation leaching procedure (SPLP) samples will be taken immediately following visual confirmation of anticipated soil lithology and the remaining

volatile organic compound samples will be prioritized for collection after the mixing of samples. The loss of volatiles through mixing of the soil is acceptable to meet the primary objectives of this work (i.e., to help estimate the biological degradation potential for the hydrocarbon-impacted soil, help determine if high contaminant of concern [COC] concentrations are impacting the microbial communities within the soil and possibly inhibiting the biodegradation process, and help determine whether there are other reduced species in the soil sample that would consume the oxidant agent where chemical oxidation is not practicable as a treatment option). Previous investigations have characterized the extent and concentrations of soil impacted with hydrocarbon compounds within the Site; therefore, this work is focused on the treatability of the soil within the Site, and it is acceptable for some loss of volatiles during the sampling process to achieve this objective.

Additional detail was added to Section 4.4.2 clarifying the procedures for splitting samples.

EPA Specific Comment 8: *Section 4.5.3.2, fourth paragraph: Please reference Table 3 holding times and confirm that posttreatment samples will be submitted for analysis within the specified holding times.*

Atlantic Richfield Company Response: To ensure that hold times are met, samples will be submitted to Pace directly from Provectus. Text has been updated in Section 4.5.3.2.

EPA Specific Comment 9: *Section 4.5.3.4, second bullet: It is stated that diesel fuel will be used for the enhanced slurry study. Please confirm why diesel would be the right external carbon source?*

Atlantic Richfield Company Response: Diesel was determined to be an appropriate external carbon source since previous Site investigation results indicated that extractable petroleum hydrocarbons (EPHs), which are typically considered diesel range organics, are the primary concern with treatability of the soil within the Site. Therefore, diesel is expected to provide an appropriate food source for the microbial community. Adding a different carbon source, such as molasses, might enhance a competing microbial population that may be detrimental to the microbial population currently present in the soil.

Additional detail was added to Section 4.5.3.4 to clarify why diesel is an appropriate external carbon source.

EPA Specific Comment 10: *Appendix A: Please include standard operating procedures for use of the following instruments:*

- *Hanby Total Petroleum Hydrocarbon Soil Kit.*
- *Photoionization and Combustible (Flame Ionization) Detectors.*

Atlantic Richfield Company Response: Requested standard operating procedures have been added.

End of Comments.

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

2021

Final

Butte Reduction Works (BRW) Smelter Area Mine Waste Remediation and Contaminated Groundwater Hydraulic Control Site Quality Assurance Project Plan (QAPP) for Microbial Analysis and Biotreatability Study

Prepared for:

Atlantic Richfield Company
317 Anaconda Road
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Prepared by:

Pioneer Technical Services, Inc.
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Revision 0. November 2021

APPROVAL PAGE

Silver Bow Creek/Butte Area NPL Site
Butte Reduction Works Smelter Area Mine Waste Remediation and Contaminated
Quality Assurance Project Plan for Microbial Analysis and Biotreatability Study

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

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

Approved: ______________________________ Date: 11/23/2021
Josh Bryson, Liability Manager
Atlantic Richfield Company

Approved: ______________________________ Date: 11/23/2021
David Gratson, Quality Assurance Manager
Environmental Standards, Inc.

Plan is effective on date of approval.

DOCUMENT REVISION TRACKING TABLE

Revision No.	Author	Version	Description	Date
Rev 0	K. Helfrich	Final	Issued for Agency Approval	11/23/2021

DISTRIBUTION LIST

Silver Bow Creek/Butte Area NPL Site
Butte Reduction Works Smelter Area Mine Waste Remediation and Contaminated Groundwater Hydraulic Control Site
Quality Assurance Project Plan for Microbial Analysis and Biotreatability Study

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LIST OF APPENDICES

ACRONYMS

Acronym	Definition	Acronym	Definition
%R	Percent Recovery	**OUR**	Oxygen Uptake Rate
%D	Percent Difference	**Pace**	Pace Analytical Services, LLC
°C	Degree Celsius	**PAH**	Polycyclic Aromatic Hydrocarbons
AECOM	AECOM Technical Services, Inc.	**PARCCS**	Precision, Accuracy, Representativeness, Comparability, Completeness, and Sensitivity
ARAR	Applicable or Relevant and Appropriate Requirements	**PCB**	Polychlorinated Biphenyl
Atlantic Richfield	Atlantic Richfield Company	**PCP**	Pentachlorophenol
ATP	Adenosine Triphosphate	**PDI**	Pre-Design Investigation
BNSF	Burlington Northern Santa Fe (Railway)	**pH**	Potential Hydrogen
BOD	Biological Oxygen Demand	**PID**	Photoionization Detector
BPSOU	Butte Priority Soils Operable Unit	**Pioneer**	Pioneer Technical Services, Inc.
BRW	Butte Reduction Works	**ppb**	Parts per billion
BSB	Butte-Silver Bow	**PPE**	Personal Protective Equipment
CAR	Corrective Action Report	**ppm**	Parts per million
CD	Consent Decree	**Provectus**	Provectus Environmental Products
CFRSSI	Clark Fork River Superfund Site Investigation	**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
CRQL	Contract Required Quantitation Limit	**QC**	Quality Control
DEQ	Department of Environmental Quality	**RA**	Remedial Action
DM/DV	Data Management/Data Validation	**RBSL**	Risk-Based Screening Level
DO	Dissolved Oxygen	**RCRA**	Resource Conservation and Recovery Act
DQA	Data Quality Assessment	**RD**	Remedial Design
DQO	Data Quality Objective	**RFC**	Request for Change
EDD	Electronic Data Deliverable	**RPD**	Relative Percent Difference
EPA	Environmental Protection Agency	**SiO2**	Silicon Dioxide
EPH	Extractable Petroleum Hydrocarbons	**SOP**	Standard Operating Procedure
eV	electron volt	**SPLP**	Synthetic Precipitation Leaching Procedure
GPS	Global Positioning System	**SQL**	Structured Query Language
Hunter	Hunter Brothers Construction	**SRM**	Standard Reference Material
LCS	Laboratory Control Sample	**SSHASP**	Site-Specific Health and Safety Plan
LCSD	Laboratory Control Sample Duplicate	**T**	Duplicate Identification for Field Samples
LDS	Laboratory Duplicate Sample	**TOD**	Total Oxidant Demand
LMS	Laboratory Matrix Spike	**TPH**	Total Petroleum Hydrocarbons
LNAPL	Light Non-Aqueous Phase Liquid	**USCS**	Unified Soil Classification System
MB	Method Blank	**USGS**	US Geological Survey
MS	Matrix Spike	**VOC**	Volatile Organic Compound
MSD	Matrix Spike Duplicate	**VPH**	Volatile Petroleum Hydrocarbon
NRDP	National Resource Damage Program	**XRF**	X-Ray Fluorescence
ORP	Oxidation Reduction Potential		

1.0 INTRODUCTION

This Butte Reduction Works (BRW) Quality Assurance Project Plan (QAPP) for Microbial Analysis and Biotreatability Study (BRW Biotreatability QAPP) provides the sampling and analytical procedures and protocols necessary to conduct a bench-scale biotreatability study, including microbial analysis, 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).

As required by the Butte Priority Soils Operable Unit (BPSOU) Consent Decree (CD) (EPA, 2020a), soil and groundwater impacted with organic pollutants within the Site above Site-specific action levels must be properly managed in a manner that is consistent with the remedy. The bench-scale biotreatability study and associated characterization will advise appropriate Site-specific action levels for hydrocarbon-impacted soil by collecting data on the characteristics of the soil (hydrocarbon leachability, microbial activity, etc.). Additionally, if treatment of hydrocarbon-impacted soil is required as part of the remedial action (RA), the bench-scale biotreatability study will help identify the proper treatment option (i.e., chemical oxidation, landfarming, expedited natural attenuation under improved conditions, etc.) and advise the management plan for hydrocarbon-impacted soil.

This BRW Biotreatability QAPP includes the excavation of test pits within a specified area to provide a range of soil types and hydrocarbon-compound concentrations within the Site based on data collected from previous Site investigation work. Soil samples from each test pit will be collected and field tested to identify hydrocarbon compounds and contaminants of concern (COCs) throughout the Site. Soil samples will be collected and sent to specified laboratories for soil characterization analysis (e.g., hydrocarbon leachability, hydrocarbon-compound concentrations, metal concentrations, etc.), total oxidant demand (TOD) analysis, and bench-scale biotreatability with microbial analysis. Samples will be collected according to the schedule listed in Table 1 at the locations listed in Table 2, and Table 3 lists the applicable sample collection and holding times.

To detail the sampling and analytical procedures and methodologies for this work, this document includes the following information, as generally required in the U.S. Environmental Protection Agency (EPA) *Remedial Design/Remedial Action Handbook, EPA 540/R- 95/059* (EPA, 1995):

1. Site Background (Section 2.0).
2. Data Quality Objectives (DQOs) (Section 3.0).
3. Sample Process and Design (Section 4.0).
    - Preparation for Field Work (Section 4.1)
    - Sample Location and Frequency (Section 4.2).
    - Sample Designation (Section 4.3).
    - Sampling Equipment and Procedures (Section 4.4).
    - Sample Handling and Analysis (Section 4.5).
4. Quality Assurance (QA)/Quality Control (QC) (Section 5.0).
5. Assessment and Oversight (Section 6.0).

6. Health and Safety (Section 7.0).
7. Project Organization and Responsibilities (Section 8.0).
8. Data Validation and Usability (Section 9.0).

Supplemental information mentioned throughout the text is included in appendices A through E and includes operating procedures, field forms, field equipment manuals, data validation checklists, and corrective action form, respectively.

1.1 Objectives

The specific objectives under this BRW Biotreatability QAPP have been identified through the DQO process (Section 3.0). The primary objectives are to collect additional data regarding the soil characteristics (e.g., COC concentrations, hydrocarbon-compound concentrations, nutrients, microbial populations, hydrocarbon leachability, etc.) to help:

1. Estimate the biological degradation potential for the hydrocarbon-impacted soil.
2. Determine if high COC concentrations are impacting the microbial communities within the soil and possibly inhibiting the biodegradation process.
3. Understand the significance of other reduced species (e.g., iron, manganese, organic carbon, pyrite, and other sulfide minerals) in the soil sample that would consume the oxidant agent to a point where chemical oxidation would not be practicable as a treatment option.

Additionally, a secondary objective is to use the soil characterization data (nutrients, metal concentrations, and hydrocarbon leachability) collected during this work, along with additional data collected during previous Site investigation activities, to advise Site-specific action levels that will be protective of human health and the environment and guide the appropriate management (refer to Section 2.4) for hydrocarbon-impacted soil at the Site. Site-specific action levels will be determined in accordance with the Montana Risk-Based Corrective Action Guidance for Petroleum Releases (DEQ, 2018a).

To achieve these objectives, test pits will be excavated to gather soil samples for this study. Field testing will include photoionization detectors (PIDs), a Hanby Soil Test Kit, and an X-ray fluorescence (XRF) field unit. This field-testing equipment will be used to determine the appropriate interval to send samples for laboratory analysis (Table 3). Samples will be sent to Provectus Environmental Products (Provectus), Pace Analytical Services, LLC (Pace), and to AECOM Technical Services, Inc. (AECOM) to further identify soil characteristics (e.g., hydrocarbon leachability, hydrocarbon-compound concentrations, metals concentrations, etc.), microbial activity, and biological degradation potential for hydrocarbon compounds within the soil. Additional information on XRF limits, relevant operating procedures, and data validation equations is listed in Table 4, Table 5, and Table 6, respectively.

Some volatiles may be lost during the test pit excavations and sample mixing. To prevent the loss of volatiles during sampling, samples to be analyzed via the synthetic precipitation leaching procedure (SPLP) will be collected immediately following visual confirmation of anticipated soil lithology, and the remaining volatile organic compound (VOC) samples will be prioritized for collection after the mixing of samples. The loss of volatiles through mixing of the soil is acceptable to meet the primary objectives of this work. Previous Site investigations have characterized the extent and concentrations of soil impacted with hydrocarbon compounds within the Site; therefore, this work is focused on the treatability of the soil within the Site and it is acceptable for some loss of volatiles during the sampling process to achieve this objective.

2.0 SITE BACKGROUND

Details of the Site, its history, and previous investigations are included in the *Butte Reduction Works (BRW) Smelter Area Mine Waste Remediation and Contaminated Groundwater Hydraulic Control Site Remedial Design Work Plan* (Atlantic Richfield, 2021a) and the corresponding Pre-Design Investigation (PDI) Work Plan included as an attachment to the remedial design work plan. These documents are working documents and will be updated as needed. Summaries relevant to the BRW Biotreatability QAPP 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).

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). The operations left behind a complex distribution of materials (including slag, tailings, manganese waste, demolition debris, foundations, and other historic structures) as well as impacted soil and groundwater.

In the center of the Site, there is an above-ground metal storage tank measuring approximately 90 feet in diameter. The tank is now empty but is thought to have been associated with the phosphate plant operation during the 1960s (GCM Services, Inc., 1991) and has been said to have previously stored petroleum hydrocarbons during the late 1900s (NRDP, 2016). The Site is also located near the following properties with recorded petroleum releases (Figure 2):

- 400 Oxford Street: Location of a leaking underground storage tank managed by the Montana Department of Environmental Quality (DEQ) in 1995 (DEQ, 2019).
- 1759 South Montana Street: Formerly the location of a Cenex Convenience Store. The site received reimbursement from the Petroleum Tank Release Compensation Board for Releases in 1990 and 2006 (DEQ, 2018b).

Additionally, Butte-Silver Bow (BSB) operated an asphalt plant at the Site from the mid-1990s to late 2020. Currently, BSB uses the Site to store materials. 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 soil and groundwater impacted with metals and hydrocarbons (Atlantic Richfield, 2021a).

2.3 Relevant Previous Investigations

2.3.1 Results from Phase I Site Investigation

Multiple investigations have been completed at the Site, including recent investigation activities, to identify impacted soil and groundwater throughout the Site. From August 2018 to March 2019, the initial Phase I Site Investigation took place according to the BRW Phase I QAPP (Atlantic Richfield, 2021b). The BRW Phase I QAPP was amended to include a request for change (RFC) for a Hydrocarbon Investigation, which took place December 2019 to February 2020, to further identify the hydrocarbon compounds that impact the soil and groundwater within the Site.

During both the initial Phase I Site Investigation and the Hydrocarbon Investigation, field personnel used two PIDs, a MiniRAE 3000 with a 10.6 electron volt (eV) lamp, and an UltraRAE 3000 with a 9.8 eV lamp to screen for the presence of hydrocarbons in the soil. Soil samples were collected if a positive PID reading was present and sent to Energy Laboratories in Helena, Montana, to be analyzed for volatile petroleum hydrocarbons (VPH) and extractable petroleum hydrocarbons (EPH) fractionation with polycyclic aromatic hydrocarbons (PAH). Additionally, groundwater samples were collected from piezometers where soil samples had a positive PID reading during drilling activities.

During the Hydrocarbon Investigation, Pioneer Technical Services Inc. (Pioneer) constructed additional piezometers and test pits to capture the existence of light non-aqueous phase liquid (LNAPL) or determine if dissolved hydrocarbon concentrations in groundwater exceeded Risk-Based Screening Levels (RBSLs). Most hydrocarbon wells were installed near an existing piezometer that had a presence of hydrocarbon contaminates within the soil or groundwater during the initial Phase I Site Investigation. The general locations of unpaired piezometers were selected based on results from the initial Phase I Site Investigation and the groundwater contours shown on Figure 3.

Based on results from the Phase I Site Investigation, including the Hydrocarbon Investigation, there is both impacted soil and groundwater within the Site that exceed DEQ's RBSLs (DEQ, 2018a) (Figure 3). Groundwater results from the initial Phase I Site Investigation and the Hydrocarbon Investigation indicate that benzene concentrations are above the RBSLs in piezometers BRW18-PZ21, BRW19-HCW37, and BRW19-HCW38. Piezometers BRW18-PZ13 and BRW18-PZ18 contained concentrations of PAHs; specifically, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene were at concentrations greater than RBSLs. Soil results from the initial Phase I Site Investigation and the Hydrocarbon Investigation include samples from BRW18-PZ18 and BRW18-PZ21 with concentrations that exceed RBSLs for VPH and EPH compounds and include high concentrations of PAHs. The Draft Final BRW PDI Evaluation Report (Atlantic Richfield, 2021c) provides additional detailed results from the Phase I Site Investigation.

2.3.2 Preliminary Results from Phase II Site Investigation

A Phase II Site Investigation began in March of 2020 and was completed in spring of 2021 in accordant with the Final Revised BRW 2021 Phase II QAPP (Atlantic Richfield, 2021d). This Phase II Site Investigation included collecting additional design data related to the groundwater and aquifer within the Site. Preliminary review of results from the Phase II Site Investigation indicated that there are no additional organic pollutant areas of concern from those already identified from the Phase I Site Investigation. Additionally, preliminary review of the results indicates that the concentrations of PAHs in piezometers BRW18-PZ13 and BRW18-PZ18 are below RBSLs. Once Site investigation activities are complete and the data are validated, results will be incorporated into a PDI Evaluation Report and submitted to Agencies for review.

2.3.3 2016 BRW Smelter Site Test Pit Report

In 2016 for the National Resource Damage Program (NRDP), Tetra Tech, Inc. conducted a test pit investigation and subsurface material sampling within the Site to characterize subsurface mine waste deposits, slag, impacted soil, and miscellaneous fill materials emplaced within the area. Thirty test pits were excavated, screened, and sampled. Of those 30 test pits, the presence of hydrocarbons was detected using a flame ionization detector in 6 test pits. Field technicians observed a hydrocarbon sheen on the groundwater surface in 4 test pits and an LNAPL layer on the groundwater surface in 1 test pit. The locations of the hydrocarbon observations are shown on Figure 4. Figures and tables with results, photographic logs, field sampling notes, and laboratory reports are included in the appendices of the BRW Smelter Site Draft Test Pit Report (NRDP, 2016).

2.4 BRW Remedial Action

The BRW RA includes 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 will include the following additional elements:

- Removing waste (as defined by the BPSOU CD Waste Identification Screening Criteria [EPA, 2020a]) from the designated and approved 275-foot average width removal corridor (referred to herein as the waste removal corridor).
- Managing soil and groundwater within the Site impacted by organic pollutants as appropriate and in a manner that is complementary with the remedy. Organic pollutants (petroleum compounds, polychlorinated biphenyl [PCB], pentachlorophenol [PCP], 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 properly addressed/managed as part of the RA. However, additional remediation of the soil and groundwater impacted with organic pollutants (i.e., treatment of organic pollutant sources) is not required by the BPSOU CD (EPA, 2020a).
- Realigning Silver Bow Creek and constructing the bank-full channel and 100-year floodplain within the 275-foot average width waste removal corridor.

- Regrading and constructing caps over the waste left in place (e.g., tailings, slag, and impacted soil). Some slag walls will remain exposed on Site for cultural and historic preservation.
- Hydraulically managing COC-impacted groundwater from the Site to control discharge of COC-impacted groundwater to surface water and sediment in BPSOU generally and within the Site specifically.

As a result of the multiple industrial operations within and adjacent to the Site, there is a potential that there are areas within the Site where the soil and/or groundwater are impacted with organic pollutants (i.e., hydrocarbon compounds, PCP, PCBs, and dioxins), in addition to the COCs (i.e., arsenic, cadmium, copper, lead, mercury, and zinc) identified in the BPSOU CD (EPA, 2020a). However, based on existing Site data, the only organic pollutants of concern present at concentrations of potential concern are hydrocarbon compounds (Atlantic Richfield, 2021c). Therefore, this BRW Biotreatability QAPP focuses on soil impacted with hydrocarbon compounds.

As required by the BPSOU CD (EPA, 2020a), hydrocarbon-impacted soil and groundwater above Site-specific action levels must be properly managed in a manner that is consistent with the remedy. Figure 5 shows the general logic for managing hydrocarbon-impacted soil within the Site as part of the RA. Soil within the preliminary waste removal corridor that is impacted with hydrocarbon compounds above Site-specific action levels must be segregated and disposed of appropriately. Soil outside the preliminary waste removal corridor that is impacted with hydrocarbon compounds above Site-specific action levels must be managed in a way that is consistent with the Applicable or Relevant and Appropriate Requirements (ARARs) identified in the Draft Final Preliminary 30% Remedial Design Report for BRW Smelter Area (Atlantic Richfield, 2021e). Soil samples are necessary for both inside and outside the waste removal corridor since the waste removal corridor boundary is preliminary and since management of hydrocarbon-impacted soil is necessary both inside and outside the waste removal corridor.

To help determine appropriate Site-specific action levels and advise the proper management plan for hydrocarbon-impacted soil, additional information is needed on the characteristics of the soil, specifically on the soil's hydrocarbon leachability and microbial activity and biological degradation potential for hydrocarbon compounds within the soil. One of the concerns is that the microbial communities within the soil may be impacted by the elevated concentrations of metal COCs within the soil that may limit the hydrocarbon-compound biodegradation process. This BRW Biotreatability QAPP includes collecting samples from five sample areas within the Site with varying soil conditions that include hydrocarbon compounds and COC concentrations and submitting the samples for laboratory analyses to help estimate the biological degradation potential for the impacted soil.

3.0 DATA QUALITY OBJECTIVES

The DQO process is used to define the type of quality, quantity, purpose, and use of the data to be collected. The U.S. Environmental Protection Agency (EPA) developed a seven-step process to ensure the data collected during field activities are adequate to support the site-specific remediation plan. The DQOs were developed for this BRW Biotreatability QAPP according to the EPA *Guidance on Systematic Planning Using the Data Quality Objectives Process* (EPA, 2006). The seven-step process is outlined below.

Step 1: State the Problem
The purpose of this step is to describe the problem to be studied and so that the focus of the investigation will not be ambiguous.

Problem: As required by the BPSOU CD (EPA, 2020a), soil and groundwater impacted with organic pollutants within the Site above Site-specific action levels must be properly managed in a way that is consistent with the remedy. Soil within the preliminary waste removal corridor that is impacted with organic pollutants above Site-specific action levels must be segregated and disposed of appropriately. Soil outside the preliminary waste removal corridor that is impacted with organic pollutants above Site-specific action levels must be managed in a way that is consistent with the ARARs identified in the Draft Final Preliminary 30% Remedial Design Report for the BRW Smelter Area (Atlantic Richfield, 2021e).

Previous Site investigation work has identified hydrocarbon compounds as the primary organic pollutants of concern and has characterized the extents of the hydrocarbon-impacted material throughout the Site. However, additional information is needed to help determine the proper management and/or treatment for the soil impacted with hydrocarbon compounds. This also includes developing Site-specific action levels for hydrocarbon-impacted soil located outside of the waste removal corridor by better understating the potential leachability of hydrocarbon compounds from soil into groundwater.

Available Resources and Schedule: Pioneer is the contractor responsible for conducting the elements of the BRW Biotreatability QAPP under the direction of Atlantic Richfield Company (Atlantic Richfield). All personnel completing field work will be properly trained in how to perform their tasks. The laboratory(s) selected to analyze the soil and groundwater samples will be an Atlantic Richfield-approved laboratory(s). The BRW Biotreatability QAPP work must be completed by March 2021 to meet the current required design schedule for the RA. However, potential constraints could delay field work and/or the RD (Step 5) and will need to be addressed by Atlantic Richfield and Agencies if they occur.

Conceptual Model of Environmental Problem: The Site has a history of multiple industrial uses. As a result, there are accumulations of slag, tailings, demolition debris, and other impacted materials that may be a source of COCs and additional constituents of concern (e.g., manganese, trace elements, organic pollutants, etc.) to the underlying groundwater. A description on the Site history, previous investigations, and required RA is included in Section 2.0.

Planning Team: Section 8.0 includes a detailed description on the project organization and responsibilities.

Step 2: Identify Goals of the Study
This step identifies the principal questions that the study will attempt to resolve and what actions may result.

Principal Study Questions:

1. Are landfarming and/or chemical oxidation feasible treatment options for the hydrocarbon compounds within the soil at the Site?
    a. Are there other reduced species (i.e., iron, manganese, organic carbon, pyrite, and other sulfide materials) in the soil that would consume an oxidant agent to the point where chemical oxidation would not be practicable as a treatment option?
    b. Do elevated concentrations of metals notably affect the biological activity within the soil?
2. Based on the soil characteristics (e.g., nutrients, metal concentrations, hydrocarbon leachability, hydrocarbon-compound concentrations, etc.), what are the Site-specific action levels that would require management of hydrocarbon-impacted soil that is located outside the waste removal corridor?

Estimation Statement: The principal study questions will be answered by excavating at least five test pits; conducting field tests to determine the appropriate interval to be sent for laboratory analysis; and submitting split samples to Provectus, Pace, and AECOM to further identify soil characteristics (e.g., hydrocarbon leachability, hydrocarbon-compound concentrations, metals concentrations, etc.), microbial activity, and biological degradation potential for hydrocarbon compounds within the soil. The data collected will be used to :

1. Estimate the biological degradation potential for the hydrocarbon-impacted soil.
2. Determine if high COC concentrations are impacting the microbial communities within the soil and possibly inhibiting the biodegradation process.
3. Understand the significance of other reduced species (e.g., iron, manganese, organic carbon, pyrite, and other sulfide minerals) in the soil sample that would consume the oxidant agent to a point where chemical oxidation would not be practicable as a treatment option.

Additionally, the data will be used to advise Site-specific action levels that will be protective of human health and the environment and guide the appropriate management (Figure 5) for hydrocarbon-impacted soil at the Site. Site-specific action levels will be determined in accordance with the Montana Risk-Based Corrective Action Guidance for Petroleum Releases (DEQ, 2018a).

The data validation procedures detailed in Step 6 will ensure the data collected are usable for this intended purpose.

Step 3: Identify Information Inputs

The purpose of this step is to identify the informational variables that will be required to answer the principal study questions and determine which variables require environmental measures.

Types of Information Needed:

- Survey-grade Global Positioning System (GPS) location coordinates collected for test pits.
- Classification and lithology recorded for each test pit including Unified Soil Classification System (USCS) classification (Appendix B); visual estimate of rock content (2-inch plus fraction); color (as per Munsell color chart [Munsell, 2009]); depth to top and bottom of each lithological unit; presence or absence of soil staining, odor, nodules, organic matter, and/or groundwater; and depth to top and bottom of each sample collected for field testing and laboratory analysis.
- Sampling interval. Field testing results will be used to determine the appropriate interval for samples to be sent for laboratory analysis based on the anticipated soil conditions for sampling that are identified in Table 2:
    - Presence of hydrocarbons. The presence will be detected in the soil through visual screening (sight and/or smell) and with two types of PIDs. Visual and olfactory observations of suspected hydrocarbons will be confirmed with a Hanby Soil Test Kit prior to collecting a sample.
    - Concentrations of COCs in the soil will be confirmed with a XRF unit prior to collecting a laboratory sample for the bench-scale biotreatability study.
    - Results from the initial field screening will help determine the proper interval for samples to be sent to the laboratory for analysis to best match the anticipated soil conditions that are identified in Table 2, as determined by the Field Team Leader and Contractor Project Manager (CPM) in consultation with the Contractor Quality Assurance Officer (QAO) (refer to Section 8.0).
- Laboratory analysis for initial characterization of soil, a TOD analysis, and initial slurry analysis and subsequent microbial analysis to determine microbial activity. Dependent on the level of bacterial activity within the initial slurry analysis, an enhanced slurry analysis will also be conducted. Table 3lists samples that will be composited, homogenized, and split in the field by Pioneer. Samples will be sent to the respective laboratories:
    - Pace for the initial characterization analysis of each sample including general parameters, metals, and hydrocarbon compounds and general hydrocarbon leachability.
    - Provectus for the TOD analysis. Based on field screening and data collected from previous Site investigations, one sample from the test pit with the greatest concentration of high molecular weight hydrocarbons (i.e., one sample for the Site) will be sent to Provectus. At the conclusion of the TOD analysis, Provectus will submit a portion of the soil from each bench-scale reactor to Pace for a post-treatment analysis. The post-treatment analysis will include the following: total metals, hydrocarbon compounds (EPH, VPH, and PAH), and potential hydrogen (pH).
    - AECOM to complete each of the initial soil slurry analyses for a sample from each sample area. The oxygen uptake rate (OUR) and total and dissolved adenosine triphosphate (ATP) measurements will be performed to assess the microbial activity of the soil bacteria. Microbial analysis to quantify bacteria populations will be

subcontracted by AECOM to Microbial Insights to perform their CENSUS-qPCR method.

- Based on the results of the initial soil slurry analyses and TOD analysis, Atlantic Richfield will determine if additional slurry analyses are needed based on professional judgment.
  - Based on the results from the TOD analysis and initial slurry analysis, Atlantic Richfield will review results and determine if a sample of the post-treatment soil will be sent to the AECOM laboratory for a slurry analysis.
  - Based on the findings from the initial microbial analysis, an enhanced analysis may be performed to further characterize bacteria populations. If necessary, and at the direction of Atlantic Richfield, AECOM will perform the enhanced slurry study which will involve the addition of nutrients and an external carbon source as well as a longer incubation time to stimulate or enhance the microbial activity in an effort to gather additional information.

Sources of Additional Information:

- Phase I Site Investigation (BRW Phase I QAPP and RFC documents) (Atlantic Richfield, 2021b).
- Phase II Site Investigation (BRW Phase II QAPP) (Atlantic Richfield, 2021d).
- BRW PDI ER (Atlantic Richfield, 2021c).
- BRW Smelter Site Draft Test Pit Report (NRDP, 2016).

Applicable Limits/Thresholds:

- Waste Identification Screening Criteria (EPA, 2020a).
- Montana RBSLs (DEQ, 2018a).

Appropriate Sampling and Analysis Methods:

- Sampling and analysis methods are detailed in Table 3.
- All laboratory results will go through a Level 2 validation. The required quantification limit is listed in Table 3.

Step 4: Define the Boundaries

The purpose of this step is to define the spatial and temporal boundaries of this study.

Target Population: Test pits to be installed are listed in Table 2 and shown on Figure 3.

Specific Spatial Boundaries, Temporal Boundaries, and Other Practical Constraints: The projected boundary of this study is the Site (shown on Figure 3). Figure 3 includes the proposed sample areas for test pits, and the anticipated depth and soil conditions for each test pit are listed in Table 2. Locations of each sample area and anticipated depth and soil conditions were identified using previous investigation results. Actual soil sample location and depth will be determined using field screening to confirm the anticipated soil conditions listed in Table 2. Soil samples are necessary from both inside and outside the waste removal corridor since the waste removal corridor boundary is preliminary, and since management of hydrocarbon-impacted soil is necessary both inside and outside the waste removal corridor.

Scale of Estimates to be Made: The sample results will be used to characterize the soil both inside and outside the waste removal corridor to help advise the management of the hydrocarbon-impacted soil within the Site.

General Spatial Boundaries, Temporal Boundaries, and Other Practical Constraints: Fieldwork will begin once Agency approval has been received. A proposed schedule is shown in Table 1. Work will be performed as weather conditions permit. Coordination with BSB will be required for each project task. Potential constraints that could delay fieldwork include adverse weather conditions, contractor availability, coordination with land managers/users, unforeseen challenges with the Covid-19 pandemic, or other unforeseen issues. Major project delays resulting from these constraints will be recorded in the field logbooks and reported to the Agencies.

Step 5: Develop the Analytical Approach
The purpose of this step is to specify the appropriate population parameters for making estimates.

Population Parameters:

- Soil characterization including general parameters, metals, and hydrocarbon compounds and general hydrocarbon leachability.
- Persulfate, sulfate, oxidation reduction potential (ORP), pH, and petroleum hydrocarbons will be measured multiple times during the bench-scale TOD analysis.
- The results of the analysis will include TOD, optimal tested oxidant, and pH adjusting amendment dose (if needed to adjust pH).
- The OUR and total and dissolved ATP measurements.
- Quantification of bacteria populations.

Specification of Estimator:

- Soil characterization results will be used to establish soil conditions prior to analysis and post-treatment. The goal is to characterize the soil that is being sent for the treatability testing and not to document the *in-situ* conditions of the soil.
- Additionally, a secondary objective is to use select soil characterization results (nutrient, metals concentrations, and hydrocarbon leachability) along with current Site data to advise Site-specific action levels that will be protective of human health and the environment and guide the appropriate management (Figure 5) for hydrocarbon-impacted soil at the Site. With the exception of the SPLP analysis results, which will be collected immediately after excavation, the hydrocarbon-compound analysis results from the BRW Biotreatability QAPP will not be used to advise Site-specific action levels since volatiles will be lost during excavation and mixing. Only analytical results that are not compromised with sampling procedures (i.e., metals and nutrient analyses) will be used.

- Persulfate, sulfate, ORP, pH, and petroleum hydrocarbons will be measured multiple times during the bench-scale TOD analysis to track how the reaction is progressing.
- The TOD, optimal tested oxidant, and pH adjusting amendment dose (if needed to adjust pH) from the TOD analysis will be used to understand the significance of other reduced species (e.g., iron, manganese, organic carbon, pyrite, and other sulfide materials) in the soil sample that would consume the oxidant agent to a point where chemical oxidation would not be practicable as a treatment option. (Section 4.5.3.2).
- The OUR and total and dissolved ATP measurements will be used to assess microbial activity and the potential for toxicity in soil bacteria. (Section 4.5.3.3).
- Quantification of bacteria populations provides a line of evidence for biodegradation of petroleum hydrocarbons and, thus, native bacteria metabolism. (Section 4.5.3.3).

Specific Action Levels: Field screening results will be used to select appropriate sample location and depth within each sample target area to collect samples for laboratory analysis. Anticipated soil depth and soil conditions are detailed in Table 2.

Step 6: Specific Performance or Acceptance Criteria
The purpose of this step is to define performance or acceptance criteria that the data collected will need to include.

All analytical data collected as part of this BRW Biotreatability QAPP will be validated to ensure that the data are suitable for the intended purpose. Specific data validation processes that will be followed to ensure analytical results are within acceptable limits are detailed in Section 9.0. Since this is a bench-scale study to determine the treatability of the hydrocarbon-impacted soil, the data collected from Pace will undergo Stage 2A Verification and the data collected from AECOM and Provectus will undergo Stage 1 Verification as defined in EPA Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use (EPA, 2009). The data validation process will include evaluating analytical control limits and the precision, accuracy, representativeness, comparability, completeness, and sensitivity (PARCCS) parameters. If significant issues with the data are found, results will be discussed with the EPA.

Step 7: Develop the Plan for Obtaining the Data
The purpose of this step is to identify a resource-effective data collection design for generating data that are expected to satisfy the DQOs.

Section 4.0 describes the applicable data collection for this BRW Biotreatability QAPP. Procedures outlined in Section 4.0 are designed to ensure that the data will be of sufficient quality and quantity to answer the principal study questions outlined in Step 2 and to inform future activities in the area.

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 Biotreatability QAPP, all data gathered will be checked to ensure they are usable for their intended purposes. Analytical control limits and the PARCCS parameters of the data will be analyzed. If significant issues with any data are found, results will be discussed with EPA and Montana 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 6.

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 Contract Required Quantitation Limit (CRQL). If either of the sample results are less than 5 times the CRQL, the control limit used will be a difference between sample results less than the CRQL. 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 CRQL. If either of the sample results are less than 5 times the CRQL, the control limit used will be a difference between sample results less than 2 times the CRQL. 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). Note that the Laboratory Reporting Limit in Table 6 will be used as the CRQL for data validation.

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 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 EPA Contract Laboratory Program (CLP) Statement of Work for Inorganic Superfund Methods (EPA, 2016), the National Functional Guidelines for Inorganic Superfund Methods Data Review (EPA, 2020b), and the CFRSSI QAPP (ARCO, 1992b).

Representativeness

Representativeness is a qualitative parameter that is addressed through proper sampling program design. 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 BRW Biotreatability QAPP, the CPM will review the BRW Biotreatability QAPP to ensure that it is designed to collect the data and information necessary to meet the purpose of the study. 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 study. Sample representativeness may also be evaluated using the RPDs for field duplicate sample results, if applicable.

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 bench-scale testing was conducted generally following published methods, if values and units were sufficient for the database, if specific sampling points can be established and documented, and if field collection methods are similar. All Standard Operating Procedures (SOPs) for this study are included in Appendix A. Analysis methods for each analytical group are listed in Table 3. The applicable analytical group for each sampling location is listed in Table 2.

Completeness

Completeness determines if enough valid data have been collected to meet the study needs. Completeness is assessed by comparing the number of valid sample results to the number of sample results planned for the study. 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 study 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.

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 4. 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.

Hanby Soil Test Kit: The method of sensitivity or lower limit of detection from the Hanby Soil Test Kit is 1 parts per million (ppm) to 1,000 ppm for total petroleum hydrocarbons (TPH) in soil samples. The Hanby Soil Test Kit will determine the hydrocarbon compound; however, additional samples will be sent for laboratory analysis (Table 3).

Laboratory Analysis: The method sensitivity for laboratory analyses is determined as part of the laboratory SOPs. The Laboratory Reporting Limit for each analyte is listed in Table 3. These detection limits will be reviewed as part of the data validation process.

4.0 SAMPLING PROCESS AND DESIGN

The BRW Biotreatability QAPP will include sampling and laboratory analysis that may consist of up to four parts: an initial characterization of soil, a TOD analysis, an initial soil slurry analysis, and possibly an enhanced slurry analysis. Composite soil samples will be collected from test pits from the anticipated depths and soil conditions (i.e., soil type, hydrocarbon-compound concentrations, and/or COC concentrations) (Table 2). With the exception of SPLP samples which will be collected immediately, the samples will be thoroughly mixed per SOP-S-06 (Appendix A) to ensure homogenized, aliquot split samples. Split samples will be sent to Pace for the initial characterization analysis, to Provectus for the TOD analysis, and to AECOM for the soil slurry analyses. The following subsections provide the procedures and protocols necessary to complete these tasks. The project schedule is included in Table 1.

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 headquarters at 1101 S. Montana Street in Butte, Montana.

In a project meeting held prior to fieldwork, all field personnel will review this BRW Biotreatability 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 Biotreatability 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 this BRW Biotreatability 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

As Atlantic Richfield owns the property where the field activities will be performed, there are no property access tasks to be completed.

4.1.3 Utility Locates

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. There is a possibility that test pit locations could shift once underground utilities are located throughout the Site.

4.2 Sample Location and Frequency

To help determine appropriate Site-specific action levels and define the proper management plan for hydrocarbon-impacted soil (both inside and outside the waste removal corridor), additional information is needed on the characteristics of the soil, specifically on the soil's microbial activity, the hydrocarbon's leachability from soil, and biological degradation potential for hydrocarbon compounds within the soil.

It is anticipated that five test pits will be excavated at the approximate sample areas shown on Figure 3 and described in Table 2. These sample areas were selected to provide a range of soil types and COC and hydrocarbon-compound concentrations within the Site based on data collected from the Phase I Site Investigation (Atlantic Richfield, 2021c) and preliminary results from the Phase II Site Investigation (Section 2.3). The anticipated soil type, general concentrations, and justification for each sample location and depth are described in Table 2.

The final number and locations of test pits will be determined by the Field Team Leader and CPM in consultation with the Contractor QAO. Considerations that will impact the decision on sampling locations include location of utilities, infrastructure and land use in the area due to ongoing BSB operations, safety concerns, and equipment access.

4.3 Sample Designation

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 test pit number with the Site name followed by the sample interval enclosed in parentheses followed by the date. For example, a sample designated BRW21-TP75(1.5-3.2)-10072021 describes a sample from test pit BRW21-TP75 taken from a depth of 1.5-3.2 feet below existing grade on October 7, 2021. 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-TP75(1.5-3.2)-10072021**

Location/Year:	*"BRW21"* - BRW project area, collected in 2021.
Type:	*"TP"* - Test Pit
Location/Number:	*"75"* - Sample Location (corresponds with Test Pit ID No.). All sample locations will be plotted on the sampling maps.
Depth Interval:	*"(1.5-3.2)"* (upper limit-lower limit in feet).
Date:	*"10072021"* - sample collected on October 7, 2021.

For field duplicates, the depth interval will be replaced by "(T)." For example, a duplicate of BRW21-TP75(1.5-3.2)-10072021 would be BRW21-TP75(T)-10072021. Field duplicate samples will be recorded in the log or logbook, and the primary sample will be clearly indicated.

4.4 Sampling Equipment and Procedures

4.4.1 Equipment

Equipment used will include, but is not limited to, the following:

- Field logbook and pens.
- Field forms and references (Appendix B).
- USCS chart (ASTM D-2488) (Appendix B).
- Munsell color chart (Munsell, 2009).
- Measuring tape/wheel.
- XRF field unit – Niton™ XL# Analyzer (XL3).
- Sieve.
- Portable heater or oven.
- Two PIDs - 9.8 eV and 10.6 eV lamps with humidity filter.
- Hanby Soil Test Kit.
- Digital camera and/or digital video camera.
- Sharpshooter shovels and spoons or disposable sampling spoons.
- 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).
- Personal Protective Equipment (PPE).
- Resource-grade GPS unit.

Field equipment will be examined by the Field Team Leader or field team members to verify that it is in proper operating order prior to use. Equipment, instruments, tools, and other items requiring preventive 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 and PID units are in Appendix A and the manual for the Hanby Soil Test Kit is in Appendix C.

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 supplies and consumables 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.

4.4.2 Procedures

Excavation of test pits will follow the general procedures in SOP-S-06 (Appendix A). Specific to this study, certain modifications to the SOP are described in this section.

4.4.2.1 Test Pit Excavation

Test pits will be excavated using the appropriate excavating equipment capable of collecting samples up to a maximum depth of 15 feet. During excavation of the test pit, the following limits will be observed:

- Test pits will be excavated using a track-mounted or rubber-tired excavator capable of excavating to a maximum depth of 15 feet. The type of excavation equipment used (e.g., excavator model number, bucket type, teeth type, etc.) as well as any modifications to the equipment (e.g., hydraulic modifications, counterweights, boom extensions, bucket thumbs, attachments, etc.) will be documented.
- Test pits will be excavated until the anticipated depth is reached, until the equipment hits refusal (i.e., cannot excavate through material), to the limits of the equipment (i.e., 15 feet), or other Site-specific limitations are encountered (e.g., sidewall stability becomes insufficient, etc.). The final depth of the test pit will ultimately be determined by the Field Team Leader and CPM in consultation with the Contractor QAO based on field conditions and results from previous investigations.
- Excavated materials will be stockpiled a minimum of 3 feet from the edge of the excavation.
- From the ground surface to a depth of 4 feet, 1 wall of the test pit will be prepared for evaluation if the desired sample interval does not exceed 4 feet. The test pit should have 1 vertical smooth wall for evaluation and 1 sloping or stepped wall for egress into and out of the test pit. Field personnel may only enter the test pit if a competent person (as identified in the corresponding Task Risk Assessment) has examined the test pit and determined it is safe to enter.

- No personnel will be permitted access to test pits deeper than 4 feet during performance of this work.
- If the depth of the test pit is greater than 6 feet, field personnel must maintain a 6-foot horizontal distance from the edge of the test pit unless they are wearing a safety harness and are appropriately anchored as identified in the Task Risk Assessment.
- Indicators of test pit stability will be documented in the corresponding Task Risk Assessment to establish protocols to cease excavation and safely backfill if a test pit becomes or appears to become unstable.
- Dewatering of test pits will not be conducted due to the considerations of impacted groundwater.

4.4.2.2 Logging

The classification and lithology of the test pit sidewalls will be logged, and the areas photographed and/or videoed. This will include a soil log of the test pit sidewall that lists USCS classification (Appendix B); visual estimate of rock content (2-inch plus fraction); color (as per Munsell color chart [Munsell, 2009]); depth to top and bottom of each lithological unit; presence or absence of soil staining, odors, nodules, organic matter, and/or groundwater; and bedrock depth (if encountered). All relevant observations will be recorded in a bound field logbook and on the forms included in Appendix B.

4.4.2.3 PID Screening Analysis

During excavation of the test pit, visual and olfactory observations (sight and/or smell), and two PIDs (9.8 eV and 10.6 eV lamps) will be used to identify sources of hydrocarbons. A slow sweeping motion will be used to detect petroleum compounds with the PIDs. The PIDs will be used to screen the soil within the test pit immediately after excavation (if it is safe to enter the pit) or the PIDs will be used to screen the soil immediately after it is excavated. If it has been determined that VPHs 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 excavator to monitor conditions near the test pit. If hazardous conditions are present, appropriate action will be taken by safety personnel.

4.4.2.4 Sampling and Analysis Procedures

Because the objective of this work is to gather data for soil with a range of hydrocarbon-compound and COC concentrations, field screening tools will be used to verify the soil conditions assumed from previous investigations. For each test pit, once the anticipated depth is reached the Field Team Leader will visually inspect the soil to determine if the anticipated lithological layer and soil type are present (Table 2).

If the visual inspection confirms the anticipated lithological layer and soil type are present, the Field Team Leader will immediately collect a sample for SPLP analysis in the required sample container(s) (Table 3). Additionally, samples will be collected for field screening following the general procedures below:

- Use 2 PIDs, one with a 9.8 eV lamp and another with a 10.6 eV lamp, to screen for any petroleum compounds via the headspace method. The procedures for using the PID units 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. The MiniRAE 3000 unit has a 10.6 eV lamp and can detect VOCs with ionization potentials below 10.6 eV (i.e., most VOCs) with a detection range of 0 to 15,000 ppm. The UltraRAE 3000+ unit has a 9.8 eV lamp and can detect VOCs with ionization potentials below 9.8 eV (e.g., benzene), with a detection range of 50 parts per billion (ppb) to 200 ppm for benzene.
    - Once the anticipated soil conditions are verified, a laboratory sample will be immediately collected for hydrocarbon compounds (Table 3) in the appropriate sample containers (i.e., two 4-ounce amber glass containers and one 8-ounce amber glass container). Additionally, the field team will immediately collect a sample 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.

- Use a Hanby Soil Test Kit (or similar test kit as determined by field personnel) to screen for hydrocarbon compounds. The detection limit for the Hanby Soil Test Kit ranges from 1 ppm to 100,000 ppm. The general procedures for using the field test kit are summarized below and additional detail is included in the user manual accompanying the test kit:
    - Weigh 5 grams of soil sample to be analyzed.
    - Place sample into beaker.
    - Add solvent to sample in beaker.
    - Stir or mix sample and solvent to form an extract.
    - Pour extract into test tube.
    - Add catalyst to test tube.
    - Shake test tube.
    - Compare test tube to color ID chart to determine presence of TPHs.

If another field test kit is used, the user manual for that unit will be followed.

- Use field XRF analyses as a guide to screen the soil for COC concentrations. The detection limits for the XRF are included in Table 4.
    - For the XRF analysis, use a Niton™ XL3 XRF Analyzer (XL3) and follow the procedures outlined in SOP-SFM-02 (Appendix A) as well as the XL3 user manual to ensure that the techniques employed are appropriate for the analytes of interest.
    - Collect samples in a ziplock bag and mix the soil.

- Dry the samples if conditions require it and 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 degrees Celsius [°C]).

Once field screening has been completed and the results confirm the anticipated soil conditions (i.e., soil type, hydrocarbon-compound concentrations, and/or COC concentrations) are present, a sample will be collected from the anticipated depth and soil conditions specified in Table 2. If the anticipated soil conditions are not present, the Field Team Leader and CPM in consultation with the Contractor QAO will determine the appropriate action, which may include excavating another test pit within the same area. If it becomes necessary to dig another test pit, Field Team Leader, CPM, and Contractor QAO will determine the intervals to send samples to the laboratory. At a minimum, one sample will be collected for laboratory analysis from each identified sample area (Figure 3).

Samples will be collected in accordance with the general procedures in SOP-S-06 (Appendix A). Samples will be collected using a disposable hand scoop or decontaminated shovel by scraping soil from the sidewall or collecting it from the appropriate excavated piles or from the excavator bucket. An appropriate sample volume will be collected to provide enough material for each required analysis (Table 3). Any large and/or coarse fragments greater than 0.5 inches will be removed from the sample. With the exception of SPLP samples which will be collected immediately, the samples will be thoroughly mixed per SOP-S-06 (Appendix A) to ensure homogenized, aliquot split samples. After the sample is thoroughly mixed, samples will be transferred to the appropriate sample containers, labeled, and immediately placed into the designated storage container (e.g., cooler).

Some volatiles may be lost during the excavation of the test pits and mixing of the samples. To prevent the loss of volatiles during sampling, SPLP samples will be taken immediately following visual confirmation of anticipated soil lithology and the remaining VOC samples will be prioritized for collection after the mixing of samples. The loss of volatiles through mixing of the soil is acceptable to meet the primary objectives of this work (i.e., to help estimate the biological degradation potential for the hydrocarbon-impacted soil, help determine if high COC concentrations are impacting the microbial communities within the soil and possibly inhibiting the biodegradation process, and help understand the significance of other reduced species in the soil sample that would consume the oxidant agent to a point where chemical oxidation would not be practicable as a treatment option). Previous Site investigations have characterized the extent and concentrations of soil impacted with hydrocarbon compounds within the Site; therefore, this work is focused on the treatability of the soil within the Site and it is acceptable for some loss of volatiles during the sampling process to achieve this objective.

No water samples will be collected for laboratory analysis; however, the potential hydrogen (pH), specific conductance, ORP, and dissolved oxygen (DO) of groundwater that enters the test pit will be tested in the field, if feasible. All field water testing results will be recorded in the field logbook. The field team will record the information on the Test Pit Log form provided in Appendix B. The field team will also record the resource-grade GPS coordinates of all test pits.

4.4.3 Standard Operating Procedures

This document references Pioneer SOPs for activities that outline specific procedures to safely complete tasks involved in this BRW Biotreatability QAPP. The SOPs applicable to the work are referenced in the appropriate sections throughout this report, are listed in Table 5, and 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 SOP limitations. 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 DQO. 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.

4.4.4 Field Documentation

4.4.4.1 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 and/or videos 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 testing results.
- Personnel and equipment decontamination procedures.
- Deviations from the BRW Biotreatability QAPP or applicable field SOPs (Appendix A).

For each test pit the following entries will be made:

- Lithologic log of the test pit 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 test pit.
- Photograph or video of each test pit with a staff gage or tape measure for scale to document existing conditions. Include Site name ID in photograph or video using a white board or note pad.
- Abnormal occurrences, deviations from this BRW Biotreatability 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 description and designation, soil type and texture (e.g., sand, silt, etc.), grain size, and color (in the field).
- Split samples taken by other parties (Agencies, etc.). 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 (where samples are stored/shipped and by whom).

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

4.4.4.2 Field Photographs or Video

Photographs and/or video will be taken of sampling locations and field activities using a digital camera and/or digital video camera. Photographs or video 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 or video documenting Site conditions will be taken, as necessary.

Documentation of all photographs or video 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 or video 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.

4.5 Sample Handling and Analysis

4.5.1 Documentation and Shipping

Sample containers and holding times are listed in Table 3. All soil samples will be collected in the proper sample container. The sample ID, date/time, 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 Table 3. 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).

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. 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 in the project records.

All samples not submitted to the laboratory will be archived or contained at the Site. If samples must be archived, they will be transported to the Pioneer field office at 244 Anaconda Road in Butte, Montana, or an alternate suitable location. When it is determined that the samples are no longer needed for analysis, the samples will be analyzed for proper disposal in accordance with SOP-DE-03 (Appendix A).

4.5.2 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 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.

4.5.2.1 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.

4.5.2.2 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.

4.5.2.3 Laboratory Custody

Laboratory custody procedures will conform to procedures established for the EPA CLP (EPA, 2016). 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).

4.5.3 Laboratory Analysis Methods

Laboratory analysis of samples collected will be performed by laboratories with established protocols and QA procedures that meet or exceed EPA guidelines. 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. Standard laboratory turnaround times will be requested.

Samples will be sent to Pace for the initial characterization analysis, to Provectus for the TOD analysis, and to AECOM for soil slurry analyses. The anticipated laboratory analytical methods and procedures for the four parts are detailed below and summarized in Table 3. The planned laboratory analysis approach may be altered by the CPM, in consultation with the Contractor QAO. Agencies will be notified of any significant changes to the laboratory analysis approach.

4.5.3.1 Initial Characterization

Soil samples collected from the test pits will be sent to Pace for the initial characterization analysis. The initial characterization will include analysis for the following: general parameters, metals, hydrocarbon compounds, and leachability of hydrocarbon compounds (Table 3). Standard laboratory turnaround ties will be requested.

4.5.3.2 Total Oxidant Demand Analysis

One soil sample will be sent to Provectus to complete the TOD analysis. The TOD analysis is routinely performed by treatability laboratories and technology vendors to provide a starting point on how much oxidant agent will be consumed over a certain period of time (ASTM, 2016 and Haselow et al., 2003).

The sample will be selected to target soil within the preliminary waste removal corridor with the greatest concentration of high molecular weight hydrocarbons based on field screening and data collected from previous Site investigations.

Provectus will test varying doses of two to three different oxidant agents to understand the significance of other reduced species (e.g., iron, manganese, organic carbon, pyrite, and other sulfide materials) in the soil sample that would consume the oxidant agent to a point where chemical oxidation would not be practicable as a treatment option. Provectus will set up bench-scale reactors and test their Provect-Ox line of chemical oxidant, activators, and buffers at a range of concentrations. Persulfate, sulfate, ORP, pH, and petroleum hydrocarbons will be measured multiple times during the bench-scale tests to track how the reaction is progressing (Table 3). The results of the TOD analysis will include TOD, optimal tested oxidant, and pH adjusting amendment dose (if needed to adjust pH).

At the conclusion of the test, Provectus will submit a portion of the soil from each bench-scale reactor to Pace for a post-treatment analysis. The post-treatment analysis will include the following: total metals, hydrocarbon compounds (EPH, VPH, and PAH), and pH.

Based on the results from the TOD analysis and initial slurry analysis (described in Section 4.5.3.3), Atlantic Richfield will review results and determine if a sample of the post-treatment soil (i.e., soil that has undergone the TOD analysis) may be sent to the AECOM laboratory for a slurry analysis.

4.5.3.3 Initial Slurry Analysis

Soil samples will also be sent to AECOM to complete the initial soil slurry analyses. The general steps, provided by AECOM, for the soil slurry analyses are detailed below and generally follow published methods used to research the effects of metals toxicity on aerobic biodegradation or organic compounds (Olaniran et al., 2013 and Sobolev and Begonia, 2008.).

Upon receipt of the soil samples, AECOM will prepare a soil slurry for each composite soil sample. These soil slurries will consist of adding laboratory water (i.e., distilled deionized water) to each of the composite soil samples in 0.5-Liter glass media bottles. The target water to soil ratio will be 5:1 on a weight basis in order to promote mixing and increase contact among native bacteria, oxygen, hydrocarbons, and the native carbon and nutrients. Each soil slurry bottle will be capped with a porous foam plug to allow exchange of oxygen and carbon dioxide between the headspace and the room atmosphere.

The soil slurries will be mixed on a stir plate for 24 hours to establish a baseline level of biomass activity. At 24 hours, samples will be collected for measurements and analysis. The OUR and total and dissolved ATP measurements will be performed to assess the potential for toxicity in soil bacteria. The OUR indicates the rate of biomass respiration which is associated to overall biomass health and activity. The OUR will be measured on an aliquot from the soil slurry using a biological oxygen demand (BOD) bottle and a DO probe. Three OUR measurements will be performed after 24 hours of incubation for QC.

As it is responsible for transferring energy between electron donors (food source) and electron acceptors (oxygen), ATP is a key molecule for bacteria cell metabolism. The ATP can be measured as total and dissolved ATP. Dissolved ATP is an indication of bacteria cells that underwent lysis (death), and thus it is a measurement of inactive biomass. By measuring both total and dissolved ATP, the ATP measurements related to active biomass can be calculated (Active ATP equals the Total ATP minus Inactive [Dissolved] ATP). In addition, a biomass stress index factor can be obtained from these measurements. Both the absolute number of ATP counts (including total, active, or inactive ATP) and the stress index indicate the biomass health and can be used to make relative comparisons among the different soil slurries. The ATP will be measured by taking a liquid sample from each soil slurry and processing it using the LuminUltra reactant kit and a luminometer. For each ATP measurement a duplicate measurement will be taken for QC. Additionally, the ATP standard will be used at the beginning and end of each batch and every 10 measurements to ensure the equipment is operating properly.

Microbial analysis to quantify bacteria populations will be subcontracted by AECOM to Microbial Insights to perform their CENSUS-qPCR method. The method amplifies the DNA gene that encodes for a biomarker target, in this case for total bacteria. The results are reported as bacteria cells/milliliter (for aqueous samples) or cells/gram (for soil samples). Approximately 10 grams of soil sample will be collected for microbial analysis. In addition to the total bacteria biomarker, functional genes related to the biodegradation of petroleum hydrocarbons will also be analyzed via CENSUS-qPCR. These will include the monooxygenase (almA) and alkane monooxygenase (alkB) genes, which encode for the enzymes responsible for short (C5-C16) and long (C20-C32) chain hydrocarbon compounds. The detection of these functional genes provides a line of evidence for biodegradation of petroleum hydrocarbons and, thus, native bacteria metabolism. Assay calibration, assay positive control, DNA extraction negative control, and assay negative control samples will be run during the analysis for QC.

4.5.3.4 Enhanced Slurry Study

Based on the findings from the initial microbial analysis, an enhanced analysis may be needed if results from the initial microbial analysis indicate the microbial activity is inadequate to quantify bacteria populations. The enhanced slurry study will stimulate or enhance the microbial activity to gather better results. If completed, the enhanced slurry study will be performed by AECOM. If performed, the enhanced microbial analysis will be similar to the initial analysis with the following exceptions:

- Nutrients, most likely salts containing nitrogen and phosphorus, and an external carbon source, such as diesel, will be added to the soil slurries when they are prepared. Nutrients and complex hydrocarbons, such as diesel, are necessary to stimulate the soil microbial activity for this study. Diesel was determined to be an appropriate external carbon source since previous Site investigation results indicated that EPHs, which are typically considered diesel range organics, are the primary concern with treatability of the soil within the Site. Therefore, diesel is expected to provide an appropriate food source for the microbial community.
- The soil slurries will go through a 2-week incubation period prior to selecting samples to submit for microbial analysis. During that 2-week incubation period, AECOM will sample the soil slurries 4 times to measure OUR and ATP.

As with the initial slurry study, Microbial Insights will be contracted by AECOM to perform their CENSUS-qPCR method to quantify bacteria populations. The CPM in consultation with the Contractor QAO will determine if the enhanced slurry study must be completed.

5.0 QUALITY ASSURANCE/QUALITY CONTROL SAMPLES

5.1.1 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. The following quality samples only apply to the laboratory samples submitted to Pace for the initial characterization of soil. All field QC samples will be shipped with field samples to Pace per SOP-SA-01 in Appendix A. Brief descriptions of the field QC samples are provided below, along with when and how many are to be collected.

Field Duplicate

At least 1 field duplicate will be collected for this sampling event since it is anticipated that there will be less than 20 samples collected for analysis. If more than 20 samples are collected, additional field duplicates will be collected so that a minimum of 1 duplicate is collected for every 20 natural samples. A field duplicate is an identical, second sample collected from the same location, in immediate succession of the primary sample, using identical techniques. 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.

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 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.

5.1.2 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 sheet 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 U.S. Geological Survey [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 analysis of the same sample will be performed to assess reproducibility of field procedures and soil heterogeneity. To run a duplicate sample on the Niton XL3, field personnel will remove the ziplock bag from the analytical stand, knead the ziplock bag once or twice, and replace it in the stand to be analyzed a second time. Duplicate samples will be recorded on the XRF field data form with a D designator in the sample identification number. A 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 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 without any remixing of the sample that is performed with duplicate analyses. Replicate samples help in assessing the stability and consistency of the XRF analysis. Replicate sample results will be recorded on the XRF field data form and designated with an R in the sample identification number.

5.1.3 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. The following laboratory QC samples only apply to the laboratory samples submitted to Pace for the initial soil characterization.

Method Blank
One method blank (MB) sample will be prepared and analyzed for this sampling event. The MB is laboratory deionized water that has gone through the applicable sample preparation and analysis procedure. Control limits vary based on the laboratory method performed and are contained in the applicable laboratory method and SOP. Failure will trigger corrective action and the blank will be reanalyzed. All samples will be footnoted with the appropriate flag to document contamination in the blank.

Laboratory Control Sample
A LCS will be prepared and analyzed for the applicable methods following the method required frequency with at least one associated with this sampling event for each applicable method. Control limits vary based on the laboratory method performed 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 reanalyzed. If reanalysis of the samples fails, the samples will need to be re-digested and reanalyzed.

Matrix Spike/Matrix Spike Duplicate
Sufficient material will be supplied and the laboratory will be requested to perform at least one matrix spike (MS) and matrix spike duplicate (MSD) sample for parameters analyzed by SM 2320B, EPA 351.2, EPA 9056A, EPA 350.1, EPA 6010, EPA 6020, EPA 7471B, MTVPH, MTEPH, EPA 8270SIM, and EPA 8015 (Table 3). The control limits also depend on the method used 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.

Laboratory Duplicate Sample

One laboratory duplicate sample (LDS) will be prepared and analyzed for this sampling event. A LCS and LCS 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.

5.2 Instrument/Equipment Testing, Inspection, Maintenance and Calibration

To ensure continual quality performance of all instruments and equipment, the testing, inspection, and maintenance activities 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.

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 preventive 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 water quality parameters from groundwater that enters the test pit as defined in previous sections and in the field equipment SOPs (Appendix A). Following proper safety protocols, a grab sample will be collected from the test pit and the multi-parameter probe will be submerged in the sample.

PID Unit

Screening for petroleum compounds will be conducted using 2 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 4.4.2.3 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.

Hanby Soil Test Kit

The Hanby Soil Test Kit will be used to determine the hydrocarbon concentrations within the soil. The procedure identifies the aromatic compounds and provides a colorimetric identification of the concentration and types of contaminants present. A manual identifying the procedures for this kit is in Appendix C.

XRF Unit

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

5.3 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 (Section 8.1.2) will be responsible for inspecting laboratory supplies in accordance with the laboratory QA program.

5.4 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, 2017). The BRW Biotreatability QAPP quality records will be maintained by Atlantic Richfield. These records, in either electronic or hard copy form, may include the following:

- Project work plans with any approved modifications, updates, and addenda.
- BRW Biotreatability QAPP with any approved modifications, updates, addenda, and any approved corrective or preventive 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 versions. 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 Level 4 data packages (simplified format), 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.

6.0 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 Biotreatability 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 system audits of field and laboratory data collection and reporting procedures are described in this section.

6.1 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 Biotreatability 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 Biotreatability QAPP, the deviation and the reasons for the deviation will be noted and then signed by the agency personnel.

6.2 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 this BRW Biotreatability 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 8.0) and reported on a Corrective Action Report (CAR) form included in Appendix E, 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.

6.3 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 re-submitting Level 4 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.

6.4 Quality Assurance Reports to Management

After the study 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 work performed.
- Summary of the 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 prior to the Intermediate 60% RD Report for the Site.

7.0 HEALTH AND SAFETY

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

8.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

The roles, duties, and responsibilities of personnel assigned to the BRW Biotreatability QAPP are provided below. An organizational chart showing the overall organization of the project team is detailed on Figure 6.

Atlantic Richfield Liability/Project Manager – Josh Bryson
The Atlantic Richfield Liability/Project Manager 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 Quality Assurance Manager (QAM) – David Gratson
The Atlantic Richfield QAM interfaces with the Atlantic Richfield Operations Project Manager on company policies regarding quality and has the authority and responsibility to approve specific QA documents including this BRW Biotreatability QAPP. Mr. Gratson is employed by Environmental Standards, Inc.

Contractor
Pioneer Technical Services, Inc. (Pioneer) is the contractor responsible for conducting the elements of the BRW Biotreatability QAPP 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 Biotreatability QAPP, and verifying effective implementation of BRW Biotreatability 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 Biotreatability 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 Biotreatability QAPP and associated RFCs have been reviewed by all members of the field team and the BRW Biotreatability 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 BRW Biotreatability QAPP 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.

8.1.1 Subcontractors

One subcontractor will assist with the BRW Biotreatability QAPP. This company will subcontract to Pioneer and follow all health and safety protocols established by Pioneer to work on the Site. The subcontractor (below) was selected based on the unique skillset and specialized equipment:

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

8.1.2 Laboratories

Three laboratories have been selected to provide analytical services: Provectus, Pace, and AECOM. These laboratories are required to generate and report high quality data that identify and define the physical and chemical characteristics of soil for environmental investigations, remediation activities, long-term monitoring programs, discharge compliance monitoring, and/or 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." 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.

9.0 DATA VALIDATION AND USABILITY

Since this is a bench-scale study to determine the treatability of the hydrocarbon-impacted soil, the data collected from Pace will undergo Stage 2A Verification and Validation and the data collected from AECOM and Provectus will undergo Stage 1 Verification and Validation Manual as defined in *EPA Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use* (EPA, 2009).

9.1 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.

9.1.1 Data Review Requirements

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

9.1.1.1 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.

9.1.1.2 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.

9.1.2 Data Verification Requirements

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

9.1.2.1 Field Data Verification

The Level A/B review, as described in the CFRSSI Data Management/Data Validation (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 container 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.

9.1.2.2 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.

Each data package from Pace will be accompanied by an EDD prepared by Pace. 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. AECOM will not provide an EDD as part of the data package.

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

- 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).

9.1.2.3 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.

9.1.3 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, 2020b), the National Functional Guidelines for Organic Superfund Methods Data Review (EPA, 2020c), 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.

9.2 Verification and Validation Methods

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

Stage 1 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.

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.
- Method blanks.
- LCS and LCSD.
- MS samples and MSD samples.
- Laboratory duplicate samples.
- Field blanks.
- Field duplicates.
- Trip Blanks.
- Surrogates.

Stage 2A data validation for each laboratory data package will be documented on the data validation checklists in Appendix D.

Data qualifiers will follow those used in the National Functional Guidelines for Inorganic Superfund Methods Data Review (EPA, 2020b) and the National Functional Guidelines for Organic Superfund Methods Data Review (EPA, 2020c).

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.

9.3 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 study 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 Plan (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, conformational purpose, risk assessment, and engineering design.
2. Screening Quality (Restricted Use) Data. Potential uses of screening quality data, depending on 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 usable 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.

Data that are only qualified as a result of the reported value lying between the laboratory reporting limit and the detection limit are also considered enforcement quality.

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

10.0 REFERENCES

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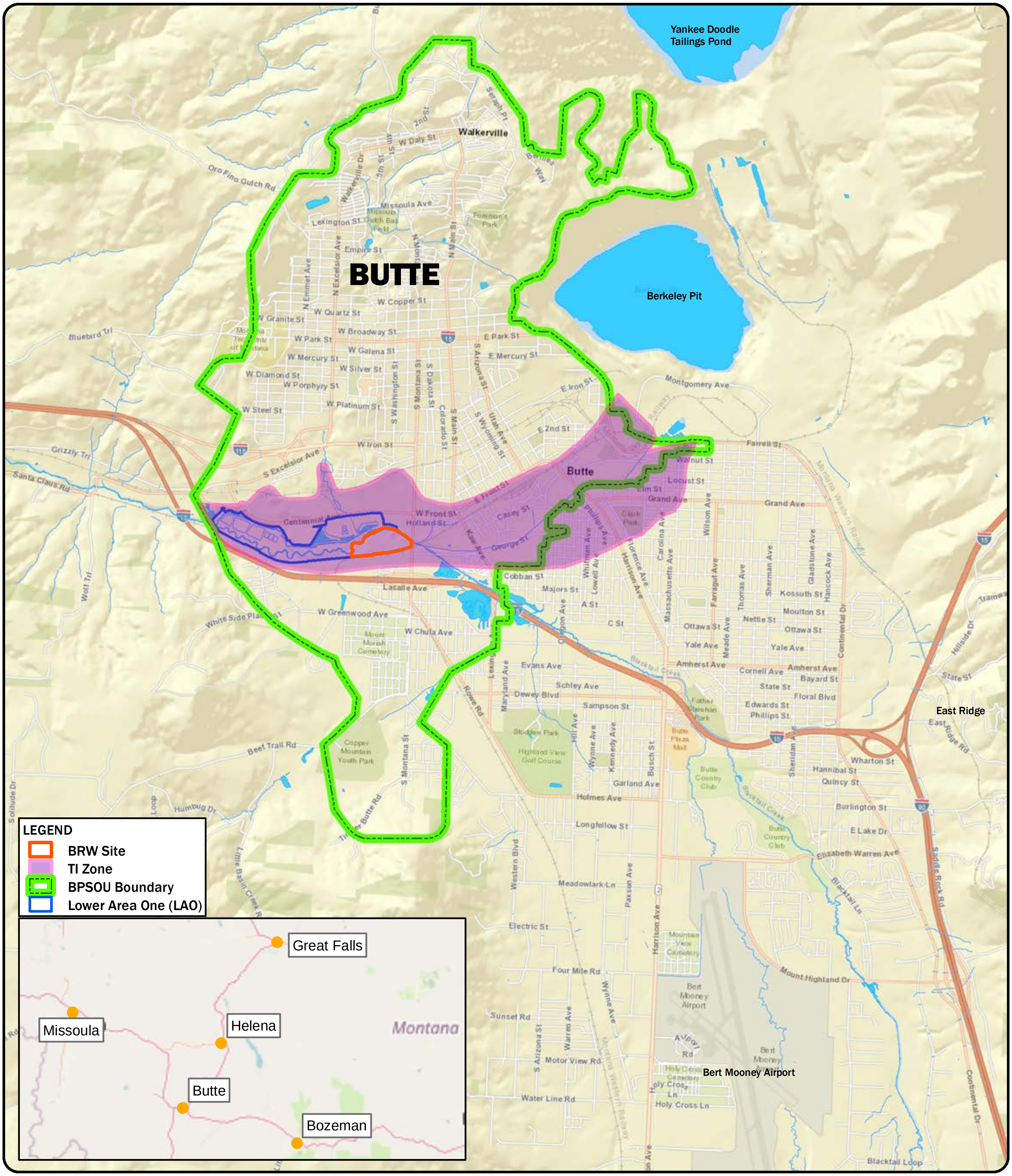
FIGURES



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PROJECTION/ZONE: MSP
DATUM: NAD 83
UNITS: INT'L FT
SOURCE: PIONEER/ARCO/BSB

0 0.375 0.75 1.5
Miles

FIGURE 1

SITE LOCATION MAP

PIONEER TECHNICAL SERVICES, INC.

Date: 8/11/2021

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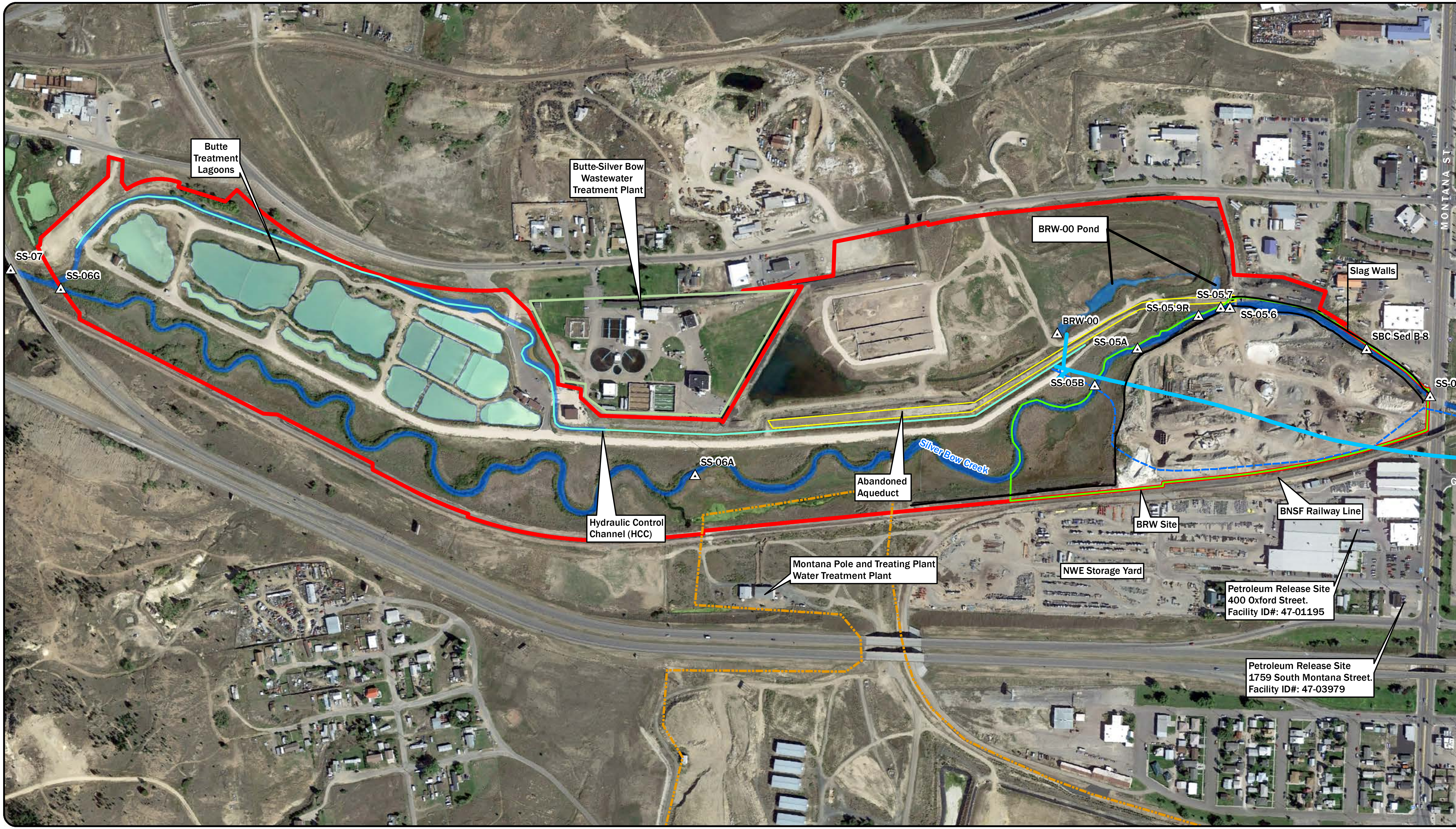


Surface Water Monitoring Points
BPSOU Subdrain Pump System Primary Force Main
BPSOU Subdrain Pump System Alternative Discharge Line
Hydraulic Control Channel
Slag Walls
BRW Site Boundary
BTL/LAO
LAO Boundary
Butte-Silver Bow Wastewater Treatment Plant Boundary
Abandoned Aqueduct
MPTP NPL Site

N

DISPLAYED AS:
PROJECTION/ZONE: MSP
DATUM: NAD 83
UNITS: INTERNATIONAL FEET
SOURCE: PIONEER/TREC/GOOGLE

0 200 400 800
Feet

FIGURE 2

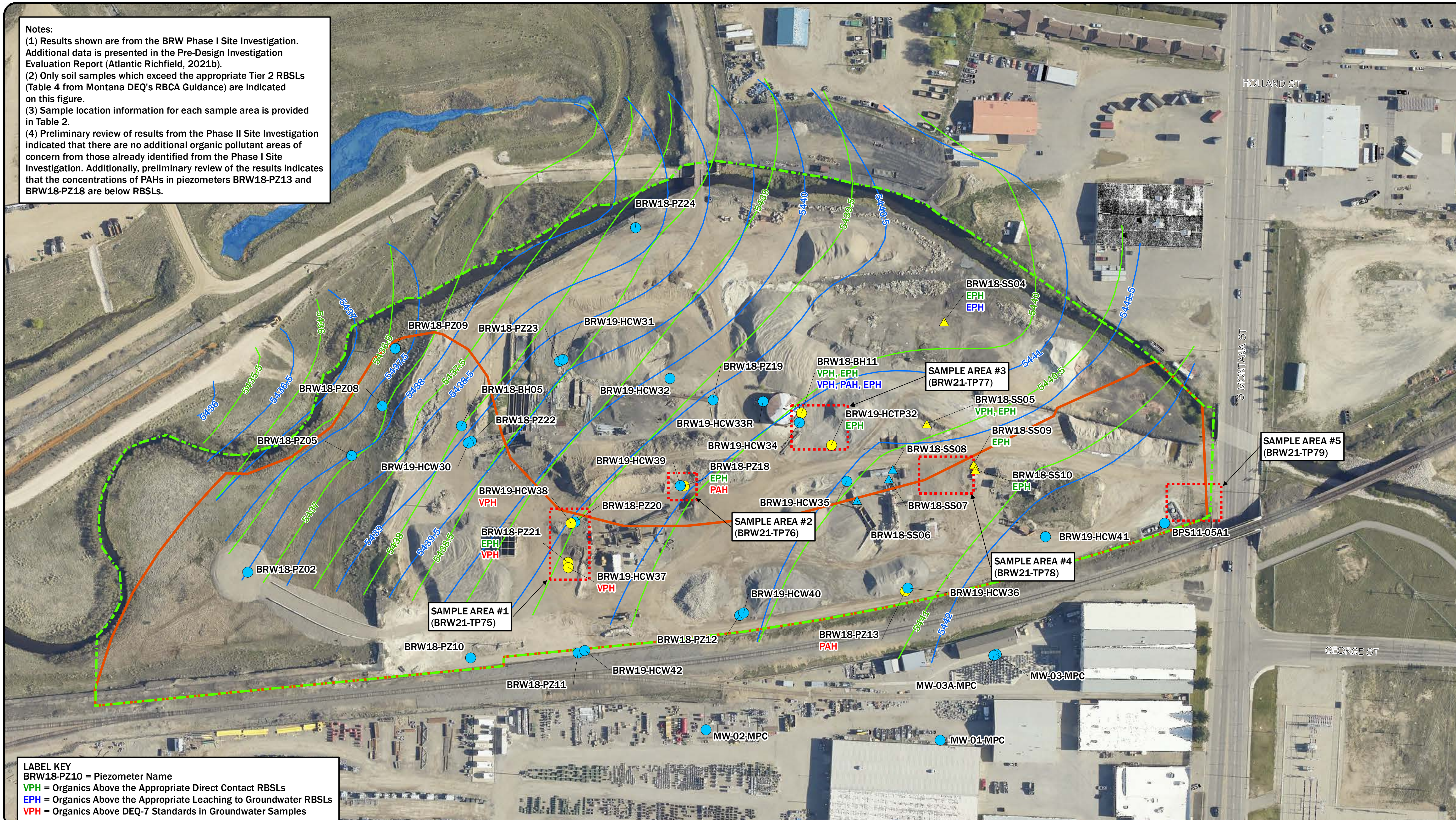
PIONEER TECHNICAL SERVICES, INC.

LOWER AREA ONE AND BRW SMELTER AREA SITE MAP

DATE: 10/29/2021

Path: Z:\Shared\Active Projects\ARCO\BPSOU\BRW\GIS\Z_PDI Evaluation Report_PI\BRW_PI_PDIER_002_SteMp_21.mxd

Notes:
(1) Results shown are from the BRW Phase I Site Investigation. Additional data is presented in the Pre-Design Investigation Evaluation Report (Atlantic Richfield, 2021b).
(2) Only soil samples which exceed the appropriate Tier 2 RBSLs (Table 4 from Montana DEQ's RBCA Guidance) are indicated on this figure.
(3) Sample location information for each sample area is provided in Table 2.
(4) Preliminary review of results from the Phase II Site Investigation indicated that there are no additional organic pollutant areas of concern from those already identified from the Phase I Site Investigation. Additionally, preliminary review of the results indicates that the concentrations of PAHs in piezometers BRW18-PZ13 and BRW18-PZ18 are below RBSLs.



LABEL KEY
BRW18-PZ10 = Piezometer Name
VPH = Organics Above the Appropriate Direct Contact RBSLs
EPH = Organics Above the Appropriate Leaching to Groundwater RBSLs
VPH = Organics Above DEQ-7 Standards in Groundwater Samples

- Surface, Sampled and No Results Above RBSLs or DEQ-7 Standards
- Subsurface, Sampled and No Results Above RBSLs or DEQ-7 Standards
- Surface, Soil Concentrations Above RBSLs
- Subsurface, Soil and/or Groundwater Above RBSL's and/or DEQ-7 Standards
- BRW Site Investigation Area
- Sample Area for Biotreatability Study Test Pit
- Preliminary Waste Removal Corridor
- April 2019 Groundwater Contours (NAVD 88)
- Feb. 2019 Groundwater Contours (NAVD 88)

N

DISPLAYED AS:
PROJECTION/ZONE: MSP
DATUM: NAD 83
UNITS: INT'L FT
SOURCE: PIONEER/QUANTUM 2020

0 75 150 300
Feet

FIGURE 3

PIONEER TECHNICAL SERVICES, INC.

PROPOSED SAMPLE AREAS FOR BIOTREATABILITY TEST PITS

DATE: 11/2/2021

Path: Z:\Shared\Active Projects\ARCO\BPSOU\BRW\GIS\Z_BiotreatabilityStudy\BRW_BioTreat_SAP_001__21.mxd

TEST PIT

REPORTED EVIDENCE OF HYDROCARBON IMPACTS
HC SHEEN - HYDROCARBON SHEEN; LNAPL - LIGHT NON-AQUEOUS PHASE LIQUID;
530 PPM - CONCENTRATION MEASURED WITH FLAME IONIZATION DETECTOR (PARTS PER MILLION)

INVESTIGATION AREA
(NATURAL RESOURCE DAMAGE PROGRAM, 2016)

N

DISPLAYED AS:
PROJECTION/ZONE: MSP
DATUM: NAD 83
UNITS: INTERNATIONAL FEET
SOURCE: PIONEER/QSI 2020

0 75 150 300
Feet

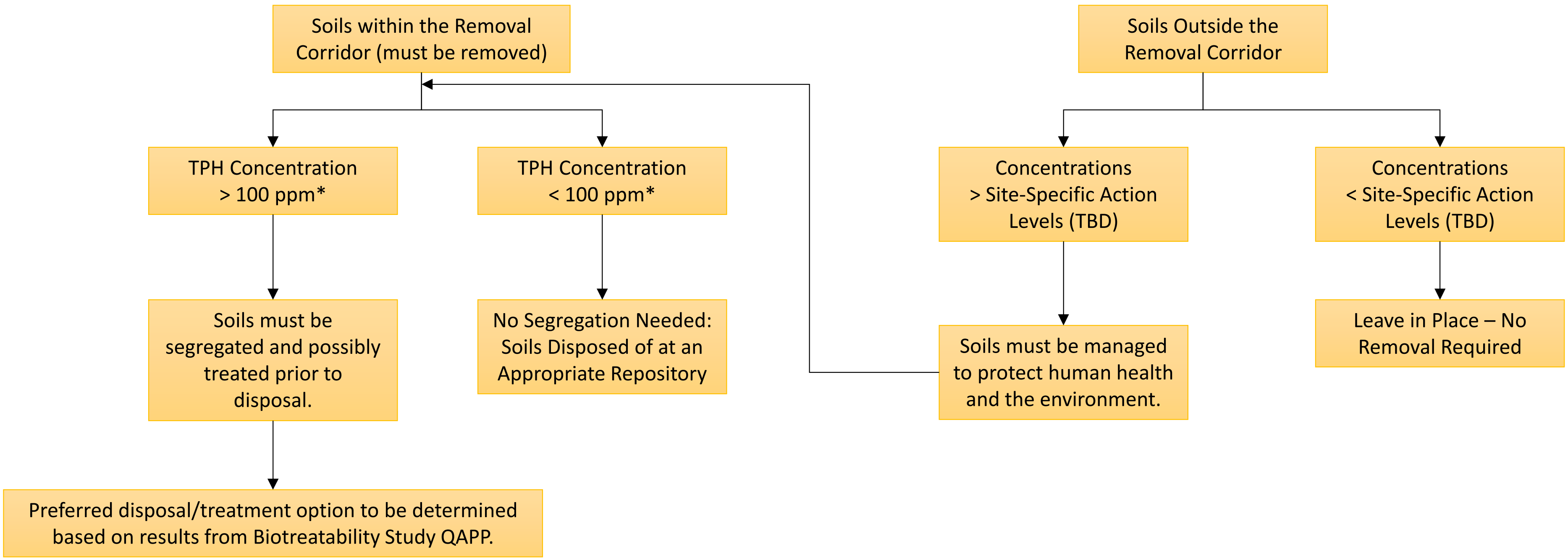
FIGURE 4

PIONEER TECHNICAL SERVICES, INC.

TEST PIT LOCATIONS
BUTTE REDUCTION WORKS
SMELTER SITE
DATA GAPS INVESTIGATION

DATE: 10/29/2021

Path: Z:\Shared\Active Projects\ARCO\BPSOU\BRW\GIS\Z_BiotreatabilityStudy\BRW_PII_RFC_004_DataGaps_21.mxd



*Assuming that the new repository threshold for hydrocarbons will be the same as the Mine Waste Repository.

Figure 5 **Hydrocarbon Management Approach**

PIONEER TECHNICAL SERVICES, INC.

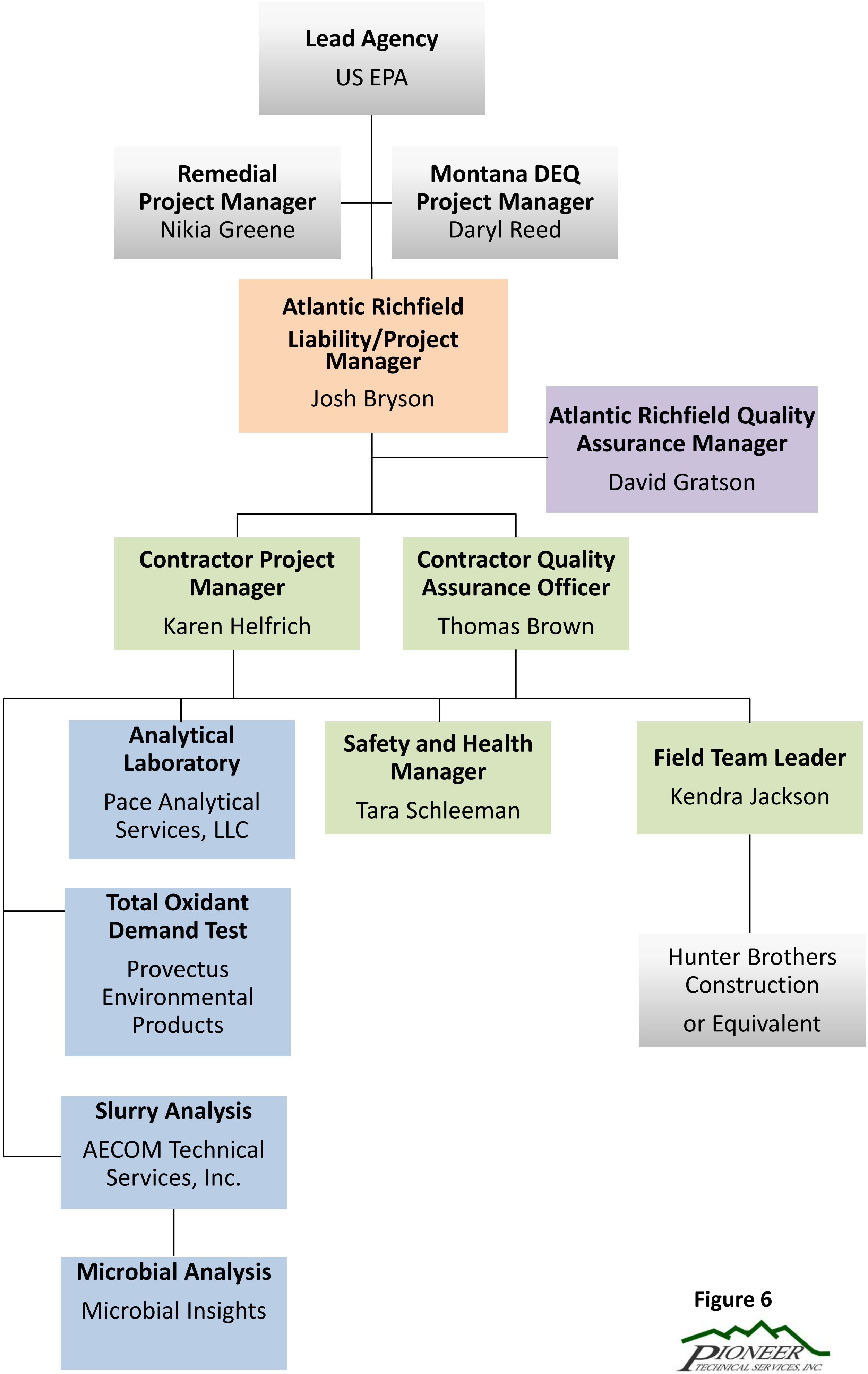


Figure 6

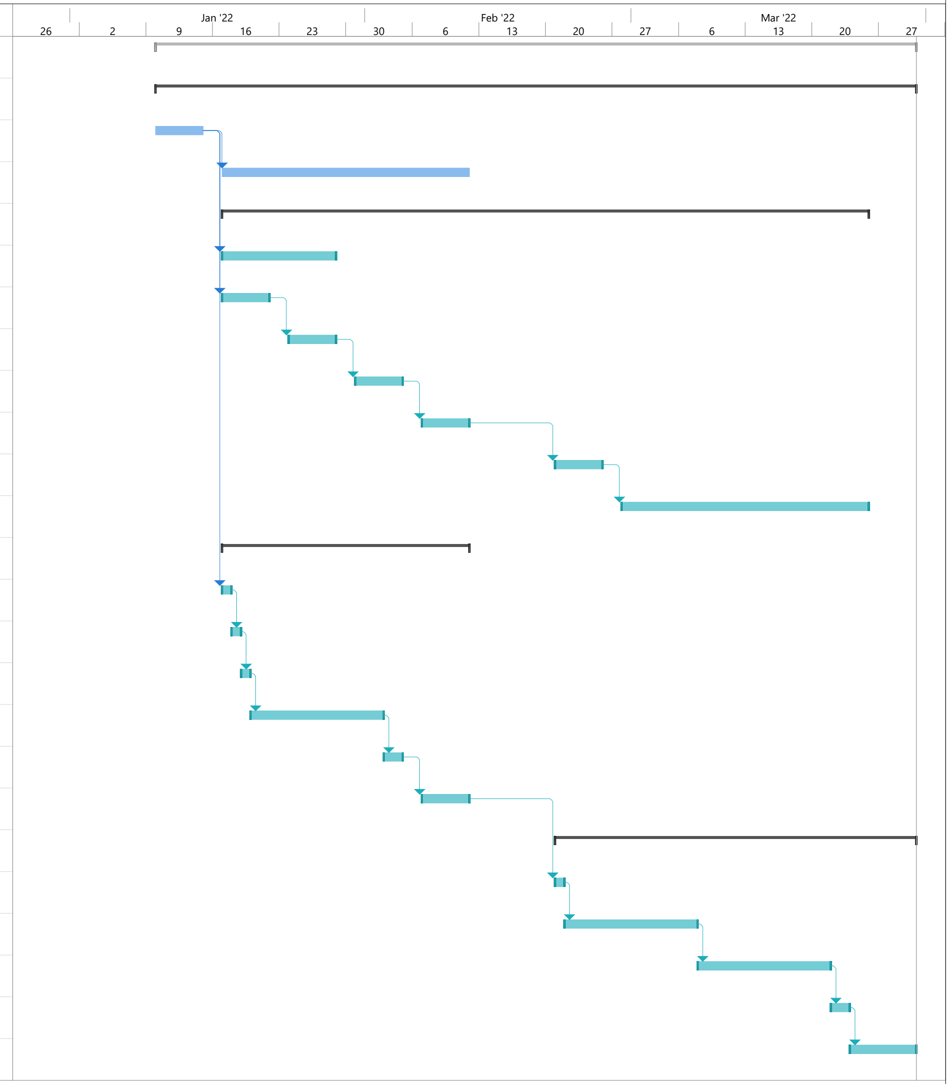
PIONEER TECHNICAL SERVICES, INC.

Project Organization Chart

TABLES

Table 1
Schedule

ID	Task Name	Duration	Start	Finish	Predecessors
0	**Table 1_Schedule**	**58 days**	**Mon 1/10/22**	**Wed 3/30/22**	
1	**Hydrocarbon Microbial Sampling**	**58 days**	**Mon 1/10/22**	**Wed 3/30/22**	
2	Sampling & Shipment	5 days	Mon 1/10/22	Fri 1/14/22	
3	Pace Lab Analysis	4 wks	Mon 1/17/22	Fri 2/11/22	2
4	**Provectus TOD Analysis**	**50 days**	**Mon 1/17/22**	**Fri 3/25/22**	
5	TOD Testing	2 wks	Mon 1/17/22	Fri 1/28/22	2
6	Baseline Sampling & Confirmation of Results	1 wk	Mon 1/17/22	Fri 1/21/22	2
7	Reactor Development	1 wk	Mon 1/24/22	Fri 1/28/22	6
8	7 Day Sampling	1 wk	Mon 1/31/22	Fri 2/4/22	7
9	14 Day Sampling	1 wk	Mon 2/7/22	Fri 2/11/22	8
10	28 Day Sampling	1 wk	Mon 2/21/22	Fri 2/25/22	9FS+5 days
11	Report Development and Submittal	4 wks	Mon 2/28/22	Fri 3/25/22	10
12	**Initial Slurry Study**	**20 days**	**Mon 1/17/22**	**Fri 2/11/22**	
13	Samples Inspection and Re-Homogenization	1 day	Mon 1/17/22	Mon 1/17/22	2
14	Slurry Reactors Assembly and Mixing	1 day	Tue 1/18/22	Tue 1/18/22	13
15	Measurements of OUR and ATP, Sample Collection for Microbial Analysis	1 day	Wed 1/19/22	Wed 1/19/22	14
16	Turnaround Time for Microbial Analysis	10 days	Thu 1/20/22	Wed 2/2/22	15
17	Data Review and Interpretation	2 days	Thu 2/3/22	Fri 2/4/22	16
18	Report Writing	5 days	Mon 2/7/22	Fri 2/11/22	17
19	**Enhanced Slurry Study (Tentative)**	**28 days**	**Mon 2/21/22**	**Wed 3/30/22**	
20	Slurry Reactors Assembly	1 day	Mon 2/21/22	Mon 2/21/22	18FS+5 days
21	Reactors Incubation and In-House Data Collection	10 days	Tue 2/22/22	Mon 3/7/22	20
22	Turnaround Time for Microbial Analysis	10 days	Tue 3/8/22	Mon 3/21/22	21
23	Data Review and Interpretation	2 days	Tue 3/22/22	Wed 3/23/22	22
24	Report Writing	5 days	Thu 3/24/22	Wed 3/30/22	23



Project: Table 1_Schedule
Date: Mon 11/22/21

Summary Progress | Task | Split | Milestone | Summary | Project Summary | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | External Tasks | External Milestone | Deadline | Progress | Manual Progress

Table 2. Sample Location Information

Sampling Area*	Location ID	Anticipated Depth	Anticipated Soil Conditions for Sampling (Soil Type, Hydrocarbon-Compound Concentrations, and/or COC Concentrations)	Justification
Biotreatability Study Test Pits				
#1	BRW21-TP75	10 to 15-feet bgs	Gravel to silty sand, slag. Located at the groundwater table. Groundwater is anticipated to be approximately 10 to 13-feet bgs. PID (10.6 eV lamp) reading near or greater than 500 ppm and PID (9.8 eV lamp) reading near of greater than 100 ppm. COC concentrations above Waste Identification Criteria (EPA, 2020). Anticipated soil conditions are based on lithology logs for piezometers BRW19-HCW37, BRW19-HCW38, BRW18-PZ20, and BRW18-PZ21.	Based on previous site investigation activities at the Site, this location was selected based on hydrocarbon-compound concentrations above DEQ Tier 2 RBSLs (DEQ, 2018) for EPH in piezometer BRW18-PZ21. The exceedances were just at the groundwater table and within a layer of soil that exceeds the Waste Identification Criteria (EPA, 2020). Additionally, this location is along the edge of the Preliminary Waste Removal Corridor boundary. Additional information is needed in this area to help determine Site-specific action levels and help determine the proper treatment/disposal methods if the soil is removed as part of the waste removal or determine proper management methods if the soil is ultimately outside the Preliminary Waste Removal Corridor to protect the remedy.
#2	BRW21-TP76	5 to 10-feet bgs	Sandy silt to silty sand with a hydrocarbon odor. Above a brown, red, orange layer and above groundwater surface. Groundwater is anticipated to be approximately 7-feet bgs. PID (10.6 eV lamp) reading near or greater than 500 ppm and PID (9.8 eV lamp) reading near of greater than 100 ppm. COC concentrations above Waste Identification Criteria (EPA, 2020). Anticipated soil conditions are based on lithology logs for piezometers BRW19-HCW39 and BRW18-PZ18.	Based on previous site investigation activities at the Site, this location was selected based on hydrocarbon-compound concentrations above DEQ Tier 2 RBSLs (DEQ, 2018) for EPH in piezometer BRW18-PZ18. The exceedances were just above the groundwater table and within a layer of soil that exceeds the Waste Identification Criteria (EPA, 2020). Additionally, this location is along the edge of the Preliminary Waste Removal Corridor boundary. Additional information is needed in this area to help determine Site-specific action levels and help determine the proper treatment/disposal methods if the soil is removed as part of the waste removal or determine proper management methods if the soil is ultimately outside the Preliminary Waste Removal Corridor to protect the remedy.
#3	BRW21-TP77	10 to 15-feet bgs	Soft, wet, silty clay with a hydrocarbon odor. Soil most likely located just below groundwater table. Groundwater is anticipated to be approximately 10-feet bgs. PID (10.6 eV lamp) reading near or greater than 500 ppm and PID (9.8 eV lamp) reading near of greater than 100 ppm. COC concentrations above Waste Identification Criteria (EPA, 2020). Anticipated soil conditions area based on lithology logs for borehole BRW18-BH11, piezometer BRW19-HCW34, and test pit BRW19-HCTP32.	Based on previous site investigation activities at the Site, this location was selected based on hydrocarbon-compound concentrations above DEQ Tier 2 RBSLs (DEQ, 2018) for VPH, EPH, and PAH in borehole BRW18-BHll and for EPH in test pit BRW19-HCTP32. Additionally, this location is along the edge of the Preliminary Waste Removal Corridor boundary. Additional information is needed in this area to help determine Site-specific action levels and help determine the proper treatment/disposal methods if the soil is removed as part of the waste removal or determine proper management methods if the soil is ultimately outside the Preliminary Waste Removal Corridor to protect the remedy.
#4	BRW21-TP78	0 to 1-foot bgs	Surface soils with visible staining, hydrocarbon odors, and detectable concentrations of hydrocarbons with Hanby Field Soil Kit.	Based on previous site investigation activities at the Site, multiple surface sample locations within this area were above DEQ's Tier 2 RBSLs (DEQ, 2018) for EPH, specifically the heavier hydrocarbon chains. This area is within the Preliminary Waste Removal Corridor. Additional information is needed in this area to help determine Site-specific action levels and help determine the proper treatment/disposal methods if the soil is removed as part of the waste removal.
#5	BRW21-TP79	1 to 5-feet bgs	Silty sand and gravel. No detectable hydrocarbons. Generally low COC concentrations, no COC concentrations above Waste Identification Criteria (EPA, 2020). Groundwater is anticipated to be approximately 5-feet bgs. Anticipated soil type is based on well log for monitoring well BPS11-05A1 since piezometers BRW18-PZ14 and BRW18-PZ15 were potholed to 8-feet bgs. There are multiple utilities in the area and the final test pit location will be adjusted based on the location of those utilities.	Based on previous site investigation activities at the Site, this location is the most likely area within the Site where a background sample (i.e., generally lower COC concentrations and no detectable hydrocarbons) could be collected.

*Sampling area locations are shown on Figure 3.

Acronyms
ppm = parts per million
bgs = below ground surface
COC = contaminant of concern
PID = Photoionization Detector
eV = electron volt
DEQ = Montana Department of Environmental Quality
RBSL = Risk-Based Screening Level

References:

EPA, 2020. Consent Decree for the Butte Priority Soils Operable Unit. Partial Remedial Design/Remedial Action and Operation and Maintenance. U.S. Environmental Protection Agency. February 13, 2020. Available at https://www.co.silverbow.mt.us/2161/ButtePriority-Soils-Operable-Unit-Conse.

DEQ, 2018. Montana Risk-Based Corrective Action Guidance for Petroleum Releases, Montana Department of Environmental Quality, May 2018. Available at this site http://deq.mt.gov/Land/statesuperfund/rbca_guide.

Table 3. Sample Collection, Preservation, and Holding Times

Analytical Lab/Company[1]	Analyte	Analytical Method	Lab Reporting Limit *(CRQL for Data Validation Purposes)*	Lab Method Detection Limit[2]	Holding Time	Container Size	Preservation[3]	Justification
Pioneer	pH	NA	NA	NA	NA	NA	NA	Determine general parameters of groundwater encountered during test pit excavation, if feasible.
	Specific Conductance (SC)							
	Oxidation Reduction Potential (ORP)							
	Dissolved Oxygen (DO)							
Pioneer XRF	Arsenic (As)	NA	NA	NA	NA	NA	NA	Field screening to confirm preferred soil conditions are present for biotreatability study.
	Cadmium (Cd)							
	Copper (Cu)							
	Lead (Pb)							
	Zinc (Zn)							
	Mercury (Hg)							
Pioneer PIDs MiniRAE (PID MR) - 10.6 eV lamp UltraRAE (PID UR) - 9.8 eV lamp	Volatile Organic Compounds BTEX (Benzene, Toluene, Ethylbenzene, and Xylenes)	NA	NA	NA	NA	NA	NA	
Hanby Field Soil Kit	BTEX (Benzene, Toluene, Ethylbenzene, and Xylenes) Semi-volatile Organic Compounds Polycyclic Aromatic Hydrocarbons	NA	NA	NA	NA	NA	NA	
Pace Analytical Services, LLC General Parameters	pH	EPA 9045C	0.1 S.U.	0.1 S.U.	15 Minutes[6]	2-4 oz. amber glass jars	None	Determine general chemistry soil samples. Data will also help inform possible hydrocarbon management strategies.
	SC	EPA 120.1	10 umhos/cm	10 umhos/cm	28 Days			
	Percent Moisture	SM 2540G	0.100 %	0.100 %	6 months			
	Total Organic Carbon	Walkley Black	100 mg/kg	25.5 mg/kg	28 Days			
	Total Alkalinity (Reported as Carbonate Alkalinity)	SM 2320B Modified	100 mg/kg	100 mg/kg	14 Days			
	Total Nitrogen, Calculation	Calculation	0.10 mg/kg	NA	28 Days			
	TKN, Nitrogen	EPA 351.2	20 mg/kg	4.48 mg/kg	28 Days			
	Nitrate	EPA 9056A	10 mg/kg	0.557 mg/kg	28 days			
	Sulfate	EPA 9056A	50 mg/kg	12.9 mg/kg	28 Days			
	Ammonia	EPA 350.1	10 mg/kg	7 mg/kg	28 Days			
	Sulfur (S)	EPA 6010 (ICP/AES)	25mg/kg	4.61 mg/kg	180 Days			
Metals	Arsenic (As)	EPA 6020 (ICP/MS)	0.50 mg/kg	0.109 mg/kg	180 Days	4-oz. amber glass container	None	Determine metals concentrations in soils to help evaluate metal toxicity to microbial activity.
	Cadmium (Cd)		0.08 mg/kg	0.0314 mg/kg				
	Copper (Cu)		1.0 mg/kg	0.242 mg/kg				
	Iron (Fe)		50 mg/kg	10 mg/kg				
	Lead (Pb)		0.20 mg/kg	0.0294 mg/kg				
	Manganese (Mn)		0.50 mg/kg	0.245 mg/kg				
	Zinc (Zn)		5.0 mg/kg	0.899 mg/kg				
	Mercury (Hg)	EPA 7471B	0.02 mg/kg	0.00868 mg/kg	28 Days		None	
Hydrocarbon-Compounds	Volatile Petroleum Hydrocarbons (VPH)	MTVPH	Analyte Specific - Meets DEQ Risk-Based Screening Level[4] where applicable.		7 Days	4-oz. amber glass container	None	Establish baseline concentrations to help determine breakdown of petroleum components. Laboratory to perform silica gel cleanup to remove potential interferences to diesel range organics (DRO).
	Extractable Petroleum Hydrocarbons (EPH) Fractionation	MTEPH			14 Days	4-oz. amber glass container	None	
	Polycyclic Aromatic Hydrocarbons (PAHs)	EPA 8270SIM						
	SPLP	EPA 1312 for SPLP Extraction Solids to be analyzed for VPH, EPH, and PAHs prior to SPLP Extraction. Leachate to be analyzed for VPH, EPH, and PAHs.			7 days	8-oz. amber glass container	None	
Provectus Environmental Products[7] TOD Analysis	Persulfate	Visual Persulfate CHEMets Test Kit (Ferric Thiocyanate)	7 mg/L	0.35 mg/L	NA	25 mL sample cup with <5 mL sample required	None	Provectus will set up bench-scale reactors and test their Provect-Ox line of chemical oxidant, activators, and buffers at a range of concentrations. Provectus will test varying doses of two to three different oxidant agents to determine whether there are other reduced species (e.g., iron, manganese, organic carbon) in the soil sample that would consume the oxidant agent where in-situ chemical oxidation is not practicable as a treatment option. Persulfate, sulfate, ORP, pH, and petroleum hydrocarbons will be measured multiple times during the bench-scale tests to track how the reaction is progressing.
	Sulfate	EPA 9056A, modified.	0.0033 mg/L	0.0033 mg/L	21 days (4° C)	25 mL plastic	None	
	ORP	Standard Methods 2580, Electrode.	NA	0.1 mV (-199.9 to 199.9); 1 mV (<-199.9 and >199.9)	NA	NA	None	
	pH	EPA 9045C	0.1 S.U.	0.1 S.U.	15 minutes/ ASAP	NA	None	
	Total Petroleum Hydrocarbons (TPH) as Gasoline Range Organics (GRO)	EPA 8015	1.6 mg/kg	1.6 mg/kg	14 Days	4-oz. amber glass container	None	
	TPH as Diesel Range Organics (DRO)/Residual Range Organics (RRO)/Oil Range Organics (ORO)	EPA 8015	20 mg/kg	20 mg/kg	14 Days	4-oz. amber glass container	None	
AECOM[5]	Oxygen Uptake Rate (OUR)	OUR will be measured on an aliquot from the soil slurry using a biological oxygen demand (BOD) bottle and a dissolved oxygen (DO) probe.	N/A	N/A	N/A	300 mL	None, performed in real-time.	OUR indicates the rate of biomass respiration which is associated to overall biomass health and activity.
	Adenosine Triphosphate (ATP)	ATP will be measured by taking a liquid sample from each soil slurry and processing using the LuminUltra reactant kit and a luminometer.	5 pg ATP/mL	3 pg ATP/mL	7 days	15 mL	Proprietary preservative.	ATP will be measured as total and dissolved ATP. Dissolved ATP is an indication of bacteria cells that underwent lysis (death), and thus it is a measurement of inactive biomass. By measuring both total and dissolved ATP, the ATP measurements related to active biomass can be calculated. In addition, a biomass stress index factor can be obtained from these measurements. Both the absolute number of ATP counts and the stress index indicate the biomass health and can be used to make relative comparisons among the different soil slurries.
Microbial Insights	Microbial Analysis (Microbial Insights)	CENSUS-qPCR Method	500 to 5,000 cells/sample	100 cells/sample	1-2 days	10 grams of soil	Temperature ≤ 4°C	The concentrations of specific microorganisms and functional genes provides a line of evidence for biodegradation of petroleum hydrocarbons, and thus, native bacteria metabolism.

[1]Atlantic Richfield may choose to use a different laboratory based on project needs. Regardless of the laboratory chosen, Atlantic Richfield will ensure the necessary reporting limits, required methodology, and the specified quality assurance/quality control and data validation requirements are followed as detailed in the BRW Biotreatability QAPP. Agencies will be informed of any changes in the reporting limits, methodology, or the quality assurance/quality control and data validation procedures.

[2] Pace Analytical Services, LLC will report results to the method detection limit. The analytical lab's reporting limits and detection limits are subject to change as these values are updated periodically to reflect analytical sensitivity and capability. Atlantic Richfield will ensure that any updates to the reporting limits or detection limits do not affect the ability for the Data Quality Objectives to be met and the updates will be specified in the Phase III Data Summary Report.

[3]In addition to the preservation listed, all samples will be cooled to <6 °C. Not all analyses require this but because multiple containers will be collected at most sample areas, all samples will be cooled.

[4]DEQ, 2018. Montana Risk-Based Corrective Action Guidance for Petroleum Releases, Montana Department of Environmental Quality, May 2018.

[5]Pioneer will supply AECOM with a minimum of 5 kilograms of soil (approximately 2 gallon Ziplock bags) for each sample to complete the identified analyses. All samples will be packed in a cooler with ice to preserve organic compounds at a temperature < 6 °C and shipped to AECOM.

[6]The holding time of 15 minutes is a goal and starts once the sample has been prepared. The method states as soon as possible.

[7]Pioneer will supply Provectus with two 1-gallon Ziplock bags to complete the identified analyses. The sample will be selected based on the greatest concentration of high molecular weight hydrocarbons from all test pits. The sample will be packed in a cooler with ice to preserve organic compounds at a temperature < 6 °C and shipped to Provectus.

Units: S.U. - Standard Unit
umhos/cm or µS/cm - microsiemen per centimeter
mg/kg - milligram per kilogram
mL - milliliter

Table 4. Limit of Detection for XRF

Metals	EPA Method 6200 (mg/kg)	Niton XL3* (mg/kg)
Arsenic (As)	40	3
Cadmium (Cd)	100	7
Calcium (Ca)	70	26
Copper (Cu)	50	14
Chromium (Cr)	150	9
Iron (Fe)	60	28
Mercury (Hg)	30	10
Lead (Pb)	20	4
Manganese (Mn)	70	30
Silver (Ag)	70	12
Zinc (Zn)	50	7

*Niton XL3 limit of detection is based on acquisition time of 120 seconds analyzing a quartz-sand matrix. Actual in-field detection limits are typically higher due to soil matrix effects.
mg/kg: milligrams per kilogram.

Table 5. Applicable and Relevant Standard Operating Procedures

SOP Number	Title	Version
PIONEER TECHNICAL SERVICES, INC. STANDARD OPERATING PROCEDURES		
SOP-DE-01	PERSONAL DECONTAMINATION PROCEDURES	12/03/2014
SOP-DE-02	EQUIPMENT DECONTAMINATION	09/08/2020
SOP-DE-03	INVESTIGATION DERIVED WASTE HANDLING	12/02/2014
SOP-FM-01	FIELD HEADSPACE ANALYSIS AND VOC MEASUREMENTS WITH PID	12/09/2020
SOP-GW-14	FIELD WATER QUALITY MEASUREMENTS USING THE GEOTECH MULTI-PROBE FLOWBLOCK FLOW THROUGH DEVICE	05/22/2015
SOP-S-01	SURFACE SOIL SAMPLING	12/11/2014
SOP-S-02	SUBSURFACE SOIL SAMPLING	12/11/2014
SOP-S-06	TEST PIT SAMPLING	11/20/2020
SOP-SA-01	SOIL AND WATER SAMPLE PACKAGING AND SHIPPING	12/11/2014
SOP-SA-04	CHAIN OF CUSTODY FORMS FOR ENVIRONMENTAL SAMPLES	11/12/2020
SOP-SA-05	PROJECT DOCUMENTATION	12/17/2014
SOP-SFM-02	OPERATING XL3 X-RAY FLUORESCENCE ANALYZER	06/05/2015
SOP-SURVEY-01	STAKING AND SURVEYING	10/24/2016
SOP-WFM-01	FIELD MEASUREMENT OF pH IN WATER	09/29/2020
SOP-WFM-02	FIELD MEASUREMENT OF OXIDATION REDUCTION POTENTIAL IN WATER	12/17/2014
SOP-WFM-03	FIELD MEASUREMENT OF SPECIFIC CONDUCTANCE	12/17/2014
SOP-WFM-07	FIELD MEASUREMENT OF DISSOLVED OXYGEN	12/17/2014

Table 6. Precision, Accuracy and Completeness Calculation Equations

Characteristic	Formula	Symbols
Precision (as relative percent difference, RPD)	$RPD = \frac{(x_i - x_j)}{\left(\frac{x_i + x_j}{2}\right)} \times 100$	x_i, x_j: replicate values of x
Precision (as relative standard deviation, RSD, otherwise known as coefficient of variation)	$RSD = \frac{\sigma}{\bar{x}} \times 100$	σ: sample standard deviation $\bar{x}$: sample mean
Accuracy (as percent recovery, R, for samples without a background level of the analyte, such as reference materials, laboratory control samples and performance evaluation samples)	$R = \frac{x}{t} \times 100$	x: sample value t: true or assumed value
Completeness (as a percentage, C)	$C = \frac{n}{N} \times 100$	n: number of valid data points produced N: total number of samples taken

Appendix A.
Standard Operating Procedures

PURPOSE	To provide standard instructions for decontamination of all personnel leaving a contaminated area.
SCOPE	This practice has been prepared for the Pioneer Technical Services, Inc. (Pioneer) workforce and applies to work carried out by and on behalf of Pioneer. All members of the Pioneer workforce who conduct the work shall be trained and competent in the risk-assessed work described below.

WORK INSTRUCTIONS

The following instructions are intended to provide sufficient guidance to perform the task in a safe, accurate, and reliable manner. Should these instructions present information that is inaccurate or unsafe, operations personnel must bring the issue to the attention of the Project Manager and the appropriate revisions made. All work carried under this SOP will be consistent with procedures and policies described in the appropriate Operation, Maintenance, and Monitoring (O&M) Plan (where applicable), appropriate Site-Specific Health and Safety Plan (SSHASP), and Pioneer Corporate Health and Safety Plan (HASP).

TASK	INSTRUCTIONS
1. Wash/ Remove outer contaminated items.	Remove nitrile or latex gloves by grasping the outside of the opposite glove near the wrist. Pull and peel the glove away from the hand, turning the glove inside out with the contaminated side now on the inside. Hold the removed glove in the opposite gloved hand. Slide one or two fingers of the ungloved hand under the wrist of the remaining glove. Peel glove off from the inside, creating a bag for both gloves. If wearing protective coveralls such as Tyvec suites, brush built up material off the suit, only if in designated decontamination zone. Unzip the coverall and begin rolling that outwards, rolling it down over your shoulders. Place both hands behind your back and pull down each arm until completely removed. Sit down and remove each shoe then roll the coveralls down (ensuring the contaminated side is not touched or comes into contact with clothing) over your knees until completely removed. If there is not a designated decontamination zone, remove personal protective equipment (PPE) carefully to contain material and place it in the appropriate disposal container. For instructions to remove additional PPE not described in this document, refer to the project's HASP. Wash with soap (nonphosphate) and tap water the outer, more heavily contaminated items, such as boots. Rinse the items in tap water.
2. Wash inner contaminated items.	If necessary, wash with soap (nonphosphate) and tap water the inner, less contaminated items. Rinse the items in tap water.
3. Store/ transport items.	Store/transport contaminated items in a separate designated area to prevent cross contamination prior to disposal.

4. Dispose of contaminated items.	Dispose of contaminated clothing and equipment in accordance with site/project, client, and/or federal and state requirements.
5. Contact the Safety and Health Manager.	For contaminants other than those found typically at uncontrolled hazardous waste sites, such as asbestos, PCB, PCE, etc. see the Safety and Health Manager.
Information about Emergency Decontamination	
1. During life-saving process.	If the decontamination procedure is essential to the life-saving process, decontamination must be performed immediately.
2. During heat-related illness.	If heat-related illness develops, protective clothing should be removed as soon as possible. Wash, rinse, and/or cut off protective clothing/equipment.
3. When medical treatment is needed.	If medical treatment is required to save a life, decontamination should be delayed until the victim is stabilized. Wrap the victim to reduce contamination of others. Alert medical personnel to the emergency and instruct them about potential contamination. Instruct medical personnel about specific decontamination procedures.

HSSE CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.				
SOURCE	***HAZARDS***	***WHERE***	***HOW, WHEN, RESULT***	***CONTROLS***
CHEMICAL	Potential contact with contaminated items and resulting water from decontamination procedures.	Sites.	Inadvertent exposure to contaminated items and water resulting from decontamination procedures could lead to adverse health effects.	Personnel will practice proper personal hygiene – wash hands prior to eating/drinking and when leaving the site. Employees will follow decontamination procedures as described above. Employees will wear nitrile gloves and safety glasses when handling contaminated items.
NOISE	Not applicable.			
ELECTRICAL	Not applicable.			
BODY MECHANICS	Not applicable.			
GRAVITY	Slips and falls.	Areas designated for decontamination procedures.	Slips and falls could occur while performing decontamination procedures due to slippery surfaces resulting in bruises, scrapes, or broken bones.	Workers will wear work boots with good traction and ankle support. Keep work area as dry as possible. Wear muck boots as necessary.
WEATHER	Cold/heat stress.	Sites.	Exposure to cold climates may result in cold burns, frostbites, and hypothermia. Exposure to high temperatures may result in heat cramps, heat exhaustion, or heat stroke.	Training on signs and symptoms of cold/heat stress is required. Personnel will wear appropriate clothing when working outdoors. Employees will remain hydrated and will have sufficient caloric intakes during the day.
	Hypothermia/frost bite.	Sites where air temperature is 35.6°F (2°C) or	Workers whose clothing becomes wet	Employees will change clothing, if it becomes wet.

HSSE CONSIDERATIONS

This section to be completed with concurrence from the Safety and Health Manager.

		less.	during decontamination procedures may be exposed to hypothermia and/or frostbite.	
	Lightning.	Outdoor sites.	Electrocution, injury, death, or equipment damage could be caused by lightning strike.	Employees will follow the 30/30 rule during lightning storms.
RADIATION	Ultraviolet (UV) radiation.	Outdoors.	Employees could be exposed to UV radiation during summer months causing sun burns, skin damage, and eye damage.	Employees will wear safety glasses with tinted lenses, long-sleeve work shirts, and long pants. Employees should wear sunscreen, if necessary.
BIOLOGICAL	Plants, insects, and animals.	Sites.	Exposure to plants, insects, and/or animals may cause rashes, blisters, redness, and swelling.	Training on the signs and symptoms of exposure to plants, insects, and animals is required. Avoid contact with plants, insects, and animals. First-aid kits will be available on site. Employees with allergies will notify their supervisor.
MECHANICAL	Not applicable.			
PRESSURE	Not applicable.			
THERMAL	Not applicable.			
HUMAN FACTORS	Inexperienced and improperly trained worker.	Sites.	Inexperienced workers and improper training could cause incidents resulting in adverse health	Employees will be properly trained in this procedure and other applicable procedures. Employees will implement stop work procedures, if necessary.

HSSE CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.				
			effects and/or property damage.	
SIMOPS	Not applicable.			

ADDITIONAL HSSE CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.	
REQUIRED PPE	Safety glasses, high-visibility work shirt or vest, long pants, work boots, and nitrile gloves.
APPLICABLE SDS	Safety Data Sheets (SDSs) will be maintained based on site characterization and contaminants.
REQUIRED PERMITS/FORMS	Per site/project requirements.
ADDITIONAL TRAINING	Per site/project requirements.

DRAWINGS, DOCUMENTS, AND TOOLS/EQUIPMENT The following documents should be referenced to assist in completing the associated task.	
P&IDS	
DRAWINGS	
RELATED SOPs/PROCEDURES/ WORK PLANS	
TOOLS	In general, the following items will be needed: soap, tap water, tarps, decontamination tubs, brushes, and sprayers. The Sampling and Analysis Plan (SAP) or Quality Assurance Project Plan (QAPP) will describe additional items needed for decontamination.
FORMS/CHECKLIST	

APPROVALS/CONCURRENCE By signing this document, all parties acknowledge the completeness and applicability of this SOP for its intended purpose. Also, by signing this document, it serves as acknowledgement that I have received training on the procedure and associated competency testing.	
SOP TECHNICAL AUTHOR	**DATE**
Julie Flammang **Julie Flammang**	**12/03/2014**
SAFETY AND HEALTH MANAGER	**DATE**
Tara Schleeman **Tara Schleeman**	**12/03/2014**

Revisions:

Revision	Description	Date

PURPOSE	To provide standard instructions for equipment decontamination.
SCOPE	This practice has been prepared for the Pioneer Technical Services, Inc. (Pioneer) workforce and applies to work carried out by and on behalf of Pioneer. All members of the Pioneer workforce who conduct the work shall be trained and competent in the risk-assessed work described below.
NOTES	All equipment leaving the contaminated area of a site must be decontaminated. Decontamination methods include removal of contaminants through physical, chemical, or a combination of both methods. Decontamination procedures are to be performed in the same level of protection used in the contaminated area of a site. In some cases, decontamination personnel may be sufficiently protected by wearing one level lower protection. The information for site specific equipment decontamination and personnel protection levels, as detailed in the Sampling and Analysis Plan (SAP), work plan (WP), and Site-Specific Health and Safety Plan (SSHASP), should be followed. The following decontamination procedures are for typical uncontrolled hazardous waste sites. For a specific or unusual contaminant, such as dioxins, see the SSHASP and consult with the Safety and Health Manager. Decontamination procedures should be used in conjunction with methods to prevent contamination of sampling and monitoring equipment. If practical, particularly with organic contaminants, one-time-use equipment should be used, and disposed of in accordance with the SAP, work plan, and SSHASP. This SOP covers all equipment decontamination EXCEPT for submersible pumps. Decontamination of pumps is detailed in SOP-DE-02A – Equipment Decontamination - Pumps for Well Sampling.

WORK INSTRUCTIONS

The following instructions are intended to provide sufficient guidance to perform the task in a safe, accurate, and reliable manner. Should these instructions present information that is inaccurate or unsafe, operations personnel must bring the issue to the attention of the Project Manager and the appropriate revisions made. All work carried under this SOP will be consistent with procedures and policies described in the appropriate Operation, Maintenance, and Monitoring (O&M) Plan (where applicable), appropriate Site-Specific Health and Safety Plan (SSHASP), and Pioneer Corporate Health and Safety Plan (HASP).

TASK	INSTRUCTIONS
1. Setup decontamination station.	Review the SAP or WP and determine if decontamination fluids need to be contained. If the fluids require containment, set up the decontamination station so that it is located within a small plastic swimming pool or on plastic sheeting with turned up edges to contain water that may slop over during the decontamination process. If pressurized or gravity flow water is available, attach a hose or piping to reach the decontamination area. If no water is available, four 5-gallon buckets can be used for cleaning most equipment. Label the buckets: gross wash; soap wash; DI rinse; final rinse. Lay out plastic or foil to place the cleaned equipment on to air dry.

	Pour approximately 2 ½ to 3 gallons of de-ionized (DI) water into each bucket. Add a **few** (1-3 drops) of Liquinox© soap to the bucket marked: soap wash.
2. Remove gross contamination.	Remove gross contamination using pressurized or gravity flow tap water, if available. If not, equipment will be scrubbed in the 5-gallon bucket of DI water marked: gross wash and a stiff brush (dedicated to the gross wash step).
3. Wash equipment.	Move the equipment to the 5-gallon bucket marked: soap wash. Wash equipment with a stiff brush (dedicated to the soap wash step).
4. Triple rinse equipment.	Triple rinse the equipment with DI water to remove any soap residue in the bucket marked: DI rinse.
5. Second Rinse with DI Water	Triple rinse the equipment again in the bucket marked: Final rinse.
6. Rinse equipment with chemicals.	In many cases, the tap water and de-ionized water rinses will be sufficient. If specified in the SAP, work plan, or SSHASP, chemical rinses of the equipment may be required. For inorganic contaminants, a mixture of 10:1 nitric acid in distilled water (10 parts water to 1 part nitric acid) is commonly used. A Methanol rinse may be required for some organic contaminants, such as hydrocarbons. Spray bottles, clearly marked with the appropriate chemical name, are an acceptable means of rinsing most equipment. To perform the chemical rinse, hold the equipment over a collection container (5-gallon bucket or bowl) spray the piece of equipment inside and out starting at the top and working down to the bottom. Make sure that all workers and vehicles are upwind of the spray. Dispose of the contained chemicals as described in the SAP, WP or SSHASP. The Safety and Health Manager and/or Project Manager must approve the disposal method used. If a chemical rinse is used, rinse the equipment again with DI water in a 5th bucket of DI water. This water will need to be retained (i.e., do not dispose of this water on site), tested, and disposed of according to federal and state requirements for the chemical used. The Safety and Health Manager and/or Project Manager must approve the disposal method used.
7. Air dry equipment.	Place equipment on plastic sheeting or foil to air dry.
8. Transport/ store equipment.	Wrap equipment in foil or plastic wrap to transport or store.
9. Triple rinse decontamination equipment.	Triple rinse equipment (i.e., brushes, buckets, tubs, etc.) used in the decontamination process with water, preferably pressurized.
10. Wash	Agitate the equipment used in the decontamination process in the soap/DI water

decontamination equipment.	solution.
11. Triple rinse decontamination equipment.	Triple rinse equipment with DI-water.
12. Store and label decontamination equipment.	Place equipment in appropriate areas, so they are used only for decontamination purposes. Label the equipment, if necessary.
13. Dispose of decontamination solutions.	When contaminants have been identified, either in the solutions or elsewhere on the site, solutions should be disposed of appropriately as discussed in the SAP, work plan, or SSHASP. If they are hazardous (e.g., characteristic, listed, etc.), dispose of them according to federal and state requirements. The Safety and Health Manager and/or Project Manager must approve the disposal method used. Note: when using other than the above mentioned solutions, check with the Safety and Health Manager and the Project Manager.
14. Measure effectiveness of procedures.	Effectiveness of the decontamination procedures will be measured using field equipment rinsate blanks (see the Site-Specific Quality Assurance Project Plan).

HSSE CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.				
SOURCE	***HAZARDS***	***WHERE***	***HOW, WHEN, RESULT***	***CONTROLS***
CHEMICAL	Potential contact with contaminated items and resulting water from decontamination procedures.	Sites.	Inadvertent exposure to contaminated items and water resulting from decontamination procedures could lead to adverse health effects.	Personnel will practice proper personal hygiene – wash hands prior to eating/drinking and when leaving the site. Employees will follow decontamination procedures as described above. Employees will wear nitrile gloves and safety glasses when handling contaminated items.
	Chemical rinse (e.g., dilute nitric acid, methanol, and hexane).	Sites.	Employees could be exposed to chemicals via ingestion and skin/eye contact when decontaminating equipment. Exposure could cause irritation of skin/eye and adverse health effects.	Check and follow safety procedures as outlined in the chemical-specific Safety Data Sheets. Employees will prevent skin/eye contact with chemicals and they will wear nitrile gloves and eye protection when handling chemicals. Employees will practice proper personal hygiene – wash hands prior to eating/drinking, after decontaminating equipment, and when leaving the site. All workers and vehicles will stand upwind when spraying equipment with chemicals. Refer to the Chemical Flushing Guidelines available inside vehicle's first aid kit for first-aid procedures in case of contact with chemicals.
NOISE	Not applicable.			
ELECTRICAL	Not applicable.			
BODY MECHANICS	Improper lifting.	Sites.	Back injuries and muscle/back strains could result when using	Personnel will use proper lifting techniques – get a good grip, keep the load close to the body, lift with legs and not

HSSE CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.				
			improper techniques to lift and carry 5-gallon containers.	with back, and avoid lifting loads above shoulder's height. Two people will lift awkward/heavy tools and equipment.
GRAVITY	Falls from slips and trips.	Areas designated for decontamination procedures.	Slips and falls could occur while performing decontamination procedures due to slippery surfaces resulting in bruises, scrapes, or broken bones.	Workers will wear work boots with good traction and ankle support. Personnel will be aware of working/walking surfaces and choose a path to avoid hazards. Keep work areas as dry as possible. Wear muck boots, as necessary.
WEATHER	Cold/heat stress.	Sites.	Exposure to cold climates may result in cold burns, frostbites, and hypothermia. Exposure to high temperatures may result in heat cramps, heat exhaustion, or heat stroke.	Training on signs and symptoms of cold/heat stress is required. Personnel will wear appropriate clothing when working outdoors. Employees will remain hydrated and will have sufficient caloric intakes during the day. Personnel will follow procedures outlined in applicable SSHASP and/or Pioneer corporate HASP.
	Hypothermia/frost bite.	Sites where air temperature is 35.6°F (2°C) or less.	Workers whose clothing becomes wet during decontamination procedures may be exposed to hypothermia and/or frostbite.	Employees will change clothing, if it becomes wet.
	Lightning.	Outdoor sites.	Electrocution, injury, death, or equipment damage could be caused by lightning strike.	Employees will follow the 30/30 rule during lightning storms.

HSSE CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.				
RADIATION	Ultraviolet (UV) radiation.	Outdoors.	Employees could be exposed to UV radiation during summer months causing sun burns, skin damage, and eye damage.	Employees will wear safety glasses with tinted lenses, long-sleeve work shirts, and long pants. Employees should wear sunscreen, if necessary.
BIOLOGICAL	Plants, insects, and animals.	Sites.	Exposure to plants, insects, and/or animals may cause rashes, blisters, redness, and swelling.	Training on the signs and symptoms of exposure to plants, insects, and animals is required. Avoid contact with plants, insects, and animals. First-aid kits will be available on site. Employees with allergies will notify their supervisor.
MECHANICAL	Not applicable.			
PRESSURE	Not applicable.			
THERMAL	Contact with hot surfaces.	Foil and decontamination equipment.	If foil and decontamination equipment are placed directly in the sun, they could get hot. Contact with hot surfaces could result in personal injury.	Personnel will prevent setting decontamination stations directly in the sun.
HUMAN FACTORS	Inexperienced and improperly trained worker.	Sites.	Inexperienced workers and improper training could cause incidents resulting in adverse health effects and/or property damage.	Employees will be properly trained in this procedure and other applicable procedures. Employees will implement stop work procedures, if necessary.
SIMOPS	Not applicable.			

HSSE CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.	
ADDITIONAL HSSE CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.	
REQUIRED PPE	Safety glasses, high-visibility work shirt or vest, long pants, work boots, and nitrile gloves.
APPLICABLE SDS	Safety Data Sheets (SDSs) for corresponding chemicals used during chemical rinse. Additional SDSs) will be maintained based on site characterization and contaminants.
REQUIRED PERMITS/FORMS	Per site/project requirements.
ADDITIONAL TRAINING	Per site/project requirements.

DRAWINGS, DOCUMENTS, AND TOOLS/EQUIPMENT The following documents should be referenced to assist in completing the associated task.	
P&IDS	
DRAWINGS	
RELATED SOPs/PROCEDURES/ WORK PLANS	
TOOLS	Five 5-gallon buckets, tap water, stiff brushes, soap, de-ionized or distilled water, chemicals for chemical rinse (if required), plastic sheeting or foil, tarps, and sprayers (if available). If additional items for decontamination are needed, they will be listed on the SAP.
FORMS/CHECKLIST	

APPROVALS/CONCURRENCE By signing this document, all parties acknowledge the completeness and applicability of this SOP for its intended purpose. Also, by signing this document, it serves as acknowledgement that I have received training on the procedure and associated competency testing.	
SOP TECHNICAL AUTHOR	**DATE**
Julie Flammang	**06/05/2015**
SAFETY AND HEALTH MANAGER	**DATE**
Tara Schleeman	**06/05/2015**

Revisions:

Revision	Description	Date

PURPOSE	To provide standard instructions for handling investigation-derived waste in accordance with the US Environmental Protection Agency (EPA) protocols and Department of Environmental Quality (DEQ) guidance. Investigation-derived waste may be generated during a Site Assessment (SA), Site Investigation (SI), or Remedial Investigation (RI).
SCOPE	This practice has been prepared for the Pioneer Technical Services, Inc. (Pioneer) workforce and applies to work carried out by and on behalf of Pioneer. All members of the Pioneer workforce who conduct the work shall be trained and competent in the risk-assessed work described below.

WORK INSTRUCTIONS

The following instructions are intended to provide sufficient guidance to perform the task in a safe, accurate, and reliable manner. Should these instructions present information that is inaccurate or unsafe, operations personnel must bring the issue to the attention of the Project Manager and the appropriate revisions made. All work carried under this SOP will be consistent with procedures and policies described in the appropriate Operation, Maintenance, and Monitoring (O&M) Plan (where applicable), appropriate Site-Specific Health and Safety Plan (SSHASP), and Pioneer Corporate Health and Safety Plan (HASP).

TASK	INSTRUCTIONS
1. Collect and dispose of decontamination fluids.	Collect and dispose of decontamination fluids by using one of the following methods: - Send fluids to a Treatment, Storage, and Disposal (TSD) facility. - Evaporate fluids. - Tread fluids using an activated carbon or air sparging unit. - Temporarily store fluids until determined if they are contaminated. Dispose of decontamination fluids, generated from cleaning equipment used in background sampling or for sampling in areas where past results indicate that contaminants are below standards, to the ground surface.
2. Discharge groundwater from developing and purging wells.	If past monitoring results and laboratory analysis indicate that all contaminants are below groundwater standards, discharge groundwater generated from developing and purging monitoring wells to the ground surface.
3. Collect/label/ store contaminated groundwater from developing and purging wells.	If past monitoring results indicate that one or more contaminants are above groundwater standards, collect the purged water and potentially contaminated water. There may be instances (e.g., inclement weather) where purge water and/or decontamination water will be temporarily stored in drums or tanks to be treated on site with granulated activated carbon or air sparging. If the water is determined by laboratory analysis to contain contaminants above groundwater standards and cannot be treated on site, store the water on site until shipping/disposal arrangements can be made. If the water is visibly contaminated, drum, label, and store the water on site until

	shipping/disposal arrangements are made. Label all containers stored on site with the following information: date, time, contents, any corresponding analytical data, collection location, contact person, and contact agency, etc.
4. Return soils back to borehole.	Unless it is visibly contaminated, place soil and/or cuttings from monitoring well installation back in the borehole.
5. Collect/label/ store contaminated soils from installing wells.	If the soil is visibly contaminated, drum, label, and store the soil/cuttings on site until shipping/disposal arrangements are made. Drum and label soils from borings/well installations located in previously sampled areas that are known to be contaminated. Leave these soils on site until shipping/disposal arrangements are made.
6. Pack and dispose of one-time use equipment and PPE.	Pack disposable equipment intended for one-time use and personal protective equipment (PPE) materials for appropriate disposal. Double bag the disposable equipment and PPE utilized for sampling and dispose of it as a solid waste in the local landfill. Package, drum, and label disposable equipment and PPE utilized for sampling visibly contaminated sites or sites known to be contaminated from previous monitoring. Leave equipment and PPE on site until shipping/disposal arrangements are made.
7. Dispose of samples not used for analysis.	Laboratories will dispose of the portions of the samples submitted, but not used for analysis. If samples are retained and not sent for analysis, they need to be returned to the site prior to remediation or disposed of according to federal and state regulations.

HSSE CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.				
SOURCE	***HAZARDS***	***WHERE***	***HOW, WHEN, RESULT***	***CONTROLS***
CHEMICAL	Potential contact with contaminated soils and resulting water from decontamination procedures.	Sites.	Inadvertent exposure to contaminated soils and water resulting from decontamination procedures could lead to adverse health effects.	Personnel will practice proper personal hygiene – wash hands prior to eating/drinking and when leaving the site. Employees will follow decontamination procedures as described above. Employees will wear nitrile gloves and safety glasses when handling contaminated items.
	Nitric acid.	Sites.	Employees could be exposed to nitric acid via ingestion and skin/eye contact when decontaminating equipment. Exposure could cause irritation of skin/eye and adverse health effects.	Employees will prevent skin/eye contact with nitric acid and they will wear nitrile gloves and eye protection when handling nitric acid. Employees will practice proper personal hygiene – wash hands prior to eating/drinking, after decontaminating equipment, and when leaving the site. Refer to the Chemical Flushing Guidelines available inside vehicle's first aid kit for first-aid procedures in case of contact with nitric acid.
NOISE	Not applicable.			
ELECTRICAL	Not applicable.			
BODY MECHANICS	Improper shoveling techniques.	Sites.	Personnel could be injured if using improper shoveling techniques to store contaminated soils/cuttings in drums, causing back injuries and muscle/back strains.	Personnel will use proper shoveling techniques: keep feet wide apart, place front foot close to shovel, put weight on front foot, use leg to push shovel, shift weight to rear foot, keep load close to body, and turn feet in direction of throw.

HSSE CONSIDERATIONS
This section to be completed with concurrence from the Safety and Health Manager.

	Improper lifting.	Sites.	Back injuries and muscle/back strains could result when using improper techniques to lift and carry 5-gallon containers of tap water.	Personnel will use proper lifting techniques – get a good grip, keep the load close to the body, lift with legs and not with back, and avoid lifting loads above shoulder's height.
GRAVITY	Falls from slips and trips.	Uneven terrain, slick/muddy/wet surfaces and steep slopes.	Walking/working on slick/muddy/wet and uneven terrain could cause slips and trips resulting in falls and injuries.	Workers will wear work boots with good traction and ankle support. Personnel will be aware of working/walking surfaces and choose a path to avoid hazards. Keep work areas as dry as possible. Wear muck boots, as necessary.
WEATHER	Cold/heat stress.	Sites.	Exposure to cold climates may result in cold burns, frostbites, and hypothermia. Exposure to high temperatures may result in heat cramps, heat exhaustion, or heat stroke.	Training on signs and symptoms of cold/heat stress is required. Personnel will wear appropriate clothing when working outdoors. Employees will remain hydrated and will have sufficient caloric intakes during the day. Personnel will follow procedures outlined in applicable SSHASP and/or Pioneer corporate HASP.
	Hypothermia/frost bite.	Sites where air temperature is 35.6°F (2°C) or less.	Workers whose clothing becomes wet during decontamination procedures may be exposed to hypothermia and/or frostbite.	Employees will change clothing, if it becomes wet.
	Lightning.	Outdoor sites.	Electrocution, injury, death, or equipment damage could be	Employees will follow the 30/30 rule during lightning storms.

HSSE CONSIDERATIONS
This section to be completed with concurrence from the Safety and Health Manager.

			caused by lightning strike.	
RADIATION	Ultraviolet (UV) radiation.	Outdoors.	Employees could be exposed to UV radiation during summer months causing sun burns, skin damage, and eye damage.	Employees will wear safety glasses with tinted lenses, long-sleeve work shirts, and long pants. Employees should wear sunscreen, if necessary.
BIOLOGICAL	Plants, insects, and animals.	Sites.	Exposure to plants, insects, and/or animals may cause rashes, blisters, redness, and swelling.	Training on the signs and symptoms of exposure to plants, insects, and animals is required. Avoid contact with plants, insects, and animals. First-aid kits will be available on site. Employees with allergies will notify their supervisor.
MECHANICAL	Not applicable.			
PRESSURE	Not applicable.			
THERMAL	Not applicable.			
HUMAN FACTORS	Inexperienced and improperly trained worker.	Sites.	Inexperienced workers and improper training could cause incidents resulting in adverse health effects and/or property damage.	Employees will be properly trained in this procedure and other applicable procedures. Employees will implement stop work procedures, if necessary.
SIMOPS	Not applicable.			

ADDITIONAL HSSE CONSIDERATIONS
This section to be completed with concurrence from the Safety and Health Manager.

REQUIRED PPE	Hard hat, safety glasses, high-visibility work shirt or vest, long pants, work boots, and nitrile gloves.

HSSE CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.	
APPLICABLE SDS	Safety Data Sheets (SDSs) will be maintained based on site characterization and contaminants. Nitric acid.
REQUIRED PERMITS/FORMS	Per site/project requirements.
ADDITIONAL TRAINING	Per site/project requirements.

DRAWINGS, DOCUMENTS, AND TOOLS/EQUIPMENT The following documents should be referenced to assist in completing the associated task.	
P&IDS	
DRAWINGS	
RELATED SOPs/PROCEDURES/ WORK PLANS	SOP-DE-02 Equipment Decontamination.
TOOLS	Five 5-gallon buckets, tap water, stiff brushes, soap, de-ionized or distilled water, nitric acid (if required), plastic sheeting or foil, tarps, decontamination tubs and buckets, sprayers, storage containers, labels, and shovels.
FORMS/CHECKLIST	

APPROVALS/CONCURRENCE By signing this document, all parties acknowledge the completeness and applicability of this SOP for its intended purpose. Also, by signing this document, it serves as acknowledgement that I have received training on the procedure and associated competency testing.	
SOP TECHNICAL AUTHOR	**DATE**
Julie Flammang (signature) **Julie Flammang**	**12/03/2014**
SAFETY AND HEALTH MANAGER	**DATE**
Tara Schleeman (signature) **Tara Schleeman**	**12/03/2014**

Revisions:

Revision	Description	Date

PURPOSE	To provide standard instructions for using a photo-ionization type detector (PID) to estimate the total concentration or presence of volatile organic compounds (VOCs) in groundwater and soils. This is a ***screening*** procedure to help in determining appropriate sample collection and/or required laboratory methods (high or low concentration methods). Actual concentrations of VOCs in samples should be determined by a laboratory.
SCOPE	Pioneer Technical Services, Inc. (Pioneer) prepared this practice for the workforce and this Standard Operating Procedure (SOP) applies to all work performed by and on behalf of Pioneer. All members of the Pioneer workforce who conduct the work shall be trained and competent (as defined by OSHA) in the risk-assessed procedure described below before performing the work.
NOTES	1. This SOP specifically discusses the procedures for using a MiniRAE 3000 PID. If another type of PID is being used, the instrument-specific user manual should be reviewed for activities such as calibration and measurement times. However, the safety precautions and general procedures described here should be followed when using any PID. 2. Static voltage sources such as AC power lines, radio transmissions, or transformers may interfere with measurements. See operating manual for discussion of necessary considerations. 3. Regular cleaning and maintenance of instrument and accessories will assure representative readings. 4. As with any field instrument, accurate results depend on the operator being completely familiar with the operator's manual for unit use.

WORK INSTRUCTIONS

The following instructions provide guidance to perform the task in a safe, accurate, and reliable manner. If these instructions present information that is inaccurate or unsafe, personnel must notify the Project Manager, Safety Manager, and the SOP Technical Author to initiate the appropriate revisions. Personnel will perform all work under this SOP in a manner that is consistent with procedures and policies described in the appropriate Operation, Maintenance, and Monitoring (O&M) Plan (where applicable), appropriate Site-Specific Health and Safety Plan (SSHASP), and Pioneer Corporate Health and Safety Plan (HASP).

TASK	INSTRUCTIONS
1. Charge battery.	**Always** fully charge the battery prior to use. Directions on charging the battery and checking battery levels are described in the operating manual.
2. Turn unit on.	Turn the unit on by pressing and holding the on/off /flashlight button (also known as mode key) on the front of the unit. The display screen should start up and display the RAE system’s logo. The instrument is now on and will perform several self-tests. If the detector indicates that any tests have failed, refer to the troubleshooting section of the user manual. As part of the startup menu, the display screen will say “Please apply zero gas.” At this point, a fresh air calibration can be performed. Start the zero calibration by

	pressing start, the display will read "Zeroing…" and perform a 30-second count down. When the zero calibration is complete you see the message: "zeroing is done! Reading = 0.0 ppm" If a full calibration is required (see Step 3), skip the zero calibration by pressing the mode key again to quit. Once the startup procedure is complete the display screen will show a numerical reading screen with icons, which indicates the instrument is ready for use. You should be able to hear the sampling pump running.
3. Calibrate unit.	In general, the PID should be calibrated at least once a week while in use, and if the PID has not been used for at least a week it should be calibrated. Calibration information (date, time, type, concentration of gas, and results of calibration) must be recorded in the project logbook or on the project field sheets. You should calibrate the unit at the office prior to leaving for the field. If calibrating the PID in the field, it is critical to choose a location where the air is not tainted by automobile, generator, and heavy equipment emissions or other potential contaminants. Pioneer generally performs a 2-point calibration consisting of a zero (fresh air) gas and an appropriate span gas. If a volatile other than VOCs are to be measured or monitored, determine the specific compounds to be evaluated, the appropriate calibration (span) gas, and concentrations required so that the calibration can be performed for an appropriate instrument response. Please check with safety personnel on the appropriate type of gas to use for calibration. Isobutylene (100 parts per million [ppm]) is the span gas used for standard hydrocarbon screening and is stored in the PID case. Follow the directions for calibration of the PID in the operating manual for a 2-point calibration. Briefly, to perform the calibration: 1. Press and hold the mode key (the button used to turn the meter on and off) and the [N/-] key simultaneously to start the calibration. 2. The password screen will appear, instead of inputting a password, press the mode key again. 3. On the calibration screen, **Zero Calib** should be highlighted. Press the [Y/+] key to perform the zero calibration. Pioneer uses fresh air for this calibration. Make sure that you are in an area with "clean" air with an oxygen value of 20.9%. 4. Press [Y/+] again to start the calibration. 5. The display will read "Zeroing…" and perform a 30-second count down. When the zero calibration is complete you see the message:

	"zeroing is done! Reading = 0.0 ppm" 6. The calibration menu will return with the **Span Calib** highlighted. Press [Y+] to enter the Span calibration. 7. Put the flow regulator on the span gas and make sure the tubing is securely attached. The flow regulator should be OFF. 8. Press [Y+] to select "Change." Choose the appropriate span gas from the list on the display screen. Isobutylene is the default span gas. Press Save. Refer to Table 1 in Attachment 1 for the required gas correction factor concentration. Enter the corrected value. Press Save. 9. Attach the span gas cylinder to the meter probe following the directions in the user manual. Turn on the span gas. 10. Immediately press the [Y/+] key to start the calibration. 11. The display will read "Calibrating…" and perform a 30-second countdown. When the calibration is complete the display screen shows: "Span 1 is done! Reading = XX ppm." Reading should be the value entered in Step 8 above. 12. This reading should be very close to the span gas value. If it is not, try the calibration sequence again. Check to see if there is gas in the cylinder and confirm the concentration of the gas has been entered correctly prior to restarting the calibration. Refer to the troubleshooting guide in the operating manual if problems persist. 13. The instrument will exit the span calibration and show the zero calibration menu on the display. Press the mode key, the instrument will then update its settings and return to the main display. Calibration is **required** if: • The user is prompted by the instrument to perform a calibration. • The lamp type is changed so as to detect different VOC ranges. • The sensor has been replaced. • It has been more than 7 days since the instrument was last calibrated. • The calibration gas type is changed.
4. Set up alarms.	The MiniRAE 3000 PID can be programmed to sound an alarm at different gas concentrations. If the concentration of VOCs exceeds any of the user-programmed alarm limits (low, high, time weighted average [TWA] or short-term exposure level [STEL]), a loud buzzer and red flashing LED are activated. See Table 2 in Attachment 1 for a list of each alarm sequence and meaning. Alarms should be adjusted for the desired contaminant gases. Refer to Table 1 in Attachment 1 for gases or check with the safety department to see which limits and concentrations should be used for the different alarm levels, if necessary. To program the different alarms, refer to the operator's manual or consult the safety department for assistance. Prior to use, confirm that the alarms are set for the appropriate concentrations.

The following sections describe the general procedures for using the PID for different monitoring/sampling medias. Prior to any sampling, **make sure that the external filter is clean and is attached to the instrument inlet tube** to prevent dust or particles from being sucked into the sensor and damaging the instrument.

Be aware that VOCs, if present, can show significant losses in concentration with even a short duration (seconds) of exposure to the atmosphere. Take care to begin readings/measurements as soon as the media is exposed to air to ensure measurement of the most volatile compounds. Planning and teamwork is essential to getting the most accurate readings possible.

5. Screening for organic vapors in a well casing.

PID readings are always taken immediately upon opening the well casing.

To measure VOCs directly in a well without an attachment for the PID tubing, complete these steps:

1. Turn on the PID and allow it to warm up before unlocking and opening the outer casing. If the meter is reading a background level of VOCs prior to opening the outer casing, record that information in the logbook. If machinery is running in the area or the site is adjacent to a road, VOC background readings may be expected.
2. If there is no cap on the inner casing, immediately put the inlet probe into the well as far as you can while still being able to read the screen. If there is an inner cap, remove the inner cap and stick the inlet probe into the well, gently cover as much of the opening with the inner cap as you can to slow down VOC loss as you monitor the readings.
3. Record the highest reading. It may take a while to start getting readings depending on the depth to water, how long the well has sat undisturbed, and the concentrations of organics in the well. Watch the display screen, when the measurement drops significantly from a high reading, remove the PID, record the highest reading, and then begin associated sampling activities, if required.

For well caps with a dedicated attachment, to measure VOCs complete these steps:

1. Prior to leaving for the field, collect any available information on the well to be sampled, including total depth and the most recent depth to water measurements. Information from prior sampling events, the Montana Groundwater Information Center (GWIC) data base, or registered well logs from GWIC, can be used to gather information on the well.
2. Prior to unlocking and opening a well, calculate how long the PID needs to run to purge the air present in the well (refer to the table below). To use the table below, identify the time to purge 1 foot of air column (in either seconds or minutes) based on the diameter of the well in inches, and multiply this number by the most recent depth to water information (i.e., air column). The MiniRAE 3000 sampling pump will purge 450 to 550 cubic centimeters per

minute (cm^3/min). Make sure that the tubing and connector for the well are available and can be attached to the inlet tube on the MiniRAE 3000.

Volume of Air per Foot in Common Well Sizes

Diameter of well (inch)	Volume per foot (in^3)	Volume per foot (cm^3)	Time to purge 1 foot of column at 450 cm^3/min (sec)	Time to purge 1 foot of column at 450 cm^3/min (min)
0.5	2.4	38.6	5	0.09
1	9.4	154.4	21	0.34
1.5	21.2	347.4	46	0.77
2	37.7	617.6	82	1.37
4	150.7	2470.3	329	5.49
6	339.1	5558.2	741	12.35

MiniRAE 3000 PID pump purges at 450-550 cubic centimeters per minute (cm^3/min).
Equation for calculating volume of cylinder – $\pi * r^2 * Ht$, *where*
$\pi = 3.1416$
r = radius of well
Ht = air column (depth to water measurement)
$1\ in^3 = 16.39\ cm^3$

3. Turn on the PID and allow it to warm up before attaching the MiniRAE 3000 to the well attachment. There may be an outer casing that needs to be opened to access the sampling port.
4. Record the highest reading. It may take a while to start getting readings depending on the depth to water, how long the well has sat undisturbed, and the concentrations of organics in the well. The prior calculations will give you an idea of the maximum amount of time before readings may be detected. Watch the display screen, when the measurement drops significantly from a high reading, remove the PID, record the highest reading, and then begin associated sampling activities, if required.

6. Screening for volatile organic vapors in drill core or Geoprobe® drill core.

PID readings are always taken immediately on opening the core, prior to any other sampling or logging activities. Soil samples can show significant losses in VOC concentration within only seconds of opening soil cores.

Detailed procedures for sampling soils in core for organics are discussed in SOP-S-12 Sampling Soil from a Geoprobe® Liner and SOP-S-13 Sampling Core from Sonic Drill. Please refer to those SOPs prior to exposing the core to air and starting these sampling activities:

1. Ensure that the driller and/or helper place caps on the end of core liners, tie the plastic ends shut or use duct tape to seal the end of the core immediately after removing the liner from the drill/probe rod so that no VOC escape prior to cutting open the core. Store capped core in the shade or on ice to avoid additional volatilization of VOCs. **Do not** open the core until just before sampling.

	2. Make sure the PID is on, calibrated and warmed up prior to opening the drill/probe core. 3. Refer to SOP-S-12 Sampling Soil from a Geoprobe® Liner -Sampling of Soil for Organic Constituents and SOP-S-13 Sampling Core from Sonic Drill – Sampling Soil for Organic Constituents, then prepare for opening the core. 4. As soon as possible after opening the core, hold the PID inlet approximately 1-2 inches above the soil surface and **slowly** scan the length of the core, noting or marking where "hits" are shown on the instrument display. If the core is compacted, or there is evidence of "smear" on the outside of the core, use gloved fingers to break up or indent the core to expose additional surface area. Please note that there may be a 1-3 second delayed response on the display as it takes time for the vapor to travel up the inlet and into the detector. After completing the scan of the entire core, go back and check the areas where readings occurred. Make note of the highest reading at these locations. The project-specific Quality Assurance Project Plan (QAPP) will provide guidance on what additional sampling may be required based on the PID screening results (i.e., sample or headspace collection). 5. Record results of the PID screening in the field documentation (project logbook or field data sheets) including the highest reading from each interval and the actual location in the core (i.e., 10 inches from the bottom) and the calculated interval depth. Refer to SOP-S-12 Sampling Soil from a Geoprobe® Liner and SOP-S-13 Sampling Core from Sonic Drill information on determining calculated interval depths. 6. If required sample following the appropriate SOP directions.
7. Screening for VOCs in hand-dug test pits or machine-excavated test pits.	**PID readings should be taken as soon as the soils are exposed to air, prior to any other sampling or logging activities. Soil samples can show significant losses in VOC concentration within only seconds of being exposed to air.** Detailed procedures for conducting surface and subsurface sampling and test pit sampling for organics are discussed in SOP-S-01 Surface Soil Sampling, SOP-S-02 Subsurface Soil Sampling and SOP-S-06 Test Pit Sampling. Please refer to these SOPs prior to starting sampling activities. Make sure the PID is turned on and warmed up and any VOC, volatile petroleum hydrocarbon (VPH) and/or extractable petroleum hydrocarbon (EPH) sampling supplies are ready prior to beginning excavation. **For surface soil:** Surface soil screening for VOCs can be performed, however expect results only if the release of hydrocarbons is recent. Removing vegetation, debris, or the immediate surface soils may result in detection of VOCs. 1. With the PID probe pointed downward, walk the sample area to see if there are any readings.

2. Any areas with "hits," areas of staining, or other indications of organic contamination should be measured carefully by placing the PID input probe 1-2 inches above the soil surface.
3. Record any measurements, location description (staining, debris, etc.), and location as needed in the field logbook or on field data sheets.

For hand-dug test pits:

1. Complete any required surface screening prior to digging.
2. As each interval (0-2 inches, 2-6 inches, etc.) is uncovered, complete a scan of exposed surfaces. Hold the input probe 1-2 inches from the wall surface and slowly scan the complete circumference of the new portion of the excavation.
3. Record measurements, location description (staining, moisture content, etc.), and location as needed in the field logbook or on field data sheets. Complete any organic sampling prior to moving to the next sample interval as described in the steps in SOP-S-02 Subsurface Soil Sampling under Volatile Organic Sampling.

For hand auger sampling:

1. Complete any required surface screening prior to digging. Following guidance in SOP-S-02 Subsurface Soil Sampling – Hand Auger Sampling for Volatile Organic Compounds, prepare for sampling the site.
2. Once the first sample interval is reached, advance the auger into the sample interval. When the auger is full, remove the head from the hole and empty the auger onto the plastic. Once the soil is on the plastic, immediately begin PID screening. Hold the input probe 1-2 inches from the soils and slowly scan the material. If the soils are mounded, using a newly gloved hand spread the soils so that readings can be taken of the whole sample interval.
3. Complete any organic sampling prior to moving to the next sample interval as described in SOP-S-02 Subsurface Soil Sampling under Hand Auger Sampling for Volatile Organic Compounds. Record measurements, location description (staining, moisture content, etc.), and location as needed in the field logbook or on field data sheets.

For machine-excavated test pits:

For excavated areas under 4 feet, the assigned, competent person (as defined by OSHA) at the site will examine the test pit and determine if the test pit is safe prior to entering **for each interval to be tested.**

1. Instruct the operator to dig set depths (i.e., 0.5 foot or 1 foot).
2. Once the appropriate interval is completed by the machine operator and the bucket is resting on the ground, enter the test pit and scan the interval uncovered. Hold the input probe 1-2 inches from the test pit wall surfaces and slowly scan.
3. If there is a "hit," return to that location after completing the overall scan and determine the extent of the higher readings. Pay particular attention to oil-stained areas or wet-looking areas that do not appear to be associated with groundwater.
4. If sampling for organics is required, complete the sampling after the PID scan and prior to digging the next interval as described in SOP-S-06 Test Pit Sampling under Sampling Test Pits for Volatile Organic Compounds.
5. Once the entire interval is scanned, exit the test pit, and have the operator dig to the next interval.
6. If entering the test pit for any interval is not possible (unsafe walls, groundwater entering), the excavated material can be scanned as it is removed from the test pit. Have the machine operator place the material at least 3 feet from the edge of the test pit and spread it out as the bucket empties.
7. As soon as the machine bucket is set on the ground and the spoils pile can be safely approached, scan the newly exposed soils. Holding the PID input probe 1-2 inches above the soils, slowly move the probe over the entire area.
8. If there is a "hit," return to that location after completing the overall scan and determine the extent of the higher readings. Pay particular attention to oil-stained areas or wet-looking areas that do not appear to be associated with groundwater.
9. If sampling for organics is required due to PID measurements, sample depth, or interval location (at groundwater interface), complete the PID measurement at this time.
10. Record the interval examined and the results in the field logbook or field data sheets.
11. Exit the spoils pile area and have the machine operator place the next bucket in the same location. **Coordination and communication between the machine operator and field personnel are key during this type of operation.**

For test pits greater than 4 feet deep:

1. For test pits that are planned to be deeper than 4 feet, scan the test pit as described above until the test pit is just under 4 feet deep.
2. For depths greater than 4 feet, PID scans will need to be taken from the spoils pile as described above. Required sampling should be completed after PID

	scans of each bucket or interval as directed in the project Sampling and Analysis Plan (SAP), QAPP, and Work Plan.
8. Field headspace analysis.	Field headspace analysis is an appropriate technique for approximation of low-level petroleum hydrocarbon concentrations. Use this procedure to estimate gasoline, #2 heating oil, diesel fuel, kerosene, and other chemically and physically similar oil contamination in mineral soil with water contents between dry and saturation. The procedure is not intended for estimating concentrations of heavy oils, lubricating oils, waste oil, and other low volatility hydrocarbon products; estimating those types of concentrations would require laboratory analysis. Field headspace analysis can be used as a screening tool to determine which samples may need to be submitted for organic analysis. It also can be used to evaluate stained or suspicious areas that did not show "hits" during the initial screening with a PID. Refer to the project SAP/QAPP/Work Plan for guidance on when head space analysis is to be used. For field headspace analysis: 1. Determine the location at which the sample is to be taken. 2. Collect up to 250 grams of the material to be sampled into a self-sealing, 1-quart freezer thickness polyethylene bag. If limited soil amounts are available, such as when sampling from Geoprobe® cores, ¼ to ½ cup can be placed in the bag, so that enough soil remains for samples. In so far as possible, samples should be mineral soil free of vegetation and stones larger than ½ inches in diameter. Seal the samples immediately by zipping the bag closed. A sufficient amount of air should be left in the bag so that the instrument can withdraw an adequate headspace sample. 3. Knead the bag until the contents are uniform. 4. If necessary, adjust sample temperatures to between 15 degrees Celsius (°C) and 25 °C by bringing sample containers into a warm vehicle. In warm weather, samples should be kept in a shaded, ventilated area during headspace development and analysis. 5. Allow at least 15 minutes but not more than 1 hour for soil hydrocarbons to reach equilibrium with the headspace. 6. If samples are to be taken for laboratory analysis, they should be collected and preserved per laboratory protocols at the time of the headspace sample collection. Refer to the project SAP/QAPP/Work Plan to determine sampling requirements. Any samples with potential for laboratory analysis of organics should be collected at this time and placed immediately in a cooler with ice. 7. Prior to the headspace analysis, turn on and let the PID warm up. 8. Knead the bags again for 30 seconds. 9. Measure the sample's headspace concentration. Poke a hole in the top corner of the ziplock bag using a pencil or small knife. The hole should be just big enough to insert the intake probe. Alternately, make a small opening using the zip and insert the intake probe. Squeeze the bag tight around the probe.

	10. Record the highest reading that remains steady for 1-2 seconds in the field logbook or on field data sheets. 11. Repeat this step until all samples have been measured. Due to the warming of the sample and the removal of VOCs during the PID measurement, the sample that is used for headspace analysis CANNOT be used for laboratory analysis for organics. It may be used for non-organic analysis (except mercury).
9. Evacuate the area if preset alarm sounds.	Be prepared to evacuate the area if any of the preset alarms sound. Actions required by each alarm are shown in Attachment 1 Table 3 and will be identified in the pre-job meetings and reviewed during daily toolbox meetings. If a preset alarm sounds while taking a core sample, be sure to take a reading within the breathing zone. If the high alarm continues to sound when measuring the breathing zone, proceed with an evacuation. If the low or high alarm sounds only while taking core samples, proceed with caution with frequent breathing zone samples. Operators using supplied air systems may not need to consider this action.
10. Turn the unit off.	Press and hold the on/off key for 3 seconds. A 5-second countdown to shutoff begins. The on/off key must be held down during the entire shut off process. Once the countdown stops, the unit should say “Unit off…” Release the on/off key.

HEALTH SAFETY SECURITY ENVIRONMENT (HSSE) CONSIDERATIONS

This section to be completed with concurrence from the Safety and Health Manager.

SOURCE	*HAZARDS*	*WHERE*	*HOW, WHEN, RESULT*	*CONTROLS*
CHEMICAL	Gases and vapors.	During measurements.	Inadvertent exposure to unknown gases and vapors via inhalation could lead to adverse health effects.	Personnel will measure concentrations of gases/vapors in the breathing area, and they will evacuate the area if preset alarm sounds.
	Isobutylene.	Equipment calibration.	Inadvertent exposure to Isobutylene gas via inhalation could lead to adverse health effects.	Personnel will wear safety glasses when handling calibration gas. Personnel will make sure the flow regulator is securely attached and turned to OFF when active calibration is not happening. Personnel will make sure tubing is securely attached before turning the flow regulator ON. Personnel will practice proper personal hygiene – wash hands prior to eating/drinking and after equipment calibration. If a volatile other than VOCs are to be measured, a different calibration gas will have to be used. Consult with the safety department to ensure the correct calibration gas is be used for the meter.
	Potential contact with contaminated soil samples or water samples.	Sample collection sites.	Inadvertent exposure to contaminated soil samples or water samples could lead to adverse health effects.	Personnel will practice proper personal hygiene – wash hands prior to eating and when leaving the site. Work will be suspended during high wind conditions that may produce large amounts of visible dust. Personnel will wear nitrile gloves and safety glasses when sampling and handling soil.

HEALTH SAFETY SECURITY ENVIRONMENT (HSSE) CONSIDERATIONS
This section to be completed with concurrence from the Safety and Health Manager.

SOURCE	*HAZARDS*	*WHERE*	*HOW, WHEN, RESULT*	*CONTROLS*
	Carbon Monoxide (CO).	Vehicle, equipment, and test pit.	Potential exposure to CO when working around idling vehicles/equipment could result in irritate eyes, headache, nausea, weakness, and dizziness. The CO from idling excavator could also end up in test pits.	Personnel will minimize the time sitting in idling vehicles and will open a window to increase ventilation. Personnel will avoid working around idling vehicles/ equipment and stay up wind. Operator will turn engine off when the excavator is not needed to prevent accumulation of CO in test pits.
	Exposure to hydraulic fluids.	Geoprobe® or heavy equipment.	Exposure to hydraulic fluids could occur while working around the Geoprobe® due to equipment malfunction/failure resulting in personal injuries.	The operator will inspect the Geoprobe® or equipment and document inspections daily before starting the work. The operator will also replace/repair all faulty equipment before stating work. When inspecting equipment, personnel will wear work gloves to prevent possible exposures to hydraulic fluids. Non-essential personnel will maintain a 20-foot buffer zone around the Geoprobe® and heavy equipment.
	Liquinox.	Equipment decontamination.	Personnel could be exposed to Liquinox via ingestion and skin/eye contact when decontaminating the equipment resulting in adverse health effects.	Personnel will wear nitrile gloves and eye protection when decontaminating the equipment.

HEALTH SAFETY SECURITY ENVIRONMENT (HSSE) CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.				
SOURCE	***HAZARDS***	***WHERE***	***HOW, WHEN, RESULT***	***CONTROLS***
	Methanol.	Equipment decontamination.	Personnel could be exposed to methanol via skin/eye contact and ingestion/ inhalation when decontaminating equipment. Exposure could cause irritation of skin/eye. Adverse health effects can also result if methanol is ingested and/or inhaled. Direct contact with methanol during winter months can result in skin discomfort due to rapid evaporative cooling.	Personnel will prevent skin/eye contact with methanol, and they will wear nitrile gloves and safety glasses when handling methanol. Personnel will use methanol in well-ventilated areas. Personnel will also practice proper personal hygiene – wash hands prior to eating/drinking, after decontamination procedures, and when leaving the site. During winter months, personnel will wear a pair of liner gloves underneath nitrile gloves.
NOISE	Elevated noise levels.	Geoprobe® or heavy equipment.	Personnel collecting samples can be exposed to elevated noise levels from the Geoprobe® or other heavy equipment resulting in hearing damage.	Personnel collecting soil samples will set up the sampling station 20 feet away from the equipment. The equipment operator or helper will bring the plastic liner to the sampling station. Personnel will wear hearing protection according to the Pioneer Corporate HASP if they must collect samples within 20 feet of the equipment.
ELECTRICAL	Not applicable.			

HEALTH SAFETY SECURITY ENVIRONMENT (HSSE) CONSIDERATIONS

This section to be completed with concurrence from the Safety and Health Manager.

SOURCE	*HAZARDS*	*WHERE*	*HOW, WHEN, RESULT*	*CONTROLS*
BODY MECHANICS	Bending, squatting, and kneeling.	During sample collection.	Bending, squatting, and kneeling during sample collection and handling could result in muscle/back strains or other injuries. Kneeling on gravel can result in bruises and knee injuries.	Personnel should stretch prior to starting work and they will take breaks when necessary. Personnel will use a foam pad or knee pads, if necessary.
	Lifting and carrying tools, equipment, and/or samples.	Testing sites.	Improper lifting and carrying tools, equipment, and/or samples could result in back injuries and muscle/back strains.	Personnel will use proper lifting techniques- get a good grip, keep the load close to the body, lift with legs and not with back, and avoid lifting loads above shoulder height. Two people will lift, if necessary.
GRAVITY	Falls from slips and trips.	Uneven terrain, slick/muddy/wet surfaces and steep slopes.	Walking/working on slick/muddy/wet and uneven terrain could cause slips and trips resulting in falls and injuries.	Personnel will wear work boots with good traction and ankle support. Personnel will also be aware of working/walking surfaces and choose a path to avoid hazards, keep work areas as dry as possible, and wear muck boots as necessary.

HEALTH SAFETY SECURITY ENVIRONMENT (HSSE) CONSIDERATIONS
This section to be completed with concurrence from the Safety and Health Manager.

SOURCE	*HAZARDS*	*WHERE*	*HOW, WHEN, RESULT*	*CONTROLS*
	Falling rocks, debris, and cave-ins.	Test pit.	Personal injuries could occur when collecting samples in test pits.	Personnel will wear Level D PPE. Sloping techniques will be used, if necessary. Competent person (as defined by OSHA) will examine test pits before entry and large rocks will be removed from above sampling locations, or sample locations will be moved to avoid the potential of falling material. Personnel will not enter test pits deeper than 4 feet. For test pits deeper than 4 feet, personnel will sample from the spoil piles once the excavator operator has placed the excavator bucket on the ground.
	Entering the test pit.	Test pit.	Personnel could slip or trip when entering the test pit due to slick, muddy, uneven, or wet terrain that could result in falls or injuries.	Personnel will wear sturdy work boots with good traction and ankle support. Personnel will be aware of walking/working surfaces and choose a path that avoids hazards. Personnel will not enter a test pit deeper than 4 feet. If a test pit will be deeper than 4 feet, personnel will sample from the spoil piles once the excavator operator has placed the excavator bucket on the ground and it is safe to approach.

HEALTH SAFETY SECURITY ENVIRONMENT (HSSE) CONSIDERATIONS
This section to be completed with concurrence from the Safety and Health Manager.

SOURCE	***HAZARDS***	***WHERE***	***HOW, WHEN, RESULT***	***CONTROLS***
WEATHER	Cold/heat stress.	Sites.	Exposure to cold temperatures may result in cold burns, frostbite, and hypothermia. Exposure to high temperatures may result in heat cramps, heat exhaustion, or heat stroke.	Training on signs and symptoms of cold/heat stress is required. Personnel will wear appropriate clothing when working outdoors, remain hydrated, and have sufficient caloric intakes during the day. Personnel will also follow procedures outlined in applicable SSHASP and/or Pioneer Corporate HASP.
	Lightning.	Sites.	Electrocution, injury, death, or equipment damage could be caused by lightning strike.	Personnel will follow the 30/30 rule during lightning storms.
RADIATION	Ultraviolet (UV) radiation.	Sites.	Exposure to UV radiation during summer months can cause sun burns, skin damage, and eye damage.	Personnel will wear safety glasses with tinted lenses, long-sleeve work shirts, and long pants. Personnel should wear sunscreen, if necessary.
BIOLOGICAL	Plants, insects, and animals.	Sites.	Exposure to plants, insects, and/or animals may cause rashes, blisters, redness, and swelling.	Training on the signs and symptoms of exposure to plants, insects, and animals is required. Personnel will avoid contact with plants, insects, and animals. First aid kits will be available on the site. Personnel with allergies will notify their supervisor.

HEALTH SAFETY SECURITY ENVIRONMENT (HSSE) CONSIDERATIONS

This section to be completed with concurrence from the Safety and Health Manager.

SOURCE	*HAZARDS*	*WHERE*	*HOW, WHEN, RESULT*	*CONTROLS*
MECHANICAL	Pinch points.	Test pits.	Personnel could cut their fingers if debris (e.g., glass, steel) is present in the test pits. Personal injury to the hands could occur when using sampling equipment/tools.	Personnel will wear nitrile gloves when sampling and handling soil. Personnel will wear leather gloves while using sampling tools.
	Struck by shovel.	Carrying tools.	Personnel can strike other workers or objects when carrying shovels and augers to/from sampling stations resulting in bodily injuries and/or property damage.	Personnel will be aware of their surroundings and, if needed, use a spotter. When carrying tools, maintain a safe distance (e.g., 4 feet or more depending on side of tool) from other personnel.
	Cutting tools and sharp edges.	Liner cutter, cut liner, and well casing.	Personnel could be exposed to hand injuries such as lacerations, punctures, scrapes, and cuts when using the liner cutter, handling the cut liner, and opening well casing.	Personnel will wear work gloves when using the liner cutter. Be cautious of sharp edges when handling plastic core liners after they have been cut open. Personnel will be trained on how to properly use the liner cutter and will inspect the tool before use. Two individuals will cut liners, if needed. Personnel will inspect well casing for sharp edges. If edges are very sharp, personnel will wear leather gloves.
	Flying debris.	Drilling operations.	Eye injuries could result from flying debris when working around drilling operations.	Personnel will wear safety glasses when working around drilling operations. Non-essential personnel will maintain a 20-foot buffer zone around the drill when possible.

HEALTH SAFETY SECURITY ENVIRONMENT (HSSE) CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.				
SOURCE	***HAZARDS***	***WHERE***	***HOW, WHEN, RESULT***	***CONTROLS***
	Struck by and/or caught in between the excavator.	Testing sites.	Personnel could be injured if struck by and/or caught in between the excavator.	Personnel will communicate and establish eye contact with the operator before approaching the excavator. The operator will stop the excavator and place the bucket on the ground before ground personnel approach the equipment. Personnel will wear high visibility clothing. When sampling from the excavated material, personnel will not approach the material until the operator has placed the bucket on the ground and it is safe to approach.
PRESSURE	Pressurized hydraulic hoses.	Geoprobe® or heavy equipment.	Hydraulic hoses could burst/rupture resulting in inadvertent contact with hydraulic fluid or personal injury due to being struck by hoses.	The operator will inspect the Geoprobe® or heavy equipment and document inspections daily before starting work. The operator will also replace/repair all faulty equipment before starting work. When inspecting equipment, personnel will wear work gloves to prevent possible exposures to hydraulic fluids. Non-essential personnel will maintain a 20-foot buffer zone round the Geoprobe® or heavy equipment.
THERMAL	Not applicable.			

HEALTH SAFETY SECURITY ENVIRONMENT (HSSE) CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.				
SOURCE	***HAZARDS***	***WHERE***	***HOW, WHEN, RESULT***	***CONTROLS***
HUMAN FACTORS	Inexperienced and improperly trained personnel. Public entering the work area.	Sites. Sites.	Inexperienced personnel and improper training could cause incidents resulting in injuries and/or property damage. Third-party members of the public could enter the work area resulting in an unsafe work environment.	Personnel will be properly trained in this procedure and other applicable procedures. Personnel will implement stop work procedures, if necessary. Stop work if members of the public enter the work area.
SIMOPS (Simultaneous Operations)	Not applicable.			

ADDITIONAL HSSE CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.	
REQUIRED PPE	**Personnel Protection Equipment** (PPE)**:** Safety glasses, high-visibility long-sleeve shirt or vest, long pants, and work boots.
APPLICABLE SDSs	**Safety Data Sheets** (SDSs) will be maintained based on site characterization and contaminants. Safety Data Sheets are available to Pioneer personnel at the link below: https://pioneertechnicalservices.sharepoint.com/Safety/SafetyDataSheets
REQUIRED PERMITS/ FORMS	Per site/project requirements.
ADDITIONAL TRAINING	Per site/project requirements.

DRAWINGS, DOCUMENTS, AND TOOLS/EQUIPMENT The following documents should be referenced to assist in completing the associated task.	
DRAWINGS	
RELATED SOPs/ PROCEDURES/ WORK PLANS	SOP-S-01 Surface Soil Sampling SOP-S-02 Subsurface Soil Sampling SOP-S-06 Test Pit Sampling SOP-S-12 Sampling Soil from a Geoprobe® Liner -Sampling of Soil for Organic Constituents SOP-S-13 Sampling Core from Sonic Drill – Sampling Soil for Organic Constituents
TOOLS/ EQUIPMENT	PID
FORMS/ CHECKLIST	Field logbook and field data sheets.

APPROVALS/CONCURRENCE By signing this document, all parties acknowledge the completeness and applicability of this SOP for its intended purpose. Also, by signing this document, it serves as acknowledgement that I have received training on the procedure and associated competency testing.	
SOP TECHNICAL AUTHOR	**DATE**
Julie Flammang **Julie Flammang**	**12/09/2020**
SAFETY AND HEALTH MANAGER	**DATE**
Tara Schleeman **Tara Schleeman**	**12/09/2020**

Attachment 1

Table 1. Frequent Gas of Interest Correction Factors and Alarm Settings

Compound Name	Calibration Gas (Isobutylene) Concentration	Correction Factor*	Input Calibration Gas Concentration	TWA	Low Alarm Value	High Alarm Value
Diesel Fuel	100 ppm	0.9	90 ppm	11 ppm	6 ppm	11 ppm
Gasoline #1	100 ppm	0.9	90 ppm	300 ppm	150 ppm	300 ppm

*Correction factor for a 10.6 eV lamp.
ppm: Parts per million. TWA: Time weighted average.
Consult Technical Note-106 and the safety department for additional compounds.

Table 2. Alarm Signals

Message	Condition	Alarm Signal
High	Gas exceeds “High Alarm” limit	3 beeps/flashes per second
Low	Gas exceeds “Low Alarm” limit	2 beeps/flashes per second
TWA	Gas exceeds “TWA” limit	1 beep/flash per second
STEL	Gas exceeds “STEL” limit	1 beep/flash per second

TWA: Time weighted average. STEL: Short-term exposure level.

Table 3. Alarm Procedures

Message	Procedure
High	Gas has reached an unsafe level. Evacuate the work area to a well-ventilated area. Open the sample trailer doors to allow the work area to ventilate. Move the sample outside of the trailer if it is safe to do so.
Low	Gas has reached the action level. Be prepared for rapidly changing conditions. Be prepared to evacuate the work area.
TWA	Gas has reached the TWA for the day.
STEL	Gas has reached the STEL. Do not come in contact with potentially contaminated samples for at least 1 hour. Do not reach the STEL alarm more than 4 times per day, with at least an hour in between each alarm exposure.

TWA: Time weighted average. STEL: Short-term exposure level.

PURPOSE	To provide standard instructions for setting up Geotech Multi-Probe Flowblock (Geotech Flowblock) flow through device for measuring field water quality parameters.
SCOPE	This practice has been prepared for the Pioneer Technical Services, Inc. (Pioneer) workforce and applies to work carried out by and on behalf of Pioneer. All members of the Pioneer workforce who conduct the work shall be trained and competent in the risk-assessed work described below.

WORK INSTRUCTIONS

The following instructions are intended to provide sufficient guidance to perform the task in a safe, accurate, and reliable manner. Should these instructions present information that is inaccurate or unsafe, operations personnel must bring the issue to the attention of the Project Manager and the appropriate revisions made. All work carried under this SOP will be consistent with procedures and policies described in the appropriate Operation, Maintenance, and Monitoring (O&M) Plan (where applicable), appropriate Site-Specific Health and Safety Plan (SSHASP), and Pioneer Corporate Health and Safety Plan (HASP).

TASK	INSTRUCTIONS
Notes	The Geotech Flowblock flow through device can be used directly in-line with most groundwater pumping systems such as the Grundfos RediFlo2™, Geotech SS Geosub, Geotech Bladder Pump, or Geopump Peristaltic Pump, and equivalent pumps. The Geotech Flowblock is designed for minimal sample volume (low-flow sampling) to reduce stirring dependence of sensors. The flowrate can vary from 100 mL/min to 1 gpm (3.8 L/min). **No laboratory samples will be taken from water that has flowed through the Geotech Flowblock or the quick-connect barbs.** Samples will be collected from tubing that was cut before contact with the Geotech Flowblock or the quick-connect barbs. The Geotech Flowblock does not need to be decontaminated between samples as it will not be in contact with laboratory samples. The Geotech Flowblock should be flushed between sample sites with tap or deionized (DI) water to flush out accumulated sediment. Refer to the following SOPs for the sampling setup in which the Geotech Flowblock will be used: SOP-GW-02 Sampling with A Bailer SOP-GW-10 Purging And Sampling with A 12-Volt Submersible Pump SOP-GW-10A Purging And Sampling with A Low Flow Submersible Pump SOP-GW-10B Purging And Sampling with Grunfoss Redi-Flow Submersible Pump SOP-GW-10C Purging And Sampling with A Peristaltic Pump SOP-GW-13 Sampling Groundwater From A Tap

	Prior to using the Geotech Flowblock, pH, specific conductivity, oxidation reduction potential (ORP), and dissolved oxygen (DO) field parameter meters need to be calibrated per the following SOPs: SOP-WFM-01 Field Measurement of pH In Water SOP-WFM-02 Field Measurement of Oxygen Reduction Potential in Water SOP-WFM-03 Field Measurement of Specific Conductance SOP-WFM-04 Field Measurement of Water Temperature SOP-WFM-07 Field Measurement of Dissolved Oxygen
1. (Option 1) Set up Geotech Flowblock.	The Option 1 set up is shown in Figure 1 below. This option can be used when using a pump that can be adjusted to a very low flow, such as the peristaltic pump and the low flow submersible pump. 1. Cut a piece of new silicon tubing. Use this tubing to connect the connecting valve to the Geotech Flowblock. Use a hose clamp to attach the tubing to the connecting valve. A hose clamp may also be needed to attach the tubing to the Geotech Flowblock. 2. Attach pump tubing to the connecting valve with a hose clamp. 3. Insert probes in the appropriate grommets in the Geotech Flowblock as depicted on Figure 1. Loosen the grommet to insert probes. The black cap on the pH and ORP columns (the center 2 grommets) may need to be removed to get the probes inserted. Make sure that the gasket present on each column stays on either the probe or in the block. Push the probes to bottom of each column and slightly tighten the black caps on the grommets. 4. Start pump and raise each probe to release pressure and get the associated column to fill. Once it is full, tighten the black cap on the grommets and move to the next probe (moving from inlet to outlet). If the columns are not filling, cover the end of the outlet discharge tubing and tighten the grommets as each column fills. No air bubbles should be present in the columns. If an air bubble is present loosen the grommet, raise the probe, wait for the bubble to disperse and lower the probe and retighten the grommets. Adjust flow using pump controls so that water is not spurting out of block. 5. The pump speed may need to be adjusted during purging as the reduction of head may require adjustment of flow through the Geotech Flowblock.

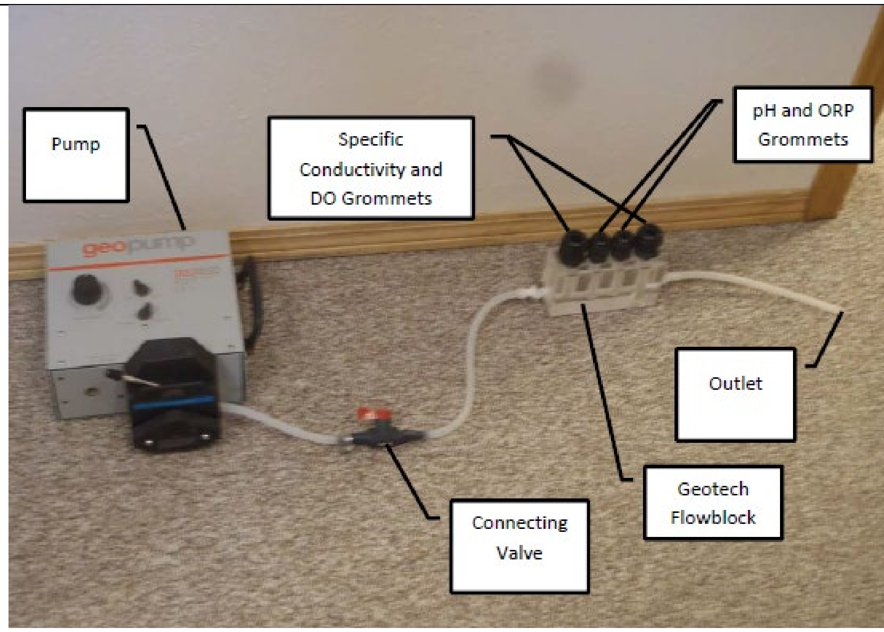


Figure 1. Geotech Flowblock

1. (Option 2) Set up Geotech Flowblock with relief valve port.

Note: The relief valve port will be used if flow is greater than the Geotech Flowblock can handle and to collect turbidity samples for field measurement.

The Option 2 set up is shown in Figure 2 below. This set up should be used for pumping situations where flow cannot be adjusted low enough that all water can flow through the Geotech Flowblock.

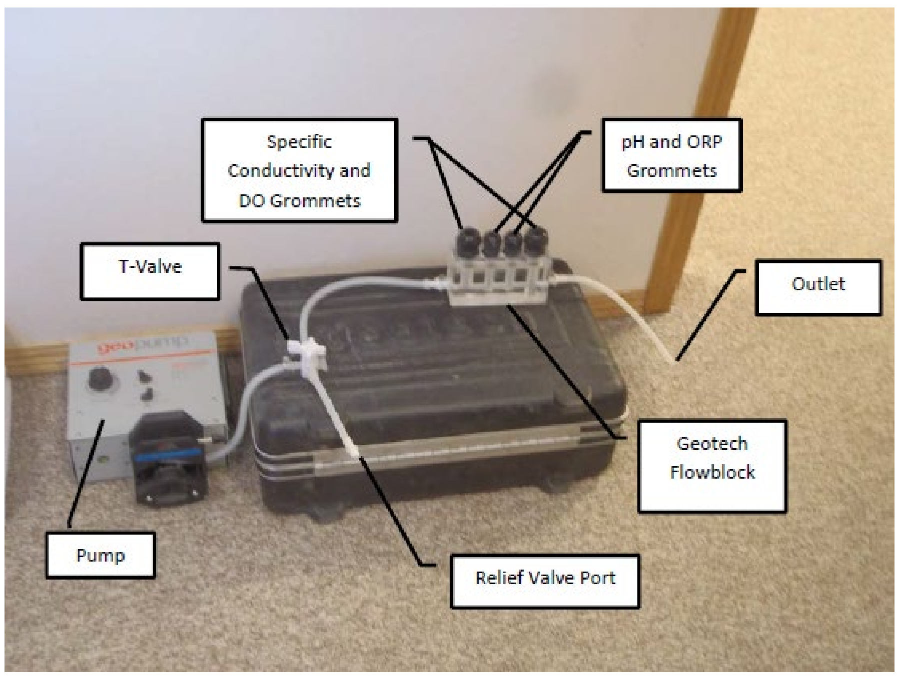
1. Cut one piece of silicon tubing to connect the relief valve to the Geotech Flowblock. Use a hose clamp and attach tubing to the outlet directly across from the input on the relief valve. Using a hose clamp attach the other end of the tubing to the Geotech Flowblock.

2. Attach pump tubing to the inlet on the relief valve with a hose clamp.

3. Cut (2) 18-inch pieces of silicon tubing to handle discharge.

4. Attach one piece of this tubing to the other outlet on the relief valve. This will provide a way to discharge water that cannot flow through the Geotech Flowblock. Laboratory samples will not be collected from the relief valve, however water for field turbidity measurements will be collected from this valve.

5. The second piece of silicon tubing will be attached to the outlet side of the Geotech Flowblock. This silicon tubing needs to be long enough to discharge to the bucket or container that is being used to measure volume.

	6. Insert probes in the appropriate grommets in the Geotech Flowblock as depicted on Figure 2. Loosen the grommet to insert a probe. The black cap on the pH and ORP columns (the center 2 grommets) may need to be removed to get the probes inserted. Make sure that the gasket present on each column stays on either the probe or in the block. Push the probes to bottom of each column and slightly tighten the black caps on the grommets. 7. Start pump and raise each probe to release pressure and get the associated column to fill. Once it is full, tighten the black cap on the grommets and move to the next probe (moving from inlet to outlet). If the columns are not filling, cover the end of the outlet discharge tubing and tighten the grommets as each column fills. No air bubbles should be present in the columns. If an air bubble is present loosen the grommet, raise the probe, wait for the bubble to disperse and lower the probe and retighten the grommets. Adjust flow using pump controls and the relief valve so that water is not spurting out of block. 8. The pump and or relief valve port may need to be adjusted during purging, as the reduction of head may require the adjustment of flow through the Geotech Flowblock.  Figure 2. Geotech Flowblock with Relief Valve Port
2. Monitor and record field parameters and depth to	Adjust pumping rate as needed to maintain a minimal drawdown of <0.1 m (<4 inches). Time, flowrate and drawdown should be recorded in the logbook or on field data sheets. During well purging, monitor field parameters including pH, conductivity, and

water level measurements.	temperature. The SAP or work plan may indicate other field parameters that need to be monitored, such as ORP (eH), DO, and turbidity. As outlined in the 2018 Groundwater Sampling Guidance from the Montana Department of Environmental Quality – Contaminated Site Cleanup Bureau, water quality parameters will be considered stable when three consecutive readings (generally 2-5 minutes apart) are as follows: a. Temperature range is no more than +/- 1 degree Celsius (°C); b. pH varies by no more than 0.1 pH units; c. Specific conductivity readings are within 3% of the average; d. ORP varies by no more than 10 mV units; e. DO readings are within 10% of the average; and f. Turbidity readings are within 10% of the average. Field parameters should be recorded in the logbook or on field data sheets.
3. Collect samples.	Purge until water quality parameters stabilize. Once these conditions occur, sampling can commence by following SOP-SA-02 Sample Preservation and Containerization for Aqueous Samples. Cut the tubing just above the Connector Valve or Relief Valve and collect the samples directly from the tubing. In general, volatile organic compound (VOC) samples should not be collected when using a peristaltic pump. If VOC analysis is required, collect the VOC samples first by filling pre-preserved sample containers. Fill the sample containers by allowing pump discharge to flow gently down the side of the bottle with minimal entry turbulence. Double check for bubbles as this method tends to produce them. Cap each bottle as filled. To check for air bubbles: turn the VOC bottle upside down, tap lightly, turn right side up, see if any bubbles float to the top. If you see a bubble, remove lid, add additional water, and reseal. If a filtered sample is required, an in-line high capacity (0.45 µm) should be inserted into the discharge end of the tubing after the other sample containers are filled. Fill the sample bottle and preserve immediately; cap the bottle.
4. Label, store, and ship samples.	Label the sample bottle as appropriate and place in a cooler. Ship with other samples in accordance with SOP-SA-01 Soil and Water Sample Packaging and Shipping.
5. Dispose of used tubing.	Tubing used in the well sampling will be disposed of in accordance with SOP-DE-03 Investigation Derived Waste Handling.

HSSE CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.				
SOURCE	***HAZARDS***	***WHERE***	***HOW, WHEN, RESULT***	***CONTROLS***
CHEMICAL	Potential contact with contaminated water.	Sites.	Inadvertent exposure to contaminated water could lead to adverse health effects.	Personnel will practice proper personal hygiene – wash hands prior to eating/drinking and when leaving the site. Employees will wear nitrile gloves and safety glasses when taking field measurements, collecting, and handling samples.
	Potential contact with field parameter buffer solutions.	Equipment calibration.	Inadvertent exposure to field parameter buffer solutions could lead to adverse health effects (e.g., irritation of eye, skin, and/or respiratory tract).	Personnel will practice proper personal hygiene – wash hands prior to eating and after calibrating equipment. Employees will wear nitrile gloves and safety glasses when handling field parameter buffer solutions.
	Preservatives (HCL, HNO_3, H_2SO_4, NaOH and $Na_2S_2O_3$).	In bottles or added to bottles through sampling process.	Inadvertent exposure to preservatives could lead to adverse health effects.	Safety Data Sheets for each preservative chemical are available to all employees on the Pioneer company web site. Personnel will wear nitrile gloves and safety glasses when adding preservatives to samples bottles. Refer to the Chemical Flushing Guidelines available inside vehicle's first aid kit for first-aid procedures in case of contact with preservatives.
NOISE	Not applicable.			
ELECTRICAL	Not applicable.			
BODY MECHANICS	Bending, squatting, and kneeling.	During measurements.	Bending, squatting, and kneeling during	Employees should stretch prior to starting work and they will take breaks when necessary.

			field parameter measurements could result in muscle/back strains or other injuries.	
GRAVITY	Falls from slips and trips.	Uneven terrain, slick/muddy/wet surfaces and steep slopes.	Walking/working on slick/muddy/wet and uneven terrain could cause slips and trips resulting in falls and injuries.	Workers will wear work boots with good traction and ankle support. Personnel will be aware of working/walking surfaces and choose a path to avoid hazards. Keep work areas as dry as possible. Wear muck boots, as necessary.
WEATHER	Cold/heat stress.	Sites.	Exposure to cold climates may result in cold burns, frostbites, and hypothermia. Exposure to high temperatures may result in heat cramps, heat exhaustion, or heat stroke.	Training on signs and symptoms of cold/heat stress is required. Personnel will wear appropriate clothing when working outdoors. Employees will remain hydrated and will have sufficient caloric intakes during the day. Personnel will follow procedures outlined in applicable SSHASP and/or Pioneer corporate HASP.
	Hypothermia/ frostbite.	Sites where air temperature is 35.6°F (2°C) or less.	Workers who become immersed in water or whose clothing becomes wet may be exposed to hypothermia and/or frostbite.	Employees will change clothing if it becomes wet. When applicable, employees will wear waders to prevent clothing from getting wet.
	Lightning.	Outdoor sites.	Electrocution, injury, death, or equipment damage could be caused by lightning strike.	Employees will follow the 30/30 rule during lightning storms.

RADIATION	Ultraviolet (UV) radiation.	Outdoors.	Employees could be exposed to UV radiation during summer months causing sun burns, skin damage, and eye damage.	Employees will wear safety glasses with tinted lenses, long-sleeve work shirts, and long pants. Employees should wear sunscreen, if necessary.
BIOLOGICAL	Plants, insects, and animals.	Sites.	Exposure to plants, insects, and/or animals may cause rashes, blisters, redness, and swelling.	Training on the signs and symptoms of exposure to plants, insects, and animals is required. Avoid contact with plants, insects, and animals. First-aid kits will be available on site. Employees with allergies will notify their supervisor.
MECHANICAL	Pinch points and scrapes.	Well caps.	Personal injury could result from fingers getting pinched when opening/closing well caps.	Employees will wear work gloves when opening/closing well caps.
	Scrapes.	Attaching hose clamps.	Personal injury could result when attaching hose clamps with a screwdriver resulting in hand scrapes.	Personnel will use a nut driver, if available. Personnel will be cautious when attaching hose clamps and will wear work gloves.
PRESSURE	Not applicable.			
THERMAL	Not applicable.			
HUMAN FACTORS	Inexperienced and improperly trained worker.	Sites.	Inexperienced workers and improper training could cause incidents resulting in adverse health	Employees will be properly trained in this procedure and other applicable procedures. Employees will implement stop work procedures, if necessary.

			effects and/or property damage.	
SIMOPS	Not applicable.			

ADDITIONAL HSSE CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.	
REQUIRED PPE	Hard hat, safety glasses, high-visibility work shirt or vest, long pants, work boots, nitrile gloves, and work gloves.
APPLICABLE SDS	HCL; HNO_3; H_2SO_4; NaOH; $Na_2S_2O_3$; ORP; electrode storage solution; specific conductivity solution; pH and ORP electrode cleaner solution; pH 4, pH 7, and pH 10 buffer solutions. Additional Safety Data Sheets (SDSs) will be maintained based on site characterization and contaminants.
REQUIRED PERMITS/FORMS	Per site/project requirements.
ADDITIONAL TRAINING	Per site/project requirements.

DRAWINGS, DOCUMENTS, AND TOOLS/EQUIPMENT The following documents should be referenced to assist in completing the associated task.	
DRAWINGS	Map with site location and sample locations.
RELATED SOPs/PROCEDURES/ WORK PLANS	SOP-GW-02 Sampling with A Bailer SOP-GW-10 Purging And Sampling with A 12-Volt Submersible Pump SOP-GW-10A Purging And Sampling with A Low Flow Submersible Pump SOP-GW-10B Purging And Sampling with Grunfoss Redi-Flow Submersible Pump SOP-GW-10C Purging And Sampling with A Peristaltic Pump SOP-GW-13 Sampling Groundwater From A Tap SOP-WFM-01 Field Measurement of pH In Water SOP-WFM-02 Field Measurement of Oxygen Reduction Potential in Water SOP-WFM-03 Field Measurement of Specific Conductance SOP-WFM-04 Field Measurement of Water Temperature SOP-WFM-07 Field Measurement of Dissolved Oxygen SOP-SA-02 Sample Preservation and Containerization for Aqueous Samples SOP-SA-01 Soil and Water Sample Packaging and Shipping SOP-DE-03 Investigation Derived Waste Handling

TOOLS	Geotech Flowblock, sample bottles, sample preservatives, water quality meters, spare batteries for the field measurement meters, ORP, electrode storage, specific conductivity, pH and ORP electrode cleaner, pH 4, pH 7, and pH 10 buffer solutions, de-ionized water, 5-gallon buckets, electronic depth to water level indicator, pump, stop watch, beaker, cooler, ice, purge containers and field logbook/field data sheets.
FORMS/CHECKLIST	

APPROVALS/CONCURRENCE By signing this document, all parties acknowledge the completeness and applicability of this SOP for its intended purpose. Also, by signing this document, it serves as acknowledgement that I have received training on the procedure and associated competency testing.	
SOP TECHNICAL AUTHOR	**DATE**
Julie Flammang **Julie Flammang**	**05/22/2015**
SAFETY AND HEALTH MANAGER	**DATE**
Tara Schleeman **Tara Schleeman**	**05/22/2015**

Revisions:

Revision	Description	Date

PURPOSE	To provide standard instructions for surface soil sampling.
SCOPE	This practice has been prepared for the Pioneer Technical Services, Inc. (Pioneer) workforce and applies to work carried out by and on behalf of Pioneer. All members of the Pioneer workforce who conduct the work shall be trained and competent in the risk-assessed work described below.
DEFINITIONS	Surface Sample: a surface sample is defined as a mineral soil sample collected from immediately beneath the vegetative mat. It generally includes some interval from the upper six inches of soil. Surface sampling under biased conditions may be selected after considering factors such as type of contaminant, length of time the area has been contaminated, the type of soil, and the past use of the area.

WORK INSTRUCTIONS

The following instructions are intended to provide sufficient guidance to perform the task in a safe, accurate, and reliable manner. Should these instructions present information that is inaccurate or unsafe, operations personnel must bring the issue to the attention of the Project Manager and the appropriate revisions made. All work carried under this SOP will be consistent with procedures and policies described in the appropriate Operation, Maintenance, and Monitoring (O&M) Plan (where applicable), appropriate Site-Specific Health and Safety Plan (SSHASP), and Pioneer Corporate Health and Safety Plan (HASP).

TASK	INSTRUCTIONS
Grab Sample	
Note	Sample collection devices include stainless steel scoops or trowels, and disposable Teflon trowels. For inorganic contaminants, disposable plastic scoops will be used. The following procedure is designed to collect a surface soil sample from the 0-2 inch horizon. These procedures may be modified in the field based on field and site conditions after appropriate annotations have been made in the field log book. These procedures are **not to** be used when sampling for volatile organic compounds. The procedures for collecting volatile organic samples are described in the following sections of this SOP.
1. Identify site-specific hazards and verify utility locates.	Perform utility locates or verify utility locates have been performed. Walk through the site and determine any site-specific hazards associated with the sampling area. Discuss findings with sampling crew and note in the field logbook. Verify the utility locate information by identifying where natural gas pipes or other utilities enter any structures on the property or if yard lights or street lights are present with no overhead lines. Determine if an underground sprinkling system is present, where applicable. If sample locations have not been assigned in the Sampling Analysis Plan (SAP), note the already marked and/or probable locations of underground utilities and try to avoid those areas when choosing sample locations. Also, note the location of overhead lines and overhead hazards and avoid those areas, if possible. If sample locations are identified in the SAP, use the appropriate survey method to

	locate and mark the sample locations.
2. Dig a 6 to 12-inch square pit.	Dig a 6 to 12-inch square pit to a depth of approximately 6 inches. The size and depth of the sample pit required depends on the amount of material needed for sample analysis and the interval to be sampled. If a sod mat is present, separate the sod mat from the mineral soil surface with the chosen sampling tool. Shake and scrape the removed sod mat over the sample collection bowl to dislodge any mineral soil particles. Place all dislodged particles in the sample. If the surface material is coarse-grained material, free of intermixed materials (i.e., graveled driveway), collect the sample from the appropriate layer below the protective barrier. However, if the graveled driveway, alley or lot contains soil/dust material on the surface, collect the sample from the appropriate interval. If the sample area is unvegetated, collect the sample material from the designated interval inches below ground surface.
3. Measure and mark the interval to be sampled.	Measure the interval to be sampled (e.g., 0-2 inches or 0-6 inches) with a stainless steel tape measure or a ruler and mark the appropriate interval.
4. Scrape the walls of the sample pit.	Scrape the walls of the sample pit within the marked interval with a decontaminated stainless steel trowel or scoop, a Teflon scoop, or a disposable plastic scoop to expose a clean surface.
5. Collect the sample.	Once the wall of the test pit has been cleaned, collect the sample by scraping the appropriate interval on the cleaned face of the pit with the sampling tool and placing the material in a decontaminated stainless steel bowl, or a new cleaned foil pan.
6. Remove coarse fragments from the bowl.	Remove all coarse fragments greater than 0.5 inches from the bowl. Mix the remaining material in the bowl with the sampling tool.
7. Pack the samples.	Transfer the soil sample directly into the appropriate sample container according to SOP-SA-01 Soil and Water Sample Packaging and Shipping and store in a cooler at 4°C or less. Any remaining sample material will be returned to the sample holes. A sufficient quantity of soil will be collected in each sample container to provide for analysis with additional soil left over to be archived.
8. Record sampling information.	Record appropriate information about the sample collection in the field logbook.
9. Return all the removed dirt	Return all the removed dirt into the hole and return the sample area to pre-sampling conditions.

into the hole.	
10. Decontaminate the equipment.	Decontaminate sampling tools according to procedures outlined in SOP-DE-02 Equipment Decontamination.
Composite Sampling	
Note	In many situations, a composite sample is more appropriate for sample collection than a grab sample. Several types of composite samples can be collected. A sampler can collect a biased composite sample by identifying specific spots within the sample area that appear to be contaminated or not contaminated and digging sample pits in those locations. Composite samples can also be collected randomly as defined in a SAP. Sub samples are often collected in a five-point (star) pattern. At each point, a sub sample of a predetermined depth is collected. The diagonal distance between points is commonly ten feet, depending on the area of soil homogeneity. Sub samples can also be collected in a three-point (triangular) pattern. At each point, a subsample of predetermined depth is collected. The diagonal distance between the points is commonly ten feet, depending on the area of soil homogeneity. The precise method for compositing the sample will be discussed in the SAP. Each sub sample test hole will be prepared and sampled in the manner discussed above under the Grab Sample section.
1. Collect composite samples.	Composite samples will consist of discrete aliquots of equal amounts of soil from each subsample location. The soil aliquots will be collected into a stainless steel bowl and thoroughly mixed. An alternative method of compositing soil sub samples is with a large disposable plastic or canvas sheet. The subsamples are mixed in the center of the sheet. Each corner is pulled up and toward the diagonally opposite corner. This process is done from each corner. After the soil is mixed, it is again spread out on the cloth into a relatively flat pile. The pile is quartered. A small scoop is used to collect small samples from each quarter until the desired amount of soil is acquired. Note: high concentrations of organic chemicals in soils can react with the plastic sheet. The sampler may also "eyeball" an equal amount of sample material from each hole into a resealable plastic bag (i.e., Ziploc®). The sample material would be thoroughly mixed between each sub sample pit and prior to placing in the appropriate sample containers.
2. Remove coarse fragments.	Remove all coarse fragments greater than 0.5 inches from the bowl. Mix the remaining material in the bowl with the sampling tool.
3. Pack the samples.	Transfer the soil sample directly into the appropriate sample container according to SOP-SA-01 Soil and Water Sample Packaging and Shipping, label the samples, and

	store in a cooler at 4°C or less. Any remaining sample material will be returned to the sample holes. A sufficient quantity of soil will be collected in each sample container to provide for analysis with additional soil left over to be archived.
4. Record sampling information.	Record appropriate information about the sample collection in the field logbook.
5. Return all the removed dirt into the hole.	Return all the removed dirt into the hole and return the sample area to pre-sampling conditions.
6. Decontami-nate the equipment.	Decontaminate sampling tools according to procedures outlined in SOP-DE-02 Equipment Decontamination.
Volatile Organic Sampling	
1. Identify site-specific hazards and verify utility locates.	Perform utility locate or verify utility locates have been performed. Walk through the site and determine any site-specific hazards associated with the sampling area. Discuss findings with sampling crew and note in the field logbook. Verify the utility locate information by identifying where natural gas pipes or other utilities enter any structures on the property or if yard lights or street lights are present with no overhead lines. If sample locations have not been assigned in the SAP, note the already marked and/or probable locations of underground utilities and try to avoid those areas when choosing sample locations. Also, note the location of overhead lines and overhead hazards and avoid those areas, if possible. If sample locations are identified in the SAP use the appropriate survey method to locate.
2. Dig a 6 to 12-inch square pit.	Dig a 6 to 12-inch square pit to a depth of approximately 6 inches. The size and depth of the sample pit required would depend on the amount of material needed for sample analysis and the interval being sampled. If a sod mat is present, separate the sod mat from the mineral soil surface with the chosen sampling tool. Shake and scrape the removed sod mat over the sample collection bottle to dislodge any mineral soil particles. Place all dislodged particles in the sample. If the surface material is coarse-grained material, free of intermixed materials (i.e., graveled driveway), collect the sample from the appropriate layer below the protective barrier. However, if the graveled driveway, alley or lot contains soil/dust material on the surface, collect the sample from the appropriate interval. If the sample area is unvegetated, collect the sample material from the appropriate depth below ground surface.

3. Measure and mark the interval to be sampled.	Measure the interval to be sampled (e.g., 0-2 inches or 0-6 inches) with a stainless steel tape measure or a ruler and mark the appropriate interval.
4. Scrape the walls of the sample pit.	Scrape the walls of the sample pit within the marked interval with a decontaminated stainless steel trowel or scoop, a Teflon scoop, or a disposable plastic scoop to expose a clean surface.
5. Collect the sample.	After the face of the test pit has been cleaned, immediately place the sampling container into the sample pit and collect the sample by scraping the appropriate interval of mineral soil directly into the sample container. Pack in the material as tightly as feasible and try to avoid getting large particles in the jar. The sampling container should be filled to the top with little to no headspace, and the lid placed on the container as soon as the jar is full. Place the sample immediately in a cooler at 4ºC or less.
6. Record sampling information.	Record appropriate information about the sample collection in the field logbook.
7. Return all the removed dirt into the hole.	Return all the removed dirt into the hole and return the sample area to pre-sampling conditions.
8. Decontami-nate the equipment.	Decontaminate sampling tools according to procedures outlined in SOP-DE-02 Equipment Decontamination.

HSSE CONSIDERATIONS

This section to be completed with concurrence from the Safety and Health Manager.

SOURCE	*HAZARDS*	*WHERE*	*HOW, WHEN, RESULT*	*CONTROLS*
CHEMICAL	Potential contact with contaminated soils.	Sites.	Inadvertent exposure to contaminated soils could lead to adverse health effects.	Personnel will practice proper personal hygiene – wash hands prior to eating/drinking and when leaving the site. Employees will wear nitrile gloves and safety glasses when collecting and handling samples.
	Chemical reaction.	Sampling sites with organic contaminants. During the alternative method to collect composite soil sub samples using a large disposable plastic or canvas sheet.	Adverse health effects could result from high concentrations of organic chemicals in soils, or reactions with the plastic sheet.	Employees will wear Level D PPE when using this method. If sampling sites with organic contaminants, be aware of the level of exposure by using PIDs. If PID reads high levels, stop work and reassess the sampling procedures.
NOISE	Not applicable.			
ELECTRICAL	Contact with underground utilities.	Testing sites.	Injury, death or property damage could occur from contact with underground utilities during soil sampling.	Personnel will follow Pioneer's underground and overhead utilities corporate program and established procedures. When possible, personnel will avoid areas with underground utilities hazards.
BODY MECHANICS	Improper shoveling techniques.	Sites.	Personnel could be injured if using improper shoveling techniques to dig and refill the test pits causing back injuries and muscle/back strains.	Personnel will use proper shoveling techniques: keep feet wide apart, place front foot close to shovel, put weight on front foot, use leg to push shovel, shift weight to rear foot, keep load close to body, and turn feet in direction of throw.

	Improper lifting.	Testing sites.	Back injuries and muscle/back strains could result when using improper techniques to lift and carry tools and equipment.	Personnel will use proper lifting techniques – get a good grip, keep the load close to the body, lift with legs and not with back, and avoid lifting loads above shoulder's height. Two employees will lift objects, if necessary.
	Bending, squatting, and kneeling.	During sample collection.	Bending, squatting, and kneeling during sample collection could result in muscle/back strains or other injuries.	Employees should stretch prior to starting work and they will take breaks when necessary.
GRAVITY	Falls from slips and trips.	Uneven terrain, slick/muddy/wet surfaces and steep slopes.	Walking/working on slick/muddy/wet and uneven terrain could cause slips and trips resulting in falls and injuries.	Workers will wear work boots with good traction and ankle support. Personnel will be aware of working/walking surfaces and choose a path to avoid hazards. Keep work areas as dry as possible. Wear muck boots, as necessary.
WEATHER	Cold/heat stress.	Sites.	Exposure to cold climates may result in cold burns, frostbites, and hypothermia. Exposure to high temperatures may result in heat cramps, heat exhaustion, or heat stroke.	Training on signs and symptoms of cold/heat stress is required. Personnel will wear appropriate clothing when working outdoors. Employees will remain hydrated and will have sufficient caloric intakes during the day. Personnel will follow procedures outlined in applicable SSHASP and/or Pioneer corporate HASP.
	Lightning.	Outdoor sites.	Electrocution, injury, death, or equipment damage could be caused by lightning strike.	Employees will follow the 30/30 rule during lightning storms.

RADIATION	Ultraviolet (UV) radiation.	Outdoors.	Employees could be exposed to UV radiation during summer months causing sun burns, skin damage, and eye damage.	Employees will wear safety glasses with tinted lenses, long-sleeve work shirts, and long pants. Employees should wear sunscreen, if necessary.
BIOLOGICAL	Plants, insects, and animals.	Sites.	Exposure to plants, insects, and/or animals may cause rashes, blisters, redness, and swelling.	Training on the signs and symptoms of exposure to plants, insects, and animals is required. Avoid contact with plants, insects, and animals. First-aid kits will be available on site. Employees with allergies will notify their supervisor.
MECHANICAL	Pinch points and cuts. Struck by shovel and pry bar.	Test pits. Loading/ unloading and mobilizing to the test site.	Employees could cut their fingers if the soil samples contain debris and/or sharp objects (e.g., glass, steel, etc.). Personal injury could result if employee is struck by shovel and pry bar.	Employees will wear nitrile gloves (work gloves, if necessary) when sampling and handling soil. Workers will visually inspect the soil samples and remove any debris and/or sharp objects. Employees will not follow too close to the person carrying the equipment. The person loading the truck must be aware of others around the trucks.
PRESSURE	Not applicable.			
THERMAL	Not applicable.			
HUMAN FACTORS	Inexperienced and improperly trained worker.	Sites.	Inexperienced workers and improper training could cause incidents resulting in adverse health effects and/or property damage.	Employees will be properly trained in this procedure and other applicable procedures. Employees will implement stop work procedures, if necessary.

SIMOPS	Struck by and/or caught in between heavy equipment or vehicles.	Sites.	Personnel could be injured if struck by and/or caught in between heavy equipment or vehicles while collecting samples.	Employees will communicate with the contractors on site. Personnel will avoid working near heavy equipment/vehicles, when possible. Personnel will wear high visibility clothing. When possible, personnel will park field vehicles or use traffic cones to prevent third party vehicles from coming into the work area.

ADDITIONAL HSSE CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.	
REQUIRED PPE	Hard hat, safety glasses, high-visibility work shirt or vest, long pants, work boots, nitrile gloves, and leather gloves.
APPLICABLE SDS	Safety Data Sheets (SDSs) will be maintained based on site characterization and contaminants.
REQUIRED PERMITS/FORMS	Per site/project requirements.
ADDITIONAL TRAINING	Per site/project requirements.

DRAWINGS, DOCUMENTS, AND TOOLS/EQUIPMENT The following documents should be referenced to assist in completing the associated task.	
P&IDS	
DRAWINGS	Map with site location and sample locations.
RELATED SOPs/PROCEDURES/ WORK PLANS	SOP-SA-01 Soil and Water Sample Packaging and Shipping and SOP-DE-02 Equipment Decontamination.
TOOLS	Sampling tools: stainless steel scoops or trowels, disposable Teflon trowels, disposable plastic scoops (for inorganic contaminants), stainless steel tape measure or a ruler, decontaminated stainless steel bowl or cleaned foil pan, one-quart plastic bag, sampling containers, and cooler. For the alternative method of compositing soil sub samples: large disposable plastic or canvas sheet, small scoop, and resealable plastic bags. Field logbook.
FORMS/CHECKLIST	

APPROVALS/CONCURRENCE By signing this document, all parties acknowledge the completeness and applicability of this SOP for its intended purpose. Also, by signing this document, it serves as acknowledgement that I have received training on the procedure and associated competency testing.	
SOP TECHNICAL AUTHOR	**DATE**
Julie Flammang **Julie Flammang**	**12/11/2014**
SAFETY AND HEALTH MANAGER	**DATE**
Tara Schleeman **Tara Schleeman**	**12/11/2014**

Revisions:

Revision	Description	Date

PURPOSE	To provide standard instructions for collecting subsurface soil samples.
SCOPE	This practice has been prepared for the Pioneer Technical Services, Inc. (Pioneer) workforce and applies to work carried out by and on behalf of Pioneer. All members of the Pioneer workforce who conduct the work shall be trained and competent in the risk-assessed work described below.
DEFINITIONS	Subsurface Soil Sample: it is defined as a mineral soil sample collected from 6 inches to 25 feet below ground surface. The need for biased sampling of subsurface soils should be evaluated by considering factors such as the precipitation, the type of soil and the length of time the site has been contaminated. If precipitation has moved contaminants into lower soil horizons, subsurface sampling may be appropriate. Several techniques can be used to collect samples from 6 inches to four or five feet below ground surface (bgs). A shovel and pry bar can be used to collect samples from 6 inches to 2 feet bgs. A hand auger may be used to collect subsurface samples up to four or five feet in depth. Because the auger is twisted into the soil the soil's cohesive structure and stratigraphic character are destroyed. An in situ soil recovery auger may also be used to collect subsurface samples up to five feet. The auger accommodates a liner and provides fast cutting of the soil with very little soil disturbance. In particularly rocky or hard soils a back hoe may be needed to excavate even shallow test pits. It is important to evaluate site conditions prior to choosing a subsurface sampling method. Each method of sampling will be discussed below.

WORK INSTRUCTIONS

The following instructions are intended to provide sufficient guidance to perform the task in a safe, accurate, and reliable manner. Should these instructions present information that is inaccurate or unsafe, operations personnel must bring the issue to the attention of the Project Manager and the appropriate revisions made. All work carried under this SDS
will be consistent with procedures and policies described in the appropriate Operation, Maintenance, and Monitoring (O&M) Plan (where applicable), appropriate Site-Specific Health and Safety Plan (SSHASP), and Pioneer Corporate Health and Safety Plan (HASP).

TASK	INSTRUCTIONS
Hang Dug Test Pits	
1. Coordinate utility locates.	Prior to site entry have a utility locate performed.
2. Locate sample site.	Locate the site as directed in the appropriate Sampling and Analysis Plan (SAP).
3. Conduct site walk.	Conduct a site walk through and determine any site-specific hazards associated with the sampling area. Discuss these with the sampling crew and note in the field logbook. During the site walk through note possible locations for underground utilities. For example, identify where natural gas pipes enter any structures on the property or if yard lights or street lights are present with no overhead lines. If sample locations have not been assigned in the SAP, note the probable locations of

	underground utilities and try to avoid those areas when choosing sample locations. If sample locations are identified in the SAP use the appropriate survey method to locate.
4. Dig test pit.	Dig a 6 to 12-inch square pit to the depth specified in the SAP plus an additional 3 to 4 inches.
5. Identify sample intervals.	Measure the interval to be sampled with a stainless steel tape measure or a ruler and mark the appropriate interval.
6. Prepare sample location.	Scrape the walls of the sample pit within the marked interval with a decontaminated stainless steel trowel or scoop, a Teflon scoop, or a disposable plastic scoop to expose a clean surface.
7. Collect samples.	Place a stainless steel bowl or a clean decontaminated disposable foil pan adjacent to or in the sample pit and collect the sample by scraping the appropriate interval on the cleaned face of the pit with the sampling tool. If more than one interval is to be collected from the hole, collect the bottom or deepest interval first. If sampling for volatile organic compounds, the soil must be placed directly into the sample container with no head space and placed into a cooler with ice immediately.
8. Remove unnecessary material from sample.	Remove all coarse fragments greater than 0.5 inches from the bowl. Mix the remaining material in the bowl with the sampling tool.
9. Transfer sample to sample container.	Transfer the soil sample directly into the appropriate sample container according to SOP-SA-01 Soil and Water Sample Packaging and Shipping. Store samples in a cooler at 4°C or less.
10. Document sample information.	Record appropriate information about the sample and collection in the field logbook.
11. Decontami-nate sampling tools.	Decontaminate sampling tools according to procedures outlined in SOP-DE-02 Equipment Decontamination.
Hand Auger Sampling	
1. Coordinate utility locates.	Prior to site entry have a utility locate performed.
2. Locate sample site.	Locate the site as directed in the appropriate Sampling and Analysis Plan (SAP).
3. Conduct site	Conduct a site walk through and determine any site-specific hazards associated with

walk.	the sampling area. Discuss with the sampling crew and note in the field logbook. During the site walk through note possible locations for underground utilities. For example identify where natural gas pipes enter any structures on the property or if yard lights or street lights are present with no overhead lines. If sample locations have not been assigned in the SAP, note the probable locations of underground utilities and try to avoid those areas when choosing sample locations. If sample locations are identified in the SAP use the appropriate survey method to locate. Note the locations of overhead lines and overhead hazards and avoid those areas if possible.
4. Auger sample hole.	Place a large piece of plastic adjacent to the sample location. Choose the appropriate auger head for the soil type at the sample site (i.e., sand, mud, normal). Measure the length of the auger head to determine the advancement depth for each full auger. Place the auger at the sample location and begin turning, when the head is full remove the auger from the hole and empty the head onto the plastic. Measure the hole depth to determine the number of auger heads needed to reach the sample interval. Keep auguring and emptying the soil onto the plastic sheet until the top of the sampling interval is reached. The soil can be placed on the sheet in the order of removal for a general soil profile.
5. Collect sample.	Place a stainless steel bowl or a clean decontaminated disposable foil pan near the sample pit (preferably on a clean portion of the plastic) and collect the sample by emptying the auger head into the bowl or pan. Continue auguring and emptying the auger head into the sampling container throughout the entire sampling interval. If sampling for volatile organic compounds, the soil must be placed directly into the sample container with no head space and placed into a cooler with ice immediately.
6. Remove unnecessary material from sample.	Remove all coarse fragments greater than 0.5 inches from the bowl. Mix the remaining material in the bowl with the sampling tool.
7. Transfer sample to sample container.	Transfer the soil sample directly into the appropriate sample container according to SOP-SA-01 Soil and Water Sample Packaging and Shipping. Store samples in a cooler at 4°C or less.
8. Document sample information.	Record appropriate information about the sample and collection in the field logbook.
9. Decontami-nate sample tools.	Decontaminate sampling tools according to procedures outlined in SOP-DE-02 Equipment Decontamination.

In-Situ Soil Recovery at Depths Greater than Five Feet A direct push soil recovery rig mounted on a truck or trailer is the most common method for the In-Situ Soil Recovery at Depths Greater than Five Feet and can be used to sample up to 75 feet or more in depth. There are also several types of hand augers with liner tubes that can be used for sampling up to 5 feet depending on soil type. The steps described in this section are for sampling from the liner tube.	
1. Coordinate utility locates.	Prior to site entry have a utility locate performed.
2. Locate sample site.	Locate the site as directed in the appropriate Sampling and Analysis Plan (SAP).
3. Conduct site walk.	Walk through the site and determine any site-specific hazards associated with the sampling area. Discuss these with the sampling crew and note in the field logbook. During the site walk through note possible locations for underground utilities, for example identify where natural gas pipes enter any structures on the property or if yard lights or street lights are present with no overhead lines. If sample locations have not been assigned in the SAP, note the probable locations of underground utilities and try to avoid those areas when choosing sample locations. If sample locations are identified in the SAP, use the appropriate survey method to locate.
4. Probing or augering the sample hole.	Actual augering or drilling of the sampling holes will be conducted following the subcontractor's SOPs and safety protocols.
5. Collect sample.	As the plastic, Teflon or stainless steel liner is removed from the drill rod, make sure that the "top" of the liner, which represents the upper intervals is identified. If entire liner is being submitted for analysis seal both ends and mark the liner with the appropriate sample number and information. Place in a cooler and store at 4°C or less. If individual sample containers need to be collected or a composite sample over several intervals is to be collected place the liner on a work surface (portable table or plastic tarp on the ground). Cut the liner tube along its length. Label the top and bottom of the liner with the appropriate depths, index cards or pieces of paper placed at the top and bottom are acceptable. Photograph the core. Measure the amount of material present in the liner and if specified in the site-specific sampling plan log the core.
6. Prepare sample.	Place a stainless steel bowl or a clean decontaminated disposable foil pan near the liner. Using a decontaminated stainless steel trowel or scoop, a Teflon scoop, or a disposable plastic scoop remove the appropriate interval from the liner and put it in the bowl/pan. If sampling for volatile organic compounds, place the soil directly into the appropriate sampling container, fill the container so that there is no head space, seal and place in a cooler with ice immediately. For all other analyses remove all coarse fragments greater than 0.5 inches from the bowl. Mix the remaining material in the bowl with the sampling tool.

7. Transfer sample to sample container.	Transfer the soil sample directly into the appropriate sample container according to SOP-SA-01 Soil and Water Sample Packaging and Shipping. Store samples in a cooler at 4°C or less.
8. Document sample information.	Record appropriate information about the sample and collection in the field logbook.
9. Decontami-nate sample tools.	Decontaminate sampling tools according to procedures outlined in SOP-DE-02 Equipment Decontamination.

HSSE CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.				
SOURCE	***HAZARDS***	***WHERE***	***HOW, WHEN, RESULT***	***CONTROLS***
CHEMICAL	Potential contact with contaminated soils.	Sample collection sites.	Inadvertent exposure to contaminated soils could lead to adverse health effects.	Personnel will practice proper personal hygiene – wash hands prior to eating and when leaving the site. Work will be suspended during high wind conditions that may produce large amounts of visible dust. Personnel will wear nitrile gloves and safety glasses when sampling and handling soil.
NOISE	Elevated noise levels.	Mechanized probing rig.	Personnel collecting soil samples can be exposed to elevated noise levels from the mechanized probing rig resulting in hearing damage.	Personnel collecting soil samples will set up the sampling station 25 feet away from the rig. The rig operator or helper will bring the plastic liner to the sampling station.
ELECTRICAL	Contact with underground utilities. Contact with overhead utilities.	Testing sites. Testing sites.	Serious injury could result from contact with a live buried utility. Walking near low hanging overhead utilities and generators on site could result in electrocution, shock, and burn due to contact or flashover.	Established ground disturbance procedures, as outlined in the Pioneer Corporate HASP will be followed. Visually inspect the sample location/yard prior to accessing. If overhead hazards are present, established overhead utility procedures will be followed. When possible, employees will avoid areas with overhead hazards.
BODY MECHANICS	Bending, squatting and kneeling.	During sample collection.	Bending, squatting and kneeling during sample collection and handling could result in	Personnel should stretch prior to starting work and they will take breaks when necessary. Personnel will use a foam pad or knee pads, if necessary.

			muscle/back strains or other injuries. Kneeling on gravel can result in bruises and knee injuries.	
	Lifting and carrying tools, equipment, and/or samples.	Testing sites.	Improper lifting and carrying tools, equipment, and/or samples could result in back injuries and muscle/back strains.	Personnel will use proper lifting techniques – get a good grip, keep the load close to the body, lift with legs and not with back, and avoid lifting loads above shoulder's height. Two people will lift, if necessary.
GRAVITY	Falls from slips and trips.	Uneven terrain, slick surfaces and steep slopes.	Workers could get injured if they fall causing bruises, scrapes, or broken bones.	Workers will wear work boots with good traction and ankle support. Workers will plan their path and walk cautiously. Access areas will be established, if necessary.
WEATHER	Cold/heat stress.	Sites.	Exposure to cold climates may result in cold burns, frostbites, and hypothermia. Exposure to high temperatures may result in heat cramps, heat exhaustion, or heat stroke.	Training on signs and symptoms of cold/heat stress. Personnel will wear appropriate clothing when working outdoors. Personnel will remain hydrated and will have sufficient caloric intakes during the day. Personnel will follow procedures outlined in applicable SSHASP and/or Pioneer corporate HASP.
	Lightning.	Testing sites.	Electrocution, injury, death, or equipment damage could be caused by lightning strike.	Employees will follow the 30/30 rule during lightning storms.
RADIATION	Ultraviolet (UV) radiation.	Outdoors.	Employees could be exposed to UV radiation during summer months causing sun	Employees will wear safety glasses with tinted lenses, long-sleeve work shirts, and long pants. Employees should wear sunscreen, if necessary.

			burns, skin damage, and eye damage.	
BIOLOGICAL	Plants, insects, and animals.	Sites.	Exposure to plants, insects, and/or animals may cause rashes, blisters, redness, and swelling.	Training on the signs and symptoms of exposure to plants, insects, and animals is required. Avoid contact with plants, insects, and animals. First-aid kits will be available on site. Employees with allergies will notify their supervisor.
MECHANICAL	Pinch points.	Test pits.	Employees could cut their fingers if debris (e.g., glass, steel) is present in test pits. Personal injury to the hands could occur when using sampling equipment/tools.	Employees will wear nitrile gloves when sampling and handling soil. Employees will wear leather gloves while using sampling tools.
	Struck by shovel or auger.	Carrying tools.	Personnel can strike other workers or objects when carrying shovels and augers to/from sampling stations resulting in bodily injuries and/or property damage.	Personnel will be aware of their surroundings and, if needed, use a spotter. When carrying tools, maintain a safe distance (e.g., 4 feet or more depending on side of tool) from other workers.
	Hand injuries.	Liner cutter.	Employees could be exposed to hand injuries such as lacerations, punctures, and cuts when using the liner cutter and handling the cut liner.	Employees will wear work gloves when using the liner cutter. Be cautious of sharp edges when handling plastic core liners after they have been cut open. Workers will be trained on how to properly use the liner cutter. Two employees will cut liners,

				if needed.
PRESSURE	Not applicable.			
THERMAL	Not applicable.			
HUMAN FACTORS	Inexperienced and improperly trained worker.	Sites.	Inexperienced workers and improper training could cause incidents resulting in adverse health effects and/or property damage.	Employees will be properly trained in this procedure and other applicable procedures. Employees will implement stop work procedures, if necessary.
	Public entering the work area.	Sites.	Third party members of the public could enter the work area resulting in an unsafe work environment.	Stop work if members of the public enter the work area.
SIMOPS	Not applicable.			

ADDITIONAL HSSE CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.	
REQUIRED PPE	Hard hat, safety glasses, high-visibility work shirt or vest, long pants, work boots, nitrile gloves, and leather gloves.
APPLICABLE SDS	Safety Data Sheets (SDSs) will be maintained based on site characterization and contaminants.
REQUIRED PERMITS/FORMS	Per site/project requirements.
ADDITIONAL TRAINING	Per site/project requirements.

DRAWINGS, DOCUMENTS, AND TOOLS/EQUIPMENT The following documents should be referenced to assist in completing the associated task.	
P&IDS	
DRAWINGS	Map with site location and sample locations.
RELATED SOPs/PROCEDURES/	SOP-SA-01 Soil and Water Sample Packaging and Shipping and SOP-DE-02 Equipment Decontamination.

WORK PLANS	
TOOLS	Sampling tools (e.g., shovel, breaker bar, ruler, hand auger, plastic sheeting, trowel, sample containers, liner cutter, bowls, and camera) and field logbook. Decontamination equipment and fluids.
FORMS/CHECKLIST	

APPROVALS/CONCURRENCE

By signing this document, all parties acknowledge the completeness and applicability of this SOP for its intended purpose. Also, by signing this document, it serves as acknowledgement that I have received training on the procedure and associated competency testing.

SOP TECHNICAL AUTHOR	**DATE**
Julie Flammang **Julie Flammang**	**05/22/2015**
SAFETY AND HEALTH MANAGER	**DATE**
Tara Schleeman **Tara Schleeman**	**05/22/2015**

Revisions:

Revision	Description	Date

PURPOSE	To provide standard instructions for mechanically excavated test pit sampling.
SCOPE	Pioneer Technical Services, Inc. (Pioneer) prepared this practice for the workforce and this Standard Operating Procedure (SOP) applies to all work performed by and on behalf of Pioneer. All members of the Pioneer workforce who conduct the work shall be trained and competent (as defined by OSHA) in the risk-assessed procedure described below before performing the work.
DEFINITIONS	**Test Pit Sampling**: a backhoe or excavator can be used effectively to sample soil from 0 to 25 feet or more below ground surface (bgs). Particularly in rocky or hard soil, a backhoe may be the most effective means of sampling shallow depths. Test pit sampling can be classified as either shallow test pit sampling or deep test pit sampling.

WORK INSTRUCTIONS

The following instructions provide guidance to perform the task in a safe, accurate, and reliable manner. If these instructions present information that is inaccurate or unsafe, personnel must notify the Project Manager, Safety Manager, and the SOP Technical Author to initiate appropriate revisions. Personnel will perform all work under this SOP in a manner that is consistent with procedures and policies described in the appropriate Operation, Maintenance, and Monitoring (O&M) Plan (where applicable), appropriate Site-Specific Health and Safety Plans (SSHASP), and Pioneer Corporate Health and Safety Plan (HASP).

TASK	INSTRUCTIONS
Shallow Test Pit Sampling – 0 to 4 feet, Inorganic Sampling	
Definition	Shallow test pits are defined as those excavated pits that are less than 4 feet deep.
Notes	Most excavation companies have their own SOPs for excavations. Pioneer SOPs and safety requirements should be communicated and understood by all parties prior to site entry and the sampling protocols adjusted accordingly. Prior to beginning excavation, on-site safety protocol for excavation and sampling will be reviewed by the excavator operator and sampling crew.
1. Verify utility locates.	Confirm that the excavation subcontractor has placed a utility locate ticket that covers the area to be sampled. Confirmation number needs to be provided to Pioneer and put on the Job Risk Assessment or corresponding safety or permit form. Utility locates need to be called in a minimum of 48 business hours prior to the planned excavation.
2. Conduct site walk.	Conduct a site walk-through and determine any site-specific hazards associated with the sampling area. Discuss these with the sampling crew and note them in the field logbook and Job Risk Assessment or corresponding safety form. As part of the site hazard assessment, identify possible locations for unidentified, privately installed underground utilities. For example, identify where natural gas pipes enter any structures on the property and confirm that gas lines from the street/alley

	have been marked. Check on yard lights or streetlights that are present with no overhead lines, underground wiring from a residence to outbuildings, or a possible gas line to a grill or outdoor kitchen.
3. Identify potential sample sites.	Verify that the ground has been marked with the location of underground utilities listed on the locate ticket from the excavation subcontractor. Locate potential sample sites as directed in the appropriate Sampling and Analysis Plan (SAP) or Work Plan (WP). Use an appropriate survey method to locate and mark the sample locations if required. If sample locations are not specifically identified in the SAP, follow the guidance in the SAP and chose and mark sample locations. If needed, adjust sample locations based on identified or potential utility locations. Refer to the Trenching, Excavation, and Ground Disturbance Program information in Pioneer's Corporate HASP to identify safe distances for digging when adjacent to specific buried utilities.
4. Excavate test pit.	The decontaminated backhoe or excavator (refer to **Decontaminate sampling tools and excavator** on page 3) will excavate the test pit to the desired depth, or to a maximum of 4 feet. The excavated material should be layered adjacent to the test pit in the sequence in which it is removed. Topsoil should be separated from the underlying layers. Removed soil should be placed a minimum of 3 feet from the final edge of the test pit. If the total depth of the test pit is less than 4 feet, the test pit should have 1 vertical smooth wall for sample collection and 1 sloping or stepped wall for entrance into the test pit. The OSHA-defined competent person will examine the test pit and determine if the test pit is safe prior to entering. The competent person will examine test pit wall stability, check for the presence of water, and check that there is a means of exit provided into and out of the test pit.
5. Identify sample intervals.	Using a shovel, scrape the walls of the test pit to clean off smear associated with the digging. Determine an area(s) for sampling. If the soil types and layering is fairly homogeneous on all walls of the test pit, choose a representative wall to sample. If soil types or layering is not similar on all walls, choose representative areas to include in the sample intervals. Sample collection will take place in the test pit at intervals specified in the site-specific SAP. Measure and mark the intervals in the area(s) selected for sampling: pin flags, nails, or a measuring stick placed vertically on the sampling wall can be used to identify the intervals. Measurement for sample intervals should begin just below the sod or root mass, where soil is first available.
6. Collect soil samples.	The deepest sample interval should be scrapped with a decontaminated stainless-steel trowel or scoop, a Teflon scoop, or a new disposable plastic scoop to expose a clean surface. Once a new face is exposed, scrape the cleaned interval with the sampling tool and place the soil in a stainless-steel bowl, a new disposable foil pan, or a resealable plastic bag. Make sure that the collection container is compatible (will not affect) with any analytes for which the sample will be analyzed. Take care to avoid material from above falling into the collected sample, sample bowl, or onto the sampling tool. If

	more than one area was identified as representative for this interval, equal aliquots of soil should be collected from each location and placed in the sample collection container.
7. Remove unnecessary material from sample.	Remove all coarse fragments greater than 0.5 inches from the bowl. Thoroughly mix the remaining soil in the bowl/pan with the sampling tool or by kneading in the bag.
8. Transfer sample to sample container.	Label all sample containers following the requirements in the associated SAP/WP. Using the sampling tool, fill all required sample containers. Place a sufficient quantity of soil in each sample container to provide for analysis with additional soil left over to be archived. Return any remaining sample material to the test pit. Immediately place the soil samples directly into the designated storage container (generally a cooler). If samples are required to be stored at 4 degrees Celsius (°C) or less by the SAP/WP or analytical method, add ice to the cooler. Samples should be kept under chain of custody protocols until transport to the laboratory, as described in SOP-SA-01 Soil and Water Sample Packaging and Shipping.
9. Document sample information.	Record appropriate information about the sample collection (sample numbers and associated depth interval, time, date, sample containers, etc.) in the field logbook as discussed in SOP-SA-05 Project Documentation. Record additional information such as soil type and rock content if required by the SAP/WP.
10. Sample remaining depth intervals.	If additional sample intervals need to be collected, working from the bottom or deepest interval to the top interval, complete Steps 6-9, above, for each sample interval.
11. Log the test pit stratigraphy.	If required by the SAP/WP, examine and log the soil and material in the wall of the test pit. If samples were collected from more than one area, make notes on the differences in soil types from one area to another. Check the project-specific documents for the amount of detail or type of information required for the test pit log. Pioneer has developed several different field data sheets to aid in collecting the correct information during test pit logging. If required by the SAP/WP, photograph the sampled wall of the test pit with the sample interval markers in place or the measuring stick for scale. Take close-up pictures of any areas of interest. Take a photograph of the marked location stake or pin flag prior to photographing the test pit to aid identification of photographs later.
12. Backfill test pit.	Once sampling and logging are complete, the test pit should be back filled by the equipment operator. Soil should be placed in the test pit in the geologic sequence in which it was removed. Topsoil should always be placed last and smoothed out to match the surrounding terrain as closely as possible.
13. Decontaminate sampling tools and excavator.	Decontaminate sampling tools (shovel, trowels, bowls) according to procedures outlined in SOP-DE-02 Equipment Decontamination. If the SAP/WP requires the

	backhoe or excavator bucket to be cleaned between holes, have the operator decontaminate the bucket as defined in their SOPs. If decontamination is not required but there is a large amount of material remaining on the excavator bucket due to muddy or clay soil, use a shovel, broom, and buckets of water to rinse the excavator bucket prior to moving to a new excavation location.
Test Pit Sampling Below 4 Feet, Inorganic Sampling	
Note	**Personnel will not enter test pits that are over 4 feet in depth at Remediation Management (RM) sites and 5 feet for non-RM sites.** Sample material from test pits over 4 feet in depth (4 feet at RM sites, 5 feet at non-RM sites) can be collected from soil piles removed and placed by the equipment. If necessary, samples will be collected from the equipment bucket once it has been placed on the ground and the equipment powered down. Most excavation companies have their own SOPs for excavations. Pioneer SOPs and safety requirements should be communicated and understood by all parties prior to site entry and the sampling protocols adjusted accordingly. Prior to beginning excavation, on-site safety protocols for excavation and sampling will be reviewed by the excavator operator and sampling crew.
1. Sample test pit to 4 feet.	For test pits up to 4 feet in depth, follow Steps 1-11 above, under **Shallow Test Pit Sampling – 0 to 4 feet, Inorganic Sampling**, to collect samples.
2. Sample test pit over 4 feet: Excavate test pit.	To sample test pits deeper than 4 feet, the sampling crew must move a safe distance from the machine. Once the sampling crew is at a safe distance, the machine operator will continue excavating the test pit to the desired depth. The excavated material should be layered adjacent to the test pit in the sequence in which it is removed (spoils piles). Removed soil should be placed a minimum of 3 feet from the final edge of the test pit. Samplers should observe carefully where material from each interval is placed. To ask questions on depth or examine material in the bucket or spoils piles, first signal the machine operator to stop digging. Once the bucket is safely on the ground, ask questions or examine material in the bucket or spoils piles.
3. Measure depth of test pit.	Use a cloth reel type tape measure to safely measure total depth and depth to respective sample intervals. Either the sampler or the machine operator can throw the end of the tape measure over the edge of the test pit and a sampler on the other side can indicate when the end is at the bottom, the base of a specific layer or interval, or depth to groundwater. While not necessarily precise, this will give you an idea of the total depth and potential sample intervals. This method must be used whenever a test pit is greater than 6 feet deep or the sides of a shallower test pit have cracks or are caving. Both samplers need to stand at least 6 feet away from their respective edges and further if the sides of the pit appear unstable.
4. Collect soil samples.	Collect samples from the test pit at intervals specified in the site-specific SAP.

	To collect samples using the backhoe or excavator as a sampling tool, one member of the sampling team needs to carefully observe the excavation process and indicate to the equipment operator which buckets of soil should be placed aside for subsequent sampling. The decision on what soil to sample will be based on information in the SAP, which may require samples based on depths, color, or lithologic changes. If sampling based on depth is required, the above method for measuring depths can be performed several times during excavation to identify what spoils piles will need to be sampled. If required, the machine operator can place soil from a specific interval in a separate location for sampling. Once test pit excavation is complete and the equipment has powered down, collect the samples from the placed piles of soil. Use a decontaminated stainless-steel trowel or scoop, a Teflon scoop, or a new disposable plastic scoop to clean the surface of the pile to be sampled if it appears to have soil other than the designated interval on the surface. Take care to get soil from the appropriate interval. To collect smaller amounts, place the soil in a stainless-steel bowl, a clean decontaminated disposable foil pan, or in a resealable plastic bag. Soil from several different places in the pile can be collected to provide a more representative sample of the interval. If a large amount of soil is needed for analysis, such as for a proctor analysis, use a clean shovel to place soil directly into a sample container.
5. Remove unnecessary material from sample.	Remove all coarse fragments greater than 0.5 inches from the bowl. Thoroughly mix the remaining soil in the bowl/pan with the sampling tool or by kneading in the bag.
6. Transfer sample to sample container.	Label all sample containers following the requirements in the associated SAP/WP. Using the sampling tool, fill all required sample containers. Place a sufficient quantity of soil into each sample container to provide for analysis with additional soil left over to be archived. Return any remaining material to the test pit. Immediately place the soil samples directly into the designated storage container (generally a cooler). If the SAP/WP or analytical method requires that samples be stored at 4 °C or less, add ice to the cooler. Samples should be kept under chain of custody protocols until transport to the laboratory as described in SOP-SA-01 Soil and Water Sample Packaging and Shipping.
7. Collect remaining sample intervals.	If more than 1 sample interval is to be sampled, use new or decontaminated sampling tools for each sample interval. Repeat Steps 4-6 above to collect all required samples from their respective spoils pile.
8. Document sample information.	Record appropriate information about the sample collection (sample numbers and associated depth interval, time, date, sample containers, etc.) in the field logbook as discussed in SOP-SA-05 Project Documentation. Record additional information such as soil type or rock content if required by the SAP/WP. Record appropriate information about the sample collection in the field logbook.

9. Log the test pit stratigraphy.	If required by the SAP/WP, examine the soil and material in the spoils piles from the test pit and log the observations. Measure the intervals associated with each spoils pile in the test pit following the directions in Step 3. Measure the depth of the test pit. Check the project-specific documents for the amount of detail or type of information required for the test pit log. Pioneer has developed several different field data sheets to aid in collecting the correct information during test pit logging. If required by the SAP/WP, photograph the test pit, with the tape measure still draped on the wall for scale. Take close-up pictures of any areas of interest. Take a photograph of the marked location stake or pin flag prior to photographing the test pit to aid identification of photographs later.
10. Backfill test pit.	Once sampling and logging are complete, the test pit should be back filled by the equipment operator. Soil should be placed in the test pit in the geologic sequence in which it was removed. Topsoil should always be placed last and smoothed out to match the surrounding terrain as closely as possible.
11. Decontaminate sampling tools and excavator.	Decontaminate sampling tools (shovel, trowels, bowls) and excavator according to procedures outlined in SOP-DE-02 Equipment Decontamination. If the SAP/WP requires the backhoe or excavator bucket to be cleaned between holes, have the operator decontaminate the bucket as defined in their SOPs. If decontamination is not required but there is a large amount of material remaining on the excavator bucket due to muddy or clay soil, use a shovel, broom, and buckets of water to rinse the excavator bucket prior to moving to a new excavation location.
Sampling Test Pits for Volatile Organic Compounds	
1. Identify site-specific hazards and verify utility locates.	Following Steps 1-3 under **Shallow Test Pit Sampling – 0 to 4 feet, Inorganic Sampling,** prepare to sample site.
2. Prepare the sample containers.	Based on information provided in the SAP/WP, prepare and label the appropriate sample containers. If organic samples are required, sample intervals may have been assigned in the SAP/WP, or samples may be collected based on photoionization detector (PID) or headspace readings or the presence of odor or staining. You must understand sample collection protocol before digging. This is particularly important when collecting samples to analyze volatile organic compounds (VOCs), volatile petroleum hydrocarbon (VPH), and/or extractable petroleum hydrocarbon (EPH). Ensure required sampling supplies are close at hand prior to starting to dig.
3. Excavate through to first sample interval.	Be aware of wind direction and, if possible, have the operator position the machine so that exhaust from the machine is blowing away from the test pit. If the sample intervals are defined in the SAP/WP, have the excavator dig to the base of the first sample interval. If sample collection is dependent on PID readings, staining, or odors, have the operator dig 1 foot. The excavated material should be

	layered adjacent to the test pit in the sequence in which it is removed. Topsoil should be separated from the underlying layers. Removed soil should be placed a minimum of 3 feet from the final edge of the test pit.
4. Clean wall of test pit.	Using a shovel, scrape the walls of the test pit to clean off smear associated with the digging.
5. Conduct PID readings if required.	**All samples to be analyzed for VOCs and VPH must be collected as quickly as possible after exposing the soil to the air.** If specified in the SAP/WP, use a PID to take readings of the test pit walls, refer to SOP-FM-01 Field Headspace Analysis and VOC Measurements with PID. Exhaust may influence the PID readings. If positioning the machine so that the exhaust is blowing away from the test pit is not possible, record background readings for the test pit prior to entering and measuring each interval.
6. Determine sample interval.	If samples are to be collected based on PID measurements or the presence of staining or odors in the test pit walls, use professional judgement about digging deeper prior to collecting samples. It may be necessary to have the operator dig the next foot, prior to making a sampling decision. If the previously exposed area is included in the sample, that area needs to be recleaned and scraped to ensure a fresh surface is included in the sample. Mark sample intervals in the area(s) selected for sampling using pin flags, nails, or a measuring stick placed vertically on the sampling wall. Measurement for sample intervals should begin just below the sod or root mass, where soil is first available.
7. Collect soil samples for VOC/VPH/ EPH.	Collect the samples to be analyzed for VOC, VPH, and EPH using a stainless-steel trowel or scoop or a new disposable plastic scoop. Make sure to scrape the wall with the sampling tool to reveal a fresh surface prior to sampling. If the entire sample interval is represented in the test pit wall, place a representative aliquot of the soil from the wall directly into the sample container and fill the jar to the top allowing no head space (or as the laboratory directs). Pack the material as tightly as feasible and try to avoid getting large particles in the jar. Place the lid on the container as soon as the jar is full. Immediately place the filled sample container in a cooler with ice. Keep samples at 4 ºC or less and under chain of custody protocols until they can be transported to the laboratory for analysis as described in SOP-SA-01 Soil and Water Sample Packaging and Shipping. **Sampling for non-organic constituents can be completed later once VOC sampling is completed.**
8. Continue sampling to 4 feet bgs.	Continue excavating foot by foot until the test pit reaches 4 feet bgs. Continue PID screening and required sampling as each foot is uncovered. This is done to limit the amount of time soil is exposed to air prior to PID measurements and sample collection.

	Additionally, use the PID to monitor the breathing zone in the test pit to ensure that the air present during sampling (particularly at the 3- and 4-foot intervals) is safe enough to complete sampling. If PID concentrations show it is not safe to sample those intervals from the test pit, collect samples from the appropriate spoils piles.
9. Record PID readings and VOC sample information in logbook.	When using a PID, record the results of the screening in the field documentation (project logbook or field data sheets), including the highest reading from the sample interval. Record the sample information in the logbook and include sample number, associated depth interval, time, date, and type of containers collected, as discussed in SOP-SA-05 Project Documentation.
10. Collect inorganic samples.	Following Steps 5-11 under **Shallow Test Pit Sampling – 0 to 4 feet, Inorganic Sampling,** collect the inorganic samples, log and photograph the test pit if required, and record inorganic sample information.
11. Excavate test pit below 4 feet bgs.	Once samples to the 4-foot depth have been collected and logged and the sampling crew has moved a safe distance from the machine, the machine operator can continue excavating the test pit in 1- to 2-foot intervals. The excavated material should be layered adjacent to the test pit in the sequence in which it is removed (spoils piles). Removed soil should be placed a minimum of 3 feet from the final edge of the test pit. Samplers should observe carefully where material from each interval is placed.
12. Conduct PID readings if required.	**All samples to be analyzed for VOCs and VPH must be collected as quickly as possible after exposing the soil to the air.** If specified in the SAP/WP, use a PID to take readings of the spoils pile. You can also take the PID readings from soil in the machine bucket; **make sure that the operator places the bucket on the ground, powers down the equipment, and signals you prior to approaching the bucket**. Refer to SOP-FM-01 Field Headspace Analysis and VOC Measurements with PID. Exhaust may influence the PID readings. If positioning the machine so that the exhaust is blowing away from the test pit is not possible, record background readings for the test pit prior to measuring each interval.
13. Collect soil samples.	Collect samples from the spoils pile or machine bucket at intervals specified in the SAP. The decision on what soil to sample will be based on information in the SAP, which may require samples based on PID measurements, depths, staining, odor, color, or lithologic changes. To collect samples using the backhoe or excavator as a sampling tool, one member of the sampling team must carefully observe the excavation process and indicate to the equipment operator which buckets of soil should be placed aside for PID measurements and subsequent sampling. If sampling based on depth is required, follow the method for measuring depths described in Step 3 - **Test Pit Sampling Below 4 Feet, Inorganic Sampling**; this can be performed several times during excavation to identify what spoils piles will need to be sampled.

	Excavating and collecting samples to be analyzed for VOCs should be completed 1 to 2 feet at a time. Once the appropriate interval has been excavated and the equipment has powered down, collect the samples from the placed piles of soil. Use a decontaminated stainless-steel trowel or scoop, a Teflon scoop, or a new disposable plastic scoop to clean the surface of the pile to be sampled. Take care to collect soil from the appropriate interval. Collect the required samples for VOC, VPH, and EPH analysis using a stainless-steel trowel or scoop or a new disposable plastic scoop. Make sure to scrape the spoils pile with the sampling tool to reveal a fresh surface prior to sampling. Place the representative soil directly into the sample container and fill the jar to the top allowing no head space (or as the laboratory directs). Pack the material as tightly as feasible and try to avoid getting large particles in the jar. Place the lid on the container as soon as the jar is full. Immediately place the filled sample containers in a cooler with ice. Keep samples at 4 ºC or less and under chain of custody protocols until they can be transported to the laboratory for analysis, as described in SOP-SA-01 Soil and Water Sample Packaging and Shipping. Sampling for non-organic constituents can be completed later, once VOC sampling is completed.
14. Continue sampling to 4 feet bgs.	Continue excavating foot by foot until the test pit reaches the required depth. Continue PID screening and required sampling as each interval is uncovered. This is done to limit the amount of time soil is exposed to air prior to PID measurements and sample collection.
15. Record PID readings and VOC sample information in logbook.	When using a PID, record the results of the screening in the field documentation (project logbook or field data sheets), including the highest reading from the sample interval. Record the sample information in the logbook and include sample number, associated depth interval, time, date, and type of containers collected as discussed in SOP-SA-05 Project Documentation.
16. Collect inorganic samples.	Following Steps 4-9, **Test Pit Sampling Below 4 Feet, Inorganic Sampling**, collect the inorganic samples, log and photograph the test pit if required, and record inorganic sample information.
17. Backfill test pit.	Once sampling and logging are complete, the test pit should be back filled by the equipment operator. Soil should be placed in the test pit in the geologic sequence in which it was removed. Topsoil should always be placed last and smoothed out to match the surrounding terrain as closely as possible.
18. Decontaminate sampling tools and excavator.	Decontaminate sampling tools (shovel, trowels, bowls) and excavator according to procedures outlined in SOP-DE-02 Equipment Decontamination. If the SAP/WP requires the backhoe or excavator bucket to be cleaned between holes, have the operator decontaminate the bucket as defined in their SOPs.

	If decontamination is not required but there is a large amount of material remaining on the excavator bucket due to muddy or clay soil, use a shovel, broom, and buckets of water to rinse the excavator bucket prior to moving to a new excavation location.

HEALTH SAFETY SECURITY ENVIRONMENT (HSSE) CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.				
SOURCE	***HAZARDS***	***WHERE***	***HOW, WHEN, RESULT***	***CONTROLS***
CHEMICAL	Potential contact with contaminated soil.	Sites.	Adverse health effects could result from ingesting and/or inhaling contaminated soil.	Personnel will practice proper personal hygiene – wash hands prior to eating and when leaving the site. Work will be suspended during high wind conditions that may produce large amounts of visible dust. Personnel will wear nitrile gloves and safety glasses when sampling and handling soil.
	Carbon Monoxide (CO).	Vehicle, equipment, and test pit.	Potential exposure to CO when working around idling vehicles/ equipment could result in irritated eyes, headache, nausea, weakness and dizziness. The CO from idling excavator could also end up in the test pits.	Personnel will minimize the time sitting in idling vehicles and will open a window to increase ventilation. Personnel will avoid working around idling vehicles/equipment and stay upwind of said vehicles/ equipment. Operator will turn the engine off when the excavator is not needed to prevent accumulation of CO in test pits.
NOISE	Not applicable.			
ELECTRICAL	Contact with underground and/or overhead utilities.	Testing sites.	Injury, death or property damage could occur from contact with underground and/or overhead utilities while digging test pits.	Personnel will follow Pioneer's underground and overhead utilities corporate program and established procedures. When possible, personnel will avoid areas with underground and overhead utility hazards.

HEALTH SAFETY SECURITY ENVIRONMENT (HSSE) CONSIDERATIONS
This section to be completed with concurrence from the Safety and Health Manager.

SOURCE	***HAZARDS***	***WHERE***	***HOW, WHEN, RESULT***	***CONTROLS***
BODY MECHANICS	Slips and trips.	Uneven terrain, slick/ muddy surfaces and/or steep slopes.	Personal injury such as sprains and muscle/back strains could result from slips and trips.	Personnel will wear work boots with good traction and ankle support. Personnel will plan their path and walk cautiously. Backhoe/excavator will slope or step one side of the test pit that will be entered to make access and egress easier.
	Bending, squatting, and kneeling.	During sample collection.	Bending, squatting, and kneeling during sample collection and handling could result in muscle/back strains or other injuries.	Personnel should stretch prior to starting work and take breaks when necessary.
	Lifting and carrying tools, equipment, and/or samples.	Testing sites.	Improper lifting and carrying tools, equipment, and/or samples could result in back injuries and muscle/back strains.	Personnel will use proper lifting techniques – get a good grip, keep the load close to the body, lift with legs and not with back, and avoid lifting loads above shoulder height. Two people will lift, if necessary.
	Struck by and/or caught in between heavy equipment.	Testing sites.	Personnel could be injured if struck by and/or caught in between the excavator or heavy equipment.	Personnel will communicate and establish eye contact with the operator before approaching the excavator or heavy equipment. The operator will stop the machine before ground personnel approach. Personnel will wear high-visibility clothing.

HEALTH SAFETY SECURITY ENVIRONMENT (HSSE) CONSIDERATIONS
This section to be completed with concurrence from the Safety and Health Manager.

SOURCE	*HAZARDS*	*WHERE*	*HOW, WHEN, RESULT*	*CONTROLS*
GRAVITY	Falls from slips and trips.	Uneven terrain, slick surfaces, steep slopes, and edge of test pit.	Personnel could get injured if they fall causing bruises, scrapes, or broken bones.	Personnel will wear work boots with good traction and ankle support. Personnel will plan their path and walk cautiously. Access areas will be established, if necessary. Personnel will stand at least 2 feet away from the edge of the test pit.
	Falling rocks, debris and cave-ins.	Test pit.	Personal injuries could occur when collecting samples in test pits.	Personnel will wear Level D personnel protective equipment (PPE). Sloping techniques will be used, if necessary. Competent person (as defined by OSHA) will examine test pits before entry and large rocks will be removed from above sampling locations, or sample location will be moved to avoid the potential of falling materials.
WEATHER	Cold/heat stress.	Sites.	Exposure to cold temperatures may result in cold burns, frostbite, and hypothermia. Exposure to high temperatures may result in heat cramps, heat exhaustion, or heat stroke.	Training on signs and symptoms of cold/heat stress is required. Personnel will wear appropriate clothing when working outdoors (e.g., layers and loose clothing). Personnel will remain hydrated and will have sufficient caloric intakes during the day. Personnel will follow procedures outlined in applicable SSHASP and/or Pioneer corporate HASP.
	Lightning.	Testing sites.	Electrocution, injury, death, or equipment damage could be caused by lightning strike.	Personnel will follow the 30/30 rule during lightning storms.

HEALTH SAFETY SECURITY ENVIRONMENT (HSSE) CONSIDERATIONS
This section to be completed with concurrence from the Safety and Health Manager.

SOURCE	***HAZARDS***	***WHERE***	***HOW, WHEN, RESULT***	***CONTROLS***
RADIATION	Ultraviolet (UV) radiation.	Outdoors.	Personnel could be exposed to UV radiation during summer months causing sun burns, skin damage, and eye damage.	Personnel will wear safety glasses with tinted lenses, long-sleeve work shirts, and long pants. Personnel should wear sunscreen, if necessary.
BIOLOGICAL	Plants, insects, and animals.	Sites	Exposure to plants, insects, and/or animals may cause rashes, blisters, redness, and swelling.	Training on the signs and symptoms of exposure to plants, insects, and animals is required. Avoid contact with plants, insects, and animals. First-aid kits will be available on site. Personnel with allergies will notify their supervisor.
MECHANICAL	Pinch points.	Test pits.	Personnel could cut their fingers if debris (e.g., glass, steel) is present in test pits.	Personnel will wear nitrile gloves when sampling and handling soil. Personnel will wear work gloves, if necessary.
PRESSURE	Pressurized hydraulic hoses.	Working around heavy equipment.	Hydraulic hoses could burst/rupture resulting in inadvertent contact with hydraulic fluid or personal injury due to being struck by hoses.	Personnel will maintain a 20-foot buffer zone around equipment when equipment is operating.
THERMAL	Not applicable.			

HEALTH SAFETY SECURITY ENVIRONMENT (HSSE) CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.				
SOURCE	***HAZARDS***	***WHERE***	***HOW, WHEN, RESULT***	***CONTROLS***
HUMAN FACTORS	Inexperienced and improperly trained personnel.	Sites.	Inexperienced personnel and improper training could cause incidents resulting in adverse health effects and/or property damage.	Personnel will be properly trained in this procedure and other applicable procedures. Personnel will implement stop work procedures, if necessary.
SIMOPS (Simultaneous Operations)	Not applicable.			

ADDITIONAL HSSE CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.	
REQUIRED PPE	**PPE**: Hard hat, safety glasses, high-visibility work shirt or vest, long pants, work boots, nitrile gloves, and leather gloves.
APPLICABLE SDSs	**Safety Data Sheets** (SDSs): Carbon Monoxide. Safety Data Sheets are available to Pioneer personnel at the link below: https://pioneertechnicalservices.sharepoint.com/Safety/SafetyDataSheets
REQUIRED PERMITS/ FORMS	Per site/project requirements.
ADDITIONAL TRAINING	Per site/project requirements.

DRAWINGS, DOCUMENTS, AND TOOLS/EQUIPMENT The following documents should be referenced to assist in completing the associated task.	
DRAWINGS	Map with site location and sample locations.
RELATED SOPs/ PROCEDURES/ WORK PLANS	SOP-SA-01 Soil and Water Sample Packaging and Shipping SOP-DE-02 Equipment Decontamination SOP-SA-05 Project Documentation SOP-FM-01 Field Headspace Analysis and VOC Measurements with PID

TOOLS/ EQUIPMENT	Shovel, reel type tape measure, pin flags, measuring stick, sampling tools (stainless-steel trowels or scoops or new disposable plastic scoops, screwdrivers), sample collection containers (stainless-steel bowl, new disposable foil pans, or resealable plastic bags), camera, field logbook, sample bottles, sample storage container (cooler with ice if needed), PID (if needed), and decontamination supplies per SOP-DE-02 or broom and buckets of water.
FORMS/ CHECKLIST	Field data sheets (optional), Ground Disturbance Permit, Construction Checklist for Trenching (when applicable), Trench Safety Daily Field Report (when appliable).

APPROVALS/CONCURRENCE

By signing this document, all parties acknowledge the completeness and applicability of this SOP for its intended purpose. Also, by signing this document, it serves as acknowledgement that I have received training on the procedure and associated competency testing.

SOP TECHNICAL AUTHOR	**DATE**
Julie Flammang **Julie Flammang**	**11/20/2020**
SAFETY AND HEALTH MANAGER	**DATE**
Tara Schleeman **Tara Schleeman**	**11/20/2020**

PURPOSE	To provide standard instructions for soil and water sample packaging and shipping.
SCOPE	This practice has been prepared for the Pioneer Technical Services, Inc. (Pioneer) workforce and applies to work carried out by and on behalf of Pioneer. All members of the Pioneer workforce who conduct the work shall be trained and competent in the risk-assessed work described below.

WORK INSTRUCTIONS

The following instructions are intended to provide sufficient guidance to perform the task in a safe, accurate, and reliable manner. Should these instructions present information that is inaccurate or unsafe, operations personnel must bring the issue to the attention of the Project Manager and the appropriate revisions made. All work carried under this SOP will be consistent with procedures and policies described in the appropriate Operation, Maintenance, and Monitoring (O&M) Plan (where applicable), appropriate Site-Specific Health and Safety Plan (SSHASP), and Pioneer Corporate Health and Safety Plan (HASP).

TASK	INSTRUCTIONS
1. Preserve the samples.	Water samples will be preserved, if required, according to SOP-SA-02 Sample Preservation and Containerization for Aqueous Samples, and SOP-SA-02B Sample Preservation and Containerization for Aqueous Samples for VOAs.
2. Place the sample containers in Ziploc bags.	Based on the analytes requested (e.g., low level mercury, low level chromium, etc.), it may be necessary to place each filled sample container in separate Ziploc bags to prevent cross contamination, keep the container clean, dry, and isolated, and protect the sample label. In most cases, all sample containers collected from a specific sample location are placed in a large Ziploc bag and shipped together.
3. Package the samples.	Place samples in a cooler, which has been previously lined with a plastic bag. Surround the samples with non-contaminating packaging materials to reduce movement and absorb any leakage. Double bag the ice and place it in the cooler. Seal the plastic bag in the cooler to contain the samples, packing material, and ice.
4. Review and sign COC forms.	The Field Team Leader or their designated representative will double check the chain-of-custody (COC) forms to assure those samples recorded on the COC forms are in the cooler. The Field Team Leader or the designated representative will then sign the chain-of-custody form to relinquish custody. One copy of the signed COC form will remain with the Field Team Leader. Make a photocopy of the completed forms, if there are no carbon copies available.
5. Tape paper work to cooler.	Place paper work in a sealed Ziploc bag and tape it to the inside of the cooler lid.
6. Bag samples for separate analytical batches.	If the shipping cooler contains more samples than can be analyzed in one analytical batch, the laboratory may request that the samples in the cooler be bagged for separate analytical batches. This may be necessary so that the appropriate Quality Control/Quality Assurance samples are included in each analytical batch. In this case, fill out separate COC forms for each batch and include the forms in the

	appropriate plastic bags. Place the COC forms for each batch in a sealed Ziploc bag. The COC forms for each batch should be placed at the top of the plastic bag so that they are clearly visible to laboratory personnel when they open the plastic bags.
7. Label the cooler.	Label the cooler with the appropriate labels to describe the content of the cooler (e.g., NOS, flammable liquids, flammable solids, this side up, fragile, etc.). Close the cooler and place the appropriate shipping labels (e.g., overnight shipping from Federal Express, UPS, or the United States Postal Service or equivalent) on the lid of the cooler.
8. Sign COC seals.	The Field Team Leader or the designated representative will sign COC seals and place the signed seals over the opening edge of the cooler.
9. Tape the cooler.	Place tape over the custody seals and around the cooler.
10. Transport the cooler.	Transport the cooler(s) to a secure storage, to the shipping agent, or directly to the laboratory. If shipping the cooler, follow established federal and state regulations depending on cooler content.
Notes	Bagging of samples and lining of coolers is not necessary, if samplers transport the samples directly to the laboratory.

HSSE CONSIDERATIONS
This section to be completed with concurrence from the Safety and Health Manager.

SOURCE	*HAZARDS*	*WHERE*	*HOW, WHEN, RESULT*	*CONTROLS*
CHEMICAL	Potential contact with contaminated soil and water samples.	Sites.	Inadvertent exposure to contaminated soil and water samples could lead to adverse health effects.	Personnel will practice proper personal hygiene – wash hands prior to eating/drinking and when leaving the site. Employees will wear nitrile gloves and safety glasses when handling sample containers.
	Preservatives (HCL, HNO3, H2SO4, Zinc, Acetate, NaOH).	In bottles or added to bottles through sampling process.	Inadvertent exposure to preservatives could lead to adverse health effects.	Safety Data Sheets for each preservative chemical are available to all employees on the Pioneer company web site. Personnel will wear nitrile gloves and safety glasses when adding preservatives to samples bottles and when handling the bottles. Refer to the Chemical Flushing Guidelines available inside vehicle's first aid kit for first-aid procedures in case of contact with preservatives.
NOISE	Not applicable.			
ELECTRICAL	Not applicable.			
BODY MECHANICS	Bending, squatting, and kneeling.	During sample packaging.	Bending, squatting, and could result in muscle/back strains or other injuries.	Employees should stretch prior to starting work and they will take breaks when necessary.
	Improper lifting.	Sites.	Back injuries and muscle/back strains could result when using improper techniques to lift and carry coolers with samples.	Personnel will use proper lifting techniques – get a good grip, keep the load close to the body, lift with legs and not with back, and avoid lifting loads above shoulder's height. Two workers will lift/carry the coolers, if needed.

GRAVITY	Not applicable.			
WEATHER	Not applicable.			
RADIATION	Not applicable.			
BIOLOGICAL	Not applicable.			
MECHANICAL	Not applicable.			
PRESSURE	Not applicable.			
THERMAL	Not applicable.			
HUMAN FACTORS	Inexperienced and improperly trained worker.	Sites.	Inexperienced workers and improper training could cause incidents resulting in adverse health effects and/or property damage.	Employees will be properly trained in this procedure and other applicable procedures. Employees will implement stop work procedures, if necessary.
SIMOPS	Not applicable.			

ADDITIONAL HSSE CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.	
REQUIRED PPE	Sampling site: hard hat, safety glasses, high-visibility work shirt or vest, long pants, work boots, and nitrile gloves. Off site: nitrile gloves.
APPLICABLE SDS	HCL, HNO3, H2SO4, Zinc, Acetate, and NaOH. Additional Safety Data Sheets (SDSs) will be maintained based on site characterization and contaminants.
REQUIRED PERMITS/FORMS	Per site/project requirements.
ADDITIONAL TRAINING	Per site/project requirements.

DRAWINGS, DOCUMENTS, AND TOOLS/EQUIPMENT The following documents should be referenced to assist in completing the associated task.	
P&IDS	
DRAWINGS	
RELATED SOPs/PROCEDURES/ WORK PLANS	SOP-SA-02 Sample Preservation and Containerization for Aqueous Samples and SOP-SA-02B Sample Preservation and Containerization for Aqueous Samples for VOAs.
TOOLS	Plastic bags, Ziploc bags, non-contaminating packaging materials, tape, COC seals, ice, and cooler.
FORMS/CHECKLIST	Chain-of-custody (COC) forms.

APPROVALS/CONCURRENCE By signing this document, all parties acknowledge the completeness and applicability of this SOP for its intended purpose. Also, by signing this document, it serves as acknowledgement that I have received training on the procedure and associated competency testing.	
SOP TECHNICAL AUTHOR	**DATE**
Julie Flammang **Julie Flammang**	**12/11/2014**
SAFETY AND HEALTH MANAGER	**DATE**
Tara Schleeman **Tara Schleeman**	**12/11/2014**

Revisions:

Revision	Description	Date

PURPOSE	This SOP establishes the requirements for documenting and maintaining environmental sample chain of custody from point of origin to receipt of sample at the analytical laboratory. This procedure shall apply to all types of air, soil, water, sediment, biological, and/or core samples collected in environmental investigations by Pioneer Technical Services, Inc. (Pioneer). It is applicable from the time of sample acquisition until custody of the sample is transferred to an analytical laboratory.
SCOPE	This practice has been prepared for the Pioneer Technical Services, Inc. (Pioneer) workforce and applies to work carried out by and on behalf of Pioneer. All members of the Pioneer workforce who conduct the work shall be trained and competent in the risk-assessed work described below.
DEFINITIONS	Chain of Custody: is an unbroken trail of accountability that ensures the physical security of samples, data, and records. Custody refers to the physical responsibility for sample integrity, handling, and/or transportation. Custody responsibilities are effectively met, if the samples are: • In the responsible individual's physical possession; • In the responsible individual's visual range after having taken possession; • Secured by the responsible individual so that no tampering can occur; or • Secured or locked by the responsible individual in an area in which access is restricted to authorized personnel only.

WORK INSTRUCTIONS

The following instructions are intended to provide sufficient guidance to perform the task in a safe, accurate, and reliable manner. Should these instructions present information that is inaccurate or unsafe, operations personnel must bring the issue to the attention of the Project Manager and the appropriate revisions made. All work carried under this SOP will be consistent with procedures and policies described in the appropriate Operation, Maintenance, and Monitoring (O&M) Plan (where applicable), appropriate Site-Specific Health and Safety Plan (SSHASP), and Pioneer Corporate Health and Safety Plan (HASP).

TASK	INSTRUCTIONS
Project Manager's Responsibilities	The Project Manager is responsible for overall management of environmental sampling activities, designating sampling responsibilities to qualified personnel, and reviewing any changes to the sampling plan.
Field Team Leader's Responsibilities	The Project Manager may act as the Field Team Leader or may choose to appoint a Field Team Leader. The Field Team Leader is responsible for general supervision of field sampling activities and ensuring proper storage/transportation of samples from the field to the analytical laboratory. Chain of Custody forms will be reviewed for accuracy and completeness to preserve sample integrity from collection to receipt by an analytical lab by the Field Team Leader. The review of Chain of Custody forms may be delegated to qualified personnel.

	The Field Team Leader is responsible for sample custody until the sample has been properly relinquished as documented on the chain of custody form.
Field Sampler's Responsibilities	The Field Sampler is responsible for sample acquisition in compliance with technical procedures, initiating the Chain of Custody, and checking sample integrity and documentation prior to transfer. Field samplers are also responsible for initial transfer of samples consisting of physical transfer of samples directly to the internal laboratory or transferred to a shipping carrier, (e.g., United Parcel Service or Federal Express) for delivery.
Laboratory Technician's Responsibilities	The receiving Laboratory Technician is responsible for inspection of transferred samples to ensure proper labeling and satisfactory sample condition. Unacceptable samples will be identified and segregated. The Laboratory Project Manager will be notified. The Laboratory Technician will review the Chain of Custody for completeness and file as part of the project's permanent record.
Samples Handling and Chain of Custody Forms	All samples shall be collected and handled in accordance with SOP-SA-01 Soil and Water Sample Packaging and Shipping and SOP-SA-02 Sample Preservation and Containerization for Aqueous Samples, or methods described in the Sampling and Analysis Plan (SAP) or work plan (WP). Samples will be transported in insulated coolers with ice ('blue ice' is acceptable) as necessary to maintain temperature at 4 °C+/- 2 °C until receipt by the analytical laboratory. The Field Team Leader or designated Field Sampler shall initiate the Chain of Custody form for the initial transfer of samples. A Chain of Custody form will be completed and accompany every sample. The form includes the following information: • Project code; • Project name; • Samplers signature; • Sample identification; • Date sampled; • Time sampled; • Analysis requested; • Remarks; • Relinquishing signature, data, and time; and • Receiving signature, date, and time. The Field Sampler relinquishing custody and the responsible individual accepting custody shall sign, date, and note the time of transfer on the Chain of Custody form.

	Note: if the transporter is not an employee of Pioneer, the Field Sampler may identify the carrier and reference the bill of lading number in lieu of the transporter's signature. One copy of the Chain of Custody form shall be filed as a temporary record of sample transfer by the Field Sampler. The original form shall accompany the samples and shall be returned to Pioneer as part of the contracted laboratory Quality Assurance/Quality Control (QA/QC) requirements. The original form will be filed as part of the project's permanent records. The Project Manager (or designee) shall track the Chain of Custody to ensure timely receipt of samples by an analytical laboratory.

HSSE CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.				
SOURCE	***HAZARDS***	***WHERE***	***HOW, WHEN, RESULT***	***CONTROLS***
CHEMICAL	Potential contact with contaminated water/soil samples.	Outside of bottles.	Inadvertent exposure to contaminated water/soil samples could lead to adverse health effects.	Personnel will practice proper personal hygiene – wash hands prior to eating/drinking and when leaving the site. Employees will wear nitrile gloves and safety glasses when handling sample containers.
	Preservatives (HCL, HNO_3, H_2SO_4, Zinc, Acetate, and NaOH).	Outside of bottles.	Inadvertent exposure to preservatives could lead to adverse health effects.	Safety Data Sheets for each preservative chemical are available to all employees on the Pioneer company web site. Personnel will wear nitrile gloves and safety glasses when handling the bottles. Refer to the Chemical Flushing Guidelines available inside vehicle's first aid kit for first-aid procedures in case of contact with preservatives.
NOISE	Not applicable.			
ELECTRICAL	Not applicable.			
BODY MECHANICS	Improper lifting.	Sites.	Back injuries and muscle/back strains could result when using improper techniques to lift and carry packaged samples and coolers.	Personnel will use proper lifting techniques – get a good grip, keep the load close to the body, lift with legs and not with back, and avoid lifting loads above shoulder's height. Two workers will lift/carry packaged samples and coolers, if needed.
GRAVITY	Falls from slips and trips.	Uneven terrain, slick/muddy/wet surfaces and steep slopes.	Walking/working on slick/muddy/wet and uneven terrain could cause slips and trips resulting in	Workers will wear work boots with good traction and ankle support. Personnel will be aware of working/walking surfaces and choose a path to avoid hazards. Keep work areas as dry as possible.

			falls and injuries.	
WEATHER	Not applicable.			
RADIATION	Not applicable.			
BIOLOGICAL	Not applicable.			
MECHANICAL	Not applicable.			
PRESSURE	Not applicable.			
THERMAL	Not applicable.			
HUMAN FACTORS	Inexperienced and improperly trained worker.	Sites.	Inexperienced workers and improper training could cause incidents resulting in adverse health effects and/or property damage.	Employees will be properly trained in this procedure and other applicable procedures. Employees will implement stop work procedures, if necessary.
SIMOPS	Not applicable.			

ADDITIONAL HSSE CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.	
REQUIRED PPE	Safety glasses, high-visibility work shirt or vest, long pants, work boots, and nitrile gloves.
APPLICABLE SDS	HCL, HNO_3, H_2SO_4, Zinc, Acetate, and NaOH. Additional Safety Data Sheets (SDSs) will be maintained based on site characterization and contaminants.
REQUIRED PERMITS/FORMS	Per site/project requirements.
ADDITIONAL TRAINING	Per site/project requirements.

DRAWINGS, DOCUMENTS, AND TOOLS/EQUIPMENT The following documents should be referenced to assist in completing the associated task.	
P&IDS	
DRAWINGS	
RELATED SOPs/PROCEDURES/ WORK PLANS	SOP-SA-01 Soil and Water Sample Packaging and Shipping and SOP-SA-02 Sample Preservation and Containerization for Aqueous Samples.
TOOLS	Seals and labels; chain of custody forms; chain of custody seals (provided by contracted laboratory); packing and shipping materials; and cooler and ice.
FORMS/CHECKLIST	Chain of Custody Forms.

APPROVALS/CONCURRENCE By signing this document, all parties acknowledge the completeness and applicability of this SOP for its intended purpose. Also, by signing this document, it serves as acknowledgement that I have received training on the procedure and associated competency testing.	
SOP TECHNICAL AUTHOR	**DATE**
Julie Flammang **Julie Flammang**	**12/17/2014**
SAFETY AND HEALTH MANAGER	**DATE**
Tara Schleeman **Tara Schleeman**	**12/17/2014**

Revisions:

Revision	Description	Date

PURPOSE	This SOP establishes the requirements for documenting and maintaining field logbooks and photographs. These procedures shall apply to all types of air, soil, water, sediment, biological, and/or core samples collected in environmental investigation by Pioneer Technical Services, Inc. (Pioneer). These procedures apply from the time field work begins until site activities are completed.
SCOPE	This practice has been prepared for the Pioneer workforce and applies to work carried out by and on behalf of Pioneer. All members of the Pioneer workforce who conduct the work shall be trained and competent in the risk-assessed work described below.

WORK INSTRUCTIONS

The following instructions are intended to provide sufficient guidance to perform the task in a safe, accurate, and reliable manner. Should these instructions present information that is inaccurate or unsafe, operations personnel must bring the issue to the attention of the Project Manager and the appropriate revisions made. All work carried under this SOP will be consistent with procedures and policies described in the appropriate Operation, Maintenance, and Monitoring (O&M) Plan (where applicable), appropriate Site-Specific Health and Safety Plan (SSHASP), and Pioneer Corporate Health and Safety Plan (HASP).

TASK	INSTRUCTIONS
1. Logbooks.	A designated field logbook will be used for each field project. If requested by the Project Manager, use a separate field logbook for each field task within a larger project. Label each logbook with the project name, dates that it covers, and logbook number. Use a waterproof marker, such as a Sharpie©, to write down the information. The logbooks will be bound and have consecutively numbered pages. The information recorded in these logbooks shall be written in ink. Begin a new page for each days notes. Write on every line of the logbook. If a blank space is necessary for clarity, such as a change of subject, skip one line before beginning the new subject. Do not skip any pages or parts of pages unless a day's activity ends in the middle of a page. Draw a diagonal line on any blank spaces of four lines or more to prevent unauthorized entries. The author will initial and date entries at the end of each day. All corrections will consist of a single line-out deletion in ink, followed by the author's initials and the date. Information not related to the project should not be entered in the logbook. The language used in the logbook should be factual and objective. These bound logbooks shall include the following entries: 1. A description of the field task. 2. Time and date fieldwork started. 3. Location and/or a description of the work areas including sketches, if needed, any maps or references needed to identify locations, and sketches of construction activities. If the location has been documented in the logbook during/prior visits, only changes in conditions should be noted. 4. Names and company affiliations of field personnel.

	5. Name, company affiliation or address, and phone number of any field contacts or official site visitors. 6. Meteorological conditions at the beginning of fieldwork and any ensuing changes in these conditions. 7. Details of the fieldwork performed and reference to field data sheets, if used. 8. Deviation from the task-specific Sampling and Analysis Plan (SAP), Work Plan (WP), or Standard Operating Procedures (SOP). 9. All field measurements made. 10. Any field laboratory analytical results. 11. Personnel and equipment decontamination procedures, if appropriate. For any field sampling work, the following entries should be made: 1. Sample location and number. 2. Sample type and amount collected. 3. Date and time of sample collection. 4. Type of sample preservation. 5. Split samples taken by other parties. Note the type of sample, sample location, time/date, name of person for whom the split was collected, that person's company, and any other pertinent information. 6. Sampling method, particularly any deviations from the SOP. 7. Documentation or reference of preparation procedures for reagents or supplies that will become an integral part of the sample, if available. This information may not be available for water or soil sampling bottles that come preserved from the laboratory or for preservatives provided by the laboratory. Bottle blanks will need to be used to evaluate the provided reagents. 8. The laboratory where the samples will be sent. No bound field logbooks will be destroyed or thrown away even if they are illegible or contain inaccuracies that require a replacement document.
2. Photographs.	Take photographs of field activities using a digital camera. Photographs should include a scale in the picture when practical. Telephoto or wide-angle shots will not be used, since they cannot be used in enforcement meetings. The following items shall be recorded in the bound field logbook or on a field data sheet for each

	photograph taken: 1. The photographer's name, the date, the time of the photograph, and the general direction faced. 2. A brief description of the subject and the fieldwork portrayed in the picture. 3. Sequential number of the photograph. An electronic copy and/or a hard copy of the photographs shall be placed in task files in the field office after each day of field activities. Supporting documentation from the bound field logbooks or field data sheets shall be photocopied and placed in the task files to accompany the photographs once the field activities are complete.

HSSE CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.				
SOURCE	***HAZARDS***	***WHERE***	***HOW, WHEN, RESULT***	***CONTROLS***
CHEMICAL	Not applicable.			
NOISE	Not applicable.			
ELECTRICAL	Not applicable.			
BODY MECHANICS	Not applicable.			
GRAVITY	Not applicable.			
WEATHER	Not applicable.			
RADIATION	Not applicable.			
BIOLOGICAL	Not applicable.			
MECHANICAL	Not applicable.			
PRESSURE	Not applicable.			
THERMAL	Not applicable.			
HUMAN FACTORS	Not applicable.			
SIMOPS	Not applicable.			

ADDITIONAL HSSE CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.	
REQUIRED PPE	
APPLICABLE SDS	Safety Data Sheets (SDSs) will be maintained based on site characterization and contaminants.
REQUIRED PERMITS/FORMS	Per site/project requirements.
ADDITIONAL TRAINING	Per site/project requirements.

DRAWINGS, DOCUMENTS, AND TOOLS/EQUIPMENT The following documents should be referenced to assist in completing the associated task.	
P&IDS	
DRAWINGS	
RELATED SOPs/PROCEDURES/ WORK PLANS	
TOOLS	Field logbook, Sharpie©, black pen, digital camera, and field data sheets.
FORMS/CHECKLIST	

APPROVALS/CONCURRENCE By signing this document, all parties acknowledge the completeness and applicability of this SOP for its intended purpose. Also, by signing this document, it serves as acknowledgement that I have received training on the procedure and associated competency testing.	
SOP TECHNICAL AUTHOR	**DATE**
Julie Flammang **Julie Flammang**	**12/17/2014**
SAFETY AND HEALTH MANAGER	**DATE**
Tara Schleeman **Tara Schleeman**	**12/17/2014**

Revisions:

Revision	Description	Date

PURPOSE	To provide standard instructions for operating XL3 X-Ray Fluorescence (XRF) analyzer.
SCOPE	This practice has been prepared for the Pioneer Technical Services, Inc. (Pioneer) workforce and applies to work carried out by and on behalf of Pioneer. All members of the Pioneer workforce who conduct the work shall be trained and competent in the risk-assessed work described below.

WORK INSTRUCTIONS

The following instructions are intended to provide sufficient guidance to perform the task in a safe, accurate, and reliable manner. Should these instructions present information that is inaccurate or unsafe, operations personnel must bring the issue to the attention of the Project Manager and the appropriate revisions made. All work carried under this SOP will be consistent with procedures and policies described in the appropriate Operation, Maintenance, and Monitoring (O&M) Plan (where applicable), appropriate Site-Specific Health and Safety Plan (SSHASP), and Pioneer Corporate Health and Safety Plan (HASP).

TASK	INSTRUCTIONS
1. Assemble XRF stand.	a. Open the case containing the stand and insert 4 legs into base of stand. b. Place stand on a solid, level surface.
2. Prep XRF sample for analysis.	a. Wearing latex or nitrile gloves, remove any large aggregate from the sample and place in a separate bag for disposal. For gravel or rocky soils, a sieve can be used to remove the large aggregates. If a sieve is used, it needs to be decontaminated between samples. Refer to SOP-DE-02 Equipment Decontamination for instructions. b. Consolidate the sample into the bottom of the baggie. c. Open the lid to the XRF stand and place sample inside, making sure that sample is flush against the opening on the inside of the XRF stand. d. Close the lid to the XRF stand.
3. Turn on XRF analyzer.	a. Open the XRF case and remove XRF gun from case. b. Slide XRF battery onto bottom of XRF gun handle. c. Press and hold power button (⏻) until XRF gun turns on and wait for system to start. d. Press where it says 'press to logon.' A warning message appears asking to verify that the user is aware of the radiation source in the XRF unit. e. Press 'Yes' to continue.
4. Log in and calibrate detector.	a. Type password (1234) when prompted. b. Click 'E' to log in. After logging in, a screen appears with 7 icons appears, this is the Main Menu screen. c. Tap the 'System Check' icon. d. Tap 'Yes.' e. The XRF unit will then go through an internal calibration. f. When the calibration is done, tap 'CLOSE' on the XRF gun to return to the Main Menu screen. **The detector should be calibrated at the start of each day of operation.**

5. Set up XRF run test.	a. Set parameters (e.g., analysis types, time, and analytes) required for the analysis as detailed in the XL3 user's manual, Sampling and Analysis Plan (SAP), or Work Plan (WP). b. Once logged into XRF system, tap the 'Analyze' icon on XRF screen. A screen appears. c. On the next screen tap 'Soils.' d. On the next screen tap 'Data Entry.' A Data Entry screen appears showing several options (Sample Name, Sampler, Date, etc.). e. In the upper right hand corner, next to the 'Sample Name' icon, click the symbol that looks like a miniature keyboard to display a keyboard on the screen. f. Type in the sample name (do not press return yet). g. Insert XRF gun into the bottom of the XRF stand with the XRF gun handle pointing away from you. Be sure that the XRF gun is securely in place in the bottom of the stand. h. Press 'return' in the lower right corner of the keyboard screen. i. To activate the unit, pull the trigger on the gun handle. The analysis will take approximately 2 minutes to complete.
6. Record data.	a. After the XRF analysis is complete, results from the analysis will appear on the screen. b. Record the results and Test Number displayed on the screen; use the up and down arrows on the XRF gun to scroll through data. c. Open the lid on the XRF stand and remove the sample. d. Mark the sample baggie as "RAN" so that sample does not get analyzed twice. Place ran samples in a labeled box for storage and record keeping.
7. Run additional samples.	a. With the XRF gun still in the XRF stand, press the return button (↵) on the XRF gun. This will display the 'Data Entry' screen. b. On the Data Entry Screen, press the keyboard symbol located to the right of 'Sample Name' to display the keyboard. c. Type the next sample name (do not press return yet). d. Place the sample into the XRF stand and close the lid to the stand (as discussed in Task 2). e. Repeat the steps in Task 5 to activate the XRF unit. f. Repeat Tasks 6 and 7 until all samples are analyzed.
8. Turn off XRF.	a. After all samples have been analyzed, remove the XRF gun from the bottom of the stand (press and hold buttons on the side of the stand to allow XRF gun to be removed from stand). b. Press the return button (↵) on the XRF gun until the Main Menu screen appears. c. Press and hold the power button (⏻) until the XRF turns off. d. Remove the battery from the gun and place these items back into the appropriate case. e. Disassemble the XRF stand and place back into the appropriate case.

Quality Assurance/Quality Control (QA/QC) Requirements.	Required QA/QC tasks: 1. Run the Niton-supplied XRF blanks and NIST standards at the start of each day. 2. Record the results in the field logbook or on the XRF field datasheet or equivalents. If the results are not within the ranges supplied by NITON in the user manual, initiate troubleshooting tasks on the analyzer (refer to the user's manual). 3. Run the blank and one standard QA/QC samples during sample analysis at the rate of 1 for every 20 samples analyzed. QA/QC includes analyzing a replicate sample every 20 samples and a duplicate sample (see the steps below). **Analyze a replicate sample (1 for every 20 samples analyzed)** 1. After recording the initial reading for a sample, DO NOT remove the sample from the holder. 2. Restart the XRF gun and rerun the sample. 3. Record the information on the field data form or logbook as a replicate (or R sample). Replicates samples help track the precision of the XRF. **Analyze a duplicate sample (after every 20 samples analyzed)** 1. After every 20 samples, analyze a duplicate sample by recording the results of the 20^{th} sample. 2. Remove the sample bag from the XRF stand, remix the sample, and replace it in the XRF stand. 3. Reanalyze the sample. 4. Record the results as a duplicate (or D sample). Duplicates help to determine the precision of the XRF analysis as well as the homogeneity of the sample matrix. 5. Run a NITON-supplied blank or NIST standard after the replicate/duplicate QA/QC samples to monitor the accuracy of the XRF results.

HSSE CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.				
SOURCE	***HAZARDS***	***WHERE***	***HOW, WHEN, RESULT***	***CONTROLS***
CHEMICAL	Potential contact with contaminated soil.	Reclamation sites and within samples.	Inadvertent exposure to contaminated soil via ingestion could result in adverse health effects.	Personnel will practice proper personal hygiene – wash hands prior to eating/drinking and handling soil samples. Workers will wear nitrile gloves and safety glasses when handling samples to prevent exposure.
NOISE	Not applicable.			
ELECTRICAL	Not applicable.			
BODY MECHANICS	Improper lifting.	Sites.	Back injuries and muscle/back strains could result when using improper lifting techniques to lift/ carry XRF analyzer.	Personnel will use proper lifting techniques: get a good grip, keep the load close to the body, lift with legs and not with back, and avoid lifting loads above shoulder's height. Take breaks if necessary. Personnel will ensure they are fit for duty, avoid staying in one position for long periods of time, and set up work area to minimize ergonomic risks.
	Repetitive motion.	From removing rocks from sample bags or filling sample cups.	Repetitive motion can result in hand cramps and fatigue.	Personnel will take breaks, if necessary. Use appropriate tools (e.g., plastic spoon or tamper) to pack sample cups. Use a sieve to remove rocks from samples prior to bagging, if needed.
GRAVITY	Falls from slips and trips.	Uneven terrain, slick/muddy/wet surfaces and steep slopes.	Walking/working on slick/muddy/wet and uneven terrain could cause slips and trips resulting in falls and injuries.	Personnel will wear work boots with good traction and ankle support. Personnel will be aware of working/walking surfaces and choose a path to avoid hazards. If conditions are wet or muddy, wear muck boots.

HSSE CONSIDERATIONS

This section to be completed with concurrence from the Safety and Health Manager.

	Dropping the XRF analyzer.	Sites.	Personnel could be injured if the XRF analyzer is dropped on their feet.	Personnel will wear steel-toe boots. Personnel will ensure the XRF analyzer is set up on a solid surface and is not moved until sampling is complete.
WEATHER	Cold/heat stress.	Outdoor sites.	Exposure to cold climates may result in cold burns, frostbites, and hypothermia. Exposure to high temperatures may result in heat cramps, heat exhaustion, or heat stroke.	Training on signs and symptoms of cold/heat stress is required. Personnel will wear appropriate clothing when working outdoors. Personnel will remain hydrated and will have sufficient caloric intakes during the day. Personnel will follow procedures outlined in applicable SSHASP and/or Pioneer corporate HASP.
	Lightning.	Outdoor sites.	Electrocution, injury, death, or equipment damage could result from lightning strike.	Employees will follow the 30/30 rule during lightning storms.
RADIATION	Radiation from x-ray tube.	X-ray tube.	Exposure to radiation could lead to serious adverse health effects.	Radiation from the x-ray tube is fully contained within the device when not in use and allowed to escape through the measurement window only while the user is analyzing a sample. Radiation emission is controlled by a shutter. Personnel will keep hands and all body parts away from the front end of the analyzer when the shutter is open to minimize exposure. Personnel will not hold the analyzer near the measurement window during testing. Never point the analyzer at yourself or anyone else when the shutter is open. Never hold samples during analysis or look into the path of the primary beam.

HSSE CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.				
	Ultraviolet (UV) radiation.	Outdoor sites.	Employees could be exposed to UV radiation during summer months causing sun burns, skin damage, and eye damage.	Employees will wear safety glasses with tinted lenses, long-sleeve work shirts, and long pants. Employees should wear sunscreen, if necessary.
BIOLOGICAL	Plants, insects, and animals.	Outdoors.	Exposure to plants, insects, and/or animals may cause rashes, blisters, redness, and swelling.	Training on the signs and symptoms of exposure to plants, insects, and animals is required. Avoid contact with plants, insects, and animals. First-aid kits will be available on site. Employees with allergies will notify their supervisor.
MECHANICAL	Pinch points.	Transport case, XRF lid, and setting up work table.	Hand/finger injuries from pinching fingers in transport case/ XRF lid and when setting up the work table.	Personnel will wear work gloves to prevent injuries from pinch points.
PRESSURE	Not applicable.			
THERMAL	Not applicable.			
HUMAN FACTORS	Inexperienced and improperly trained worker.	Sites.	Inexperienced workers and improper training could cause incidents resulting in adverse health effects and/or property damage.	Employees will be properly trained in the procedure described above and other applicable procedures. Employees will follow the stop work policy, if there are any issues.
SIMOPS	Not applicable.			

HSSE CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.	
ADDITIONAL HSSE CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.	
REQUIRED PPE	Hard hat, safety glasses, high-visibility work shirt or vest, long pants, work boots, nitrile or latex gloves, and work gloves.
APPLICABLE SDS	Safety Data Sheets (SDSs) will be maintained based on site characterization and contaminants.
REQUIRED PERMITS/FORMS	Per site/project requirements.
ADDITIONAL TRAINING	Per site/project requirements.

DRAWINGS, DOCUMENTS, AND TOOLS/EQUIPMENT The following documents should be referenced to assist in completing the associated task.	
P&IDS	
DRAWINGS	
RELATED SOPs/PROCEDURES/ WORK PLANS	SOP-DE-02 Equipment Decontamination.
TOOLS	XRF and hand tools.
FORMS/CHECKLIST	

APPROVALS/CONCURRENCE By signing this document, all parties acknowledge the completeness and applicability of this SOP for its intended purpose. Also, by signing this document, it serves as acknowledgement that I have received training on the procedure and associated competency testing.	
SOP TECHNICAL AUTHOR	**DATE**
Julie Flammang **Julie Flammang**	**06/05/2015**
SAFETY AND HEALTH MANAGER	**DATE**
Tara Schleeman **Tara Schleeman**	**06/05/2015**

Revisions:

Revision	Description	Date

PURPOSE	To provide standard instructions for operating survey equipment, staking, flagging and painting survey marks, and recording of field work performed.
SCOPE	This practice has been prepared for the Pioneer Technical Services, Inc. (Pioneer) workforce and applies to work carried out by and on behalf of Pioneer. All members of the Pioneer workforce who conduct the work will be trained and competent in the risk-assessed work described below.

WORK INSTRUCTIONS

The following instructions are intended to provide sufficient guidance to perform the task in a safe, accurate, and reliable manner. Should these instructions present information that is inaccurate or unsafe, operations personnel must bring the issue to the attention of the Project Manager and the appropriate revisions made. All work performed under this SOP will be consistent with procedures and policies described in the appropriate Operation, Maintenance, and Monitoring (O&M) Plan (where applicable), appropriate Site-Specific Health and Safety Plan (SSHASP), and Pioneer Corporate Health and Safety Plan (HASP).

TASK	INSTRUCTIONS
1. Storing survey equipment.	Store survey equipment in a secure, climate-controlled weatherproof area when not in use.
2. Charging Global Positioning System (GPS), robot, and data collector batteries.	Charge batteries used in survey equipment in a climate-controlled weatherproof area. The use of a surge protector (power strip) to supply power to the battery chargers is recommended. Only use manufacturer’s approved batteries and chargers.
3. Transporting survey equipment in vehicles.	Transport survey equipment in a weatherproof area of a vehicle to prevent unnecessary exposure to elements that could adversely affect the calibration of various survey instruments and their accessories. Secure equipment in the vehicle during transportation so that it does not become a projectile in the case of an accident or other sudden maneuver.
4. Setting stakes/lath and hubs.	Setting of survey stakes and hubs often requires the use of a 3-to 4-pound engineer or drilling hammer (hand held) (refer to Figure 1) or a 8- to 12-pound sledgehammer, and a gad (frost pin) (refer to Figure 2) manufactured and/or distributed by Red Top or Lo-Ink, designed to mushroom and not splinter when struck, to create a pilot hole in various soil surfaces in order to set the stake or hub.

Figure 1 – Drilling Hammer

Figure 2 – Gad (Frost Pin)

The gad (frost pin) will be from an authorized survey supply company. Any type of gad (frost pin) that is made of a material that can create shrapnel (i.e., jack hammer bits) or from an unauthorized survey supply company will not be used. When hammering stakes/hubs into surface, care will be taken to avoid splintering of stake/hub.

Set the hubs and stakes/lath in the following manner:

- After determining the position of the hub/stake/lath, determine the soil condition.
- If soil is loose or non-compacted, simply drive the hub/stake/lath into the ground until the hub/stake/lath is stable.

If soil is hard packed or compacted, use the following steps:

- Make a pilot hole using a gad.
- Grip the gad in your non-dominant hand halfway up the length of the gad and place the point of the gad at the desired position of the survey point.
- Using the drilling hammer in your dominant hand, strike the top of the gad a sufficient number of times to make a pilot hole of the desired depth.
- To remove the gad from the pilot hole, strike the sides of the gad with the drilling hammer in opposing horizontal directions to loosen the gad.
- Remove the gad from the pilot hole and insert the hub/stake/lath into the ground until the hub/stake/lath is stable.

5. Setting rebar.

Setting of rebar is necessary to establish control points and property corners. The use of a rebar driver (refer to Figure 3) manufactured and/or distributed by Surv-Kap or Lo-Ink, designed to mushroom and not splinter when struck, will be utilized to prevent mushrooming of the rebar and to allow for a larger striking surface. The proper sized driver for the proper sized rebar will be used (i.e., ½ inch for #4 rebar, 5/8 inch for #5 rebar, etc.).

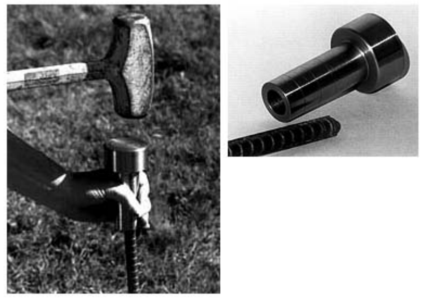
<table>
<tr><td></td><td>


Figure 3 – Rebar Driver

Set rebar in the following manner:

After determining the desired position of the property corner or control point, select a section of 5/8-inch rebar (12-inch length for control points, 24-inch length for property corners).
Inspect the section of rebar and ensure that it is straight and free of burrs at the ends.
Place one end of the rebar at the desired position and hold it with your non-dominant hand.
Place the rebar driver over the end of the rebar. Using the drilling hammer (held in your dominant hand), strike the rebar driver until the bottom of the rebar driver contacts the surface that the rebar is being driven into. This will leave the rebar exposed approximately 2½ inches, allowing either a plastic or aluminum survey cap to be placed on the exposed end of the rebar.
Drive the rebar and cap flush with the surface by placing a “cap driver” (sold by Surv-Kap) over the cap and striking the “cap driver” to set the cap flush to the surface.
In the event that a control point or property corner needs to be set in a paved surface, a pilot hole will be drilled first with a hammer drill and the correct sized bit.

</td></tr>
<tr><td>6. Checking points daily.</td><td>
Check points will be performed daily (per job) to verify the following:

Base point and height of base are correct.
Survey coordinate system and datum are correct.
Control remains within project specifications.

</td></tr>
<tr><td>7. Using point ranges.</td><td>
The following point ranges will be used on all jobs:

1-299 Project Control (found or set).
300-499 Found Monuments.
500-999 Calculated Monuments.
1000-2999 Calculated Design.
3000-Infinity Topo and staking store points.

</td></tr>
</table>

8. Booking of survey activities.	Record surveying activities on a daily basis (per job) in a field book to facilitate the ease of record keeping and the ability at a later date to recall the activity performed. The following will be the minimum data recorded in the field book:
	
	• Job name, location, coordinate system, and vertical datum used (header page) along with a brief description of the survey activities performed.
	• Date of field work and initials of all crew members.
	• Base point used along with height and type of measure up (fixed height, slant height, center bumper height, bottom of antenna mount, etc.).
	• Check point(s) used with Δ Northing, Δ Easting, and Δ Elevation differences written along with "Stored As" point (i.e., CK7-5 would be the 5th check point on CP7).
	• Any new control points or bench marks set (or found) along with their description.
	• Description of property corners set or found (e.g., type of rebar/cap, found stone, pipe, etc.) along with ties to any accessories (e.g., fence corners, bearing trees, road intersections, etc.).
	• Point ranges stored and a brief description (e.g., 3001-4063 – topo of road and ditches from xxx intersection to xxx intersection).
	• Type of alignments staked and the point range that staked points were stored in.
	• Occupy and backsight points for conventional survey work (gun work) along with backsight check and points staked – per set up.
	• Any changes in rod height and the associated point ranges.
	• Leveling bench marks, foresights, backsights, and side shots will be recorded (when leveling is performed).
	• Any pertinent sketches deemed necessary.
	• Any issues with equipment, land owners, contractors, etc. that arise.
	• Any other information deemed pertinent by the individual performing the survey.
	
	Field books will be numbered in the following manner:
	
	• Volume by county using the Montana County numbers (i.e., Silver Bow is 1, Deer Lodge is 30, Lewis and Clark is 5, etc.).
	• Book by series (e.g., B1, B2, B3, etc.).
	• County name.
	• All of the above will be marked on the front outside cover and the side binding of the field book.
	• The title page at the beginning of the book will be filled out with the office information/address that the surveyor performing the work is based out of.
	    o An example of field book number is: V1-B4 Silver Bow (i.e., Volume 1 – Book 4 of Silver Bow County).
	    o Each individual page will be numbered as such (i.e., V1-B4-1, V1-B4-2, etc.) in the upper right hand corner of each page. One page is considered to be both the left and right page of any given field book when in an open position.

	o Once a field book is filled, the index at the front of the book will be filled in to aid in future tracking of field work already performed. The preferred type of field book is a Rite in the Rain All-Weather Transit No.300 series. **Note: all of the above is necessary to provide for an accurate means of recalling activities performed.**
9. Painting and flagging of survey marks.	 Figure 4 – Spray Paint Use the following steps when painting and flagging survey marks: • Stand upwind of survey marks to be painted. • Invert spray can, aim nozzle at survey mark, and depress nozzle spraying paint in a sweeping motion. • After desired amount of paint has been dispensed, point nozzle straight up and depress nozzle on quick time to prevent clogging. • Flagging will be tied securely to the mark or stake as necessary. **Note: per the Mine Safety and Health Administration regulations, spray paint will not to be stored in the cab of any vehicle. If it is necessary to warm cold paint cans up, do not leave cans unattended in the vehicle, and do not place them directly over heat vents.**
10. Placing control points.	Locations of control points, especially those that may be used for a GPS base point or Total Station, will be placed in a safe location away from overhead and underground utilities and out of the lanes of traffic. The GPS control will be in an area that is obstruction free in order to have the best view of satellites in the sky. A minimum of three control points per project will be established, preferably intervisible. The preferred primary control type is a #5 rebar (12 inches long) with a 2 inch aluminum control cap marked with the Control Point Number and the year it was set stamped into it. Secondary control (i.e., any control that will not be used for longer than one month) can be a 60D nail and flagging, RR spike, hub and tack, or other acceptable "temporary" style of control.

HSSE CONSIDERATIONS
This section to be completed with concurrence from the Safety and Health Manager.

SOURCE	*HAZARDS*	*WHERE*	*HOW, WHEN, RESULT*	*CONTROLS*
CHEMICAL	Potential contact with contaminated soils and dust.	Reclamation sites.	Adverse health effects could result from ingesting and/or inhaling contaminated soils/dust.	Personnel will practice proper personal hygiene: wash hands prior to eating/drinking and when leaving the site. Work will be suspended during high wind conditions that may produce large amounts of visible dust. Personnel will wear nitrile gloves, if contact with contaminated soil is possible.
	Fumes from marking paint.	Survey marks.	Inhalation of paint fumes when placing survey marks could result in adverse health effects such as headaches/ dizziness.	Personnel will stay upwind from the paint being sprayed.
NOISE	Not applicable.			
ELECTRICAL	Equipment contact with overhead utilities.	Sites with overhead utilities.	Injury, death or property damage could occur from survey equipment (i.e., survey rod) contact with overhead utilities.	Personnel will follow the procedures outlined in the Pioneer Overhead Utilities Program. When possible, personnel will avoid areas with overhead utility hazards.
	Equipment contact with underground utilities.	Sites.	Injury, death or property damage could occur from survey equipment (i.e., gad, stake, and rebar) contact with underground utilities.	Personnel will follow the procedures outlined in the Pioneer Trenching, Excavation, and Ground Disturbance Program.

BODY MECHANICS	Repetitive motion.	Body.	Repetitive motion when reaching and positioning while using tools and survey equipment could result in injuries such as muscle strains.	Personnel will maintain a balanced position when reaching and positioning survey equipment. They will bend at knees while keeping back straight and upright to paint, place or pound in survey markers. Personnel should also stretch before starting work and will take breaks when necessary.
	Lifting and carrying tools and equipment.	Sites.	Improper lifting and carrying tools and equipment could result in back injuries and muscle/back strains.	Personnel will use proper lifting techniques: get a good grip, keep the load close to your body, lift with legs and not with back, and avoid lifting loads above shoulder height. Two people will lift heavy objects, if necessary.
GRAVITY	Uneven terrain, slick surfaces, and steep slopes.	Sites.	Walking/working on slick/muddy/wet and uneven terrain could cause slips and trips resulting in falls and injuries.	Personnel will wear work boots with good traction and ankle support, be aware of working/walking surfaces and choose a path to avoid hazards, keep work areas as dry as possible, and wear muck boots as necessary.
WEATHER	Cold/hot temperatures.	Outdoor sites.	Exposure to cold climates may result in cold burns, frostbite, and hypothermia. Exposure to high temperatures may result in heat cramps, heat exhaustion, or heat stroke.	Training on signs and symptoms of cold/heat stress is required. Personnel will wear appropriate clothing when working outdoors (e.g., layers and loose clothing), remain hydrated, and have sufficient caloric intakes during the day. Personnel will use their field vehicle to take breaks, when needed. Personnel will also follow the procedures outlined in the Pioneer Heat/Cold Stress Program.

WEATHER (cont.)	Lightning.	Outdoor sites.	Electrocution, injury, death or equipment damage could be caused by lightning strike.	Personnel will follow the 30/30 rule during lightning storms.
RADIATION	Ultraviolet (UV) radiation.	Outdoor sites.	Exposure to UV radiation during summer months can cause sun burns, skin damage, and eye damage.	Personnel will wear safety glasses with tinted lenses, long-sleeve work shirts, and long pants. Personnel should wear sunscreen, if necessary.
BIOLOGICAL	Plants, insects, and animals.	Outdoor sites.	Exposure to plants, insects, and animals may cause rashes, blisters, redness, swelling, and other injuries.	Training on the signs and symptoms of exposure to plants, insects, and animals is required. Personnel will avoid contact with plants, insects, and animals. First aid kits will be available on the site. Personnel with allergies will notify their supervisor.
MECHANICAL	Driving.	Sites.	Interaction with light and heavy equipment could result in vehicle incidents. Driving on uneven/muddy/ slick terrain could also result in vehicle incidents.	Personnel will maintain communication with equipment operators and other site personnel, yield to haul traffic, and use defensive driving techniques. Personnel will not approach active heavy equipment with vehicle. If site conditions are not safe, postpone work or access the site using another means or route.
	Unsecured equipment.	Vehicle.	Injury could result from being struck by an unsecured piece of equipment while driving.	Personnel will secure equipment to vehicle.

MECHANICAL (cont.)	Contact with engineer or drilling hammer.	Setting survey stakes and hubs.	Injuries to hands, foot, and knees could result when using an engineer or drilling hammer to set survey stakes and hubs.	Personnel will wear work gloves and steel-toed boots. Personnel will also keep knees away from the survey gad while creating a pilot hole. Be aware of finger/hand placement and do not put fingers/hands between objects. Inspect tools prior to each use.
	Flying debris.	Setting survey stakes, hubs, and rebar.	Survey gad, stakes, hubs, and rebar could splinter and/or break while being struck with hammer and flying pieces could cause eye injuries.	Personnel will wear safety glasses. Personnel will use survey gad designed to mushroom and not splinter when struck. When establishing control points/property corners, personnel will use a rebar driver to set up rebar. Personnel will also inspect survey gad, stakes, hubs, and rebar prior to installing them.
	Pinch points.	Hand tools and equipment.	Exposure to pinch points when using hand tools and equipment could result in personal injuries.	Personnel will wear work gloves to protect against pinch-point injuries. Inspect all tool and equipment prior to each use.
PRESSURE	Not applicable.			
THERMAL	Not applicable.			
HUMAN FACTORS	Inexperienced and improperly trained personnel.	Sites.	Inexperienced personnel and improper training could cause incidents resulting in injuries and/or property damage.	Personnel will be trained in this procedure and other applicable procedures. Personnel will implement stop work procedures, if necessary.
SIMOPS	Not applicable.			

ADDITIONAL HSSE CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.	
REQUIRED PPE	Long-sleeved work shirt, high-visibility vest/outwear, long pants, safety glasses, hard hat, work globes, and steel-toed boots.
APPLICABLE SDS	Survey Marking Paint. Additional Safety Data Sheets (SDSs) will be maintained based on site characterization and contaminants.
REQUIRED PERMITS/FORMS	Per site/project requirements.
ADDITIONAL TRAINING	Per site/project requirements.

DRAWINGS, DOCUMENTS, AND TOOLS/EQUIPMENT The following documents should be referenced to assist in completing the associated task.	
P&IDS	
DRAWINGS	
RELATED SOPs/PROCEDURES/ WORK PLANS	
TOOLS	Hand-held GPS, survey rod, engineer or drilling hammer, sledgehammer, survey gad, stakes, lath, rebar, rebar driver, survey cap, cap driver, paint cans, and field book.
FORMS/CHECKLIST	

APPROVALS/CONCURRENCE By signing this document, all parties acknowledge the completeness and applicability of this SOP for its intended purpose. Also, by signing this document, it serves as acknowledgement that I have received training on the procedure and associated competency testing.	
SOP TECHNICAL AUTHOR	**DATE**
Mike Newhouse	**08/16/2016**
SAFETY AND HEALTH MANAGER	**DATE**
Tara Schleeman	**10/24/2016**

APPROVALS/CONCURRENCE

By signing this document, all parties acknowledge the completeness and applicability of this SOP for its intended purpose. Also, by signing this document, it serves as acknowledgement that I have received training on the procedure and associated competency testing.

Revisions:

Revision	Description	Date

PURPOSE	To provide standard instructions for field measurement of pH in water.
SCOPE	Pioneer Technical Services, Inc. (Pioneer) prepared this practice for the workforce and this Standard Operating Procedure (SOP) applies to all work performed by and on behalf of Pioneer. All members of the Pioneer workforce who conduct the work shall be trained and competent (as defined by OSHA) in the risk-assessed procedure described below before performing the work.

WORK INSTRUCTIONS

The following instructions provide guidance to perform the task in a safe, accurate, and reliable manner. If these instructions present information that is inaccurate or unsafe, personnel must notify the Project Manager, Safety Manager, and the SOP Technical Author to initiate appropriate revisions. Personnel will perform all work under this SOP in a manner that is consistent with procedures and policies described in the appropriate Operation, Maintenance, and Monitoring (O&M) Plan (where applicable), appropriate Site-Specific Health and Safety Plans (SSHASP), and Pioneer Corporate Health and Safety Plan (HASP).

TASK	INSTRUCTIONS
1. Prepare the pH meter.	Pioneer owns and operates different brands and models of pH field measurement meters. All units, in general, have automatic temperature correction (ATC) capabilities. Prior to using a pH meter, verify that it has the ATC function. User manuals for each meter are available and the specific directions for calibrating and measuring pH with that meter should be followed. Calibrate pH meter in the field at the beginning of each day and if a standard check is out of calibration. Record the calibration information in the field logbook. 1. For a new probe, prepare the pH probe according to the directions in the electrode user guide. 2. Connect the probe to the appropriate connection on the meter. 3. Turn the meter on and make sure it is in the pH measurement mode. Calibrate instrument as described in the meter-specific operating manual.
2. Calibrate the meter.	The following is a general summary for instrument calibration: 1. Rinse the ATC pH probe in deionized water. 2. Turn on meter and immerse the ATC pH probe in a pH 7 buffer solution. Calibrate meter to pH 7 allowing enough time for meter to stabilize. 3. Rinse ATC pH probe with deionized water. 4. Immerse ATC pH probe in a pH 4 buffer solution. Calibrate meter to pH 4 allowing enough time for meter to stabilize.

	5. Rinse pH and temperature probe with deionized water. 6. Immerse ATC pH probe in a pH 10 buffer solution. Calibrate meter to pH 10 allowing enough time for meter to stabilize. 7. Record the slope reading in the field logbook. 8. Recheck meter calibrations with the pH 4, pH 7, and pH 10 calibration solutions. Repeat the calibration process (steps 2-6) if a value for any final pH check is outside the manufacturer's stated accuracy as stated in the user's manual
3. Take field measurements.	The following is a general summary for field measurement of pH: 1. Rinse beaker with sample water 3 times. 2. Rinse ATC pH probe with deionized water. 3. Fill beaker with sample water. 4. Turn on meter and immerse ATC pH probe in sample water. Stir sample for thorough mixing. Read and record pH to the nearest 0.01 unit once pH reading has stabilized. 5. Rinse electrodes with deionized water and store in carrying case. Note: pH may also be measured by placing the probe directly into the water body being tested. The probe must be moved slowly in a circular motion when measuring stagnant water.
Important information about meter.	1. Store meter in case during transport. 2. Check batteries before taking meter into the field. Carry spare batteries and deionized water for rinsing probe. 3. Inspect probe for damage or dirt. 4. Dust and wipe the meter with a damp cloth. If necessary, warm water or mild water-based detergent can be used to clean the case. Immediately remove any spilled substance from the meter using the proper cleaning procedure for the type of spill. 5. If meter readings are erratic, replace the probe. If readings continue to be erratic, return the meter to factory for repair.

HEALTH SAFETY SECURITY ENVIRONMENT (HSSE) CONSIDERATIONS

This section to be completed with concurrence from the Safety and Health Manager.

SOURCE	*HAZARDS*	*WHERE*	*HOW, WHEN, RESULT*	*CONTROLS*
CHEMICAL	Potential contact with contaminated water.	Testing sites, during pH measurements.	Inadvertent exposure to contaminated water could lead to adverse health effects.	Personnel will practice proper personal hygiene – wash hands prior to eating/drinking and when leaving the site. Personnel will wear nitrile gloves and safety glasses when taking measurements.
	Potential contact with pH buffer solutions.	Equipment calibration.	Inadvertent exposure to pH buffer solutions could lead to adverse health effects (e.g., irritation of eye, skin, and/or respiratory tract).	Personnel will practice proper personal hygiene – wash hands prior to eating and after calibrating equipment. Personnel will wear nitrile gloves and safety glasses when handling pH buffer solutions.
NOISE	Not applicable.			
ELECTRICAL	Not applicable.			
BODY MECHANICS	Bending, squatting, and kneeling.	During pH measurements.	Bending, squatting, and kneeling during pH measurements could result in muscle/back strains or other injuries.	Personnel should stretch prior to starting work and they will take breaks when necessary.
	Drowning and/or entrapment hazards.	Bodies of water, during pH measurements.	If personnel need to stand in bodies of water to take measurements, they could be exposed to drowning and/or entrapment hazards from soft soils and/or sudden changes in depth of water.	If necessary, personnel will use rods to test soil stability and/or depth of water as they walk to sample locations. Additionally, personnel may be required to wear life vests when crossing deeper bodies of water. When possible, personnel will not enter the water body and take measurements from the bank.

HEALTH SAFETY SECURITY ENVIRONMENT (HSSE) CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.				
SOURCE	***HAZARDS***	***WHERE***	***HOW, WHEN, RESULT***	***CONTROLS***
GRAVITY	Falls from slips and trips.	Uneven terrain, slick/ muddy/wet surfaces and steep slopes.	Walking/working on slick/muddy/wet and uneven terrain could cause slips and trips resulting in falls and injuries.	Personnel will wear work boots with good traction and ankle support. Personnel will be aware of working/walking surfaces and choose a path to avoid hazards. Keep work areas as dry as possible. Wear muck boots, as necessary.
WEATHER	Cold/heat stress.	Sites.	Exposure to cold climates may result in cold burns, frostbites, and hypothermia. Exposure to high temperatures may result in heat cramps, heat exhaustion, or heat stroke.	Training on signs and symptoms of cold/heat stress is required. Personnel will wear appropriate clothing when working outdoors. Personnel will remain hydrated and will have sufficient caloric intakes during the day. Personnel will follow procedures outlined in applicable SSHASP and/or Pioneer corporate HASP.
	Hypothermia/ frostbite.	Sites where air temperature is 35.6 °F (2 °C) or less.	Personnel who become immersed in water or whose clothing becomes wet may be exposed to hypothermia and/or frostbite.	Personnel will change clothing if it becomes wet. When applicable, Personnel will wear waders to prevent clothing from getting wet.
	Lightning.	Outdoor sites.	Electrocution, injury, death, or equipment damage could be caused by lightning strike.	Personnel will follow the 30/30 rule during lightning storms.
RADIATION	Ultraviolet (UV) radiation.	Outdoors.	Personnel could be exposed to UV radiation during summer months causing sun burns, skin damage, and eye damage.	Personnel will wear safety glasses with tinted lenses, long-sleeve work shirts, and long pants. Personnel should wear sunscreen, if necessary.

HEALTH SAFETY SECURITY ENVIRONMENT (HSSE) CONSIDERATIONS

This section to be completed with concurrence from the Safety and Health Manager.

SOURCE	*HAZARDS*	*WHERE*	*HOW, WHEN, RESULT*	*CONTROLS*
BIOLOGICAL	Plants, insects, and animals.	Sites.	Exposure to plants, insects, and/or animals may cause rashes, blisters, redness, and swelling.	Training on the signs and symptoms of exposure to plants, insects, and animals is required. Avoid contact with plants, insects, and animals. First-aid kits will be available on site. Personnel with allergies will notify their supervisor.
MECHANICAL	Not applicable.			
PRESSURE	Not applicable.			
THERMAL	Not applicable.			
HUMAN FACTORS	Inexperienced and improperly trained personnel.	Sites.	Inexperienced personnel and improper training could cause incidents resulting in adverse health effects and/or property damage.	Personnel will be properly trained in this procedure and other applicable procedures. Personnel will implement stop work procedures, if necessary.
SIMOPS (Simultaneous Operations)	Not applicable.			

ADDITIONAL HSSE CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.	
REQUIRED PPE	**Personal Protection Equipment** (PPE): Hard hat, safety glasses, high-visibility work shirt or vest, long pants, work boots, and nitrile gloves.
APPLICABLE SDSs	**Safety Data Sheets** (SDSs): pH 4, pH7, and pH10 buffer solutions. Safety Data Sheets are available to Pioneer personnel at the link below: https://pioneertechnicalservices.sharepoint.com/Safety/SafetyDataSheets
REQUIRED PERMITS/ FORMS	Per site/project requirements.
ADDITIONAL TRAINING	Per site/project requirements.

DRAWINGS, DOCUMENTS, AND TOOLS/EQUIPMENT The following documents should be referenced to assist in completing the associated task.	
DRAWINGS	Map with site location and sample locations.
RELATED SOPs/ PROCEDURES/ WORK PLANS	
TOOLS/ EQUIPMENT	pH field measurement meters, spare batteries for the pH field measurement meters, deionized water, pH 7 buffer solution, pH 4 buffer solution, pH 10 buffer solution, beaker, and field logbook.
FORMS/ CHECKLIST	

APPROVALS/CONCURRENCE By signing this document, all parties acknowledge the completeness and applicability of this SOP for its intended purpose. Also, by signing this document, it serves as acknowledgement that I have received training on the procedure and associated competency testing.	
SOP TECHNICAL AUTHOR	**DATE**
Julie Flammang **Julie Flammang**	**09/29/2020**
SAFETY AND HEALTH MANAGER	**DATE**
Tara Schleeman **Tara Schleeman**	**09/29/2020**

PURPOSE	To provide standard instructions for field measurements of oxidation reduction potential (ORP) in water.
SCOPE	Pioneer Technical Services, Inc. (Pioneer) prepared this practice for the workforce and this Standard Operating Procedure (SOP) applies to all work performed by and on behalf of Pioneer. All members of the Pioneer workforce who conduct the work shall be trained and competent (as defined by OSHA) in the risk-assessed procedure described below before performing the work.

WORK INSTRUCTIONS

The following instructions provide guidance to perform the task in a safe, accurate, and reliable manner. If these instructions present information that is inaccurate or unsafe, personnel must notify the Project Manager, Safety Manager, and the SOP Technical Author to initiate appropriate revisions. Personnel will perform all work under this SOP in a manner that is consistent with procedures and policies described in the appropriate Operation, Maintenance, and Monitoring (O&M) Plan (where applicable), appropriate Site-Specific Health and Safety Plans (SSHASP), and Pioneer Corporate Health and Safety Plan (HASP).

TASK	INSTRUCTIONS
Important information about meter's calibration.	Pioneer owns and operates different brands and models of ORP field measurement meters. At this time, Pioneer uses YSI, In-Situ, Thermo Scientific ORION (Orion 3 Star or Orion 5 Star) Portable Meters for ORP measurements. An Orion 9179BNMD epoxy low maintenance ORP/ATC Triode is attached to the ORION meters. The Orion Star meters can perform an automatic ORP calibration adjusted for temperature. User manuals for each meter are available and the specific directions for calibrating and measuring ORP with that meter should be followed. If there is a choice between measuring ORP in the millivolt (mV) or relative millivolt (RmV), measure in **mV mode**. The Orion meters are calibrated using RmV mode and then changed to mV for measuring. The YSI and In-Situ multi probes, units will be in mV for both calibration and measurements. The mV values can be compared among multiple meters and electrode systems. Listed below is the general calibration procedure. Refer to the meter specific operating manual for detailed calibration instructions.
1. Prepare electrode.	1. Remove the protective shipping cap from the sensing element and save the cap for storage. 2. Clean any salt deposits from the exterior of the electrode by rinsing with distilled water. 3. Shake the electrode downward (similar to a clinical thermometer) to remove air bubbles from the Orion and YSI probes. 4. Connect the electrode to the meter.

2. Connect the electrode to the meter.	1. For the Orion meters, insert the ORP connector (large diameter) in the pH or BNC electrode input jack on the meter and the reference electrode connector (small diameter) into the reference electrode input jack. 2. For the YSI and In-Situ meters, slide probe into correct slot and turn counterclockwise to tighten. Make sure threads are not cross threaded and tighten. **Hand tighten only!**
3. Calibrate the meter.	All field meters must be calibrated prior to use. Calibration shall be performed at a minimum of once per day when the instrument is in use. Calibration shall be performed prior to the first measurements of the day. All calibration results **will** be recorded in the field logbook, or if stored on the meter, downloaded and saved in the project file. Downloaded calibration files will be included as part of the field logbook record. 1. For the Orion meters, set the meter to the RmV mode referring to the specific meter's user guide for instructions. If using YSI or In-Situ meters skip to step 2. 2. Rinse the electrode with deionized or distilled water and place the ORP electrode in an appropriate ORP standard. Pioneer uses a 400 mV standard (Orion 967901 or similar) for most calibrations. If project-specific measurements of ORP are expected to be much higher or lower than 400 mV, use an ORP calibration standard with an appropriate concentration. **Always** use fresh ORP standard for calibrations. Empty the ORP calibration container in the Pioneer Calibration Kit, rinse the bottle with fresh ORP solution, empty it, and then pour enough of the calibration fluid into the bottle to cover the bottom of the electrode. 3. For Orion meters, wait for the RmV icon to quit flashing. If using YSI or In-Situ meters, wait for mV to stabilize and accept calibration. 4. The Orion Star meters will automatically calculate the mV. Small adjustments may be required to the reading to achieve the mV value of the ORP standard at the measured temperature. Information provided in the Thermo Orion User Guide for Redox/ORP Electrodes or Table 1, on page 4, can be used as a reference for the appropriate reading. Adjust the meter referring to the meter user's guide for detailed instructions on adjusting the reading. 5. For Orion meters, press the measure symbol to end the calibration. The mV offset will be displayed and the meter will proceed to the measurement mode. The In-situ meter will display the mV offset and temperature immediately after accepting the calibration. This information can be stored for downloading. 6. If using the YSI meter, calibration is stored on the meter and can be downloaded. To access the calibration information immediately to record in the logbook, return to the main display screen. Press "File," scroll down to the "GLP" file, and press enter to view. The information from the latest calibration will be displayed at the top. Scroll down to view previous calibrations.

	7. Record the calibration information in the logbook or save for later download.
4. Conduct field measurements.	Field ORP measurements for surface water may be made by direct submersion of the instrument probe into the sample stream. If flow is turbulent or shallow, or if direct immersion could damage the probe, a grab sample can be collected in a beaker or bottle and the probe should be placed immediately into the beaker for measurement. Field ORP measurements of groundwater may be made by inserting the probe into a flow-through device or by collection of a grab sample and immediate analysis of that sample in the field. Specific requirements may be listed in the project-specific documents (sampling and analysis plan, quality assurance project plan, work plan, etc.). The ORP measurements are considered stable during groundwater sampling when 3 consecutive readings vary by no more than 10 mV units. Oxidation Reduction Potential is always measured and reported in mV. Refer to the meter specific user manual for measurement instructions. Listed below are general measurement instructions: 1. Rinse the electrode with distilled or deionized water. Shake off any excess water and blot the electrode dry with lint-free tissue. 2. Check and make sure that the meter is measuring in mVs. 3. Place the electrode directly into the water to be measured. If the probe cannot be placed directly into the water being measured, rinse a decontaminated beaker with sample water 3 times and fill the beaker with the water to be measured. 4. Continuously stir or move the probe through the sample at a rate of about 1 foot per second. 5. If the meter is in the continuous measurement mode, it will start reading immediately and continuously update the display. The mV icon will flash until the reading is stable. 6. Read and record the result in the field logbook or on a field data sheet. 7. Remove the electrode from the sample, rinse it with distilled or deionized water, and blot it dry before inserting the probe into the storage sleeve.
Important information about the meter.	1. Store meter in its case during transport. 2. Check batteries before taking meter into the field. Carry spare batteries and deionized water for rinsing probe. 3. Inspect probe for damage or dirt.

	4. Dust and wipe the meter with a damp cloth. If necessary, warm water or mild water-based detergent can be used to clean the case. Immediately remove any spilled substance from the meter using the proper cleaning procedure for the type of spill. 5. If meter readings are erratic, replace the probe. If measurement readings continue to be erratic, return the meter to factory for repair.

Table 1. ORP Standard Values – Page 1

Table 1– ORP Standard Values

Absolute mV values may vary by ± 60 mV

Temperature (°C)	E_H Value (mV)	Absolute Value with Cat. No. 900011 Filling Solution (mV)	Absolute Value with Cat. No. 900001 Filling Solution (mV)
0	438	218	176
1	437	218	176
2	437	218	176
3	436	218	176
4	435	218	176
5	435	218	176
6	434	218	176
7	433	218	176
8	433	218	175
9	432	219	175

Table 1. ORP Standard Values – Page 2

Temperature (°C)	E_H Value (mV)	Absolute Value with Cat. No. 900011 Filling Solution (mV)	Absolute Value with Cat. No. 900001 Filling Solution (mV)
10	431	219	175
11	430	219	175
12	430	219	175
13	429	219	175
14	428	219	175
15	428	219	175
16	427	219	174
17	426	219	174
18	425	219	174
19	424	219	174
20	424	219	174
21	423	219	174
22	422	219	174
23	421	219	173
24	420	220	173
25	420	220	173
26	419	220	173
27	418	220	173
28	417	220	172
29	416	220	172
30	415	220	172
31	414	220	172
32	413	220	172
33	412	220	171
34	412	220	171
35	411	220	171
36	410	220	171
37	409	220	171
38	408	220	170
39	407	220	170
40	406	220	170
41	405	220	170
42	404	220	169
43	403	220	169
44	402	220	169
45	401	220	169
46	400	220	168
47	399	220	168
48	398	220	168
49	397	220	168
50	396	220	167

HEALTH SAFETY SECURITY ENVIRONMENT (HSSE) CONSIDERATIONS
This section to be completed with concurrence from the Safety and Health Manager.

SOURCE	***HAZARDS***	***WHERE***	***HOW, WHEN, RESULT***	***CONTROLS***
CHEMICAL	Potential contact with contaminated water.	Testing sites, during field measure-ments.	Inadvertent exposure to contaminated water could lead to adverse health effects.	Personnel will practice proper personal hygiene – wash hands prior to eating/drinking and when leaving the site. Personnel will wear nitrile gloves and safety glasses when taking measurements.
	Potential exposure to ORP standard solution.	Equipment calibration.	ORP standard solution is moderately toxic if ingested. It may also irritate eyes and skin.	Personnel will practice proper personal hygiene – wash hands prior to eating and after calibrating equipment. Personnel will wear nitrile gloves and safety glasses when handling the ORP standard solution.
NOISE	Not applicable.			
ELECTRICAL	Not applicable.			
BODY MECHANICS	Bending, squatting, and kneeling.	During field measure-ments.	Bending, squatting, and kneeling during field measurements could result in muscle/back strains or other injuries.	Personnel should stretch prior to starting work and they will take breaks when necessary.
	Drowning and/or entrapment hazards.	Bodies of water, during field measure-ments.	If personnel need to stand in bodies of water to take measurements, they could be exposed to drowning and/or entrapment hazards from soft soils and/or sudden changes in depth of water.	If necessary, personnel will use rods to test soil stability and/ or depth of water as they walk to sample locations. Also, personnel may be required to wear life vests when crossing deeper bodies of water. When possible, personnel will not enter the water body and take measurements from the bank.

HEALTH SAFETY SECURITY ENVIRONMENT (HSSE) CONSIDERATIONS
This section to be completed with concurrence from the Safety and Health Manager.

SOURCE	*HAZARDS*	*WHERE*	*HOW, WHEN, RESULT*	*CONTROLS*
GRAVITY	Falls from slips and trips.	Uneven terrain, slick/muddy/ wet surfaces and steep slopes.	Walking/working on slick/muddy/wet and uneven terrain could cause slips and trips resulting in falls and injuries.	Personnel will wear work boots with good traction and ankle support. Personnel will be aware of working/walking surfaces and choose a path to avoid hazards. Keep work areas as dry as possible. Wear muck boots, as necessary.
WEATHER	Cold/heat stress.	Sites.	Exposure to cold climates may result in cold burns, frostbites, and hypothermia. Exposure to high temperatures may result in heat cramps, heat exhaustion, or heat stroke.	Training on signs and symptoms of cold/heat stress is required. Personnel will wear appropriate clothing when working outdoors. Personnel will remain hydrated and will have sufficient caloric intakes during the day. Personnel will follow procedures outlined in applicable SSHASP and/or Pioneer corporate HASP.
	Hypothermia/ frostbite.	Sites where air temperature is 35.6 °F (2 °C) or less.	Personnel who become immersed in water or whose clothing becomes wet may be exposed to hypothermia and/or frostbite.	Personnel will change clothing if it becomes wet. When applicable, Personnel will wear waders to prevent clothing from getting wet.
	Lightning.	Outdoor sites.	Electrocution, injury, death, or equipment damage could be caused by lightning strike.	Personnel will follow the 30/30 rule during lightning storms.
RADIATION	Ultraviolet (UV) radiation.	Outdoors.	Personnel could be exposed to UV radiation during summer months causing sun burns, skin damage, and eye damage.	Personnel will wear safety glasses with tinted lenses, long-sleeve work shirts, and long pants. Personnel should wear sunscreen, if necessary.

HEALTH SAFETY SECURITY ENVIRONMENT (HSSE) CONSIDERATIONS

This section to be completed with concurrence from the Safety and Health Manager.

SOURCE	***HAZARDS***	***WHERE***	***HOW, WHEN, RESULT***	***CONTROLS***
BIOLOGICAL	Plants, insects, and animals.	Sites.	Exposure to plants, insects, and/or animals may cause rashes, blisters, redness, and swelling.	Training on the signs and symptoms of exposure to plants, insects, and animals is required. Avoid contact with plants, insects, and animals. First-aid kits will be available on site. Personnel with allergies will notify their supervisor.
MECHANICAL	Not applicable.			
PRESSURE	Not applicable.			
THERMAL	Not applicable.			
HUMAN FACTORS	Inexperienced and improperly trained personnel.	Sites.	Inexperienced personnel and improper training could cause incidents resulting in adverse health effects and/or property damage.	Personnel will be properly trained in this procedure and other applicable procedures. Personnel will implement stop work procedures, if necessary.
SIMOPS (Simultaneous Operations)	Not applicable.			

ADDITIONAL HSSE CONSIDERATIONS

This section to be completed with concurrence from the Safety and Health Manager.

REQUIRED PPE	**Personal Protection Equipment** (PPE): Hard hat, safety glasses, high-visibility work shirt or vest, long pants, work boots, and nitrile gloves.
APPLICABLE SDSs	**Safety Data Sheets** (SDSs): ORP Standard Solution Safety Data Sheets are available to Pioneer personnel at the link below: https://pioneertechnicalservices.sharepoint.com/Safety/SafetyDataSheets

REQUIRED PERMITS/FORMS	Per site/project requirements.
ADDITIONAL TRAINING	Per site/project requirements.

DRAWINGS, DOCUMENTS, AND TOOLS/EQUIPMENT The following documents should be referenced to assist in completing the associated task.	
DRAWINGS	Map with site location and sample locations.
RELATED SOPs/ PROCEDURES/ WORK PLANS	
TOOLS/ EQUIPMENT	ORP field measurement meters, ORP standard solution, spare batteries for the meters, distilled water or deionized water, lint-free tissue, beaker, and field logbook or field data sheet.
FORMS/ CHECKLIST	

APPROVALS/CONCURRENCE By signing this document, all parties acknowledge the completeness and applicability of this SOP for its intended purpose. Also, by signing this document, it serves as acknowledgement that I have received training on the procedure and associated competency testing.	
SOP TECHNICAL AUTHOR	**DATE**
Julie Flammang **Julie Flammang**	**10/15/2020**
SAFETY AND HEALTH MANAGER	**DATE**
Tara Schleeman **Tara Schleeman**	**10/15/2020**

PURPOSE	To provide standard instructions for field measurements of specific conductance.
SCOPE	This practice has been prepared for the Pioneer Technical Services, Inc. (Pioneer) workforce and applies to work carried out by and on behalf of Pioneer. All members of the Pioneer workforce who conduct the work shall be trained and competent in the risk-assessed work described below.

WORK INSTRUCTIONS

The following instructions are intended to provide sufficient guidance to perform the task in a safe, accurate, and reliable manner. Should these instructions present information that is inaccurate or unsafe, operations personnel must bring the issue to the attention of the Project Manager and the appropriate revisions made. All work carried under this SOP will be consistent with procedures and policies described in the appropriate Operation, Maintenance, and Monitoring (O&M) Plan (where applicable), appropriate Site-Specific Health and Safety Plan (SSHASP), and Pioneer Corporate Health and Safety Plan (HASP).

TASK	INSTRUCTIONS
Important information about the meter.	Pioneer owns and operates different brands and models of specific conductance (SC) field measurement meters. All the units, in general, have automatic temperature correction (ATC) capabilities. Prior to using a SC meter check that it does have the ATC function. User manuals for each meter are available and the specific directions for calibrating and measuring SC with that meter should be followed. The following is a general summary for field measurement of SC.
1. Calibrate the meter.	All field meters must be calibrated prior to use. Calibration shall be performed at a minimum of once per day for each day of instrument use. Calibration shall be performed prior to the first measurements of the day. Refer to the meter specific operating manual for calibration instructions. Listed below are general calibration requirements: 1. For a new probe, prepare the SC probe according to the directions in the electrode user guide. 2. Connect the probe to the appropriate connection on the meter. 3. Turn the meter on and make sure it is in the conductivity measurement mode. Calibrate instrument as described in the meter specific operating manual. Unless specified in the Sampling and Analysis Plan (SAP) or work plan, one conductivity standard is used for calibration. Unless directed otherwise, use the 1413 micromhos/centimeter (µs/cm) calibration standard present in all of Pioneers calibration cases. Make sure that the calibration standard in the case is fresh. The container of calibration standard should be emptied, rinsed with new calibration standard and filled prior to a field sampling event. Replace batteries and try fresh calibration solutions if meter does not calibrate properly. 4. Record the calibration results in the field logbook. If the meter displays an average calculated cell constant, record this in the field logbook. 5. Once the SC meter is in measure mode, measure the calibration standard and

	record this result and the measurement temperature in the field logbook. 6. Re-measure the calibration fluid at the end of the day and note any drift. Record the information in the field logbook.
2. Conduct field measurements.	Field conductivity measurements for surface water may be made by direct submersion of the instrument probe into the sample stream. When flow is turbulent or shallow, or when direct immersion of the probe would risk damaging the probe, measurements may be made by collection of a grab sample and immediate analysis of the grab sample in the field. Field SC measurements of groundwater may be made by inserting the probe into a flow through device or by collection of a grab sample and immediate analysis of the grab sample in the field. Specific requirements may be listed in the SAP or work plan. Field SC is measured in units of µS/cm (micromhos/centimeter) or mS/cm (millihos/centimeters) on all Pioneer meters. Refer to the meter specific operating manual for measurement instructions. Listed below are general measurement instructions: 1. If the probe cannot be placed directly into the water being measured, rinse the decontaminated beaker with sample water three times. 2. Fill the beaker with the water to be measured. 3. With the meter in measurement mode, rinse the conductivity cell with distilled water, blot dry with a lint-free tissue and place the cell into the water being measured. 4. Submerge conductivity probe in sample so that flow cell holes are immersed and wait for the readings to stabilize. 5. Read and record the SC result in the field logbook or on a field data sheet making sure that the correct units are recorded, either µS/cm or mS/cm. Record the sample temperature to the nearest 0.1 degree Celsius (°C) from the conductivity meter after temperature has equilibrated. 6. Repeat the above steps for all samples. 7. When all samples have been measured, store the electrode according to their specific user guides.
Important information about the meter.	1. Store meter in case during transport. 2. Check batteries before taking meter into the field. Carry spare batteries and de-ionized water for rinsing probe. 3. Inspect probe for damage or dirt.

	4. Dust and wipe the meter with a damp cloth. If necessary, warm water or mild water based detergent can be used to clean the case. Immediately remove any spilled substance from the meter using the proper cleaning procedure for the type of spill. 5. If meter readings are erratic, replace the probe. If readings continue to be erratic, return the meter to factory for repair.

HSSE CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.				
SOURCE	***HAZARDS***	***WHERE***	***HOW, WHEN, RESULT***	***CONTROLS***
CHEMICAL	Potential contact with contaminated water.	Testing sites, during field measurements.	Inadvertent exposure to contaminated water could lead to adverse health effects.	Personnel will practice proper personal hygiene – wash hands prior to eating/drinking and when leaving the site. Personnel will wear nitrile gloves and safety glasses when taking measurements.
	Exposure to 1413 µs/cm calibration standard solution.	Equipment calibration.	The calibration standard solution may cause irritation of eyes and skin.	Personnel will practice proper personal hygiene – wash hands prior to eating and after calibrating equipment. Personnel will wear nitrile gloves and safety glasses when handling the calibration standard solution.
NOISE	Not applicable.			
ELECTRICAL	Not applicable.			
BODY MECHANICS	Bending, squatting, and kneeling.	During field measurements.	Bending, squatting, and kneeling during field measurements could result in muscle/back strains or other injuries.	Employees should stretch prior to starting work and they will take breaks when necessary.
	Drowning and/or entrapment hazards.	Bodies of water, during field measurements.	If employees need to stand in bodies of water to take measurements, they could be exposed to drowning and/or entrapment hazards from soft soils and/or sudden changes in depth of water.	If necessary, personnel will use rods to test soil stability and/or depth of water as they walk to sample locations. In addition, personnel may be required to wear life vests when crossing deeper bodies of water. When possible, workers will not enter the water body and take measurements from the bank.

GRAVITY	Falls from slips and trips.	Uneven terrain, slick/muddy/wet surfaces and steep slopes.	Walking/working on slick/muddy/wet and uneven terrain could cause slips and trips resulting in falls and injuries.	Personnel will wear work boots with good traction and ankle support. Personnel will be aware of working/walking surfaces and choose a path to avoid hazards. Keep work areas as dry as possible. Wear muck boots, as necessary.
WEATHER	Cold/heat stress.	Sites.	Exposure to cold climates may result in cold burns, frostbites, and hypothermia. Exposure to high temperatures may result in heat cramps, heat exhaustion, or heat stroke.	Training on signs and symptoms of cold/heat stress is required. Personnel will wear appropriate clothing when working outdoors. Personnel will remain hydrated and will have sufficient caloric intakes during the day. Personnel will follow procedures outlined in applicable SSHASP and/or Pioneer corporate HASP.
	Hypothermia/ frostbite.	Sites where air temperature is 35.6°F (2°C) or less.	Workers who become immersed in water or whose clothing becomes wet may be exposed to hypothermia and/or frostbite.	Employees will change clothing if it becomes wet. When applicable, employees will wear waders to prevent clothing from getting wet.
	Lightning.	Outdoor sites.	Electrocution, injury, death, or equipment damage could be caused by lightning strike.	Employees will follow the 30/30 rule during lightning storms.
RADIATION	Ultraviolet (UV) radiation.	Outdoors.	Employees could be exposed to UV radiation during summer months causing sun burns, skin damage, and eye damage.	Employees will wear safety glasses with tinted lenses, long-sleeve work shirts, and long pants. Employees should wear sunscreen, if necessary.

BIOLOGICAL	Plants, insects, and animals.	Sites.	Exposure to plants, insects, and/or animals may cause rashes, blisters, redness, and swelling.	Training on the signs and symptoms of exposure to plants, insects, and animals is required. Avoid contact with plants, insects, and animals. First-aid kits will be available on site. Employees with allergies will notify their supervisor.
MECHANICAL	Not applicable.			
PRESSURE	Not applicable.			
THERMAL	Not applicable.			
HUMAN FACTORS	Inexperienced and improperly trained worker.	Sites.	Inexperienced workers and improper training could cause incidents resulting in adverse health effects and/or property damage.	Employees will be properly trained in this procedure and other applicable procedures. Employees will implement stop work procedures, if necessary.
SIMOPS	Not applicable.			

ADDITIONAL HSSE CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.	
REQUIRED PPE	Hard hat, safety glasses, high-visibility work shirt or vest, long pants, work boots, and nitrile gloves.
APPLICABLE SDS	1413 µs/cm calibration standard solution. Additional Safety Data Sheets (SDSs) will be maintained based on site characterization and contaminants.
REQUIRED PERMITS/FORMS	Per site/project requirements.
ADDITIONAL TRAINING	Per site/project requirements.

DRAWINGS, DOCUMENTS, AND TOOLS/EQUIPMENT The following documents should be referenced to assist in completing the associated task.	
P&IDS	
DRAWINGS	Map with site location and sample locations.
RELATED SOPs/PROCEDURES/ WORK PLANS	
TOOLS	Specific conductance field measurement meter, calibration standard solution, calibration kit, spare batteries for the meter, distilled water or de-ionized water, lint-free tissue, beaker, and field logbook or field data sheet.
FORMS/CHECKLIST	

APPROVALS/CONCURRENCE By signing this document, all parties acknowledge the completeness and applicability of this SOP for its intended purpose. Also, by signing this document, it serves as acknowledgement that I have received training on the procedure and associated competency testing.	
SOP TECHNICAL AUTHOR	**DATE**
Julie Flammang (signature) **Julie Flammang**	**12/17/2014**
SAFETY AND HEALTH MANAGER	**DATE**
Tara Schleeman (signature) **Tara Schleeman**	**12/17/2014**

Revisions:

Revision	Description	Date

PURPOSE	To provide standard instructions for field measurements of dissolved oxygen.
SCOPE	This practice has been prepared for the Pioneer Technical Services, Inc. (Pioneer) workforce and applies to work carried out by and on behalf of Pioneer. All members of the Pioneer workforce who conduct the work shall be trained and competent in the risk-assessed work described below.

WORK INSTRUCTIONS

The following instructions are intended to provide sufficient guidance to perform the task in a safe, accurate, and reliable manner. Should these instructions present information that is inaccurate or unsafe, operations personnel must bring the issue to the attention of the Project Manager and the appropriate revisions made. All work carried under this SOP will be consistent with procedures and policies described in the appropriate Operation, Maintenance, and Monitoring (O&M) Plan (where applicable), appropriate Site-Specific Health and Safety Plan (SSHASP), and Pioneer Corporate Health and Safety Plan (HASP).

TASK	INSTRUCTIONS
Note	Pioneer owns and operates several brands and models of dissolved oxygen (DO) field measurement meters. All the units have automatic barometric pressure and salinity content compensation. User manuals for each meter are available and the specific directions for calibrating and measuring DO with that meter should be followed. The following is a general summary for field measurement of DO.
1. Calibrate the meter.	All field meters must be calibrated prior to use. Calibration shall be performed at a minimum of once per day for each day of instrument use. Calibration shall be performed prior to the first measurements of the day. Refer to the meter specific operating manual for calibration instructions. Listed below are general calibration requirements: 1. Inspect DO meter and probe for damage. If one of the YSI DO meters is to be used, inspect the probe for sufficient electrolyte and to determine if the oxygen sensor membrane is in good condition. Replace membrane, if torn or wrinkled. Inspect for air bubbles beneath the membrane. If bubbles are present, remove membrane and add electrolyte solution. Replace membrane so that air bubbles are absent. If the Thermo Scientific DO meters are used, check to make sure the RDO Optical Dissolved Oxygen probe has not exceeded its lifespan. 2. Turn the meter on and if needed place the meter in the DO measurement mode. Calibrate instrument as described in the meter specific operating manual. Unless specified in the Sampling and Analysis Plan (SAP) or work plan, calibration should be conducted in the % saturation mode. Replace batteries and clean probe, if meter does not calibrate properly. 3. With all of Pioneers DO meters, an air calibration is performed in water saturated air using the calibration/storage sleeve. To begin, check the sponge in the calibration sleeve and moisten the sponge with distilled water, if needed. Place 3-6 drops of water on the sponge and then allow any excess water to drain out of the chamber. The wet sponge creates a 100% water saturated air environment for the probe. This environment is ideal for DO calibration and for

	storage of the probe during transport and non-use. 4. Allow the probe and calibration standard (water saturated air) to reach equilibrium. 5. Calibrate the meter according to manufacturer's instructions. To accurately calibrate the YSI DO meters you will need to know the following information: • The approximate salinity of the water you will be analyzing. Fresh water has a salinity of approximately zero. Seawater has a salinity of approximately 35 parts per thousand (ppt). • For calibration in % saturation mode, the approximate altitude (in feet) of the region where you are located is required. This information can be obtained over the internet or from a topographic map. 6. Record the % saturation number displayed at the end of the automatic calibration.
2. Take measurements.	Field DO measurements for surface water may be made by direct submersion of the instrument probe into the sample stream. If flow is turbulent or shallow, or if direct immersion of the probe would risk damaging the probe, a grab sample can be collected and immediate measurement of the grab sample conducted. Field DO measurements of groundwater may be made by inserting the probe into a flow through device or by collection of a grab sample and immediate analysis of the grab sample in the field. Specific requirements may be listed in the SAP or work plan. The site-specific document may list the units that DO should be measured in (e.g., % saturation or mg/L). Refer to the meter-specific operating manual for measurement instructions. Listed below are general measurement instructions: 1. If the probe cannot be placed directly into the water being measured, rinse the decontaminated beaker with sample water three times. 2. Fill the beaker with the water to be measured. 3. Continuously stir or move the probe through the sample at a rate of about one foot per second. 4. Allow temperature and dissolved oxygen readings to stabilize. 5. Read and record the DO result in the field logbook or on a field data sheet making sure that the correct units are recorded (either % Sat or mg/L). Record the sample temperature to the nearest 0.1ºC from a pH meter, if available, after the temperature has equilibrated. 6. Spray the probe with de-ionized water and wipe clean before reinserting to calibration/storage sleeve. 7. Repeat the above steps for all samples.

	8. When all samples have been measured, store the electrode according to their specific user guides.
3. Maintenance of equipment.	1. Store meter in case during transport. 2. Check batteries before taking meter into the field. Carry spare batteries and de-ionized water for rinsing probe. 3. Inspect probe for damage or dirt. 4. Dust and wipe the meter with a damp cloth. If necessary, use warm water or mild water based detergent to clean the case. Immediately remove any spilled substance from the meter using the proper cleaning procedure for the type of spill. 5. If meter readings are erratic, replace the probe. If measurement readings continue to be erratic, return the meter to factory for repair.

HSSE CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.				
SOURCE	***HAZARDS***	***WHERE***	***HOW, WHEN, RESULT***	***CONTROLS***
CHEMICAL	Potential contact with contaminated water.	Testing sites, during field measurements.	Inadvertent exposure to contaminated water could lead to adverse health effects.	Personnel will practice proper personal hygiene – wash hands prior to eating/drinking and when leaving the site. Personnel will wear nitrile gloves and safety glasses when taking measurements.
NOISE	Not applicable.			
ELECTRICAL	Not applicable.			
BODY MECHANICS	Bending, squatting, and kneeling. Drowning and/or entrapment hazards.	During field measurements. Bodies of water, during field measurements.	Bending, squatting, and kneeling during field measurements could result in muscle/back strains or other injuries. If employees need to stand in bodies of water to take measurements, they could be exposed to drowning and/or entrapment hazards from soft soils and/or sudden changes in depth of water.	Employees should stretch prior to starting work and they will take breaks when necessary. If necessary, workers will use rods to test soil stability and/or depth of water as they walk to sample locations. In addition, personnel may be required to wear life vests when crossing deeper bodies of water. When possible, workers will not enter the water body and take measurements from the bank.
GRAVITY	Falls from slips and trips.	Uneven terrain, slick/muddy/wet surfaces and steep slopes.	Walking/working on slick/muddy/wet and uneven terrain could cause slips and trips resulting in	Personnel will wear work boots with good traction and ankle support. Personnel will be aware of working/walking surfaces and choose a path to avoid hazards. Keep work areas as dry as possible. Wear

			falls and injuries.	muck boots, as necessary.
WEATHER	Cold/heat stress.	Sites.	Exposure to cold climates may result in cold burns, frostbites, and hypothermia. Exposure to high temperatures may result in heat cramps, heat exhaustion, or heat stroke.	Training on signs and symptoms of cold/heat stress is required. Personnel will wear appropriate clothing when working outdoors. Personnel will remain hydrated and will have sufficient caloric intakes during the day. Personnel will follow procedures outlined in applicable SSHASP and/or Pioneer corporate HASP.
	Hypothermia/ frostbite.	Sites where air temperature is 35.6°F (2°C) or less.	Workers who become immersed in water or whose clothing becomes wet may be exposed to hypothermia and/or frostbite.	Employees will change clothing if it becomes wet. When applicable, employees will wear waders to prevent clothing from getting wet.
	Lightning.	Outdoor sites.	Electrocution, injury, death, or equipment damage could be caused by lightning strike.	Employees will follow the 30/30 rule during lightning storms.
RADIATION	Ultraviolet (UV) radiation.	Outdoors.	Employees could be exposed to UV radiation during summer months causing sun burns, skin damage, and eye damage.	Employees will wear safety glasses with tinted lenses, long-sleeve work shirts, and long pants. Employees should wear sunscreen, if necessary.
BIOLOGICAL	Plants, insects, and animals.	Sites.	Exposure to plants, insects, and/or animals may cause rashes, blisters, redness, and swelling.	Training on the signs and symptoms of exposure to plants, insects, and animals is required. Avoid contact with plants, insects, and animals. First-aid kits will be available on site. Employees with allergies will notify their supervisor.

MECHANICAL	Not applicable.			
PRESSURE	Not applicable.			
THERMAL	Not applicable.			
HUMAN FACTORS	Inexperienced and improperly trained worker.	Sites.	Inexperienced workers and improper training could cause incidents resulting in adverse health effects and/or property damage.	Employees will be properly trained in this procedure and other applicable procedures. Employees will implement stop work procedures, if necessary.
SIMOPS	Not applicable.			

ADDITIONAL HSSE CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.	
REQUIRED PPE	Hard hat, safety glasses, high-visibility work shirt or vest, long pants, work boots, and nitrile gloves.
APPLICABLE SDS	Safety Data Sheets (SDSs) will be maintained based on site characterization and contaminants.
REQUIRED PERMITS/FORMS	Per site/project requirements.
ADDITIONAL TRAINING	Per site/project requirements.

DRAWINGS, DOCUMENTS, AND TOOLS/EQUIPMENT The following documents should be referenced to assist in completing the associated task.	
P&IDS	
DRAWINGS	Map with site location and sample locations.
RELATED SOPs/PROCEDURES/ WORK PLANS	
TOOLS	Dissolved oxygen field measurement meter, de-ionized water, distilled water, decontaminated beaker, field logbook or field data sheet, and spare batteries for meter.
FORMS/CHECKLIST	

APPROVALS/CONCURRENCE By signing this document, all parties acknowledge the completeness and applicability of this SOP for its intended purpose. Also, by signing this document, it serves as acknowledgement that I have received training on the procedure and associated competency testing.	
SOP TECHNICAL AUTHOR	**DATE**
Julie Flammang **Julie Flammang**	**12/17/2014**
SAFETY AND HEALTH MANAGER	**DATE**
Tara Schleeman **Tara Schleeman**	**12/17/2014**

Revisions:

Revision	Description	Date

Appendix B.
Field Forms and Tables

FORMS

Test Pit Log

Project: Biotreatability Study
Location No:
Arrival/Start Excavation Time:
Contrator:
Equipment Used:
Excavation Stop Time:
Date:
Operator:
GW Depth:
Logged By:
Weather (including ambient temp.):

Depth		Soil Characterization	PID (MR)	PID (UR)	Sample Time
IN	FT				

Notes:

Butte Reduction Works Phase I, Field XRF Results 2018									Units are mg/kg or ppm NA - Not applicable.
		Soil Performance Standards	200	20	1,000	NA	1,000	1,000	If three of the six criteria listed are exceeded, or any one contaminant is abouve 5,000 mg/kg then the material is considered waste.
XRF Reading #	**Date**	**Sample ID**	**XRF Results**						**Comments**
			As	**Cd**	**Cu**	**Fe**	**Pb**	**Zn**	

TABLES

ORDER FOR DESCRIPTIONS

Density

- Very soft, Soft, Medium Stiff, Stiff, Stiff, Very Stiff, Hard
- Very loose, Loose, Medium Dense, Dense, Very Dense
- SEE TABLE

Moisture Content

- Dry, Moist, Wet
- See Table

General Color

Soil Description

- Minor soil type name with "y" added if ≥ 30 percent and ≤ 50%
- Descriptive adjective for main soil type
  - Particle-size distribution adjective for gravel and sand (fine – coarse)
  - Plasticity adjective (slight to high) and soil texture (silty or clayey) for inorganic and organic silts or clays
- Main soil type's name (**all capital letters**)
- Descriptive adjective such as trace (0-5%), slightly or some (5-12%), for minor soil type

Structures

- See Tables

Geologic Classification

- If applicable – alluvium, fill, tailings, slag, debris

USCS Classification

- See Tables

Examples:
Medium dense, wet, dark brown, sandy SILT, trace of clay, numerous organics and strong organic odor (marsh deposits) ML.

Medium stiff, moist, dark gray, medium plastic silty CLAY, slightly sandy, laminated with light gray silt (tailings), CL

Very dense, moist, light brown, slightly silty, sandy fine gravel, trace of cobbles, scattered roots, GP-GM

Density/Consistancy Word Choices

Consistency of Fine-Grained Soils-Silts, Clays

Consistency	Results of Manual Manipulation
Very Soft	Specimen (height = twice the diameter) sags under its own weight; extrudes between fingers when squeezed
Soft	Specimen can be pinched in to between the thumb and forefinger; remolded by light finger pressure
Medium stiff	Can be imprinted easily with fingers; remolded by strong finger pressure
Stiff	Can be imprinted with considerable pressure from fingers or indented by thumbnail
Very stiff	Can be barely imprinted by pressure from the fingers or indented by thumbnail
Hard	Cannot be imprinted by fingers or difficult to indent by thumbnail

Density of Coarse or Cohesionless Soils-Gravels/Sands and Silt
Very loose
Loose
Medium Dense
Dense
Very Dense

WATER CONTENT

Description	Conditions
Dry	No sign of water and soil dry to touch
Moist	Signs of water and soil is relatively dry to touch
Wet	Signs of water and soil definitely wet to touch; granular soil exhibits some free water when densified, saturated

SIZES FOR SOIL DESCRIPTIONS

Term	Example	Size
Boulders	> Basketball size	> 12"
Cobbles	Fist to Basketball size	3"-12"
Gravel – Coarse	**Thumb to fist size**	**¾"-3"**
Gravel – Fine	**Pea to Thumb size**	**5 mm to ¾"**
Sand – Coarse	**Rock salt to pea size**	**2 mm to 5 mm**
Sand – Medium	**Sugar to rock salt**	**0.4 mm to 2 mm**
Sand – Fine	**Flour to sugar**	**0.08 mm to 0.4 mm**
Fines – Clay and silt	**Grains are not visible**	**<0.08 mm**

Boulders and cobbles are not considered soil or part of the soil's classification or description, except under miscellaneous descriptions; i.e. --, with cobbles at about 5 percent (volume).

Well graded coarse-grained soil - contains a good representation of all particle sizes from largest to smallest, with ≤ **12% fines.**
Poorly graded coarse-grained soil is uniformly graded with most particles about the same size or lacking one or more intermediate sizes, with 12% fines.

Describe type and size of organic debris

Adjective	**Presence as % by Volume**
Occasional	0-1%
Scattered	1-10%
Numerous	10-30%
Organic – as a minor constituent in description	30-50%
PEAT – MAJOR constituent	50-100%

Highly Organic Materials

These materials containing a predominance of undecomposed plant or woody fiber are described as follows:

- *Root Mat*: Pronounced structure of living root fibers characteristic of marsh or swampy deposits.
- *Peat*: Fossiliferous root mat with a varying degree of decomposition, often containing a matrix of amorphous, colloidal organic clays and silts.
- *Humus*: Decomposed root and leaf litter, characteristic of organic forest cover in well-drained areas.

SOIL PLASTICITY DESCRIPTIONS

Plasticity Adjective	Dry Strength	Smear Test	Thread Smallest Diameter, in. (mm)	ML & MH (SILT)	CL & CH (CLAY)	OL & OH (ORGANIC SILT OR CLAY)
nonplastic	none-crumbles into powder with mere pressure	gritty or rough	ball crakcs	----	----	ORGANIC SILT
low plasticity	low-crumbles into powder with some finger pressure	rough to smooth	1/4 to 1/8 (3 to 6)	----	silty	ORGANIC SILT
medium plastic	medium - breaks into pieces or crumbles with considerable finger pressure	smooth and dull	1/16 (0.5 to 1)	clayey	silty to no adj.	ORGANIC clayey SILT
highly plastic	high- cannot be broken with finger pressure; will break into pieces between thumb and a hard surface	shiny	1/32 (0.75)	clayey	----	ORGANIC silty CLAY
very plastic	very high - can't be broken between thumb and a hard surface	very shiny and waxy	1/64 (0.5)	clayey	----	ORGANIC

Thread Test:

Moisture is added or worked out of a small ball (about 1 1/2-inch diameter) and the ball is kneaded until it consistency approaches medium stiff to stiff and it breaks, or crumbles. A thread is then rolled out to the smallest diameter possible before disintegration. The smaller the thread achieved, the higher the plasticity of the soil. Fine-grained soils of high plasticity will have threads smaller than 1/32 inch in diameter. Soils with low plasticity will have threads larger the 1/8 inch in diameter

Layered Soils

Type of Layer	Thickness	Occurrence
Parting	< 1/16 in.	
Lamination	< ¼ in.	
Seam	1/16 to ½ in.	
Layer	½ in. to 12 in.	
Stratum	> 12 in.	
Pocket	Small erratic deposit	
Lens	Lenticular deposit	
Varved (also layered)		Alternating seams or layers of silt and/or clay and sometimes f. sand
Occasional		One or less per foot of thickness or laboratory sample inspected
Frequent		More than one per foot of thickness or laboratory sample inspected

Place the thickness designation before the type of layer, or at the end of each description and in parentheses, whichever is more appropriate.

Examples of descriptions for layered soils are:

- Medium stiff, moist to wet 1/4"-3/4" interbedded seams and layers of: gray, medium plastic, silty CLAY (CL); and lt. gray, low plasticity SILT (ML); (Alluvium).

Other Layer Adjectives

Description	Criteria (thickness)
Stratified	Alternating Layers
Interbedded	Alternating Layers > ½" thick
Laminated	Alternating layers < ¼" thick
Fractured	Breaks easily along definite fractured planes
Slickensided	Polished, glossy, striated, fracture planes
Blocky	Easily breaks into small angular lumps
Lensed	Small pockets of different soils
Homogeneous	Same color and appearance throughout
Sheared	Disturbed texture, mix of strengths

Coarse- Grained Soils			
Coarse-Grained Soils	Gravel and Gravelly Soils	GW	Well-graded gravels or gravel- sand mixtures, little or no fines
		GP	Poorly graded gravels or gravel- sand mixtures, little or no fines
		GM	Silty gravels, gravel-sand-silt mixtures (more than 12% fines)
		GC	Clayey gravels, gravel-sand- clay mixtures (more than 12% fines)
	Sand and Sandy Soils	SW	Well-graded sands or gravelly sands, little or no fines
		SP	Poorly graded sands or gravelly sands, little or no fines
		SM	Silty sands, sand-silt mixtures (more than 12% fines)
		SC	Clayey sands, sand-silt mixtures (more than 12% fines)

Well Graded - all particle sizes are present, less than 12% fines

Poorly Graded - most particles are about the same size or missing 1 or 2 sizes, 12% fines

FINE - GRAINED SOILS			
Fine-Grained Soils	Silts and Clays Liquid Limit < 50	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
		OL	*Organic* silts and organic silt- clays of low plasticity
	Silts and Clays Liquid Limits $\geq$ 50	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
		CH	Inorganic clays of high plasticity, fat clays
		OH	*Organic* clays of medium to high plasticity, organic silts
Highly *Organic* Soils		Pt	Peat and other highly organic soils

ROCK DESCRIPTIVE TERMS

Term		Defining Characteristics	
Hardness	Soft	Scratched by fingernail	
	Moderately Hard	Scratched easily by penknife	
	Hard	Difficult to scratch with a penknife	
	Very Hard	Cannot be scratched by penknife	
Weathering	Unweathered	Rock is unstained. May be fractured, but discontinuities are not stained.	
	Slighty	Rock is unstained. Discontinuities show some staining on the surfaces of rocks, but discoloration does not penetrate rock mass.	
	Moderate	Discontinuity surfaces are stained. Discoloration may extend into rock along discontinuity surfaces.	
	High	Individual rock fragments are thoroughly stained and may be crumbly.	
	Severe	Rock appears to consist of gravel-sized fragments in a "soil" matrix. Individual fragments are thoroughly discolored and can be broken with fingers.	
Bedding Planes	Laminated	< .04 in.	< 1 mm
	Parting	.04 in. - .24 in.	1mm - 6mm
	Banded	.24 in. - 1in.	6 mm - 3 cm
	Thin	1 in. - 4 in.	3 cm - 9.1 cm
	Medium	4 in. - 12 in.	9.1 cm - 30.5 cm
	Thick	12 in.- 36 in.	30.5 cm - 1m
	Massive	> 36 in.	> 1 m
Joints and Fracture Spacing	Very tight	< 2 in.	< 5.1 cm
	Tight	2 in. - 1ft.	5.1 - 30.5 cm
	Moderately tight	1ft. - 3 ft.	30.5 cm - 91.4 cm
	Wide	3 ft. - 10 ft.	91.4 cm - 3 M
	Very wide	> 10 ft.	> 3 M
Voids	Porous	Smaller than a pinhead. Their presence is indicated by the degree of absorbency.	
	Pitted	Pinhead size to a 1/4 inch. If only thin walls separate the individual pits, the core may be described as honeycombed.	
	Vug	1/4 inch to the diameter of the core. The upper limit will vary with core size.	
	Cavity	Larger than the diameter of the core.	

Rock Particle Percent Composition Estimation

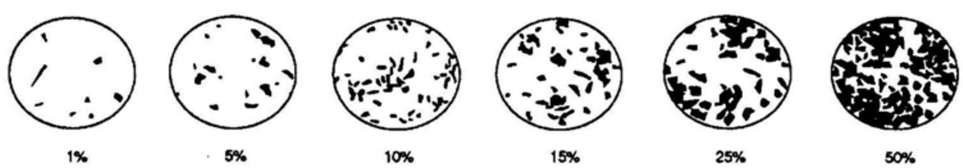


Figure 3 Rock Descriptive Terms

Appendix C.
Hanby Soil Test Kit Manual

Hanby Environmental

"For Accurate Field Analysis."

HIGH RANGE (%)

SOIL KIT
INSTRUCTIONS & CALIBRATION
PHOTOBOOK

2019

Table of Contents

Included in your Soil Test Kit:

15 Ampoules Extraction Reagent
15 Vials of Color Development Reagent
15 Screw Top Test Tubes w/ Scribed Measurement
6 Screw Top Test Tubes
1 Wooden Test Tube Rack
1 Soil Color Calibration Photobook (located behind top foam of Kit)
6 Beakers
1 Electronic Balance
1 Waste Bottle & Box (located behind top foam of Kit)
1 Graduated Cylinder
3 Pairs of Safety Gloves
1 Pair of Safety Glasses
1 MSDS Safety Instruction(located behind top foam of Kit)
1 Soil Kit Instruction
1 Instructional Video
1 Case with Foam Inserts

One order of Refills includes:

15 Ampoules Extraction Reagent
15 Vials of Color Development Reagent
15 Screw Top Test Tubes w/ Scribed Measurement
1 Waste Bottle
3 Pairs of Safety Gloves

A Note about Soil Sampling

Soils are heterogeneous. That is, they are composed of different substances that vary widely in composition, density, and absorptive properties. To simplify matters, we will describe only three soil types: sand, sandy loam, and clay. Typically, you will be using Hanby Soil Kit to rapidly check several samples to determine their contamination level. Here are a few guidelines from users of our kits for over 33 years that can assist you in using the kit to best accomplish your field tasks.

1. In general, a looser (less dense) soil, such as sand, or sandy loam, will absorb more liquid (petroleum or water) than compact clay.
2. Humic soils are usually very absorbent. These soils are typically dark and loose. Typically you should select these materials in a sample when you are trying to determine “worst case” (highest concentration of TPH) in your sample. Conversely, clays, which are typically light colored, compact and “gummy” show low TPH.
3. Visually inspect several samples before you take time to analyze them with the kit.
4. Remember that in most cases you want to “screen” a site for the highest level of contaminant present.

Following these guidelines will help insure that your field tested samples will not be “false negatives” in comparison to the follow up samples you send to a lab for confirmations.

Hanby Environmental

"For Accurate Field Analysis."

Hanby

COLORIMETRIC

Field Test Kit for TPH

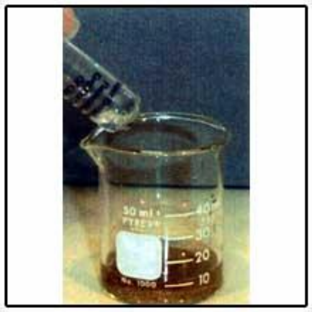
HIGH RANGE SOIL

KIT INSTRUCTIONS

Six easy steps to Screening TPH's in Soil

Rapid, sensitive, positive detection of petroleum in solid samples

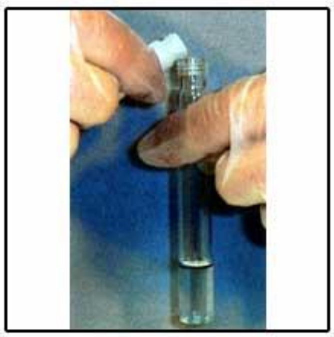
1. Weigh sample into tared beaker
(5 grams of soil)



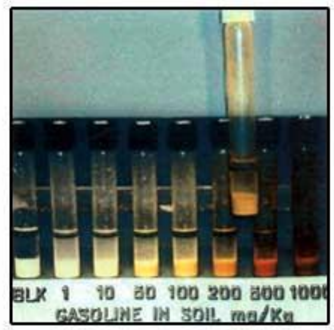
2. Snap ampoule, add solvent

3. Stir. Mix well

4. Pour solvent into test tube.



5. Add catalyst, cap, shake.



6. Compare with standard photo.

Hanby Method publications of the U.S. EPA: "Field Methods: Dependable Data When You Need It" , Sept., '90 Subsurface Characterization and Monitoring Techniques", May, '93; S.I.T.E. Evaluation Program, Dec '96; "Expedited Site Assessment Tools for Underground Storage Tank Sites", March '97

Colorado Oil and Gas Commission , **Soil Analysis Report Form #24**, Rev. 3/03

Hanby
Environmental, LLC

Hanby Soil Test Kit Instructions

CAUTION: Wear safety glasses and gloves, avoid fumes.
Keep work area clean and well ventilated. Safety First!

Introduction

The accurate determination of petroleum substances in soils requires that analysis be performed as rapidly and efficiently as possible. Hanby Kits are designed to meet this important objective. Please familiarize yourself with this Field Test Kit and its procedures. Watch the video instructions, observe all cautions concerning the chemical reagents, and set up your kit on a stable surface, in a open ventilated area.

Soil Procedure

1. Place one of the beakers on the balance and turn it on. It automatically zeros.
2. Add 5 grams of soil sample to the beaker with your spatula spoon.
3. Remove one of the soil extraction ampoules from the foam block, hold it firmly on a flat surface and snap off the top. Avoid the sharp glass edges! Empty the ampoule into the beaker. **Avoid solvent fumes!**
4. Chop the sample with the spatula and stir it in the solvent for one minute. If the soil is a clay it will be necessary to 'smear' the soil under the solvent to insure extraction.
5. Remove one of the test tubes from the foam. Carefully pour the solvent from the beaker into the test tube up to the marked line.
6. Take one of the Color Development Vials out of the jar, remove the cap, and carefully empty all the white powder into the test tube. **Avoid contact with the powder on skin, eyes and water!**
7. Firmly screw the cap on the test tube and vigorously shake the tube for 15 seconds. Over the next 2 minutes, periodically shake the tube for 5 seconds.
8. Compare the color of the solid material in the bottom with the appropriate calibration photograph in your High Range RULE 91 photobook. As soon as you have finished the test, record your results.
9. **Important!** Empty the liquid from the test tube into the waste bottle, **DO NOT POUR THE COLORED MATERIAL INTO THE BOTTLE**. This remains in the bottom of the test tube. Put the used test tube back in the foam block foam for later disposal according to MSDS instructions. Do not leave solvent in used test tube. **CAREFUL! The waste bottle builds up fumes…hold it away from eyes and breathing zone when opening it!**

PLEASE DISPOSE OF WASTE PROPERY ACCORDING TO MSDS INSTRUCTIONS.

HANBY CAN NO LONGER ACCEPT WASTE BOTTLES.

Hanby Environmental

"For Accurate Field Analysis."

Hanby

COLORIMETRIC

Field Test Kit for TPH

SOIL

KIT INSTRUCTIONS

Soil Analysis Dilution Procedure

After performing a standard analysis, if the result is very dark to black, putting the results out of the range of the calibration scale, then the following steps should be performed:

Using the 10 ml graduated cylinder included in the kit, you would put 1 ml of the extract solvent that still remians in the beaker from the original extraction into the graduated cylinder.

Then open a new ampoule and fill to the 10 ml mark on the graduated cylinder which adds 9 of the 10 mls from the new ampoule.

Put your thumb over the end of the graduated cylinder and turn upside down and right side up 2-3 times (this makes sure that the solvent is fully introduced through the original extract).

Then pour from this graduated cylinder into a new test tube up to the line as the standard process.

Then continue with the standard process by adding a new CDR catalyst vial and shaking the test tube.

Then compare the result to the color calibration photo standard. Once the reading is obtained, you add a "0" to the end which is multiplying by the factor of 10 from the 10 to 1 dilution performed.

If you believe that a 10 to 1 dilution is not necessary and may be too far of a dilution, a 5 to 1 dilution can be performed by doing the same process, only multiplying the result reading by 5 instead of 10.

Hanby Environmental

"For Accurate Field Analysis."

SOIL

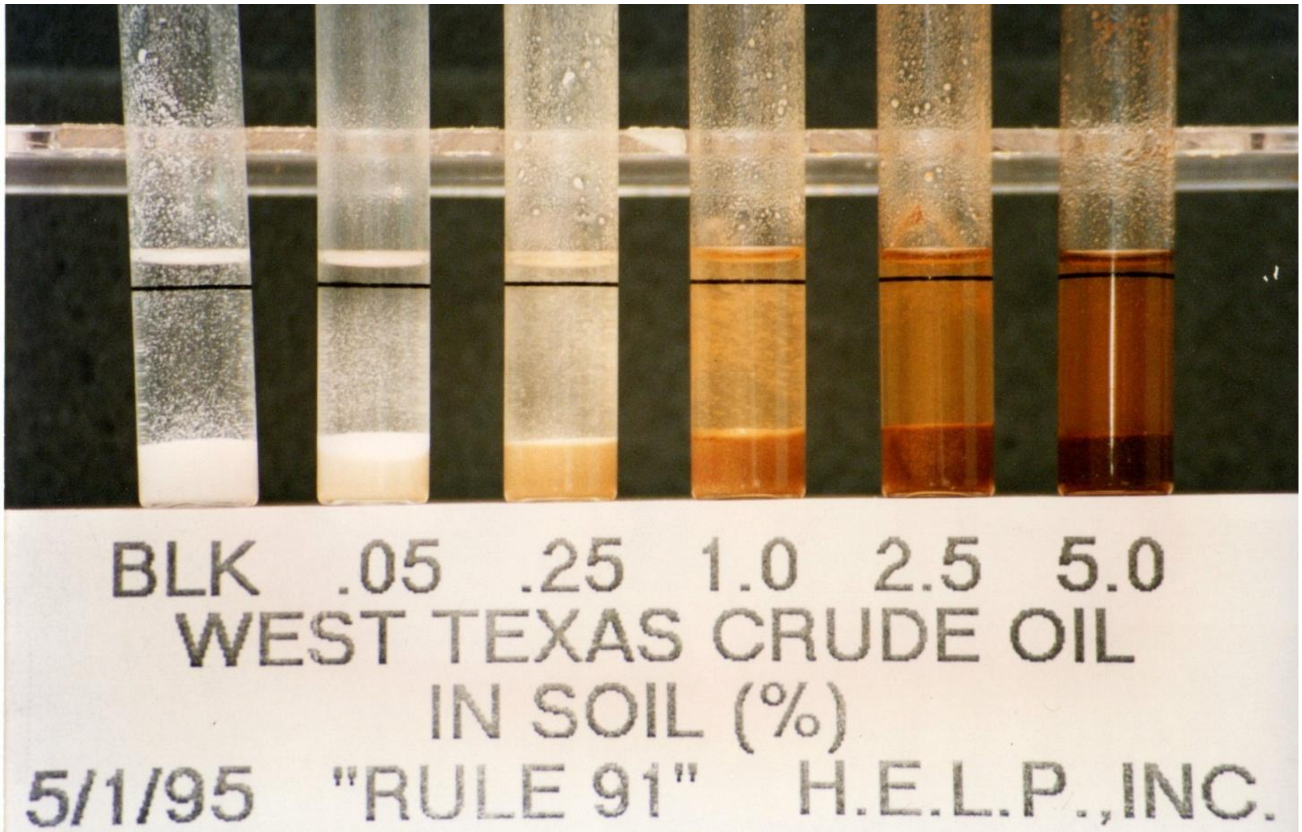
Calibration Photobook

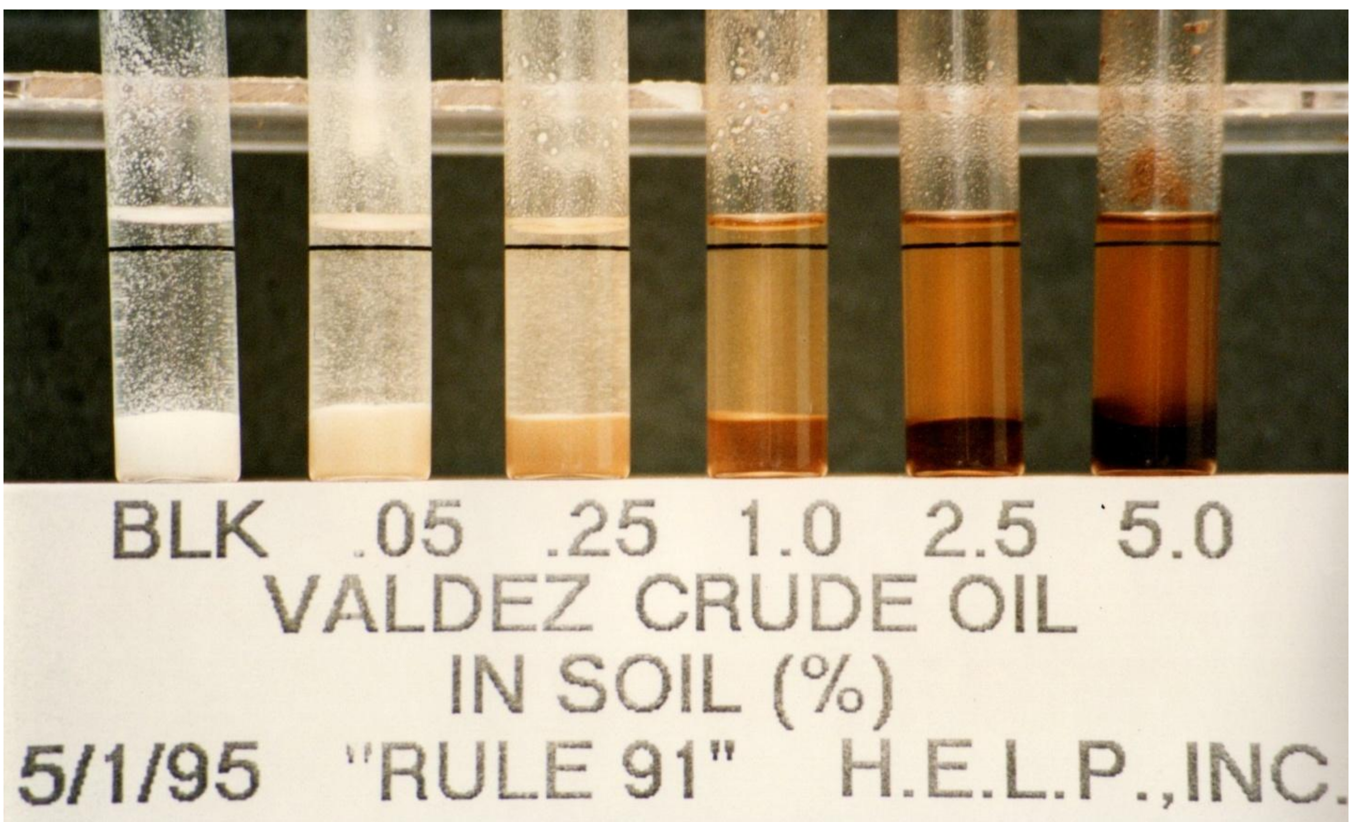
HIGH RANGE (%)

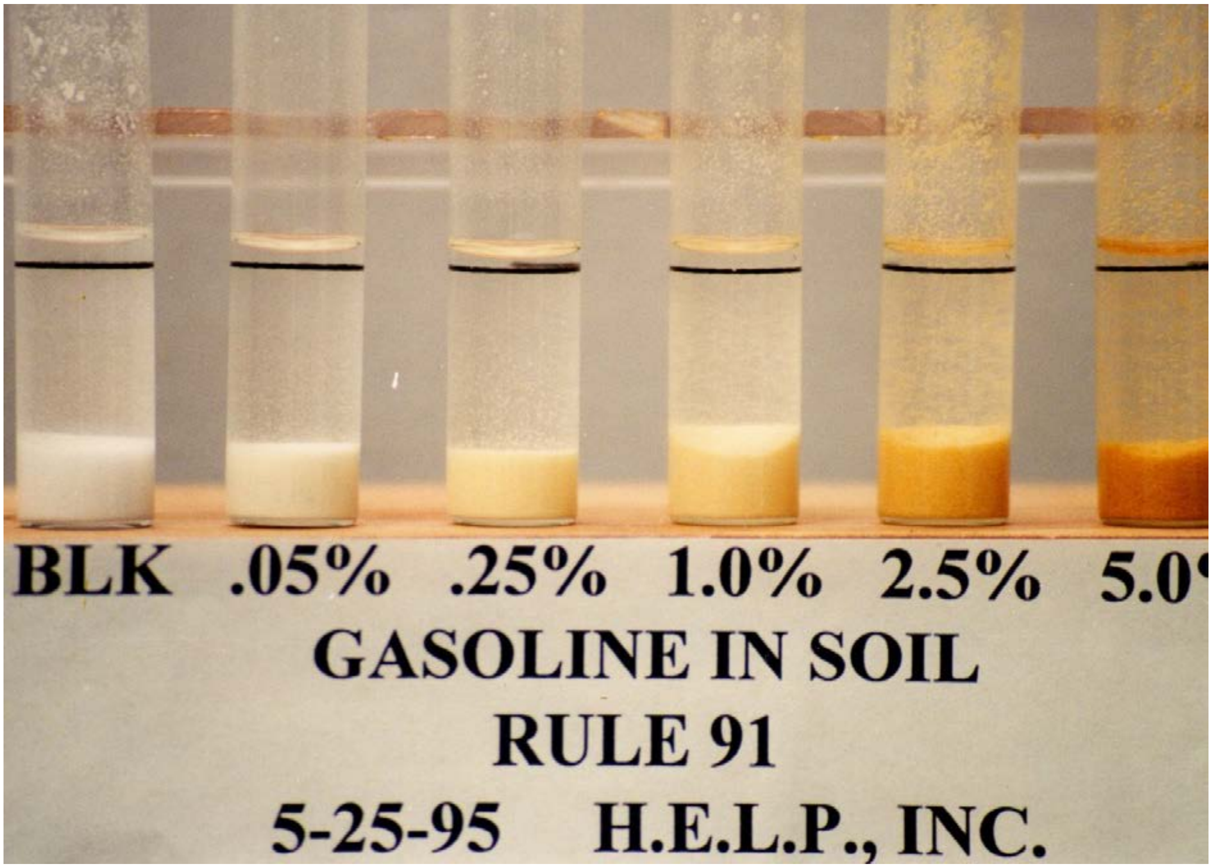
RRC ("Rule 91") Photo Standards

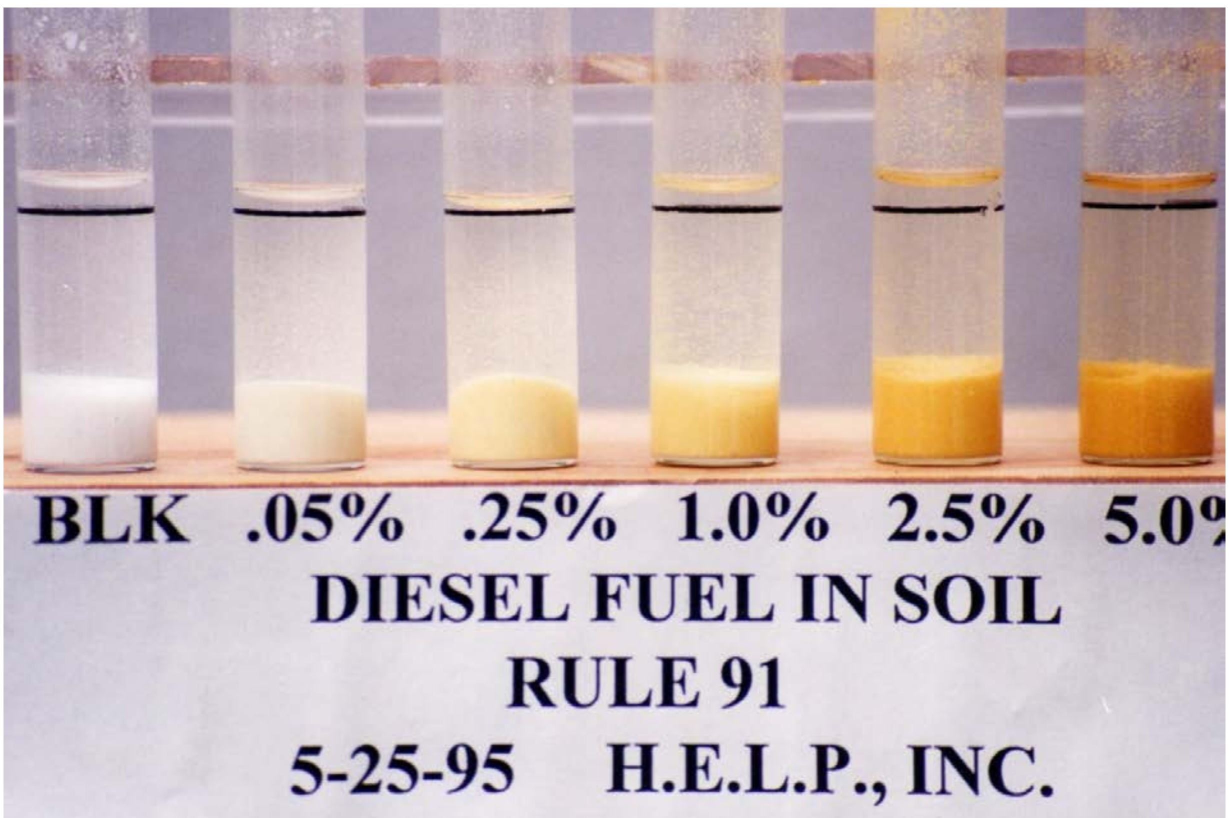
These calibration photographs for the Hanby test Kit "High Range" Standards are based on the Texas Rail Road Commission's cleanup regulations pertaining to oil field spills from wells, pipelines, tank cars, etc. Except for the condensate photo (19Z-34B) they are in "weight percent" (grams/hundred grams). The conversion factor for weight percent to parts-per-million is 10,000. For instance, 1.0% = 10,000 PPM.

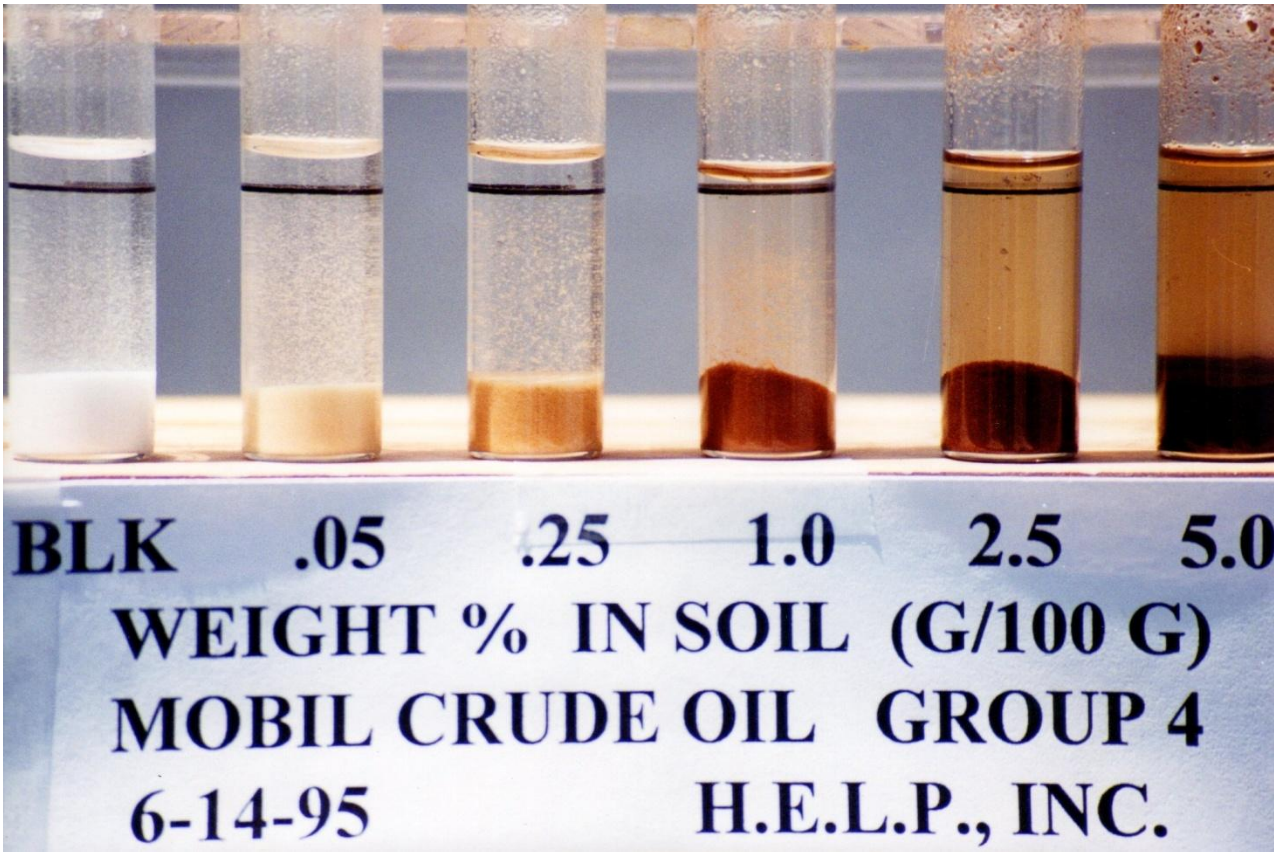
These calibration standards are for a range of substances including: gasoline, diesel, (4) crude oils, and a condensate in the range of 500PPM (.05%) to 100,000 PPM (10%).

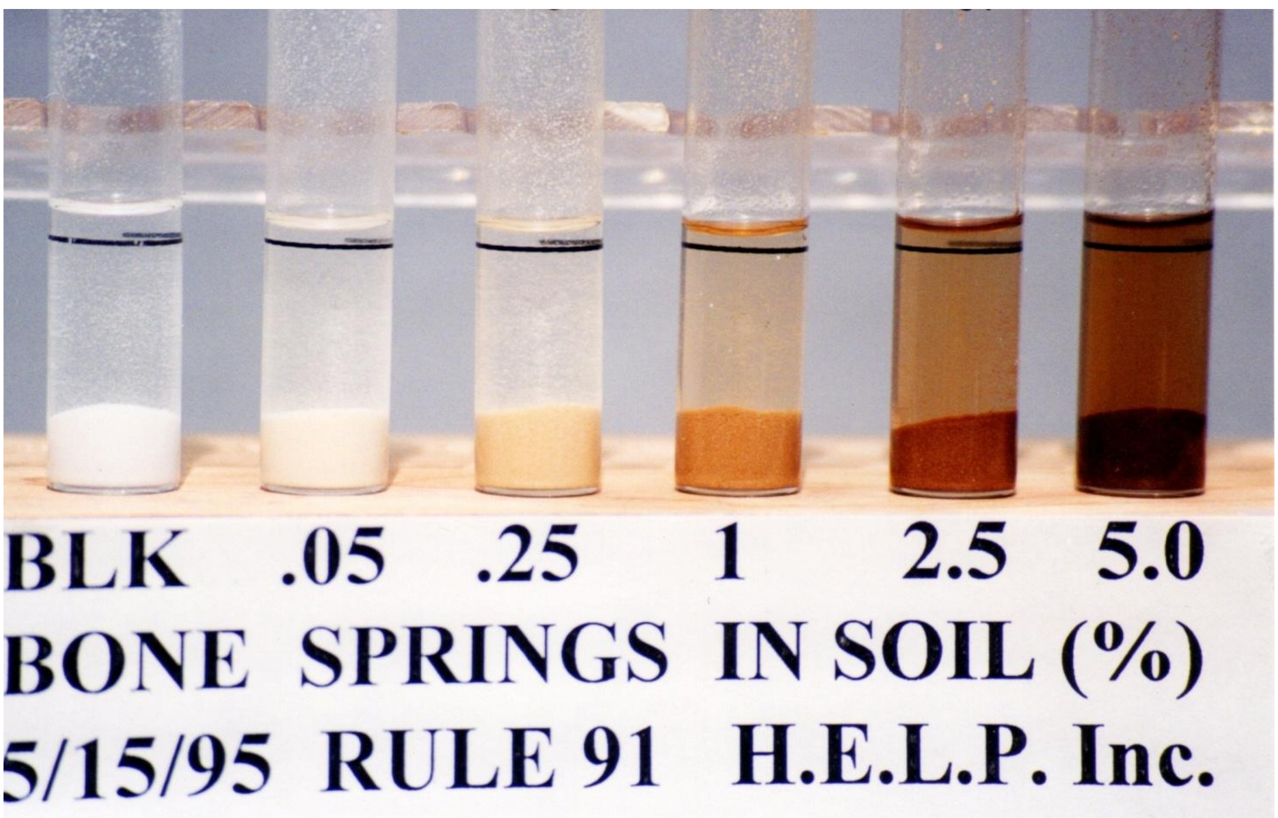

BLK .05 .25 1.0 2.5 5.0
WEST TEXAS CRUDE OIL
IN SOIL (%)
5/1/95 "RULE 91" H.E.L.P.,INC.

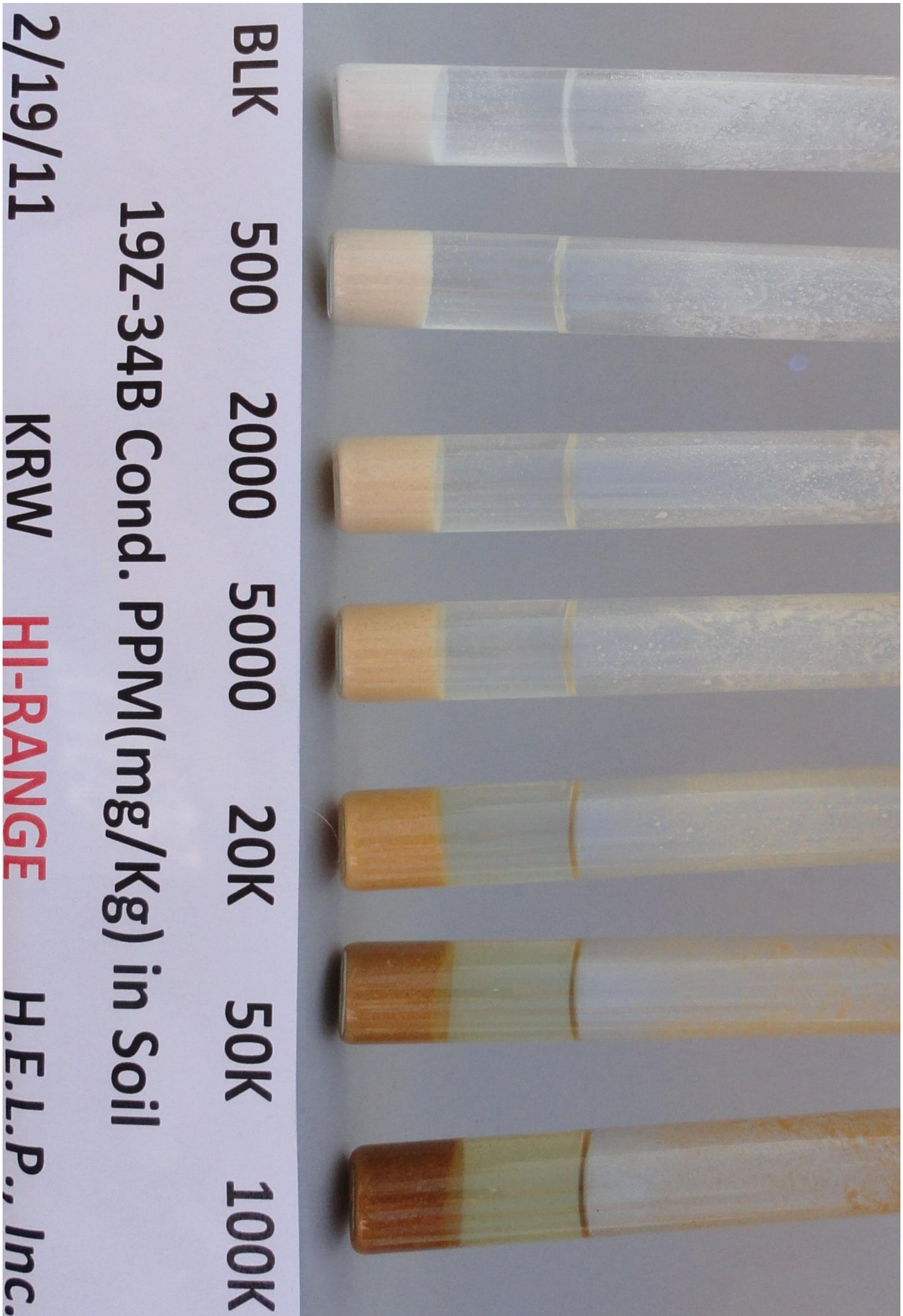

BLK .05 .25 1.0 2.5 5.0
VALDEZ CRUDE OIL
IN SOIL (%)
5/1/95 "RULE 91" H.E.L.P.,INC.


BLK .05% .25% 1.0% 2.5% 5.0
GASOLINE IN SOIL
RULE 91
5-25-95 H.E.L.P., INC.

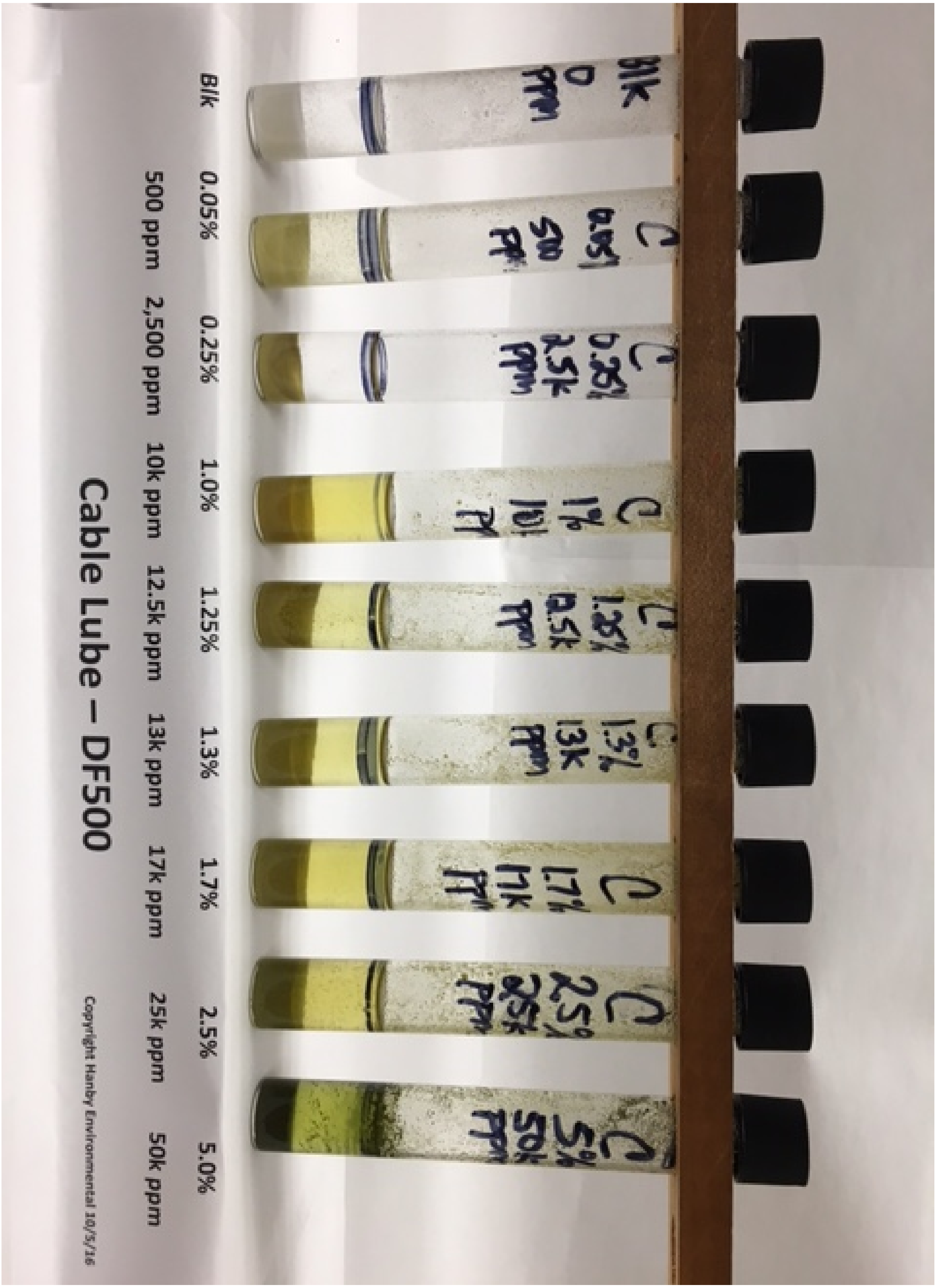

BLK .05% .25% 1.0% 2.5% 5.0
DIESEL FUEL IN SOIL
RULE 91
5-25-95 H.E.L.P., INC.


BLK .05 .25 1.0 2.5 5.0
WEIGHT % IN SOIL (G/100 G)
MOBIL CRUDE OIL GROUP 4
6-14-95 H.E.L.P., INC.


BLK .05 .25 1 2.5 5.0
BONE SPRINGS IN SOIL (%)
5/15/95 RULE 91 H.E.L.P. Inc.

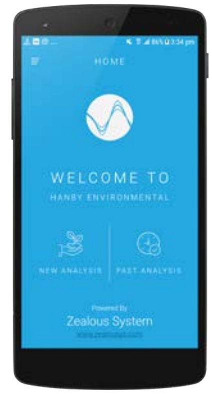

BLK
500
2000
5000
20K
50K
100K
19Z-34B Cond. PPM(mg/Kg) in Soil
2/19/11
KRW
HI-RANGE
H.E.L.P., Inc.


Blk
0.05%
500 ppm
0.25%
2,500 ppm
1.0%
10k ppm
1.25%
12.5k ppm
1.3%
13k ppm
1.7%
17k ppm
2.5%
25k ppm
5.0%
50k ppm
Feeder Oil - DF100
Copyright Hanby Environmental 9/30/16


Blk
0.05% 500 ppm
0.25% 2,500 ppm
1.0% 10k ppm
1.25% 12.5k ppm
1.3% 13k ppm
1.7% 17k ppm
2.5% 25k ppm
5.0% 50k ppm
Cable Lube – DF500
Copyright Hanby Environmental 10/5/16

Please Make Sure To Review Our Instructional Video
Found On YouTube at:
https://youtu.be/sD3tU_ni5Gs

Please Make Sure To Obtain Our Hanby Mobile Application at:
www.HanbyMobileApp.com
and Review The Walk-thru YouTube Video
at The Bottom of The Page or at
https://youtu.be/i2dyMhup9E4



Download on the App Store

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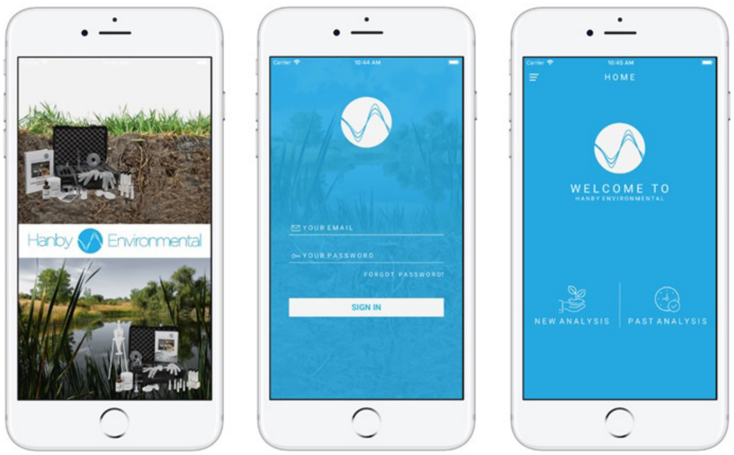

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Appendix D.
Data Validation Checklists

Site: | **Case No:** | **Laboratory:**
Project: | **Sample Matrix:** | **Analyses:**
Sample Date(s): | **Analysis Date(s):**
Data Validator: | **Validation Date(s):**

1. Holding Times

Analyte	Laboratory	Matrix	Method	Holding Times	Collection Date(s):	Analysis Date(s)	Holding Time Met (Y/N)	Affected Data Flagged (Y/N)

Were any data flagged because of holding time? Y ☐ N ☐
Were any data flagged because of preservation problems? Y ☐ N ☐

Describe Any Actions Taken:

Comments:

2. Blanks

Were Method Blanks (MBs) analyzed at the frequency of 1 per analytical batch? Y ☐ N ☐
Were MBs within the control window? Y ☐ N ☐
Were any data flagged because of blank problems? Y ☐ N ☐

Describe Any Actions Taken:

Comments:

3. Laboratory Control Samples

Were Laboratory Control Samples (LCS) analyzed at the frequency of 1 per batch? Y ☐ N ☐
Were LCS results within the control window? Y ☐ N ☐
Were any data flagged because of LCS problems? Y ☐ N ☐

Describe Any Actions Taken:

Comments:

4. Duplicate Sample Results

Were Laboratory Duplicate Samples (LDS) analyzed at the frequency of 1 per batch? Y ☐ N ☐
Were LDS results within the control window? Y ☐ N ☐
Were any data flagged because of LDS problems? Y ☐ N ☐

Describe Any Actions Taken:

Comments:

5. Matrix Spike Sample Results

Were Laboratory Matrix Spike Samples (LMS) analyzed at the frequency of 1 per batch? Y ☐ N ☐
Were LMS results within the control window? Y ☐ N ☐
Were any data flagged because of LMS problems? Y ☐ N ☐

Describe Any Actions Taken:

Comments:

6. Field Blanks

Were field blanks submitted as specified in the Sampling Analysis Plan (SAP)?	Y ☐	N ☐	N/A ☐
Were field blanks within the control window?	Y ☐	N ☐	N/A ☐
Were any data qualified because of field blank problems?	Y ☐	N ☐	N/A ☐

Describe Any Actions Taken:

Comments:

7. Field Duplicates

Were field duplicates submitted as specified in the Sampling Analysis Plan (SAP)?	Y ☐	N ☐	N/A ☐
Were results for field duplicates within the control window?	Y ☐	N ☐	N/A ☐
Were any data qualified because of field duplicate problems?	Y ☐	N ☐	N/A ☐

Describe Any Actions Taken:

Comments:

8. Overall Assessment

Are there analytical limitations of the data that users should be aware of?	Y ☐	N ☐

If so, explain:

Comments:

9. Authorization of Data Validation

	Data Validator	Reviewed by:
Name:		
Signature:	____________________	____________________
Date:	____________________	____________________

Site:
Project:
Sample Date(s):
Data Validator:
Case No:
Sample Matrix:
Analysis Date(s):
Validation Date(s):
Laboratory:
Analyses:

1. Holding Times

Analyte	Laboratory	Matrix	Method	Holding Times	Collection Date(s):	Analysis Date(s)	Holding Time Met (Y/N)	Affected Data Flagged (Y/N)

Were any data flagged because of holding time? Y ☐ N ☐
Were any data flagged because of preservation problems? Y ☐ N ☐

Describe Any Actions Taken:

Comments:

2. Blanks

Were Method Blanks (MBs) analyzed at the frequency of 1 per analytical batch? Y ☐ N ☐
Were MBs within the control window? Y ☐ N ☐
Were any data flagged because of blank problems? Y ☐ N ☐

Describe Any Actions Taken:

Comments:

3. Laboratory Control Samples

Were Laboratory Control Samples (LCS) analyzed at the frequency of 1 per batch? Y ☐ N ☐
Were LCS results within the control window? Y ☐ N ☐
Were any data flagged because of LCS problems? Y ☐ N ☐

Describe Any Actions Taken:

Comments:

4. Duplicate Sample Results

Were Laboratory Duplicate Samples (LDS) analyzed at the frequency of 1 per batch? Y ☐ N ☐
Were LDS results within the control window? Y ☐ N ☐
Were any data flagged because of LDS problems? Y ☐ N ☐

Describe Any Actions Taken: None required

Comments:

5. Matrix Spike Sample Results

Were Laboratory Matrix Spike Samples (LMS) analyzed at the frequency of 1 per batch? Y ☐ N ☐
Were LMS results within the control window? Y ☐ N ☐
Were any data flagged because of LMS problems? Y ☐ N ☐

Describe Any Actions Taken: None required

Comments:

6. Field Blanks

Were field blanks submitted as specified in the Sampling Analysis Plan (SAP)?	Y ☐	N ☐	N/A ☐
Were field blanks within the control window?	Y ☐	N ☐	N/A ☐
Were any data qualified because of field blank problems?	Y ☐	N ☐	N/A ☐

Describe Any Actions Taken:

Comments:

7. Field Duplicates

Were field duplicates submitted as specified in the Sampling Analysis Plan (SAP)?	Y ☐	N ☐	N/A ☐
Were results for field duplicates within the control window?	Y ☐	N ☐	N/A ☐
Were any data qualified because of field duplicate problems?	Y ☐	N ☐	N/A ☐

Describe Any Actions Taken:

Comments:

8. Overall Assessment

Are there analytical limitations of the data that users should be aware of? Y ☐ N ☐

If so, explain:

Comments:

9. Authorization of Data Validation

Data Validator		
Name:		**Reviewed by:**
Signature:	______________________	______________________
Date:	______________________	______________________

Data Validation Checklist for Organics (GC) Sample Analysis

Site:
Project:
Sample Date(s):
Data Validator:

Case No:
Sample Matrix:
Analysis Date(s):
Validation Date(s):

Laboratory:
Analyses:

1. Holding Times

Analyte	Laboratory	Matrix	Method	Holding Times	Collection Date	Prep Date	Analysis Date(s)	Holding Time Met (Y/N)	Affected Data Flagged (Y/N)

Were any data flagged because of holding time? Y ☐ N ☐
Were any data flagged because of preservation problems? Y ☐ N ☐

Describe Any Actions Taken:

Comments:

2. Blanks

Were Method Blanks (MBs) analyzed at the frequency of 1 per analytical batch? Y ☐ N ☐
Were MBs within the control window? Y ☐ N ☐
Were any data flagged because of blank problems? Y ☐ N ☐

Describe Any Actions Taken:

Comments:

3. Surrogates

Were surrogates present in all extracted samples (including QC)? Y ☐ N ☐
Were surrogate recoveries within the control window? Y ☐ N ☐
Were any data flagged because of surrogate problems? Y ☐ N ☐

Describe Any Actions Take:

Comments:

4. Laboratory Control Samples

Were Laboratory Control Samples (LCS) analyzed at the frequency of 1 per batch? Y ☐ N ☐
What was the source of the LCS? Unknown
Were LCS results within the control window? Y ☐ N ☐
Were any data flagged because of LCS problems? Y ☐ N ☐

Describe Any Actions Taken:

Comments:

5. Duplicate Sample Results

Were Laboratory Duplicate Samples (LDS) analyzed at the frequency of 1 per batch? Y ☐ N ☐
Were LDS results within the control window? Y ☐ N ☐
Were any data flagged because of LDS problems? Y ☐ N ☐

Describe Any Actions Taken:

Comments:

6. Matrix Spike Sample Results

Were Laboratory Matrix Spike Samples (LMS) analyzed at the frequency of 1 per batch?	Y		N	
Were LMS % Recovery (%R) results within the control window?	Y		N	
Were any data flagged because of LMS problems?	Y		N	

Describe Any Actions Taken:

Comments:

7. Field Blanks

Were field blanks submitted as specified in the Sampling Analysis Plan (SAP)?	Y		N			
Were field blanks within the control window?	Y		N		N/A	
Were any data qualified because of field blank problems?	Y		N		N/A	

Describe Any Actions Taken:

Comments:

8. Field Duplicates

Were field duplicates submitted as specified in the Sampling Analysis Plan (SAP)?	Y	X	N			
Were the field duplicates within the control window?	Y		N		N/A	
Were any data qualified because of field duplicate problems?	Y		N		N/A	

Describe Any Actions Taken: None required

Comments:

9. Overall Assessment

Are there analytical limitations of the data that users should be aware of?	Y		N	

If so, explain:

Comments:

10. Authorization of Data Validation

Data Validator
Name: **Reviewed by:**

Signature: ______________________________

Date: ______________ ______________________________

Site:
Project:
Sample Date(s):
Data Validator:

Case No:
Sample Matrix:
Analysis Date(s):
Validation Date(s):

Laboratory:
Analyses:

1. Holding Times

Analyte	Laboratory	Matrix	Method	Holding Times	Collection Date	Prep Date	Analysis Date(s)	Holding Time Met (Y/N)	Affected Data Flagged (Y/N)

Were any data flagged because of holding time? Y ☐ N ☐
Were any data flagged because of preservation problems? Y ☐ N ☐

Describe Any Actions Taken:

Comments:

2. Blanks

Were Method Blanks (MBs) analyzed at the frequency of 1 per analytical batch? Y ☐ N ☐
Were MBs within the control window? Y ☐ N ☐
Were any data flagged because of blank problems? Y ☐ N ☐

Describe Any Actions Taken:

Comments:

3. Surrogates

Were surrogates present in all extracted samples (including QC)? Y ☐ N ☐
Were surrogate recoveries within the control window? Y ☐ N ☐
Were any data flagged because of surrogate problems? Y ☐ N ☐

Describe Any Actions Take:

Comments:

4. Laboratory Control Samples

Were Laboratory Control Samples (LCS) analyzed at the frequency of 1 per batch? Y ☐ N ☐
What was the source of the LCS? Unknown
Were LCS results within the control window? Y ☐ N ☐
Were any data flagged because of LCS problems? Y ☐ N ☐

Describe Any Actions Taken:

Comments:

5. Duplicate Sample Results

Were Laboratory Duplicate Samples (LDS) analyzed at the frequency of 1 per batch? Y ☐ N ☐
Were LDS results within the control window? Y ☐ N ☐
Were any data flagged because of LDS problems? Y ☐ N ☐

Describe Any Actions Taken:

Comments:

6. Matrix Spike Sample Results

Were Laboratory Matrix Spike Samples (LMS) analyzed at the frequency of 1 per batch?	Y		N			
Were LMS % Recovery (%R) results within the control window?	Y		N			
Were any data flagged because of LMS problems?	Y		N			

Describe Any Actions Taken:

Comments:

7. Field Blanks

Were field blanks submitted as specified in the Sampling Analysis Plan (SAP)?	Y		N			
Were field blanks within the control window?	Y		N		N/A	
Were any data qualified because of field blank problems?	Y		N		N/A	

Describe Any Actions
Taken:

Comments:

8. Field Duplicates

Were field duplicates submitted as specified in the Sampling Analysis Plan (SAP)?	Y	X	N			
Were the field duplicates within the control window?	Y		N		N/A	
Were any data qualified because of field duplicate problems?	Y		N		N/A	

Describe Any Actions Taken: None required

Comments:

9. Overall Assessment

Are there analytical limitations of the data that users should be aware of?	Y		N	

If so, explain:

Comments:

10. Authorization of Data Validation

Data Validator
Name: **Reviewed by:**

Signature: ____

Date: ____________________ ____

Appendix E.
Corrective Action Report

Corrective Action Report/ Corrective Action Plan

Project ID	Project Name	Document ID

Preparer's Signature/Submit Date	Submitted to:

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

Corrective Action Report/
Corrective Action Plan

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