Atlantic Richfield Company

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July 5, 2022

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RE: Final Blacktail Creek Pumping Test Quality Assurance Project Plan (QAPP)

Agency Representatives:

I am writing you on behalf of Atlantic Richfield Company (Atlantic Richfield) to submit the Final *Blacktail Creek Remediation and Contaminated Groundwater Hydraulic Control Site Pumping Test Quality Assurance Project Plan* (Blacktail Creek Pumping Test QAPP) for your review and approval. Included with the Blacktail Creek Pumping Test QAPP are Atlantic Richfield's response to Agency comments received on January 11, 2022.

The Blacktail Creek Pumping Test QAPP includes the *Blacktail Creek Remediation and Contaminated Groundwater Hydraulic Control Site Piezometer Installation and Monitoring Well Repair Plan* (Blacktail Creek Piezometer Installation and Monitoring Well Repair Plan) in Appendix B. The Blacktail Creek Piezometer Installation and Monitoring Well Repair Plan includes Atlantic Richfield's response to Agency comments provided in the June 28, 2022, letter Re: *Approval on the Draft Butte Priority Soils Operable Unit (BPSOU) Blacktail Creek Piezometer Installation and Monitoring Well Repair Plan (dated June 10, 2022)*.

Fieldwork described herein will begin once Agency approval has been received. A proposed schedule is included in the QAPP. To meet the proposed schedule, Atlantic Richfield is respectfully requesting that Agencies please review the QAPP and provide approval or comments by August 5, 2022.

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The report may be downloaded at the following link:

https://pioneertechnicalservices.sharepoint.com/:f:/s/submitted/EqX5ZL0ztTBBjJyqp2KbvLcBAQJdM14rSdz0S63285cDFA.

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

Sincerely,

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

Cc: Patricia Gallery / Atlantic Richfield - email
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SILVER BOW CREEK/BUTTE AREA NPL SITE
BUTTE PRIORITY SOILS OPERABLE UNIT

2022

Final

Blacktail Creek Remediation and Contaminated Groundwater Hydraulic Control Site

Pumping Test Quality Assurance Project Plan (QAPP)

July 2022

Response to Agency Comments to the
Butte Priority Soils Operable Unit (BPSOU) Blacktail Creek Remediation and Contaminated Groundwater Hydraulic Control Site Pumping Test Quality Assurance Project Plan
Prepared for Atlantic Richfield Company
By Pioneer Technical Services, Inc.
Dated October 20, 2021
Date of Comments: January 11, 2022

General Comments

EPA General Comment 1: [Note responses were divided into 5 parts to facilitate addressing the different components of this comment].

> **EPA General Comment 1a:** *The DQOs table conforms to the EPA guidance quite well and does a nice job of summarizing the objectives of the study, analyses to be conducted, field work, and data quality.*

Atlantic Richfield Company Response: Comment noted.

> **EPA General Comment 1b:** *One of the goals of the study is to collect the data necessary to design an extraction system to control discharge of contaminated groundwater to surface water. Presumably, the goal of the hydraulic control system is to extract enough water to reverse the gradient and convert this section of BTC from gaining to losing or prevent impacted groundwater discharge from the right bank. As a practical means of doing so, the water level in the observation wells next to BTC would need to be lower than the water level of the BTC surface water. Therefore, it would seem useful to install an instrumented stilling well in BTC within the pumping test area.*

Atlantic Richfield Company Response: While measurement of hydraulic gradients is expected to be part of groundwater control monitoring (and it is agreed that stilling wells will be useful to evaluate groundwater and surface water interaction), Atlantic Richfield Company (Atlantic Richfield) would like to clarify the goals of the groundwater control system. Gradient reversal along the extent of additional groundwater control shown in the BPSOU Consent Decree Figure BTC-1 is not a required component of the groundwater control. The goal for the control of contaminated groundwater in this Blacktail Creek (BTC) area is to reduce ongoing and potential future groundwater loading of contaminants of concern (COCs) to sediments and surface water as described in the Surface Water Management Plan (SWMP) and the Further Remedial Elements Scope of Work (FRESOW). The objective is to control discharge of contaminated groundwater to prevent exceedances of water quality Performance Standards in surface water at monitoring stations SS-06G and SS-07 and to limit loading of COCs to sediments within the BPSOU. To accomplish this objective, it may not be necessary to reverse the gradient in the BTC area as suggested in the Agency comment. The FRESOW states that an initial 100 gallons per minute of contaminated groundwater will be collected by the groundwater control and that the extent and quantity of groundwater capture will be evaluated as part of the BTC Pre-Design Investigation Evaluation Report. Further, the performance of the groundwater control system may be optimized following construction to meet the objective of controlling discharge of contaminated groundwater to this area of BTC, to the extent necessary, to limit loading of COCs to sediments and to meet water quality Performance Standards at SS-06G and SS-07.

The following BTC monitoring stations have been added to the BTC Pumping Test monitoring network and will be used in conjunction with groundwater monitoring points near BTC to estimate aquifer connectivity to surface water: SS-01.6, BWE-1, BWE-2, BWE-3, BWE-4, and SS-04. These stations are currently equipped with a staff gage, stilling well, and a Solinst pressure transducer and were installed in 2019 as part of the Butte Mine Flooding Operable Unit (BMFOU) monitoring network as described in *Berkeley Pit and Discharge Pilot Project Field Sampling Plan Revision 0*.

> **EPA General Comment 1c:** *Note that the proposed loading analysis may underpredict the effectiveness of the hydraulic controls. The Groundwater/Surface Water Interaction Report showed that SBC/BTC sediments contain secondary copper and zinc minerals that control aqueous concentrations of copper and zinc within the pore water. The effect of removing the groundwater source on BTC loading may not be fully realized until after the secondary solids dissolve or after the impacted sediment is removed during RA. Therefore, a direct measure of the water levels in the near-creek wells and in BTC is needed. A direct measure of water elevations in BTC will also help account for any changes caused by varying discharge rates from the Pilot Project.*

Atlantic Richfield Company Response: As described in response to EPA General Comment 1b, additional stilling well/transducer monitoring stations have been added to the BTC Pumping Test monitoring network to provide a direct measure of the water levels in BTC and near-creek wells. In addition, paired Natural Resources Damage Program (NRDP) wells, PMP-11A/B have been added to the monitoring network to provide hydrologic information in the area between BTC-PW-01 and BTC as described in response to EPA Specific Comment 5.

Atlantic Richfield agrees that the loading analysis proposed as part of the BTC pumping test may not be effective in evaluating groundwater control within BTC. As noted in additional Agency comments, the proposed loading analysis may be limited by the following:

1. The presence of impacted sediment in wetland surface water and BTC channel (which will be removed during remedial action [RA], but not prior to conducting the BTC pumping test) may affect metals loading concentrations to a greater degree than removing groundwater loading sources (EPA General Comment 1c and 1d);
2. The short duration of the pumping test (72+ hours) may not result in chemical equilibrium in the aquifer (EPA General Comment 1e); and
3. The difference in BTC groundwater gain during the pumping test compared to baseline conditions may well be within the measurement error for gaging methodology and instrumentation (EPA Specific Comment 12).

Additionally, the proposed section of BTC for the loading analysis has been previously evaluated in several previous investigations as described in Section 2.3. These previous evaluations include:

1. Sodium bromide tracing conducted in fall 2011 by Montana Bureau of Mines and Geology (MBMG) (*Stream Characterization of Blacktail and Silver Bow Creeks: A Continuous Tracer Injection Investigation Conducted During Baseflow Conditions in an Urban Area Impacted by Mining: Butte, Montana*);
2. Radon tracing and thermal imaging performed in spring 2011 by Atlantic Richfield. A second radon tracing study was performed in fall 2011 in conjunction with the MBMG tracer study (*BPSOU Final Revised 2011 Blacktail Creek and Silver Bow Creek Radon Tracing and Thermal Imaging Survey Technical Memorandum*); and
3. The United States Environmental Protection Agency (EPA) conducted surface water, sediment pore water, groundwater, sediment, and soil sampling in 2016 to determine the interaction between groundwater and surface water in BTC (*Final Report: Groundwater and Surface Water Interaction, Butte Priority Soils Operable Unit, Silver Bow Creek/Butte Area NPL Site*).

Due to anticipated loading analysis limitations and availability of the previous evaluations listed above, Atlantic Richfield has revised the Final BTC Pumping Test Quality Assurance Project Plan (QAPP) and removed the loading study. The revised data quality objectives (DQOs) now primarily focus on evaluating aquifer physical parameters (DQO 1) with secondary focus on evaluating water quality (DQO 2) to inform BTC construction dewatering, treatment at BTL, and groundwater control design. The results of the BTC pumping test will be used in conjunction with existing aquifer parameters, lithology, surface water flow, groundwater level, and water quality data to facilitate construction and calibration of the sitewide groundwater model which will be used to support the design of the BTC groundwater control system.

> **EPA General Comment 1d:** *The groundwater that is pumped from the BTC area will likely be affected by BTC and possibly wetland surface water. In order to achieve the goal to; "…anticipate the quality and quantity of contaminant of concern (COC) impacted groundwater that may need to be treated at BTL for both systems." the long-term water quality of the pumped water needs to be known.*

Atlantic Richfield Company Response: Comment noted. As described in EPA General Comment 1e, chemical equilibrium of the groundwater pumped from the BTC area may not be achieved during the pumping test. However, evaluation of water quality within the BTC area is one of the BTC Pumping Test DQOs. Groundwater quality samples will be collected from all newly installed piezometers prior to the start of pumping to establish initial water quality. Locations to be sampled include BTC-PZ01S/D, BTC-PZ02S/D, BTC-PZ03S/D, BTC-PZ04S/D, BTC-PZ05S/D, BTC-PZ06S/D, and BTC-PZ07, as well as the production well (BTC-PW-01) as described in Table 2 and Table 3. Water quality parameters collected as part of the BTC Pumping Test, along with existing long-term water quality data, will be used to inform evaluation of the water quality in the area. However, as noted previously in EPA Comment 1c, the effect of removing the groundwater source on the long-term quality of pumped groundwater may not be fully known until after the BTC groundwater control is operational and functional and impacted sediment has been removed from the BTC channel.

> **EPA General Comment 1e:** *While hydraulic steady state may be achieved during the 72+ hour test, chemical equilibrium may not be. Chemical data are to be collected at the beginning and end of the test, so it will not be possible to determine what happened in between. The chemical parameters may stabilize 24 hours into the test, or they could still be changing when the test is concluded. Transducers equipped with conductivity probes should be placed into track surface water influence and movement of the CoC plume with time. The procedure outlined in section 4.2.8.2 for the pumping well will also track changes in water chemistry, but by monitoring the outlying observation wells, the trends can be identified sooner (i.e., before reaching the pumping well). Monitoring the time at which a chemical boundary condition is reached (i.e., decrease in conductivity) for various monitoring wells can also help to determine if preferential pathways exist. It is unclear in Section 4.2.6.1 where the Solinst LTC transducers will be deployed.*

Atlantic Richfield Company Response: Text previously contained in Section 4.2.6.1 is now located in Section 4.2.5.1. Section 4.2.5.1, Figure 3, and Table 2 have been updated to indicate the following groundwater and surface water monitoring locations where conductivity transducers (Solinst LTC transducers) will be deployed. These locations include: BTC-PW-01, BTC-PZ03S/D, BTC-PZ04S/D, BTC-PZ06S/D, BPS07-21/B, BWE-3, BWE-4, SS-04, and PMP-11A/B (pending access). The specific conductance data collected from the observation wells, drawdown and recovery curves for individual and paired well locations collected during the BTC pumping test, and analyses of subsurface lithology will support evaluation of potential preferential pathways.

Specific Comments

> **EPA Specific Comment 1:** *Section 1.2, page 3 – In the third square bulleted item, shouldn't the phrase be "...when these changes revert…" instead of "…if these changes revert…"? Or is there some expectation that the pumping test could result in permanent changes to the groundwater?*

Atlantic Richfield Company Response: It is not anticipated that the proposed pumping test will result in permanent changes to the groundwater. This bullet has been removed per proposed changes to the scope of work as described in response to EPA General Comment 1c above.

> **EPA Specific Comment 2:** *Pg. 6, Section 2.4.2, 2nd paragraph on page – The increased surface water elevations resulting from the Pilot Project flow will decrease the amount of pumping required to reverse the gradient and create losing conditions within this segment of BTC compared with prior to or after the pilot. If the pilot does*

> *not become a permanent change this may affect the construction dewatering and hydraulic control designs. Please discuss how this will be accounted for.*

Atlantic Richfield Company Response: Under the *Berkeley Pit and Discharge Pilot Project Field Sampling Plan Revision 1*, changes in surface water elevations resulting from Pilot Project flows have been evaluated since October 2019. Tabulated observed changes are published in the BMFOU Berkeley Pit and Discharge Pilot Project Quarterly Reports and have been summarized in *Assessment of Berkeley Pit and BMFOU Discharge Effluent Mixing Zone and Blacktail Creek Backwater Monitoring Data* which is an attachment to the *Berkeley Pit and Discharge Pilot Project Quarterly Pilot Project Report Fourth Quarter 2021*. These data, along with streamflow data collected before the Pilot Project, may be used in conjunction with a sitewide groundwater model to evaluate results for varying conditions (e.g., with or without the Pilot Project flows discharging to SBC). Variable surface water elevations are not anticipated to substantively impact the effectiveness of the pumping test in estimating aquifer properties used to support development and calibration of the groundwater model. Additional text was added to Section 2.4.2 for clarity.

> **EPA Specific Comment 3:** <u>*Section 2.4.4 and Figure 4*</u> *– The Pumping Test QAPP nor the Stress Test QAPP do not provide the screened interval depths for the pumping well, but it is assumed that PW-01 is installed to at least 30 to 40 feet in depth or 20 to 30 feet below the water table. With this configuration, it is likely that the hydraulic influence will extend beyond Blacktail Creek in the middle part of the aquifer. Figure 4 does not show any drawdown south of Blacktail Creek. The assumption of a constant head boundary may not prove to be accurate. Monitoring wells and a staff gage south of Blacktail Creek will be useful to determine the actual extent of drawdown.*

Atlantic Richfield Company Response: Figure 7 has been updated to include as-built specifications of BTC-PW-01; the screened interval is 42.5 to 52.5 feet below ground surface (bgs) or approximately 28.5 to 38.5 feet below the water table.

Atlantic Richfield agrees that hydraulic influence may extend south beyond BTC. Monitoring wells BPS11-12A, BPS11-09, BPS11-04, and AMW-11, and a staff gage, stilling well, and transducer in the wetland pond (MSDSG-01) have been included in the observation network to aid in evaluating the extent of drawdown south of the creek. Section 2.4.4 has been revised to describe the method and assumptions used to obtain results presented on Figure 4 and reference the existing well configuration and results obtained during the step-drawdown evaluation conducted in September 2021. Additionally, the descriptions on Figure 4 have been revised from "Expected Drawdown…" to "Anticipated Drawdown…".

> **EPA Specific Comment 4:** <u>*Section 2.4.4*</u> *– The last sentence in this section indicates that the preliminary model will be updated. Is this referring to the forward model in AQTESOLV or a more sophisticated groundwater model?*

Atlantic Richfield Company Response: The preliminary model in that sentence refers to AQTESOLV forward solution software. The text has been updated to clarify this statement.

> **EPA Specific Comment 5:** *Section 4.2.1 – The purpose of the groundwater controls to be installed as a part of remedy is to prevent impacted groundwater from entering Blacktail Creek. Although there are no DQOs to evaluate the potential design of the control, this is an opportunity to collect potentially useful data for design. Monitoring drawdown between the pumping well and Blacktail Creek could provide pertinent hydrologic information in this area. Consider shallow wells or drive points in between PW-01 and Blacktail Creek.*

Atlantic Richfield Company Response: Measurement of hydraulic gradients will be part of the groundwater control monitoring, including the area between the pumping well and Blacktail Creek. However, as described in the SWMP and FRESOW, the objective of BTC groundwater control is to control discharge of contaminated groundwater to prevent exceedances of water quality Performance Standards in surface water at monitoring stations SS-06G and SS-07 and to limit loading of COCs to sediments within the BPSOU. To accomplish this objective, it may not be necessary to completely "prevent" impacted groundwater from entering the BTC area as suggested in the Agency comment. Additional discussion on this clarification is included in response to EPA General Comment 1b.

Paired NRDP wells, PMP-11A/B, are located approximately 75 feet southeast of the production well, directly between BTC-PW-01 and BTC. Rather than installing additional piezometer(s) adjacent to PMP-11A/B, Atlantic Richfield proposes to use the existing NRDP paired wells to provide the requested groundwater data in the area between BTC-PW-01 and BTC. As discussed in response to EPA General Comment 1b, PMP-11A/B are also located near the BWE-3 surface water monitoring location BWE-3, which is currently instrumented with a staff gage, a stilling well, and a Solinst transducer. Atlantic Richfield and NRDP will coordinate access to PMP11A/B to install transducers during the pumping test, obtain necessary manual measurements, and remove after the pumping test is completed.

> **EPA Specific Comment 6:** *<u>Section 4.2.4</u> – Given that PW-01 has already been installed, specific information should be provided including the well log and construction diagram. Figure 7 should be converted to as-built conditions with actual lengths and depths.*

Atlantic Richfield Company Response: Figure 7 has been updated to include as-built specifications of BTC-PW-01. Additionally, the well construction log was added to Appendix C.3; please note that all X-Ray Fluorescence (XRF) data presented are preliminary and have not been validated.

> **EPA Specific Comment 7:** *<u>Pg. 18, Section 4.2.6.1</u> – Where will the LTC transducers (with temperature and SC measurement) be used? Please discuss.*

Atlantic Richfield Company Response: Text previously contained in Section 4.2.6.1 is now located in Section 4.2.5.1. Section 4.2.5.1, Figure 3, and Table 2 have been updated to indicate the following groundwater and surface water monitoring locations where Solinst LTC transducers will be deployed: BTC-PW-01, BTC-PZ03S/D, BTC-PZ04S/D, BTC-PZ06S/D, BPS07-21/B, BWE-3, BWE-4, SS-04, and PMP-11A/B.

EPA Specific Comment 8: Section 4.2.7 *– Since the step drawdown test has been completed, please include the results in this QAPP.*

Atlantic Richfield Company Response: Section 4.2.2.2 was created to include output of the step-drawdown analysis performed using AQTESOLV.

EPA Specific Comment 9: Section 4.2.8.2 *– Please replace "cone of depression" with "capture zone at the time of sampling" to reflect that the hydraulic changes propagate much farther and faster than actual capture and discharge of water particles. Boundary conditions should be identifiable in the drawdown data, but a 72-hour test is not likely to capture and discharge water from a recharge boundary that is measurable in samples.*

Atlantic Richfield Company Response: The text has been changed to *"capture zone at the time of sampling"*.

EPA Specific Comment 10: Section 4.2.8.3, Pg. 20-21 *– Will the observation wells be sampled for water quality?*

Atlantic Richfield Company Response: Text previously contained in Section 4.2.8.3 is now located in Section 4.2.4. This text has been modified to clarify water quality samples will be collected for newly installed piezometers prior to conducting the pumping test as well as the production well within 4 hours after starting the long-term pumping test and within 4 hours before concluding the test. See Table 2 for sampling frequency and Table 3 for analyses.

EPA Specific Comment 11: *Section 4.3 – None of the principal study questions in Table 2 in the BTC Loading Analysis column require sampling of surface water during the aquifer test. What is expected to be learned? See comment 4.2.1. This sampling may be useful for design of the groundwater control.*

Atlantic Richfield Company Response: As described in response to EPA General Comment 1c, the BTC pumping test has been revised to focus on evaluating aquifer parameters (DQO 1) and groundwater quality (DQO 2). Data quality objectives have been revised to remove the loading analysis portion of the BTC pumping test.

EPA Specific Comment 12: *Section 4.3.3 – Given the anticipated pumping rate of 75 to 125 gpm and the base flow surface water discharge of approximately 10 cfs (4,500 gpm), even if all of the pumped water was captured from surface water, the difference would be less than 3% which may not be observable in the discharge measurements. It is likely that only a portion of the pumped water would be captured from surface water and changes in surface flow would be below the precision of the gaging methodology and instrumentation.*

Atlantic Richfield Company Response: Atlantic Richfield agrees that the influence of the pumping test will likely have no measurable influence on surface water flows nor elevation of BTC. As described in response to EPA General Comment 1c, the Final BTC Pumping Test

QAPP has been revised, and the loading analysis portion has been removed from the BTC Pumping Test QAPP. Although the need for flow measurements within BTC for the loading analysis has been removed, staff gages at BWE-3, BWE-4, and SS-04 will be equipped with LTC transducers and measurements will be monitored in case there is notable influence on BTC.

> **EPA Specific Comment 13:** *Section 4.3.3 – Surface water samples will be collected, but there is no indication in this section that they will be analyzed. Please provide a description of the analyses to be performed and a reference to Tables 2 and 3.*

Atlantic Richfield Company Response: Surface water quality samples will not be collected as the loading study has been removed from this evaluation as described in response to EPA General Comment 1c.

> **EPA Specific Comment 14*:*** *Section 4.3.3 – The frequency of sampling is not specified in this section or in Table 2. Samples collected during ambient conditions will answer the first two principal study questions for the loading analysis. Will sampling evaluate changes in loading incrementally during pumping or only at the end of pumping? How long after pumping stops will the final samples be collected?*

Atlantic Richfield Company Response: Surface water flow measurements will not be performed as the loading study has been removed from this evaluation as described in response to EPA General Comment 1c.

> **EPA Specific Comment:** *Table 1, Step 2, Pumping Test column – The first principal study question asks "…are there any identifiable contaminant sources in the alluvium?" No analysis of soil samples is included in the QAPP. What information or data will be collected to answer this question?*

Atlantic Richfield Company Response: Installation and XRF testing of BTC-PW-01 was conducted using procedures specified in the Final BTL Stress Test QAPP. Atlantic Richfield agrees that XRF data from one location is insufficient to identify contaminant sources in the alluvium. The principal study question referenced has been removed.

> **EPA Specific Comment Table 1:** *Table 1, Step 2, Pumping Test column – The second study question seems incomplete. Should it say "…create measurable drawdown in observation wells throughout the Site?" or "…create measurable drawdown in observation wells along the BPSOU CD-defined extent of additional ground water control?"*

Atlantic Richfield Company Response: The principal study question referenced has been removed.

EPA Specific Comment Table 1: *Table 1, Step 2, Pumping Test column – What elements of the investigation will aid in locating preferential flow paths? If a path is identified, the answer to the fifth question would be "Yes," but if none are found, this cannot be answered due to the difficulty of proving a negative.*

Atlantic Richfield Company Response: Analyses of drawdown and recovery curves, comparing aquifer parameters (transmissivity, storativity, and hydraulic conductivity) along with an assessment of subsurface lithology will be used to provide lines of evidence related to preferential flow pathways. Additionally, as described in response to EPA General Comment 1e, Solinst LTC transducers will be deployed to further assist identifying the presence of preferential flow paths.

EPA Specific Comment Table 1: *Table 1, Step 2, Pumping Test column – The last study question is unlikely to be answered. Groundwater chemistry and hydrology are not interdependent in a way to affect the divide. Please reword.*

Atlantic Richfield Company Response: The principal study question referenced has been removed and replaced with *"How does groundwater flow at the Site change when BTC-PW-01 is pumped at a sustained rate during normal flow conditions?"*, as the referenced data quality objective is focused on evaluating the physical effects of the pumping test on the groundwater divide.

EPA Specific Comment Table 1: *Table 1, Step 2, Loading Analysis column – The last study question is related to the aquifer test, not the loading analysis. Shouldn't this be in the Pumping Test column?*

Atlantic Richfield Company Response: The study questions have been revised to focus on evaluating aquifer parameters (DQO 1) and groundwater quality (DQO 2). The study question referenced has been revised to: *"What influence could the BTC groundwater control and construction dewatering have on surface water (BTC, Silver Bow Creek [SBC], and nearby wetland ponds) and existing groundwater control features (e.g., BPSOU subdrain)?"* and placed in the Aquifer Physical Parameter Evaluation column.

EPA Specific Comment Table 1: *Table 1 – DQOs, BTC Pumping Test, Step 3 – pH is the negative log of the hydrogen ion activity (-log[H+]). Please delete "potential Hydrogen" and just say "pH."*

Atlantic Richfield Company Response: Comment noted. Any reference to "Potential Hydrogen" has been replaced with "pH."

EPA Specific Comment Table 1: *Table 1 – DQOs, BTC Pumping Test, Step 4 – Please describe additional temporal boundaries. Are there times of the year when the pumping test cannot or should not be performed?*

Atlantic Richfield Company Response: Text has been added to the temporal boundaries section stating that efforts will be made to schedule the pumping test during fair weather, normal flow conditions with no local or high elevation runoff or precipitation. Coordination will also be necessary with the Polishing Facility operators to obtain discharge data during the pumping test to account for any changes in elevation.

EPA Specific Comment Table 1: *Table 1 – DQOs, BTC Pumping Test, Step 5 – Will water quality be sampled in any of the piezometers or just in the pumping well? Please include the subdrain manhole analyses in the description.*

Atlantic Richfield Company Response: Table 1 – DQOs, Step 5 has been updated indicating that water quality samples will be collected from newly installed piezometers as well as the production well for sampling frequencies indicated in Table 2 and analyses listed in Table 3. The BPSOU subdrain will not be sampled for water quality since the loading study has been removed from this evaluation as described in response to EPA General Comment 1c.

EPA Specific Comment Figures 3, 4, and 5: *Figures 3, 4, and 5 and Section 1.2 – The BPSOU Consent Decree Figure BTC-1 shows the conceptual groundwater control to extend from GS-28 to upper Silver Bow Creek. Figure 3 shows GS-28 to be approximately 1000 feet from the pumping well. Figure 5 shows minimal drawdown at 1000 feet and Figure 4 shows less than 1 foot of drawdown southwest of PZ02. Is this single well aquifer test going to be sufficient to "…adequately design the construction dewatering system for the installation of the BTC hydraulic control, inform the design of the BTC hydraulic control…" as described in Section 1.2 of the QAPP?*

Atlantic Richfield Company Response: Section 1.2 has been modified to state that data collected during the aquifer test will be used to estimate hydraulic parameters of the aquifer surrounding BTC-PW-01. Although the proposed conceptual groundwater control extends beyond the anticipated area of influence for this aquifer test, aquifer parameters obtained during the BTC pumping test will be used in conjunction with existing groundwater elevation and subsurface lithology data to facilitate construction and calibration of the sitewide groundwater model which will be used to evaluate groundwater control effectiveness for varying conditions. After the test has been completed, the results will be documented in the Pre-Design Investigation Evaluation Report, which will include a summary of data gaps and recommendations for additional investigations, if needed. The design is expected to include flexibility for optimization after installation.

End of Comments.

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

2022

Final

Blacktail Creek Remediation and Contaminated Groundwater Hydraulic Control Site

Pumping Test Quality Assurance Project Plan (QAPP)

Prepared for:

Atlantic Richfield Company
317 Anaconda Road
Butte, Montana 59701

Prepared by:

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

July 2022

APPROVAL PAGE

Silver Bow Creek/Butte Area NPL Site Butte Priority Soils Operable Unit
Blacktail Creek Remediation and Contaminated Groundwater Hydraulic Control Site
Pumping Test Quality Assurance Project Plan (QAPP)

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

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

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

Approved: ______________________________ Date: ________
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REVISION SUMMARY

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Silver Bow Creek/Butte Area NPL Site Butte Priority Soils Operable Unit
Blacktail Creek Remediation and Contaminated Groundwater Hydraulic Control Site Pumping Test
Quality Assurance Project Plan (QAPP)

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ACRONYMS

Acronym	Definition	Acronym	Definition
°C	Degrees Celsius	**LDS**	Laboratory Duplicate Sample
%R	Percent Recovery	**LMS**	Laboratory Matrix Spike
Atlantic Richfield	Atlantic Richfield Company	**LMSD**	Laboratory Matrix Spike Duplicate
bgs	Below ground surface	**MAU**	Middle Alluvial Unit
BMFOU	Butte Mine Flooding Operable Unit	**MB**	Method blank
BPSOU	Butte Priority Soils Operable Unit	**MBMG**	Montana Bureau of Mines and Geology
BSB	Butte-Silver Bow	**MGD**	Million gallons per day
BTL	Butte Treatment Lagoons	**NAVD**	North American Vertical Datum
BTC	Blacktail Creek	**NFG**	National Functional Guidelines
BTC PM	Blacktail Creek Project Manager	**NPL**	National Priorities List
CAR	Corrective Action Report	**NRDP**	Natural Resource Damage Program
CD	Consent Decree	**NTU**	Nephelometric Turbidity Units
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act	**ORP**	Oxidation-Reduction Potential
CFRSSI	Clark Fork River Superfund Site Investigation	**PARCCS**	Precision, Accuracy, Representativeness, Comparability, Completeness, and Sensitivity
cfs	cubic feet per second	**PDF**	Portable Document Format
CLP	Contract Laboratory Program	**PDI ER**	Pre-Design Investigation Evaluation Report
COC	Contaminant of Concern	**Pioneer**	Pioneer Technical Services, Inc.
CPM	Contractor Project Manager	**QA**	Quality Assurance
DEQ	Montana Department of Environmental Quality	**QAM**	Quality Assurance Manager
DI	Deionized	**QAO**	Quality Assurance Officer
DM	Data Management	**QAPP**	Quality Assurance Project Plan
DO	Dissolved Oxygen	**QC**	Quality Control
DQA	Data Quality Assessment	**RA**	Remedial Action
DQO	Data Quality Objective	**RD**	Remedial Design
DSR	Data Summary Report	**RM**	Remediation Management
DV	Data Validation	**ROD**	Record of Decision
DVR	Data Validation Report	**RPD**	Relative Percent Difference
EDD	Electronic Data Deliverable	**RL**	Reporting Limit

EPA	Environmental Protection Agency	**S2AVEM**	Stage 2A Validation Electronic and Manual
FRE	Further Remedial Element	**SBC**	Silver Bow Creek
FRESOW	Further Remedial Elements Scope of Work	**SC**	Specific Conductance
gpm	Gallons per minute	**SOP**	Standard Operating Procedure
GPS	Global Positioning System	**SS**	Sampling Station
hp	Horsepower	**SSHASP**	Site-Specific Health and Safety Plan
HCC	Hydraulic Control Channel	**SWMP**	Surface Water Management Plan
HDPE	High-Density Polyethylene	**TI**	Technical Impracticability
LAO	Lower Area One	**UAU**	Upper Alluvial Unit
LAU	Lower Alluvial Unit	**USGS**	U.S. Geological Survey
LCS	Laboratory Control Sample	**VFD**	Variable Frequency Drive
LCSD	Laboratory Control Sample Duplicate	**XRF**	X-Ray Fluorescence

1.0 INTRODUCTION

This Blacktail Creek (BTC) Pumping Test Quality Assurance Project Plan (QAPP) provides the procedures and protocols necessary to conduct a groundwater pumping test as a part of the BTC groundwater control remedial design (RD) and remedial action (RA) effort for the BTC Remediation and Contaminated Groundwater Control Site (Site) (Figure 1).

The Site is located within the Butte Priority Soils Operable Unit (BPSOU) located within the city of Butte, Montana (Figure 1), southeast of the confluence of Silver Bow Creek (SBC) and BTC (Figure 2). It is bounded on the west by Montana Street and the NorthWestern Energy substation, the south by Interstate 90 (I-90), and the east by Kaw Avenue and the KOA campground area.

The BTC Pumping Test Investigation consists of a pumping test and a recovery test (collectively referred to as the BTC Pumping Test or Investigation). Data collection activities under this QAPP follow framework outlined in the *BPSOU Final Quality Management Plan* (Atlantic Richfield Company, 2020a) and the *EPA Region 8 Quality Assurance Document Review Crosswalk* checklist (EPA, 2016a). Data Quality Objectives (DQOs) for the BTC Pumping Test Investigation are included in Section 3.0 and follow the U.S. Environmental Protection Agency (EPA) *Guidance on Systematic Planning Using the Data Quality Objectives Process* (EPA, 2006a).

1.1 Investigation Purpose

As required in the *Consent Decree* (CD) *for the Butte Priority Soils Operable Unit Partial Remedial Design/Remedial Action and Operation and Maintenance* (EPA, 2020a) (BPSOU CD), groundwater control is being evaluated to control discharge of contaminated groundwater to reduce ongoing and potential future groundwater loading of contaminants of concern (COCs) to BTC sediments and surface water as described in the Surface Water Management Plan (SWMP) and Further Remedial Elements Scope of Work (FRESOW). The FRESOW states that an initial 100 gallons per minute (gpm) of contaminated groundwater will be collected by the BTC groundwater control and the extent of groundwater capture will be evaluated as part of the BTC Pre-Design Investigation Evaluation Report (PDI ER). However, the FRESOW also indicates that the exact means of groundwater control cannot be determined based on existing available data and, depending on the findings from further investigations, control of groundwater may be accomplished by hydraulic capture and treatment and/or other methods approved by EPA in consultation with Montana Department of Environmental Quality (DEQ). Additional information on the aquifer physical parameters and groundwater quality is needed to inform selection and design of the BTC groundwater control. This additional information will also support construction and calibration of a Sitewide groundwater model which will be used to support evaluation of the BTC groundwater control design and other FRESOW components near the Site.

To support the Investigation, this document includes the following:

- Background (Section 2.0).
- DQOs (Section 3.0).

- Sampling Process and Design (Section 4.0).
- Data Measurement Performance Criteria (Section 5.0).
- Assessment and Oversight (Section 6.0).
- Health and Safety (Section 7.0).
- Data Validation and Usability (Section 8.0).
- Project Organization and Responsibilities (Section 9.0).
- Schedule (Section 10.0).
- Reporting (Section 11.0).

This document references current Standard Operating Procedures (SOPs), developed by Pioneer Technical Services, Inc. (Pioneer), based on *Clark Fork River Superfund Site Investigations* (CFRSSI) *SOPs* (ARCO, 1992a), which outline specific procedures to safely complete tasks. All referenced SOPs are included in Appendix A.

1.2 Investigation Objectives

This Investigation consists of two components: the primary focus is evaluating aquifer physical parameters and the secondary focus is evaluating water quality. Specific objectives for each component, identified through the DQO process (discussed in Section 3.0 and outlined in Table 1), are as follows:

Aquifer Physical Parameter Evaluation

Proposed piezometers will be installed and developed as described in the *Final Blacktail Creek (BTC) Remediation and Contaminated Groundwater Hydraulic Control Site Piezometer Installation and Monitoring Well Repair Plan* (Installation and Repair Plan; Appendix B). Water levels, specific conductance (SC) (select locations), and flow rates will be monitored before, during, and after the pumping test, as shown in Table 2 and described in Section 4.2.6. A long-term aquifer pumping test will be conducted as described in Section 4.2 and will continue for at least 72 hours, depending on the stabilization of the aquifer and the observed effects of any delayed yield (if applicable). The recovery test will follow pump shut off for approximately 72 hours.

Data collected before, during, and after the pumping test will be used to:

- Estimate Site-specific values for alluvial aquifer physical parameters (hydraulic conductivity, transmissivity, and storativity).
- Provide lines of evidence for identifying the presence of hydraulic boundaries, preferential flow paths, and the pumping well's area of influence using distance-drawdown and SC measurements at multiple distances and directions from the pumping well.
- Evaluate the impact of groundwater extraction on the subdrain using groundwater elevation and flow rates measured in the subdrain during the BTC pumping test.

- Evaluate the connection between surface water and groundwater in BTC and the nearby wetlands using surface water elevations and elevations measured in near-creek wells.
- Provide data to support construction dewatering and calibration of a Sitewide groundwater model.

Water Quality Evaluation

Proposed piezometers will be installed and developed as described in the Installation and Repair Plan (Appendix B). Newly installed piezometers will be sampled before conducting the pumping test as described in Section 4.2.4.1 to establish groundwater quality measurements for these new monitoring locations and enable comparison to existing long-term groundwater quality data. The production well, BTC-PW-01, will be sampled and field parameters will be monitored during the pumping test as described in Section 4.2.4.2 and SC (select locations) will be monitored before, during, and after the pumping test (Table 2).

These data will be used to:

- Compare water quality data for newly installed piezometers with long-term water quality from the Site.
- Identify if there are water chemistry changes in the pumping well or SC changes at select monitoring locations during the BTC pumping test.
- Prepare iso-concentration maps by interpolating COC concentrations between sample locations.
- Estimate the groundwater quality that may be captured during construction dewatering and by the BTC groundwater control, which may require treatment at Butte Treatment Lagoons (BTL).
- Provide data to support construction dewatering and calibration of a Sitewide groundwater model.

2.0 BACKGROUND

Placer mining began in the Butte area in 1864, and by the 1870s multiple silver and copper mines, mills, and smelting facilities had been established in the area. Due to over 100 years of historical mine waste accumulation and direct disposal and run off of waste to surface water, impacts to the alluvial aquifer resulted in issuance of a Technical Impracticability (TI) waiver of groundwater standards in portions of the aquifer (see TI Zone, Figure 1). Contaminated sediment removal from the stream bed, banks, and adjacent floodplain along BTC and SBC above its confluence is prescribed in the *BPSOU Record of Decision* (ROD) (EPA, 2006b) and BPSOU CD (EPA, 2020a) to mitigate contaminated groundwater re-expressing as surface water. Remedial action is required for nine further remedial elements (FREs), one of which is BTC RA. Atlantic Richfield Company is responsible for remediation activities for the BTC Site, which include “control[ing] discharge of contaminated ground water to surface water in the area” (EPA, 2020a).

2.1 Site Description

Blacktail Creek flows southeast to northwest through the Site to the confluence with SBC near George Street and Montana Street. The Site and surrounding area also exhibit wetland features and associated tributaries from locally upwelling groundwater (Figure 2). The Site conditions will change following BTC RA, which will remove existing COC-impacted sediment in BTC and will likely affect Site groundwater quality. Groundwater and surface water quality measurements collected during the BTC Pumping Test will be limited to evaluating current conditions.

2.2 Site History

The Site includes the likely historical location of the confluence of BTC and SBC. Historical maps of the area (Baker and Harper, 1889) suggest that the confluence of BTC and SBC was located to the southeast of the current confluence location. Later maps (Weed, 1897) suggest that water from SBC was impounded in the area near present day Montana Street, with water backing up along BTC to between monitoring wells AMW-13 and GS-28 (Figure 3). Although the BTC drainage experienced less historical disturbance than SBC, the Site was adversely affected by the 1908 flood, which likely led to extensive scour and deposition of mine tailings from upgradient impoundments. Additionally, when BTC was rerouted and confined by the berms on both sides of the creek, the COCs contained in the berms likely impacted the nearby soil and groundwater.

2.3 Relevant Previous Investigations

Summaries of relevant previous investigations conducted at and near the Site are included below. A selection of figures from the studies are included in Appendix C.

2.3.1 BPSOU Subdrain Mid-Level Aquifer Pumping Test

The pumping test, conducted near the Butte Civic Center (Figure 1), characterized the mid-level portion of the alluvial aquifer located immediately to the east of the Site. The average transmissivity of the mid-level portion of the aquifer in the upper portion of the SBC drainage basin was estimated to be approximately 9,000 square feet per day, and the average hydraulic conductivity was estimated to be approximately 600 feet per day (Atlantic Richfield Company, 2010). These parameters were used as a basis for the preliminary forward solution analysis discussed in Section 2.4.4.

2.3.2 BTC and SBC Radon Tracing and Thermal Imaging Survey

In 2011, a thermal imaging and radon tracing investigation (Radon Tracing Study) was conducted along BTC and SBC. The intent of the study was to identify losing and/or gaining reaches of BTC and SBC and evaluate if losing reaches could be attributed to interception of the historical channel or loss of flow to the groundwater aquifer. The Radon Tracing Study identified two sub-reaches within the Site with gains of flow and dissolved load. The investigation identified the origin of stream COC load gain as either upwelling groundwater, tributary flow, pore water from within the bed sediment, or mobilization of bed sediment (Atlantic Richfield

Company, 2016). The thermal imaging survey did not detect groundwater gains to BTC within the Site. Figures from the Radon Tracing Study showing gaining and losing reaches of BTC during the spring and fall of 2011 are included in Appendix C.1

2.3.3 Stream Characterization of BTC and SBC

A bromide tracer study was completed to investigate areas of groundwater reporting to surface water at the Site. Results of the tracer study indicated that BTC, in the vicinity of the Site, contains both net gaining and net losing reaches and that adjacent wetland areas receive most gains from groundwater (Montana Bureau of Mines and Geology [MBMG], 2014). A selection of the figures from the report are included in Appendix C.2 and show which reaches were identified to be gaining and losing during spring of 2011, according to this study.

2.3.4 Groundwater and Surface Water Interaction Study

Surface water, sediment pore water, groundwater, sediment, and soil samples collected in a 2016 sampling effort were analyzed to evaluate the interaction of groundwater and surface water near the Site (EPA, 2018). The investigation intent was to determine if impacted groundwater sources were contributing to surface water loads (as opposed to wet weather sediment loading events) using a combination of analytical sample analysis and geochemical modeling. In the study area relevant to this effort (the reach from sample station [SS] SS-01 to SS-04), important findings from the report included the following:

- Increased concentrations of dissolved arsenic, copper, and zinc between SS-01 and SS-04 in surface water samples (SS-01 and SS-04 are shown on Figure 1).
- Positive sediment pore water gradients, indicating contribution of groundwater to surface water.
- Lower concentrations of COCs in groundwater samples than in sediment pore water samples.

The study concluded that impacted sediment and localized impacted groundwater may be affecting surface water quality in the Site area (EPA, 2018).

2.3.5 Soil Lithologic Logging and Field XRF of BTC-PW-01

Soil lithologic logging and field x-ray fluorescence (XRF) analysis were performed as part of the BTL Stress Test field activities during installation of the pumping well, BTC-PW-01 (Atlantic Richfield Company, 2021a). The first 7 feet of the BTC borehole were hydro-excavated by Hunter Brothers Construction to mitigate disturbance of sub-surface utilities. A sample was collected from each lithological layer observed in the BTC borehole core as observed by field personnel. Field metals analysis was conducted for each material horizon via the XRF unit. The XRF samples were collected using the procedures outlined in SOP-S-12 and analyzed for arsenic, cadmium, copper, iron, lead, manganese, silver, and zinc following the procedures outlined in SOP-SFM-02 (Appendix A). The lithology log and preliminary XRF data from the collected core are provided in Appendix C.3.

2.4 Site Geology and Hydrogeology

The Butte, Montana, area lies within the Summit Valley of southwest Montana and is characterized by Quaternary alluvium surrounded by the Butte granite of the Cretaceous Boulder Batholith (U.S. Geological Survey [USGS], 2012).

2.4.1 Geology

Alluvium

The primary source of the alluvial material existing at the Site is the granitic bedrock (i.e., Butte granite) surrounding most of the Summit Valley. The alluvial material at the Site consists of various mixtures of clays, silts, sands, and gravels. Generally, the upper portion of the alluvium is more finely grained with prevalent clay and silt. With increasing depth, the alluvium gets coarser with sand and gravel becoming more predominant.

Bedrock

Depth to bedrock is approximately 80 to 90 feet below ground surface (bgs) at the Site. While interactions with groundwater in bedrock are not expected to be an important component of the Investigation, the depth to bedrock is greater than 200 feet bgs where BTC crosses underneath Lexington Avenue and is approximately 25 to 30 feet bgs where SBC crosses underneath Montana Street (Figure 2). Bedrock depth shallowing from east to west in the area is inferred to result in groundwater discharging to the surface.

2.4.2 Surface Water

Surface water features in and near the Site include BTC, SBC, and a series of natural wetlands and tributaries located between Lexington Avenue and Montana Street (Figure 2). Blacktail Creek flows through the Site from southeast to northwest, and the Site is located upstream of the confluence with SBC to the northwest. Adjacent to BTC are wetland features recharged by locally upwelling groundwater, including a wetland located to the north of BTC and south of the Butte KOA, a wetland located to the south of BTC and north of Interstate 15 (I-15)/I-90, and a wetland located to the south of I-15/I-90 (Figure 2). Within the Site, BTC is a low gradient, low sinuosity, single-channel creek with a median annual flow of approximately 20 cubic feet per second (cfs). Peak flows (2- to 5-year return interval) range from 153 to 289 cfs (USGS, 2022). Groundwater is near the surface in this area, inferred to be influenced by the shallowing depth to bedrock (Section 2.4.1), and the surface water elevation for all three wetland ponds is higher than the adjacent BTC during normal flow. To monitor and understand the influence of each wetland pond on the pumping test and adjacent aquifer, an existing staff gage and a newly installed staff gage at the wetland ponds located to the north of I-15/I-90 will be monitored before, during, and after the pumping test (Section 4.1).

Downstream of the Site, up to 10 million gallons per day (MGD) of effluent water is being discharged into SBC at the Butte Mine Flooding Operable Unit (BMFOU) Berkeley Pit and Discharge Pilot Project (Pilot Project) discharge structure (Figure 2) with a mean discharge of 6 to 7 MGD). The Pilot Project discharge structure is located to the north and adjacent to the SBC channel, approximately 75 feet upstream of the confluence with BTC (Figure 2). The observed local effects of the effluent discharge include increased surface water elevations near the confluence which has caused a slight backwatering effect within BTC upstream of the confluence. Under the *Berkeley Pit and Discharge Pilot Project Field Sampling Plan Revision 1* (Atlantic Richfield Company, 2022a), changes in surface water elevations resulting from Pilot Project flows have been evaluated since October 2019. Tabulated observed changes are published in the BMFOU Berkeley Pit and Discharge Pilot Project Quarterly Reports and have been summarized in Assessment of Berkeley Pit and BMFOU Discharge Effluent Mixing Zone and Blacktail Creek Backwater Monitoring Data which is an attachment to the *Berkeley Pit and Discharge Pilot Project Quarterly Pilot Project Report Fourth Quarter 2021* (Atlantic Richfield Company, 2022b). Coordination with the BMFOU polishing facility will be conducted to ensure, where possible, steady creek flows at USGS Station 12323242 (Figure 1) for the duration of the Investigation. Blacktail Creek and SBC data collected prior to and during the Pilot Project will be used in conjunction with a long-term transient model to evaluate results for varying conditions (e.g., seasonality, flows during the Pilot Project, flows during construction dewatering, etc.).

2.4.3 Groundwater

Depth to groundwater at the Site ranges from 5 to 15 feet bgs. Within and to the east of the Site, there is a groundwater flow divide within the upper alluvial unit (UAU) (Figure 2). On the north side of the groundwater divide, the direction of groundwater flow is to the north/northwest toward the subdrain, and on the south side of the groundwater divide, the direction of groundwater flow is to the southwest toward BTC. As described in the Draft Final *BPSOU Capture and Treatment System Performance Evaluation Scoping Document* (Atlantic Richfield, 2020b), the configuration for conceptual groundwater control as described in the FRESOW and alternative-proposed conceptual groundwater control locations (Alternative 1a and Alternative 1b, respectively) can be viewed on Figure 2.

Groundwater at the Site travels through a heterogenous aquifer which includes layers of material ranging from fine silts and clays to medium gravel (alluvial aquifer). Further upgradient along SBC, the relatively consistent aquifer units (lower alluvial unit [LAU], middle alluvial unit [MAU], and UAU) can be correlated laterally between lithologic logs. Within the Site, correlation between lithologic logs and identification of separate aquifer units are less clear. Interbedded silts and clays result in areas of lower hydraulic conductivity, whereas sands, gravels, and possibly buried fluvial sediments from historical channels provide areas of higher hydraulic conductivity. The thickness of alluvium decreases from east to west across the Site, due to the shallowing of the depth to competent bedrock (Section 2.4.1). The resulting effects include areas of upwelling groundwater (e.g., the three wetland areas located along BTC, Figure 2) within and adjacent to the Site (Atlantic Richfield, 2016).

2.4.4 Preliminary Estimations

The anticipated area of influence of the pumping test has been estimated using AQTESOLV software to complete forward solutions using aquifer parameters derived from the 2010 *Mid-Level Aquifer Pumping Test Technical Memorandum* (Atlantic Richfield Company, 2010). Assumptions used to complete preliminary estimates, shown on Figure 4 and Figure 5, included a constant head boundary at BTC and a no-flow boundary at the subdrain. The anticipated drawdown in the vicinity of the pumping well is illustrated on Figure 4, assuming a pumping rate of 125 gpm. Note that this is lower than the proposed pumping test rate of 130 gpm. The aquifer parameters used in the model input and the predicted distance-drawdown curve are shown on Figure 5. These preliminary estimations have been used to design the location of the pumping test wells and the appropriate extent of a monitoring network (Figure 3). The AQTESOLV forward solution was updated using results obtained from the step-drawdown test conducted in September 2021; output of this analysis is presented in Section 4.2.2.2.

3.0 DATA QUALITY OBJECTIVES

The DQOs were identified according to the EPA *Guidance on Systematic Planning Using the Data Quality Objectives Process* (EPA, 2006a). The DQOs are statements that define the type, quality, quantity, purpose, and use of data to be collected. EPA developed a seven-step process for establishing DQOs to help ensure that data collected during a field sampling program will be adequate to support reliable site-specific decision making or estimations, whichever is appropriate (EPA, 2006a). The DQOs for the Investigation were developed according to the seven-step decision-making process. For the Investigation, DQOs follow the guidance for estimation type fieldwork and are listed in Table 1.

4.0 SAMPLING PROCESS AND DESIGN

The Investigation will collect appropriate data to refine the characterization of the aquifer within the Site area. The location of the pumping well BTC-PW-01 shown on Figure 3 was selected due to its proximity to the conceptual groundwater control depicted on Figure BTC-1 of the BPSOU CD, configuration with existing monitoring wells and surface water monitoring locations, and proximity to BTC.

The proposed piezometers will be installed and developed before conducting the pumping test (see Installation and Repair Plan in Appendix B). Newly installed piezometers will be sampled to establish groundwater quality measurements for these new monitoring locations and enable comparison to existing long-term groundwater quality data (Table 2 and Table 3).

The pumping test will be completed using the pumping well and the pumping test discharge line shown on Figure 6. Figure 7 shows the pumping well construction and pump installation configuration detail. The pumping well will be used to pump groundwater from the aquifer at a constant rate. Before, during, and after pumping, groundwater and surface water levels and specific conductance (select locations) will be recorded and monitored for water level response. Before, during, and after pumping, flow rates from BTC-PW-01, BTC, SBC, BMFOU Pilot Project effluent, and BPSOU subdrain will be recorded and monitored to quantify trends and observe response to pumping, if any. Production water quality samples will be collected and sent for laboratory analyses (Table 2 and Table 3). Pumped groundwater will be conveyed directly to the subdrain vault (Figure 6) where it will then be conveyed to BTL for treatment.

This section details the fieldwork that will be completed for the Investigation. Table 2 lists the data to be collected and the proposed monitoring for the pumping test.

4.1 Pre-Test Activities

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

4.1.1 Training

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

In a project meeting held prior to fieldwork, all field personnel will review this BTC Pumping Test QAPP and receive training per the QAPP. Field personnel will review sampling and monitoring procedures and requirements prior to field activities so that collecting and handling methods are completed according to the QAPP requirements. Field personnel will be trained in how to properly use field equipment and complete activities according to the field data collection SOPs (Appendix A) and equipment manufacturer's recommendations. Field personnel will also become familiar with field notes and field forms (Appendix D) to collect data that meet the DQO requirements and the data validation checklists (Appendix E).

The Field Team Leader will review the 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 SSHASP review will cover all other safety aspects of 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 and overseeing field personnel on how to use and calibrate the field measurement instruments that will be used. One hard copy of the current approved version of this BTC Pumping Test QAPP will be maintained for reference purposes in the field vehicle and/or field office. All field team personnel will have access to electronic versions of all documents pertaining to sampling.

4.1.2 Property Access

Butte-Silver Bow (BSB) owns the property where the pumping test will be performed. Atlantic Richfield representatives will coordinate access to the property with the BSB Department of Reclamation and Environmental Services and Butte Chamber of Commerce before beginning work. During the pumping test, any work related to monitoring wells that are located on private property will use existing access agreements or the Atlantic Richfield Liability Manager (or designated representative) will acquire updated or new access agreements, as necessary. Copies of the access agreements will be placed in the field binder to have on hand during the pumping test activities.

Natural Resource Damage Program (NRDP) owns monitoring wells PMP-11A/B that are included in the monitoring network (Figure 3). Atlantic Richfield representatives will coordinate access to PMP11A/B with NRDP or their representative to install transducers during the pumping test, obtain necessary manual measurements, and remove the transducers after the pumping test is completed.

4.1.3 Utility Locates

Utility locates will be performed prior to any field work and will follow Remediation Management (RM) supplier's procedures for ground disturbance in addition to applicable control measures addressed in the internal SSHASP. Final utility locates for the work area will be completed by the performing authority prior to any ground disturbance activities.

4.2 Blacktail Creek Pumping Test

The BTC Pumping Test objectives include evaluating aquifer physical parameters and water quality, discussed in detail (Table 1). Table 2 lists the data that will be collected and the proposed monitoring for the pumping test.

4.2.1 Pumping Test Design

The pumping test is designed to collect data of sufficient quality and quantity to answer the principal study questions in Step 2 of the DQO process (Section 3.0 and Table 1).

The layout of the pumping well and observation network is designed to facilitate evaluation of alluvial aquifer physical parameters across the Site, the impact of groundwater extraction on the subdrain, and the connection between surface water and groundwater in BTC and nearby wetlands. Groundwater elevation and SC data collected from the observation wells, drawdown and recovery curves for individual and paired well locations collected during the BTC pumping test, and analyses of subsurface lithology will support evaluation of aquifer physical parameters, potential preferential pathways, and potential changing water chemistry. Groundwater quality samples and field parameter measurements collected from BTC-PW-01 will assist to identify potential changing water chemistry. Groundwater quality samples will be collected from all newly installed piezometers prior to the start of pumping to establish initial water quality and enable comparison of water quality data for newly installed piezometers to existing long-term monitoring locations and estimate groundwater quality that may be captured during construction dewatering and by the BTC groundwater control, which may require treatment at BTL.

The results of the BTC pumping test will be used in conjunction with previously estimated aquifer parameters, lithology, surface water flow, groundwater level, and water quality data to facilitate development and calibration of the sitewide groundwater model which will be used to support evaluation and design of the BTC groundwater control system.

The Field Team Leader will be responsible for coordination, safety, and quality of the fieldwork during the pumping test (Section 4.2). During the pumping test, transducers will be installed in the groundwater observation locations per Table 2. A second, backup transducer will be installed in select groundwater observation locations, where deemed necessary by the Contractor Project Manager (CPM) and/or Quality Assurance Officer (QAO). Manual backup measurements will be recorded by the field team each time a transducer is downloaded (at a minimum).

Prior to starting the pumping test, the discharge line will be installed from the pumping well to the subdrain vault using the same or a similar configuration as was used during the step-drawdown test conducted during BTL Stress Test field activities. Concurrent with the installation of the discharge line, groundwater levels across the pumping test area will be monitored to assess trends that can be applied to pumping test water level information when it is evaluated. This section describes the work tasks required to complete the pumping test in detail:

4.2.2 Pumping Test Infrastructure Locations

The Installation and Repair Plan (Appendix B) provides the procedures and protocols necessary to install, develop, and survey new piezometers and repair an existing monitoring well (BPS11-10A) and associated reporting. This additional infrastructure will support groundwater and surface water elevation monitoring and water quality monitoring during the BTC Pumping Test as described in further detail below.

4.2.2.1 Observation Network Staff Gage Installation and Survey

A staff gage (MSDSG-01) will be installed as shown on Figure 3. Field personnel will adjust the locations as necessary to accommodate field conditions. The staff gage will be installed in a location that minimizes the potential for clogging from pond sediments and floating debris and in a location where it can be secured to prevent movement. The staff gage will be mounted vertically and plumb to the water surface. After installation, MSDSG-01 and all surface water staff gage locations will be surveyed per SOP-SURVEY-01 Staking and Surveying (Appendix A) at the location and "zero elevation." The CPM may add a survey of additional monitoring locations at ground surface and measuring point, as necessary.

4.2.2.2 Step-Drawdown Test

The step-drawdown test for BTC-PW-01 was conducted as part of the BTL Stress Test field activities. The purpose of this test was to determine a suitable pumping rate for the pumping test as well as longer-term pumping associated with the BTL Stress Test. The step-drawdown test was performed on September 20, 2021, and lasted approximately 3 hours. The data collected during the step-drawdown test was evaluated with the software package AQTESOLV to determine initial aquifer parameters using the Neuman and Witherspoon Solution for Confined Two-Aquifer Systems with Leakage. These parameters were then input to AQTESOLV forward solution software to determine a sustainable 72-hour pumping rate. From these analyses, a pumping rate of 130 gpm was selected for the BTC-PW-01 pumping test, which is slightly higher than initially predicted. The Field Team Leader, in consultation with CPM and QAO, may modify the final pumping rate based on field conditions. Additional details on how the step-drawdown test was conducted are included in the *Final BTL Stress Test QAPP* (Atlantic Richfield Company, 2021a).

4.2.2.3 Pumping Well Development

The pumping well (BTC-PW-01) was installed and developed in August 2021 as described in the *Final BTL Stress Test QAPP* (Atlantic Richfield Company, 2021a). It is not anticipated that BTC-PW-01 will need to be redeveloped prior to completing the BTC Pumping Test. The Field Team Leader, in consultation with the CPM, and QAO will determine if additional well development is needed. If additional well development is needed, the field team will follow the guidance in SOP-GW-12 to develop the pumping well.

4.2.3 Pumping Test Systems

This section describes the details of the various pumping test systems that will be installed at the pumping well location.

4.2.3.1 Site Security

Increased security concerns for this work are present since the Site is adjacent to a public walking trail and public sidewalks and therefore accessible to the public. To restrict access to nonessential personnel, a chain-link security fence will be installed surrounding BTC-PW-01 and the pumping well power supply. Jersey barriers will be installed at both the north and east access to the parking lot as shown on Figure 8.

4.2.3.2 Submersible Pumps and Controls

The selection of a suitable submersible pump and flow controls will be critical to the success of the pumping test. A single submersible pump (Grundfos 7.5 horsepower [hp] stainless steel or equivalent) with an estimated pumping range of 25 to over 200 gpm will be installed; the pumping flow rate will be controlled using a variable frequency drive (VFD) (Phase Technologies 2XD207 or equivalent). Final selection of the pump may be adjusted based on technical input from the pump manufacturer, results of the step-drawdown test, and any additional well development conducted before the start of the pumping test, with approval from the CPM and/or QAO.

The intake screen of the submersible pump will be installed approximately 1 to 2 feet into the 5-foot “0-wrap” well sump. This configuration will provide the maximum drawdown possible during the pumping test without causing cavitation of the pump. The pump and independent check valve will be attached to an appropriate size drop pipe. The drop pipe will be secured at the surface with a pipe hanger resting on the 12-inch diameter steel surface casing. The discharge pipe will then be routed horizontally off the ground (control section) with a slight upward incline (3 inches in a 10-foot run) to help maintain full pipe flow and ensure flow meter accuracy. The discharge pipe will then run to the subdrain vault (Figure 6 and Section 4.2.3.3). The Field Team Leader, CPM, and QAO may modify the discharge line type or alignment as field conditions merit.

The submersible pump control section (Figure 7) will consist of a flow meter(s), pressure regulator, sample port for collecting water quality samples, and a gate valve for flow control. The pumping rate will be controlled during the pumping test by varying the pump motor speed using a VFD and adjusting the gate valve. The VFD will allow the operator to adjust the pump motor speed to control the flow rate and will be connected to a single submersible level transmitter (Mercoid Bird Cage 0 to 15.0 pounds per square inch or equivalent), preventing dry-run conditions, and a single gauge pressure sensor (Omega 0 to 100 pounds per square inch gauge [psig] or equivalent), regulating operating pressure range.

Production water flow meters will be clamp-on ultrasonic (or equivalent). The meters will have a flow range of approximately 25 gpm to 250 gpm to encompass the anticipated pumping rates at the Site. A clamp-on ultrasonic flow meter is preferred because it can be adapted and calibrated to different pipe materials, wall thicknesses, and diameters. The flow meters will have a constant read screen showing instantaneous flow rates (in gpm), totalizers to record the volume pumped, and data loggers to store the flow data. For proper flow meter accuracy, the setup requires full pipe flow, a straight length of upstream piping that is ten times the pipe diameter in length (10D), and a straight length of downstream piping that is five times the pipe diameter in length (5D). Flow meters will be located at both the pumping location and at the discharge to the subdrain vault to aid in correlation.

A sampling port will be installed in the control piping to collect water quality samples and will be located downstream of the flow meter(s) to avoid interference with flow measurements. The sample port will be placed at a minimum of five times the pipe diameter (5D) downstream of the flowmeter as per the manufacturer's specifications. The sample port will have a three-quarter-inch pipe fitting with a gate valve to control flow. Tubing will be connected from the sampling port to a flow cell to measure field parameters and collect groundwater samples.

A flow control device (e.g., gate valve) will be installed at the downstream end of the flow meter piping. This valve may be used to put backpressure on the pump and/or flow meter or provide additional flow control. The Field Team Leader, CPM, and QAO may modify the installation and/or location of submersible pumps, controls, and meters as necessary.

4.2.3.3 Discharge Line

Production water from the pumping well will be routed underneath George Street through a culvert installed as part of the BTL Stress Test field activities and conveyed directly into the subdrain wet vault (Figure 6), where it will travel through the Primary Force Main and/or Alternate BPSOU Discharge Line to the hydraulic control channel (HCC). Production water will then route through BTL. If necessary, increased flows to the subdrain vault will be transmitted to the HCC using the existing temporary transfer pumps (Godwin Diesel CD150 and/or 300HH electric submersible pumps [electric pump as backup]). Protective devices will be installed to safeguard transfer pumps from dry-run conditions.

The conveyance line will consist of 4-inch diameter Duraline PolyPipe butt fusion welded high-density polyethylene (HDPE), or equivalent. The discharge line will not cross BTC or SBC above the confluence with BTC, therefore it is anticipated that secondary containment and/or dual wall piping will not be necessary. All temporary conveyance piping will be inspected for potential leaks during use. Inspections will occur daily with additional inspections as determined by the Field Team Leader and CPM, in consultation with the Contractor QAO. In addition to daily conveyance piping inspections, flow meters will be installed at the pumping location and at the discharge to the subdrain vault to aid in correlation as discussed in Section 4.2.3.2. The Field Team Leader, CPM, and QAO may modify the temporary conveyance line configuration based on the field conditions.

4.2.3.4 Electrical Power and Controls

An electric line power service connection was installed as part of the BTL Stress Test field activities to provide power to the pump, drive, meters, and other equipment at the pumping well. Installation of temporary line power service to the pumping location in lieu of diesel generator power will decrease disturbance to the community, reduce the footprint required for equipment, improve safety, and increase reliability during the test.

The approximate location and alignment of the power service connection to the BTC pumping well is shown on Figure 8. Power service to the pumping well consists of a single span of overhead power line from the main service line along George Street to a pole installed near the pumping well. A certified electrician (Section 9.1) will connect and disconnect the pump to the VFD and the VFD to the service meter before the start of the pumping test and after completion of the pumping test, respectively.

4.2.4 Water Quality Monitoring

This section describes the water quality sampling planned at newly installed piezometers before the pumping test, and the sampling planned at the production well during the pumping test.

4.2.4.1 New Piezometer Water Quality Sampling

New piezometers BTC-PZ01S/D, BTC-PZ02S/D, BTC-PZ03S/D, BTC-PZ04S/D, BTC-PZ05S/D, and BTC-PZ06S/D (Figure 3), installed and developed per Appendix B, will be sampled a minimum of 24 hours after development, prior to conducting the long-term pumping test. Collecting water quality samples as outlined in Table 2 and Table 3 will establish groundwater quality measurements for these new monitoring locations and enable comparison to existing long-term groundwater quality data.

Sample collection will follow the SOPs included in Appendix A for collecting groundwater samples: SOP-DE-01, SOP-DE-02, SOP-DE-03, SOP-GW-03, SOP-GW-10A, SOP-SA-01, SOP-SA-02, SOP-SA-03A, and SOP-SA-03B. The samples will be collected in appropriate sample containers, labeled, preserved, and sent to the analytical laboratory for analyses as shown in Table 3.

4.2.4.2 Production Well Water Quality Samples

The pumping test production water will be sampled within 4 hours after starting the long-term pumping test and within 4 hours before concluding the test. Additional samples may be collected from the pumping well as determined by observations in field water quality parameters (Section 4.2.4.3), or as deemed necessary by the Field Team Leader, CPM, and/or QAO. Collecting water quality samples as outlined in Table 2 and Table 3 will document initial water quality and water quality after pumping has occurred.

Sample collection will follow the SOPs included in Appendix A for collecting water samples: SOP-DE-03, SOP-GW-03, SOP-SA-01, SOP-SA-02, SOP-SA-03A, and SOP-SA-03B. Additional production water opportunity samples may be collected based on field observations such as changing field parameters or notable changes in water levels in the pumping or observation wells during the long-term pumping test. The samples will be collected in appropriate sample containers, labeled, preserved, and sent to the analytical laboratory for analyses as shown in Table 3.

4.2.4.3 Field Parameters

General water quality will be assessed in water pumped from the pumping well by monitoring field parameters and collecting groundwater samples (Table 2). As the capture zone at the time of sampling from the pumping well moves outward, away from the pumping test well, boundary conditions could be encountered. For example, if SC readings remain steady through the initial part of the pumping test, but readings begin to drop as the pumping test proceeds, this would suggest that the capture zone at the time of sampling has expanded to a nearby source of less-impacted water. If one or more field parameters vary by 10 percent or greater between readings (see Table 2 for sample collection intervals), this may merit additional water quality samples at the pumping well to characterize the shifting water quality (Section 4.2.4.2). The data will assist in evaluating potential changes in source water.

Field parameters listed in Table 3 (pH, SC, temperature, DO, oxidation-reduction potential [ORP]) will be measured and recorded using a multi-probe field meter and flow-through cell (flow cell) (SOP-GW-14 in Appendix A). The flow cell will be connected to the sampling port located on the pumping test control piping (Figure 7). Flow from the sampling port will be modulated to direct a continuous flow of water through the flow cell, allowing water quality measurements to be made continuously as the pumping test progresses. Field parameters will be recorded every 15 minutes for the first 8 hours and then hourly for the remainder of pumping, with the field meter data logger system, and manual readings will be recorded on field data sheets as appropriate. The water passing through the flow cell will be redirected into the discharge line to the subdrain vault or collected and transported to the BTL drying beds.

4.2.5 Water Level Monitoring

Water level monitoring will be conducted during all phases of the pumping test (7-day baseline water level trend monitoring, pumping test, and recovery test). Primary and backup water levels will be monitored with automatic water level recording (i.e., pressure transducers). A primary transducer will be installed at each location with a direct read cable, and a second backup transducer may be installed without a direct read cable in some locations. Manual water level measurements will be collected throughout the test to correct for any shift or drift within the transducer measurements. Water levels at the Site will be measured at selected observation wells from the available locations identified on Figure 3 and in Table 2 or as determined by the Field Team Leader, CPM, and QAO. The selection of monitoring wells may be adjusted depending on field conditions.

4.2.5.1 Baseline Water Level Trends

Once the pumping well has been developed and piezometer water quality samples have been collected, water level trend baseline monitoring will start at least 7 days before the pumping test. New and/or existing transducers will be programmed and deployed in the Site area observation wells and surface water monitoring locations to quantify the natural variability and water level trends within the Site. The transducer recording interval for baseline monitoring will be set to 15 minutes (Table 2). Water levels will be measured manually and recorded during transducer deployment and at each download interval to correct for survey elevation, verify appropriate placement within the water column, and confirm functionality of the instruments. Existing equipment consists of Solinst® brand transducers that are programmed to collect water level readings every 15 minutes (SOP-GW-15) as well as record temperatures (LT model) or temperature and SC (LTC model). LTC model transducers will be placed at groundwater and surface water monitoring locations identified in Table 2 and on Figure 3. Baseline monitoring data will be downloaded prior to conducting the long-term pumping test. The Field Team Leader, CPM, and QAO may modify the location and number of transducers used for baseline water level trends or add additional steps.

4.2.5.2 Manual Water Level Measurements

Manual water level measurements will be used to convert transducer water level data to known elevations using surveyed measuring points. Manual water levels will be recorded during transducer installation, and at each download interval, weekly, or as deemed appropriate by the Field Team Leader, CPM, and QAO. Manual water level measurements will also be collected during the pumping and recovery tests at intervals deemed appropriate based on the installation of dual transducers. At a minimum, the transducers will be downloaded and manual measurements taken just prior to starting the pumping test, just before starting the recovery test, during the recovery test, and after the end of the recovery test.

Field measurement of water level at the pumping well will be conducted at appropriate intervals as directed by the Field Team Leader. These intervals will be more frequent at the beginning and end of pumping as the groundwater surface elevation decreases or increases, respectively, to equilibrium. Field team members performing manual measurements will have synchronized watches or cell phones to collect water levels recordings concurrently. To avoid error caused by measuring water levels with different meters, team members will minimize the number of water level meters used at any given location and will record any change in the water level meter equipment at a location in the appropriate field logbook (Section 4.5.2).

4.2.5.3 Automated Water Level Measurements

Water level measurements will be logged every 1-minute during the pumping test and recovery test (Table 2). Although the variability of measured water levels during the pumping test phase will decrease over the period of pumping and recovery, a logarithmic recording cycle will not be used because of the unknown start time for the recovery portion of the pumping test and the fact that the transducers will have ample data storage space. The Field Team Leader, CPM, and QAO may modify measurement intervals for the transducers to meet changing conditions (e.g., extended pumping as outlined in Section 4.2.7). Manual water level measurements will be collected at the time of transducer installation or at any download event.

4.2.6 Flow Rate Monitoring

Flow and level will be recorded continuously in the subdrain at 15-minute intervals via dedicated area-velocity flow meters (ISCO 2150 Area Velocity Module or equivalent) for the duration of pumping test activities at nearby manhole locations, MH-MSD106 and MH-MSD108. Manual depth measurements will be recorded at each download interval, weekly, or as deemed appropriate by the Field Team Leader, CPM, and QAO. Existing BPSOU subdrain pump station in-line magnetic flow meters (installed in north and south discharge lines) (Atlantic Richfield Company, 2021b) will corroborate flow measurements collected at BTC-PW-01 (Section 4.2.3.2) and the BPSOU subdrain manhole locations.

Stage-discharge reporting for USGS stations 12323233 and 12323242 (USGS, 2022) will provide continuous flow and level measurements for BTC and SBC, respectively. Pilot Project discharge flow rates measured and reported as described in the BMFOU Pilot Project QAPP (Atlantic Richfield Company and Montana Resources, 2021) and Discharge System Field Sampling Plan (Atlantic Richfield Company, 2022a) will be used to assess local effects of potential variable effluent discharge.

4.2.7 Long-Term Pumping Test and Recovery Test

The pumping test will be scheduled during consistent weather conditions without significant precipitation and local or high-elevation runoff conditions resulting in steady flows at USGS BTC Station 12323233. Coordination will also be necessary with the BMFOU polishing facility to maintain steady creek flows at SBC Station USGS 12323242 (Figure 1) (USGS, 2022). The schedule will be adjusted to minimize data complications from precipitation and/or fluctuations in surface water elevations for the duration of the pumping and recovery tests.

The pumping test will extend a minimum of 72 hours, depending on the stabilization of the aquifer and the observed effects of any delayed yield (if applicable). Pumping rates and adjacent drawdown will be monitored for the duration of pumping, although automation and/or telemetry of the pump and monitoring system will be implemented where possible to reduce necessary personnel. The recovery test will be conducted for approximately 72 hours, depending on recovery of the aquifer. Pumping and recovery test water levels will be measured per Section 4.2.7.1. The Field Team Leader, CPM, and QAO will determine the end of the pumping test and recovery test.

The tasks listed in this section are necessary to conduct the pumping test. Each task is broken into greater detail to list the steps necessary to complete a comprehensive, reliable pumping test. The Field Team Leader, in consultation with the CPM and/or QAO, may modify the configuration, duration, and other details regarding each long-term pumping test, depending on the field conditions and final setup of the pumping test.

4.2.7.1 Recovery

Once the decision is made to conclude the active pumping of the test well, preparations for conducting the recovery test will begin. Transducers will record water levels at 1-minute intervals during the recovery test. The recovery test will be conducted for approximately 72 hours; the Field Team Leader, in consultation with the CPM and/or QAO, may modify the duration of the recovery test, depending on the observed rate of recovery (Section 4.2.6).

4.2.7.2 Drawdown Data Analysis

Data from all observation wells where notable drawdown/recovery occurs will be analyzed using the AQTESOLV software package, or equivalent. For the purposes of this Investigation, notable drawdown is defined as a change in water level that is greater than the water level transducer instrument error and is distinguishable from natural variability measured during the 7 days leading up to and 7 days following each pumping test. During the data analyses activity, drawdown data will be corrected for groundwater trends and barometric changes. It is anticipated that a subset of more distant observation wells will not have notable drawdown, demonstrating that the pumping test had limited to no effect on the aquifer at those locations.

4.3 Weather Monitoring

Weather will be monitored through all phases of the long-term pumping test including daily high and low temperatures, barometric pressure, and precipitation amounts. The test will be performed in periods of fair weather, as much as possible. Weather events that do occur during baseline monitoring, pumping test monitoring, or recovery test monitoring will be noted in the field logbook. The weather station located at BTL/Lower Area One (LAO) (KMTBUTTE5) will be used to monitor high and low temperatures and document precipitation amounts. Barometric pressure will be monitored and recorded using a Solinst Barologger (barologger) set to record barometric pressure every 15 minutes. The barologger will be kept at Pioneer's office in Butte to safeguard the monitoring tool.

4.4 Standard Operating Procedures

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

4.5 Documents and Records

The following sections outline the recording, sample tracking, and documentation procedures implemented for the pumping test. All significant observations, measurements, data, and results will be clearly documented in field logbooks or on field data sheets according to the methods and procedures outlined in SOP-SA-05 Project Documentation (Appendix A).

All water quality samples collected as part of the pumping test investigation will be shipped to a laboratory for analyses as detailed in Table 3. Laboratory analyses of the samples collected during this study will be performed by an Atlantic Richfield-approved laboratory with established protocols and quality assurance (QA) procedures that meet or exceed EPA guidelines. Standard laboratory turnaround times will be requested.

4.5.1 Sample Labeling and Identification

A sample number system will be used to uniquely identify the project Site, the sample type, and the specific sample location. The following is an example of the sample numbering system:

Sample Number: **BTC-PZ02S-091022-D**

Location/Year:	*"BTC"* – BTC project area, collected in 2022.
Media:	"*PZ*" – sampled from a piezometer in BTC Site.
Location:	"*02S*" – piezometer location and paired piezometer depth ("S" for shallow).
Date:	*"091022"* - sample collected on September 10, 2022.
Duplicates:	"D" – duplicate samples will be recorded on the field log or logbook.

A permanent marker will be used for labeling. All groundwater samples will be collected in the appropriate groundwater sample container with preservative in place from the laboratory (if necessary). Samples will be collected and shipped to the identified laboratory for analyses. Samples will be stored, handled, and shipped as described in Table 3. A copy of the chain of custody record will accompany the samples during shipment and will serve as the laboratory request form. A chain of custody form will be completed that specifies the type of analysis requested for each individual sample. The original form will be maintained with the field notes and in the project records.

4.5.2 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 Site conditions during sampling activities. Each logbook will be bound and will have a unique document control number and consecutively numbered pages. All entries will be in waterproof ink, and any mistakes will be crossed 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 global positioning system (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:

- Description of the field task or applicable field SOPs (Appendix A).
- Time and date fieldwork started.
- Location and description of the work area including sketches, if possible, map references, and references to photographs collected.
- Names and titles of field personnel.
- Name, address, and phone number of any field contacts or Site visitors (e.g., Agency representatives, auditors, etc.).
- Meteorological conditions at the beginning of fieldwork and any ensuing changes in the weather conditions.
- Details of the fieldwork conducted, and the field data sheets used.
- All field measurements made.
- Any field analysis results.
- Personnel and equipment decontamination procedures (SOP-DE-01 and SOP-DE-02).
- Deviations from this QAPP.

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

- Sample location and identification (ID) number.
- Sample type collected.
- Date and time of sample collection.
- Sample location descriptions and designations. Further sample information will be included with the laboratory results.
- Sampling method, particularly any deviations from the field SOPs (Appendix A).
- Sample preservation (if used).

4.5.3 Field Photographs

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

- Time, date, and location.
- Photograph number from the camera, as necessary.
- Identity of the person taking the photograph.
- 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.

4.5.4 Sample Handling, Documentation, and Shipping

As applicable, samples will be either hand delivered or shipped via Federal Express, or equivalent, to the appropriate laboratory under the chain of custody procedures detailed in SOP-SA-04. Samples will be shipped in appropriate containers that will prevent detrimental effects to the sample.

Sample containers and holding times are listed 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).

4.5.5 Chain of Custody

The SOP for chain of custody (SOP-SA-04) is in Appendix A. Maintaining the integrity of the sample from collection through data reporting is critical to the sampling and analytical program. This process includes the ability to trace the possession and handling of samples from the time of collection through analysis and final disposition. This documentation of the sample's history is referred to as chain of custody. A sample is considered 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.

4.5.5.1 Chain of Custody Form

A chain of custody form will be completed and will accompany every sample. 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, date, and time.
- Receiving signature, date, and time.

4.5.5.2 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.

4.5.5.3 Laboratory Custody

Laboratory custody procedures will conform to procedures established for the EPA Contract Laboratory Program (CLP) (EPA, 2016b). These procedures include the following:

- Designation of sample custodian.
- Correct completion of the chain of custody form, recording sample identification numbers, and documenting 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 so that 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).

4.5.6 Analytical Laboratory Records

Results received from the laboratory will be documented both in report form and in an electronic format. Laboratory documentation will include copies of the signed chain of custody forms, laboratory confirmation reports that include information on how samples were batched and the analyses requested, sample data packages that include the laboratory report and the electronic data deliverable (EDD), and any change requests or corrective action requests. Section 4.6.2 lists the laboratory reporting requirements in detail. The deliverable (“limited data package”) issued by the laboratory will include data necessary to complete validation of laboratory results according to the specifications included in Section 8.0. Original hard copy deliverables and electronic files received from the laboratory will be maintained with the project QA/quality control (QC) records.

Excel spreadsheets have been developed to enable data retrieval for validation. These spreadsheets are populated during the data validation process and resubmitted to the data management team. The validated data, including associated validation qualifiers, codes, quality designation for each data point, and Level A/B status for each sample, are then uploaded to the database. Analytical data submitted directly to the database coordinator will be uploaded to the EQuIS system once review and validation are complete. The QA/QC checks are in place to ensure that data upload is successful and data quality is preserved.

4.6 Quality Assurance/Quality Control Samples

The following sections outline the QA and QC sample collection that will be performed during the test for the various field and laboratory samples collected as part of sampling activities.

4.6.1 Field Quality Control Samples

Field QC samples are used to identify any biases from transportation, storage, and field handling processes during sample collection and to determine sampling precision. All field QC samples will be shipped with field samples to the laboratory per SOP-SA-01, SOP-SA-02, SOP-SA-03A, and SOP-SA-03B (Appendix A). Brief descriptions of the field QC samples are below along with when and how many need to be collected. A summary of the control limits for field QC samples and the corrective action required for failure to meet criteria are listed in Table 4. This includes control limits for field XRF performed for BTC-PW-01 (Section 2.3.5 and Appendix C.3) as these XRF data will be evaluated under this QAPP. A description of field XRF QC samples can be found in the *Final BTL Stress Test QAPP* (Atlantic Richfield Company, 2021a) under which the XRF data were originally collected.

4.6.1.1 Field Duplicates

Field duplicates will be collected for the groundwater sampling. A field duplicate is an identical, second sample collected from the same location immediately after the primary sample is collected 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 samples will be compared to determine sampling precision. Field duplicate samples will be collected at a frequency of 1 per 20 samples.

4.6.1.2 Field Blanks

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

4.6.1.3 Equipment, Cross Contamination, or Rinsate Blanks

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

4.6.2 Laboratory Quality Control Samples

Laboratory QC samples are introduced into the measurement process to evaluate laboratory performance and sample measurement bias. Laboratory QC samples may be prepared from environmental samples or generated from standard materials in the laboratory per laboratory SOPs. 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. A summary of the control limits for laboratory QC samples and the corrective action required for failure to meet criteria are listed in Table 4. A sample will be designated for use as a matrix spike sample on the chain of custody form in the notes/comments section for that sample at a rate of 1 in 20 natural samples. Additional volume for a matrix spike sample may be required depending on the method.

4.6.2.1 Laboratory Blanks

Method blanks (MBs) will be used to monitor laboratory processes and performance. A MB is a volume of deionized water that is carried through the entire sample preparation and analyses procedures. The MB volume or weight will be approximately equal to the sample volumes or sample weights being processed. The MBs are used to monitor interference caused by constituents in solvents and reagents and on glassware and other sampling equipment. Blank results outside of specified control limits will be rerun and/or flagged by the laboratory per the QC requirements of the analytical method.

4.6.2.2 Laboratory Control Samples

A laboratory control sample (LCS), or a blank spike, is a control sample of known composition that is analyzed using the same sample preparation, reagents, and analytical methods employed for the project samples. The LCS is obtained from an outside source or is prepared in the laboratory by spiking reagent water or a clean solid matrix from a stock solution that is different from that used for the calibration standards. The LCS is the primary indicator of process control used to demonstrate whether the sample preparation and analytical steps are in control, apart from sample matrix effects. If the LCS recovery falls outside the specified control limits, the samples will be rerun and/or flagged by the laboratory per the QC requirements of the analytical method.

LCS analyses will be performed every 20 samples; failure will trigger corrective action and reanalysis of non-detect samples per laboratory method (Appendix A).

4.6.2.3 Analytical Duplicates

Analytical duplicates are samples that are split in the laboratory at some step in the measurement process and then carried through the remaining steps of the process. Duplicate analyses provide information on the precision of the operations involved. As the analytical duplicates are a pair of subsamples from a field sample taken through the entire preparation and analyses procedure, any difference between the results indicates the precision of the entire method in the given matrix. Analyses of analytical duplicates and laboratory matrix spike duplicates (LMSD) monitor the precision of the analytical process. The frequency of analyses, precision goals, and corrective action information pertaining to analytical duplicates is included in example SOPs included in Appendix A. Information related to specific sites will be included in the individual site documents. If the analytical duplicate precision falls outside the specified control limits, the samples will be rerun and/or flagged by the laboratory per the QC requirements of the analytical method.

4.6.2.4 Matrix Spikes

Laboratory matrix spike (LMS) samples are used to evaluate potential sample matrix effects on the accurate quantitation of an analyte using the prescribed analytical method. The LMS and LMSD samples are prepared by adding an analyte to a subsample of a field sample before sample preparation and analyses. A percent recovery is calculated from the concentrations of the analyte in the spiked and unspiked samples. Control limits vary based on laboratory method. A LMS and/or LMSD failure will trigger corrective action including, for some analyses, performing a post digestion spike (PDS).

4.6.2.5 Post Digestion Spike

The PDSs will be prepared and analyzed based on laboratory method and as corrective action in the event of LMS and/or LMSD failure. Control limits also depend on the method and are contained in the applicable laboratory method and SOP included in Appendix A.

4.6.3 Field Equipment

To verify continual quality performance of all instruments and equipment, testing, inspections, and maintenance will be performed and recorded as described in this section. All field and laboratory equipment will be operated, maintained, calibrated, and standardized according to all EPA and manufacturer's recommended procedures. Field equipment will be examined to verify that it is in proper operating order prior to its first use. Equipment, instruments, tools, gauges, and other items requiring preventative maintenance will be serviced and/or calibrated according to 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. Any equipment deficiencies or malfunctions during fieldwork will be recorded, as appropriate, in field logbooks.

The following screening steps will be taken to verify that the water level measuring device data accurately represent field conditions.

- **Calibration:** Calibration of the SC metering transducers will be completed in the Pioneer office prior to deployment per manufacturer's specification.
- **Compensation:** Raw water level data will be barometrically compensated and, if necessary, manually adjusted in an appropriate program to match acceptable manual water level measurements recorded in the field notes (manual measurements at deployment and each download). The compensated data will then be downloaded into the project database and plotted and analyzed for abnormalities (e.g., spikes, drops, inconsistencies, fluctuations, etc.).
- **Comparison:**
  - To justify atypical water level fluctuations, water level data will be compared to precipitation events at the BTL weather station (Section 4.3), flow data within the creek, and other relevant information.
  - Background trends in water levels will also be determined before pumping begins.
  - Any discrepancies will be flagged in the data.

The following screening steps will be taken to verify that the flow meter data accurately represent field conditions and to identify a threshold where the differences in flow meter readings are considered significant.

- **Verify Accuracy and Precision:** Verify that flow meters are reading both accurately and similarly to each other by measuring flows at BTL on a pipe near a calibrated flow meter.
- **Identify Threshold for Inspection:** Identify a threshold of difference between the two flow meters that would initiate an inspection by the field team. The Field Team Leader and CPM, in consultation with the QAO, will identify the threshold based on the variance of simultaneous flow measurements and professional judgement.

4.6.4 Laboratory Equipment

Instruments used by the approved laboratory(ies) will be maintained according to the laboratory QA plan requirements and analytical method requirements. All analytical measurement instruments and equipment used by the laboratory(ies) will be controlled by a formal calibration and preventative maintenance program.

The laboratory(ies) will keep maintenance records and make them available for review, if requested. Laboratory(ies) preventative maintenance will include routine equipment inspection and calibration at the beginning of each day or each analytical batch, per the laboratory internal SOPs and method requirements.

4.7 Inspection/Acceptance of Supplies

All equipment used for the investigation will be checked to verify that the condition of all components is satisfactory and 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). The Field Team Leader and/or field team members will inspect the field supplies. The personnel at each laboratory will be responsible for inspecting laboratory supplies according to the laboratory QA program.

4.8 Data Management Procedures

This section describes how the data for the project will be managed, including field and laboratory data. Data will be managed according to the BPSOU *Final Draft Data Management Plan* (Atlantic Richfield Company, 2017). The QAPP quality records will be maintained by Atlantic Richfield. These records, in either electronic or hard copy form, may include the following:

- Project sampling plan with any approved modifications, updates, and addenda.
- Project QAPP with any approved modifications, updates, addenda, and any approved corrective or preventative actions.
- Field documentation (including logbooks, data sheets, and photographs) in accordance with SOP-SA-05 Project Documentation (Appendix A).
- Chain of custody records (SOP-SA-04 Chain of Custody Forms for Environmental Samples in Appendix A).
- Field forms as provided in Appendix D.
- Laboratory documentation (results received from the laboratory will be documented in hard copy and in an electronic format).
- Data Summary Report (DSR).
- Data Validation Report (DVR).
- PDI ER.

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

All field and laboratory data and supporting documentation will be subject to appropriate review to verify the accuracy and completeness of original data records prior to being uploaded 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 EDDs provided in Microsoft Excel format and correlating portable document format (PDF) Level 2 "limited data packages" will be reviewed as part of the internal data review process. Following these review steps, field and laboratory electronic data files will be imported to the project database.

Standardized data import formats and procedures will be used to upload both field and laboratory information 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 datasets and within the database. Using these standardized formats will allow quick querying to retrieve data as desired. Data can be retrieved by exporting into an Excel file, and because the data will be formatted with parameter names, data can be made into a pivot table in Excel for data processing.

5.0 DATA MEASUREMENT PERFORMANCE CRITERIA

Specific data validation processes verify that analytical results are within acceptable limits. All information and data gathered during this investigation will be checked to verify they are usable for their intended purposes. An evaluation of analytical control limits and of the precision, accuracy, representativeness, comparability, completeness, and sensitivity (PARCCS) parameters will be performed (Table 5). If significant issues with the data are found, data results will be discussed with EPA and Montana DEQ project managers. EPA, in consultation with 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 definitions of PARCCS are provided below along with the acceptance criteria for collected data and sensitivity parameters.

5.1 Precision

Precision is the amount of scatter or variance that occurs in repeated measurements of a particular analyte. Analytical precision is determined by the analyses of field and laboratory generated duplicates. An analytical duplicate is the preferred measure of analytical method precision. The overall random error component of precision is a function of sampling. Precision may be evaluated using duplicate analyses of laboratory prepared samples such as LCS/LCSD (laboratory control sample duplicate) and LMS/LMSD samples. Relative Percent Difference (RPD) is one way of reporting precision.

For this QAPP, precision will be determined by the analyses of field duplicates, laboratory (analytical) duplicates, and the evaluation of the RPD for these various paired measurements. For this study, acceptable precision will be an RPD of plus or minus 20% for aqueous samples when sample results are greater than 5 times the Reporting Limit (RL). If either of the sample results are less than 5 times the RL, the control limit used will be an absolute difference between sample results less than the RL. This precision requirement is derived from the *National Functional Guidelines* (NFG) *for Inorganic Superfund Methods Data Review* (EPA, 2020b) and the *CFRSSI QAPP* (ARCO, 1992b).

5.2 Accuracy

Accuracy is the ability of the analytical procedure to determine the actual or known quantity of a particular substance in a sample. The LCS and LMS are used to measure accuracy, and accuracy acceptance or rejection is based on the percent recovery (%R) of the LMS and LCS. Perfect recovery will be 100% (the analysis result is exactly the known concentration of the LMS or LCS). An acceptable accuracy range is 80.0% to 120.0% in aqueous samples. Accuracy requirements for this project are derived from the NFG (EPA, 2020b) and the *CFRSSI QAPP* (ARCO, 1992b).

5.3 Representativeness

Data representativeness is defined as the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or environmental conditions. Representativeness is a qualitative parameter that is most concerned with the proper design of the sampling program. Representativeness will be achieved through judicious selection of sampling locations and methods. This QAPP has been designed to provide samples that are representative of the medium being sampled in sufficient quantity to meet the project DQOs and to satisfy the required design elements.

The CPM, in consultation with the Groundwater Remedy Project Manager (BTC PM), will review the QAPP to verify that it is designed to collect the data and information necessary to meet the purpose of the investigation. The review will consider the volume, variability, and intended use of the data to verify proper sampling methods and adequate spatial distribution of samples.

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

5.4 Comparability

Data comparability is defined as the measure of the confidence with which one dataset can be compared to another. Comparability is a qualitative parameter but must be considered in the design of the sampling plan and selection of analytical methods, QC protocols, and data reporting requirements. Comparability will be verified by analyzing samples obtained according to this QAPP and the appropriate SOPs, which are comparable to the sampling methods used during previous investigations at the Site. All data will be reported in units consistent with standard reporting procedures so that the analytical results can be compared with results from previous investigations. Groundwater elevations will be measured in feet (North American Vertical Datum [NAVD] 88).

5.5 Completeness

Completeness determines if enough valid data have been collected to meet the investigation needs. Completeness for project requirements is assessed by comparing the number of planned samples to the number of samples collected. Completeness of data quality is assessed by comparing the number of valid sample results to the number of sample results collected during the investigation. The completeness target for this investigation is 95% or greater as designated in the *CFRSSI QAPP* (ARCO, 1992b).

5.6 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.

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. A review of these detection limits will be conducted as part of the data validation process (Section 8.0).

Laboratory Analyses
The method sensitivity for laboratory analyses is determined as part of the laboratory's SOPs. A review of these detection limits will be conducted as part of the data validation process (Section 8.0).

6.0 ASSESSMENT AND OVERSIGHT

Assessment and oversight of data collection and reporting activities are designed to verify that sampling and analyses are performed according to the procedures established in this QAPP. The audits of field and laboratory activities include two independent parts: internal and external audits. Internal audits will be performed by Atlantic Richfield, their contractor, or a contracted laboratory consultant, as necessary. EPA will perform external audits, as necessary. This section describes the performance and systems audits of field and laboratory data collection and reporting procedures.

6.1 Field Activities Oversight

Any deviations from this 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 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 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. Several 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 analysis. Corrective actions to address these conditions will be taken in consultation with the Project Manager/Coordinator and reported on a Corrective Action Report (CAR) form (Appendix D). 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.

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 Project Manager/Coordinator and Field Team Leader will review to assess whether reanalysis or resampling 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. If corrective action requests are not in complete accordance with approved project planning documents, EPA will be consulted, and concurrence will be obtained before the change is implemented. All corrective action records will be included with the QAPP records.

6.3 Corrective Action During Data Assessment

During data assessment, the QAO could identify the need for corrective action. Potential types of corrective action include resampling by the field team, reanalyzing samples by the laboratory, or requesting revised Level 2 data packages from the analytical laboratory if clerical or reporting errors are identified. The appropriate and feasible corrective actions are dependent 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 consensus will be attained before the change is implemented. Corrective actions of this type will be documented by the QAO on a CAR and will be included in any subsequent reports.

6.4 Quality Assurance Reporting

After the investigation is complete, Atlantic Richfield's contractor will prepare a PDI ER (Section 11.0) summarizing the sampling activities. The report will describe specific field activities performed and the physical characteristics of the study area. The report will include field documentation, documentation of field QC procedures, and the results of all field and laboratory audits. The report will also contain a discussion of the Data Quality Assessment (DQA). These discussions will contain the results of any associated field and laboratory audits, information generated on achieving specific DQOs, and a summary of any corrective actions that were implemented and their immediate results on the project. A detailed listing of any deviations from the approved QAPP will also be provided with an explanation for each deviation and a description of the effect on data quality and usability, if any. This information will be compiled into a DVR included with the PDI ER.

The CPM and Contractor QAO are responsible for preparing the PDI ER. The report will be submitted to EPA and Montana DEQ for review. Upon receipt of Agency comments, prepared by EPA in consultation with Montana DEQ, the report will be revised to address the comments and resubmitted to EPA for final approval.

7.0 HEALTH AND SAFETY

All work completed by Pioneer and its subcontractor during the execution of the pumping test will be performed according to all procedures outlined in the SSHASP. Potential hazards associated with this work include the following:

- Late or long hours associated with the pumping test data collection.
- Working around heavy equipment hazards.
- Exposure to heavy metals from impacted soil and groundwater.

Site-specific hazards and applicable control measures will be addressed in the SSHASP. All tasks will be risk assessed prior to starting work.

8.0 DATA VALIDATION AND USABILITY

This section addresses the final project checks conducted after the data collection phase of the project is completed to confirm that the data obtained meet the project objectives and to estimate the effect of any deviations on data usability for the express purposes of achieving the stated DQOs (Section 3.0). Based on a review of EPA guidance, Atlantic Richfield will conduct a Level 2 data validation. The analytical data collected will undergo Stage 2A Validation Electronic and Manual (S2AVEM) validation as defined in EPA *Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use* (EPA, 2009) (Level 2 data validation).

8.1 Data Review

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

8.1.1 Field Data Review

Raw field data will be entered in field logbooks and/or field data sheets, 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 the field crew have made any transcription errors. If transcription errors have been made, the Field Team Leader and field crew will address the errors to provide resolution.

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

8.1.2 Laboratory Data Review

Internal laboratory data reduction procedures will be conducted according to each laboratory's quality management plan. At a minimum, the analysts will maintain paper records to document the sample identification number and the sample tag number with sample results and other details, such as the analytical method used (e.g., method SOP), name of analyst, the date of analysis, matrix sampled, reagent concentrations, instrument settings, and the raw data. These records will be signed and dated by the analyst. Secondary review of these records by laboratory personnel will take place prior to final data reporting to Atlantic Richfield. The laboratory will appropriately flag unacceptable data in the data package.

8.2 Data Verification

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

8.2.1 Field Data Verification

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

The Level A criteria are as follows:

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

The Level B criteria are as follows:

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

8.2.2 Laboratory Data Verification

The laboratory will prepare Level 2 data packages for transmittal of results and associated QC information to Atlantic Richfield or its designee within a standard turnaround time, unless otherwise required, with all the requested types of information in an organized, consistent, and readily reviewable format.

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

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

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

8.2.3 Verification and Validation Methods

The Level A/B Assessment checklists included in Appendix E are based on the *CFRSSI DM/DV Plan* guidance (ARCO, 1992c). Level 2 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.
- Preservation.
- Reported detection limits.
- MBs.
- LCS and LCSD.
- MS and MSD samples.
- Post-digestion spikes (per corrective action based on laboratory method only).
- Laboratory Duplicate Sample (LDS).

- Field blanks.
- Field duplicates.

Field XRF data verification and validation will include verification and validation checks for laboratory data including an evaluation of the following, as applicable for each method and as described in detail in the Final BTL Stress Test QAPP (Atlantic Richfield Company, 2021a):

- Holding times.
- Preservation.
- Blanks.
- Calibration verification check samples.
- Duplicate samples.
- Replicate Samples.

Data qualifiers will follow those used in the NFG for Inorganic Superfund Methods Data Review (EPA, 2020b). Data validation for each laboratory data package will be documented on the Stage 2A Data Validation Checklist in Appendix E. Data validation for XRF will be documented on the XRF Data Validation Checklist Appendix E.

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

8.2.4 Reconciliation and User Requirements

The DQA process described in the *CFRSSI DM/DV Plan* (ARCO, 1992c) and the *Guidance for Data Quality Assessment EPA QA/G-9* (EPA, 2000) will be used 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 interpretation of results but will state conclusions regarding the quality of the results).

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

The PARCCS data quality indicators (Section 5.0) will be used when conducting the DQA. If the PARCCS assessment satisfies the project DQOs, then usability of the data will follow the enforcement/screening/unusable data categories as described in the *CFRSSI DM/DV* (ARCO, 1992c):

1. Enforcement Quality (Unrestricted Use) Data

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

2. Screening Quality (Restricted Use) Data

   Potential uses of screening quality data, depending on their quality, include site characterization, determining the presence or absence of COCs, 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 qualified first as screening quality but deemed usable during the DQA and also associated with Level B criteria will be identified as Enforcement quality, using the "A" qualifier per *CFRSSI DM/DV* (ARCO, 1992c). The rationale for data usability will be documented in the DSR and will therefore meet the administrative record requirement. Data that meet only the Level A criteria and are not rejected during the data validation process can be assessed as screening quality data. Screening quality data can be used only for certain activities, which include engineering studies and design. Data that do not meet the Level A and/or B criteria and/or are rejected during the data validation process are designated as unusable. The data are assigned one of the following qualifiers:

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

Enforcement/Screening Designation Guide

	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

9.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

This section addresses available resources and roles of project execution.

9.1 Roles, Duties, and Responsibilities

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

Atlantic Richfield Liability Manager – Josh Bryson

The Atlantic Richfield Liability Manager communicates directly to the Agencies on project matters, monitors the performance of the contractor(s), consults with the CPM and 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 Liability Manager on company policies regarding quality and has the authority and responsibility to approve specific QA documents including this QAPP.

Blacktail Creek Groundwater Control Project Manager (BTC PM) – Brent Lucyk (Stantec)

The BTC PM maintains consistency in the direction of work performed across the groundwater remedy program as part of the BPSOU CD. The BTC PM is responsible for verifying that the work meets the requirements set forth in the BPSOU CD and is consistent with the overall project schedules and goals of the groundwater remedy optimization efforts. The BTC PM will serve in an advisory role to the CPM and QAO with respect to meeting project goals, evaluating the significance of any changes or field decisions as they fit into BPSOU CD work progression, and maintaining consistency between interrelated projects.

Contractor

Pioneer is the Contractor responsible for conducting the elements of the pumping test under the direction of Atlantic Richfield.

Contractor Quality Assurance Officer (QAO) – Adam Logar

The Contractor QAO is responsible for verifying effective implementation of QAPP requirements and procedures, including reviewing field and laboratory data, and evaluating data quality. The QAO may conduct on-site reviews and prepare site review reports for the QAM. The QAO will have a direct line of communication to the QAM to resolve issues related to project QA.

The 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 Contractor Project Manager (CPM) – Jackie Janosko

The CPM is responsible for scheduling all testing and sampling work to be completed and ensuring that the work is performed according to 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 and verifying effective implementation of QAPP requirements and procedures. This includes reviewing field and laboratory data and evaluating data quality.

Pioneer Field Team Leader – Drew Conrady

The Field Team Leader verifies that the QAPP and any associated requests for changes have been reviewed by all members of the field team and the 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, managing equipment, and coordinating with the CPM and 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 work activities to maintain compliance with technical project requirements and the SSHASP. The Field Team Leader is responsible for identifying potential Integrity Management issues during field activities and reporting any issues to the QAO.

Safety and Health Manager – Tara Schleeman

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

Subcontractor

At least four subcontractors (Hunter Brothers Construction, Jordan Construction, O'Keefe Drilling, and Colbert's Electric, or equivalent) will assist with the Investigation. These companies will subcontract to Pioneer and follow all health and safety protocols established by Pioneer to work on the Site. These subcontractors have been selected due to their unique skillset and specialized equipment.

Hunter Brothers Construction (Hunter). If necessary, the fine material on the bottom of the well sump will be vacuumed out using a vacuum truck. The material will be hauled to the drying beds for disposal and treatment at the BTL. Hunter will also provide other supporting services where needed.

Jordan Construction, Inc. (JCI). JCI will be responsible for fusing and installing the discharge line as discussed in Section 4.2.3.3. The culvert underneath George Street for the discharge line was previously installed as part of the BTL Stress Test field activities.

O'Keefe Drilling (O'Keefe). O'Keefe Drilling will install the well pump. Development (if required, see Section 4.2.2.3) of the pumping test well will be performed by O'Keefe or an equivalent contractor approved by Atlantic Richfield.

Colbert's Electric (Colbert). A certified electrician from Colbert's Electric will connect the electrical service to the pump, VFD, and associated electrical systems.

9.2 Authority to Stop Work

All personnel, including third parties, have the authority, obligation, and responsibility to stop work for situations involving imminent danger to health and safety of personnel and/or environment. Safety takes precedence over schedule. Personnel have stop-work authority in circumstances where, if in the judgment of that individual, work is performed contrary to controls, safety requirements, or approved methods described in the SSHASP or herein. Upon notice of stop work, the initiator will immediately notify the affected workforce and the immediate supervisor. Communication from the immediate supervisor to additional affected parties will follow the line of communication shown on Figure 9. Problems and associated corrective actions will be documented on a CAR (Appendix D).

9.3 Laboratory

The laboratory(ies) selected to analyze the groundwater samples will be an Atlantic Richfield-approved laboratory in general accordance with EPA CLP Statement of Work (EPA, 2016b). The laboratory is required to generate and report high quality data that identify and define the chemical characteristics of groundwater for environmental investigations, remediation activities, long-term monitoring programs, discharge compliance monitoring, and waste characterization under the purview of Comprehensive Environmental Response, Compensation and 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.

10.0 SCHEDULE

Fieldwork will begin once Agency approval has been received. A proposed schedule is shown on Figure 10. Coordination with the BMFOU polishing facility will be conducted to attempt to maintain steady creek flows at USGS BTC Station 12323233 and SBC Station 12323242 (USGS, 2022) for the duration of the Investigation (Figure 1). Work will be performed as weather conditions permit. Potential constraints that could delay fieldwork include adverse weather conditions, contractor availability, coordination with land managers/users, challenges with drilling caused by Site conditions, or other unforeseen issues. Major project delays resulting from these constraints will be recorded in the field logbooks and reported to the Agencies.

11.0 REPORTING

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

DSR (Attachment to PDI ER)

- Summary of the investigations performed.
- Summary of investigation results.
- Photographs documenting the work conducted.

DVR (Attachment to PDI ER)

- Summary of validated data (i.e., tables and graphics).
- DVRs and laboratory data reports.

PDI ER

- Narrative interpretation of data and results.
- Results of statistical and modeling analyses.
- Conclusions and recommendations for RD, including design parameters and criteria.
- Recommendations for an additional phase(s) (if necessary).

The PDI ER will be submitted to EPA and DEQ for review. Upon receipt of Agency comments, prepared by EPA in consultation with DEQ, the PDI ER will be revised to address the comments and resubmitted to EPA for final approval.

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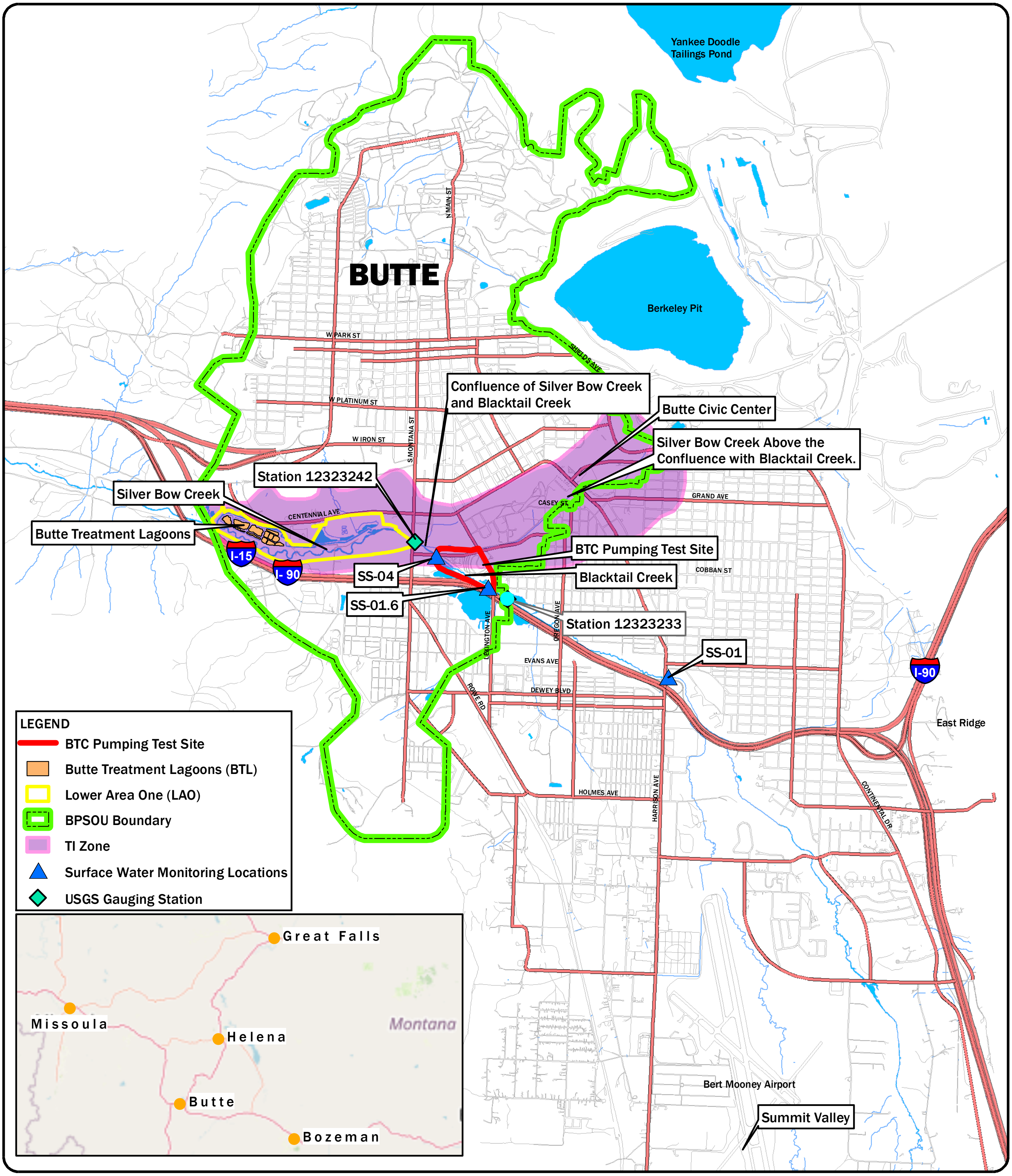
FIGURES



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UNITS: INT'L FT
SOURCE: PIONEER/ARCO/BSB

0 0.375 0.75 1.5
Miles

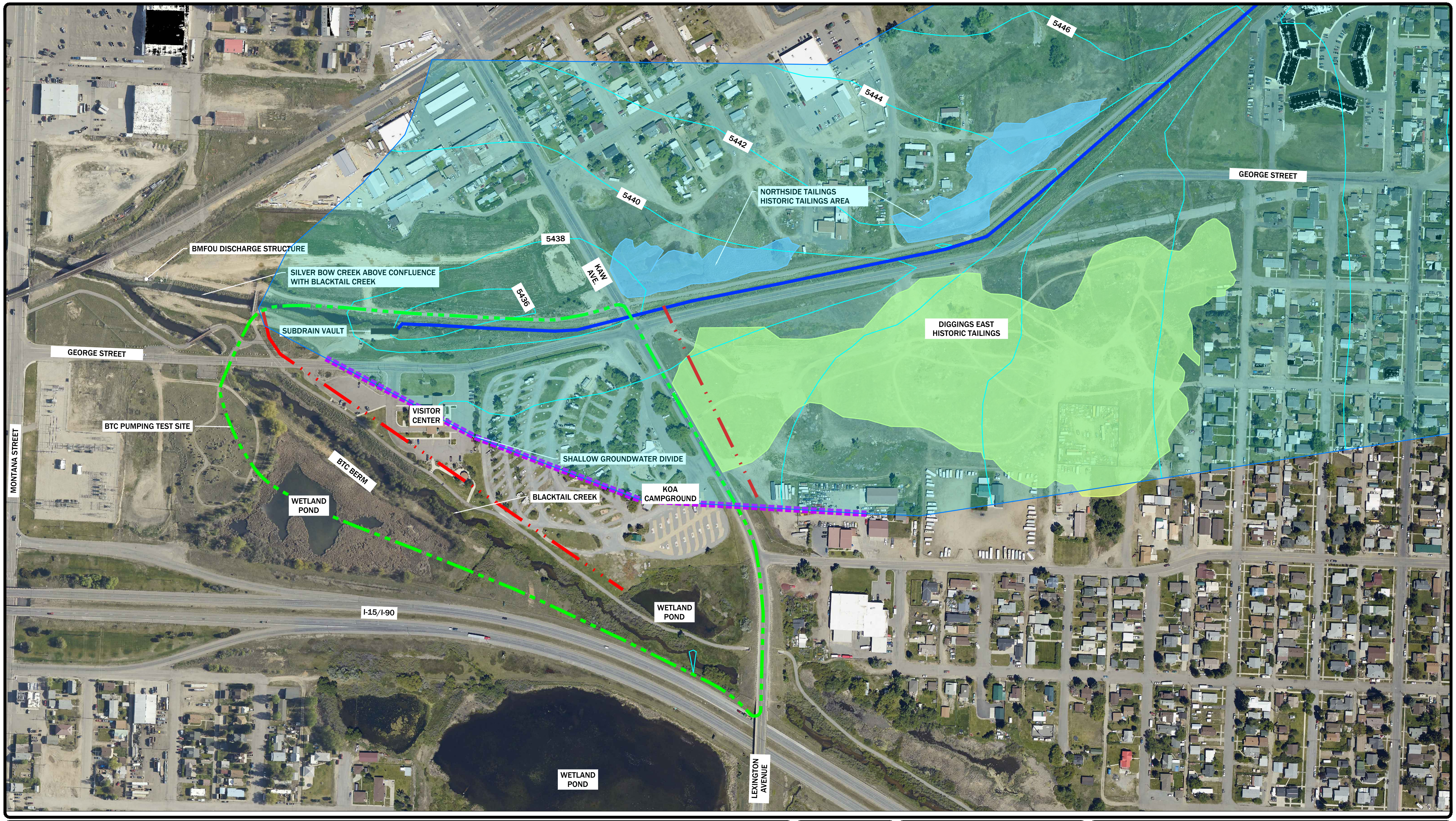
FIGURE 1

PIONEER TECHNICAL SERVICES, INC.

DATE: 6/20/2022

SITE LOCATION MAP

Path: Z:\SHARED\ACTIVE PROJECTS\ARCO\BPSOU\BTCPumpingTest\GIS\PumpingTestFinal\BTC_OPT_PumpTest_001_22.mxd



LEGEND:

- NORTHSIDE TAILINGS HISTORIC TAILINGS AREA
- DIGGINGS EAST HISTORIC TAILINGS AREA
- UAU CAPTURE ZONE AND CONTOURS (2' INTERVAL, FEB 2013)
- BTC PUMPING TEST SITE
- BPSOU SUBDRAIN
- POTENTIAL HYDRAULIC CONTROL OPTIONS (ALTERNATIVES 1A & 1B FROM DRAFT SCOPING DOCUMENT, ATLANTIC RICHFIELD, 2020)
- SHALLOW GROUNDWATER DIVIDE

N

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DATUM:	NAVD88
UNITS:	IF
SOURCE:	PIONEER/AES

SCALE IN FEET
0 300 600

FIGURE 2 SITE OVERVIEW

PIONEER TECHNICAL SERVICES, INC.
1101 SOUTH MONTANA
BUTTE, MONTANA 59701
(406) 782-5177

DATE: 2/2022

6/30/2022 10:20:38 AM Z:\SHARED\ACTIVE PROJECTS\ARCO\BPSOU\BTCPUMPINGTEST\CADD\FIGURES\BTC-FG-PLN-005-20.DWG

LEGEND

- Pumping Well
- Proposed Piezometers
- BPSOU Monitoring Stations
- Subdrain Monitoring Locations
- Existing Surface Water Monitoring Locations (See Note 1)
- NRDP Monitoring Location
- Distance from Production Well (Ft)
- Shallow Groundwater Contours March 2012 (ft)
- USGS Gauging Station
- BMFOU Discharge Structure
- BWE-4 Conductivity Metering Transducer Locations

N

DISPLAYED AS:
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DATUM: NAD 83
UNITS: INTL FT
SOURCE: PIONEER/QSI 2020

0 125 250 500
Feet

FIGURE 3

PIONEER TECHNICAL SERVICES, INC.

DATE: 6/20/2022

BTC PUMPING TEST PROPOSED OBSERVATION NETWORK

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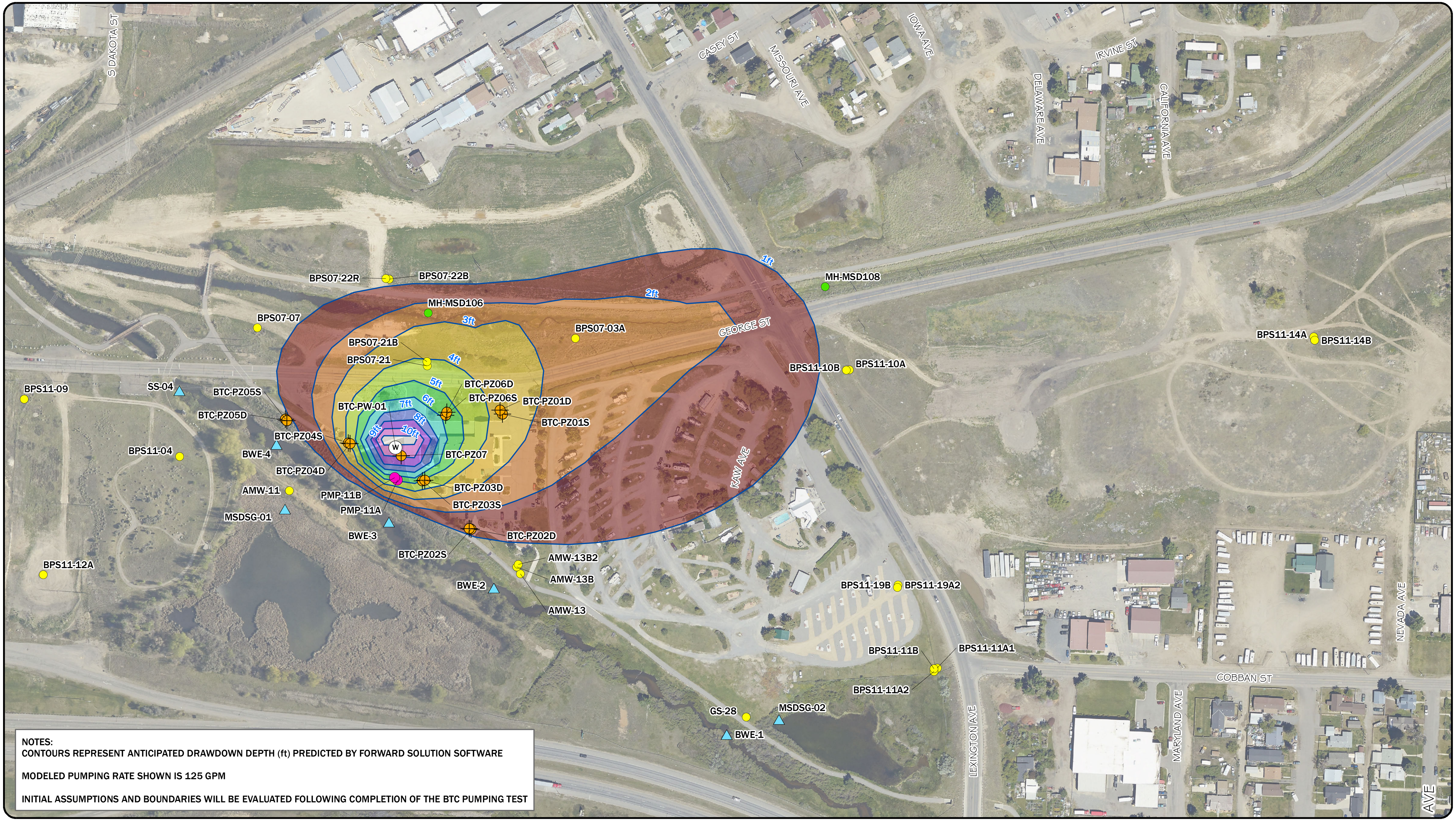

NOTES:
CONTOURS REPRESENT ANTICIPATED DRAWDOWN DEPTH (ft) PREDICTED BY FORWARD SOLUTION SOFTWARE

MODELED PUMPING RATE SHOWN IS 125 GPM

INITIAL ASSUMPTIONS AND BOUNDARIES WILL BE EVALUATED FOLLOWING COMPLETION OF THE BTC PUMPING TEST

- NRDP Monitoring Location
- Existing Surface Water Monitoring Locations
- Proposed Pumping Well
- Proposed Piezometers
- Subdrain Monitoring Locations
- BPSOU Monitoring Stations
- 2.0 ft Estimated Drawdown Depth

Estimated Drawdown

1'	2' - 3'	5' - 6'	8' - 9'
1' - 2'	3' - 4'	6' - 7'	9' - 10'
	4' - 5'	7' - 8'	

N

DISPLAYED AS:
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DATUM: NAD 83
UNITS: INTL FT
SOURCE: PIONEER/QSI 2020

0 100 200 400
Feet

FIGURE 4

ANTICIPATED DRAWDOWN IN VICINITY OF PUMPING TEST

PIONEER TECHNICAL SERVICES, INC.

DATE: 6/14/2022

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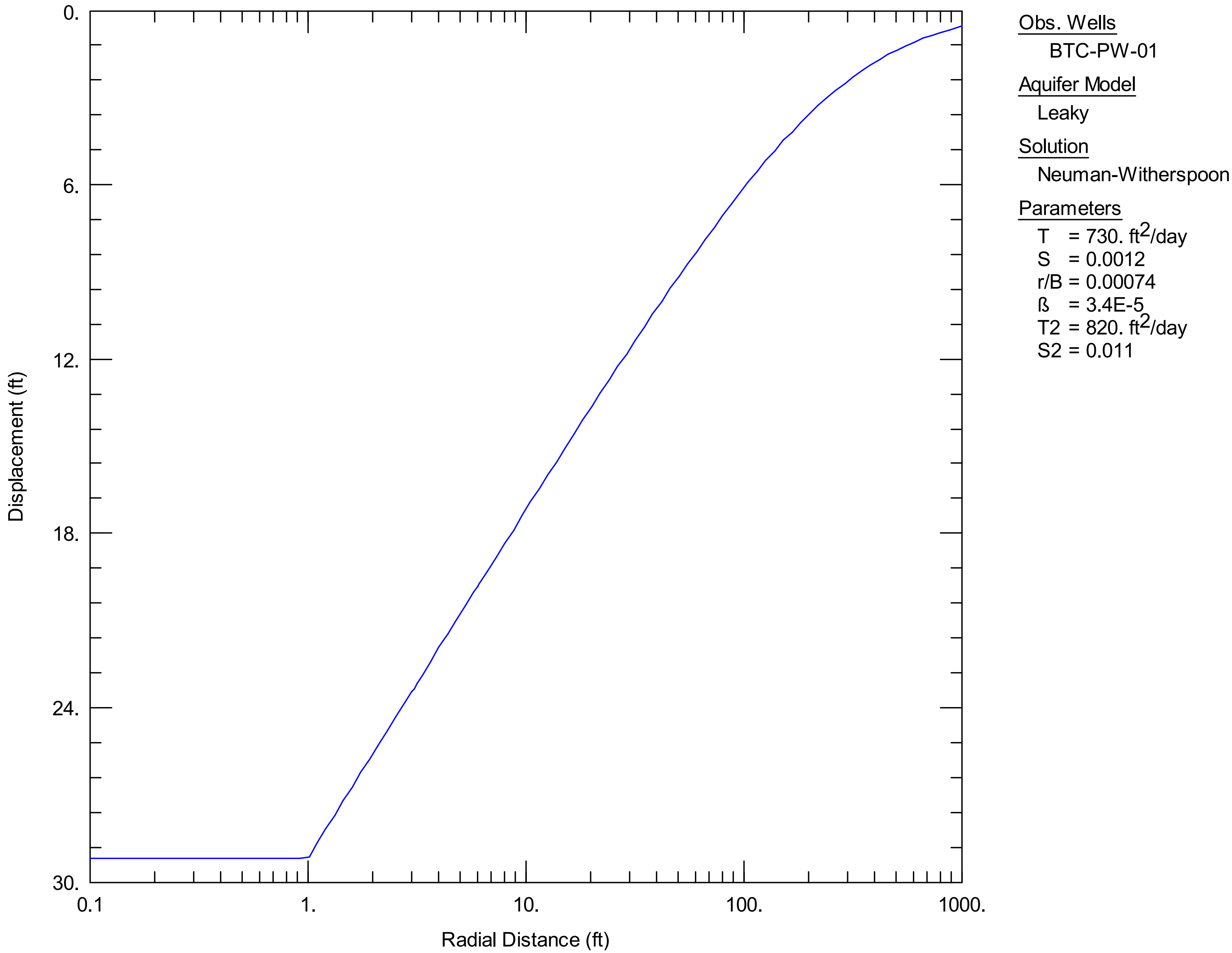
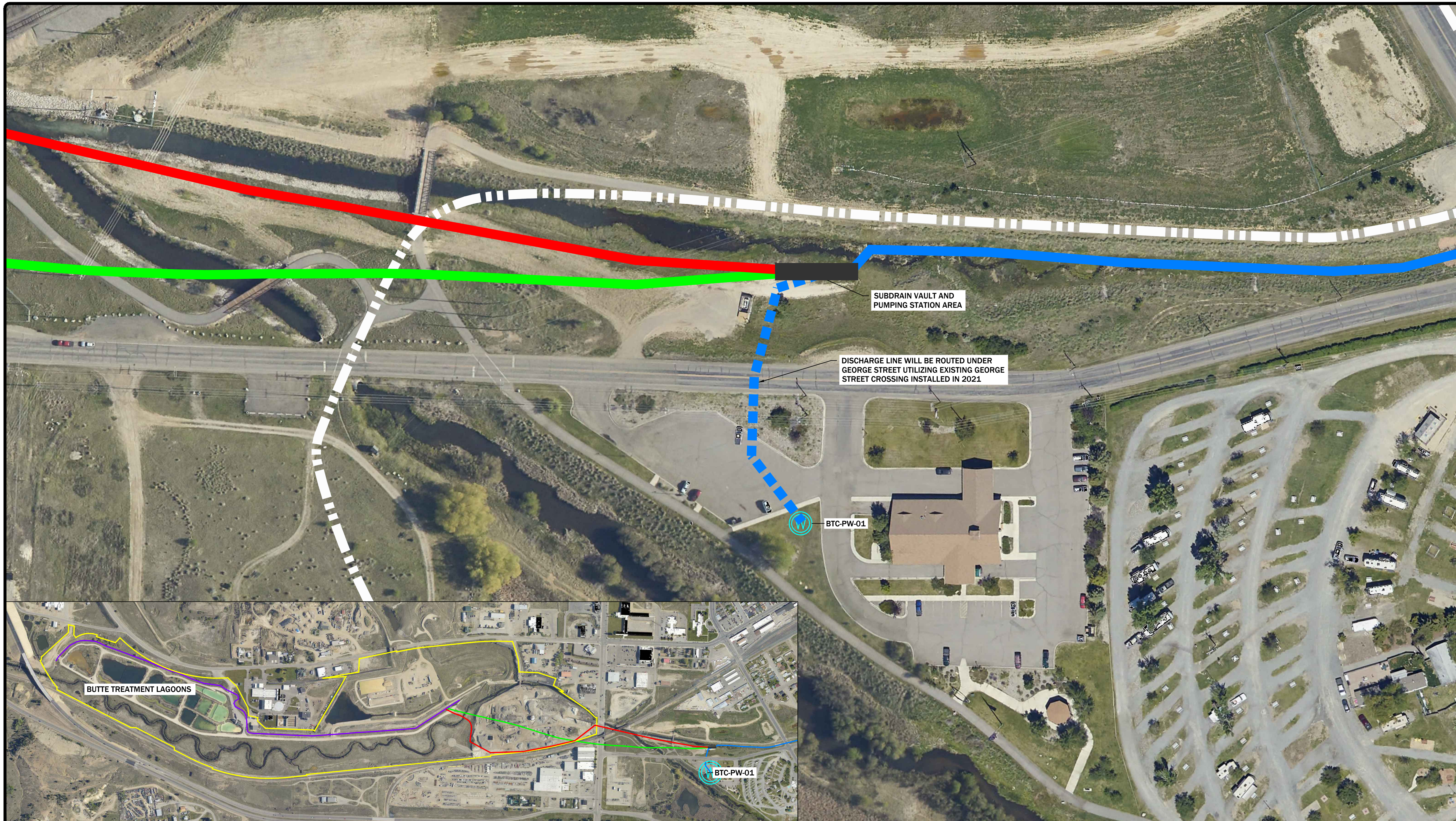


FIGURE 5: Anticipated Distance-Drawdown Relationship

PIONEER TECHNICAL SERVICES, INC.



LEGEND:

Water conveyance line alignment (blue dashed)	WATER CONVEYANCE LINE ALIGNMENT
(W)	BTC CONSTRUCTION DEWATERING SIMULATION PUMPING WELL
Blue line	BPSOU SUBDRAIN
Red line	BPSOU FORCEMAIN
Green line	BPSOU ALTERNATE DISCHARGE LINE
Purple line	HYDRAULIC CONTROL CHANNEL
Black bar	BPSOU VAULT
Yellow line	LAO BOUNDARY

N

DISPLAYED AS:
COORD SYS/ZONE: MSP83
DATUM: NAVD88
UNITS: INTL FT
SOURCE: PIONEER/AES

SCALE IN FEET
0 50 100

FIGURE 6

PIONEER TECHNICAL SERVICES, INC.
1101 SOUTH MONTANA
BUTTE, MONTANA 59701
(406) 782-5177

BTC PUMPING TEST DISCHARGE ALIGNMENT

DATE: 2/2022

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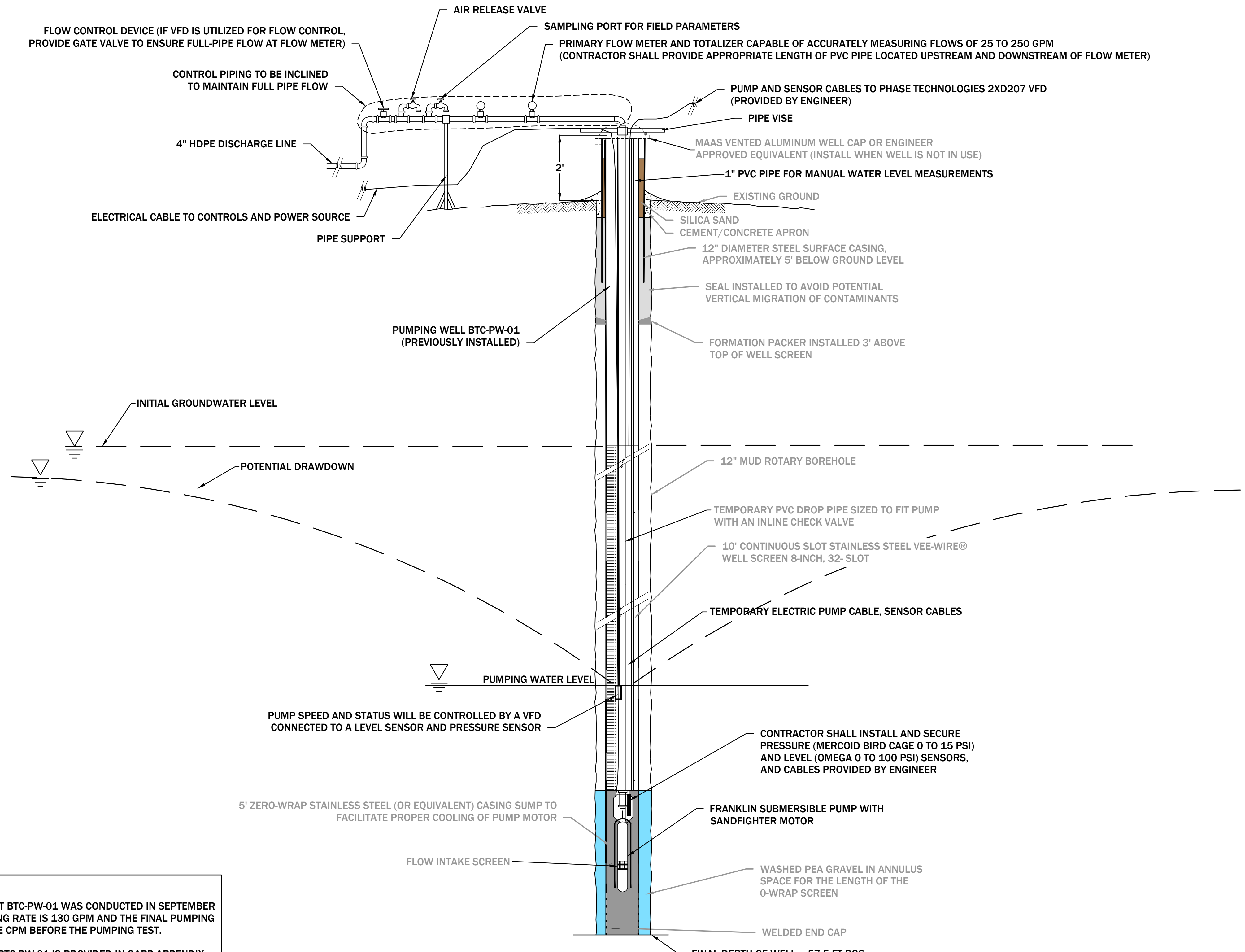

PUMPING WELL INSTALLATION DETAIL

N.T.S.

NOTES:

1. THE STEP-DRAWDOWN TEST AT BTC-PW-01 WAS CONDUCTED IN SEPTEMBER 2021. THE PROJECTED PUMPING RATE IS 130 GPM AND THE FINAL PUMPING RATE WILL BE VERIFIED BY THE CPM BEFORE THE PUMPING TEST.
2. THE CONSTRUCTION LOG FOR BTC-PW-01 IS PROVIDED IN QAPP APPENDIX C.3.

LEGEND:

GREY TEXT = EXISTING INFRASTRUCTURE

DISPLAYED AS:

COORD SYS/ZONE: NA
DATUM: NA
UNITS: FEET
SOURCE: PIONEER

SCALE IN FEET
0 N.T.S.

FIGURE 7

PIONEER TECHNICAL SERVICES, INC.
1101 SOUTH MONTANA
BUTTE, MONTANA 59701
(406) 782-5177

BTC PUMPING TEST
PUMPING WELL CONSTRUCTION AND PUMP INSTALLATION DETAIL

DATE: 6/2022

LEGEND:

- OHP — OVERHEAD POWER LINE
- (W) PUMPING WELL
- CHAIN LINK FENCE
- JERSEY BARRIERS

NOTES:

1. THE TEMPORARY POWER SERVICE IS CONCEPTUAL IN NATURE AND SUBJECT TO CHANGE FOLLOWING COORDINATION WITH NORTHWESTERN ENERGY.

N

DISPLAYED AS:
COORD SYS/ZONE: MSP
DATUM: NAD 83
UNITS: FEET
SOURCE: PIONEER

SCALE IN FEET
0 50 100

FIGURE 8

PIONEER TECHNICAL SERVICES, INC.
1101 SOUTH MONTANA
BUTTE, MONTANA 59701
(406) 782-5177

BLACKTAIL CREEK TEMPORARY POWER SERVICE INSTALLATION LOCATIONS

DATE: 6/2022

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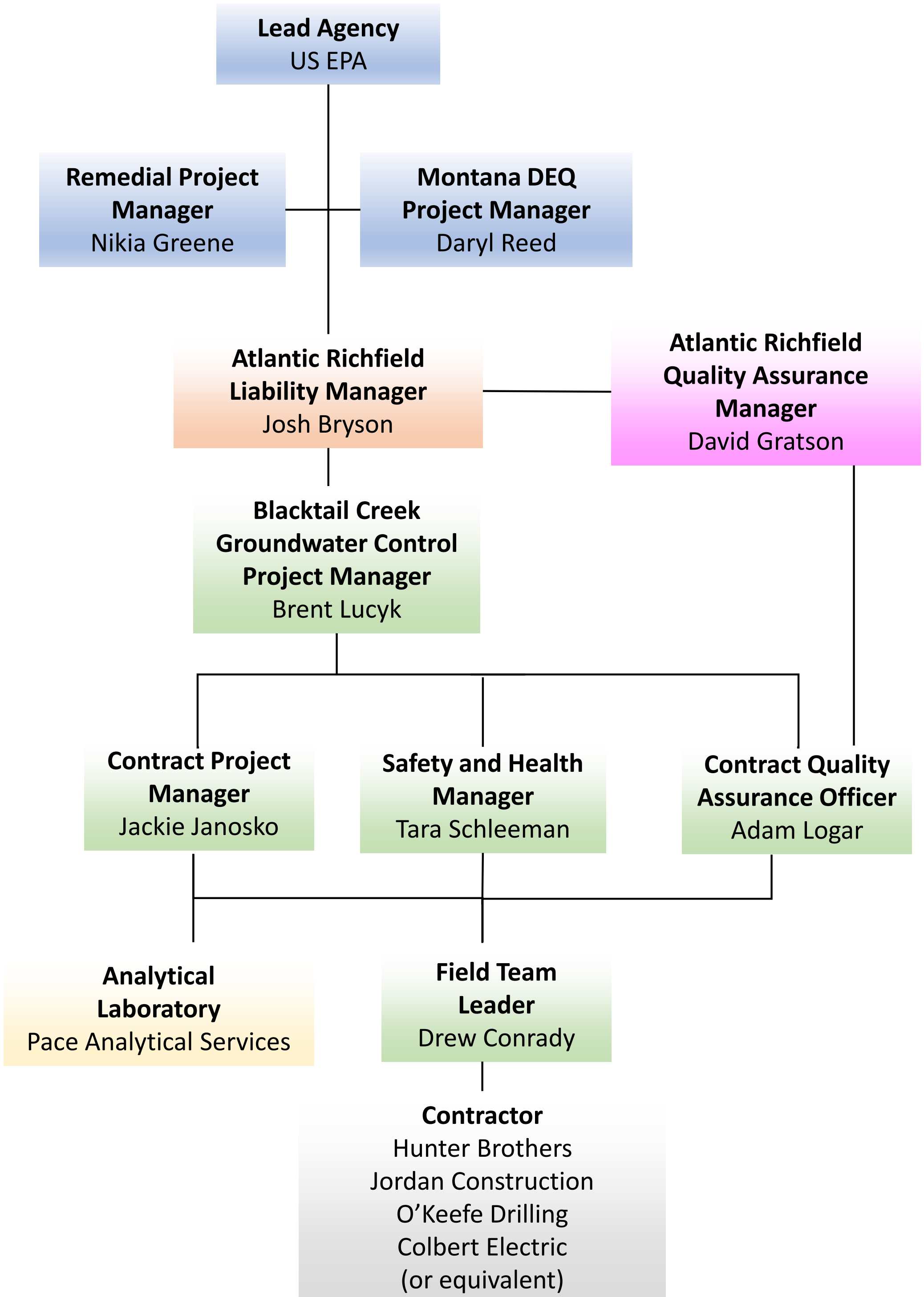
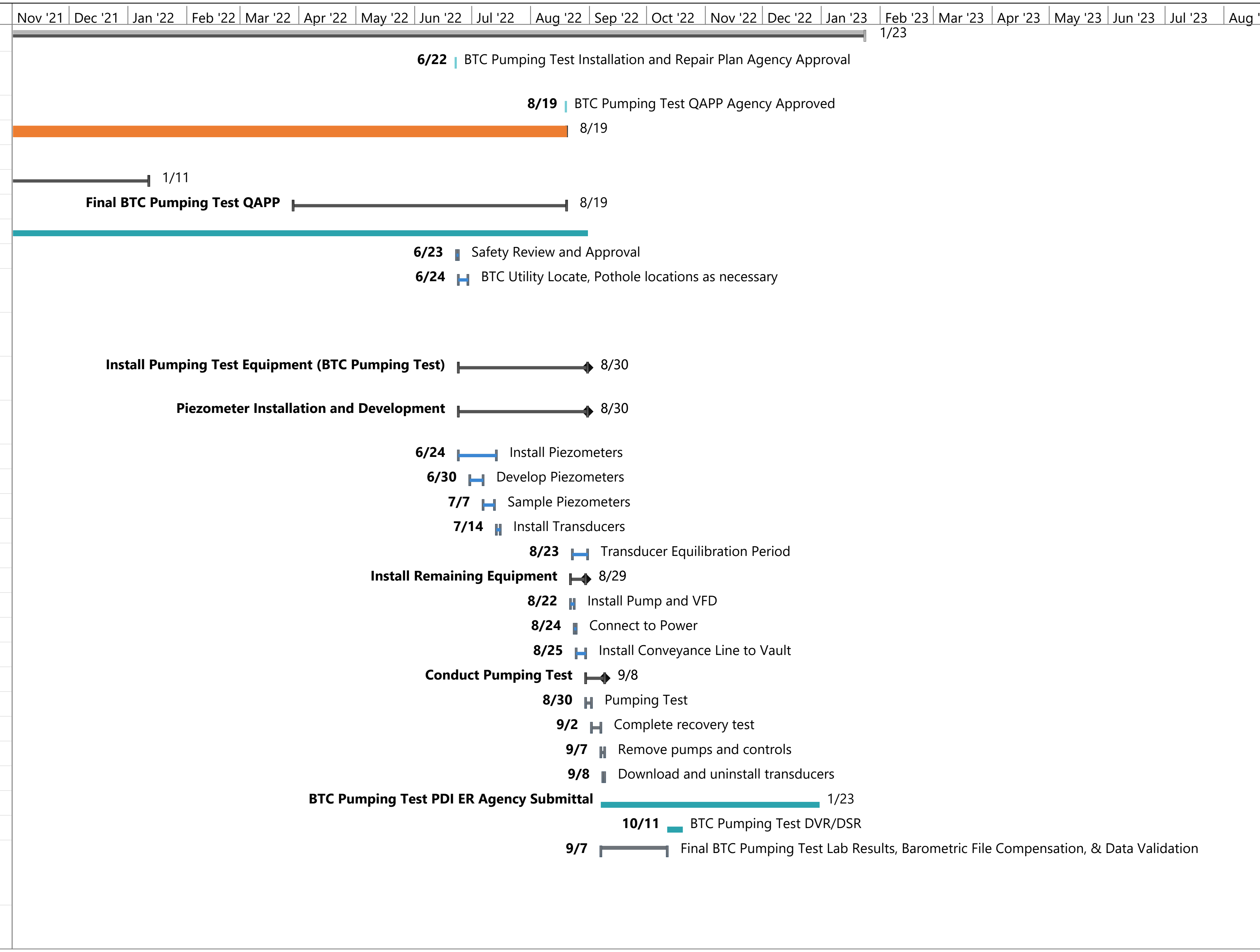


PIONEER TECHNICAL SERVICES, INC.

Figure 9: Project Organizational Chart

Figure 10. Proposed Project Schedule

ID	Task Name	Duration	Start	Finish
0	**BTC Pumping Test**	**460 days**	**Tue 4/20/21**	**Mon 1/23/23**
1	BTC Pumping Test Installation and Repair Plan Agency Approval	1 day	Wed 6/22/22	Wed 6/22/22
2	BTC Pumping Test QAPP Agency Approved	1 day	Fri 8/19/22	Fri 8/19/22
3	**Blacktail Creek Pumping Test QAPP**	**349 days**	**Tue 4/20/21**	**Fri 8/19/22**
4	**Pioneer Review**	**35 days**	Tue 4/20/21	Mon 6/7/21
8	**Draft Final**	**156 days**	Tue 6/8/21	Tue 1/11/22
16	**Final BTC Pumping Test QAPP**	**104 days**	Tue 3/29/22	Fri 8/19/22
30	**Pre-Test Construction**	**48 days**	Thu 6/23/22	Mon 8/29/22
31	Safety Review and Approval	1 day	Thu 6/23/22	Thu 6/23/22
32	BTC Utility Locate, Pothole locations as necessary	3 days	Fri 6/24/22	Tue 6/28/22
33	**Install Pumping Test Equipment (BTL Stress Test)**	**37 days**	Mon 8/2/21	Tue 9/21/21
39	**Install Pumping Test Equipment (BTC Pumping Test)**	**48 days**	Fri 6/24/22	Tue 8/30/22
40	**Piezometer Installation and Development**	**48 days**	Fri 6/24/22	Tue 8/30/22
41	Install Piezometers	14 days	Fri 6/24/22	Wed 7/13/22
42	Develop Piezometers	5 days	Thu 6/30/22	Wed 7/6/22
43	Sample Piezometers	4 days	Thu 7/7/22	Tue 7/12/22
44	Install Transducers	2 days	Thu 7/14/22	Fri 7/15/22
45	Transducer Equilibration Period	6 days	Tue 8/23/22	Tue 8/30/22
46	**Install Remaining Equipment**	**6 days**	Mon 8/22/22	Mon 8/29/22
47	Install Pump and VFD	2 days	Mon 8/22/22	Tue 8/23/22
48	Connect to Power	1 day	Wed 8/24/22	Wed 8/24/22
49	Install Conveyance Line to Vault	3 days	Thu 8/25/22	Mon 8/29/22
50	**Conduct Pumping Test**	**8 days**	Tue 8/30/22	Thu 9/8/22
51	Pumping Test	3 days	Tue 8/30/22	Thu 9/1/22
52	Complete recovery test	3 days	Fri 9/2/22	Tue 9/6/22
53	Remove pumps and controls	2 days	Wed 9/7/22	Thu 9/8/22
54	Download and uninstall transducers	1 day	Thu 9/8/22	Thu 9/8/22
55	**BTC Pumping Test PDI ER Agency Submittal**	**15 wks**	Tue 10/11/22	Mon 1/23/23
56	**BTC Pumping Test DVR/DSR**	**3 wks**	Tue 10/11/22	Mon 10/31/22
60	Final BTC Pumping Test Lab Results, Barometric File Compensation, & Data Validation	5 wks	Wed 9/7/22	Tue 10/11/22
61	**Technical Review Meeting to Discuss Preliminary Results**	**1 day**	Wed 11/9/22	Wed 11/9/22



NOTE:
The proposed schedule is subject to change. Potential constraints that could delay fieldwork include adverse weather conditions, contractor availability, coordination with landowners or land users, challenges with Site conditions, or other unforeseen issues. Major project delays resulting from these constraints will be recorded in the field logbooks and reported to the Agencies.

Project: BTC Pumping Test Date: Mon 6/13/22	Task	Project Summary	Completed during the BTL Stress Test
	Summary	External Tasks (Connected to another Project File)	

TABLES

Table 1: BTC Pumping Test Investigation Data Quality Objectives

<table>
<tr><th>BTC Pumping Test – Aquifer Physical Parameter Evaluation</th><th>BTC Pumping Test – Water Quality Evaluation</th></tr>
<tr><td>Estimation Problem</td><td>Estimation Problem</td></tr>
<tr><td colspan="2">This table lists the data quality objectives (DQOs) for the Blacktail Creek (BTC) Remediation and Contaminated Groundwater Hydraulic Control Site Pumping Test Quality Assurance Project Plan (QAPP).</td></tr>
<tr><td colspan="2">Step 1: State the Problem: The purpose of this step is to describe the problem to be studied so that the focus of the investigation will not be ambiguous.</td></tr>
<tr><td>The BTC Pumping Test Site (Site) is shown on Figure 2 and Figure 3. As required in the Consent Decree (CD) for the Butte Priority Soils Operable Unit (BPSOU) Partial Remedial Design/Remedial Action and Operation and Maintenance (EPA, 2020) (BPSOU CD), groundwater control is being evaluated to control discharge of contaminated groundwater to reduce ongoing and potential future groundwater loading of contaminants of concern (COCs) to BTC sediments and surface water as described in the Surface Water Management Plan (SWMP) and Further Remedial Elements Scope of Work (FRESOW). The FRESOW states that an initial 100 gallons per minute of contaminated groundwater will be collected by the BTC groundwater control and that the extent of groundwater capture will be evaluated as part of the BTC Pre-Design Investigation Evaluation Report (PDI ER). However, the FRESOW also indicates that the exact means of groundwater control cannot be determined based on existing available data, and depending on the findings from further investigations, control of groundwater may be accomplished by hydraulic capture and treatment and/or other methods approved by U.S. Environmental Protection Agency (EPA) in consultation with Montana Department of Environmental Quality (DEQ). Additional information on the aquifer physical parameters is needed to inform selection and design of the BTC groundwater control. This additional information will also support construction and calibration of a Sitewide groundwater model which will be used to support evaluation of the BTC groundwater control design and other FRESOW components near the Site.</td><td>Groundwater control is being evaluated to reduce ongoing and potential future groundwater loading of COCs to BTC stream sediments and surface water as described in the SWMP and FRESOW. Water quality in the area has been characterized by existing long-term water quality monitoring; however, additional water quality information is needed to evaluate the BTC groundwater control design and to estimate the quality of groundwater that may be extracted during construction dewatering and evaluate if treatment is required at Butte Treatment Lagoons (BTL).</td></tr>
<tr><td colspan="2">Conceptual Model of Environmental Problem: The Site has a history of impacts from mining activities and is located within a Technical Impracticability zone (CDM Smith, Inc., 2006). Previous investigations identified tailings and other mining impacted materials within and adjacent to BTC that may be a source of COCs. The BTC Pumping Test QAPP includes a detailed description on the Site history and previous investigations (Section 2.0).

Planning Team: The BTC Pumping Test QAPP includes a detailed description on the project organization and responsibilities (Section 9.0).

Available Resources and Schedule: Pioneer Technical Services Inc. and Stantec Inc. will collaborate to conduct the BTC Pumping Test per the QAPP, under the direction of Atlantic Richfield Company (Atlantic Richfield). All personnel completing field work will be properly trained to perform their tasks. The laboratory selected to analyze groundwater samples will be Atlantic Richfield-approved laboratory that meet or exceed qualifications required in the EPA Contract Laboratory Program Statement of Work (EPA, 2016). The anticipated schedule for conducting the BTC Pumping Test is late summer or fall of 2022. However, potential constraints could delay field work (Step 5) and will need to be addressed by Atlantic Richfield and Agencies if they occur.</td></tr>
<tr><td colspan="2">Step 2: Identify the Goals of the Study: This step identifies the principal questions that the study will attempt to resolve and what actions may result.</td></tr>
<tr><td>Principal Study Questions:
• What are physical characteristics of the subsurface and alluvial aquifer physical parameters at the Site?
• How does groundwater flow at the Site change when BTC-PW-01 is pumped at a sustainable rate during normal flow conditions?
• What is the radius of influence and capture zone of the existing extraction well (BTC-PW-01) during normal flow conditions?
• What influence could the BTC groundwater control and construction dewatering have on surface water (BTC, Silver Bow Creek [SBC], and nearby wetland ponds) and existing groundwater control features (e.g., BPSOU subdrain)?
• What is the quantity of COC-impacted groundwater required: (1) to provide suitable construction dewatering to install the designed BTC groundwater control; (2) to capture for purposes of providing effective groundwater control; and (3) to treat at BTL?</td><td>Principal Study Question:
• How does the water quality from newly installed piezometers compare to the water quality of existing long-term monitoring locations?
• What is the distribution of dissolved-phase COCs in the alluvial aquifer at the Site?
• Will there be observable changes in water quality measured in BTC-PW-01 or groundwater and surface water monitoring locations over the course of a 72-hour pumping test?
• What is the expected water quality of groundwater that may be: (1) pumped during construction dewatering activities to install the designed BTC groundwater control; (2) captured during initial operation of the designed BTC groundwater control; and (3) treated at BTL?</td></tr>
</table>

Table 1: BTC Pumping Test Investigation Data Quality Objectives

<table>
<tr><th>BTC Pumping Test – Aquifer Physical Parameter Evaluation</th><th>BTC Pumping Test – Water Quality Evaluation</th></tr>
<tr><td>Estimation Statement: The principal study questions will be answered by installing piezometers; measuring water elevations, specific conductance (select locations), and flow rates (BTC-PW-01, BTC, SBC, Butte Mine Flooding Operable Unit [BMFOU] Pilot Project effluent, and BPSOU subdrain); and conducting a long-term aquifer pumping test by pumping BTC-PW-01 at a constant rate as specified in the QAPP. Data collected before, during, and after the pumping test will be used to:

Estimate Site-specific values for alluvial aquifer physical parameters (hydraulic conductivity, transmissivity, and storativity).
Provide lines of evidence for identifying the presence of hydraulic boundaries, preferential flow paths, and the pumping well's area of influence using distance-drawdown and specific conductance measurements at multiple distances and directions from the pumping well.
Evaluate the impact of groundwater extraction on the subdrain using groundwater elevation and flow rates measured in the subdrain during the BTC pumping test.
Evaluate the connection between surface water and groundwater in BTC and nearby wetlands using surface water elevations and elevations measured in near-creek wells.
Provide data to support construction dewatering and calibration of a Sitewide groundwater model.

These data will be used to support calibration of a Sitewide groundwater model which will facilitate selection and design of the BTC groundwater control.</td>
<td>Estimation Statement: The principal study questions will be answered by installing piezometers and collecting water quality data before and during the BTC Pumping Test. These data will be used to:

Compare water quality data for newly installed piezometers with long-term water quality from the Site.
Identify if there are water chemistry changes in the pumping well and monitoring locations during the BTC pumping test.
Prepare iso-concentration maps by interpolating COC concentrations between sample locations.
Estimate the groundwater quality that may be captured during construction dewatering and by the BTC groundwater control, which may require treatment at BTL.
Provide data to support construction dewatering and calibration of a Sitewide groundwater model.

These data will be used to improve groundwater characterization within the Site, evaluate BTC groundwater control, and estimate the quality of groundwater that may need to be treated at BTL.</td></tr>
<tr><td colspan="2">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 measurements.</td></tr>
<tr><td>Types of Information that are Needed:

Depth, thickness, and descriptive data for subsurface lithology (e.g., grain size, color, texture, etc.) collected from the observation monitoring network (Figure 3).
Construction information (e.g., screen interval, slot size, screen diameter, boring diameter, etc.) for each well and piezometers included in the observation monitoring network.
Survey-grade Global Positioning System (GPS) locations and measuring point elevations collected for each observation location to be monitored during the pumping test.
Groundwater and surface water elevations measured continuously (at the frequency described in Table 2) and manually (corrected for survey elevation) before, during, and after the pumping test as per Table 2.
Groundwater and surface water temperature and specific conductance measured continuously (at frequencies listed in Table 2) in select observation locations (Table 2 and Figure 3).
Flow rates measured continuously (at frequencies listed in Table 2) from the production well (BTC-PW-01) and the subdrain (MH-MSD106 and MH-MSD108).

Applicable Limits/Thresholds: None.</td>
<td>Types of Information that are Needed:

Water quality samples and field water quality measurements (pH, specific conductance [SC], dissolved oxygen [DO], oxidation-reduction potential [ORP], temperature, and turbidity) collected from newly installed piezometers per Table 2 and analyzed as outlined in Table 3.
Field water quality measurements (pH, SC, DO, ORP, temperature, and turbidity) in the production water (Table 2).
Production well water chemistry during the pumping test within 4 hours after starting the long-term pumping test and within 4 hours before concluding the test (Table 2 and Table 3).
Groundwater and surface water temperature and specific conductance measured continuously (at frequencies listed in Table 2) in select observation locations (Table 2 and Figure 3).
Survey-grade GPS locations for each observation location to be monitored during the pumping test.

Applicable Limits/Thresholds: Water quality performance standards for surface water, including COC concentrations above the Normal Flow Compliance Standards listed in Table 2-1 of Appendix D to the BPSOU CD (EPA, 2020) and/or surface water discharge standards from the Circular DEQ-7 (DEQ, 2019).</td></tr>
</table>

Table 1: BTC Pumping Test Investigation Data Quality Objectives

<table>
<tr><th>BTC Pumping Test – Aquifer Physical Parameter Evaluation</th><th>BTC Pumping Test – Water Quality Evaluation</th></tr>
<tr><td colspan="2">Sources of Additional Information:

BPSOU subdrain pump station in-line magnetic flow meters (installed in north and south discharge lines) (Atlantic Richfield Company, 2021a).
Step-drawdown test results for BTC-PW-01, conducted on September 20, 2021, as part of the BTL Stress Test field activities (Atlantic Richfield Company, 2021b).
Weather/precipitation records at nearby BTL/Lower Area One (KMTBUTTE5).
Blacktail Creek and SBC measurements from United States Geological Survey (USGS); stage-discharge reporting for stations 12323233 and 12323242 (USGS, 2022).
Long-term BPSOU groundwater monitoring data measured and reported as described in 2022 Final BPSOU Interim Site-Wide Groundwater Monitoring QAPP (Atlantic Richfield Company, 2022a).
Long-term BPSOU surface water monitoring data measured and reported as described in 2022 Final BPSOU Interim Site-Wide Surface Water Monitoring QAPP (Atlantic Richfield Company, 2022b).
The BMFOU Berkeley Pit and Discharge Pilot Project (Pilot Project) discharge flow rates measured and reported as described in the BMFOU Pilot Project QAPP (Atlantic Richfield Company and Montana Resources, LLP, 2021) and Discharge System Field Sampling Plan (Atlantic Richfield Company, 2022c).
BMFOU Effluent Mixing Zone and Backwater Assessment as summarized in Assessment of Berkeley Pit and BMFOU Discharge Effluent Mixing Zone and BTC Backwater Monitoring Data (Atlantic Richfield Company, 2022d).
Long-term BPSOU subdrain monitoring data measured and reported as described in BTL Groundwater Treatment System and Subdrain Sampling and Monitoring QAPP (Atlantic Richfield Company, 2018a).
Additional BPSOU groundwater and surface water monitoring data measured and reported as described in Draft Final Parrot Removal Monitoring Sampling Analysis Plan (Atlantic Richfield Company, 2018b).
Sodium bromide tracing conducted in fall 2011 by Montana Bureau of Mines and Geology (MBMG, 2014).
Radon tracing and thermal imaging performed in spring 2011 by Atlantic Richfield and fall 2011 by MBMG (radon tracing; Atlantic Richfield Company, 2016).
Surface water, sediment pore water, groundwater, sediment, and soil sampling performed in 2016 by EPA to determine the interaction between groundwater and surface water in BTC (EPA, 2018).
Other BPSOU groundwater remedy optimization efforts or investigation activities where groundwater, surface water, or subdrain data were collected from the Site and surrounding area (if data meets applicable performance or acceptance criteria).
</td></tr>
<tr><td>Appropriate Sampling and Analysis Methods: Field equipment will be calibrated, installed, and verified per manufacturer’s recommendation and as described in QAPP Section 4.7.1. Field Equipment Sampling methods are described in detail in Table 3 and Appendix A.</td><td>Appropriate Sampling and Analysis Methods: All laboratory analytical results conducted under this QAPP will go through a Stage 2A validation. The required analytical methods, quantification limit, and other relevant information are listed in Table 3. Sampling and analyses methods are detailed in Table 2, Table 3, and Appendix A.</td></tr>
<tr><td colspan="2">Step 4: Define the Boundaries of the Study: The purpose of this step is to define the spatial and temporal boundaries of the study.</td></tr>
<tr><td>Target Population: Figure 3 shows the pumping test layout and proposed observation network. Table 2 lists the pumping test observation network.

Specific Spatial Boundaries, Temporal Boundaries, and Other Practical Constraints: The spatial boundary of the pumping test is limited to the Site (BTC Pumping Test Site shown on Figure 2) and aquifer material underneath the Site to the depth influenced by pumping. Groundwater and surface water physical measurements collected during the BTC Pumping Test will be limited to evaluating current Site conditions.</td><td>Target Population: Figure 3 shows the pumping test layout and proposed observation network. Table 2 lists the pumping test observation network (groundwater sampling locations and specific conductance-metered locations) and Table 3 lists sampling and analyses methods.

Specific Spatial Boundaries, Temporal Boundaries, and Other Practical Constraints: The spatial boundary of water quality evaluated before and during the Pumping Test is limited to individual monitoring locations (Figure 3). The Site conditions will change following remedial action at BTC which will remove existing COC-impacted sediment in BTC and will likely affect Site groundwater quality. Groundwater and surface water quality measurements collected during the BTC Pumping Test will be limited to evaluating current conditions.</td></tr>
<tr><td colspan="2">General Spatial Boundaries, Temporal Boundaries, and Other Practical Constraints: As described in the QAPP Section 4.2, the BTC Pumping Test will incorporate monitoring of baseline water level trends for a minimum of 7 days prior to pumping BTC-PW-01 at a constant rate. The pumping test will extend at least 72 hours, depending on the stabilization of the aquifer and the observed effects of any delayed yield (if applicable). The recovery test will follow pump shut-off for approximately 72 hours.

The pumping test field work will begin once Agency approval has been received. Efforts will be made to schedule the pumping test during fair weather, normal flow conditions with no local or high elevation runoff or precipitation, and not during seasonal groundwater fluctuations. The anticipated schedule for conducting the BTC Pumping Test is late summer or fall of 2022. A proposed schedule is shown on Figure 10. Potential constraints that could delay fieldwork include adverse weather conditions, contractor availability, coordination with landowners or land users, challenges with Site conditions, or other unforeseen issues. Major project delays resulting from these constraints will be recorded in the field logbooks and reported to the Agencies.

Scale of Estimates to be Made: Because the pumping test will provide an appropriate extent of influence on the Site, these data can be used to design BTC groundwater controls (e.g., construction dewatering system, BTC groundwater control, and water treatment needs at BTL). Data collected from the pumping test and previous investigations will inform a Sitewide groundwater model which will be used to evaluate BTC groundwater control and FRESOW components near the Site. The collected data will provide information for typical normal-flow conditions and normal subdrain operating conditions; the groundwater model will be used to evaluate results for varying conditions (e.g., with or without the BMFOU Pilot Project Off-Site discharge to SBC). The BTC groundwater control design is expected to include flexibility for optimization after installation.</td></tr>
</table>

Table 1: BTC Pumping Test Investigation Data Quality Objectives

<table>
<tr><th>BTC Pumping Test – Aquifer Physical Parameter Evaluation</th><th>BTC Pumping Test – Water Quality Evaluation</th></tr>
<tr><td colspan="2">Step 5: Develop the Analytical Approach: The purpose of this step is to specify the appropriate population parameters for making estimates.</td></tr>
<tr><td>
Population Parameters:

Lithology parameters compiled in well logs (grain size, color, texture, etc.).
Groundwater and surface water elevations (corrected to survey elevation) before, during, and after the pumping test.
Flow rates measured continuously (at frequencies listed in Table 2) in BTC-PW-01, MH-MSD106, MH-MSD108, BTC, SBC, and the BMFOU Pilot Project discharge.
Aquifer parameters to be defined (transmissivity, hydraulic conductivity, and storativity).
Specific conductance and temperature (select locations) measured continuously (at frequencies listed in Table 2) before, during, and after the pumping test to aid in indicating preferential flow paths.
Characteristics of the aquifer (presence of hydraulic barriers and/or sources of storage, preferential flow, anisotropy and heterogeneity of the aquifer, and the role of confining and/or less conductive units).
Characteristics of BTC-PW-01 (well efficiency and specific capacity).

Specification of the Estimator:
A constant rate, 72-hour pumping test will be conducted to support evaluation of BTC groundwater control, estimate how construction dewatering may affect the current capture in the subdrain, and estimate the quantity of groundwater that may be sent to BTL for treatment. These data, along with groundwater elevation and flow data (BTC, SBC, BMFOU Pilot Project effluent, and BPSOU subdrain) will be used in conjunction with a Sitewide groundwater model to evaluate results for varying conditions (e.g., with or without BMFOU Pilot Project flows discharging to SBC).
In total, approximately 50 existing and newly installed monitoring locations will be used to measure water elevations before, during, and after the pumping test to determine aquifer parameters to support evaluation of BTC groundwater control. A total of 14 monitoring locations will be equipped with transducers measuring specific conductance to aid in identification of preferential flow paths. A step-drawdown test was conducted on September 20, 2021, as part of the BTL Stress Test field activities (Atlantic Richfield Company, 2021b) to determine an appropriate pumping rate to be used during the pumping test. Flow meters will be used to measure and record continuous flow rates per Table 2.
Analyses of the pumping test drawdown data will be completed in AQTESOLV (or equivalent) software, and the results will provide appropriate aquifer parameters. These data will also be used to characterize the pumping well (well efficiency and specific capacity). Additional interpretation of available data (e.g., specific conductance) will support determination of preferential flow (anisotropy and heterogeneity of the aquifer, and the role of confining and/or less conductive units) and summarized in a corresponding PDI ER. The estimation will evaluate the data gathered and activities performed for the pumping test to answer the study questions in Step 2.
Data collected to inform the population parameters above will be used to estimate:

Aquifer parameters across the BTC Pumping Test Site.
The potential for construction dewatering to influence the subdrain capture zone.
The quantity of groundwater that may be extracted during construction dewatering for the installation of the BTC groundwater control system, operation of the BTC groundwater control system and estimate the quantity of groundwater that may need to be treated at BTL for both systems.

Specific Action Level: After the test has been completed, the results will be documented in the PDI ER, which will include a summary of data gaps and recommendations for additional investigations, if additional information is needed.
</td><td>
Population Parameters:

Existing Site long-term water quality data and water quality data from newly installed piezometers.
Water quality data collected from BTC-PW-01.
Groundwater and surface water temperature and specific conductance (select locations) measured continuously (at frequencies listed in Table 2) before, during, and after the pumping test to aid in indicating potential changing water chemistry.

Specification of the Estimator:
Installing piezometers, compiling existing Site long-term water quality data (recent COC concentrations measured for shallow and deep alluvial units), and collecting water quality data before and during the BTC Pumping Test will be used to inform evaluation of BTC groundwater control, estimate the current distribution of dissolved-phase COCs in the alluvial aquifer, estimate how construction dewatering and installation of the BTC groundwater control may affect Site water quality, and estimate the quality of groundwater that may be sent to BTL for treatment.
A flow-through cell will be utilized to measure and record water quality parameters for BTC-PW-01. Approximately 14 monitoring locations will be equipped with transducers measuring specific conductance to aid in identification of potential changing water chemistry. During the pumping test, the production water will be sampled for analytes listed in Table 3 at the beginning of the test and immediately before the end of the pumping test (with opportunity samples as necessary during the test) to determine water quality which will assist in future dewatering treatment options. Additionally, baseline groundwater quality samples will be collected from newly installed piezometers indicated in Table 2 and analyzed for the analytes listed in Table 3. Water quality monitored and sampled before and during the pumping test will be compared to existing long-term monitoring data (locations listed in Table 2, analyses listed in Table 3.) Water quality parameters collected as part of the BTC Pumping Test, along with existing long-term water quality data collected to inform the population parameters above, will be used to estimate:

Water quality across the Site.
The quality of groundwater that may be extracted during construction dewatering for installation of the designed BTC groundwater control system, during initial operation of the designed BTC groundwater control system; and if it requires treatment at BTL.

Specific Action Level:

If field parameters measured in BTC-PW-01 indicate changing conditions, based on professional judgment, additional opportunity grab samples will be collected.
If water quality field parameter or analytical results measured in newly installed piezometers indicate atypical or changing conditions, additional sampling may be warranted to augment data collected during BTC pumping test activities.
After the test has been completed, the results will be documented in the PDI ER, which will include a summary of data gaps and recommendations for additional investigations, if necessary.

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

Table 1: BTC Pumping Test Investigation Data Quality Objectives

<table>
<tr><th>BTC Pumping Test – Aquifer Physical Parameter Evaluation</th><th>BTC Pumping Test – Water Quality Evaluation</th></tr>
<tr><td colspan="2">Step 6: Specify Performance or Acceptance Criteria: The purpose of this step is to define the performance or acceptance criteria that the collected data will need to achieve.</td></tr>
<tr><td>Specify Acceptable Limits on Estimation Uncertainty: The pumping test will be considered a success if sufficient data are collected to adequately determine the aquifer parameters identified in Step 5. While some uncertainty in the estimate is inevitable and a minimum level of uncertainty is preferred, traditional statistics do not apply to the spatial aspects of designing and conducting a pumping test. Therefore, non-statistical (expert judgment) methods will be used primarily as the basis for designing and conducting the pumping test. Field data review and verification will be performed according to Section 8.0. If significant issues with the data are found, results will be discussed with the Agencies.

Specific Performance or Acceptance Criteria: For estimation problems (Step 6B of EPA guidance), the collected data will be used to estimate unknown parameters, together with some reported measure of uncertainty in the estimate. Errors occur when data mislead the Site managers into choosing an inappropriate response. The potential for errors exists because all field measurements inherently contain sampling error and/or measurement errors.

• Sampling Error: Sampling design errors occur when the data collection scheme does not adequately address the inherent variability of the matrix being sampled. Sampling design errors will be minimized by following the procedures outlined in the QAPP.
• Measurement Error: Measurement errors occur from the inherent variability in taking field measurements Field measurement errors will be minimized by following the relevant Standard Operating Procedures (SOPs) (e.g., SOP for water level measurements).</td><td>Specify Acceptable Limits on Estimation Uncertainty: All analytical data gathered during the BTC Pumping Test will be validated to verify that the data are suitable for their intended purpose. Specific data validation processes are detailed in Section 8.0. The data validation process will include evaluating analytical control limits and the precision, accuracy, representativeness, comparability, and completeness parameters. If significant issues with the data are found, results will be discussed with the Agencies.

Specific Performance or Acceptance Criteria: For estimation problems (Step 6B of EPA guidance), the collected data will be used to estimate unknown parameters, together with some reported measure of uncertainty in the estimate. Errors occur when data mislead the Site managers into choosing an inappropriate response. The potential for errors exists because all field and analytical measurements inherently contain sampling error and/or measurement errors.

• Sampling Error: Sampling design errors occur when the data collection scheme does not adequately address the inherent variability of the matrix being sampled. Sampling design errors will be minimized by following the procedures outlined in the QAPP.
• Measurement Error: Measurement errors occur from the inherent variability in taking field measurements and/or collecting, preparing, and analyzing an environmental sample. Field measurement errors will be minimized by following the relevant SOPs (e.g., SOP for groundwater sample collection).</td></tr>
<tr><td colspan="2">Step 7: Develop the Plan for Obtaining the Data: This step identifies a resource-effective data collection design for generating data expected to satisfy the DQOs.</td></tr>
<tr><td>Sampling Design: Section 4.2 of the QAPP outlines the applicable data collection design for the pumping test. The procedures are designed to ensure that data will be of sufficient quality and quantity to answer the principal study questions outlined in Step 2 and to aid in evaluation of BTC groundwater control.

Evaluating Key Assumptions: It is assumed that conducting a pumping test as outlined will provide adequate information to sufficiently characterize the aquifer, inform BTC groundwater control evaluation, and facilitate construction and calibration of a Sitewide groundwater model which will be used to support evaluation of BTC groundwater control. Data collected will be evaluated and summarized in a corresponding PDI ER, which will include any deficiencies, provided to Agencies for review. Any additional work will be proposed in a request for change for Agencies' review and approval.</td><td>Sampling Design: Section 4.2 of the QAPP outlines water quality data collection design for before and during the pumping test. Sampling and data collection procedures for this effort are designed to ensure that data will be of sufficient quality and quantity to answer the principal study questions outlined in Step 2 and to aid in evaluation of BTC groundwater control.

Evaluating Key Assumptions: It is assumed that the planned sampling, along existing long-term water quality data, will provide enough information to adequately estimate water quality and evaluate potential changing conditions during extraction. Data collected will be evaluated and summarized in a corresponding PDI ER, which will include any deficiencies, provided to Agencies for review. Additional sampling may be conducted if data gaps are identified. Any additional work will be proposed in a request for change for Agencies' review and approval.</td></tr>
</table>

References:

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USGS, 2022. United States Geological Survey stage-discharge data reported at Blacktail Creek above Grove Gulch, 12323233 (co-located with Atlantic Richfield station SS-01.35) https://waterdata.usgs.gov/mt/nwis/uv/?site_no=12323233&PARAmeter_cd=00065,00060,00010) and Blacktail Creek at Montana Street, 12323242 (https://waterdata.usgs.gov/nwis/uv?site_no=12323240).

Legend:

Atlantic Richfield: Atlantic Richfield Company. BMFOU: Butte Mine Flooding Operable Unit. BPSOU: Butte Priority Soils Operable Unit. BTC: Blacktail Creek. BTL: Butte Treatment Lagoons. CD: Consent Decree. COC: Contaminant of Concern. DO: dissolved oxygen. DQO: Data quality objectives. EPA: U.S. Environmental Protection Agency. FRESOW: Further Remedial Element Scope of Work. GPS: Global Positioning System. MBMG: Montana Bureau of Mines and Geology. ORP: Oxidation reduction potential. PDI ER: Pre-Design Investigation Evaluation Report. QAPP: Quality Assurance Project Plan. RA: Remedial Action. SBC: Silver Bow Creek. SC: Specific conductance. SOP: Standard Operating Procedure. subdrain: BPSOU subdrain. SWMP: Surface Water Management Plan. USGS: United States Geological Survey.

Table 2. BTC Pumping Test Sampling Details

Location	Approx. Distance From Pumping Well (ft)	Flow or Stage Measurement	*Frequency*	Transducer (Y/N)	Baseline Water Level Trends (Start 7 Days Prior to Pumping Test)	Primary Transducer (Pumping Test)	Backup Transducer (Pumping Test)	Water Quality Samples (Analytical Group From Table 3)	*Timing and Freqency of Sample Collection*	*Sample Purpose* [1]
Pumping Well										
BTC-PW-01	-	Flow	1-minute automated	Y_{ltc}	-	1-minute	1-minute	1, 2	**Group 1** (Field Parameters) collected at 15-minute intervals for first 8 hours, hourly for remainder of the pumping test. **Group 2** (Analytical Samples) collected at start and end of pumping with opportunity samples collected as necessary.	PT & WQ
Proposed Piezometers										
BTC-PZ07	40	-	-	Y	15-minutes	1-minute	15-minute Intervals at Locations Determined by Field Team Leader in Consultation with QAO	1, 3	Before pumping	PT & WQ
BTC-PZ04S	83	-	-	Y_{ltc}	15-minutes	1-minute		1, 3	Before pumping	PT & WQ
BTC-PZ04D	79	-	-	Y_{ltc}	15-minutes	1-minute		1, 3	Before pumping	PT & WQ
BTC-PZ03S	111	-	-	Y_{ltc}	15-minutes	1-minute		1, 3	Before pumping	PT & WQ
BTC-PZ03D	114	-	-	Y_{ltc}	15-minutes	1-minute		1, 3	Before pumping	PT & WQ
BTC-PZ06S	148	-	-	Y_{ltc}	15-minutes	1-minute		1, 3	Before pumping	PT & WQ
BTC-PZ06D	154	-	-	Y_{ltc}	15-minutes	1-minute		1, 3	Before pumping	PT & WQ
BTC-PZ05S	230	-	-	Y	15-minutes	1-minute		1, 3	Before pumping	PT & WQ
BTC-PZ05D	226	-	-	Y	15-minutes	1-minute		1, 3	Before pumping	PT & WQ
BTC-PZ02S	263	-	-	Y	15-minutes	1-minute		1, 3	Before pumping	PT & WQ
BTC-PZ02D	259	-	-	Y	15-minutes	1-minute		1, 3	Before pumping	PT & WQ
BTC-PZ01S	266	-	-	Y	15-minutes	1-minute		1, 3	Before pumping	PT & WQ
BTC-PZ01D	264	-	-	Y	15-minutes	1-minute		1, 3	Before pumping	PT & WQ
Existing Groundwater/Surface Water Elevation and Groundwater Quality Monitoring										
PMP-11A	72			Y_{ltc}	15-minutes	1-minute	15-minute Intervals at Locations Determined by Field Team Leader in Consultation with QAO	-	-	PT & WQ
PMP-11B	79			Y_{ltc}	15-minutes	1-minute		-	-	PT & WQ
BPS07-21	201	-	-	Y_{ltc}	15-minutes	1-minute		-	-	PT & WQ
BPS07-21B	209	-	-	Y_{ltc}	15-minutes	1-minute		-	-	PT & WQ
BPS07-21C	208	-	-	Y	15-minutes	1-minute		-	-	PT
AMW-11	232	-	-	Y	15-minutes	1-minute		-	-	PT
AMW-13	410	-	-	Y	15-minutes	1-minute		-	-	PT
AMW-13B	394	-	-	Y	15-minutes	1-minute		-	-	PT
AMW-13B2	393	-	-	Y	15-minutes	1-minute		-	-	PT
AMW-13C	383	-	-	Y	15-minutes	1-minute		-	-	PT
BPS07-07	384	-	-	Y	15-minutes	1-minute		-	-	PT
BPS07-22R	371	-	-	Y	15-minutes	1-minute		-	-	PT
BPS07-22B	369	-	-	Y	15-minutes	1-minute		-	-	PT
BPS07-22C	377			Y	15-minutes	1-minute		-	-	PT
BPS07-03A	483	-	-	Y	15-minutes	1-minute		-	-	PT
BPS11-04	453	-	-	Y	15-minutes	1-minute		-	-	PT
BPS11-09	802	-	-	Y	15-minutes	1-minute		-	-	PT
BPS11-12A	805	-	-	Y	15-minutes	1-minute		-	-	PT
GS-28	996	-	-	Y	15-minutes	1-minute		-	-	PT
BPS11-10A	1038	-	-	Y	15-minutes	1-minute		-	-	PT
BPS11-10B	1032	-	-	Y	15-minutes	1-minute		-	-	PT
BPS11-10C	1034			Y	15-minutes	1-minute		-	-	PT
BPS11-19A2	1172	-	-	Y	15-minutes	1-minute		-	-	PT
BPS11-19B	1173	-	-	Y	15-minutes	1-minute		-	-	PT
BPS11-11A1	1313	-	-	Y	15-minutes	1-minute		-	-	PT
BPS11-11A2	1309	-	-	Y	15-minutes	1-minute		-	-	PT
BPS11-11B	1307	-	-	Y	15-minutes	1-minute		-	-	PT
BPS11-11C	1315			Y	15-minutes	1-minute		-	-	PT
BPS11-14A	2063	-	-	Y	15-minutes	1-minute		-	-	PT
BPS11-14B	2064	-	-	Y	15-minutes	1-minute		-	-	PT
Surface Water Locations										
SS-04	472	Stage		Y_{ltc}	15-minutes	15-minutes	-	-	-	PT & WQ
BWE-4	241	Stage	-	Y_{ltc}	15-minutes	15-minutes		-	-	PT & WQ
BWE-3	168	Stage	-	Y_{ltc}	15-minutes	15-minutes		-	-	PT & WQ
BWE-2	393	Stage	-	Y	15-minutes	15-minutes		-	-	PT
BWE-1	985	Stage	-	Y	15-minutes	15-minutes		-	-	PT
SS-01.6	1399	Stage		Y	15-minutes	15-minutes				PT
MSDSG-01	263	Stage		Y	15-minutes	15-minutes		-	-	PT
MSDSG-02	1056	Stage	-	Y	15-minutes	15-minutes		-	-	PT
BMFOU Discharge Structure	890	Flow	10-minute automated	N	-	-		-	-	PT
USGS Station 12323242	1140	Flow/Stage	15-minute automated	N	-	-		-	-	PT
USGS Station 12323233	2200	Flow/Stage	15-minute automated	N	-	-		-	-	PT

Table 2. BTC Pumping Test Sampling Details

Location	Approx. Distance From Pumping Well (ft)	Flow or Stage Measurement	*Frequency*	Transducer (Y/N)	Baseline Water Level Trends (Start 7 Days Prior to Pumping Test)	Primary Transducer (Pumping Test)	Backup Transducer (Pumping Test)	Water Quality Samples (Analytical Group From Table 3)	*Timing and Freqency of Sample Collection*	*Sample Purpose* [1]
Subdrain Locations										
MH-MSD106	308	Stage/Flow	15-minute automated	N	-	-	-	-	-	PT
MH-MSD108	1030	Stage/Flow	15-minute automated	N	-	-		-	-	PT
BPSOU Subdrain Pump Station Flow Meters (North and South)	3000	Flow	5-second automated	N	-	-		-	-	PT

Quality Assurance Samples			
Type		***Applicable Group***	***Frequency***
Field Duplicate		2, 3	1 per 20 samples
Equipment Blank		2, 3	1 per 20 samples, as required by method
Field Blank		2, 3	1 per 20 samples

[1] Sample Purpose: BTC Pumping Test (PT) and/or Water Quality (WQ)

ltc Indicates groundwater or surface water monitoring location equipped with conductivity metering transducer

Table 3. Sample Collection, Preservation, Holding Time, and Analysis

Company[1]	Sample Group	Analyte	Analytical Method	Anticipated Laboratory Reporting Limit (RL)	Holding Time	Container Size	Preservation[2]	Location(s)
Field Parameters								
Pioneer	1	Temperature	SOP-WFM-04	NA	NA	NA	NA	BTC-PW-01 (Production Well), Proposed Piezometers (Newly installed locations only)
		Specific conductance (SC)	SOP-WFM-03					
		Dissolved Oxygen (DO)	SOP-WFM-07					
		pH	SOP-WFM-01					
		Oxidation Reduction Potential (ORP)	SOP-WFM-02					
		Turbidity	SOP-WFM-08					
Laboratory Samples								
Pace Analytical or equivalent	2	Total and dissolved aluminum (Al)	EPA 200.8/200.7	20.0 µg/L	6 Months	2, 250-mL high-density polyethylene (HDPE) bottles	Acidified with HNO_3, field filtered with 0.45 µm filter (dissolved)	BTC-PW-01 (Production Well)
		Total and dissolved arsenic (As)		0.5 µg/L				
		Total and dissolved barium (Ba)		0.3 µg/L				
		Total and dissolved boron (B)		10 µg/L				
		Total and dissolved cadmium (Cd)		0.08 µg/L				
		Total and dissolved calcium (Ca)		40 µg/L				
		Total and dissolved chromium (Cr)		0.5 µg/L				
		Total and dissolved copper (Cu)		1.0 µg/L				
		Total and dissolved iron (Fe)		50 µg/L				
		Total and dissolved lead (Pb)		0.1 µg/L				
		Total and dissolved lithium (Li)		0.5 µg/L				
		Total and dissolved magnesium (Mg)		10 µg/L				
		Total and dissolved manganese (Mn)		0.5 µg/L				
		Total and dissolved potassium (K)		100 µg/L				
		Total and dissolved selenium (Se)		0.5 µg/L				
		Total and dissolved silica as SiO_2		214 µg/L				
		Total and dissolved silver (Ag)		0.5 µg/L				
		Total and dissolved sodium (Na)		50 µg/L				
		Total and dissolved strontium (Sr)		0.5 µg/L				
		Total and dissolved zinc (Zn)		5.0 µg/L				
		Dissolved Hardness (calculation)	SM 2340	40 µg/L				
		Total and dissolved mercury (Hg)	EPA 245.1	0.0045 µg/L	28 days			
		Sulfate (SO_4)	EPA 300.0	1.20 mg/L	28 Days	1, 500-mL HDPE bottle	Raw	
		Fluoride (F^-)		0.05 mg/L				
		Chloride (Cl^-)		1.20 mg/L				
		Bromide (Br^-)		0.08 mg/L				
		Alkalinity (Total as $CaCO_3$)	SM 2320B	5 mg/L	14 days			
		Total Dissolved/Suspended Solids (TDS/TSS)	SM 2540C/D	10 mg/L / 2 mg/L	7 days			
		Nitrogen, Ammonia	EPA 350.1	0.10 mg/L	28 days	1, 250-mL HDPE bottle	Acidified with H_2SO_4	
		Nitrogen, Nitrate-Nitrite	EPA 353.2	0.10 mg/L				
		Phosphorus, Total	SM 4500-P-F	0.1 mg/L				
		Total organic carbon (TOC)	EPA 9060A	1,000 µg/L	28 days	2, 250-mL amber glass bottles	Zero head space; H_2SO_4 preserved for TOC / unpreserved for TIC	
		Total inorganic carbon (TIC)						
	3	Total and dissolved aluminum (Al)	EPA 200.8	20.0 µg/L	6 Months	2, 250-mL HDPE bottles	Acidified with HNO_3, field filtered with 0.45 µm filter (dissolved)	Proposed Piezometers (Newly installed locations only)
		Total and dissolved arsenic (As)		0.5 µg/L				
		Total and dissolved cadmium (Cd)		0.08 µg/L				
		Total and dissolved calcium (Ca)		40 µg/L				
		Total and dissolved copper (Cu)		1.0 µg/L				
		Total and dissolved iron (Fe)		50 µg/L				
		Total and dissolved lead (Pb)		0.1 µg/L				
		Total and dissolved magnesium (Mg)		10 µg/L				
		Total and dissolved potassium (K)		100 µg/L				
		Total and dissolved silver (Ag)		0.5 µg/L				
		Total and dissolved sodium (Na)		50 µg/L				
		Total and dissolved zinc (Zn)		5.0 µg/L				
		Dissolved Hardness (calculation)	SM 2340B	40 µg/L				
		Total and dissolved mercury (Hg)	EPA 245.1	0.0045 µg/L	28 days			
		Total Dissolved/Suspended Solids (TDS/TSS)	SM 2540C/D	10 mg/L / 2 mg/L	7 Days	1, 500-mL HDPE bottle	Raw	
		Sulfate (SO_4)	EPA 300.0	1.20 mg/L	28 Days			
		Chloride (Cl^-)		1.20 mg/L				
		Alkalinity (Total as $CaCO_3$)	SM 2320B	5 mg/L	14 days			

[1]Information contained in Table 3, including RL, Holding Time, Container Size and Preservation are method-specific, from the analytical laboratory. Atlantic Richfield may choose to use a different laboratory based on project needs, though will ensure necessary reporting limits, required methodology, and the specified quality assurance/quality control and data validation requirements are followed as detailed in the Stress Test QAPP. Agencies will be informed of significant changes in reporting limit, methodology, or quality assurance/quality control and data validation procedures.

[2]In addition to the preservation listed, samples will be stored at ≤ 6ºC (but not frozen). For total and dissolved metals analyses, cooling is not required (EPA, 2020).

NA - Not Applicable

Acronyms:

L - liter, HDPE - High-density polyethylene, µg - microgram, mg - milligram, RL - reporting limit, SOP - Standard Operating Procedure

XRF							
Quality Control	**Frequency**	**Acceptance Criteria**	**Criteria**	**Action** **Associated Sample Result Detected**	**Associated Sample Result Non-Detected**	**Reason Code**	**Reference**
System Check	Performed daily, prior to sample analysis	Performed daily, prior to sample analysis	System Check not performed	Professional Judgment J/R	Professional Judgment UJ/R	CX	SOP-SFM-02
		Resolution < 195	Resolution ≥ 195	Professional Judgment J/R	Professional Judgment UJ/R	SC	
SiO₂ Standard	Performed daily, prior to sample analysis, at least 1 for every 20 sample analyses, and at end of each day of analysis	Performed daily, prior to sample analysis, at least 1 for every 20 sample analyses, and at end of each day of analysis	Frequency criteria not met	J	UJ	CX	SOP-SFM-02 Niton XL3 Mining QC Sheet
		Arsenic ≤10 mg/kg	>10 mg/kg	Results < 10x the SiO2 result - J+	No Qualification	B	
		Cadmium ≤50 mg/kg	>50 mg/kg				
		Calcium ≤2000 mg/kg	>2000 mg/kg				
		Chromium ≤120 mg/kg	>120 mg/kg				
		Copper ≤20 mg/kg	>20 mg/kg				
		Iron ≤50 mg/kg	>50 mg/kg				
		Lead ≤10 mg/kg	>10 mg/kg				
		Manganese ≤300 mg/kg	>300 mg/kg				
		Mercury ≤10 mg/kg	>10 mg/kg				
		Silver ≤30 mg/kg	>30 mg/kg				
		Zinc ≤10 mg/kg	>10 mg/kg				
Calibration Check Samples	Performed daily, prior to sample analysis, at least 1 for every 20 sample analyses, and at end of each day of analysis	Performed daily, prior to sample analysis, at least 1 for every 20 sample analyses, and at end of each day of analysis	Frequency criteria not met	J	UJ	CX	SOP-SFM-02 Niton XL3 Mining QC Sheet
		NIST Standard: Arsenic 0 - 35 mg/kg Cadmium 0 - 60 mg/kg Calcium 13,900 - 23,900 mg/kg Chromium 50 - 200 mg/kg Copper 0 - 60 mg/kg Iron 25,000 - 35,000 mg/kg Lead 0 - 35 mg/kg Manganese 0 - 700 mg/kg Mercury 0 - 12 mg/kg Silver 0 - 40 mg/kg Zinc 50 - 160 mg/kg	< Lower Control Limit	J-	UJ	CSS	
		RCRA Standard: Arsenic 400 - 600 mg/kg Cadmium 400 - 600 mg/kg Chromium 400 - 600 mg/kg Lead 400 - 600 mg/kg Silver 400 - 600 mg/kg	> Upper Control Limit	J+	No Qualification		
XRF Duplicate	1 per 20 samples	RPD ≤ 35% for detected results	Frequency criteria not met	J	UJ	DX	SOP-SFM-02 BTL Pumping Test QAPP
			RPD ≤ 35%	No Qualification	No Qualification	D%	
			RPD > 35%	J	UJ		
XRF Replicate	1 per 20 samples	RPD ≤ 35% for detected results	Frequency criteria not met	J	UJ	RX	SOP-SFM-02 BTL Pumping Test QAPP
			RPD ≤ 35%	No Qualification	No Qualification	R%	
			RPD > 35%	J	UJ		
Field Duplicate	1 per 20 samples	RPD ≤ 35% for detected results	Frequency criteria not met	J	UJ	FDX	BTL Pumping Test QAPP
			RPD ≤ 35%	No Qualification	No Qualification	FD	
			RPD > 35%	J	UJ		

Pace								
Quality Control	Frequency	Parameter (Method)	Acceptance Criteria	Criteria	Data Validation Action Associated Sample Result - Detected	Data Validation Action Associated Sample Result - Non-Detected	Data Validation Action Reason Code	Reference
Laboratory Analysis Quality Control Samples								
Holding Time	Every Sample	EPA 200.7/200.8/SM 2340 (calculation) (total and dissolved metals)	≤ 6 months	> 6 months	J-	Professional Judgement UJ or R	H	NFG BTC Pumping Test QAPP
		EPA 245.1 (mercury)	≤ 28 days	> 28 days				
		EPA 300.0 (SO4, F^-, Cl^-, Br^-)	≤ 28 days	> 28 days	J	Professional Judgement UJ or R		BTC Pumping Test QAPP
		SM 2320B (Alkalinity, Total as $CaCO_3$)	≤ 14 days	> 14 days				
		SM 2540C/D (Total Dissolved/Suspended Solids)	≤ 7 days	> 7 days				
		EPA 350.1 (Nitrogen, Ammonia)	≤ 28 days	> 28 days				
		EPA 353.2 (Nitrogen, Nitrate-Nitrite)	≤ 28 days	> 28 days				
		EPA 365.1 (Phosphorus, Total)	≤ 28 days	> 28 days				
		EPA 9060A (Total organic carbon)	≤ 28 days	> 28 days				
		EPA 9060A (Total inorganic carbon)	≤ 28 days	> 28 days				
Preservation	Every Sample	EPA 200.7/200.8/SM 2340 (calculation) (total and dissolved metals)	pH ≤ 2	Samples received pH > 2 and pH not adjusted	Professional Judgement J-	Professional Judgement R	Pres	NFG Pace SOP BTC Pumping Test QAPP
		EPA 245.1 (mercury)						
		EPA 300.0 (SO4, F^-, Cl^-, Br^-)	Raw; ≤ 6°C	Samples received pH > 2 and pH not adjusted (for sample with acid preservation); Samples received >6°C	Professional Judgement J-	Professional Judgement UJ or R		Pace SOP BTC Pumping Test QAPP
		SM 2320B (Alkalinity, Total as $CaCO_3$)	Raw; ≤ 6°C					
		SM 2540C/D (Total Dissolved/Suspended Solids)	Raw; ≤ 6°C					
		EPA 350.1 (Nitrogen, Ammonia)	H_2SO_4; ≤ 6°C					
		EPA 353.2 (Nitrogen, Nitrate-Nitrite)	H_2SO_4; ≤ 6°C					
		EPA 365.1 (Phosphorus, Total)	H_2SO_4; ≤ 6°C					
		EPA 9060A (Total organic carbon)	H_2SO_4; ≤ 6°C					
		EPA 9060A (Total inorganic carbon)	Raw; ≤ 6°C					
Method Blank (MB)	One per batch of up to 20 samples.	All methods	blank result ≤ 2x MDL	blank result ≤ 2x MDL	No Qualification	No Qualification	MB	CFRSSI QAPP
				positive blank result > 2x MDL	Results < 5x blank result U	No Qualification		
				absolute value of negative blank results > 2x MDL	Results < 5x absolute value of negative blank result J	UJ		
Laboratory Control Sample (LCS)	One per batch of up to 20 samples.	All methods	%R 80-120% (all methods)	%R < 40%	J-	R	L%	CFRSSI QAPP NFG
				%R 40-79%	J-	UJ		
				%R 80-120%	No Qualification	No Qualification		
				%R > 120%	J+	No Qualification		
				%R > 150%	R	No Qualification		
Laboratory Duplicate Sample (LDS)[3]	One per batch of up to 20 samples.	All methods	1. If both original sample and duplicate sample results are≥ 5x the RL, then RPD ≤ 20% 2. If original sample or duplicate sample result < 5x the RL (including non-detect), then absolute difference between sample and duplicate ≤ RL	Both original and duplicate sample results are≥ 5x the RL and RPD ≤ 20%	No Qualification	No Qualification	D%	CFRSSI QAPP NFG
				Both original and duplicate sample results are≥ 5x the RL and RPD is > 20%	J	UJ		
				RPD > 100%	Professional Judgement	Professional Judgement		
				Original sample or duplicate sample result < 5x the RL, and absolute difference between sample and duplicate≤ RL	No Qualification	No Qualification		
				Original sample or duplicate sample result is < 5x the RL and absolute difference between the sample and duplicate > RL	J	UJ		

Pace								
					Data Validation Action			
Quality Control	**Frequency**	**Parameter (Method)**	**Acceptance Criteria**	**Criteria**	**Associated Sample Result - Detected**	**Associated Sample Result - Non-Detected**	**Reason Code**	**Reference**
Laboratory Analysis Quality Control Samples, continued								
Laboratory Matrix Spike (LMS)	One per batch of up to 20 samples.	EPA 200.7/200.8 (total and dissolved metals) EPA 245.1 (mercury)	%R 75-125% If the original sample results is > 4x the spike amount added, the data shall not be flagged even if the %R exceeds the acceptance criteria.	%R < 75%	J-	UJ	S%	CFRSSI QAPP NFG
				%R 75-125%	No Qualification	No Qualification		
				%R > 125%	J+	No Qualification		
				sample analyte concentration≥ 4x spike concentration	No Qualification	No Qualification		
		EPA 300.0 (SO4, F^-, Cl^-, Br^-) SM 2320B (Alkalinity, Total as $CaCO_3$) EPA 350.1 (Nitrogen, Ammonia) EPA 353.2 (Nitrogen, Nitrate-Nitrite) EPA 365.1 (Phosphorus, Total) EPA 9060A (Total organic carbon) EPA 9060A (Total inorganic carbon)	%R 80-120% If the original sample results is > 4x the spike amount added, the data shall not be flagged even if the %R exceeds the acceptance criteria.	%R < 80%	J-	UJ		
				%R 80-120%	No Qualification	No Qualification		
				%R > 120%	J+	No Qualification		
				sample analyte concentration≥ 4x spike concentration	No Qualification	No Qualification		
Field Quality Control Samples								
Field Blank	One per 20 samples collected	All methods	blank result ≤ 2x MDL	blank result ≤ 2x MDL	No Qualification	No Qualification	FB	CFRSSI QAPP
				positive blank result > 2x MDL	Results < 5x blank result U	No Qualification		
				absolute value of negative blank results > 2x MDL	Results < 5x absolute value of negative blank result J	UJ		
Equipment Rinsate Blank	One per 20 samples collected if reusable equipment is utilized.	All methods	blank result ≤ 2x MDL	blank result ≤ 2x MDL	No Qualification	No Qualification	RB	CFRSSI QAPP
				positive blank result > 2x MDL	Results < 5x blank result U	No Qualification		
				absolute value of negative blank results > 2x MDL	Results < 5x absolute value of negative blank result J	UJ		
Field Duplicate Sample	One per 20 samples collected.	All methods	1. If both original sample and duplicate sample results are≥ 5x the RL, then RPD ≤ 20% 2. If original sample or duplicate sample result < 5x the RL (including non-detect), then absolute difference between sample and duplicate ≤ RL	Both original and duplicate sample results are≥ 5x the RL and RPD RPD ≤20%	No Qualification	No Qualification	FD	CFRSSI QAPP NFG
				Both original and duplicate sample results are≥ 5x the RL and RPD is > 20%	J	UJ		
				RPD > 100%	Professional Judgement	Professional Judgement		
				Original sample or duplicate sample result is < 5x the RL, and absolute difference between sample and duplicate ≤ RL	No Qualification	No Qualification		
				Original sample or duplicate sample result is < 5x the RL and absolute difference between the sample and duplicate > RL	J	UJ		

Notes:

1. Associated sample results:
   - For Field Blank results that do not meet technical criteria, apply action to all samples in the SDG.
   - For Field Duplicate results that do not meet technical criteria, apply action to field duplicate pair and any samples from the same sample location in the SDG.
   - For MB and LCS results that do not meet technical criteria, apply action to all samples in the analytical batch.
   - For LDS or LMS/LMSD results that do not meet technical criteria, apply action to the parent sample and, per the NFG, "apply the action to all samples of the same matrix if the samples are considered sufficiently similar."
   - For holding time and preservation that do not meet technical criteria, apply action to sample.
2. For consistency in validations between validators, if a sample result is reported as non-detect, the MDL is used for the duplicate absolute difference calculations.
3. An LCS, an LMS, or an original sample may all be used to perform a laboratory duplicate. If an LCS Duplicate or LMS Duplicate is used, the QC sample must also meet the applicable %R technical criteria.

Qualifications:

U - Non-detect
UJ - Estimated non-detect
J - Estimated
J+ - Estimated high
J- - Estimated low
R - Rejected

Abbreviations:

MDL - method detection limit
RL - reporting limit
%R - percent recovery
RPD - relative percent difference

References:
CFRSSI QAPP - ARCO, 1992. Clark Fork River Superfund Site Investigations (CFRSSI) Quality Assurance Project Plan (QAPP). Prepared for ARCO by PTI Environmental Services, Bellevue, Washington. May 1992.
NFG - EPA, 2020. National Functional Guidelines for Inorganic Superfund Methods Data Review. November 2020.
-- Available at EPA's Superfund Analytical Services and Contract Laboratory Program website: https://www.epa.gov/clp/contract-laboratory-program-national-functional-guidelines-data-review
SOP-SFM-02 - Operating XL3-X-Ray Fluorescence Analyzer General. Pioneer Technical Services, Inc. January 2018.
BTC Pumping Test QAPP - BTC Pumping Test Quality Assurance Project Plan (QAPP). Prepared for Atlantic Richfield Company by Pioneer Technical Services, Inc, Butte, Montana.
Niton XL3 Soil QC Sheet - Niton XL3 Soil QC Certificate of Calibration. Thermo Fisher Scientific. June 2014.

Pace SOPs:

EPA 200.7	ENV-SOP-MIN4-0052: Metals Analysis by ICP - Method 6010 and 200.7
EPA 200.8	ENV-SOP-MIN4-0043: Metals Analysis by ICP/MS - Method 6020 and 200.8
EPA 245.1	ENV-SOP-MIN4-0054: Mercury in Liquid and Solid/Semi-Solid Waste by 7470A, 7471, 7471B, and 245.1
EPA 300.0	ENV-SOP-MIN4-0129: Inorganic Anions by Ion Chromatography by 300.0/9056A
SM 2320B	ENV-SOP-MIN4-0103: Alkalinity, Titrimetric by SM 2320B
SM 2540C/D	ENV-SOP-MIN4-0122: Solids in Aqueous Samples by SM 2540B/C/D, EPA 160.4 TSS
EPA 350.1	ENV-SOP-MIN4-0139: Ammonia by Flow Injection Analysis Gas Diffusion Separation Method by 350.1
EPA 353.2	ENV-SOP-MIN4-0130: Determination of Nitrate/Nitrite by 353.2
SM 4500	ENV-SOP-MIN4-0147 Total Phosphorus in Aqueous Samples by SM 4500-P-F
EPA 9060A	ENV-SOP-MTJL-0185 TOC by EPA 415.1, SW-846 9060A, SM 5310

Table 5: Precision, Accuracy, and Completeness Calculations

Characteristic	Formula	Symbols
Precision (as relative percent difference, RPD)	$RPD = \frac{\lvert(x_i - x_j)\rvert}{\left(\frac{x_i + x_j}{2}\right)} \times 100$	x_i, x_j: replicate values of x
Precision (as relative standard deviation, RSD, otherwise known as coefficient of variation)	$RSD = \frac{\sigma}{\bar{x}} \times 100$	σ: sample standard deviation $\bar{x}$: sample mean
Accuracy (as percent recovery, %R, for samples without a background level of the analyte, such as reference materials, laboratory control samples and performance evaluation samples)	$\%R = \frac{x}{t} \times 100$	x: sample value t: true or assumed value
Accuracy (as percent difference, %D, for non-zero standards such as serial dilution performance evaluation samples)	$\%D = \frac{\lvert(I - F)\rvert}{I} \times 100$	I = initial sample result F = final sample result
Completeness of Data Quality (as a percentage, C)	$C = \frac{n}{N} \times 100$	n: number of valid data points produced N: total number of data points generated
Completeness for Project Requirements (as a percentage, C)	$C = \frac{n}{N} \times 100$	n: number of samples collected N: total number of samples planned

Appendix A
Standard Operating Procedures

Applicable and Relevant Standard Operating Procedures

SOP Number	Title	Version
Pioneer Technical Services, Inc. Standard Operating Procedures		
SOP-DE-01	Personal Decontamination	03/30/2022
SOP-DE-02	Equipment Decontamination	09/08/2020
SOP-DE-02A	Equipment Decontamination – Pumps for Well Sampling	03/29/2022
SOP-DE-03	Investigation Derived Waste Handling	04/12/2022
SOP-G-01	Determining and Recording Station Locations	9/21/2015
SOP-GW-03	Depth to Water Level Measurements	01/18/2022
SOP-GW-10	Purging and Sampling with a 12-Volt Submersible Pump	12/03/2014
SOP-GW-10A	Purging and Sampling with a Low-Flow Submersible Pump	12/11/2014
SOP-GW-10C	Purging and Sampling with a Peristaltic Pump	12/11/2014
SOP-GW-12	Well Development using a Modified Over-Pumping Technique	04/10/2018
SOP-GW-14	Field Water Quality Measurements using the Geotech Multi-Probe Flowblock Flow through Device	05/22/2015
SOP-GW-15	Continuous Groundwater Level Monitoring (Solinst Models)	06/05/2015
SOP-SA-01	Soil and Water Sample Packaging and Shipping	04/12/2022
SOP-SA-02	Sample Preservation and Containerization for Aqueous Samples	04/13/2022
SOP-SA-03A	Field Quality Control Samples for Water Sampling	09/29/2020
SOP-SA-03B	Preparation of Equipment Rinsate Blanks for Submersible Pumps	04/20/2022
SOP-SA-04	Chain of Custody Forms for Environmental Samples	11/12/2020
SOP-SA-05	Project Documentation	04/14/2022
SOP-S-12	Sampling Soil from a Geoprobe Liner	11/18/2020
SOP-SFM-02	Operating XL3 X-Ray Fluorescence Analyzer	06/05/2015
SOP-SURVEY-01	Staking and Surveying	10/24/2016
SOP-SW-02	Field Sample Filtration	06/08/2022

SOP-WFM-01	Field Measurement of pH in Water	06/08/2022
SOP-WFM-02	Field Measurement of Oxidation Reduction Potential in Water	06/08/2022
SOP-WFM-03	Field Measurement of Specific Conductance	06/09/2022
SOP-WFM-04	Field Measurement of Water Temperature	09/30/2020
SOP-WFM-07	Field Measurement of Dissolved Oxygen	06/09/2022
SOP-WFM-08	Field Turbidity Measurement	10/13/2020

PURPOSE	To provide standard instructions for decontamination of all personnel leaving a contaminated area.
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. Wash/ remove outer contaminated items.	**If wearing two layers of gloves, remove outer contaminated items. If task requires only one pair of gloves, skip to Step 2:** a. Remove nitrile or latex gloves by grasping the outside of the opposite glove near the wrist. b. Pull and peel the glove away from the hand, turning the glove inside out with the contaminated side now on the inside. c. Hold the removed glove in the opposite gloved hand. d. Slide one or two fingers of the ungloved hand under the wrist of the remaining glove. e. Peel off the glove from the inside, creating a bag for both gloves. **If wearing protective coveralls such as Tyvek suites**: a. Keep inner layer of nitrile or latex gloves on while decontamination process occurs. b. If in a designated decontamination zone*, brush built-up material off the suit. c. Unzip the coverall and begin rolling it outwards, rolling it down over your shoulders. d. Place both hands behind your back and pull down the sleeve of each arm until the arms are completely out of the sleeves. e. Sit down and remove each shoe. f. Roll the coveralls down (ensuring the contaminated side is not touched or does not come into contact with clothing) over your knees until completely removed. g. Place the coveralls into a designated bag for storage/transportation to proper disposal area. h. With soap (non-phosphate) and tap water, wash the outer, more heavily contaminated items, such as boots (if in a designated decontamination zone, there may be a specific place to rinse off boots). i. Rinse the outer items in tap water.

	*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 SSHASP.
2. Wash/remove inner contaminated items.	Remove the inner layer of nitrile or latex gloves following the procedure in Step 1. If necessary, wash with soap (non-phosphate) 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 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, polychlorinated biphenyls (PCB), perchloroethylene (PCE), etc., contact 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 (i.e., the contamination/exposure is the cause of needing medical treatment), decontamination must be performed immediately before medical treatment can be administered.
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 (i.e., the reason for medical treatment is not related to the contamination/exposure), 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. Once the victim is medically stable, decontamination should be performed as soon as possible for the victim and any affected medical personnel.

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 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; follow decontamination procedures as described in the SSHASP; and wear nitrile gloves and safety glasses when handling contaminated items.
NOISE	Not applicable.			
ELECTRICAL	Not applicable.			
BODY MECHANICS	Potential awkward, repetitive postures when performing decontamination tasks.	Sites.	Exposure to repeated postures, awkward postures when completing decontamination.	Stretch prior to completing task and break up tasks as necessary to reduce awkward and repetitive postures.
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.	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 area as dry as possible, and wear muck boots as necessary.
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 follow procedures outlined in applicable SSHASP and/or Pioneer Corporate HASP.

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
	Hypothermia/ frostbite.	Sites where air temperature is 35.6 °F (2°C) or less.	Personnel whose clothing becomes wet during decontamination procedures may be exposed to hypothermia and/or frostbite.	If it becomes wet, personnel will change clothing.
	Lightning.	Outdoor sites.	Electrocution, injury, death, or equipment damage could result from 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.
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.
MECHANICAL	Not applicable.			
PRESSURE	Not applicable.			
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 injuries 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	**Personnel Protection Equipment** (PPE)**:** Safety glasses, high-visibility work shirt or vest, long pants, work boots, and nitrile or latex gloves.
APPLICABLE SDSs	**Safety Data Sheets** (SDSs) are available to Pioneer personnel on the internal website under Safety.
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	
TOOLS/ EQUIPMENT	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**
Kendra Overley **Kendra Overley**	**03/30/2022**
SAFETY AND HEALTH MANAGER	**DATE**
Tara Schleeman **Tara Schleeman**	**03/30/2022**

PURPOSE	To provide standard instructions for equipment decontamination.
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	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 at 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, WP, 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 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. Set up decontamination station.	a. Review the SAP or WP and determine if decontamination fluids need to be contained and the need for special decontamination requirements (i.e., chemical rinse). b. 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.

	c. If pressurized or gravity flow water is available, attach a hose or piping to reach the decontamination area. If no water is available, bring 5-gallon containers of tap and deionized water (DI) to the decontamination area to clean the equipment. d. Label empty 5-gallon buckets: *gross wash, soap wash, DI rinse, final rinse, and chemical rinse* (if required). e. Lay out clean plastic or foil to place cleaned equipment on to allow for air drying. f. If a chemical rinse is required, fill a spray bottle with the appropriate chemical and label the spray bottle with the chemical's name. g. Pour approximately 2.5 to 3 gallons of tap water into the buckets labeled: *gross wash* and *soap wash*. h. Add a **few drops** (1-3 drops) of Liquinox© soap to the bucket marked *soap wash*. i. Pour 2.5-3 gallons of DI water into the buckets labeled: *DI rinse* and *final rinse.* If a chemical rinse is required, pour DI water into the bucket labeled: *chemical rinse.*
2. Remove gross contamination.	Remove gross contamination using pressurized or gravity flow tap water, if available. If not, manually scrub the equipment using the 5-gallon bucket of 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.	In the bucket marked *DI rinse*, triple rinse the equipment with DI water to remove any soap residue.
5. Second rinse with deionized water.	Using DI water, triple rinse the equipment again in the bucket marked *final rinse* if a chemical rinse is not required.
6. Rinse equipment with chemicals.	In many cases, the tap water and DI water rinses will be sufficient. However, if specified in the SAP, WP, 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) may be specified. 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:** a. Hold the equipment over a collection container (5-gallon bucket or bowl). b. Make sure that all personnel and vehicles are upwind of the spray. c. Spray the piece of equipment inside and out starting at the top and working down to the bottom. d. 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.

7. Rinse equipment with deionized water.	After a required chemical rinse, rinse the equipment again with the DI water in the bucket marked *chemical rinse*. This DI water will need to be retained (i.e., do not dispose of this water on the 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. After the rinse in the *chemical rinse* bucket, triple rinse the equipment again in the bucket marked *final rinse.*
8. Air dry equipment.	Place equipment on plastic sheeting or foil to air dry.
9. Transport/ store equipment.	Wrap equipment in foil or plastic wrap to transport or store.
10. Clean decontamination equipment.	a. Triple rinse equipment from the *gross wash* and *soap wash* (brushes and buckets) with clean tap water, preferably with pressurized water. Soap can be used on particularly dirty equipment. b. Triple rinse all decontamination equipment with DI water, including *DI rinse* and *final rinse* buckets. c. Store decontamination equipment, labeled and in a clean location so they are used only for decontamination purposes.
11. Dispose of decontamination solutions.	Storage of contained decontamination fluids as required by the SAP, QAPP, or WP or of residue from a chemical rinse should have been arranged on site prior to sampling. Once the sampling and associated decontamination is complete, sampling of the stored fluids for hazardous waste criteria will be required. If the fluids are determined to be hazardous (e.g., meet the characteristics of a hazardous waste [ignitability, corrosivity, reactivity, or toxicity] or contain listed wastes from title 40 of the Code of Federal Regulations [CFR] in part 261.4), 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.
12. Measure effectiveness of procedures.	Measure the effectiveness of the decontamination procedures using field equipment rinsate blanks as discussed in the SAP, QAPP, or WP.

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 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); follow decontamination procedures as described above; and wear nitrile gloves and safety glasses when handling contaminated items.
	Chemical rinse (e.g., dilute nitric acid, methanol, and hexane).	Sites.	Personnel 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.	Personnel will check and follow safety procedures as outlined in the chemical-specific Safety Data Sheets. Personnel will prevent skin/eye contact with chemicals and they will wear nitrile gloves and eye protection when handling chemicals. Personnel will practice proper personal hygiene (wash hands prior to eating/drinking, after decontaminating equipment, and when leaving the site). All personnel and vehicles will stand upwind when spraying equipment with chemicals. Refer to the Chemical Flushing Guidelines available inside any Pioneer vehicle's first aid kit for first-aid procedures in case of contact with chemicals.
NOISE	Not applicable.			
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	Improper lifting.	Sites.	Back injuries and muscle/back strains could result when using improper techniques to lift and carry 5-gallon containers.	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 awkward/heavy tools and equipment.
GRAVITY	Falls from slips and trips.	Areas designated for decontamin-ation procedures.	Slips and falls could occur while performing decontamination procedures due to slippery surfaces resulting in bruises, scrapes, or broken bones.	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.
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, remain hydrated, and have sufficient caloric intakes during the day. Personnel will also 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 whose clothing becomes wet during decontamination procedures may be exposed to hypothermia and/or frostbite.	Personnel will change clothing if it becomes wet.

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*
	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.
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.
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 not set decontamination stations directly in the sun.

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 injuries 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	**Personnel Protection Equipment** (PPE)**:** Safety glasses, high-visibility work shirt or vest, long pants, work boots, and nitrile gloves.
APPLICABLE SDSs	**Safety Data Sheets** (SDSs) for corresponding chemicals used during chemical rinse will be maintained based on the site characterization and contaminants. Safety Data Sheets are available to Pioneer personnel on the internal website under Safety.
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	

TOOLS/ EQUIPMENT	Five empty 5-gallon buckets, tap water, stiff brushes, Liquinox soap, four 5-gallon containers of DI (or distilled water if DI water is not available), chemicals for chemical rinse (if required), small plastic swimming pool/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 **Julie Flammang**	**09/08/2020**
SAFETY AND HEALTH MANAGER	**DATE**
Tara Schleeman **Tara Schleeman**	**09/08/2020**

PURPOSE	To provide standard instructions to decontaminate pump equipment used to collect samples from wells.
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 Plan (SSHASP), and Pioneer Corporate Health and Safety Plan (HASP).

TASK	INSTRUCTIONS
Notes	All non-disposable or non-dedicated equipment used for sampling or monitoring activities must be decontaminated prior to leaving a site. Decontamination methods include removing contaminants through physical methods, chemical cleaning, or a combination of both methods. Personnel should complete decontamination of non-dedicated equipment wearing the same level of protection as worn during sampling. In some cases, personnel may be sufficiently protected during decontamination activities by wearing one level lower of the specified Personal Protection Equipment (PPE). Personnel will follow the requirements for site-specific equipment decontamination and personnel protection levels as detailed in the sampling and analysis plan (SAP), work plan (WP), or SSHASP. These decontamination procedures are for typical uncontrolled hazardous waste sites. Regarding specific or unusual contaminant, such as dioxins, the decontamination procedures should be discussed in the SAP, WP, and/or SSHASP. Decontamination procedures should be used in conjunction with storage methods that prevent contamination of cleaned sampling and monitoring equipment. It is preferred that personnel use one-time use equipment (disposable) if practical, and it should be disposed of in accordance with the SAP, WP, and/or SSHASP. Dedicated equipment should be used, when practical, for long-term sampling at a location. *Prior to the sampling event,* review the SAP and SSHASP to determine if purge and decontamination water needs to be contained, and if so determine the proper disposal and storage requirements. The SAP/SSHASP should specify if water from all stages of the decontamination procedure needs to be contained or if only water from initial stages of the process requires containment. The SAP/SSHASP should also provide information to allow an estimate of the amount of water that could be generated during the sampling event, and the type and concentrations of potential contaminants. Use this estimate as part of the planning process to determine a method for storage and disposal of purge and decontamination fluids, the amount of water that could be generated during the sampling

	event, and the type and concentrations of potential contaminants. If needed, make sure the proper equipment for either storage or disposal is available on the site at the start of sampling. Water can be contained at the sampling location or on the site in tanks, barrels or buckets for later disposal. Purge and decontamination water stored on the site can be sampled and analyzed so that the proper disposal method can be determined. Wastewater can be removed at the time of sampling with a pump truck to a disposal site.
Procedures to decontaminate inorganic contaminants.	1. Set up the decontamination *station*. If water used in the process needs to be contained, place a small swimming pool or a sheet of plastic on the ground in the decontamination area. If using plastic, wrap the edges of the plastic sheeting around pieces of polyvinyl chloride (PVC) or boards to form a small pool to prevent any spilled water from running onto adjacent ground. **All decontamination activities should take place within this confined area. If the fluids used in the process must be contained, set up a way to collect the fluid (i.e., bucket, hose, barrel, etc.).** 2. Based on the size of the pump and amount of tubing, set up a decontamination *container* within the station. The container can range from a stainless-steel pan that holds 1-2 gallons for a small 12-volt submersible pump with a small amount of tubing to a 5-gallon bucket or similar large container that will hold the larger pumps such as a Grunfos Redi-Flo II or larger submersible pump. The container should be tall enough to hold the submerged pump and still take on additional fluid. Non-dedicated tubing, such as that on the Grunfos Redi-Flo II, will be decontaminated on the reel. For smaller amounts of reusable tubing typically found on the 12-volt submersible pumps, coil the tubing and electric cord as it is removed from the well and place it in a bucket dedicated for decontamination. 3. Set up an appropriate storage area and refuse container to store cleaned equipment or dispose of disposable equipment. 4. Put on a new pair of nitrile gloves. 5. Remove the pump from the well making sure that the tubing and the pump do not contact the ground. If disposable tubing was used, remove the tubing from the pump and place it in the appropriate refuse container. If dedicated tubing was used, remove the tubing from the pump and place it in the appropriate storage container. 6. Next, attach a small, new piece of tubing to run water through the pump and clean the inside of the pump (Step 10 below). 7. Place the pump in the decontamination container. 8. If not done previously, don a new pair of nitrile gloves. 9. Pour tap water into the container to cover the pump.

10. To remove the well water from the pump, turn the pump on and continue pouring tap water into the container until all water from the well has been flushed from the pump and tubing. The amount will depend on the amount of tubing associated with the pump and can range from 1 gallon for the smaller pumps to 5 gallons for the Grunfos pumps.

    If the water purged from the well is turbid or colored, monitor the water flowing from the pump discharge to determine when the well water has been removed. If the water is to be contained, make sure it is discharged throughout the decontamination process into the appropriate container.

11. Add a **very** small pinch or drop of non-phosphate soap (use Liquinox© or Alconox©) to the container and turn on the pump. Continue pouring tap water into the container to flush the pump until the soapy water has been pumped through the entire length of tubing.

12. Turn the pump off and place it in a second container for a de-ionized (DI) water flush of the soapy water.

13. Pour DI water into the container to cover the pump. Turn the pump on and continue pouring DI water into the container until the soapy water has been flushed from the system. Discharge this water over any tubing that will be reinserted into the next well. Keep in mind that this process is to remove contaminants from the pump and tubing so that they are not introduced to the next well. Make sure that the tubing is thoroughly rinsed. Water from the next well will be run through the tubing prior to sampling and will flush remaining DI water from the tubing.

14. Turn the pump off, empty the water from the bucket containing tubing if necessary and place the pump and tubing into a bucket dedicated for pump storage.

15. Return the Grunfos Redi-Flow II pump to the pump holder on the reel; remember to rinse the pump holder with DI water between wells.

16. Keep tubing and pumps from touching the ground or other surfaces during transport and storage. A plastic bag can be placed over the container holding the pump or a dedicated plastic container can be used to transport or store the pump.

17. Dispose of water. If containment is required, empty the water remaining in the decontamination containers and station into the storage/disposal container.

    a. Cover the dedicated decontamination containers with plastic, foil, or a lid to prevent contaminants from entering the containers during transport or storage.
    b. Empty the water in the swimming pool or plastic into the storage container by scooping the water into the disposal container. Use a funnel dedicated to the project to help move the water into the container.

	If containment is not required, dispose of the water. Refer to the **Dispose of decontamination solutions** section.
Procedures to decontaminate organic contaminants.	**It is strongly recommended that disposable or dedicated tubing be used for all organic contaminant sampling.** **If a submersible pump is required for sampling, a stainless-steel pump that can be taken apart for cleaning is recommended.** **If free product is detected in a well, use disposable tubing or a bailer to collect the sample as purging large amounts of product through tubing makes it almost impossible to clean.** 1. Set up the decontamination *station*. If water used in the process needs to be contained, place a small swimming pool or a sheet of plastic on the ground in the decontamination area. If using plastic, wrap the edges of the plastic sheeting around pieces of PVC or boards to form a small pool to prevent any spilled water from running onto adjacent ground. **All decontamination activities should take place within this confined area. If the fluids used in the process must be contained, set up a way to collect the fluid (i.e., bucket, hose, barrel, etc.)**. 2. Based on the size of the pump and amount of tubing, set up a decontamination *container* within the station. The container can range from a stainless-steel pan that holds 1-2 gallons for smaller 12-volt submersible pumps with a small amount of tubing to a 5-gallon bucket or similar large container that will hold the larger pumps such as a Grunfos Redi-Flo II or larger submersible pump. The container should be tall enough to hold the submerged pump and still take on additional fluid. Non-dedicated tubing, such as that on the Grunfos Redi-Flo II, will be decontaminated on the reel. For smaller amounts of reusable tubing typically found on the 12-volt submersible pumps, coil the tubing and electric cord as it is removed from the well and place it in a bucket dedicated for decontamination. 3. Set up an appropriate storage area and refuse container to store cleaned equipment or dispose of disposable equipment. 4. Put on a new pair of nitrile gloves. 5. Remove the pump from the well making sure that the tubing and the pump do not contact the ground. If disposable tubing was used, remove the tubing from the pump and place it in the appropriate refuse container. If dedicated tubing was used, remove the tubing from the pump and place it in the appropriate storage container. 6. Don a new pair of nitrile gloves. 7. Wipe the pump with a paper towel wetted with DI or methanol (or solvent specified in the SAP/WP/SSHASP). Add a small piece of tubing to the pump. If tubing is to be reused, wet a paper towel with a small amount of DI or methanol (or other

solvent specified in the SAP/WP/SSHASP) and wipe the pump and the tubing as it is removed from the well.

8. Place the pump in the decontamination container.

9. If not done previously, don a new pair of nitrile gloves.

10. Pour tap water into the container to cover the pump.

11. To remove the well water from the pump, turn the pump on and continue pouring tap water into the container until all water from the well has been flushed from the pump and tubing. The amount will depend on the amount of tubing associated with the pump and can range from 1 gallon for the smaller pumps to 5 gallons for the Grunfos pumps.

    If the water purged from the well was turbid or colored, monitor the water flowing from the pump discharge to determine when the well water has been removed. If the water is to be contained, make sure it is discharged throughout the decontamination process into the appropriate container.

12. Add a **very** small pinch or drop of non-phosphate soap (use Liquinox© or Alconox©) to the container and turn on the pump. Continue pouring tap water into the container to flush the pump until the soapy water has been pumped through the entire length of tubing.

13. At this time, run a small amount of methanol or solvent through the pump, depending on the expected contaminants and as outlined in the SAP:

    a. Turn off the pump and place it into a container holding the appropriate solvent.
    b. Turn the pump on and run the solvent through the pump.
    c. Make sure that a container is available to catch and retain the used solvent. Turn off the pump.

14. If using a stainless-steel pump that can be taken apart, follow the manufacturer's directions to dissemble the pump and then wipe all parts of the pump with methanol, DI, or other solvent and reassemble.

15. Place the pump in a container for a DI water flush of the pump and tubing.

16. Pour DI water into the container to cover the pump. Turn the pump on and continue pouring DI water into the container until the solvent (methanol) has been flushed from the system. Discharge this water over any tubing that will be reinserted into the next well. Keep in mind that this process is to remove contaminants from the pump and tubing so that they are not introduced to the next well. Make sure that the tubing is thoroughly rinsed. Water from the next well will be run through the tubing prior to sampling and will flush remaining DI water from the tubing.

	17. Turn the pump off, empty the water from the bucket containing tubing if necessary and place the pump and tubing into a bucket dedicated for pump storage. 18. Return the Grunfos Redi-Flow II pump to the pump holder on the reel; remember to rinse the pump holder with DI water between wells. 19. Keep tubing and pumps from touching the ground or other surfaces during transport and storage. A plastic bag can be placed over the container holding the pump or a dedicated plastic container can be used to transport or store the pump. 20. Dispose of water. If containment is required, empty the water remaining in the decontamination containers into the storage/disposal container. a. Cover the dedicated decontamination containers with plastic, foil, or a lid to prevent contaminants from entering the containers during transport or storage. b. Empty the water in the swimming pool or plastic into the storage container by scooping the water into the disposal container. Use a funnel dedicated to the project to help move the water into the container. If containment is not required, dispose of the water. Refer to the **Dispose of decontamination solutions** section.
Clean equipment used for decontamination.	The containers used to decontaminate the pump need to be rinsed out. Typically, the process uses three stainless-steel tubs labeled gross, wash, and rinse. The gross and wash tubs use tap water, and the rinse tub uses DI water. In this case, clean the gross and wash tubs with tap water but do not use tap water on the rinse tub. 1. Rinse equipment used in the decontamination process with tap water, preferably pressurized. **Do not rinse the container labeled DI!** 2. Keep decontamination equipment separated so that it is only used for decontamination. Make sure it is labeled appropriately.
Dispose of decontamination solutions.	1. Dispose of the soap/tap water solution and the DI water rinse as detailed in the SAP, WP, or SSHASP. 2. Dispose of the solvent rinse residue into proper waste containers. Be sure to check with the health and safety officer and the project manager for disposal requirements. For example, some solvents can be evaporated.
Determine effectiveness of decontamination.	Measure the effectiveness of the decontamination procedures using field equipment rinsate blanks (see the site-specific Quality Assurance Project Plan and SOP-SA-03B Preparation of Equipment Rinsate Blanks for Submersible Pumps).

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 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, after decontamination procedures, and when leaving the site; follow decontamination procedures as described above; and wear nitrile gloves and safety glasses when handling contaminated items and decontaminating equipment.
	Methanol.	Sites.	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, and 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.

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***
	Liquinox©/ Alconox©	Sites.	Personnel could be exposed to Liquinox©/ Alconox© via ingestion and skin/eye contact during equipment decontamination resulting in adverse health effects.	Personnel will wear nitrile gloves and safety glasses during equipment decontamination.
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 containers, decontamination solutions, and tools/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 height. Two people will lift awkward or heavy tools/equipment, if necessary.
GRAVITY	Falls from slips and trips.	Areas designated for decontamin-ation procedures.	Slips and falls could occur while performing decontamination procedures due to slippery surfaces resulting in bruises, scrapes, or broken bones.	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, 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*
	Dropping decontamination solution containers.	Work truck and decontamination site.	Moving, carrying, or pouring solution from containers can result in the container falling and striking personnel.	Personnel will wear steel-toed boots and be cautious when carrying/moving containers.
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 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 whose clothing becomes wet during decontamination procedures may be exposed to hypothermia and/or frostbite.	Personnel will change clothing if it becomes 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.

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. 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	Pinch points.	Pumps.	Personnel could be exposed to hand injuries such as pinched fingers when taking apart pumps for cleaning.	Personnel will wear gloves when taking apart pumps for cleaning.
PRESSURE	Not applicable.			
THERMAL	Contact with hot surfaces.	Foil and decontamin-ation equipment.	If foil and decontamination equipment (e.g., stainless-steel pans) are placed directly in the sun, they could get hot. Contact with hot surfaces could result in personal injuries.	Personnel will prevent setting decontamination stations directly in the sun.

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	**Personnel Protection Equipment** (PPE): Hard hat, safety glasses, high-visibility work shirt or vest, long pants, work boots, and nitrile gloves (liner gloves, during winter months).
APPLICABLE SDSs	**Safety Data Sheets** (SDSs): Methanol and Liquinox©/ Alconox©. Safety Data Sheets are available to Pioneer personnel on the internal website under Safety.
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-03B Preparation of Equipment Rinsate Blanks for Submersible Pumps.
TOOLS/ EQUIPMENT	Pump, small swimming pool or plastic sheeting, pieces of PVC or boards, tap water, stainless-steel pan or 5-gallon bucket/similar large container (to fit pump), Liquinox© or Alconox, DI water, and plastic bags. Optional: bucket, hose, barrel, etc. for water containment, funnel, and methanol.
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**
Kendra Overley **Kendra Overley**	**03/29/2022**
SAFETY AND HEALTH MANAGER	**DATE**
Tara Schleeman **Tara Schleeman**	**03/29/2022**

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	Pioneer Technical Services, Inc. (Pioneer) prepared this practice for the workforce and this Standard Operation 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 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 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, place water in a storage container (drum or tank), label storage container, 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 soil back to borehole.	Unless the soil is visibly contaminated, place soil and/or cuttings from monitoring well installation back in the borehole.
5. Collect/label/ store contaminated soil from installing wells.	If the soil is visibly contaminated, place soil in a storage container (drum or tank), label storage container, and store the soil/cuttings on site until shipping/disposal arrangements are made. Labelled storage containers that include soil from borings/well installations should be located in previously sampled areas that are known to be contaminated, or place storage containers in a specified containment area (review the SSHASP and/or consult the project manager). Leave these containers 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 used for sampling and dispose of it as a solid waste in the local landfill. Package the disposable equipment, place in storage drum, and label disposable equipment and PPE used 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.

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 and water/ decontamination fluids.	Sites.	Inadvertent exposure to contaminated soil and water/ decontamination fluids 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 handling contaminated items.
NOISE	Not applicable.			
ELECTRICAL	Not applicable.			
BODY MECHANICS	Improper shoveling techniques.	Sites.	Personnel could be injured if using improper shoveling techniques to store contaminated soil/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.
	Improper lifting.	Sites.	Back injuries and muscle/back strains could result when using improper techniques to lift and carry storage containers.	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.

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 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.
	Hypothermia/ frostbite.	Sites where air temperature is 35.6 °F (2°C) or less.	Personnel whose clothing becomes wet may be exposed to hypothermia and/or frostbite.	If it becomes wet, personnel will change clothing.
	Lightning.	Outdoor sites.	Electrocution, injury, death, or equipment damage could result from 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. 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	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 injuries 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	**Personnel 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) are available to Pioneer personnel on the internal website under Safety.
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	
TOOLS/ EQUIPMENT	Storage containers, garbage bags, 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**
Kendra Overley **Kendra Overley**	**04/12/2022**
SAFETY AND HEALTH MANAGER	**DATE**
Tara Schleeman **Tara Schleeman**	**04/12/2022**

PURPOSE	To provide standard instructions for determining and recording station locations.
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 geographic coordinates of all locations at which samples are collected (stations) must be known to allow accurate data interpretation and to allow resampling of the same location. In addition to the geographic coordinates of the station, an estimate of the accuracy of those coordinates must be provided. This SOP describes methods by which station coordinates, and the accuracy of those coordinates, are to be determined. Station locations are to be reported to the data management standards outlined in the approved Sampling and Analysis Plan (SAP) and/or Quality Assurance Project Plan (QAPP). Depending on the availability of information from the Geographic Information System (GIS), one of the following two general approaches should be taken to determine the location of new stations.
Approach 1 – Reference to Features within GIS Coverage	
1. Approach 1 – reference to features within GIS coverage.	Approach 1 may be used whenever the area to be sampled falls within the region for which the project specific GIS has high resolution vector coverage and the sampling stations are within 100 feet of a permanent landmark identifiable on GIS maps. A high-resolution coverage is one derived from maps with a scale of 1:2,400 or larger. The procedure of using this approach is as follows: 1. At least four weeks prior to sampling, meet with the GIS staff and determine the scale, area, and features to be included on GIS maps to be used by field personnel; in special circumstances a shorter lead time may be possible. 2. On the GIS maps supplied, mark each location with a small “x.” Write the station identifier next to the “x.” On the border of the map, record the distance to each landmark within 100 feet, and estimate of the potential error associated with the marked location (if appropriate), and any other brief comment useful to describe the station’s location. 3. When data are submitted to the U.S. EPA, include the annotated map.

Approach 2 – Surveying of Station Location

1. Approach 2 – Surveying of station location.

Approach 2 should be used whenever the area to be sampled is outside the region of high-resolution GIS coverage or when the area within the region of high-resolution GIS coverage but there are no landmarks within 100 feet. This approach may also be used whenever Approach 1, described above, is allowable, at the discretion of field personnel.

Either conventional surveying (i.e., total station) or a Global Positioning System (GPS) must be used to identify the location of each station. GPS surveys must be differentially corrected, using a coarse-acquisition (C-A) level or better GPS receiver within 25-meter accuracy unless stricter standards are required by the project-specific SAP. An estimate of the absolute accuracy (in feet) must be made by the operator of the surveying instrument.

For each station, the location, the estimated error, the surveying method used, and any applicable narrative description of the location must be recorded. The location must be expressed in Montana State Plane coordinates, based on NAD 83 datum.

Use of Public Lands Survey Data

1. Use of public lands survey data.

In addition to state plane coordinates (or in lieu of state plane coordinates if such information is not available) station location data can be provided in terms of Public Lands Survey (PLS) township, range, section, and sub-section designations. PLS section information should be presented in terms of grid cell codes instead of narrative form (an example of the narrative form is: "NE quarter of SW quarter of SW quarter of Section 21"). Grid cell codes are more concise and more amenable to computerized manipulation.

Grid cell codes consist of the section number followed by letters to indicate the quadrants. Quadrants are lettered starting with "A" in the northeast quadrant, "B" in the northwest quadrant, "C" in the southwest quadrant, and "D" in the southeast quadrant, as the following figure illustrates:

B	A
C	D

Each quadrant can be successively subdivided in a similar manner:

<table>
<tr><td colspan="2">B</td><td>A</td></tr>
<tr><td>B</td><td>A</td><td rowspan="2">D</td></tr>
<tr><td>C</td><td>D</td></tr>
</table>

	PLS quadrants are coded starting with the largest and proceeding to the smallest. Therefore, the NE quarter of the SE quarter of the SE quarter of the NW quarter of section 21 would be coded as: 21BDDA
Recording of Elevation Data	
1. Recording of elevation data.	Measurements (or estimates) of the vertical as well as the horizontal position of each station should be made. The information to be recorded in association with each elevation observation includes: • The method used to determine the station elevation (e.g., altimeter, GPS, survey, topographical map interpolation); • The vertical coordinate datum (National Geodetic Vertical Datum 1929 or North American Vertical Datum 1983); and • An estimate of the potential error associated with the recorded elevation (in feet).
Resampling of a Station	
1. Resampling of a station.	Some locations (stations) may be sampled more than once during different investigations. If it is known that stations sampled during the current investigation (survey) were previously sampled and are described in previous reports, the relationship between old and new station identifiers should be recorded. Specifically, the following information should be included with the station description: • Station identifier used for the current survey; • Identity of previous survey (s) (i.e., survey name and code) under which the station was sampled; and • Station identifiers used for each previous survey.
Summary	
1. Summary.	Complete and accurate records of station locations are necessary to allow meaningful data interpretation and resampling. Either of two methods described above may be used to record the locations at which samples are collected. If stations are within 100 feet of a landmark within GIS'1:2,400 coverage, then the station locations may be marked on a GIS map. Otherwise, the station location must be surveyed using either conventional or GPS techniques.

	The information to be maintained for each station includes the following: • Station ID; • Station coordinates in Montana State Plane Zone 3 coordinates; • Station elevation; • An estimate of the horizontal and vertical error of the station location; • An indication of the method used to locate the station (marked GIS map, GPS, or conventional survey); • An indication of the method used to estimate station elevation; • The address of the parcel containing the station, if appropriate; • A brief narrative description of the station location; and • The correspondences to any station IDs established under previous surveys.

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	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.
WEATHER	Cold/heat stress. Lightning.	Sites. 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. Electrocution, injury, death, or equipment damage could be caused by lightning strike.	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. 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	Employees will wear safety glasses with tinted lenses, long-sleeve work shirts, and long pants. Employees should wear sunscreen, if necessary.

HSSE CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.				
			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	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, and work boots.
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	Global Positioning System (GPS).
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	**09/21/2015**
SAFETY AND HEALTH MANAGER	**DATE**
Tara Schleeman	**09/21/2015**

Revisions:

Revision	Description	Date

PURPOSE	To provide standard instructions for conducting depth to water level measurements.
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 work 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 Plan (SSHASP), and Pioneer Corporate Health and Safety Plan (HASP).

TASK	INSTRUCTIONS
Electric Depth to Water Indicator	
1. Inspect well casing.	Inspect well and casing for a marked measuring point (e.g., a line or arrow made with a permanent marker, or an indentation on the well's inner casing). If no measuring point is marked, locate the north side of the well and establish a marking point. Choose the point for ease in accurately reading the measuring tape. Mark the measuring point with a Sharpie© or paint pen.
2. Turn on and test the water level indicator.	Turn the depth to water meter on. Test that the water level indicator is on and working by pushing the test button on the body of the meter. Check the buzzer sound level and/or check that the indicator light flashes. Before using the meter, clean and decontaminate the meter per SOP-DE-02 Equipment Decontamination.
3. Lower the sensor.	Lower the sensor probe slowly into the well to minimize disturbance of water when it is encountered. As the sensor is lowered down the well, the buzzer and/or flashing light will indicate contact with water. Be aware that the sensor may indicate water prior to actual water level if the probe contacts condensation on the well; in this case the buzzer on the meter will buzz intermittently.
4. Align probe cable.	Once a solid tone is heard or the indicator light stays on, a depth to water reading can be taken. Align the marked probe cable with the designated marking point and gently raise and lower the probe until the exact mark on the probe cable, when water is encountered, is identified.
5. Record information.	Record this information in the project logbook as the depth to water (DTW) along with the time the reading was taken. Additionally, record where the marking point was located (e.g., top of casing [TOC], top of steel casing [TOSC], top of polyvinyl

	chloride (PVC) [TOPVC], inner PVC [IPVC], etc.) to help maintain continuity, if subsequent depth to water readings are needed from this well.
6. Reel in equipment.	Reel in sensor probe.
7. Decontaminate equipment.	Decontaminate all equipment prior to re-use per SOP-DE-02 Equipment Decontamination.
Chalked Measuring Tape Depth to Water Measurements	
1. Coat tape with chalk.	Make sure the equipment is clean and decontaminated per SOP-DE-02 Equipment Decontamination. Coat the lower 3 to 5 feet of tape with chalk and lower into the well. Listen for a slight splash when the weight contacts water or the cable may feel a slight drag or be lighter once it contacts the water, then lower tape an additional 0.5 foot.
2. Record information.	Record measure point and pull tape carefully from well. Read the wetted chalk mark and record. Subtract the wetted chalk mark from the measure point for true depth to water.
3. Decontaminate equipment.	Decontaminate all equipment prior to re-use per SOP-DE-02 Equipment Decontamination.

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.	Sites.	Inadvertent exposure to contaminated soil and 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 collecting and handling samples.
NOISE	Not applicable.			
ELECTRICAL	Not applicable.			
BODY MECHANICS	Bending, squatting, and kneeling.	During depth measurements.	Bending, squatting, and kneeling during depth measurements could result in muscle/back strains or other injuries.	Personnel should stretch prior to starting work and 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.	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 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. 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.

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*
	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.
BIOLOGICAL	Plants, insects, and animals.	Sites and well casings.	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	Scrapes and cuts.	Well casing.	Scrapes and cuts could result when taking measurements, from sharp edges in metals or PVC casings.	Personnel will inspect well casing for sharp edges. If edges are very sharp, personnel will wear leather gloves.
PRESSURE	Not applicable.			
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)	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.	Personnel 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	**Personnel 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) will be maintained based on site characterization and contaminants. Safety Data Sheets are available to Pioneer personnel on the internal website under Safety.
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 well locations.
RELATED SOPs/PROCEDURES /WORK PLANS	SOP-DE-02 Equipment Decontamination.
TOOLS/ EQUIPMENT	Depth to water meter or measuring tape and chalk 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**
Patricia Olson **Patricia Olson**	**01/18/2022**
SAFETY AND HEALTH MANAGER	**DATE**
Tara Schleeman **Tara Schleeman**	**01/18/2022**

PURPOSE	To provide standard instructions for purging and sampling with a low flow submersible pump.
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	Sampling wells in order of increasing chemical concentrations is preferred.
1. Determine the water level in the well.	Using clean, non-contaminating equipment (e.g., an electronic depth to water level indicator (avoid indicating paste)), per SOP-DE-02 Equipment Decontamination, determine the water level in the well. Refer to SOP-GW-03 Depth to Water Level Measurements for instructions.
2. Attach tubing to the pump outlet.	Attach the appropriate disposable or decontaminated tubing to the pump outlet. Teflon or Teflon lined tubing is preferred when sampling for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), pesticides, and polychlorinated biphenyl (PCBs). Polyvinyl chloride (PVC), polyethylene, and polypropylene tubing can be used when sampling for inorganics. **Note**: all down-hole and potentially wetted surfaces must also be non-contaminating/non-contributing, per SOP-DE-02 Equipment Decontamination. This includes power and suspension cables and compressed gas or sample tubing. The pump should also be constructed of materials compatible with the required sample analysis.
3. Lower pump and tubing into well.	Lower the pre-cleaned pump and tubing gently into the well to the predetermined sampling zone. The mid-point of the saturated screen is used by convention as the location of the pump intake. Chemical concentrations or permeability considerations may require pump placement in a different zone; this will be indicated in the Sampling and Analysis Plan (SAP) or work plan. If possible, keep the pump at least 2 feet from the bottom of the well to avoid mobilization of particulates in the bottom of the well.
4. Lower electronic depth to water	Lower the electronic depth to water level indicator probe back into the well to monitor drawdown during the purging and sampling process.

level indicator back into the well.	
5. Start the pump and collect samples.	Start the pump at the lowest setting and gradually increase the speed until discharge occurs. Measure the water level and record the measurement in the logbook as initial drawdown. Adjust the pump speed until no or minimal water level drawdown occurs. The goal is a water level drawdown of less than 0.3 feet. If the minimal water level drawdown that can be achieved is greater than 0.3 feet, but then the water level remains stable, continue purging until parameters stabilize. The discharge rate, in general, should be between 0.25 and 0.5 liters a minute. The final purge volume must be greater than the stabilized drawdown volume plus the extraction tubing volume. Do not let the water level in the well fall to the intake level. If the recharge rate is slower than an attainable extraction rate using the pump and the well becomes essentially dewatered (e.g., water level falls below the intake level), the well should be allowed to recover sufficiently to fill all the appropriate sample containers. If possible do not move the pump intake during this process. Samples may then be collected even though parameters have not stabilized.
6. Dispose of purged water and measure purge volume.	Collect and dispose of purged water in accordance with SOP-DE-03 Investigation Derived Waste Handling. Measure and record the total purge volume.
7. Monitor and record field parameters and depth to water level measurements.	During well purging, monitor indicator field parameters including pH, conductivity, and temperature. The SAP or work plan may indicate other field parameters that need to be monitored, such as Oxidation Reduction Potential (ORP), dissolved oxygen (DO), and turbidity. 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; and c. Specific conductivity readings are within 3% of the average. Field parameters, as well as, depth to water level measurements should be recorded in the logbook or on field data sheets.
8. Collect samples.	Once stabilization has occurred, sampling can commence. If VOC analysis is required, VOC samples should be collected first and directly into 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. Cap each bottle as filled. Add preservative as required by analytical methods to samples immediately after collection if not collected in pre-preserved containers. If a filtered sample is required, an in-line high capacity (0.45 µm) should be inserted into the discharge hose after the other sample containers are filled. Fill the sample bottle and preserve immediately; cap the bottle.

9. Label sample bottles.	Label the sample bottle with an appropriate tag/label. Be sure to complete the tag with necessary information. Record the information in the field logbook and complete all chain-of-custody documents.
10. Transport sample bottles.	Place the properly labeled sample bottles in an appropriate carrying container maintained at 4°C +/- 2°C throughout the sampling and transportation period.
11. Decontaminate pump.	The pump will be thoroughly decontaminated after each use, according to 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 and water.	Sites.	Inadvertent exposure to contaminated soils and 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 collecting and handling samples. Pour water from bucket into disposal area slowly to prevent splashes and skin contact.
	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. Refer to the Chemical Flushing Guidelines available inside vehicle's first aid kit for first-aid procedures in case of contact with preservatives.
	Carbon Monoxide (CO).	Generator.	Potential exposure to CO when working around the generator could result in irritated eyes, headache, nausea, weakness, and dizziness.	Employees will stay up wind when working around the generator. The generator will not be operated indoors or near openings to any buildings that might be occupied.
	Contact with gasoline.	Fueling generator.	Inadvertent exposure via inhalation and/or skin contact can result in adverse	Fuel generator in well-ventilated area, stand up wind while fueling, and minimize splash hazards so skin contact does not occur. Wear nitrile

			health effects and skin irritation if contact with gasoline occurs.	gloves when removing fuel cap and filter.
NOISE	Not applicable.			
ELECTRICAL	Improper use of 12-volt battery.	Sites, when using battery to power pump.	Personal injuries could result from improper use and maintenance of a 12-volt battery. Example are: shocks, acid burns on skin or eyes, skin burns from electrical charge transfer through a tool and into a metal ring or watch, and battery explosions.	Employees will remove all jewelry before working with a 12-volt battery. Workers will wear leather gloves and safety glasses. Employees will disconnect the negative cable first and re-connect it last to prevent getting a shock from current overflow. Employees will use batteries in well-ventilated areas. Personnel will inspect battery before and after each use.
	Improper use of generator.	Testing sites (during wet conditions).	Electrocution, shock, death, or equipment damage could be caused when using a generator during wet conditions.	If workers must use a generator when it is wet outside, the generator should be protected from moisture. The generator should be equipped with a Ground Fault Circuit Interrupter (GFCI). Keep extension cord (if used) and connections as dry as possible. Place generator on a surface where water cannot puddle or drain under it. Workers should dry hands, if wet, before touching the generator. Items should be connected to the generator using heavy-duty extension cords that are specifically designed for outdoor use.

BODY MECHANICS	Improper lifting.	Testing sites.	Back injuries and muscle/back strains could result when using improper techniques to lift and carry tools, samples, 12-volt battery, and/or generator.	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 load/unload the generator.
	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 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.	Well caps.	Personal injury could result from fingers getting pinched in the well cap.	Personnel will wear leather gloves when removing well caps.
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	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

			collecting samples.	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	Gasoline, CO, 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	Map with site location and sample locations.
RELATED SOPs/PROCEDURES/ WORK PLANS	SOP-DE-02 Equipment Decontamination, SOP-DE-03 Investigation Derived Waste Handling, and SOP-GW-03 Depth to Water Level Measurements.
TOOLS	Electronic depth to water level indicator, low flow submersible pump, sample bottles, water quality meters, 12-volt battery or generator, cooler, 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**	**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 purging and sampling with a peristaltic pump.
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	Sampling wells in order of increasing chemical concentrations is preferred.
1. Determine the water level in the well.	Using clean, non-contaminating equipment (e.g., an electronic depth to water level indicator (avoid indicating paste)), per SOP-DE-02 Equipment Decontamination, determine the water level in the well. Refer to SOP-GW-03 Depth to Water Level Measurements for instructions. Calculate the fluid volume in the case ("casing volume") and record in the logbook. If depth to mid-point of screen is over 8 meters, choose alternative system.
2. Measure tubing to be used.	Measure the appropriate amount of disposable or decontaminated tubing to be inserted into the well. Add an additional two to four feet of tubing that will remain outside the well and attach to the soft tubing in the peristaltic pump. Teflon or Teflon lined tubing is preferred when sampling for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), pesticides, and polychlorinated biphenyl (PCBs). Polyvinyl chloride (PVC), polyethylene and polypropylene tubing can be used when sampling for inorganics.
3. Insert tubing into the well.	Insert the tubing into the well to the predetermined sampling zone. The mid-point of the saturated screen is used by convention as the location of the tubing end. Chemical concentrations or permeability considerations may require tubing placement in a different zone. This will be indicated in the Sampling Analysis Plan (SAP) or work plan. If possible keep the tubing at least 2 feet from the bottom of the well to avoid mobilization of particulates in the bottom of the well.
4. Measure and record the discharge rate.	Insert the soft tubing into the peristaltic pump following the instructions in the operating manual. Insert the hard tubing into the soft tubing end. Start the pump head and adjust the pump speed until an appropriate discharge rate is achieved. The pump should discharge at an extraction rate that avoids drawing down the water level below the pump intake. Measure the discharge rate using a bottle or beaker and a stop watch. Record this information in the logbook. If the recharge rate is slower than an attainable extraction rate using the pump and the well becomes

	essentially dewatered (e.g., water level falls below the intake level), the well should be allowed to recover sufficiently to fill all the appropriate sample containers. If possible, do not move the pump intake during this process. Samples may then be collected.
5. Dispose of purged water and record total purge volume.	Collect and dispose of purged water in accordance with SOP-DE-03 Investigation Derived Waste Handling. Measure and record the total purge volume.
6. Monitor and record field parameters and depth to water level measurements.	During well purging, monitor indicator field parameters including pH, conductivity, and temperature. The SAP or work plan may indicate other field parameters that need to be monitored, such as eH, dissolved oxygen (DO), and turbidity. 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; and c. Specific conductivity readings are within 3% of the average. Field parameters should be recorded in the logbook or on field data sheets.
7. Collect samples.	Purge a minimum of three casing volumes and/or until water quality parameters stabilize. Once these conditions occur, sampling can commence. In general, VOC samples should not be collected when using a peristaltic pump. If VOC analysis is required, collect the VOC samples first and then place them directly into 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. Add preservative as required by analytical methods to samples immediately after collection, if not collected in pre-preserved containers. If a filtered sample is required, an in-line high capacity (0.45 µm) should be inserted into the discharge end of the soft tubing after the other sample containers are filled. Fill the sample bottle and preserve immediately; cap the bottle. 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.
8. Label sample bottles.	Label the sample bottle with an appropriate tag/label. Be sure to complete the tag with necessary information. Record the information in the field logbook and complete all chain-of-custody documents.
9. Transport sample bottles.	Place the properly labeled sample bottles in an appropriate carrying container maintained at 4°C +/- 2°C throughout the sampling and transportation period.

10. 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 soils and water.	Sites.	Inadvertent exposure to contaminated soils and 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 collecting and handling samples. Pour water from bucket into disposal area slowly to prevent splashes and skin contact.
	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. 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.	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 people will lift objects, if necessary.
	Bending, squatting, and kneeling.	During sample collection.	Bending, squatting, and kneeling during sample collection	Employees should stretch prior to starting work and they will take breaks when necessary.

			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.
	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.	Well caps.	Personal injury could result from fingers getting pinched in the well cap.	Personnel will wear leather gloves when removing well caps.
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	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	Map with site location and sample locations.
RELATED SOPs/PROCEDURES/ WORK PLANS	SOP-DE-02 Equipment Decontamination, SOP-DE-03 Investigation Derived Waste Handling, and SOP-GW-03 Depth to Water Level Measurements.
TOOLS	Sample bottles, water quality meters, 5-gallon buckets, electronic depth to water level indicator, peristaltic pump, stop watch, cooler, 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**	**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 well development and the removal of fine grained sediments from the vicinity of the well screen. Well development allows the water to flow freely from the formation into the well and reduces the turbidity of the water during groundwater sampling. Initial well development is critical to ensure that the well has the pumping volume required for future use.
SCOPE	This practice is 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 procedure described below. This Standard Operating Procedure (SOP) discusses well development using a modified over-pumping technique and can be used with the following pumps: peristaltic, low flow Grundfos, PROACTIVE 12-volt submersible, and Grundfos Redi-Flo II. Less vigorous methods of well development include bailers or manual surge blocks. These methods are addressed in other SOPs. If a well requires more vigorous development than over-pumping (e.g., soil types, chemicals used during installation, large required production volumes, etc.), a well installer or subcontractor may be required to complete the development.

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 Standard Operating Procedure (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. Select pump.	The table below summarizes the types of pumps Pioneer has readily available for well development. Personnel should select the appropriate pump for the well development required using the table below.

Pump/ Development Type	Well Diameter (inches)	Max Well Depth (ft)	Anticipated Production
Bailer[1]	1	100	Poor to Good
	≥2	100	Poor
Manual Surge Block[1]	1	100	Poor to Good
	≥2	100	Poor
Peristaltic Pump	1	25	Poor to Good
	2	25	Poor
Low Flow Grundfos	≥2	200	Poor to Good
PROACTIVE 12-volt Submersible Pump	≥2	80	Good
Grundfos Redi-Flo II	≥2	250	Good
Subcontractor/Well Installer	≥2	>250	Poor to Good

1. If a bailer or manual surge block is the only alternative, the modified over-pumping technique cannot be used. Instead, personnel should follow the appropriate, alternative SOP.

2. Gather information.	Review the Site Sampling and Analysis Plan (SAP) or Work Plan for purge water containment requirements. Compile the necessary equipment and well installation information (e.g., total depth, screen interval, etc.) prior to traveling to the site.
3. Set up equipment.	Upon arrival at the well/piezometer to be developed, place the containers that will be used to contain purge water (if required) in an accessible location. Set up the remainder of the equipment adjacent to the well, within spill containment if required.
4. Take and initial DTW reading.	Open the well/piezometer and take an initial depth to water (DTW) reading following the instructions outlined in SOP-GW-03 Depth to Water Level Measurements. Record the initial DTW in the field logbook and on the well development field data sheet.
5. Check the total depth of the well.	Check the total depth of the well by turning off the buzzer on the DTW meter and lowering probe to the bottom of the well. Record this information in the field logbook and on the well development field data sheet. Remove the DTW probe from the well. Record the screen depth and length (available from the well installation log).
6. Set up pump and tubing.	If needed, attach an appropriate length of disposable or decontaminated tubing to the pump outlet or put tubing in the pump head. Don a new, clean pair of gloves prior to handling the tubing. Lower pump or tubing into the well. The pump intake should be located near the bottom of the screened interval. If the screen extends to the bottom of the well, make sure the intake for the pump is located above any slurry that may be present in the bottom of the well, approximately 1/2 to 1 foot above the bottom if using the submersible pumps.

	If using a peristaltic pump, tubing can be located closer to the bottom of the well as slurry will only clog the tubing and not damage the pump itself. If using a submersible 12-volt pump without a controller, put a valve on the discharge end of tubing and securely fasten. Record the depth of the pump intake in the field logbook and on the well development field data sheet.
7. Measure DTW with the pump installed.	Put the DTW probe back in the well and make sure it is turned on. Record the DTW with the pump installed.
8. Turn the pump on and adjust water flow.	If using a 12-volt submersible pump, start the pump with the attached discharge valve all the way open. If using a Grundfos pump with a controller or a peristaltic pump, turn the pump on and raise the pumping rate slowly until water starts to flow. Monitor the DTW meter; the water elevation should drop until the tubing is full and water is flowing freely. If the water elevation continues to drop after water is flowing smoothly, turn flow down using either the discharge valve or the controller until the water elevation stabilizes. Record the time development starts, the stabilized water elevation, and an estimate of volume purged in the field logbook and on the well development field data sheet as “Initial Drawdown.”
9. Measure the stabilized water flow rate.	Measure the stabilized water flow rate using an appropriately-sized container (e.g., graduated cylinder, marked beaker, marked bucket, etc.) and a stopwatch to determine the volume of water per minute being purged from the well. Record the water flow rate in the field logbook and on the well development field data sheet.
10. Record the characteristics of the purged water.	Record the color of water, presence of sand or silt, and any odors or sheen. If the water is not extremely dirty, run an initial turbidity measurement and record.
11. Track the volume of water being removed.	Track the volume of water being removed. Volume may be calculated by either multiplying the elapsed time by the water flow rate or multiplying the number of buckets/drums purged by the volume of the bucket/drum. Keep a record of time, water removed, turbidity measurements and DTW readings in the field logbook and on the well development field data sheet.
12. Measure and record the field parameters.	Once the water appears to be clear, begin measuring field parameters. At a minimum, measure temperature, pH, specific conductivity (SC), and turbidity. If required by the SAP or Work Plan, measure and record the oxidation reduction potential (ORP) and dissolved oxygen (DO). Depending on the water flow rate field parameter probes can be placed in a 5-gallon bucket, in a ½- to 1-liter beaker or in a flow thru cell. Turnover of water in the container should be quick (e.g., 1 to 2 minutes). As an example, if the water is purging

	at 4 gallons a minute, a 5-gallon bucket could be used, as turnover in the bucket would be about 1 minute. If water is purging at 1 to 2 gallons a minute, a liter beaker may be more appropriate. If the water is fairly clear, a flow through cell with appropriately sized bypass tubing can be used with any flow rate. The flow through cell allows the water in the bypass tubing to be discharged directly into a storage container or to the ground a safe distance downgradient from the well. Record parameter measurements every 5 to 10 minutes. Record DTW measurements and estimated volume along with the parameter readings in the field logbook and/or on the well development field data sheet.
13. Purge the well and monitor drawdown.	If possible, when turbidity falls below 50 Nephelometric Turbidity Unit (NTU), increase the flow by adjusting the discharge valve or turning up the controller. Purge the well at about twice the stabilized water flow rate determined in Steps 8 and 9. Monitor drawdown constantly as you do not want to purge the well dry. • The water elevation may stabilize at a level lower than the initial DTW reading. If so, record how long it took to stabilize at the lower level, the amount of water purged, and the new DTW elevation in the field logbook and on the well development field data sheet. • If the water elevation in the well drops to about 4 to 5 feet above the pump intake (the acceptable drawdown elevation should be adjusted based on the water column, screen length and depth of the well being developed; ideally you want to develop the well along the entire screen length), turn the discharge valve or controller below the starting flow rate and allow the well to "recover." Record the duration, amount purged, and DTW when done with the initial over-pumping of the well. • If the pump is purging at maximum capacity, or if no drawdown occurs at a higher flow, turn the pump off, let the well "recover" for 1 to 5 minutes, and turn the pump back on. Record the duration of the stoppage and the new starting water level in the field logbook and on the well development field data sheet.
14. Continue monitoring turbidity and recording field parameters.	Turbidity may increase after the over-pumping or stopping. Continue recording field parameters unless the turbidity exceeds 1000 NTU. At this point, remove the field parameter probes and wait for the water to clear up before recording field parameters. Note this in the field logbook or on the well development field data sheet. Once turbidity measures less than 50 NTU, repeat Steps 12 and 13 until the clarity of water does not change significantly between lower and higher flows.
15. Adjust pump as needed.	If time permits (as designated in the SAP or Work plan) and the stabilized water level allows, raise the pump to the midpoint of the screen and repeat Steps 12 through 14, recording time, field parameters, volume purged, and DTW readings until turbidity readings are less than 50 NTU.
16. Continue monitoring turbidity and	The well is considered developed when 3 consecutive readings for turbidity are below the SAP or Work Plan designated requirements (e.g., the Clark Fork River Superfund Site Investigation SOP [ARCO, 1992] requires readings below 5 NTU, and the U.S.

field parameters to determine if the well is developed.	Environmental Protection Agency [EPA] well development protocol requires readings below 50 NTU) and the remaining required field parameters have stabilized. Water quality parameters are considered stable when three consecutive readings are as follows: • Temperature range is no more than +/- 1 degree Celsius (°C); • pH varies by no more than 0.1 pH units; and • SC readings are within 3% of the average.
17. Record the final DTW and calculate the total amount of water purged.	Before turning off the pump, record a final DTW. Calculate the total amount of water purged and record the volume in the field logbook and on the well development field data sheet.
18. Dispose of the purge water and tubing.	Dispose of the purge water and tubing as outlined in the SAP or Work 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 soils and water.	During well development.	Inadvertent exposure to contaminated soils and 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 contact with purge water is possible. Pour purge water from buckets into disposal area/containers used to contain purge water slowly to prevent splashes and skin contact. Keep control of high-flow discharge hoses to prevent water spraying and skin contact.
	Carbon monoxide (CO).	Generator.	Potential exposure to CO when working around the generator could result in irritated eyes, headache, nausea, weakness, and dizziness.	Personnel will stay up wind when working around the generator. The generator will not be operated indoors or near openings to any buildings that might be occupied.
	Contact with gasoline.	Fueling the generator.	Inadvertent exposure via inhalation and/or skin contact can result in adverse health effects and skin irritation if contact with gasoline occurs.	Personnel will fuel the generator in a well-ventilated area, stand up wind while fueling, and minimize splash hazards so skin contact does not occur. Wear nitrile gloves when removing the fuel cap and filter.

HSSE CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.				
NOISE	Elevated noise levels.	Using the generator.	Exposure to elevated noise levels from the generator may result in hearing damage.	Personnel will set up the generator away from the well development activities to prevent exposure to elevated noise levels.
ELECTRICAL	Improper use of the generator.	Sites (during we conditions).	Electrocution, shock, death, or equipment damage could be caused when using a generator during wet conditions.	If personnel must use a generator when it is wet outside, the generator will be protected from moisture and it will be equipped with a Ground Fault Circuit Interrupter (GFCI). Keep extension cord (if used) and connections as dry as possible. Place generator on a surface where water cannot puddle or drain under it. Personnel will dry hands, if wet, before touching the generator. Items will be connected to the generator using heavy-duty extension cords that are specifically designed for outdoor use.
	Improper use of the 12-volt battery.	Using the battery to power the 12-volt submersible pump.	Personal injuries could result from improper use and maintenance of a 12-volt battery. Example are: shocks, acid burns on skin or eyes, skin burns from electrical charge transfer through a tool and into a metal ring or watch, and battery explosions.	Personnel will remove all jewelry before working with a 12-volt battery. Personnel will disconnect the negative cable first and re-connect it last to prevent getting a shock from current overflow. Personnel will use the battery in well-ventilated areas and inspect the battery before and after each use. Personnel will wear leather gloves and safety glasses when handling the battery.

HSSE CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.				
BODY MECHANICS	Improper lifting.	During well development.	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 workers will lift/handle heavy items.
	Bending, squatting, and kneeling.	During well development.	Bending, squatting, and kneeling during work activities could result in muscle/back strains or other injuries.	Personnel 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.	Personnel will wear work boots with good traction and ankle support. Personnel will be aware of walking/working surfaces and choose a path to avoid hazards. Keep work areas as dry as possible. If conditions are wet or muddy, wear muck boots.
WEATHER	Cold/heat stress.	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. 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.	Personnel 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.	Outdoor sites.	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.	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 the site. Personnel with allergies will notify their supervisor.
MECHANICAL	Pinch points.	Well caps.	Personal injury could result from fingers getting pinched in well caps.	Personnel will wear leather gloves when removing well caps.
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 the procedure described above and other applicable procedures. Personnel 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	**Personal Protective Equipment** (PPE): Hard hat, safety glasses, high-visibility work shirt or vest, long pants, work boots, nitrile gloves, and work gloves.
APPLICABLE SDS	**Safety Data Sheets** (SDSs) will be maintained based on the 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	
RELATED SOPs/ PROCEDURES /WORK PLANS	SOP-GW-03 Depth to Water Level Measurements
TOOLS	DTW meter, pump and tubing (see step 1 for pump selection), turbidity meter, container to measure water flow rate (e.g., graduated cylinder, marked beaker, marked bucket, etc.), stopwatch, field parameter meters, and containers to contain purge water (if required).
FORMS/ CHECKLIST	Field logbook, well development field data sheet, and well installation log.

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**	**04/10/2018**
SAFETY AND HEALTH MANAGER	**DATE**
Tara Schleeman **Tara Schleeman**	**04/10/2018**

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.

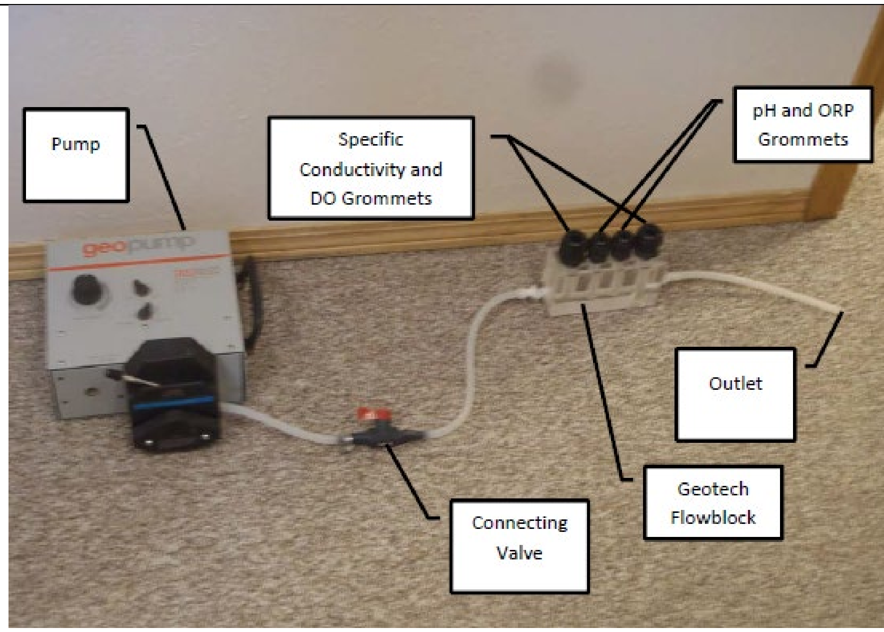
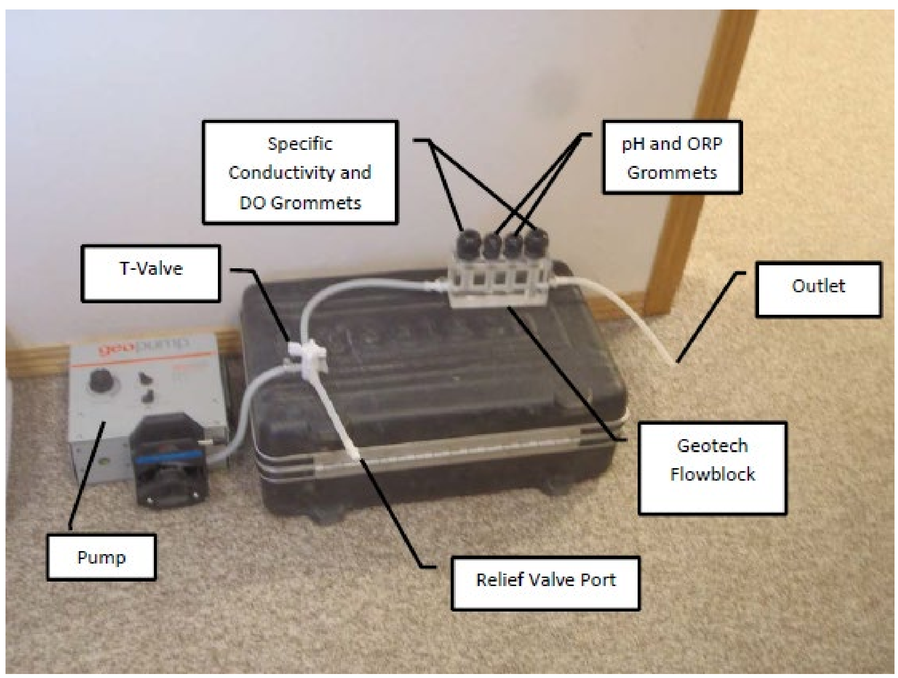


Figure 1. Geotech Flowblock

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 (signature) **Julie Flammang**	**05/22/2015**
SAFETY AND HEALTH MANAGER	**DATE**
Tara Schleeman (signature) **Tara Schleeman**	**05/22/2015**

Revisions:

Revision	Description	Date

PURPOSE	To provide standard instructions for using a pressure transducer datalogger for continuous groundwater level measurements.
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 out under this Standard Operating Procedure (SOP) will be consistent with procedures and policies described in the appropriate Operation, Maintenance, and Monitoring (OM&M) Plan (where applicable), appropriate Site-Specific Health and Safety Plan (SSHASP), and Pioneer Corporate Health and Safety Plan (HASP).

TASK	INSTRUCTIONS
Installation	

1. Program transducer.	It is recommended that transducers are programmed in the office rather than in the field to make sure everything is accurate (refer to manual for step-by-step instructions). The following information is needed when programming each transducer:
	
	• Project ID.
	• Location.
	• Level – Units in feet.
	  ○ Offset – Set to 0.0 feet.
	  ○ Altitude – Set to 0.0 feet unless site topography varies over 1,000 feet in elevation (e.g., one transducer located in a valley while another transducer is located at the top of a hill).
	  ○ Density – 1.0 kg/L.
	• Temperature – Units in degrees Celsius.
	• Standard Conductivity – Units in microsiemens per centimeter (µS/cm).
	• Datalogger Memory Mode – Set to slate mode.
	• Verification that the transducers and programming instrument (e.g., Solinst Leveloader™) are using the most current software/firmware.
	
	There are different models of transducers that are currently being used. Each model may not record all of the parameters listed above.

2. Determine the site-specific water column (static water level and total	Establish well specifics to determine water column (e.g., well log, if available) in an effort to bring enough supplies. Once in the field, verify water column information by using clean, non-contaminating equipment (e.g., an electronic depth to water level indicator [avoid indicating paste]), decontaminated per SOP-DE-02 Equipment Decontamination. Refer to SOP-GW-03 Depth to Water Level (DTW)

depth) and its variability.	Measurements, measure and record DTW in the logbook. For consistent water level readings, use the same DTW meter during each site visit.
3. Determine hanging height of transducer.	Determination of the transducer hanging depth in the well is site specific and depends on the well and the water level fluctuation in the area. The main priority is to keep the transducer submerged at all times while making sure it is off of the bottom of the well where sediments can build up over time. Determine a depth at which to install the transducer.
4. Determine set up to secure the transducer to the PVC/well casing.	There are many different ways to secure the transducer at the top of the well and to keep it in place depending on well construction and the project budget. Kevlar string or Dyneema® fiber work well to hang the transducer at the desired depth. Neither will stretch much after installation. It is imperative that the transducer is unable to shift/slide/slip/etc. from its original hanging position after it is attached to the polyvinyl chloride (PVC) or well casing. Again, this is site specific and should be verified with the Project Manager. If direct read cables are used, they must be properly secured to assure the transducer hanging height does not change and should have a backup hanging system (e.g., Kevlar string) in the event the cable is cut. Never attach the transducer to anything removable (e.g., well cap) unless there are no other means to attach the device. The easiest and most effective method for securing the transducer at a specified depth in the well is to install an eye-bolt or hook into the outer well casing (hook or eye should be to the inside of the casing). A large hose clamp over the inner PVC casing could also be used to secure the string. For security reasons, try to attach the string or direct read cable so that it is entirely contained within the outer well casing. Don a new pair of nitrile or latex gloves. Tie the string/fiber to the transducer. Measure the appropriate amount of string/fiber required to install the transducer at the determined depth plus a small amount to attach the string/fiber to the casing. While measuring the string/fiber, field personnel should wear latex or nitrile gloves and make sure the string/fiber does not contact the ground. Cut the string/fiber. If using a direct read cable, screw the direct read cable to the transducer. Care should be taken to only twist the connectors and not the cable. Measure out the appropriate amount of cable to install the transducer at the pre-determined depth, coil and secure any leftover cable with a zip tie. Secure the string/fiber to the hook, eye bolt or hose clamp at the top of the casing.
5. Start the transducer.	If needed, remove the cap from the transducer and/or direct read cable. Using special care to only twist the connectors and not the cables, connect to the transducer or direct read cable using either the Leveloader™ or a field laptop computer (pre-loaded with the most recent version of transducer specific software) using a PC connector cable. An optical reader can also be used in conjunction with the Leveloader™ or a field laptop computer to program the transducer. Check, and if needed, set the present date and time. Daylight savings time should never be accounted for and the transducer's time should always be set to standard. The time should also be synced to an exact time (e.g., cell phone). Set the transducer for a future start time, never start at the current time. Double check the interval time set

	in the initial program setup (e.g., a reading every four hours, readings at 15-minute intervals, etc.). Set the future start time so that one of the interval loggings occurs at 12:00 AM. If transducers are to be installed in more than one well, set each transducer to start recording at the same future start time and the same logging interval. Once the programming is complete, close out of the program, and disconnect the transducer from the Leveloader™ or field laptop computer. Put the cap back on the transducer and/or the direct read cable, being careful to only twist the cap and not the cables.
6. Deploy the transducer.	Confirm that the string/fiber is firmly attached to both the transducer and the top of the well. Lower the transducer into the well slowly to the predetermined depth. Reconfirm that the string/fiber are firmly attached to the top of the well. Replace the well cap. Close and lock the well casing.
7. Barologger installation.	A Barologger will need to be installed to log barometric pressure. Barologger readings can be used to compensate any transducer data from wells that are within 1,000 feet of elevation and within a 20-mile radius. If possible, choose a central location that allows all transducers being installed to fall within these criteria. The Barologger can be installed within a well, above the high water level, at the location or in a nearby building. Additional Barologgers will need to be installed if any transducers fall outside of these parameters. Following the manufactures operating manual, set the Barologger to start at the same time as the transducers and record at the same time interval. The following information should also be programmed into the Barologger: • Project ID. • Location. • Level – Units in kPa. • Temperature – Units in degrees Celsius. Installation of the Barologger is similar to installing a transducer. After verifying the high water level to avoid the Barologger coming into contact with water, cut a piece of Kevlar string or Dyneema® fiber to hang the Barologger at the desired height within the well casing. In an ideal situation the Barologger will be installed between the inner well casing (PVC) and the outer metal protective casing. The length of the string should allow the Barologger to hang down below the top of the inner well casing so it won't be disturbed during monitoring/sampling activities, but short enough that it doesn't touch the ground. The Barologger can also be installed within the inner well casing if there is not enough space between the inner and outer casing. The Barologger will need to be removed during sampling and monitoring activities. Do not remove it when a logging interval is near as it could impact the specific reading. The Barologger can be hung from the same eye-bolt, hook or hose clamp as the transducer, or hung using its own dedicated setup.

Downloading	
1. Measure the water level in the well.	The static water level must be measured prior to downloading the transducer. This insures the water column height was not compromised (e.g., pulling the transducer causing the water level to drop). Using clean, non-contaminating equipment (e.g., an electronic depth to water level indicator [avoid indicating paste]), decontaminated per SOP-DE-02 Equipment Decontamination, determine the water level in the well. Refer to SOP-GW-03 Depth to Water Level Measurements for instructions and record in the logbook. To ensure consistent water level readings an effort should be made to use the same DTW meter during each site visit. Rinse probe with DI water between locations.
2. Download data.	If a direct read cable was used in the well, connect to the transducer using either the Leveloader™ or a PC interface cable and the field laptop. If a direct read cable was not installed, don a pair of nitrile or latex gloves and remove the transducer from the well, noting the time on the field data sheet or in the field logbook. Place a piece of new plastic on the ground and place string on it as the transducer is removed from the well, alternately have field personnel collect the string so that it does not touch the ground during removal. Remove the cap from the transducer and/or direct read cable and place it in the optical reader or attach the PC interface cable (twist the connector, not the cable). Care should be taken not to misplace the cap removed from the transducer or direct read cable. The field laptop computer should have the most current software/firmware. Using either the Leveloader™ or the field laptop computer download the data (refer to manual for step-by-step instructions). If a direct read cable is installed, also record the real-time measurements in the logbook.
3. Start the transducer.	Set the transducer to a future start at a specific time (e.g. every four hours, 15-minute intervals, etc.) with one of the intervals logging at 12:00 AM. Never start at the current time.
4. Reinstall the transducer.	When downloading is complete, put the cap back on the direct read cable or transducer taking care not to twist the cable only the connectors. Replace the direct read cable inside the well casing or reinstall the transducer into the well as discussed in Step 6 above. Once the transducer is back in place note the time in the logbook or on the field data sheet. Close and lock the well casing.
Maintenance	
1. Battery Life	Each transducer has a 10-year battery life (based on one reading/min). Prior to transducer deployment, it is important to note the age of the instrument as well as monitor the battery level during each field visit. When reaching the end of the battery life, readings may begin to drift from the actual water levels. Periodic readings from the transducer should be compared to the manual water levels to help indicate the accuracy of the transducer and if it should be replaced.
2. Calibration	The Solinst® LTC Levelogger Junior F30/M10 transducer should be calibrated for conductivity every six months (refer to manual for step-by-step instructions).

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 during monitoring activities.
	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. Employees 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 monitoring activities.	Bending, squatting, and kneeling during monitoring activities 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	Training on signs and symptoms of cold/heat stress is required. Personnel will wear

			burns, frostbites, and hypothermia. Exposure to high temperatures may result in heat cramps, heat exhaustion, or heat stroke.	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.	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. Watch hand placement when opening/closing well caps.
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.
	Interaction with public.	Sites.	Public can enter the work area and interfere with work activities.	Personnel will stop work, if public enters the work area. Work will resume once public has left the 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 work gloves.
APPLICABLE SDS	Safety Data Sheets (SDSs) will be maintained based on site characterization and contaminants. Standard conductivity calibration solution (1413 µS/cm).
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-DE-02 Equipment Decontamination and SOP-GW-03 Depth to Water Level Measurements.
TOOLS	Electronic depth to water level indicator, appropriate instrument connecting cables, eye bolt, string, piece of plastic sheeting, keys to locks, field laptop/Leveloader, field logbook, DI water, and standard conductivity calibration solution (1413 µS/cm).
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 sampling soil from a liner using a Geoprobe® unit.
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
Preparation	
1. Check of liner materials.	Make sure that the liner used to contain the soil in the Geoprobe® probe rods is made of material compatible with the contaminants being analyzed.
2. Verify utility locates and conduct site walk.	Confirm that the Pioneer Geoprobe® operators or the Geoprobe subcontractor has placed a utility locate ticket that covers the area to be sampled. Confirmation number needs to be provided to the Pioneer field team leader 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 drilling activities. 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 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. Adjust sample locations based on this information. Before probing activities begin, verify that the ground has been marked with the location of underground utilities listed on the locate ticket. If needed, adjust sample locations based on identified or potential utility locations. See the Trenching, Excavation, and Ground Disturbance Program information in Pioneer's Corporate HASP to identify safe distances for drilling when adjacent to specific buried utilities.

3. Set up the sample and staging area.	Cover a folding table with plastic. The table should be at least as long as the liners to be sampled. A tailgate covered with plastic can also be used. If the only available surface is the ground, place several layers of plastic a couple of feet longer than the liners. Secure the layers of plastic so they do not blow around during sampling. In addition to the sampling area, a staging area for unsampled core needs to be designated. This area should also be covered with plastic to keep the liners clean before placement on the sampling area.
4. Mark the liners.	As the Geoprobe® operator removes core (liners) from the probe rods, mark with a waterproof marker the "top" and "bottom" of the liner as well as the interval that the liner represents. Cap the liner ends with vinyl or Teflon end caps. Move core to the staging area.
5. Record information provided by the operator.	If possible, confer with the Geoprobe® operator for any issues associated with probing each interval. Potential problems they may report: • A loss of material due to a rock blocking the tube. • A section that drilled extremely easy indicating material that was easily compressed such as clay or debris. • The presence of a potential void. • A problem with recovery due to saturated soil. • Heaving sands, which could result in overestimation of the width or depth of a layer due to re-coring of the same interval. • Recognition of slough into the hole prior to drilling the next interval. Record any information provided by the operator in the field logbook or on the field data sheet. This information can be referenced when logging the core.
Sampling of Soil for Inorganic Constituents	
1. Cut the plastic liner lengthwise.	The Geoprobe® operator and/or helper will cut the top portion of the plastic liner lengthwise. The opening along the top should be at least 2 inches wide. Care should be taken when handling and working around the cut liner as the cut edges are sharp.
2. Place the liner on the prepared sampling surface.	Place the liner on the prepared sampling surface and take the cut portion off. The portion of the liner marked "top" should be placed in the same direction on the sample surface each time. Place the index cards marked "top" and "bottom" on the appropriate ends of the liner. Place an extended tape measure adjacent to the liner. Index cards marked with appropriate intervals can also be used. Take a picture of the exposed soil. Do not move the tape measure or core after the photo. If the core does not need to be photographed, and it is **NOT** being analyzed for organics, mark the liner at the appropriate foot intervals with a Sharpie®.

3. Measure and record material in the core.	Measure and record the number of inches of material in the core, this will be recorded in the field logbook or on the field data sheet as "length recovered" (e.g., 36 inches from a 4-foot push or 18 inches from a 2-foot push). This measurement should not include any material that appears to have sloughed from an upper interval (i.e., leaves or topsoil present at the top of deeper subsurface cores). Record this information in the field logbook or on a field data sheet as specified in the Sampling and Analysis Plan (SAP). Evaluate the recovery of the core based on the operator's comments. The preferred method is to determine the amount of material that represents 1 foot of the profile. For example, 36 inches of recovered soil from a 4-foot probe may indicate 9 inches were recovered per foot. An alternate method for determining interval depth is to assume that the 36 inches represents 36 inches from either the top or bottom of the probed interval and that there was no recovery for 4 inches of the interval. These are not precise ways to determine how far below ground surface a soil horizon lies, as different soil types and moisture levels will compress or expand differently when pushed with the probe. There is no way to determine where or whether compression / expansion in the soil profile occurred. Choose one of the methods and be consistent throughout the project. Another scenario that may occur is if the operator indicates an obstruction was encountered that may have blocked soil from entering the liner at the 2-foot interval in a probe. If there is only 24 inches of soil and a large rock present in the liner, this may represent only the 0-2 foot interval in that core and should be recorded that way in the field logbook or on the field data sheet along with the operator's comment.
4. Log the core.	Examine and log the material in the liner. Check the project specific documents for the amount of detail or type of information required from the core log. Pioneer has developed several different field data sheets to aid in collecting the correct information during core logging. Keep in mind that due to smearing of soil during probing, a coating of wet or fine material may be present on the outside of the soil core. Using a gloved finger, make indentations down the core noting differences in texture, color, staining, or odor; to avoid cross contamination, change fingers as you make indentations. Record this information in the field logbook or on the field data sheet.
5. Determine sample intervals.	Determine sample intervals as described in the SAP or Work Plan (WP). If the material is **NOT** being sampled for organics, the sample intervals can be marked on the liner using a Sharpie®. An alternate method would be to separate the sample intervals so that a gap exists between the intervals. This makes it easier to get the appropriate intervals in the sample if the tape measure is moved during sampling activities.
6. Collect soil samples.	Slide the tube to the end of the table or sampling surface. Using a new plastic disposable scoop, slide the appropriate marked sample interval into a new disposable foil pan, stainless steel bowl, or resealable plastic bag. Alternately, instead of a scoop

	you can use a gloved finger or a clean screwdriver. A screwdriver is particularly helpful if portions of the soil are hardpacked or compressed. Mix the material in the pan/bowl thoroughly and remove rock and debris greater than 0.5 inches. If more material is required to fill sample containers, a second hole can be probed immediately adjacent to the first and material from the second liner from the same interval can be added to the pan/bowl and mixed. Repeat this process for all intervals to be sampled. Decontaminated bowls and screwdrivers and new foil pans, new resealable plastic bags, and new disposable scoops should be used for each interval sampled. Be aware of the potential for cross contamination and if needed change gloves between intervals.
7. Put samples in containers.	Prepare the appropriate sample containers with a label as described in the SAP or the Quality Assurance Project Plan. Fill the sample containers with homogenized material from the pan/bowl using the associated sampling tool. After sampling, place the samples in a cooler with ice until they can be transported to the laboratory for analysis as described in SOP-SA-01 Soil and Water Sample Packaging and Shipping.
8. Record sampling information.	Record appropriate information about the sample collection (sample number 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.
9. Store or dispose of remaining core	Disposal or storage information should be available in the project-specific SAP/WP. In most cases, soil can be returned to the drill hole from which it came. If the information is not available in the SAP, discuss disposal requirements with the project manager.
Sampling of Soil for Organic Constituents	
1. Preparation prior to screening for volatile organic vapors in drill or Geoprobe® drill core.	**Photoionization detector (PID) meter readings are taken immediately upon opening the core, prior to any other sampling or logging activities. Soil samples can show significant losses in volatile organic compound (VOC) concentrations within only seconds of opening soil cores.** If measurements using an organic vapor detector, PID, are required, please refer to SOP-FM-01 Field Headspace Analysis and VOC Measurements with PID for information on calibrating and using a PID for headspace analysis and VOC measurements.
2. Place caps on the end of the core tubes.	Ensure that the Geoprobe® operator and/or helper place caps on the end of the core tubes immediately after removing the liner from the probe rod so that no VOCs escape prior to cutting open the core. Store capped core in the shade or on ice to avoid additional volatilization of VOCs. **Do not** have the operator/helper cut the tubes until just before core will be sampled.

3. Prepare the sample containers.	Based on information provided in the SAP/WP, prepare and label the appropriate sample containers. If samples are required, sample intervals may have been assigned in the SAP/WP, or samples may be collected based on PID or headspace readings or the presence of odor or staining. The sampler needs to understand sample collection protocol prior to opening the core liner. This is particularly important in collecting samples for VOC, volatile petroleum hydrocarbon (VPH), and/or extractable petroleum hydrocarbon [EPH] analysis. Ensure required sampling supplies are close at hand prior to opening core.
4. Cut the plastic liner lengthwise.	Have the Geoprobe® operator and/or helper cut the top portion of the plastic liner lengthwise. The opening should be at least 2 inches wide. **DO NOT REMOVE THE CUT PORTION OF THE LINER**. Care should be taken when handling and working around the cut liner as the cut edges are sharp.
5. Place the liner on the prepared sampling surface.	Place the liner on the prepared sampling surface. **Do not** remove the cut portion. Place the portion of the liner marked "top" in the same direction on the sample surface each time. Place the index cards marked "top" and "bottom" on the appropriate ends of the liner. Place an extended tape measure adjacent to the liner. Index cards marked with appropriate intervals can also be used.
6. Measure and record material in the core.	**Prior** to removing the cut portion of the liner, measure and record the number of inches of material in the core. See discussion in Step 3 of Sampling of Soil for Inorganic Constituents to determine how depth of sample intervals will be determined.
7. Take a picture of the exposed soil.	Remove the cut portion of the liner. Quickly take a picture of the exposed soil. Do not move the tape measure or core after the photo.
8. Conduct PID readings if required.	**The VOC and VPH samples need to be collected as quickly as possible after opening the tube.** If specified in the SAP/WP, use a PID to take readings of the length of the core, refer to SOP-FM-01 Field Headspace Analysis and VOC Measurements with PID for information on calibrating and using a PID for headspace analysis and VOC measurements.
9. Collect soil samples for VOC / VPH / EPH.	Collect the required VOC, VPH, or EPH samples directly from the tube using a plastic disposable scoop, gloved hand, or screwdriver. After VOC, VPH, and EPH samples are collected from all tubes/cores, collect inorganic (metals) samples if needed. The tape measure can be used to identify the intervals. Gaps from removed sample material should be left so that logging of the remaining core material can be completed. Place the soil directly into the sample container and fill the jar to the top allowing no head space (or as the laboratory directs). Be aware of the potential for cross contamination and if needed change gloves between intervals. New disposable scoops and a clean screwdriver should also be used for each sample interval. Immediately place the sample containers in a cooler with ice. Keep samples at 4 degrees Celsius (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.
10. Record PID readings and VOC sample information in Logbook.	If PID screening is conducted, record results of the screening in the field documentation (project logbook or field data sheets) and include the highest reading from each interval, the actual location in the core (i.e., 10 inches from the bottom), and the calculated interval depth. Record the sample information for the VOC, VPH, or EPH samples in the logbook and include time, date, and type of containers collected.
11. Continue sampling cores for VOCs.	Once the VOC samples have been collected from a section of core, replace the end caps and put the cut portion of the liner back on the core. The core can then be moved back to the staging area so that the next section of core can be screened and sampled for VOCs as quickly as possible. Process all available core for VOC samples prior to collecting inorganic samples or logging the core.
12. Log the core.	Once all the VOC samples have been collected. Logging the core can begin. Move a piece of core to the sample table and remove the cut portion of the liner, *being careful to keep it horizontal so as not to shift "gap" areas*. Realign the tape measure with the bottom and top of the tube. Examine and log the material in the liner. Check the project-specific documents for the amount of detail or type of information required regarding the core log. Pioneer has developed several different field data sheets to aid in collecting the correct information during core logging. If the initial measurement of the length of core (Step 6 above) included slough, adjust the information on the field data sheet or logbook to reflect the actual length of core. Include information on material removed for VOC samples, as determined during sampling. Keep in mind that due to smearing of soil during probing, a coating of wet or fine material may be present on the outside of the soil core. Using a gloved finger, make indentations down the core and record the information in the field logbook or on the field data sheet; to avoid cross contamination, change fingers as you make indentations.
13. Prepare soil samples for additional analytes.	Sample intervals that are not going to be submitted for VOC, VPH, or EPH analysis can be sampled once logging of the core is completed. Ensure that all information from logging the core is recorded in the field logbook or on the field data sheet. Determine the intervals to be sampled for additional analytes. Separate the sample intervals for the inorganic samples, so that a gap is present between the intervals. This makes it easier to get the appropriate sections into the sample if the tape measure or core is moved. Record sample information and include interval sampled and associated sample number in the field logbook or on the field data sheet.

14. Collect soil samples.	Slide the tube to the end of the table or sampling surface. Using a new plastic disposable scoop, slide the appropriate marked sample interval into a new disposable foil pan or stainless steel bowl. Alternately, instead of a scoop you can use a gloved finger or a clean screwdriver. The screwdriver is particularly helpful if portions of the soil are hardpacked or compressed. Mix the material in the pan/bowl thoroughly and remove rock and debris greater than 0.5 inches. If more material is required to fill sample containers, a second hole can be probed immediately adjacent to the first and material from the second liner from the same interval can be added to the pan/bowl and mixed. Fill the sample containers with the homogenized materials from the pan/bowl using the associated sampling tool. Repeat this process for all intervals to be sampled. Be aware of the potential for cross contamination and if needed change gloves, screwdriver, or scoops between intervals.
15. Label the sample containers and store them in a cooler.	Make sure all sample containers are labeled correctly. These sample containers should also be placed in a cooler with ice (if required). Samples should be kept at 4 ºC or less (if required by the analytical method) and under chain of custody protocols until transport to the laboratory as described in SOP-SA-01 Soil and Water Sample Packaging and Shipping.
16. Record sampling information.	Record appropriate information about the sample collection (sample number 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.
17. Store or dispose of remaining core.	Disposal or storage information should be available in the project-specific SAP/WP. Soil with potential organic contamination will need to be contained for testing and potential landfarm treatment or disposal at an approved facility. If the information is not available in the SAP, discuss disposal requirements with the project manager. Removed soil may also be returned to the drill hole from which it came.
Decontamination of Equipment following both Organic or Inorganic Sampling	
1. Clean the plastic placed over the sample area.	Between each core, sweep or wipe down the plastic using paper towels wetted with deionized water (DI). If a particularly muddy core was sampled, the plastic may need to be replaced or a new piece placed over the sample area.
2. Decontaminate equipment.	Decontaminate the cutting tool, tape measure, and screwdrivers using paper towels wetted with a Liquinox/water mixture and the DI water spray bottle to rinse. If sampling for organics, use paper towels wetted with methanol for a final wipe down. If stainless steel bowls, spoons, and trowels were used, please follow instructions in SOP-DE-02 Equipment Decontamination.

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 and groundwater.	Sites.	Inadvertent exposure to contaminated soil and groundwater 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 contact with soil and groundwater is possible. Sampling will be conducted outdoors or in a trailer with open doors.
	Exposure to hydraulic fluids.	Geoprobe® operations.	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® 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 around the Geoprobe®.
	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® operations.	Personnel could be exposed to elevated noise levels when working near the Geoprobe® operations resulting in hearing damage.	Personnel will wear hearing protection (e.g., ear plugs) when working near the Geoprobe®. Non-essential personnel will maintain a 20-foot buffer zone around the Geoprobe®, when possible. Hearing protection will be administered and used in accordance with the policies and procedures outlined in the Pioneer Corporate HASP.
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 fieldwork activities.	Bending, squatting, and kneeling during fieldwork activities could result in muscle/ back strains or other injuries.	Personnel should stretch prior to starting work and they will take breaks when necessary.
	Improper lifting / handling of heavy items.	During field work activities.	Back injuries and muscle/back strains could result when using improper techniques to lift/carry heavy coolers and containers with core pieces.	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 workers will lift/handle heavy items as needed.
	Flying debris.	Geoprobe® operations.	Eye injuries could result from flying debris when working around Geoprobe® operations.	Personnel will wear safety glasses when working around Geoprobe® operations. Non-essential personnel will maintain a 20-foot buffer zone around the Geoprobe® when possible.
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. They will plan their path, walk cautiously, and keep work areas as dry as possible. Personnel will 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*
WEATHER	Cold/heat stress.	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). Personnel will remain hydrated and will have sufficient caloric intakes during the day. Personnel will follow procedures outlined in the applicable SSHASP and/or Pioneer corporate HASP.
	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 sites.	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.	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 in company vehicles. 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	Sharp edges and cutting tool.	Plastic liners and cutting tool.	Personal injury could result while cutting the plastic liners open to collect the soil samples. The plastic liners could also have sharp edges after they are cut. Cuts and scrapes could result from direct contact with sharp edges.	Personnel will use a specialized tool to cut the plastic liners and they will wear work gloves to prevent hand injuries. Personnel will use a tray and clamp to hold the plastic liner in place and keep it from moving around. Personnel will be aware of hand placement to prevent exposure to sharp edges and cutting tool.
PRESSURE	Pressurized hydraulic hoses.	Geoprobe®.	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® 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 around the Geoprobe®.
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 the procedure described above and other applicable procedures. Personnel will follow the stop work policy if there are any issues.

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***
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, nitrile gloves, and leather gloves.
APPLICABLE SDSs	**Safety Data Sheets** (SDSs) will be maintained based on the site characterization and contaminants. Safety Data Sheets are available to Pioneer personnel on the internal website under Safety.
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-FM-01 Field Headspace Analysis and VOC Measurements with PID, SOP-SA-01 Soil and Water Sample Packaging and Shipping, SOP-DE-02 Equipment Decontamination (Inorganic Contaminants), and SOP-SA-05 Project Documentation.
TOOLS/ EQUIPMENT	Sample area – plastic sheeting, folding table (1 or 2), tape to secure plastic, tape measure, index cards to indicate top and bottom, camera, PID (if required), plastic disposable scoops or stainless steel spoons or spatulas, screwdrivers, filled DI water spray bottle, filled Liquinox/water spray bottle, methanol, paper towels, foil disposable pans or stainless steel bowls, sample containers, cooler, ice, dual blade cutter, and liner holders.
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	**11/18/2020**
SAFETY AND HEALTH MANAGER	**DATE**
Tara Schleeman	**11/18/2020**

PURPOSE	To provide standard instructions for soil and water sample packaging and shipping.
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. Preserve the samples.	Water samples should be preserved immediately upon collection, if required, according to SOP-SA-02 Sample Preservation and Containerization for Aqueous Samples, or as required by the specified analytical method (consult with laboratory prior to sampling), or as directed in the project-specific sampling and analysis plan (SAP), work plan (WP) or quality assurance project plan (QAPP). Some analytical methods for soil may require preservation upon collection. The sampler needs to thoroughly understand the required sample collection protocol prior to sampling.
2. Place the sample containers in Ziploc bags.	Based on the analytes requested (e.g., low level mercury, low level chromium, volatile organic compounds [VOCs], 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. Review and sign chain of custody forms.	The Field Team Leader, or designated representative, will double check the chain of custody forms (see SOP-SA-04 Chain of Custody Forms for Environmental Samples for guidance) to ensure that required information is included and to assure only those samples recorded on the chain of custody forms are in the cooler. Make sure that field blanks, bottle blanks, and rinsate blanks are marked “DO NOT USE FOR QA/QC” (quality assurance/quality control) in the comments column. If required by the laboratory, SAP, or WP, identify which samples should be used for laboratory duplicates or matrix spike samples. The Field Team Leader, or designated representative, will then sign the chain of custody form to relinquish custody. One copy of the signed chain of custody form will remain with the Field Team Leader. Make a photocopy of the completed forms if no carbon copies are available.
4. Package the samples.	Place samples in a plastic-bag-lined cooler or alternate shipping container (e.g., cardboard box). Seal the plastic bag with tape. Place a signed chain of custody seal around the tape. Surround the plastic bag containing the samples with non-contaminating

	packaging materials to reduce movement and absorb any leakage. If the samples must remain cool (see required analytical method or SAP/WP/QAPP), double bag the ice and place it in the cooler. Be aware of temperatures between the sample shipment location and the laboratory, more or less ice may be needed to keep samples within the required temperature range or prevent samples from freezing.
5. Tape paperwork to cooler.	Place paperwork in a sealed Ziploc bag and tape it to the inside of the cooler lid. If an alternate shipping container is used place the bag on the top of the contents.
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 QA/QC samples are included in each analytical batch. In this case, fill out separate chain of custody forms for each batch and include the forms in the appropriate plastic bags. Place the chain of custody forms for each batch in a sealed Ziploc bag. The chain of custody 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., keep cool, flammable liquids, flammable solids, this side up, fragile, etc.) if needed. Sections 14 and 16 on chemical safety data sheets (SDS) have shipping/transportation information for an individual chemical. In most cases, environmental samples will not need to be labeled. Unknown waste samples from an uncontrolled site or soil samples preserved with methanol may need to be labeled. 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 or top of the alternative shipping container. Use clear packing tape to secure the label to the container.
8. Sign chain of custody seals.	The Field Team Leader, or designated representative, will sign chain of custody seals and place the signed seals over the opening edge of the cooler or edges of the alternative shipping container. If the shipping container can be opened in more than one way, (i.e., cardboard box or lid of cooler lifts off completely), chain of custody seals should be placed so that the container **cannot** be opened without disturbing a placed seal. This maintains the chain of custody requirements for legally defensible data.
9. Tape the shipping container.	Place tape over the custody seals and around the shipping container. Enough tape should be used to guarantee that the container cannot open accidently or allow foreign material to enter. If the shipping container is a cooler and there is an outlet hole to drain water, this should be closed and taped shut.
10. Transport the shipping container.	Transport the shipping container(s) to secure storage, to the shipping agent, or directly to the laboratory. If shipping the container, follow established federal and state regulations depending on shipping container content.

11. Record shipping information in logbook.	Record the shipping information in the project logbook. This should include the sample identification for those samples shipped if not all collected samples are shipped. If all collected samples are shipped, write *all samples collected on the (sample collection date) are included in this shipment* (for example, all samples collected on 4/12/2022 are included in this shipment), the date shipped, the carrier used and associated tracking number, and the laboratory to which the samples were shipped. If more than one cooler is shipped, record tracking numbers for all and reference chain of custody sheets for the samples in each cooler. The chain of custody forms and carrier receipts need to be placed in the project file as part of the chain of custody documentation.
Notes	Bagging samples and lining coolers is not necessary if samplers are transporting the samples directly to the laboratory. However, chain of custody seals, ice, and chain of custody protocol must still be followed. If chain of custody forms cannot be handed directly to laboratory personnel for signature, they must be placed in the cooler prior to sealing with the chain of custody seals. Record that the samples were hand delivered to the laboratory, with the date, time, and sample numbers as discussed in Step 11.

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 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. Personnel will wear nitrile gloves and safety glasses when handling sample containers.
	Preservatives: hydrochloric acid (HCL), nitric acid (HNO_3), sulfuric acid (H_2SO_4), zinc, acetate, sodium hydroxide (NaOH).	In bottles or added to bottles through sampling process.	Inadvertent exposure to preservatives could lead to adverse health effects.	The SDS for each preservative chemical are available to all personnel on the Pioneer company website. 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 kneeling could result in muscle/back strains or other injuries.	Personnel 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 height. Two workers will lift/carry the coolers, if needed.

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	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 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. Off site: safety glasses, work shirt, long pants, work boots, and nitrile gloves.
APPLICABLE SDSs	**Safety Data Sheets** (SDSs): HCL, HNO_3, H_2SO_4, zinc, acetate, and NaOH. Safety Data Sheets are available to Pioneer personnel on the internal website under Safety.
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-SA-02 Sample Preservation and Containerization for Aqueous Samples SOP-SA-04 Chain of Custody Forms for Environmental Samples
TOOLS/ EQUIPMENT	Plastic bags, Ziploc bags, non-contaminating packaging materials, tape, chain of custody seals, logbook, ice, and cooler or other appropriate shipping container.
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**
Patricia Olson	**04/12/2022**
SAFETY AND HEALTH MANAGER	**DATE**
Tara Schleeman	**04/12/2022**

PURPOSE	To provide procedures required to collect aqueous samples being analyzed for commonly requested organic, inorganic, and radiochemical parameters. Guidance is provided on industry standard containers, preservatives, analytical methods, and holding times associated with sample collection.
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	Sample containers may come certified from the laboratory (preferred). Bottles that are certified should have a label with a tracking or batch ID that can be associated with a laboratory analytical report. Certified bottles may come pre-preserved for specific analytes (refer to the tables in the Instructions section below). If the sample bottles are not certified (have no trackable ID on the bottle) then they must be rinsed 3 times (triple rinse) using the water to be sampled prior to collecting the sample. If bottles do not contain the required preservatives, field personnel will need to add it at the time of water sample collection. In general, the preservatives are added to the sample container immediately before collecting groundwater or volatile organic compound (VOC) samples. If the sample bottle will be submerged in water for sample collection (i.e., grab surface water containers), the preservative should be added after the sample is collected. Most laboratories will provide any required preservatives. Specific instructions for containers and preservatives are included in the tables in the Instructions section below. The information in this SOP was supplied to Pioneer from Pace Analytical Services. If another laboratory is contracted for analyzing samples, verify with the laboratory the appropriate containers, preservatives, and holding time limits for the required analyses. Additional site-specific analyses may be included in the project Sampling and Analysis Plan (SAP) or work plan (WP).

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. Label samples.	Prior to sampling, label the appropriate sample bottles using a water-resistant ink pen or permanent marker. **Make sure to write legibly**. If labels are attached to the bottle or provided by the laboratory, make sure all information is filled out correctly. If an error is made during labeling, cross the mistake out with a single line mark through the error, initial and date the strikeout, and then add the correct information. Labels should be taped over with clear heavy duty shipping tape to make sure label information is not erased or smudged during sample collection, storage, and shipping.

	If no labels are provided by the laboratory, use a stick-on label (water or weatherproof is preferred) or write on the bottle with a permanent marker. Again, tape over the completed label with clear heavy duty shipping tape. Labels should include the following information: • Project Name. • Sample Identification Number. • Date and time sample is collected (start of actual sample collection). • Preservative and if sample is filtered (i.e., nitric acid [HNO3]/Filtered, Raw/Filtered, Raw, HNO3, etc.). • Sampler's Initials. • Analyte or Analytical Method required from that sample bottle (i.e., total metals, dissolved metals, EPA 200.8, nitrate, etc.).
2. Preserve samples.	The information charts on the next few pages were supplied to Pioneer from Pace Analytical Services. If another laboratory is contracted for analyzing samples, verify with the laboratory the appropriate containers, preservatives, and holding time limits for the required analyses.

Organic Parameters in Aqueous Samples

Parameter	Method			Container	Preservative	Max Hold Time
	EPA Drinking Water	EPA Water	EPA Waste SW-846			
Aromatic and Halogenated Volatiles		601/602	8021	3 - 40mL vials	pH<2 HCl, ≤6°C, $Na_2S_2O_3$ if Cl present	14 Days (7 days for aromatics if unpreserved)
Base/Neutrals and Acids		625	8270	1L Amber Glass	≤6°C, $Na_2S_2O_3$ if Cl present	7/40 Days
Base/Neutrals, Acids & Pesticides	525.2			1L Amber Glass	pH <HCl, sodium sulfite if Cl present	14/30 Days
Diesel Range Organics			8015	1L Amber Glass	≤6°C, $Na_2S_2O_3$ if Cl present	7/40 Days
Dioxins and Furans	1613B			1L Amber Glass	≤6°C, $Na_2S_2O_3$ if Cl present	1 Year
Dioxins and Furans			8290	1L Amber Glass	≤6°C, $Na_2S_2O_3$ if Cl present	30/45 Days
Dissolved Organic Carbon			Method 5310	250 ml Amber Glass	Field Filter from an Unpreserved Sample into an pH<2 H2SO4, ≤6°C	28 days
EDB & DBCP	504.1		8011	40mL vials	≤6°C, $Na_2S_2O_3$ if Cl present	14 Days
Explosives			8330/8332	1L Amber Glass	≤6°C	7/40 Days
Gasoline Range Organics			8015	40mL vials	pH<2 HCl	14 Days
Haloacetic Acids	552.1/552.2			40mL Amber vials	NH_4Cl, ≤6°C	14/7 Days if extracts stored at ≤6°C or 14/14 Days if extracts stored at ≤-10°C
Herbicides, Chlorinated	515.1/515.3		8151	1L Amber Glass	≤6°C, $Na_2S_2O_3$ if Cl present	7/40 Days for 8151; 14/28 Days for 515.1/515.3
PCBs, Organochlorine			8082	1L Amber Glass	≤6°C; $Na_2S_2O_3$ if Cl present	1 Year/1Year
PCBs & Pesticides, Organochlorine		608		1L Amber Glass	≤6°C; $Na_2S_2O_3$ if Cl present	7/40 Days
Pesticides, Organochlorine			8081	1L Amber Glass	≤6°C, $Na_2S_2O_3$ if Cl present	7/40 Days
Pesticides, Organophosphorus			8141	1L Amber Glass	pH 5-8 with NaOH or H_2SO_4; ≤6°C, $Na_2S_2O_3$ if Cl Present	7/40 Days
Polynuclear Aromatic Hydrocarbons			8270 SIM	1L Amber Glass	≤6°C, $Na_2S_2O_3$ if Cl present	7/40 Days
Volatiles		624	8260	3 - 40mL vials	pH<2 HCl; ≤6°C	14 Days (7 Days for aromatics if unpreserved)
Volatiles (see note 1)	524.2			40mL vials (in duplicate)	pH<2 HCl, ≤6°C, $Na_2S_2O_3$ if Cl present	14 Days

Note 1: Method 524.2 lists ascorbic acid as the preservative when residual chlorine is suspected. If gases at room temperature (such as Vinyl Chloride) are requested for **any** of the following compounds: Acetone, Acrylonitrile, Allyl Chloride, 2-Butanone, Carbon Disulfide, Chloroacetonitrile, 1-Chlorobutane, trans-Dichloro-2-Butene, 1,1-Dichloropropanone, cis-1,3-Dichloropropene, trans-1,3-Dichloropropene, Diethyl Ether, Ethyl Methacrylate, Hexachloroethane, 2-Hexanone, Methacrylonitrile, Methyl Acrylate, Methyl Iodide, Methyl Methacrylate, 4-Methyl-2-Pentanone, Methyl-tert-Butyl ether, Nitrobenzene, 2-Nitrobenzene, Pentachloroethane, Propionitrile, or Tetrahydrofuran, then sodium thiosulfate is the preservative recommended. Check with laboratory to determine correct preservative.

Inorganic Parameters in Aqueous Samples

Parameter	Method			Container	Preservative	Max Hold Time
	EPA Water	Standard Methods	EPA Waste SW-846			
Acidity		SM2310B		Plastic/Glass	≤6°C	14 Days
Alkalinity	310.2	SM2320B		Plastic/Glass	≤6°C	14 Days
Anions by IC, including Br, Cl, F, NO2, NO3,o-Phos, SO4, bromate, chlorite, chlorate)	300.0			Plastic/Glass	≤6°C	All analytes 28 days except NO2, NO3, o-Phos (48 hours); chlorite (immediate); NO2/NO3 combo 28 days
Bacteria, Total Plate Count		SM9221D		Plastic/WK	≤6°C, $Na_2S_2O_3$	24 Hours
BOD/cBOD		SM5210B/Hach 10360		Plastic/Glass	≤6°C	48 hours
Chloride		SM4500Cl-C,E		Plastic/Glass	None	28 Days
Chlorine, Residual	330.5	SM4500Cl-D, E, G / Hach 8167		Plastic/Glass	None	15 minutes
COD	410.4	SM5220C, D / Hach 8000		Plastic/Glass	pH<2 H_2SO_4, ≤6°C	28 Days
Color		SM2120B,E		Covered Plastic, Acid Washed Amber Glass	≤6°C	24 Hours
Cyanide, Reactive			Chapter 7	Plastic/Glass	None	28 Days
Cyanide, Total and Amenable	335.4	SM4500CN-A,B,C,D,E,G,I,N	9010/9012	Plastic/Glass	pH>12 NaOH; ≤6°C ascorbic acid if Cl present	14 Days (24 hrs if sulfide present - applies to SM4500CN only)
Ferrous Iron		SM3500Fe-D		Glass	None	Immediate
Flashpoint/Ignitability			1010	Plastic/Glass	None	28 Days
Fluoride		SM4500Fl-C,D		Plastic	None	28 Days
Hardness, Total (CaCO3)	130.1	SM2340B,C		Plastic/Glass	pH<2 HNO_3	6 Months
Hexavalent Chromium	218.6	SM3500Cr-C,D	7196	Plastic/Glass	≤6°C	24 Hours, unless preserved per method, then 28 Days
Mercury	245.1/245.2		7470	Plastic/Glass	pH<2 HNO_3	28 Days
Mercury, Low Level	1631E			Fluoropolymer (Glass if Hg is only analyte being tested)	12N HCl or BrCl	48 hours for preservation or analysis; 28 days to preservation if sample oxidized in bottle; 90 days for analysis if preserved
Metals (ICP/ICPMS)	200.7/200.8		6010/6020	Plastic/Glass	pH<2 HNO_3	6 Months
Nitrogen, Ammonia	350.1	SM4500NH3		Plastic/Glass	pH<2 H_2SO_4, ≤6°C	28 Days
Nitrogen, Kjeldahl	351.2	SM4500-Norg		Plastic/Glass	pH<2 H_2SO_4, ≤6°C	28 Days
Nitrogen, Nitrate	352.1	SM4500-NO3		Plastic/Glass	≤6°C	48 Hours
Nitrogen, Nitrate & Nitrite, combined	353.2	SM4500-NO3		Plastic/Glass	pH<2 H_2SO_4, ≤6°C	28 Days
Nitrogen, Organic	351.2 / 350.1	SM4500-Norg		Calculation	pH<2 H_2SO_4, ≤6°C	28 Days
Odor		SM2150B		Glass	≤6°C	24 Hours
Oil and Grease/HEM	1664A	SM5520B	9070	Glass	pH<2 H_2SO_4 or HCl, ≤6°C	28 Days
Oxygen, Dissolved (Probe)		SM4500-O		Glass	None	15 minutes
Paint Filter Liquid Test.			9095	Plastic/Glass	None	N/A

Inorganic Parameters in Aqueous Samples (Cont.)

Parameter	Method			Container	Preservative	Max Hold Time
	EPA Water	Standard Methods	EPA Waste SW-846			
Phenol, Total	420.1/420.4		9065/9066	Glass	pH<2 H_2SO_4, ≤6°C	28 Days
Phosphorus, Orthophosphate	365.1/365.3	SM4500P		Plastic	Filter, ≤6°C	Filter within 15 minutes, Analyze within 48 hours
Phosphorus, Total	365.1 / 365.3 / 365.4	SM4500P		Plastic/Glass	pH<2 H_2SO_4, ≤6°C	28 Days
Silica, Dissolved		SM4500Si-D		Plastic	≤6°C	28 Days
Solids, Settleable		SM2540F		Glass	≤6°C	48 Hours
Solids, Total		SM2540B		Plastic/Glass	≤6°C	7 Days
Solids, Total Dissolved		SM2540C		Plastic/Glass	≤6°C	7 Days
Solids, Total Suspended	USGS I-3765-85	SM2540D		Plastic/Glass	≤6°C	7 Days
Specific Conductance	120.1	SM2510B	9050	Plastic/Glass	≤6°C	28 Days
Sulfate	375.2	SM4500S04 / ASTM D516	9036/9038	Plastic/Glass	≤6°C	28 Days
Sulfide, Reactive			Chapter 7	Plastic/Glass	None	28 Days
Sulfide, Total		SM4500S	9030	Plastic/Glass	pH>9 NaOH and ZnOAc; ≤6°C	7 Days
Sulfite		SM4500SO3		Plastic/Glass	None	15 minutes
Surfactants (MBAS)		SM5540C		Plastic/Glass	≤6°C	48 Hours
Total Organic Carbon (TOC)		SM5310B,C,D	9060	Glass	pH<2 H_2SO_4 or HCl, ≤6°C	28 Days
Total Organic Halogen (TOX)		SM5320	9020/9021	Glass (No headspace)	pH<2 H_2SO_4, ≤6°C	14 Days
Turbidity	180.1	SM2130B		Plastic/Glass	≤6°C	48 Hours

RADIOCHEMICAL PARAMETERS

Parameter	Method			Container	Preservative	Max Hold Time
	EPA Water	Standard Methods	EPA SW-846			
Gamma Emitting Radionuclides (see note 2)	901.1			Plastic/Glass	pH<2 HNO_3	180 days
Gross Alpha (NJ 48Hr Method)	NJAC 7:18-6			Plastic/Glass	pH<2 HNO_3	48 hours
Gross Alpha and Gross Beta (see note 2)	900.0		9310	Plastic/Glass	pH<2 HNO_3	180 days
Radium-226 (see note 2)	903.0/903.1			Plastic/Glass	pH<2 HNO_3	180 days
Radium-228 (see note 2)	904.0		9320	Plastic/Glass	pH<2 HNO_3	180 days
Radioactive Strontium (see note 2)	905.0			Plastic/Glass	pH<2 HNO_3	180 days
Total Alpha Radium (see note 2)	903.0		9315	Plastic/Glass	pH<2 HNO_3	180 days
Total Uranium (see note 2)	908.0	D5174-97		Plastic/Glass	pH<2 HNO3	180 days
Tritium	906.0			Glass	None	180 Days

Note 2: Methods 9315 and 9320 both state that if samples are unpreserved, the samples should be brought to the laboratory within 5 days of collection, preserved in the laboratory, and then allowed to sit for a minimum of 16 hours before sample preparation/analysis.

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 samples.	Sites.	Inadvertent exposure to contaminated 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. Personnel will wear nitrile gloves and safety glasses when handling sample containers.
	Preservatives: hydrochloric acid (HCL), nitric acid (HNO_3), sulfuric acid (H_2SO_4), sodium hydroxide (NaOH), and sodium thiosulfate ($Na_2S_2O_3$).	In bottles or added to bottles through the sampling process.	Inadvertent exposure to preservatives could lead to adverse health effects.	Safety Data Sheets for each preservative chemical are available to all Personnel on the Pioneer company internal website. Personnel will wear nitrile gloves and safety glasses when using preservatives 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	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 height. Two workers will lift/carry the coolers, if needed.

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, 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/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. 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 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.	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. 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): HCL, HNO_3, H_2SO_4, NaOH, and $Na_2S_2O_3$. Safety Data Sheets are available to Pioneer personnel on the internal website under Safety.
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	
TOOLS/ EQUIPMENT	Sample containers, preservatives, labels, water-resistant ink pen or permanent marker, and clear heavy duty shipping tape.
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**
Patricia Olson **Patricia Olson**	**04/13/2022**
SAFETY AND HEALTH MANAGER	**DATE**
Tara Schleeman **Tara Schleeman**	**04/13/2022**

PURPOSE	This Standard Operating Procedure (SOP) describes the preparation and collection frequency of field quality control (QC) blanks and duplicate samples from water media.
SCOPE	Pioneer Technical Services, Inc. (Pioneer) prepared this practice for the workforce and this 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
Field Quality Control	At least one set of field QC samples will be prepared for each sampling event or as detailed in the project-specific Sampling and Analysis Plan (SAP) or Quality Assurance Project Plan (QAPP). The QC samples will be collected at a frequency of 1:20 or as detailed in the project-specific SAP or QAPP. If the number of field QC samples taken is not equal to an integer multiple of 20 or the interval specified in the SAP/QAPP, the next higher multiple will be used. For example, if a frequency of 1:20 is indicated and 28 samples are taken, 2 QC samples will be prepared. All field QC samples will be shipped with field samples to the contract laboratory as per SOP-SA-01 Soil and Water Sample Packaging and Shipping.
Field Blank or Bottle Blank	A minimum of 1 field bottle blank is required for every 20 natural samples. A bottle blank is a sample bottle containing deionized or analyte free water and preservatives and is prepared in the field. A sample bottle is randomly chosen from each lot of bottles received by the contract laboratory or supplier and deionized or analyte free water (depending on the analysis requested) is poured directly into the sample bottle while in the field and the bottle is preserved and shipped to the laboratory with the field samples. The field blank must be prepared in the field to evaluate the potential for contamination of a sample by site contaminants from sources not associated with the sample collected (e.g., air-borne dust). The appropriate sample number will be placed on the bottle and recorded in the project logbook as a bottle blank.

Trip Blank	One trip blank should be included in each cooler shipped when volatile organic compound (VOC) or volatile petroleum hydrocarbon (VPH) samples are collected. Trip blanks are used to determine if samples are contaminated during storage and/or transportation back to the laboratory. A trip blank is only required for VOC/VPH samples. Trip blanks are prepared for field personnel by the contract laboratory staff prior to the sampling event and are shipped and stored in the same coolers with the investigative VOC/VPH 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/VPH 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, and until they arrive at the laboratory. **Note**: If trip blanks are received from the laboratory with air bubbles in them **NOTIFY** the team leader or project manager and have the laboratory send new trip blanks prior to the sampling event.
Equipment, Cross Contamination, or Rinsate Blank	A minimum of 1 equipment blank is required for every 20 natural samples. Equipment blanks are collected after the completion of decontamination of sampling equipment and prior to sampling. An equipment blank is prepared by running distilled, deionized, or analyte free water through or over the cleaned sampling equipment and adding the appropriate chemical preservatives. Equipment blanks are generally prepared in the field. One equipment blank at a minimum must be prepared for each type of preservative and for any filtered samples. Equipment blanks will assess the adequacy of the decontamination process as well as the potential contamination of samples by the containers, preservatives, and filters. The appropriate sample number will be placed on the bottle and recorded in the project logbook as equipment blank.
Field Duplicate	A minimum of 1 duplicate is required for every 20 natural samples. A field duplicate is defined as a second sample, from the same location, collected in immediate succession, using identical techniques. This applies to all routine surface and groundwater collection procedures, including in-stream grab samples, bucket grab samples (e.g., from bridges), pumps, and other water sampling devices. Duplicate samples are sealed, handled, stored, shipped, and analyzed in the same manner as the primary sample. Duplicates should be submitted as “blind” meaning that the duplicate sample is given a separate sample identification number, so it is not identified with the primary sample. Field duplicates assess sampling precision.

Temperature Blank	One temperature blank is required for each cooler shipped. A temperature blank is a vial of tap or deionized water placed in each cooler that will be opened and tested upon arrival at the laboratory to ensure that the temperature of the contents of the sample shipping containers are within the required 4 °C ± 2°.

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 samples.	Sites.	Inadvertent exposure to contaminated 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. Personnel will wear nitrile gloves and safety glasses when handling sample containers.
	Preservatives (HCL, HNO_3, H_2SO_4, Zinc, Acetate, and 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 personnel and are located on the Pioneer company web site. Personnel will wear nitrile gloves and safety glasses when using preservatives 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	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 height. Two workers will lift/carry packaged samples and coolers, if needed.

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 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. 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 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.
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. 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	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): Safety glasses, high-visibility work shirt or vest, long pants, work boots, and nitrile gloves.
APPLICABLE SDSs	**Safety Data Sheets** (SDS): HCL, HNO_3, H_2SO_4, Zinc, Acetate, and NaOH. Safety Data Sheets are available to Pioneer personnel on the internal website under Safety.
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-SA-01 Soil and Water Sample Packaging and Shipping.
TOOLS/ EQUIPMENT	Preservatives, sample glass bottles, ice, and cooler.
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 describe the preparation of equipment or rinsate blanks for a submersible pump.
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	Equipment blanks, also known as rinsate blanks, are collected periodically after decontaminating sampling equipment and prior to resuming sampling. Equipment blanks allow the laboratory to assess the adequacy of the decontamination process and the potential contamination of samples via the containers, preservatives, and filters. Consequently, an equipment blank may include single or multiple sample containers that represent the natural sampling process. **If a decontamination process occurs during a sampling event, a minimum of 1 equipment blank is required for every 20 natural samples.** Blanks are collected by running deionized (DI) or analyte free water through or over the cleaned sampling equipment and adding the appropriate chemical preservative (if necessary). Equipment rinsate blanks should be collected in an environment free from dust and automobile exhaust. A separate blank must be collected for each type of preservative (e.g., hydrochloric acid [HCL], nitric acid [HNO_3], sulfuric acid [H_2SO_4], sodium hydroxide [NaOH], etc.) used and each sample preparation method (e.g., unfiltered or filtered) used. If more than one type of pump is used for sampling (e.g., peristaltic pump, 12-volt submersible pump, Grundfos Redi-Flo II pump, etc.), equipment blanks should be collected from the pump type used to collect the majority of samples, unless project-specific requirements differ. The following examples demonstrate how the number of equipment blanks may be determined. *Example #1:* A project requires 14 samples to be collected using a peristaltic pump and 5 samples to be collected using a 12-volt submersible pump. There are no project-specific equipment blank requirements. Only 1 equipment blank is necessary because less than 20 natural samples will be collected. The equipment blank should be collected from the peristaltic pump because it was used to collect a majority of the natural samples. *Example #2:* A project requires 23 samples to be collected using a 12-volt submersible pump, 5 samples to be collected using a Grundfos Redi-Flow II pump, and 19 samples to be collected using a peristaltic pump. There are no project-specific equipment blank requirements. A minimum of 3 equipment blanks must be collected because the total number of natural samples is greater than 40. To evaluate potential cross contamination from each piece of sampling equipment, 1 equipment blank should be collected from each of the 3 pumps. Prior to starting the fieldwork, personnel should review the project-specific Sampling and Analysis Plan (SAP), Work Plan (WP), Quality Assurance Project Plan (QAPP), or Field Sampling Plan (FSP) to determine requirements for the field quality control (QC) samples to be collected during the sampling events.

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. Label and preserve equipment rinsate blank sample containers.	**If decontamination process occurs during a sampling event, a minimum of 1 equipment blank is required for every 20 natural samples (see NOTES Section above).** Any natural sample collected and submitted for analytical testing will include an accompanying equipment rinsate blank submitted for the same analytical tests as the natural sample collected. Samples will be collected and preserved as completed for natural samples. Equipment rinsate blank samples should be submitted “blind” to the laboratory. Label the sample containers with the appropriate sample number as designated in the SAP, WP, QAPP, or FSP. If quality assurance (QA) and QC sample identification numbers are not discussed in these documents, Pioneer has generic identifiers that can be used for QA/QC samples. The following designators are used in place of the well identification portion of the sample name: • 990 – Duplicate Samples • 991 – Equipment Rinsate Samples • 992 – Bottle or Field Blank Samples Equipment rinsate sample labels should contain all the same information as the natural sample containers as discussed in SOP-SA-02. Place clear tape over the sample label to ensure the label does not move or get destroyed during shipment.
2. Blank container preparation.	Pioneer has stainless-steel bins that are dedicated to equipment rinsate blank collection and are labeled “Blanks Only.” These bins should only be used after the pump has gone through the entire decontamination process as described in SOP-DE-02A. Locate a new unopened bottle of DI water or analyte free water to use for filling the equipment blanks in a stainless-steel bin labeled “Blanks Only.” Prepare the equipment blank bin by removing the cover and rinsing the inside of the bin with DI water or analyte free water. Properly dispose of the water that was used to rinse the bin prior to filling the bin for equipment blank sample collection.
3. Remove pump.	Put on a new pair of nitrile gloves and remove the decontaminated pump from its storage container. Make sure that the attached tubing (if appropriate) and pump do not contact any other surface (i.e., the ground). If disposable tubing is being used for the sampling event, attach a short piece of clean tubing representative of the tubing used for sampling to the pump.

4. Fill "Blank Only" bin.	Place the pump in the bin labeled "Blanks Only" dedicated to equipment rinsate blanks. Pour the jug of DI water or analyte free water into the bin, covering the pump with several inches of water. Place and secure the other end of the discharge tubing into a storage container for proper disposal, prior to starting the pump. Refer to the project-specific SAP, WP, QAPP, and/or FSP for details on the proper disposal of water used for each sampling event.
5. Purge and collect samples.	Turn the pump on and continue to pour DI water into the bin. Purge enough DI water or analyte free water through the pump to simulate the purging done when sampling a well. Once an appropriate volume of water (enough water to simulate purging a well) has been discharged from the pump, fill sample containers in the same order and method that they were filled when collecting an associated natural sample. If filtered samples were collected for natural field samples, insert a filter into the discharge tube in the same order and method as the natural sample after all non-filtered samples have been collected and fill the appropriate number of sample containers. If necessary, preserve the sample as completed for the associated natural sample.
6. Record in logbook.	In the project logbook, record the sample identification (ID) and a description of the collection process. Include the pump identifier, the code for the DI water or analyte free water used for the blank, and clearly identify the sample as an equipment blank. The sample entry into the logbook should be identical to any sample collected except for its identification as an equipment rinsate blank and DI code notation.
7. Put samples in storage/transport container (cooler).	Place sample containers into a cooler with ice **immediately** upon collection. Keep samples at 4 degrees Celsius (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. Properly preserved metals and general chemistry samples may need to be stored and shipped on ice; refer to the SAP, WP, QAPP, FSP or the analytical laboratory submittal requirements to determine storage and transportation requirements.
8. Empty and cover "Blank Only" bin.	Properly dispose of any remaining water out of the dedicated equipment rinsate bin and cover the container to avoid inadvertently contaminating the interior prior to the next blank sample. Refer to the project-specific SAP, WP, QAPP, and/or FSP for details on the proper disposal of water used for each sampling event.

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 samples.	Sites.	Inadvertent exposure to contaminated 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. Personnel will wear nitrile gloves and safety glasses when handling sample containers.
	Preservatives (HCL, HNO_3, H_2SO_4, zinc, acetate, and 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 Personnel on the Pioneer company internal website. Personnel will wear nitrile gloves and safety glasses when using preservatives 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	Connecting pump to battery or hooking battery and inverter to pump.	Sites.	Connecting pump to battery or hooking battery and inverter to pump could result in shock or electrocution.	Inspect pump and inverter before connecting. Keep equipment dry 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
BODY MECHANICS	Improper lifting.	Sites.	Back injuries and muscle/back strains could result when using improper techniques to lift and carry packaged samples, coolers, and large containers of 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 height. Two workers will lift/carry packaged samples, coolers, and large containers of water, 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. Keep work areas as dry as possible. Wear muck boots, as necessary.
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.

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	Hypothermia/ frostbite.	Sites where air temperature is 35.6 °F (2°C) or less.	Personnel whose clothing becomes wet during decontamination procedures may be exposed to hypothermia and/or frostbite.	If it becomes wet, personnel will change clothing.
	Lightning.	Outdoor sites.	Electrocution, injury, death, or equipment damage could result from 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.
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.
MECHANICAL	Not applicable.			
PRESSURE	Not applicable.			
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 injuries 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): Safety glasses, high-visibility work shirt or vest, long pants, work boots, and nitrile or latex gloves.
APPLICABLE SDSs	**Safety Data Sheets** (SDSs): HCL, HNO_3, H_2SO_4, zinc, acetate, and NaOH. Safety Data Sheets are available to Pioneer personnel on the internal website under Safety.
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-DE-02A, Equipment Decontamination – Pumps for Well Sampling SOP-SA-01 Soil and Water Sample Packaging and Shipping SOP-SA-02 Sample Preservation and Containerization for Aqueous Samples
TOOLS/ EQUIPMENT	Preservatives, sample bottles, pumps, dedicated rinsate stainless-steel bins, DI water, labels, clear packing tape, ice, cooler, and 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**
Kendra Overley **Kendra Overley**	**04/20/2022**
SAFETY AND HEALTH MANAGER	**DATE**
Tara Schleeman **Tara Schleeman**	**04/20/2022**

PURPOSE	This Standard Operating Procedure (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 will 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	Pioneer prepared this practice for the workforce and this 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	**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 (usually for shipping); 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 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
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. The Field Team Leader is also responsible for maintaining sample custody as defined above until the sample has been properly relinquished as documented on the chain of custody form.

	The Field Team Leader will review chain of custody forms for accuracy and completeness to preserve sample integrity from collection to receipt by an analytical laboratory. The review of chain of custody forms may be delegated to qualified personnel.
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 inspecting 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.
Fill out Chain of Custody Forms	The Field Team Leader or designated Field Sampler will initiate the chain of custody form for the initial transfer of samples. A chain of custody form will be completed and accompany every sample set. Only those samples included in the shipping container (cooler or box) should be listed on the chain of custody form included in the container. All chain of custody forms must be completed and include the following information: • Project code. • Project name. • Sampler's signature. • Sample identification. • Date sampled. • Time sampled. • Analysis requested. • Remarks column should contain information about a sample that the laboratory might need. Examples of remarks that should be included: ▪ If samples could have very high or low expected concentrations (outside of normal instrument calibration range). ▪ DO NOT USE FOR QA/QC (quality assurance/quality control) should be indicated for field blanks, bottle blanks, or equipment rinsate blanks. ▪ If a sample should be held for later analysis (i.e., if sample being analyzed requires results from another sample to determine analysis status).

	▪ The sample should be archived after initial analysis by the laboratory for potential additional analysis in the future. ▪ Requires filtering (if not completed in the field). ▪ Requires preservation (if not completed in the field). ▪ Any other sample specific information that will aid the laboratory in completing the appropriate analysis. • Relinquishing signature, data, and time. • Receiving signature, date, and time. Laboratory-provided chain of custody forms should be used if provided, and all required fields should be filled out. Pioneer also has generic chain of custody forms that can be used if no laboratory forms are available. Make sure that the above required information is on the form and include the laboratory name and address to which the samples are being shipped. The Field Sampler relinquishing custody and the responsible individual accepting custody will 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 will be filed as a temporary record of sample transfer by the Field Sampler. The original form will accompany the sample set and will be returned to Pioneer as part of the contracted laboratory QA/QC requirements. The original form and the transporter's receipt will be filed as part of the project's permanent records. The Project Manager (or designee) will track the chain of custody to ensure timely receipt of samples by an analytical laboratory. Shipping information, including date shipped, laboratory shipped to, transporter's identity (i.e., Federal Express), and tracking number should be recorded in the field logbook. If more than one sample shipment occurs during a project, the associated samples per shipment should be referenced (sample numbers or samples collected on these dates).
Sample Handling.	All samples will 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 as necessary to maintain a temperature of 4 degrees Celsius (°C) plus or minus 2 °C until receipt by the analytical laboratory. Alternate shipping containers can be used if the analytical method, SAP, or WP does not have temperature requirements for the samples.

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/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. Personnel 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 Personnel on the Pioneer company website. 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 height. Two workers will lift/carry packaged samples and coolers, if needed.

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.
WEATHER	Not applicable.			
RADIATION	Not applicable.			
BIOLOGICAL	Not applicable.			
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): Safety glasses, high-visibility work shirt or vest, long pants, work boots, and nitrile gloves.
APPLICABLE SDSs	**Safety Data Sheets** (SDSs): HCL, HNO_3, H_2SO_4, Zinc, Acetate, and NaOH. Safety Data Sheets are available to Pioneer personnel on the internal website under Safety.
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-SA-01 Soil and Water Sample Packaging and Shipping and SOP-SA-02 Sample Preservation and Containerization for Aqueous Samples.
TOOLS/ EQUIPMENT	Seals and labels, chain of custody forms, chain of custody seals (provided by contracted laboratory), packing and shipping materials, 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	**11/12/2020**
SAFETY AND HEALTH MANAGER	**DATE**
Tara Schleeman	**11/12/2020**

PURPOSE	This Standard Operating Procedure (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	Pioneer prepared this practice for the workforce and this 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	Please be very aware that logbooks are a **LEGAL** document. As such, they can and most likely will be placed into the public domain with any final reports to clients. They can also be used as evidence for a trial or lawsuit. They can be used to ask questions and to respond in a deposition. They will be used by other Pioneer personnel for data validation, report writing, and for referencing project- or sample-specific information. Beyond being used and reviewed by the client and agencies, they also might be shared with other consulting firms. Be very careful in what and how any information is written. The language used in the logbook should be factual and objective. Logbooks will contain a complete description of field activities, so that the event can be recreated without having to rely on field team memories. Decision making parameters and consultation with clients, subcontractors, or agency personnel should always be recorded. Any deviations from a Sampling and Analysis Plan (SAP)/Quality Assurance Project Plan (QAPP)/Work Plan (WP) or contract requested by agencies, client, subcontractors, property owners, or any stake holder should always be recorded in detail. Any deviation from the SAP/QAPP/WP or contract due to a decision of field personal should also be recorded. If any deviation will result in a change of scope, require additional compensation, or affect the quality of the samples or information to be collected the Project Manager should be notified. The conversation and decision by the Project Manager will also need to be recorded in the logbook. **Refer to the PowerPoint presentation available on the Pioneer SharePoint Field Sampling site, *Logbook and Decontamination Requirements Review Presentation* 20XX – where XX is the most recent year).** The presentation details the logbook and field data sheet requirements and includes checklists of required elements to ensure collection of proper field information.

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. Logbooks.	A designated field logbook will be used for each field project. The logbooks will be bound and have consecutively numbered pages. If requested by the Project Manager, use a separate field logbook for each field task within a larger project. Label each logbook cover with the project name, dates that it covers, and logbook number. Use a waterproof marker, such as a Sharpie©, to write down the information. Write relevant project personnel names and phone numbers, such as the Project Manager, Pioneer safety personnel, client representative, field team leaders, agency contacts, and subcontractor names on the first page of the logbook, so they can be easily referenced. The information recorded in these logbooks must be written **legibly** in **black** indelible ink. Begin a new page for each day's 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 through any blank spaces of three lines or more and add your initial and the date to prevent unauthorized entries. All corrections will consist of a single strike-out 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 always be factual and objective. Add the following entries into the project logbook for each field day: 1. On the logbook cover: project name, dates that logbook covers, and logbook number. 2. On the first page: relevant project personnel names and phone numbers, such as the Project Manager, Pioneer safety personnel, client representative, field team leaders, agency contacts, and subcontractor names. 3. A description of the field task (i.e., monthly groundwater level monitoring). 4. Time and date fieldwork started. 5. 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. 6. Names and company affiliations of field personnel.

7. Name, company affiliation or address, and phone number of any field contacts or official site visitors.

8. Meteorological conditions at the beginning of fieldwork and any ensuing changes in these conditions.

9. Details of the fieldwork performed and reference to field data sheets, if used.

10. Deviations from the task-specific SAP, WP, or SOP.

11. All field measurements performed. If field data sheets are used to record field measurements or observations (logging of drill core, blow counts, water quality parameters) the specific field data sheet needs to be referenced in the logbook. If associated with a specific sample, for example groundwater collected from a well, the final water quality stabilization parameters should be listed with the sample information in the logbook.

12. Any field analytical results (such as X-ray fluorescence [XRF] or field iron tests) should be recorded in the logbook. If this information is recorded on field data sheets or maps, those sheets or maps should be referenced. If information from one of these documents is used for decision making (i.e., to stop boring), the result and decision should be recorded in the logbook.

13. Personnel and equipment decontamination procedures, if appropriate.

For field samples, the following entries will be made for **every sample collected**, whether or not the sample is submitted to a laboratory:

1. Sample location and field sample identification number for every sample collected.

2. The number and type of sample containers collected for the sample (1 - 1L Poly, etc.).

3. Type of sample preservation and or preparation (i.e., raw, filtered, sieved) for each sample container.

4. Analytes or analytical method associated with each sample container.

5. If the analytical laboratory requests additional containers from a natural sample to complete their quality assurance and control (record this with the sample container). A laboratory will often ask for additional volume for their matrix spike or duplicate analysis.

6. Date and time of sample collection; the start time for the collection of each sample should be recorded. This start time will also be recorded on the sample containers and the chain of custody form for the laboratory. The start time for collection of the sample starts the clock on the analytical holding time. If a sample takes a long time to collect due to the number of sample containers or the sample collection procedure, the sample completion time should also be recorded.

7. If the sample is a composite sample, the start and end time of sample collection should be recorded.

   Information about the number of aliquots included in the sample should also be recorded (i.e., samples from 8 holes from 0-6 inches were collected or 4 locations along 10 feet of stream were sampled and mixed).

8. Field quality control sample identification (i.e., field duplicate of [associated field sample number], field blank, or equipment rinsate blank). For equipment rinsate blank, the equipment "rinsed" for the blank should be identified. The method of collection for this sample also needs to be described. For example:

   a. For a field blank: deionized (DI) water poured directly into sample bottles (bottle code from DI water container should be recorded).
   b. For a duplicate sample: fill sample bottles immediately following natural sample or collect sample from the same sample hole immediately following collection of natural sample into separate pan; mix each and place in appropriate bottles.
   c. For an equipment rinsate: DI water (record DI water container code) poured or ran through [identify which piece of equipment] into appropriate sample containers.

   Information on preparing field quality control samples is discussed in Pioneer SOP-SA-03A Field Quality Control Samples for Water Sampling and SOP-SA-03B Preparation of Equipment Rinsate Blanks for Submersible Pumps.

9. Split samples taken by other parties. Note the type of sample, sample location, time/date, name of individual for whom the split was collected, that individual's company, and any other pertinent information. How the split sample was collected should also be recorded. Was it collected as a duplicate sample (separate collection) or as a replicate sample (all material collected and then mixed and divided into individual containers)? Replicate soil and surface water samples are more appropriate for this type of sample.

10. Sampling method, particularly any deviations from the SAP and SOP. A generalized description of the sampling procedure can be described at the beginning of the project logbook and then the page can be referenced for succeeding sampling days, if sampling protocol will be the same for every sample. If referencing a description, make sure that any deviations associated with the individual sample are recorded, such as refusal in hole 2 and 4 at 5 inches.

11. 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.

12. The laboratory where the samples will be sent. Note that this might be container specific (i.e., organic sample containers may be going to one laboratory and inorganic

	samples may be shipped to a different laboratory). If this is the case, the laboratory performing analysis should be listed with the analytical method/analyte descriptions as discussed above. 13. Chain of Custody Form: Information on sample submittal to laboratories needs to be recorded in the logbook to maintain chain of custody for the samples. This information will include the following: a. The samples shipped to each laboratory: the samples can be listed individually or listed as a general description of the samples shipped (i.e., all EPH, TPH samples collected on specific dates). b. The method shipped (i.e., FedEx Overnight, UPS ground, or hand delivered). c. Any tracking numbers associated with the shipment. d. Number of shipping containers shipped or delivered. e. Date and time sample containers were relinquished. Any documentation from the transport company (receipts or tracking numbers) and copies of chain of custody forms included in the shipping containers will be placed in the project record file and retained to prove chain of custody was maintained. Further information on preparing samples for shipping is detailed in Pioneer SOP-SA-01 Soil and Water Sample Packaging and Shipping and SOP-SA-04 Chain of Custody Forms for Environmental Samples. No bound field logbooks will be destroyed or thrown away even if they are illegible or contain inaccuracies that require a replacement document. If the logbook is replaced, write REPLACED on the cover of the logbook and reference the new logbook and number. The original logbook should be referenced at the beginning of the replacement logbook along with the reason the original was replaced. Keep in mind that any information not recorded in a logbook or on a field data sheet or comparable document is not part of the project documentation and **cannot be used**. If a sample is not recorded in the logbook or associated documentation it **does not exist** and cannot be used for decision making purposes.
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 are not recommended; if you take these types of photographs, they should be identified as such. The following items will be recorded in the bound field logbook or on a field data sheet for each photograph taken: 1. The photographer's name, the date and 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 will 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 will be photocopied and placed in the task files to accompany the photographs once the field activities are complete.

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	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 (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): None Required
APPLICABLE SDSs	**Safety Data Sheets (**SDSs) will be maintained based on site characterization and contaminants. Safety Data Sheets are available to Pioneer personnel on the internal website under Safety.
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-SA-01 Soil and Water Sample Packaging and Shipping SOP-SA-03A Field Quality Control Samples for Water Sampling SOP-SA-03B Preparation of Equipment Rinsate Blanks for Submersible Pumps SOP-SA-04 Chain of Custody Forms for Environmental Samples
TOOLS/ EQUIPMENT	Field logbook, Sharpie©, black pen, and digital camera.
FORMS/ CHECKLIST	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**
Patricia Olson **Patricia Olson**	**04/14/2022**
SAFETY AND HEALTH MANAGER	**DATE**
Tara Schleeman **Tara Schleeman**	**04/14/2022**

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.

<table>
<tr>
<td>Quality Assurance/Quality Control (QA/QC) Requirements.</td>
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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.
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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:

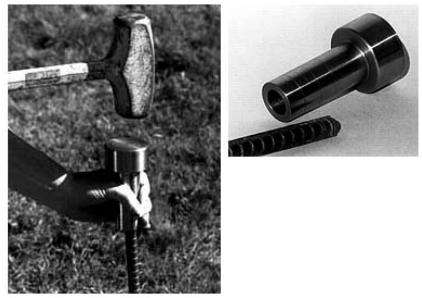
- After determining the position of the hub/stake/lath, determine the soil condition.
- If soil is loose or non-compacted, simply drive the hub/stake/lath into the ground until the hub/stake/lath is stable.

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.).

	 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.
6. Checking points daily.	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.
7. Using point ranges.	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.

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 conducting field filtration of 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 Plan (SSHASP), and Pioneer Corporate Health and Safety Plan (HASP).

TASK	INSTRUCTIONS
Field Sample Filtration	
Notes	The general procedures listed below are applicable for field filtration of water samples for subsequent analysis of dissolved analytes. Refer to the SOPs mentioned in the text and listed under **RELATED SOPs/PROCEDURES/ WORK PLANS** for the sampling setup in which filtering will occur.
Field Filtering When Sampling With A Bailer	
Notes	Prior to the sampling event, include an extra 1-liter unpreserved sample container for each sample site on the laboratory bottle order. If necessary, a 1-liter sample container can be decontaminated as described in SOP-DE-02. However, this is not recommended as there is a potential for introducing contamination. Use a peristaltic pump for filtering the sample. Order peristaltic pump tubing prior to the sampling event. Order enough tubing for approximately 18 inches of silicon tubing and 12 inches of polyethylene tubing to be used per sampling site. Use a new disposable filter (0.45 micrometers [µm]) for each sampling site.
1. Prep for sampling.	Follow the procedures outlined in SOP-GW-02 through the step for collecting samples using a bailer.
2. Collect sample for filtering.	While filling sample containers, also fill the extra 1-liter unpreserved sample container; this water will be used for filtering. Put on a new set of nitrile gloves and install the new tubing in the peristaltic pump. Place one end of the tubing into the filled 1-liter unpreserved sample and connect an in-line high capacity (0.45 µm) disposable filter on the tubing. Make sure that the filter is inserted so that the flow arrow is pointed toward the discharge end of the filter.

	Place a discharge storage container underneath the discharge end of the filter to capture water that is not used for sample collection. Start the pump and let a small amount of water flow through the filter and into the discharge storage container before filling the sample container. Hold the filter at an angle to ensure no unfiltered water from the tubing leaks into the sample container and only the filtered water enters the sample container. If water stops discharging from filter, replace the filter with a new filter. If an unpreserved sample container is used as a part of the samples to be submitted for analytical testing, this sample container can be used in lieu of an extra container to collect the water for filtering. Then, refill the container after filtration is completed. Follow SOP-SA-02 to complete sample collection. If extremely turbid water is encountered, place an in-line high capacity (10 µm) disposable filter before the in-line high capacity (0.45 µm) disposable filter. Document any additional filters used during sampling into a bound logbook (refer to SOP-SA-05).
3. 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.
4. Dispose of used bailer, tubing, filters, and extra 1-liter sample container.	Dispose of the bailer, tubing, filters, the extra 1-liter unpreserved sample container, and the excess water purged into the discharge storage container in accordance with SOP-DE-03.
Filtering Sample with 12-Volt Submersible Pump, Low Flow Submersible Pump, and Grundfos Redi-Flo Submersible Pump	
Note	Use a new disposable filter (0.45 µm) for each sampling site.
1. Prep for sampling.	Follow the procedures as outlined in the appropriate SOP listed below through the step for collecting samples. • SOP-GW-08 • SOP-GW-10.1 • SOP-GW-10.2
2. Collect sample for filtering.	Prior to sample collection, put on a new pair of nitrile gloves. Fill the unfiltered sample containers as detailed in SOP-SA-02. Insert an in-line high capacity (0.45 µm) disposable filter in the discharge end of the tubing.

	Place a discharge storage container underneath the discharge end of the filter to capture water that is not used for sample collection. Make sure that the filter is inserted so that the flow arrow is pointed toward the discharge end of the filter. Let a small amount of water flow through the filter before filling the sample container. Hold the filter at an angle to ensure no unfiltered water from the tubing leaks into the sample container and only the filtered water enters the sample container. If water stops discharging from filter, replace the filter with a new filter. If an in-line high capacity (0.45 µm) disposable filter is in place and the water stops discharging due to inadequate flow for the filter, disconnect the filter from the discharge tubing and follow the "*Filtering Sample with Peristaltic Pump*" section of this SOP to collect filtered sample. If an unpreserved sample container is used as part of the samples to be submitted for analytical testing, this sample container can be used in lieu of an extra container to collect the water for filtering. Then, refill the container after filtration is completed. Follow SOP-SA-02 to complete sample collection. If extremely turbid water is encountered, place an in-line high capacity (10 µm) disposable filter before the in-line high capacity (0.45 µm) disposable filter. Document any additional filters used during sampling into a bound logbook (refer to SOP-SA-05).
3. 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.
4. Dispose of used disposable tubing and filters.	Dispose of tubing, filters, and the excess water purged into the discharge storage container in accordance with SOP-DE-03.
Filtering Sample with Peristaltic Pump	
Note	Use a new disposable filter (0.45 µm) for each sampling site.
1. Prep for sampling.	Follow the procedures for setting up the pump and purging as outlined in SOP-GW-10.1 through the step for collecting samples.
2. Collect sample for filtering.	Prior to sample collection, put on a new pair of nitrile gloves. Fill the unfiltered sample containers as detailed in SOP-SA-02. Insert an in-line high capacity (0.45 µm) disposable filter on the discharge end of the tubing. Make sure that the filter is inserted so that the flow arrow is pointed toward the discharge end of the filter.

	Place a discharge storage container underneath the discharge end of the filter to capture water that is not used for sample collection Let a small amount of water flow through the filter before filling the sample container. Hold the filter at an angle to ensure no unfiltered water from the tubing leaks into the sample container and only the filtered water enters the sample container. If water stops discharging from filter, replace the filter with a new filter. If an unpreserved sample container is used as part of the samples to be submitted for analytical testing, this sample container can be used in lieu of an extra container to collect the water for filtering. Then, refill the container after filtration is completed. Follow SOP-SA-02 to complete sample collection. If extremely turbid water is encountered, place an in-line high capacity (10 µm) disposable filter before the in-line high capacity (0.45 µm) disposable filter. Document any additional filters used during sampling into a bound logbook (refer to SOP-SA-05).
3. 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.
4. Dispose of used disposable tubing and filters.	Dispose of tubing, filters, and the excess water purged into the discharge storage container in accordance with SOP-DE-03.
Filtering Sample from a Tap	
Notes	Prior to the sampling event, include an extra 1-liter unpreserved sample container for each sample site on the laboratory bottle order. If necessary, a 1-liter sample container can be decontaminated as described in SOP-DE-02. However, this is not recommended as there is a potential for introducing contamination. Use a peristaltic pump for filtering the sample. Order peristaltic pump tubing prior to the sampling event. Order enough tubing for approximately 18 inches of silicon tubing and 12 inches of polyethylene tubing to be used per sampling site. Use a new disposable filter (0.45 µm) for each sampling site.
1. Prep for sampling.	Follow the steps to purge the tap water as outlined in SOP-GW-13 through the step for collecting samples.
2. Collect sample for filtering.	Prior to sample collection, put on a new pair of nitrile gloves. While filling sample containers, also fill the extra 1-liter unpreserved sample container; this water will be used for filtering. Put on a new set of nitrile gloves and install the new tubing in the peristaltic pump.

	Place one end of the tubing into the filled 1-liter unpreserved sample and connect an in-line high capacity (0.45 µm) disposable filter on the tubing. Make sure that the filter is inserted so that the flow arrow is pointed toward the discharge end of the filter. Place a discharge storage container underneath the discharge end of the filter to capture water that is not used for sample collection. Start the pump and let a small amount of water flow through the filter and into the discharge storage container before filling the sample container. Hold the filter at an angle to ensure no unfiltered water from the tubing leaks into the sample container and only the filtered water enters the sample container. If water stops discharging from filter, replace filter with a new filter. If an unpreserved sample container is used as part of the samples to be submitted for analytical testing, this sample container can be used in lieu of an extra container to collect the water for filtering. Then, refill the container after filtration is completed. Follow SOP-SA-02 to complete sample collection. If extremely turbid water is encountered, place an in-line high capacity (10 µm) disposable filter before the in-line high capacity (0.45 µm) disposable filter. Document any additional filters used during sampling into a bound logbook (refer to SOP-SA-05).
3. 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.
4. Dispose of used disposable tubing, filters, and extra 1-liter sample container.	Dispose of tubing, filters, the extra 1-liter sample container, and the excess water purged into the discharge storage container in accordance with SOP-DE-03.

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 and filters.	Sites.	Inadvertent exposure to contaminated water and filters 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.
	Preservatives: hydrochloric acid (HCL), nitric acid (HNO_3), sulfuric acid (H_2SO_4), zinc, acetate, and sodium hydroxide (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 personnel on the Pioneer company website. Personnel will wear nitrile gloves and safety glasses when adding preservatives to sample 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	Improper lifting.	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 height. Two people will lift objects, 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
	Bending, squatting, and kneeling.	During sample collection.	Bending, squatting, and kneeling during sample collection could result in muscle/back strains or other injuries.	Personnel 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.	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 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.
	Hypothermia/ frostbite.	Sites where air temperature is 35.6 °F (2°C) or less.	Personnel whose clothing becomes wet during decontamination procedures may be exposed to hypothermia and/or frostbite.	If it becomes wet, personnel will change 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**
	Lightning.	Outdoor sites.	Electrocution, injury, death, or equipment damage could result from 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.
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.
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 injuries 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, nitrile gloves, and work gloves.
APPLICABLE SDSs	**Safety Data Sheets** (SDSs): HCL, HNO_3, H_2SO_4, zinc, acetate, and NaOH. Safety Data Sheets are available to Pioneer personnel on the internal website under Safety.
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-DE-02 Equipment Decontamination SOP-DE-03 Investigation Derived Waste Handling SOP-GW-02 Sampling with a Bailer SOP-GW-08 Sampling Seeps and Springs SOP-GW-10.1 Purging and Sampling Using the Traditional Multi-Volume Purge Method SOP-GW-10.2 Purging and Sampling Using the Low Flow Purge Method SOP-GW-13 Sampling Groundwater From a Tap SOP-SA-01 Soil and Water Sample Packaging and Shipping SOP-SA-02 Sample Preservation and Containerization for Aqueous Samples SOP-SA-05 Project Documentation
TOOLS/ EQUIPMENT	Bailer, filter, tubing, pump, sample collection tools, cooler, sample bottles, and preservatives.
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**
Kendra Overley **Kendra Overley**	**06/08/2022**
SAFETY AND HEALTH MANAGER	**DATE**
Tara Schleeman **Tara Schleeman**	**06/08/2022**

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. **At the end of every day, recheck the calibration by placing the probe into pH 4, pH 7, and pH 10. Note the live readings into the field logbook.**
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 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. 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 on the internal website under Safety.
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	**06/08/2022**
SAFETY AND HEALTH MANAGER	**DATE**
Tara Schleeman	**06/08/2022**

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. **At the end of the day, recheck calibration by placing the probe back into the calibration solution. Record the live reading into the field logbook.**
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 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. 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 on the internal website under Safety.

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**	**06/08/2022**
SAFETY AND HEALTH MANAGER	**DATE**
Tara Schleeman **Tara Schleeman**	**06/08/2022**

PURPOSE	To provide standard instructions for field measurements of specific conductance (SC).
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 Plan (SSHASP), and Pioneer Corporate Health and Safety Plan (HASP).

TASK	INSTRUCTIONS
Important information about the meter.	Pioneer owns and operates Professional Plus YSI Meters (YSI Meters) for SC field measurements. All the units have automatic temperature correction (ATC) capabilities. 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. For standard instructions for setting up the YSI Meters refer to SOP-GW-14.
Storing and using the meter.	1. Store meter in its case during transport. 2. Check batteries before taking any meter into the field. Carry spare batteries and deionized (DI) water for rinsing probe. 3. Inspect meter probe for damage or dirt before and after field work. 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 that is on the meter using the proper cleaning procedure for the type of spill. 5. If meter readings are erratic, inform a trained technician and probes will be replaced or sent to manufacturers accordingly. 6. If Oxidation Reduction Potential (ORP) is also required for field work, make sure to calibrate SC before measuring ORP; otherwise, the reading could be in error. Calibrating ORP prior to SC will help deviate error messages during calibration. Calibration steps for SC are described below. Error messages from the sensor typically indicate that the sensor could be dirty. First verify sensor is clean by spraying or rinsing the probe with DI water or analyte free water. If this does not work, place the probe into standard solution potential

	hydrogen (pH) 4. If this does not work, contact a trained technician for assistance.
1. Calibrate the meter.	**All field meters must be calibrated prior to use.** Field meters must be calibrated at a minimum of once per day for each day of instrument use and prior to collecting field measurements for water quality data. Refer to the meter-specific operating manual for calibration instructions. Listed below are calibration requirements for the YSI Meters: **Note:** A trained technician from Pioneer will have the YSI Meter and probes installed and set up for field crews to use to collect water quality data. If a probe needs to be replaced, a trained technician will replace it accordingly. 1. Turn the meter on. 2. Take the probes out of tap water or storage solution by unscrewing the probe from the storage container. 3. Spray or rinse the probes with DI water or analyte free water. Make sure there is a discharge storage container underneath the probes to capture the discharge. 4. Blot the probes dry with a lint-free tissue. 5. Place the probes into the calibration solution. 6. Press the "Cal" key for calibration. Select "Conductivity" from the list that appears. Then select "Sp. Conductance" from the next list that appears. Select "SPC- µS/cm (micromhos/centimeter)" for correct units for calibration. Unless specified in the Sampling and Analysis Plan (SAP) or work plan, one conductivity standard (1413 µS/cm) is used for calibration. Make sure that the calibration standard in the case is fresh by checking the date it was last changed. Update the date the calibration solution was changed if necessary. Replace the meter batteries and try fresh calibration solutions if the meter does not calibrate properly. 7. When calibrating for SC, make sure the "Calibration Value" is set to 1413, or other to match the calibration standard solution. 8. Wait for the readings to stabilize. Once the readings have stabilized, press the middle "Enter" button to accept the reading. 9. Record the calibration results in the field logbook. The meter will record and save all calibrations completed. To view the results, select "File" on the top right of the instrument. Then select "View GLP" from the list displayed. A list of all calibrations completed for the instrument will appear on the meter. Record the "Cal Cell Constant" in the logbook.

	10. Once the "Cal Cell Constant" is recorded in the logbook, press the "Esc" key twice to get back to the live reading screen or measurement mode. Measure the calibration standard and the measurement temperature and record this result in the field logbook. 11. **The stabilization range for the SC should be within 3% of the calibration solution. If the measurement is out of the 3% range, the unit must be re-calibrated prior to field work.** If requirements for the project specifically state using a different calibration range, follow the standard for the project.
2. Conduct field measurements.	**Surface water readings:** Collect field conductivity measurements for surface water by directly submersing 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, you can take the measurements by collecting a grab sample and immediately analyzing the grab sample in the field. **Groundwater readings:** Collect field conductivity measurements for groundwater by inserting the probe into a flow cell (refer to SOP-GW-14) or by collecting a grab sample and immediately analyzing the grab sample in the field. Specific requirements may be listed in the SAP or work plan. Field conductivity is measured in units of µS/cm or millihos/centimeters (mS/cm) on all meters. Refer to the meter-specific operating manual for measurement instructions. Listed below are general measurement instructions: 1. With the meter in measurement mode, rinse the conductivity cell with DI water or analyte free water and blot dry with a lint-free tissue. Place the cell into the water being measured. a. If the probe cannot be placed directly into the water being measured, rinse the decontaminated beaker with sample water three times. b. Fill the beaker with the water to be measured. 2. Submerge conductivity probe into the water and wait for the readings to stabilize. 3. 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. 4. Repeat the above steps for all samples. 5. When all samples have been measured, store the meter and probes into their cases for proper transportation. 6. **At the end of the day, recheck the calibration by placing the probe into the calibration solution. Record the live reading into the field logbook.**

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 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 field 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 parameter measurements could result in muscle/back strains or other injuries.	Personnel should stretch prior to starting work and they will take breaks when 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
	Drowning and/or entrapment hazards.	Bodies of water, during field 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 soil 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.
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 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.
	Hypothermia/ frostbite.	Sites where air temperature is 35.6 °F (2°C) or less.	Personnel whose clothing becomes wet during decontamination procedures may be exposed to hypothermia and/or frostbite.	If it becomes wet, personnel will change 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
	Lightning.	Outdoor sites.	Electrocution, injury, death, or equipment damage could result from 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.
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.
MECHANICAL	Pinch points.	Equipment cases and caps.	Opening/closing equipment cases and caps may result in pinch points.	Wear gloves and watch hand placement when opening and closing cases and caps.
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 properly trained in this procedure and other applicable procedures. Personnel will implement stop work procedures, 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**
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, nitrile gloves, and work gloves.
APPLICABLE SDSs	**Safety Data Sheets** (SDSs): 1413 µS/cm calibration standard solution. Safety Data Sheets are available to Pioneer personnel on the internal website under Safety.
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-14 Field Water Quality Measurements Using the YSI Meter and Flow Cell
TOOLS/ EQUIPMENT	Specific conductance field measurement meter, calibration standard solution, calibration kit, spare batteries for the meter, DI water or analyte free 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**
Kendra Overley **Kendra Overley**	**06/09/2022**
SAFETY AND HEALTH MANAGER	**DATE**
Tara Schleeman **Tara Schleeman**	**06/09/2022**

PURPOSE	To provide standard instructions for field measurement of water temperature.
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
Note	Pioneer uses a pH field measurement meter or multi-meter for measuring temperature.
1. Prepare the pH meter for measuring water temperature.	Pioneer owns and operates different brands and models of pH and multi-meters. All units, in general, have automatic temperature correction (ATC) capabilities. Prior to using a pH meter or multi-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 in the field at the beginning of each day. 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 the 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 more than the manufacture's listed accuracy in the associated user's manual. Record pH and temperature calibration recheck values in logbook.
3. Take field measurements.	The following is a general summary for field measurement of pH and temperature: 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 temperature to the nearest 0.01 unit once pH and temperature readings have stabilized. 5. Rinse electrodes with deionized water and store in carrying case. Note: Temperature 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 a 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 temperature 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/drinking 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 temperature measurements.	Bending, squatting, and kneeling during temperature measurements could result in muscle/back strains or other injuries.	Personnel should stretch prior to starting work and take breaks when necessary.
	Drowning and/or entrapment hazards.	Bodies of water, during temperature 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 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. 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, pH 7, and pH 10 buffer solutions. Safety Data Sheets are available to Pioneer personnel on the internal website under Safety.

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**	**09/30/2020**
SAFETY AND HEALTH MANAGER	**DATE**
Tara Schleeman **Tara Schleeman**	**09/30/2020**

PURPOSE	To provide standard instructions for field measurements of dissolved oxygen (DO).
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 Plan (SSHASP), and Pioneer Corporate Health and Safety Plan (HASP).

TASK	INSTRUCTIONS
Important information about the meter.	Pioneer owns and operates Professional Plus YSI Meters (YSI Meter) for DO field measurements. All the units have automatic barometric pressure and salinity content compensation. A user manual for the meter is available in each case and the specific directions for calibrating and measuring DO with the meter should be followed. The following is a general summary for field measurement of DO. For standard instructions for setting up the YSI Meters refer to SOP-GW-14.
Storing and using the meter.	1. Store meter in its case during transport. 2. Check batteries before taking any meter into the field. Carry spare batteries and deionized (DI) water or analyte free water for rinsing probe. 3. Inspect meter probe for damage or dirt before and after field work. 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 substances that is on the meter using the proper cleaning procedure for the type of spill. 5. If meter readings are erratic, inform a trained technician and probes will be replaced or sent to manufacturers accordingly. 6. Elevation influences DO readings. All calibrations for DO should be completed at or near the same elevation of the sample points. Use lukewarm to cold tap water during calibration activities and never use warm to hot water. This will create issues and errors during calibration.

1. Calibrate the meter.	**All field meters must be calibrated prior to use.** Field meters must be calibrated at a minimum of once per day for each day of instrument use and prior to collecting field measurement for water quality data. Refer to the meter-specific operating manual for calibration instructions. Listed below are general calibration requirements for the YSI Meters: Note: A trained technician from Pioneer will have the YSI Meter and probes installed and set up for field crews to use to collect water quality data. If a probe needs to be replaced, a trained technician will replace it accordingly. 1. Turn the meter on. 2. Take the probes out of the tap water or storage solution by unscrewing the probes from the storage container. 3. Spray or rinse the probes with DI water or analyte free water. Make sure there is a discharge storage container underneath the probes to capture the discharge. 4. Blot the probes dry with a lint-free tissue and ensure there are no water droplets on the probes. 5. Place a small amount of clean (tap) water (about 1/8 inch) in the storage container. Then place the probes into the storage container by screwing the probes into the storage container about 3 full turns. Make sure there are 1-2 threads showing between the cup and the bulkhead of the probes to allow atmospheric pressure to enter the storage container for proper calibration. Make sure the probes are not touching the water in the bottom of the storage container. 6. Press the “Cal” key for calibration. Select “DO” for DO and then “DO %” for DO percent saturated from the list that appears. 7. Wait for readings to stabilize. Once the readings have stabilized, press the middle “Enter” button to accept the reading. 8. Record the calibration results in the field logbook. The meter will record and save all calibrations completed. To view the results, select “File” on the top right of the instrument. Then select “View GLP” from the list displayed. This will provide a list of all calibrations completed for the instrument. Record the “Barometer” in millimeters of mercury (mmHg) into the filed logbook. 9. Once the mmHg is recorded in the logbook, press the “Esc” key twice to get back to the live reading screen or measurement mode. Measure the live reading of percent saturated (% sat) and micrograms per liter (mg/L) and record the values in the field logbook. 10. **Remeasure tap water (same procedure as above) at the end of the day and note the live readings. Record the information in the field logbook.**

2. Conduct field measurements.	**Surface water readings:** Collect field DO measurements for surface water by submerging the instrument probe into the sample stream. If flow is turbulent or shallow, or when direct immersion of the probe would risk damaging the probe, you can take the measurements by collecting a grab sample and immediately analyzing the grab sample in the field. **Groundwater readings:** Collect field DO measurements of groundwater by inserting the probe into a flow cell (refer to SOP-GW-14) or by collecting a grab sample and immediately analyzing the grab sample in the field. Specific requirements may be listed in the project Sampling and Analysis Plan or work plan. The project-specific document(s) may list the units for which DO should be measured (e.g., % sat or mg/L). Refer to the meter-specific operating manual for measurement instructions. Listed below are general measurement instructions: 1. Fill the beaker with the water to be measured. If the probe cannot be placed directly into the water being measured, rinse the decontaminated beaker with sample water three times. 2. Allow temperature and DO readings to stabilize. 3. 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 0.1 degree Celsius (ºC) after the temperature has equilibrated. 4. Spray the probe with DI water or analyte free water and wipe the probe clean before reinserting into the calibration/storage container. 5. Repeat the above steps for all samples. 6. When all samples have been measured, store the meter and probes into their cases for proper transportation.

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 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 field measurements.
NOISE	Not applicable.			
ELECTRICAL	Not applicable.			
BODY MECHANICS	Bending, squatting, and kneeling.	During field measurements.	Bending, squatting, and kneeling during field parameter 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 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 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.
	Hypothermia/ frostbite.	Sites where air temperature is 35.6 °F (2°C) or less.	Personnel whose clothing becomes wet during decontamination procedures may be exposed to hypothermia and/or frostbite.	If it becomes wet, personnel will change clothing.
	Lightning.	Outdoor sites.	Electrocution, injury, death, or equipment damage could result from 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. 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	Pinch points.	Equipment cases and caps.	Opening/closing equipment cases and caps may result in pinch points.	Wear gloves and watch hand placement when opening and closing cases and caps.
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 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 Protective Equipment** (PPE): Hard hat, safety glasses, high-visibility work shirt or vest, long pants, work boots, nitrile gloves, and work gloves.
APPLICABLE SDSs	**Safety Data Sheets** (SDSs) will be maintained based on site characterization and contaminants. Safety Data Sheets are available to Pioneer personnel on the internal website under Safety.
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-14 Field Water Quality Measurements Using the YSI Meter and Flow Cell
TOOLS/ EQUIPMENT	Dissolved oxygen field measurement meter, DI water or analyte free water, tap 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
Kendra Overley Kendra Overley	06/09/2022
SAFETY AND HEALTH MANAGER	**DATE**
Tara Schleeman Tara Schleeman	06/09/2022

PURPOSE	To provide standard instructions for field turbidity measurements.
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
Note	The turbidity of the water pumped during well development and sampling or surface water testing will be measured using a portable turbidimeter. **Record** the calibrations and sampling and stabilization information in the bound logbook, field data sheets, or on the well development data form, as appropriate. The turbidity measurement data for groundwater sampling will include, at a minimum, the well number, date and time, volume of water pumped, and the Nephelometric Turbidity Units (NTU) reading.
Equipment description	A HACH Model Portable Turbidity Meter (HACH Turbidimeter) operates on the nephelometric principle of turbidity measurement and meets EPA Method 180.1. The meter measures turbidity directly in NTU on a precalibrated meter scale. Calibration of the meter is based on an accepted primary standard of turbidity measurement and will be completed per the manufacturer's guidance.
1. Verify standards.	Verify that the turbidimeter is reading the standard cells accurately. This should be done at a minimum of once per day prior to beginning measurements. If based on the verification standards, a calibration is required, perform the calibration. The HACH Turbidimeter verification is accomplished with 4 standards provided in the meter kit by the manufacturer: 10, 20, 100, and 800 NTU. The HACH's accuracy is +/- 2% of the reading. If the turbidity meter being used is not a HACH Turbidimeter, verify accuracy with manufacture's user manual. To verify the standards: 1. Place the meter on a flat steady surface. Do not hold the meter during operation. Turn on the meter and let it warm up. 2. **Note:** Before inserting the calibration cell, make sure that the sample cell is clean. Wipe the sample cell thoroughly with a lint free cloth. If needed, oil the sample cell with silicone oil. To ensure that the standard solutions are well-mixed, gently invert each standard before inserting into the meter. Insert so that the diamond or orientation

	mark aligns with the raised orientation mark in front of the cell compartment. **To start the verification process**, select "Verify Calibration" and follow the directions on the display. Insert the calibration sample cell marked 10 NTU in the instrument cell compartment, close the lid and press "Read." 3. Record the result in the logbook and press "Done." 4. Clean and gently mix the sample cell marked 20 NTU. Place the sample cell in the instrument cell compartment, close the lid and press "Read." 5. **Record** the result in the field logbook and press "Done." 6. Repeat the process with the remaining 2 standards, 100 and 800 NTU. Make sure to clean and gently invert each calibration cell prior to inserting in the meter. **Record** the results of each standard in the field logbook.
2. Calibrate instrument.	The HACH Turbidimeter calibration is accomplished using 3 of the verification standards provided in the meter kit. 1. Place the meter on a flat steady surface. Do not hold the meter during operation. Turn on the meter and let it warm up. 2. Start the calibration process by pushing the "Calibration" key to enter the calibration mode and follow the instructions on the display. 3. **Note:** Before inserting the calibration cell, make sure that the sample cell is clean. Wipe the sample cell thoroughly with a lint free cloth. If needed, oil the sample cell with silicone oil. To ensure that the standard solutions are well-mixed, gently invert each standard before inserting into the meter. Insert so that the diamond or orientation mark aligns with the raised orientation mark in front of the cell compartment. Insert the calibration sample cell marked 20 NTU in the instrument cell compartment, close the lid and press "Read." 4. Record the result in the logbook. 5. Repeat steps 3 and 4 with the 100 NTU and 800 NTU calibration cells. Clean and gently invert each calibration cell prior to inserting in the meter. 6. Push "Done" to review the calibration details and record in logbook. 7. Push "Store" to save results. 8. The meter automatically goes into the "Verify Calibration" mode once the calibration sequence is complete. Insert the 10 NTU Verification Standard and close the lid.

	9. Push "Read." The display shows "Stabilizing" and then shows the result and tolerance range. Record this information in the field logbook. 10. Push "Done" to return to the reading display. Repeat the calibration verification if the verification failed. These steps may vary from different models and manufactures. Always refer to manufacture's user manual.
3. Collect samples.	The HACH Turbidimeter requires collection of a sample for subsequent turbidity measurements. The sample may be collected using any clean container including a sample cell. Rinse sample cells three times with the water to be measured prior to filling the cell for measurement. Collect samples for field measurement purposes by submersion of the sample container into the flow whenever possible. For surface water, always collect samples upstream of sampling personnel and equipment. The sample container should be pointed upstream into the flow when the container is opened for sample collection. Take care not to sample water downstream of areas where sediments have been disturbed in any manner by field personnel. Collect samples from a location where visually the stream flow appears to be completely mixed. Ideally, this is at the center of the flow cross section, but site conditions do not always allow this. Preferably, the location should be accessible by direct reach from the bank or shore, or in the case of a receiving water body, via wading. Caution is required when wading, as flowing water provides more force than visually anticipated. If the center of the flow cannot be sampled by direct reach or by wading into the flow, use a sampling pole or other sampling device to reach the sampling location. Such devices typically involve a way to extend the reach of the sampler, with the sample bottle attached to the end of the device for filling at the desired location. For groundwater, fill the sample cells with sample water directly from the pump tubing during purging activities. Rinse the sample cell three times with purge water prior to sample collection.
4. Take turbidity measure-ments.	Always cap the sample cell prior to placing in the cell compartment to prevent spillage of the sample into the instrument. Use clean sample cells in good condition. Dirty, scratched, or damaged cells can cause inaccurate readings. Make sure that cold samples do not "fog" the sample cell. 1. Collect a representative sample in a clean container. Fill a sample cell to the line (about 15 milliliters). Take care to handle the sample cell by the top. Cap the cell. 2. Wipe the cell with a soft, lint-free cloth to remove water spots and fingerprints. 3. Apply a thin film of silicone oil (provided in meter kit), if needed. Wipe with soft cloth (provided in meter kit) to obtain an even film over the entire surface.

	4. Push the "Power" key to turn on the meter. Make sure that the meter is placed on a level, stationary surface during the measurement. Do not hold the meter in the hand during measurement. 5. Gently invert the sample cell to ensure mixing. Insert the sample cell in the instrument cell compartment so the diamond or orientation mark aligns with the raised orientation mark in front of the cell compartment. Close the lid. 6. Push the "Read" key. The display shows "Stabilizing" then displays the turbidity in NTU. 7. Record the value in the field logbook or on the field data form. These steps may vary for different models and manufactures. Always refer to the turbidity meter manufacturer's user manual. Repeat sample collection and measurement process as required in the sampling and analysis plan or work plan. For groundwater sampling, unless indicated in the project documents, turbidity can be considered stable when 3 consecutive readings are within 10% for values greater than 5 NTU or if 3 consecutive turbidity values are less than 5 NTU. After use, rinse the sample cells with deionized water. Store the sample cells with caps on to prevent cells from drying. Do not air dry the sample cells after use.
5. Store sample cells.	To properly store the sample cells: 1. Fill the sample cell with deionized water. 2. Cap the sample cell. 3. Wipe the outside of the sample cell dry with a soft cloth and store the sample cell with the turbidity meter case in such a way as that it will not break during transport.

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 sample collection and 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 collecting samples and taking measurements.
	20 NTU, 100 NTU, and 800 NTU verification standards.	During equipment calibration.	Personnel can be exposed to verification standards via skin/ eye contact and ingestion/ inhalation when calibrating equipment, which can result in skin/ eye irritation and adverse health effects.	Personnel will prevent skin/ eye contact with verification standards, and they will wear nitrile gloves and safety glasses when handling verification standards. Personnel will practice proper personal hygiene – wash hands prior to eating/ drinking, after equipment calibration, and when leaving the site.
NOISE	Not applicable.			
ELECTRICAL	Not applicable.			
BODY MECHANICS	Bending, squatting, and kneeling.	During sample collection and measure-ments.	Bending, squatting, and kneeling during sample collection and measurements could result in muscle/ back strains or other injuries.	Personnel should stretch prior to starting work and take breaks when 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***
	Drowning and/ or entrapment hazards.	Bodies of water, during sample collection.	If personnel need to stand in bodies of water to collect samples, 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. Caution is required when wading, as flowing water might provide more force than visually anticipated. When possible, personnel will not enter the water body and collect samples 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. Wear muck boots, as necessary.
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. 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.

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*
	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.
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.	Well caps.	Personal injury could result from fingers getting pinched when opening/closing well caps.	Personnel will wear work gloves when opening/closing well caps.
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.

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***
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): 20 NTU, 100 NTU, and 800 NTU verification standards. Safety Data Sheets are available to Pioneer personnel on the internal website under Safety.
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	Turbidimeter and meter kit; bound logbook, field data sheets, or well development data form; clear containers for sample collection; sampling pole or other sampling device (if the center of the flow cannot be sampled by direct reach or by wading into the flow); paper towels; and deionized water.
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**	**10/13/2020**
SAFETY AND HEALTH MANAGER	**DATE**
Tara Schleeman **Tara Schleeman**	**10/13/2020**

Appendix B
Blacktail Creek Remediation and Contaminated Groundwater Hydraulic Control Site
Piezometer Installation and Monitoring Well Repair Plan

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

Final

Blacktail Creek Remediation and Contaminated Groundwater Hydraulic Control Site

Piezometer Installation and Monitoring Well Repair Plan

Atlantic Richfield Company

July 2022

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 8, MONTANA OFFICE
FEDERAL BUILDING, 10 West 15TH Street, Suite 3200
Helena, MT 59626-0096
Phone 866-457-2690
www.epa.gov/region8

Ref: 8MO

June 28, 2022

Mr. Josh Bryson
Liability Manager
Atlantic Richfield Company
317 Anaconda Road
Butte, MT 59701

Re: Approval on the Draft Butte Priority Soils Operable Unit (BPSOU) Blacktail Creek Piezometer Installation and Monitoring Well Repair Plan (dated June 10, 2022)

Dear Josh:

The U.S. Environmental Protection Agency (EPA), in consultation with the Montana Department of Environmental Quality (DEQ), is providing an approval contingent on addressing minor comments on the *Blacktail Creek Piezometer Installation and Monitoring Well Repair Plan (dated June 10, 2022)*. Please incorporate these comments and distribute the final version of the document.

Comments:

- Section 2.3.3 – The Administrative Rules of Montana (ARM) cited requires a minimum of 1.5 inches of seal on all sides of the casing for monitoring wells. It isn't clear if the piezometers installed using the Geoprobe can meet this requirement. Please clarify the diameters of the casing and equipment.
- Section 4.0 – If the well has not met the development field parameter requirements after 4 hours, the well is not considered to be fully developed. Either the method of development is not appropriate for the well or there is potentially a problem with the well. If the field parameter requirements are not met after 4 hours, discontinue developing and prepare a corrective action plan that will result in the well meeting the field parameter requirements. Please revise this section to address this concern.

If you have any questions or concerns, please call me at (406) 457-5019.

Sincerely,

NIKIA GREENE

Digitally signed by NIKIA GREENE
Date: 2022.06.29 09:44:06 -06'00'

Nikia Greene
Remedial Project Manager

cc: (email only)
Butte File
Matt Dorrington, DEQ
Daryl Reed; DEQ
Will George; DEQ
Jon Morgan; DEQ counsel
Carolina Balliew; DEQ
Harley Harris; NRDP
Katherine Hausrath; NRDP
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Pat Cunneen; NRDP
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Brandon Warner; BSBC
Chad Anderson; BSBC
Karen Maloughney; BSBC
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Abby Peltomaa; BSBC
Jeremy Grotbo; BSBC
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Leo Berry; BNSF and UP counsel
Doug Brannan; Kennedy Jenks for BNSF and UP
Brooke Kuhl; BNSF counsel
Lauren Knickrehm; for BNSF
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Bob Andreoli; Patroit/RARUS
Becky Summerville; counsel for Inland Properties Inc.
Robert Lowry, BNSF counsel
Loren Burmeister; AR
Josh Bryson; AR
Chris Greco; AR
Mike Mcanulty; AR
Dave Griffis; AR

Jean Martin; Counsel AR
Mave Gasaway; attorney for AR
Adam Cohen; Counsel for AR
Pat Sampson; Pioneer for AR
Scott Sampson; Pioneer for AR
Scott Bradshaw; TREC
Karen Helfrich; Pioneer for AR
Andy Dare; Pioneer for AR
Scott Sampson; Pioneer for AR
Brad Archibald; Pioneer for AR
Andy Dare; Pioneer for AR
Tina Donovan; Woodardcurran for AR
Ted Duaime; MBMG
Gary Icopini; MBMG
David Shanight, CDM Smith
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Chapin Storrar; CDM Smith
Erin Agee, EPA
Joe Vranka; EPA
Chris Wardell; EPA
Dana Barnicoat; EPA
Charlie Partridge; EPA
Jean Belille; EPA
Ian Magruder; CTEC (Tech Advisor)
Janice Hogan; CTEC
Marissa Stockton; Rosendale State Director
Kristi Carroll; Montana Tech Library

Response to Agency Comments to the
Blacktail Creek Draft Butte Priority Soils Operable Unit (BPSOU) Blacktail Creek Piezometer Installation and Monitoring Well Repair Plan
Prepared for Atlantic Richfield Company
By Pioneer Technical Services, Inc.
Dated June 10, 2022
Date of Comments: June 28, 2022

Comments

> **EPA Comment 1:** *Section 2.3.3 – The Administrative Rules of Montana (ARM) cited requires a minimum of 1.5 inches of seal on all sides of the casing for monitoring wells. It isn't clear if the piezometers installed using the Geoprobe can meet this requirement. Please clarify the diameters of the casing and equipment.*

Atlantic Richfield Company Response:

Blacktail Creek piezometers will be installed using 1.5-inch nominal Schedule 40 PVC pipe and 1.5-inch x 2.5-inch outside diameter (OD) pre-packed well screens as shown on Figure 2. Installation will be completed using the Geoprobe® dual tube soil sampling system using a 3.25-inch outer rod. This installation method will result in approximately 0.7 inches of bentonite seal on all sides of the casing.

Since the direct push methods do not meet the Administrative Rules of Montana (ARM) minimum seal requirement of 1.5 inches, Section 2.3.3 has been revised to remove the reference to ARM 36.21.8. Specific guidance for direct push wells is not included in the ARM water well construction standards due to the direct push methods becoming available after the development of the ARM regulations. Montana Department of Natural Resources and Conservation has verified that the proposed direct push installation methods meet the intent of the ARM seal requirement when following the manufacturer's best practices, and they will not require a construction variance. Installation of Blacktail Creek piezometers will be performed according to Pioneer Technical Service's Standard Operating Procedure (SOP) for groundwater monitoring well design and construction (SOP-GW-11; Appendix A) as described in Section 2.3.3. This SOP meets the manufacturer's best practices for direct push installation of monitoring wells with pre-packed screens.

> **EPA Comment 2:** *Section 4.0 – If the well has not met the development field parameter requirements after 4 hours, the well is not considered to be fully developed. Either the method of development is not appropriate for the well or there is potentially a problem with the well. If the field parameter requirements are not met after 4 hours, discontinue developing and prepare a corrective action plan that will result in the well*

meeting the field parameter requirements. Please revise this section to address this concern.

Atlantic Richfield Company Response:

Section 4.0 has been modified to incorporate the Agency comment. If water quality field parameter stabilization requirements are unmet after 4 hours of developing the well, a corrective action plan will be prepared to correct any issues and result in the well meeting the field parameter requirements.

End of Comments.

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

Final

Blacktail Creek Remediation and Contaminated Groundwater Hydraulic Control Site

Piezometer Installation and Monitoring Well Repair Plan

Prepared for:

Atlantic Richfield Company
317 Anaconda Road
Butte, Montana 59701

Prepared by:

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

July 2022

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LIST OF FIGURES

LIST OF ATTACHMENTS

REVISION SUMMARY

Revision No.	Author	Version	Description	Date
Rev 0	J. Janosko	Draft Final	Issued for Agency Review	06/10/2022
Rev 1	J. Janosko	Final	Issued for Agency Review	07/05/2022

ACRONYMS

Acronym	Definition
ARM	Administrative Rules of Montana
Atlantic Richfield	Atlantic Richfield Company
bgs	Below ground surface
BPSOU	Butte Priority Soils Operable Unit
BSB	Butte-Silver Bow
BTL	Butte Treatment Lagoons
BTC	Blacktail Creek
BTC PM	Blacktail Creek Groundwater Control Project Manager
CAR	Corrective Action Report
CD	Consent Decree
CPM	Contractor Project Manager
DE	Diggings East
EPA	Environmental Protection Agency
GWIC	Groundwater Information Center
MBMG	Montana Bureau of Mines and Geology
PDI ER	Pre-Design Investigation Evaluation Report
Pioneer	Pioneer Technical Services, Inc.
PVC	Polyvinyl Chloride
QA	Quality Assurance
QAM	Quality Assurance Manager
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
RM	Remediation Management
SOP	Standard Operating Procedure
SSHASP	Site-Specific Health and Safety Plan

1.0 INTRODUCTION

This Blacktail Creek (BTC) Remediation and Contaminated Groundwater Hydraulic Control Site Piezometer Installation and Monitoring Well Repair Plan (Installation and Repair Plan) provides the procedures and protocols necessary to install new piezometers and repair an existing monitoring well.

2.0 ADDITIONAL BLACKTAIL CREEK PIEZOMETERS

This section provides procedures and protocols necessary to install 13 additional piezometers to support the BTC Pumping Test. Twelve piezometers are proposed in locations that are radial to the pumping well location (BTC-PW-01), and these piezometers will be paired when installed (i.e., with both a ‘shallow’ and ‘deep’ screened interval): BTC-PZ01-S/D, BTC-PZ02-S/D, BTC-PZ03-S/D, BTC-PZ04-S/D, BTC-PZ05-S/D, and BTC-06-S/D (Figure 1). An additional piezometer (BTC-PZ07) will be installed adjacent to the pumping well to obtain water level measurements near the pumping well. Shallow piezometer screen intervals will be completed in the unpumped aquifer, just below the water table. Deep piezometer screen intervals will be completed in the pumped aquifer at approximately the same interval as the pumping well, BTC-PW-01, as field conditions allow. BTC-PW-01 is screened from 42.5 to 52.5 feet below ground surface (bgs) or approximately 28.5 to 38.5 feet below the water table. With approval from the Contractor Project Manager (CPM), in consultation with the Quality Assurance Officer (QAO), piezometer final locations and installation measurements may be altered by the Field Team Leader.

2.1 Property Access

Butte-Silver Bow (BSB) owns the property where the new piezometers will be installed. Atlantic Richfield Company (Atlantic Richfield) representatives will coordinate access to the property with the BSB Department of Reclamation and Environmental Services prior to commencing work. During field activities, any work related to monitoring wells that are located on private property will use existing access agreements or the Atlantic Richfield Liability Manager (or designated representative) will acquire updated or new access agreements, as necessary. Copies of the access agreement(s) will be placed in the field binder to have on hand during field activities.

2.2 Utility Locates

Utility locates will be performed prior to any ground disturbance activities and will follow Remediation Management (RM) supplier’s procedures for ground disturbance in addition to applicable control measures addressed in the internal Site-Specific Health and Safety Plan (SSHASP). Final utility locates for the work area will be completed by the performing authority prior to any ground disturbance activities.

2.3 Installation

The field team will use a Geoprobe® unit to drill and log boreholes for the purpose of installing the proposed paired piezometers to provide sufficient data at strategic locations surrounding the pumping test well. Pioneer Technical Services, Inc. (Pioneer) anticipates using a 7822DT Geoprobe® rig to drill and install 12 paired shallow/deep piezometers and 1 additional deep piezometer (Figure 1). The equipment used may change based on field conditions and equipment availability. Pioneer will follow the Geoprobe® Standard Operating Procedures (SOPs; Attachment A) to install these piezometers. Additionally, Figure 2 shows the typical piezometer construction details.

2.3.1 Borehole Drilling Procedures

The Geoprobe unit will provide continuous core samples using the dual tube soil sampling system. These core samples are anticipated to be 5 feet in length by approximately 1.5 inches in diameter. To temporarily store the sediment core from the Geoprobe, plastic liners will be used within the inner core barrel to collect the core samples. Each 5-foot length will be properly labeled for storage within appropriately labeled and oriented core storage containers (described further in the next section).

The final depth of each borehole will depend on field conditions, determined by the Field Team Leader, CPM, and QAO based on the observed lithology in the boreholes. Piezometers will be located and completed in aquifer materials inferred to be conductive and hydraulically connected to the targeted pumping zone, where possible. If the depth of a piezometer borehole is installed deeper than the screen depth of the piezometer, a second borehole may be drilled to install the piezometer.

The following general procedures will be performed at each borehole location (at the required depth intervals). Note that this list is not intended to be complete. Detailed drilling procedures are outlined in the Geoprobe SOPs in Attachment A.

- Prepare Geoprobe unit for operation: decontaminate drilling tools and sampling equipment, level rig, prepare the down-hole tool, and establish the drill location.
- Begin advancing the core barrel. Advance the core barrel to collect the core sample, then retrieve the inner core barrel to recover the core sample. Continue adding core barrel segments and collecting core samples until desired depth is reached.
- Decontaminate the drill rig core barrel(s) between samples by rinsing with tap water and/or using a high-pressure washer.

2.3.2 Lithology Logging

The continuous core samples will be examined to produce a detailed lithologic characterization log of the subsurface materials at each borehole location. For paired piezometers, classification and lithology of the core from the deeper boreholes will be logged and photographed following the general procedures presented in SOP-Geoprobe-06 Geoprobe Dual Tube Sampling System and SOP-S-12 or SOP-S-13. The core for the single piezometer, BTC-PZ07, will also be logged and photographed following the same procedures. The soil classification and lithology of the core from the deeper piezometers will be used to select the screen depth for the deep and shallow piezometers.

The core will be placed in properly labeled sample core boxes for transport (the labels will include location, depth interval, and core orientation). It is imperative that the core sample is marked clearly and is carefully transported horizontally, as it may be used for further observation. Sediment cores will be stored in their entirety (in increments) at the Pioneer field office at 244 Anaconda Road in Butte, Montana, or an alternate suitable location. When it has been determined that enough sample is present for design-related purposes, additional samples will be shared with other parties, transferred off the Site, or disposed of appropriately. Refer to SOP-DE-03 Investigation Derived Waste Handling (Attachment A) for further information on handling investigation derived waste.

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

- Field logbook and pens.
- Field data sheets and forms (Attachment B).
- Measuring tape.
- Unified Soil Classification System chart (ASTM D-2488; Attachment B).
- Sieve.
- Sample containers and labels.
- Core boxes.
- 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 and SOP-DE-02A in Attachment A).
- Digital camera and/or digital video camera.
- Appropriate safety personal protective equipment.

2.3.3 Installing Piezometers

Final piezometer locations will be adjusted in the field, as necessary, to allow for safe installation and monitoring as well as property access. Installation will be completed according to the requirements SOP-GW-11 Groundwater Monitoring Well Design and Construction, included in Attachment A. The primary Contaminants of Concern will be metals in groundwater; therefore, polyvinyl chloride (PVC) material will be appropriate for piezometer casing. Piezometers will be constructed using pre-pack well screens and details for piezometer construction are provided on Figure 2. The procedures below assume that a Geoprobe unit will be used to install the piezometers. These procedures may change based on field conditions and equipment availability.

The target depth for the piezometer screen will be determined by the Field Team Leader, CPM, and QAO. Equipment, materials, and supplies used to install the piezometer are outlined in Geoprobe SOPs (Attachment A).

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

- Time and date installed.
- Borehole, casing, and screen diameters.
- Bottom cap length.
- Boring depth (plus or minus 0.1 foot) in relation to the ground surface.
- Well depth (plus or minus 0.1 foot) in relation to the ground and final measuring point.
- Lithology logs (lithology collected at deeper piezometer locations will be used for paired piezometer lithology logs).
- Casing materials.
- Screen size, slot size, length, and depth to top and bottom of screen from ground surface.
- Filter pack material, size, and thickness in relation to the ground surface.
- Seal thickness and depth below ground in relation to the ground surface.
- Depth to groundwater at time of completion, in relation to the ground and final measuring point.
- Survey-grade X and Y coordinates and elevations for the measuring point (marked on the north side of the PVC casing), top of protective casing, and ground surface (SOP-G-01 and SOP-SURVEY-01 in Attachment A).

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

If any boreholes or piezometers need to be abandoned in place, the field team will follow the procedures in Pioneer SOP-GW-18 Groundwater Monitoring Well Abandonment (Attachment A). Details of borehole and/or well abandonment may be modified by the Field Team Leader, CPM, and QAO if necessary.

3.0 EXISTING MONITORING WELL BPS11-10A

This section provides the procedures and protocols necessary for Atlantic Richfield to assess damage and preferentially repair or, if repair is not possible, abandon and replace monitoring well BPS11-10A. Monitoring well BPS11-10A was installed in 2011 and has served as a long-term monitoring well until it was struck by a vehicle in August 2020, and the casing was bent, rendering the monitoring well unusable (Atlantic Richfield Company, 2011 and Atlantic Richfield Company, 2022).

3.1 Property Access

Monitoring well repair or abandonment and replacement activities will take place on Atlantic Richfield property within the Diggings East (DE) Site.

3.2 Utility Locates

Utility locates will be performed prior to ground disturbance activities and will follow RM supplier's procedure for ground disturbance in addition to applicable control measures addressed in the internal SSHASP. Final utility locates for the work area will be completed by the performing authority prior to ground disturbance activities, including repair of BPS11-10A.

3.3 Repair

Repair of the monitoring well is the preferred alternative to maintain groundwater monitoring continuity and reduce disturbance to the subsurface. The location of the existing monitoring well is shown on Figure 1. The monitoring well will be repaired or replaced, as feasible, to match the existing configuration of the well prior to being damaged as closely as possible (see Figure 3 and Figure 4). The following alternatives are proposed for monitoring well BPS11-10A:

- If the monitoring well is salvageable, it will be repaired by removing the external casing, either replacing at the closest, accessible threaded joint (if possible) or cutting the internal casing below the damaged section, and gluing on a new section of 2-inch Schedule 40 PVC pipe using a PVC coupling. The external casing will be reinstalled, the well will be redeveloped to remove accumulated sediment, and a new measuring point surveyed as outlined below (Section 6.0).
- If the damaged section cannot be accessed or repaired, the monitoring well will be replaced and the existing well will be abandoned. A replacement well will be installed to match the configuration of the well prior to being damaged as closely as possible (see Figure 3) as outlined in the next section.

3.4 Abandonment and Replacement

If repair is not feasible, the replacement well (BPS11-10AR) will be installed a minimum of 10 feet away from the original structure to avoid subsurface disturbance and will be installed using either a vibratory roto-sonic drilling rig or Geoprobe unit. The exact location of the well will be adjusted in the field, as necessary, to allow for safe installation and monitoring as well as property access. Installation will be completed according to the requirements of Administrative Rules of Montana (ARM) 36.21.8, monitoring well construction standards. The replacement well will be constructed of 2-inch diameter, schedule 40 PVC well casing with a 10-foot section of screen (set as close as possible to the original screen interval of 10.67 to 21.67 feet bgs), and a solid riser section from 3 feet above ground to 11 feet bgs. The well will include surface casing and will be secured with a 4-inch to 6-inch diameter steel protective casing with concrete collar. The well will have a factory pre-pack screen, and additional sand completion to about 10 feet bgs, where a bentonite seal will be added to the annulus to the depth of about 1 foot bgs.

The borehole for the replacement monitoring well (BPS11-10AR), if necessary, will extend to match the depth (21.67 feet bgs) of the existing BPS11-10A well. Lithology will be logged to confirm subsurface conditions at the new location and compared to the existing, damaged well. The target depth for the well screen is 10.67 to 21.67 feet bgs, which may be modified based on field conditions. Well installation procedures and generation of a new monitoring well log will be performed, if necessary, according to SOP-GW-18 (Attachment A).

Monitoring well abandonment, if necessary, will be completed according to the requirements of ARM 36.21.810, permanent abandonment of wells, and according to Pioneer's SOP-GW-18 Groundwater Monitoring Well Abandonment (Attachment A). The surface casing and concrete collar will be removed and disposed of, and the well casing will be cut or driven so that the top of the casing is a minimum of 3 feet bgs. The well casing will be sealed from bottom to top with bentonite grout. If the monitoring well is abandoned, a licensed monitoring well constructor will submit a Montana Well Abandonment Report (Attachment C) to the Montana Bureau of Mines and Geology (MBMG) within 60 days of abandonment so the Groundwater Information Center (GWIC) database can be updated.

4.0 DEVELOPMENT

Newly installed piezometers and BPS11-10A (or BPS11-10AR) will be developed following the general procedures detailed in SOP-GW-12 Well Development Using a Modified Over Pumping Technique (Attachment A). The piezometers and well will be considered developed when 3 consecutive readings for turbidity are below 5 Nephelometric Turbidity Units or are within 10% of each other. If stability criteria are unmet after 4 hours of development, development will be discontinued and a Corrective Action Report (CAR) (Section 7.2) will be prepared with the goal of meeting stability criteria. The water quality parameters are considered stable when 3 consecutive readings are as follows:

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

Development water will be transported to a holding tank and then taken to the Butte Treatment Lagoons (BTL) drying beds for disposal. Refer to SOP-DE-03 Investigation Derived Waste Handling (Attachment A) for further information on handling investigation derived waste.

5.0 DECONTAMINATION

All drilling, well development, and related equipment required to complete the work will be decontaminated before and after use by the contractor using procedures outlined in SOP-GEOPROBE-10 Equipment Decontamination for Inorganic Contaminants, SOP-DE-01 Personal Decontamination, and SOP-DE-02 Equipment Decontamination. Decontamination water will be transported via a holding tank to the drying beds at BTL following procedures outlined in SOP-DE-03 Investigation Derived Waste Handling (Attachment A).

6.0 WELL SURVEY AND DOCUMENTATION

After development is completed, top of newly installed PVC casings will be cut level and measuring points will be clearly marked on the north side of the PVC casing. Newly installed piezometers and the repaired or replaced well will be surveyed at ground surface elevation and measuring point (within plus or minus 0.01 feet) per SOP-SURVEY-01 Staking and Surveying (Attachment A). A licensed monitoring well constructor will submit a Montana Well Log Report (Attachment D) to the MBMG within 60 days of installation so the GWIC database can be updated. Once the installation is completed, the revised or new monitoring well log will be provided to all contractors using the monitoring well, so it may be updated in appropriate sampling plans and/or QAPPs.

7.0 ASSESSMENT AND OVERSIGHT

7.1 Field Activities Oversight

Atlantic Richfield will provide oversight personnel to oversee all field activities for installation of additional piezometers and repair or abandonment/replacement of BPS11-10A. Assessment and oversight of installation activities are designed to verify that infrastructure installation is performed in accordance with the procedures established in this Installation and Repair Plan. The audits of field and laboratory activities include two independent parts: internal and external audits. Internal audits will be performed by Atlantic Richfield, or their contractor. External audits will be performed by the Environmental Protection Agency (EPA), or designated representative, as necessary.

Agency oversight personnel will have the ability to inspect each piezometer completion interval and verify that the appropriate installation and documentation are performed. Copies of field logbook pages and completed soil logs may be made available to Agency oversight personnel during installation activities.

Any deviations from this plan will be brought to the attention of Agency oversight personnel. If the deviation is first determined by Agency 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 Agency oversight personnel request a deviation from the plan, the deviation and the reasons for the deviation will be noted and then signed by the Agency personnel.

7.2 Corrective Action Procedures

Corrective action is the process of identifying, recommending, approving, and implementing measures to counter unacceptable procedures. Corrective actions implemented by field personnel will follow appropriate field SOPs (Attachment A), as necessary.

Corrective actions to address unsatisfactory conditions will be taken in consultation with the Project Manager/QAO and reported on a Corrective Action Report (CAR) form (Attachment B). If corrective action requests are not in complete accordance with approved project planning documents, EPA will be consulted, and concurrence will be obtained before the change is implemented. All corrective action records will be included with the plan records.

8.0 HEALTH AND SAFETY

All work completed by Pioneer and its subcontractor(s) during the execution of the Installation and Repair Plan will be performed in accordance with all procedures outlined in the BTC Pumping Test SSHASP. Potential hazards associated with this work include the following:

- Drilling activities.
- Late or long hours associated with infrastructure installation.
- Working around heavy equipment hazards.
- Exposure to heavy metals from impacted soil and groundwater.

Site-specific hazards and applicable control measures will be addressed in the SSHASP. All tasks will be risk assessed prior to starting work. All field personnel will have a current certification for the 40-hour Occupational Safety and Health Administration Hazardous Waste Site and Emergency Response Training. Current certification records will be maintained at Pioneer's headquarters at 1101 S. Montana Street in Butte, Montana.

In a project meeting held prior to fieldwork, all field personnel will review this BTC Installation and Repair Plan and receive any specified training. Field personnel will review procedures and requirements prior to field activities and will be trained in how to properly use field equipment and complete activities according to field data collection SOPs in Attachment A.

The Field Team Leader will review the internal 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 SSHASP review will cover all other safety aspects related to the Site including personnel responsibilities and contact information, additional safety requirements and procedures, and the emergency response plan. The Field Team Leader will be responsible for training field personnel on how to calibrate field measurement instruments. The Field Team Leader will be experienced in the use and calibration of the equipment that will be used and responsible for training and overseeing the support staff. One hard copy of the current approved version of the BTC Installation and Repair Plan will be maintained for reference purposes in the field vehicle and/or field office. All field team personnel will have access to electronic PDF files of all documents pertaining to fieldwork.

9.0 PROJECT ORGANIZATION

9.1 Roles, Duties and Responsibilities

The roles, duties, and responsibilities of personnel assigned to the Installation and Repair Plan are provided below. An organizational chart showing the overall organization of the project team is shown on Figure 5.

Atlantic Richfield Liability Manager – Josh Bryson

The Atlantic Richfield Liability Manager communicates directly to the Agencies on project matters, monitors the performance of the contractor(s), consults with the Groundwater Remedy

Project Manager (BTC PM), CPM and QAO on deficiencies, and helps finalize resolution actions.

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

The Atlantic Richfield QAM interfaces with the Atlantic Richfield Liability Manager on company policies regarding quality and has the authority and responsibility to approve specific quality assurance (QA) documents including the BTC Pumping Test QAPP.

Blacktail Creek Groundwater Control Project Manager (BTC PM) – Brent Lucyk (Stantec)

The BTC PM maintains consistency in the direction of work performed across the groundwater remedy program as part of the Butte Priority Soils Operable Unit (BPSOU) Consent Decree (CD). The BTC PM is responsible for verifying that the work meets the requirements set forth in the BPSOU CD and is consistent with the overall project schedules and goals of the groundwater remedy optimization efforts. The BTC PM will serve in an advisory role to the CPM and QAO with respect to meeting project goals, evaluating the significance of any changes or field decisions as they fit into BPSOU CD work progression, and maintaining consistency between interrelated projects.

Contractor

Pioneer is the Contractor responsible for conducting the elements of the piezometer installation and monitoring well repair or abandonment and replacement under the direction of Atlantic Richfield and Stantec.

Contractor Quality Assurance Officer (QAO) – Adam Logar

The QAO is responsible for verifying effective implementation of QAPP requirements and procedures, including reviewing field and laboratory data, and evaluating data quality. The QAO may conduct on-site reviews and prepare site review reports for the QAM. The QAO will have a direct line of communication to the QAM to resolve issues related to project QA.

The 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 quality controls or approved methods and further work would make it difficult or impossible to obtain acceptable results.

Pioneer Contractor Project Manager (CPM) – Jackie Janosko

The CPM is responsible for scheduling 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 and verifying effective implementation of plan requirements and procedures. This includes reviewing data collected in the field.

Pioneer Field Team Leader – Drew Conrady

The Field Team Leader verifies that this Plan and any associated requests for changes have been reviewed by all members of the field team and procedures herein 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, managing equipment, and coordinating with the CPM and 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 work activities to maintain compliance with technical project requirements and the SSHASP. The Field Team Leader is responsible for identifying potential Integrity Management issues during field activities and reporting any issues to the QAO.

Safety and Health Manager – Tara Schleeman

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

Subcontractor – Hunter Brothers Construction

Hunter Brothers Construction, or equivalent, will subcontract to Pioneer and follow all health and safety protocols established by Pioneer to work on the Site. Hunter Brothers Construction will assist with repair and redevelopment of BPS11-10A and hydro excavate select new piezometer locations, as determined necessary by the Field Team Leader, in consultation with the CPM and QAO.

9.2 Authority to Stop Work

All personnel, including third parties, have the authority, obligation, and responsibility to stop work for situations involving imminent danger to health and safety of personnel and/or environment. Safety takes precedence over schedule. Personnel have stop-work authority in circumstances where, if in the judgment of that individual, work is performed contrary to controls, safety requirements, or approved methods described in the SSHASP or herein. Upon notice of stop work, the initiator will immediately notify the affected workforce and the immediate supervisor. Communication from the immediate supervisor to additional affected parties will follow the line of communication shown on Figure 5. Problems and associated corrective actions will be documented on a CAR (Attachment B).

10.0 SCHEDULE

Fieldwork will begin once Agency approval has been received. Infrastructure installation described in this plan is anticipated to take approximately four weeks. Work will be performed as weather conditions permit. Potential constraints that could delay fieldwork include adverse weather conditions, contractor availability, coordination with land managers/users, challenges with drilling caused by Site conditions, or other unforeseen issues. Major project delays resulting from these constraints will be recorded in the field logbooks and reported to the Agencies.

11.0 REPORTING

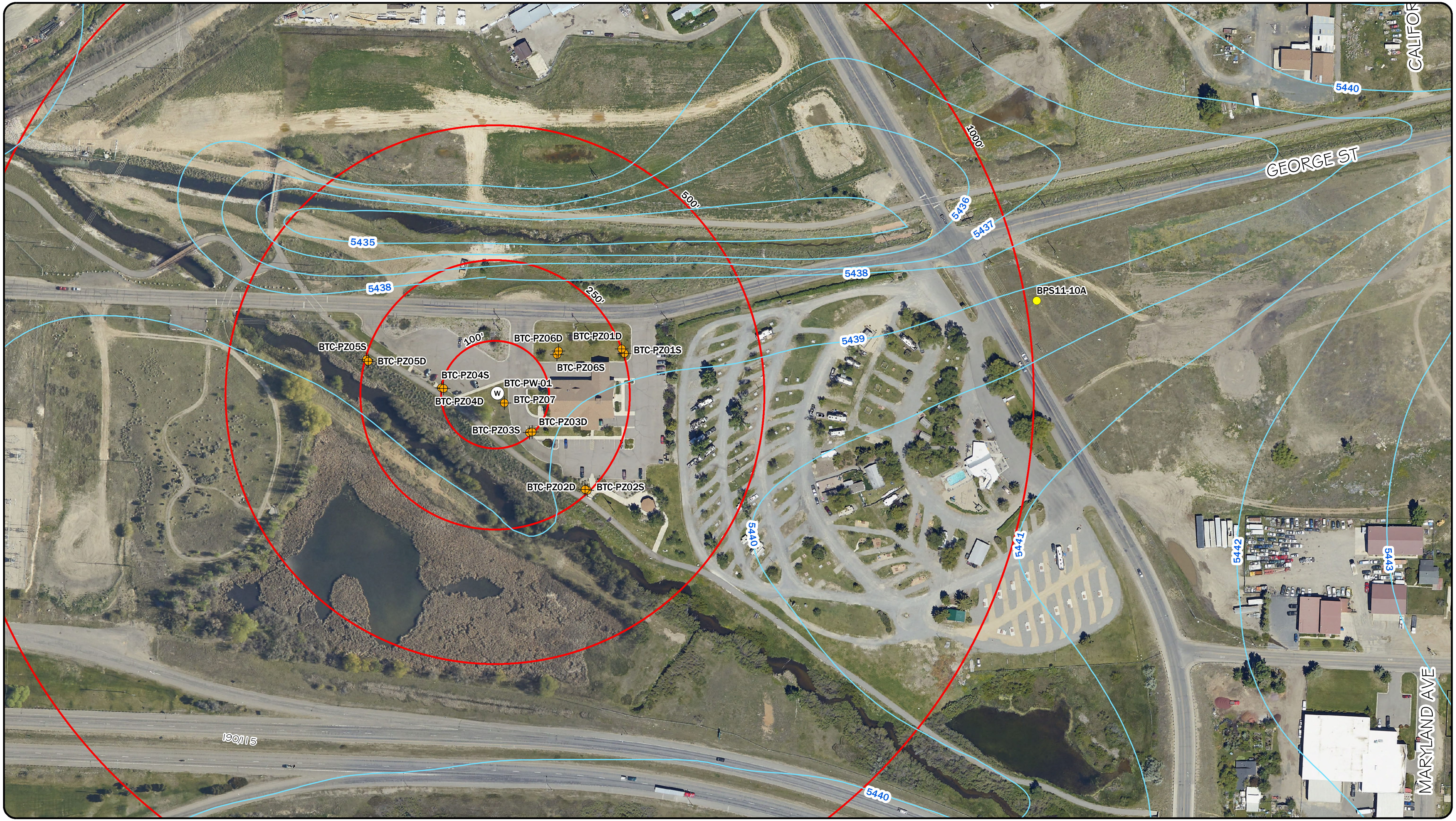
Montana Well Log Reports will be submitted to MBMG to update the GWIC for all newly installed piezometers and the repaired or replaced monitoring well as described in Section 6.0. All additional reporting, such as the summary of all infrastructure installed, as well as new and/or revised well logs generated by activities described herein, will be included in the BTC Pumping Test PDI ER as described in BTC Pumping Test Investigation QAPP (Atlantic Richfield Company, 2021).

12.0 REFERENCES

Atlantic Richfield Company, 2022. 2021 Butte Priority Soils Operable Unit (BPSOU) Draft Groundwater Monitoring Data Summary Report January 2021 – December 2021. Atlantic Richfield Company. April 2022.

Atlantic Richfield Company, 2011. Butte Priority Soils Operable Unit Silver Bow Creek/Butte Area Superfund Site Draft Ground Water Monitoring Well Installation Plan. November 2011.

FIGURES



LEGEND

- W Pumping Well
- Proposed Piezometers
- BPSOU Monitoring Well Repair or Replacement Location
- Radius in Feet
- Shallow Groundwater Contours March 2012 (ft)

N

DISPLAYED AS:
PROJECTION/ZONE: MSP
DATUM: NAD 83
UNITS: INTL FT
SOURCE: PIONEER/QSI 2020

0 125 250
Feet

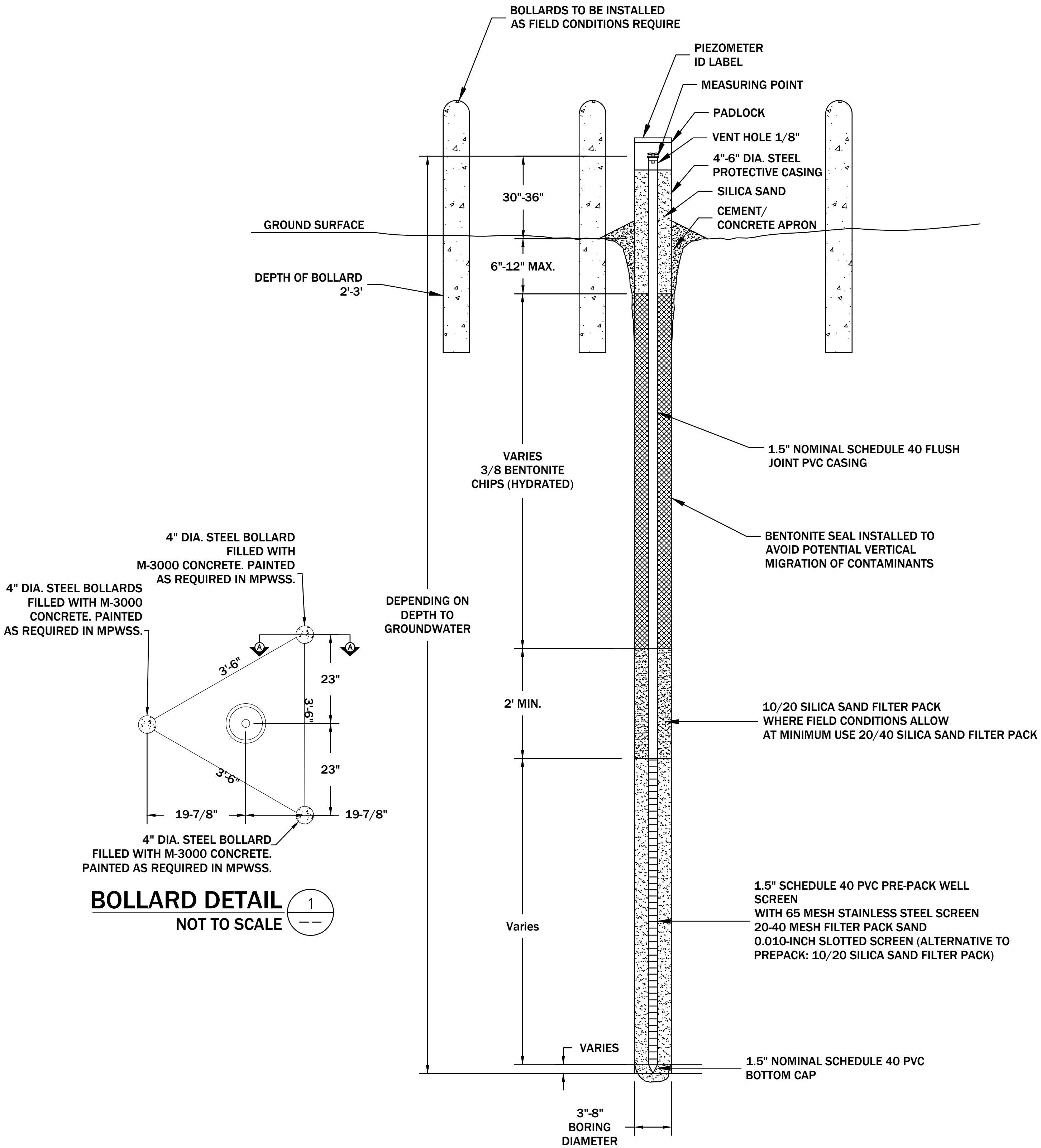
FIGURE 1

PIONEER TECHNICAL SERVICES, INC.

DATE: 5/20/2022

BTC PIEZOMETER AND MONITORING WELL REPAIR LOCATIONS

Path: Z:\Shared\Active Projects\ARCO\BPSOU\BTCPumpingTest\GIS\RFC\InstallationPlan_001_22.mxd



DISPLAYED AS:	
COORD SYS/ZONE:	N/A
DATUM:	N/A
UNITS:	N/A
SOURCE:	PIONEER

SCALE IN FEET
0 NTS

FIGURE 2

PIONEER TECHNICAL SERVICES, INC.

BTC PIEZOMETER CONSTRUCTION DETAILS

DATE: 5/2022

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PIONEER TECHNICAL SERVICES, INC.

Well Log

Well Name: BPS11-10A

Project: 2011 BPSOU MWIP		Location: Butte, Montana	
Well Owner : Atlantic Richfield Co.		Depth to Water: 12.84 ft	Date: 2/15/2012 Time: 11:19
Drilled by: Environmental West	Silica Sand Size: 10-20	Casing Type/Dia: PVC/2.0"	Screen Slot Size: 0.020"
Drilling Method: Roto-Sonic	Bentonite Seal: 3/8" chips	Screen Type/Length: PVC Machine Slot/10'	Borehole Dia: 6.0"

XRF Data From Collected Core

Cd, Zn, Ni, Ca, Mn, K, Cu, Fe

Concentration (mg/kg) Log Scale: 1, 10, 100, 1000, 10000, 100000

Particle Size Distribution

1"=30%

Gravel, Coarse; Sand, Coarse; Sand, Fine; Clay; Gravel, Fine; Sand, Medium; Silt

Percent (%): 0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100

Depth (ft) | Elevation (NGVD 29) | Lithology Log | Lithology Description | Well Construction

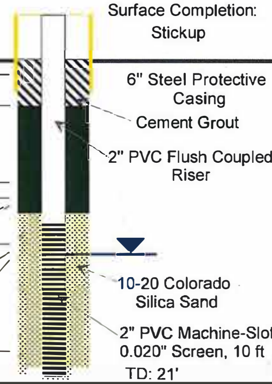
TOC Elevation: 5451.74 ft (NGVD 29)
5456.1 ft (NAVD 88)

Logged by: W. Goldberg

Stickup: -2.92 ft

Ground Level

Depth (ft)	Elevation (NGVD 29)	Lithology Description
	5,450	
0		TOPSOIL
		FILL, CONCRETE, BRICK, SILTY SAND
5	5,445	NO RECOVERY
	5,440	SAND, FINE ANGULAR QUARTZ GRAINS, TRACE MICA
		CLAY, COHESIVE, OLIVE
10		ORGANIC SILT, BLACK, PLANT FRAGMENTS
		CLAY, COHESIVE
		SILTY SAND WITH TRACE SUBROUNDED GRAVEL
15	5,435	NO RECOVERY
20	5,430	SAND, FINE TO MEDIUM, OXIDIZED, MAGNETIC. PIECE OF SHEETMETAL AT 18'.



Concrete Collar Elevation: 5448.82 ft. (NGVD 29)
5453.18 ft. (NAVD 88)
Well Completion Date: 12/17/2011
Screen Interval: 10.67-20.67 ft. Filter Pack Interval: 10-21 ft.

Driller: J.R. Cantrell   Monitoring Well License: #451
Signature ____________

Well Construction Key: Bentonite; Riser; Cement Grout; Slough; Steel Casing; Filter Pack; Screen

Lithology: Ash; Asphalt; Clay; Clayey gravel; Clayey sand; Clayey Sand, some gravel; Clayey silt; Fill; Granite; No Recovery; Organic silt; Residual weathered granite; Sand; Sand, oxidized; Sand and gravel; Sand and gravel, oxidized; Sand, some gravel; Sand, some gravel oxidized; Sandy clay; Sandy silt; Sandy silt, some gravel; Silt; Silt, oxidized; Silty Clay; Silty Clay, oxidized; Silty Clay, some gravel; Silty sand; Silty Sand some gravel; Slag; Tailings; Topsoil; Weathered granite

Latitude (NAD83):45.99490361 (Dec. Degrees)
Longitude (NAD83):-112.53031392 (Dec. Degrees)
Northing (SP-N83):651084.16 ft. (IF)
Easting (SP-N83):1198834.6 ft. (IF)
T3N R8W S24

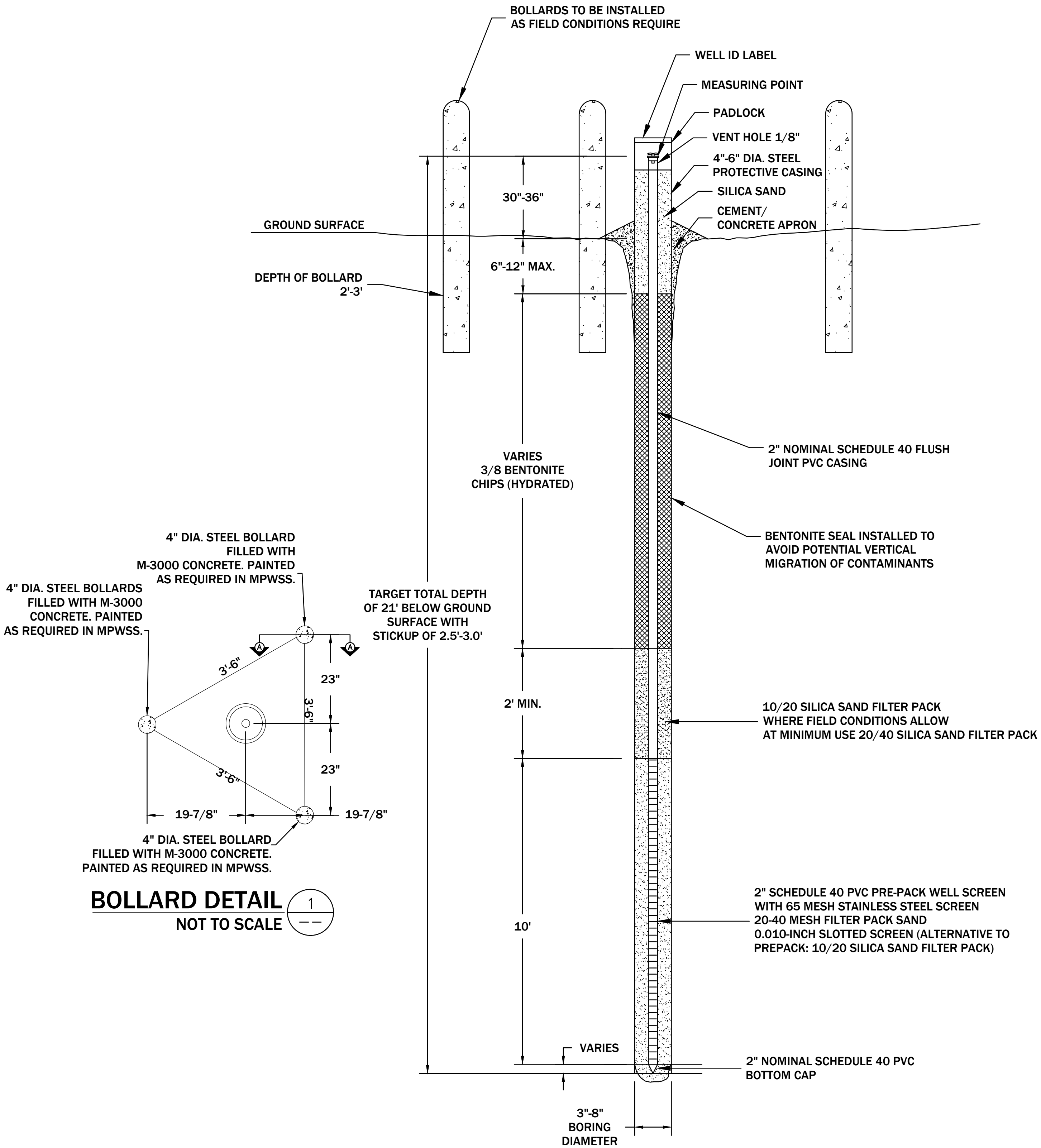
GWIC ID # 264087

FIGURE 3

BPS11-10A
MONITORING WELL LOG

PIONEER TECHNICAL SERVICES, INC.

DATE: 5/9/2022



DISPLAYED AS:	
COORD SYS/ZONE:	N/A
DATUM:	N/A
UNITS:	N/A
SOURCE:	PIONEER

SCALE IN FEET
0 NTS

FIGURE 4

PIONEER TECHNICAL SERVICES, INC.

BPS11-10A WELL REPLACEMENT CONSTRUCTION DETAILS

DATE: 5/2022

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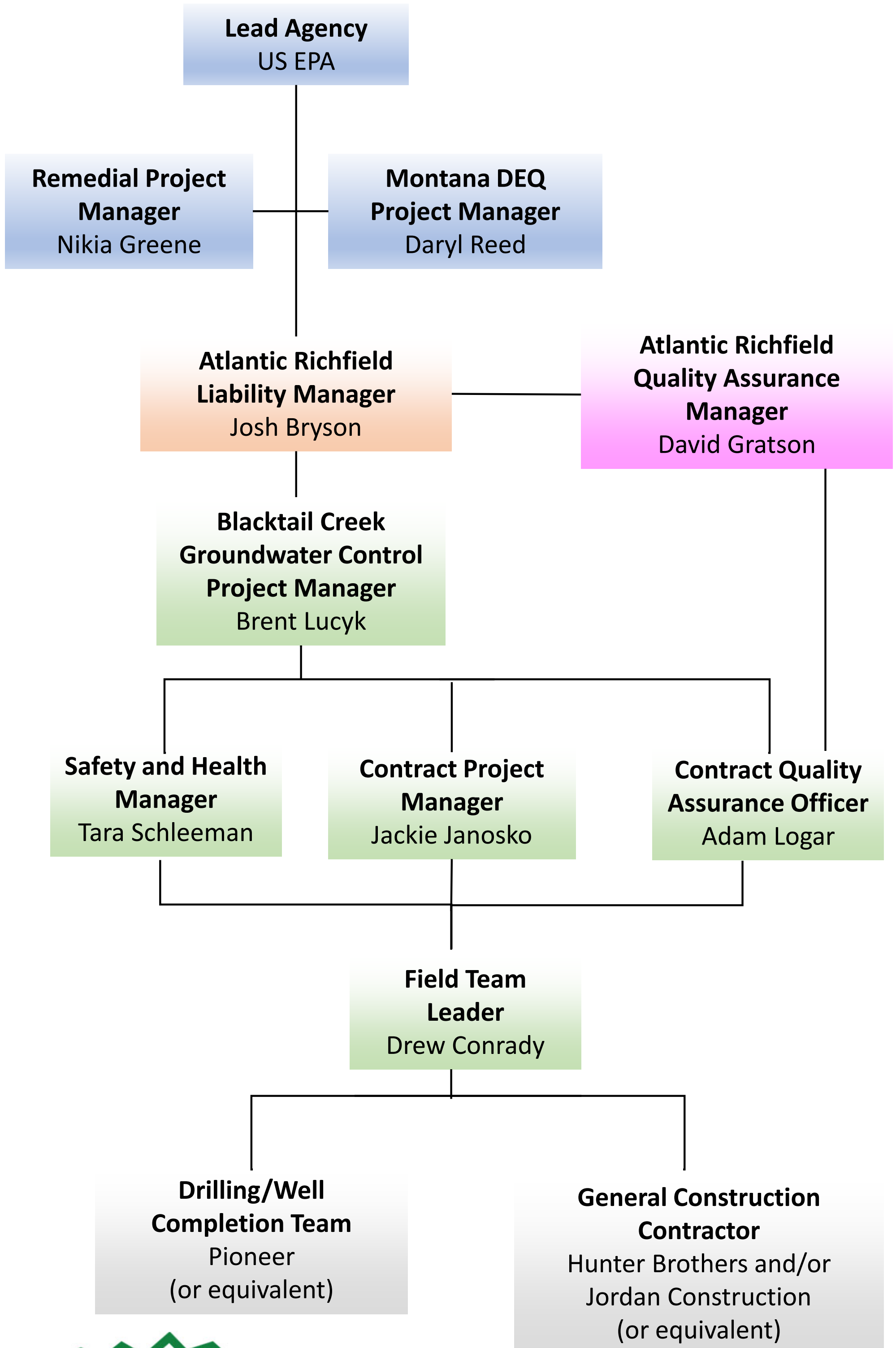

PIONEER TECHNICAL SERVICES, INC.

Figure 5: Project Organizational Chart

Attachment A
Standard Operating Procedures

SOP Number	Title	Version
SOP-GEOPROBE-01	Mobilization and Loading/Unloading the Geoprobe	11/16/2020
SOP-GEOPROBE-02	Pre and Post Job inspection	11/16/2020
SOP-GEOPROBE-03	Starting and Stopping the Kubota Engine	11/16/2020
SOP-GEOPROBE-04	Driving and Positioning the Geoprobe Model 7822DT	11/16/2020
SOP-GEOPROBE-05	Geoprobe® DT-22 Dual Tube Sampling System	11/16/2020
SOP-GEOPROBE-06	Geoprobe® DT-325/375 Dual Tube Sampling System	11/16/2020
SOP-GEOPROBE-07	Operating the Geoprobe® During Probing Operations	11/16/2020
SOP-GEOPROBE-09	DH133 Automatic Drop Hammer	11/16/2020
SOP-GEOPROBE-10	Equipment Decontamination – Inorganic Contaminants	03/30/2022
SOP-DE-01	Personal Decontamination	03/30/2022
SOP-DE-02	Equipment Decontamination	09/08/2020
SOP-DE-02A	Equipment Decontamination – Pumps for Well Sampling	03/29/2022
SOP-DE-03	Investigation Derived Waste Handling	04/12/2022
SOP-GW-11	Groundwater Monitoring Well Design and Construction	04/23/2018
SOP-GW-12	Well Development Using a Modified Over-Pumping Technique	04/10/2018
SOP-GW-18	Groundwater Monitoring Well Abandonment	03/17/2017
SOP-S-12	Sampling Soil from a Geoprobe Liner	11/18/2020
SOP-S-13	Sampling Core from Sonic Drill	11/16/2020
SOP-SA-05	Project Documentation	04/14/2022
SOP-SURVEY-01	Staking and Surveying	10/24/2016

PURPOSE	To provide standard instructions for mobilizing and loading/unloading the Geoprobe® Model 7822DT.
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
Trailer hook-up	1. Turn on the diesel work truck to allow the glow plugs to warm up. To warm the glow plugs, turn the ignition switch to the first setting on the truck and there will be a light on the dashboard that looks like a pig tail. When this light goes off, the glow plugs are warmed, and the truck can be started. 2. Before backing up the truck, ensure that the gooseneck is high enough that it won't hit the truck when backing up. Using a spotter, back the truck up so the ball on the truck's hitch is right below the coupler on the trailer hitch. 3. When the ball of the truck's hitch is located under the coupler on the trailer, ensure that the coupler is unlatched. To do this, make sure the pin, which is normally locked in the down position is raised up and flipped over into the catch and you will see it has locked in the up position. 4. Turn the front trailer jack's crank counterclockwise to lower trailer onto the truck's hitch . 5. To make sure coupler is latched securely to ball, swing pin out of the catch and let it drop straight down through the hole in the plate and then swing it to the side. 6. When the trailer is locked to the truck's hitch, pull the clip and safety pin from the front jack's foot plate and move the spring-loaded foot plate up into the jack and replace the safety pin and clip. 7. Attach the trailer's safety chains and break away system to the truck's hitch system. 8. Inspect and attach the trailer's brake and trailer's lights cord to the power output connection on the truck. Verify that the trailer's lighting and braking system are

	working. 9. Ensure that the trailer's doors are all locked during transport. 10. Verify that all jacks (two on the front of the trailer) are up off the ground and secured. Also verify that the safety chains, pins, and power cord are attached and secured. 11. Remove the chocks out from under the trailer's tires and place them in the back of the truck. The Geoprobe® trailer is now ready for mobilization to and from job sites.
Unloading the Geoprobe®	1. Park the trailer on level ground. Set the parking brake on the truck and place tire chocks under the front and rear of one set of trailer's tires. Verify that the trailer's hitch is securely fastened to the truck. 2. Remove the safety pin and then pull down the spring assisted ramps. 3. Take the front and back ratchet straps off of the Geoprobe®. 4. Start the Geoprobe® and allow its fluids sufficient time to warmup to prevent unnecessary wear on the engine and hydraulic systems. While the Geoprobe® is going through the warmup, the system will lock out the Geoprobe® so that it can't be moved until the warmup is completed. 5. Prior to backing out of the trailer, ensure the blade and/or toolbox are raised so that they do not drag or get caught on anything during the unloading process. Slowly back the Geoprobe® out of the trailer using the remote control. For proper alignment, split the middle of the two tracks when unloading the Geoprobe®. Use the slow speed on the remote control when unloading the Geoprobe® from the trailer. **Note:** when the Geoprobe's center of gravity is at the end of the trailer, the front portion of the tracks will lift off the trailer's floor and the back portion of the tracks will lower onto the ramps, however the operator is controlling the Geoprobe® from the remote control and is not operating the Geoprobe® from a driver's seat on the machine. 6. Back the Geoprobe® 4 to 5 feet off the ramp and perform the pre-job inspection. Refer to SOP-GEOPROBE-02 Pre-Job and Post-Job Inspection for this procedure.
Loading the Geoprobe®	1. Perform the post-job inspection per SOP-GEOPROBE-02 Pre-job and Post-job Inspection as necessary. 2. Connect the truck to the trailer and park the trailer on level ground. Set the truck's parking brake and place tire chocks under the front and rear of one set of trailer's tires.

	3. Remove the safety pin and then pull down the spring assisted ramps. 4. Cool down of the Geoprobe® may be necessary before loading into the trailer. There are two fans that are used to cool the machine and will be visible on the control panel if they are turned on. If either fan is operating, do not turn off the Geoprobe®. The fans will turn off automatically when the Geoprobe® reaches the necessary cool down temperature. 5. Slowly move the Geoprobe® forward into the trailer using the remote control. For proper alignment, split the middle of the two tracks when loading the Geoprobe®. Ensure the Geoprobe® blade is up as high as it can go so the job box does not drag or get caught during the loading process. Use the slow speed on the remote control when loading the Geoprobe® into the trailer. 6. Flip the spring assisted Ramps back up and put the safety pin back in place. Loading the Geoprobe® is complete.
Securing the Geoprobe® in the trailer	1. Ensure the Geoprobe® is centered in the trailer. Refer to SOP-GEOPROBE-04 Driving the Geoprobe® Model 7822DT for driving procedures. 2. Make sure the Geoprobe® tracks are 3-4 inches in front of where the black strips start on the trailer floor. This will put the Geoprobe® in an optimal position for weight distribution on the trailer axles and tongue. 3. Attach the two front ratchet straps to the front strap connection on the Geoprobe® and the front strap rings located on the floor towards the front of the trailer. Tighten the ratchet strap so there is no slack in the strap. 4. Attach the two ratchet straps to the back-strap rings located at the rear of the trailer. Tighten the strap so there is no slack in the strap.

HSSE CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.				
SOURCE	***HAZARDS***	***WHERE***	***HOW, WHEN, RESULT***	***CONTROLS***
CHEMICAL	Hydraulic fluid and diesel.	Geoprobe®.	Employees could be exposed to hydraulic fluid and/or diesel via inhalation, ingestion and skin/eye contact, when operating the Geoprobe®, or if equipment malfunctions resulting in adverse health effects.	Employees will wear work gloves and safety glasses, if contact with hydraulic fluid/diesel is possible. In the event of a spill/leak, personnel will contain the fluid using the spill cleanup material available in the Geoprobe's trailer. Cleanup materials will be disposed of according to state's regulations. All components of the Geoprobe® will be inspected prior to and at the completion of the task. Non-essential personnel will maintain a 20-foot buffer zone around the equipment.
NOISE	Elevated noise levels.	Geoprobe®.	Employees could be exposed to elevated noise levels when driving the Geoprobe® resulting in irritability, decreased concentration, and noise-induced hearing loss.	Personnel within a 20-foot buffer of the Geoprobe® will wear single hearing protection (e.g., ear muffs). Non-essential personnel will maintain a 20-foot buffer zone around the Geoprobe®.
ELECTRICAL	Defective electrical lines.	Geoprobe®.	Contact with defective electrical lines could result in personal injury.	Inspect electrical lines of the Geoprobe® prior to and at the completion of the task.
BODY MECHANICS	Not Applicable			

GRAVITY	Falls from slips and trips.	Uneven terrain, slick/muddy/wet surfaces and steep slopes.	Walking 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. Employees will plan their path and walk cautiously. Keep work area free of tools/rods. If conditions are wet/muddy, muck boots may be worn.
	Geoprobe® falling off of ramps.	Geoprobe®.	The Geoprobe® could fall off of the ramps when loading/ unloading it resulting in personal injuries and/or property damage.	Use a spotter when loading/unloading the Geoprobe®. Workers will use special caution when loading the Geoprobe® onto a trailer with wet ramps. It is significantly easier for the tracks to slip under such conditions.
WEATHER	Cold/heat stress.	Outdoors.	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 (e.g., layers). 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.	Sites.	Electrocution, injury, death, or equipment damage could be caused by lightning strike.	Employees will follow the 30/30 rule during lightning storms. When the Geoprobe® is running, the Geoprobe's helper will watch for thunder/lightning.
RADIATION	Ultraviolet (UV) radiation.	Outdoors.	Employees could be exposed to UV radiation during	Employees will wear safety glasses with tinted lenses, long-sleeve work shirts, and long

			summer months causing sun burns, skin damage, and eye damage.	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 should notify their supervisor.
MECHANICAL	Backing up the work truck.	Sites.	Incidents could occur when backing up the work truck to connect the trailer to the truck resulting in personal injury and/or property damage.	Use a spotter when backing up the work truck. If a spotter is not available, walk around the truck to check distances and look for obstacles that may be in your blind spots. The spotter will wear high visibility clothing.
	Unloading the Geoprobe®.	Sites.	Incidents could occur when backing up the Geoprobe® to unload it from the trailer resulting in personal injury and/or property damage.	As a precaution, the operator should be ready to move the track control levers forward to stop the reverse motion. The operator will use the slow speed on the remote control when backing up the Geoprobe®.
	Towing the Geoprobe's trailer.	Road.	Incidents could occur when towing the Geoprobe's trailer to and from the job site resulting in personal injury and/or property damage.	Driver will follow defensive driving techniques and will be trained on how to tow a trailer. Driver will verify that the trailer's safety chains are attached to the truck's hitch system.

	Pinch points.	Loading/unloading the Geoprobe®.	Employees could be exposed to hand injuries, such as lacerations, punctures, cuts, and pinched fingers, when connecting the trailer to the work truck and when setting up the trailer's ramps.	Personnel will wear work gloves and will watch for hand placement when performing these tasks.
	Struck by/caught between the work truck, trailer, and/or Geoprobe®.	Loading/ unloading the Geoprobe®.	Personnel could be struck by/caught between the work truck, trailer, and/or Geoprobe® resulting in injury and/or property damage.	Set the truck's parking brake and place the tire chalks under the tires of the trailer before unloading and loading the Geoprobe®. When unloading the Geoprobe®, the helper will maintain a 20-foot buffer zone from the Geoprobe®. All employees will wear high visibility clothing. Non-essential personnel will maintain a 20-foot buffer zone around the rig. Use traffic cones to delineate the space needed to load/unload the Geoprobe®.
PRESSURE	Pressurized hydraulic lines.	Geoprobe®.	Faulty pressurized hydraulic lines could burst resulting in personal injury/exposure and hydraulic fluid release.	All components of the Geoprobe® will be inspected prior to and at the completion of the task. In the event of a spill/leak, personnel will contain the fluid using the spill cleanup material available in the Geoprobe's trailer. Cleanup materials will be disposed of according to state's regulations. Non-essential personnel will maintain a 20-foot buffer zone around the equipment.
THERMAL	Not applicable.			

HUMAN FACTORS	Inexperienced and improperly trained worker.	Sites.	Inexperience workers and improper training could cause incidents resulting in personal injuries and/or property damage.	Employees will be properly trained in this procedure and other applicable procedures. When loading/unloading for the first time, an experienced operator should be on site to help coach the loading/unloading process. All employees operating the Geoprobe® will be familiar with the basic controls of the machine including the Emergency Kill switch button. 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	Level D PPE (hard hat, safety glasses, high-visibility work shirt or vest, long pants, steel-toed boots), work gloves, and single hearing protection (e.g., ear muffs).
APPLICABLE SDS	SDSs will be maintained based on-site characterization and contaminants. Hydraulic Fluid and diesel.
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-GEOPROBE-02 Pre-Job and Post-Job Inspection SOP-GEOPROBE-03 Starting and Stopping the Kubota Engine SOP-GEOPROBE-04 Driving the Geoprobe® Model 7822DT
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**
SAFETY AND HEALTH MANAGER	**DATE**

Revisions:

Revision	Description	Date
1	Updates to SOP to reflect Geoprobe ® Model 7822DT	11/16/2020

PURPOSE	To provide standard instructions for conducting a pre-job and post-job Geoprobe® inspection.
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
Pre-job Geoprobe® setup.	Note: this procedure assumes that the Geoprobe® is out of the trailer. Refer to SOP-GEOPROBE-01 Mobilization and Loading/Unloading the Geoprobe® for instructions on how to back the Geoprobe® out of the trailer. The pre- and post-job inspections cannot be fully performed while the Geoprobe® is in the trailer due to the mast being folded over and preventing the removal of the engine cover lid. 1. Place the Geoprobe® on flat ground. 2. Unfold the derrick by pushing the fold lever downward. Unfold the derrick until the foot of the Geoprobe® is parallel to the ground. 3. Lower the foot of the Geoprobe® until it touches the ground by pushing the foot lever downward. 4. Turn off the Geoprobe®.
Pre-job engine hours.	1. Locate the run time odometer on the control panel and write down the machine's current hours on the Geoprobe's pre-operation inspection sheet. A Geoprobe's pre-operation inspection form is attached to this SOP as an example.
Pre-job engine compartment inspection.	1. Open the engine compartment by removing the rear upper engine cover. 2. Check the engine oil level using the oil dip stick. The oil level should be between the marks on the dip stick. If the oil level is below the lowest mark, additional engine oil is required for engine protection. 3. Check the engine's coolant fluid level inside the radiator by checking where the fluid is in relation to the "Full" and "Low" line on the reservoir.

	4. Check the hydraulic fluid level by reading the sight glass located On the control panel. Maintain the hydraulic fluid at or within 0.5 inches below the upper solid black line on the glass. If the hydraulic fluid level is below, new hydraulic oil must be added to the hydraulic oil tank until the fluid rises to the upper mark on the site glass. 5. Check diesel fuel level by removing the fuel cap and visually inspecting fuel level or by turning ignition switch to energize fuel gage on the control panel. 6. Ensure the hydraulic fluid cap, fuel cap, and radiator cap are all in place. 7. Check the radiator for leaks, cracks, and cleanliness. Inspect radiator's hoses and radiator's body for coolant leaks and inspect the engine's compartment for signs of coolant leakage. 8. Inspect the engine belts for cracking and glazing, indicators that the belts are worn and will need replacement. Also, check the belts for tension by pushing on the longest length of belt to determine the amount deflection. If the deflection is greater than 0.5 inches, the belt tension will require adjustment. 9. Document fluid levels and other notable conditions on the pre-operation inspection sheet. 10. Close the engine compartment.
Pre-job machine chassis inspection.	1. Inspect the rubber tracks for cracks and nicks, indicating that the tracks will need to be replaced soon. Also, check for proper tension by raising the tracks off the ground. The tracks should have 3 inches of slack in them at the midpoint of the track. 2. Grease three Zirk fittings on Geoprobe® as required. A single Zirk fitting is located under the rig in the rotation bearing. The bearing requires 5 pumps of multipurpose grease every 100 hours of operation. To gain access to the grease fitting, first make sure the engine is off and the ignition key is removed. Slide in between the tracks from under the front of the vehicle. Two additional Zirk fittings are located on the fold bracket pivot points. These fittings require 3 pumps of grease every 50 hours of operation. 3. Visually check the hydraulic cylinders for leaks. The hydraulic cylinders will require little to no maintenance. Under normal use, hydraulic cylinder rods will have some fluid accumulation. Excessive leaks between the cylinder rod and cylinder rod seal indicates that service is necessary by Geoprobe® Systems or a qualified hydraulic cylinder

	service. 4. Locate the battery and fuse/relay box by opening the side door behind the pipe rack. Check the battery and fuse/relay box. Ensure they are clean and free of corrosion. 5. Visually check the hydraulic hoses and fittings for leaks. Operator should look for hydraulic hoses that are leaking, cut, collapsed, or bulged. **Note:** if hydraulic fittings are loose, tighten them. If hoses are leaking or fittings cannot be tightened, immediately stop work, and have the given fittings and/or hoses replaced. 6. Check the Geoprobe's frame for cracks or damage. 7. Ensure the rear-tool basket (if used) is attached to rear blade of the Geoprobe®. 8. Ensure the fire extinguisher is inspected and located in the basket or with the Geoprobe® at all times during Geoprobing activities. 9. Ensure the five emergency stop buttons are functioning properly. Test each button individually by starting the Geoprobe® and pushing that individual emergency stop button. If the engine quits, that emergency stop button is working. If the emergency stop buttons are not working, field work will be halted until the stop buttons are repaired and functioning properly. 10. Inspect Geoprobe's assembly bolts and look for loose screws and nuts. The hammering operations tend to loosen fasteners over time making it important to visually check chassis screws, nuts, and bolts. Tighten any loose fasteners that are identified. 11. Check the hose carriers/housings for breaks in brackets.
Pre-job control panel and accessories inspection.	1. Ensure all gauges are operating properly by examining each gauge to see if the measurement is normal or the dial indicator is moving. 2. Ensure all control levers are in the neutral position and are secure. 3. Ensure all control switches are operating properly by testing each switch to determine if function control is maintained. 4. Visually inspect the winch line and winch safety hook for any damage or fraying. 5. If the drop hammer is being used make sure it is secured. Check the

	hoses coming from the drop hammer to ensure there are no leaks and also make sure the auxiliary hydraulic line and fittings are free of leaks. Refer to SOP-GEOPROBE-09 DH133 Drop Hammer to see the drop hammer securing procedures.
Post-job Geoprobe® inspection.	1. Move Geoprobe to a flat, safe location. 2. With the engine running and cooling down, perform a visual inspection of the Geoprobe®, looking for leaking oil, coolant, or hydraulic fluid. Additionally, look for loose bolts, nuts, and screws that may have come loose during the day's operation. This inspection will identify any new issues with the Geoprobe® that could be repaired or replaced before the next work day. **Note:** a thorough inspection is not usually performed at the end of the day when the Geoprobe® components are hot. Checking fluid levels in a hot engine is hazardous, especially coolant levels.

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

SOURCE	***HAZARDS***	***WHERE***	***HOW, WHEN, RESULT***	***CONTROLS***
CHEMICAL	Diesel, Oil, hydraulic fluid, coolant, and fitting grease.	Geoprobe®.	Employees could be exposed to diesel, hydraulic fluid, coolant, and/or fitting grease via inhalation, ingestion, and skin/eye contact, when inspecting the Geoprobe®, or if equipment malfunctions resulting in adverse health effects.	Employees will wear work gloves and safety glasses, if contact with diesel, oil, hydraulic fluid, coolant or fitting grease is possible. In the event of a spill/leak, personnel will contain the fluid using the spill cleanup material available in the Geoprobe's trailer. Cleanup materials will be disposed of according to state's regulations. All components of the Geoprobe® will be inspected prior to and at the completion of the task. Non-essential personnel will maintain a 20-foot buffer zone around the equipment.
NOISE	Elevated noise levels.	Geoprobe®.	Employees could be exposed to elevated noise levels when the Geoprobe® is running resulting in irritability, decreased concentration, and noise-induced hearing loss.	Personnel within a 20-foot buffer of the Geoprobe® will wear single hearing protection (e.g., earmuffs). Non-essential personnel will maintain a 20-foot buffer zone around the Geoprobe®.
ELECTRICAL	Defective electrical lines.	Geoprobe®.	Contact with defective electrical lines could result in personal injury.	Inspect electrical lines of the Geoprobe® prior to and at the completion of the task. Do not operate the Geoprobe® if defective electrical lines are found during the pre/post job inspection.
BODY MECHANICS	Not applicable.			
GRAVITY	Falls from slips and trips.	Uneven terrain, slick/muddy/wet	Walking on slick/muddy/wet	Workers will wear work boots with good traction and ankle

HSSE CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.				
		surfaces and steep slopes.	and uneven terrain could cause slips and trips resulting in falls and injuries.	support. Employees will plan their path and walk cautiously. Keep work area free of tools/rods. If conditions are wet/muddy, muck boots may be worn.
WEATHER	Cold/heat stress.	Outdoors.	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. Electrocution, injury, death, or equipment damage could be caused by lightning strike.	Training on signs and symptoms of cold/heat stress is required. Personnel will wear appropriate clothing when working outdoors (e.g. layers). Employees will remain hydrated and will have sufficient caloric intake during the day. Personnel will follow procedures outlined in applicable SSHASP and/or Pioneer corporate HASP. Employees will follow the 30/30 rule during lighting 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, animals, and insects.	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 in work trucks. Employees with allergies should notify their supervisor.
MECHANICAL	Pinch Points from folding and	Geoprobe®	Employees could be exposed to	Personnel will wear work gloves and will watch for hand

HSSE CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.				
	unfolding the Geoprobe.		hand injuries, such as lacerations, punctures, cuts, and pinched fingers, when folding and unfolding the Geoprobe® during pre/post job inspection.	placement when performing these tasks. All non-essential personnel will maintain a 20-foot buffer zone around the Geoprobe®.
PRESSURE	Pressurized hydraulic lines.	Geoprobe®.	Faulty pressurized hydraulic lines could burst resulting in injury/ exposure and hydraulic fluid release.	All components of the Geoprobe® will be inspected prior to and at the completion of the task. In the event of a spill/leak, personnel will contain the fluid using the spill cleanup material available in the Geoprobe's trailer. Cleanup materials will be disposed of according to state's regulations. Non-essential personnel will maintain a 20-foot buffer zone around the equipment.
THERMAL	Hot fluids in the engine compartment.	Geoprobe®.	Employees could be exposed to hot fluids in the engine compartment that if contact occurs could result in injury/exposure or fluid release.	All components of the Geoprobe® will be inspected prior to and at the completion of the task. Allow time for the engine and fluids to cool prior to performing the pre/post job inspection. In the event of a spill/leak, personnel will contain the fluid using the spill cleanup material available in the Geoprobe's trailer. Cleanup materials will be disposed of according to state's regulations. Employees will use Level D PPE and proper gloves when preforming pre/post job inspections. Non-essential personnel will maintain a 20-foot buffer zone around the equipment.

HSSE CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.				
HUMAN FACTORS	Inexperienced and improperly trained worker.	Sites.	Inexperienced workers and improper training could cause incidents resulting in personal injuries and/or property damage.	Employees will be properly trained in this procedure and other applicable procedures. When performing the pre/post job inspection for the first time, an experienced operator should be on site to help coach the pre/post job inspection process. All employees operating the Geoprobe® will be familiar with the basic controls of the machine including the Emergency kill switch button. 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	Level D PPE (hard hat, safety glasses, high-visibility work shirt or vest, long pants, steel-toed boots), work gloves, and single hearing protection (e.g., earmuffs).
APPLICABLE SDS	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/	SOP-GEOPROBE-01 Mobilization and Loading/Unloading the Geoprobe® SOP-GEOPROBE-09 DH133 Drop Hammer

WORK PLANS	
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**
SAFETY AND HEALTH MANAGER	**DATE**

Revisions:

Revision	Description	Date
1	Updates to SOP to reflect Geoprobe ® Model 7822 DT	11/16/2020

PURPOSE	To provide standard instructions for starting and stopping the Kubota Diesel Engine on the Geoprobe®.
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
Preparing the Engine for Start Up	1. Make sure the Geoprobe® is in an open area for ventilation. When starting the Geoprobe® in the trailer completely open the front and back doors to provide ventilation. 2. Ensure as the operator you are familiar with all five kill switches on the Geoprobe®. There is a kill switch located on the remote control, on the control panel, one on each side of the Geoprobe®, and the last kill switch is a pull latch cable located next to the control panel.
Starting the Kubota Engine.	1. Warm the glow plugs before starting. To warm the glow plugs, turn the key counterclockwise. A message will appear on the control panel when the machine is ready. **Note:** In cold weather conditions, it is good practice to warm the glow plugs twice. Also, if the machine has been warmed up and been running, then there is no need to warm the glow plugs again before start up. 2. Turn ignition key clockwise to activate the starter motor. Release the ignition key when the engine starts and runs on its own power. **IMPORTANT: Do not run the starter motor for longer than 10 seconds. If the engine does not start running, then allow 30 seconds to pass and repeat the starting procedure.** 3. Verify the oil pressure gauge is reading in the white on the pressure gauge and the battery gauge is also reading in the white. **(Refer to the Kubota Manual for troubleshooting procedures).**

	4. Allow the engine to run approximately 5 to 10 minutes, or through a complete warm up cycle, to bring the coolant and hydraulic fluid up to running temperature. The machine will be locked out until the warm up cycle is completed and fluids are at correct operating temperatures. The control panel has gauges that show hydraulic fluid temperature, hydraulic tank temperature, and coolant temperature.
Running the Kubota Engine	1. When the engine is running between pushing and/or sampling procedures, the machine is equipped with an automatic throttle and will lower the throttle. This will help to conserve fuel, prolong the engine life, and reduce noise levels.
Stopping the Kubota Engine	1. Check the control panel to see if the two fans are running. If either fan is on, the Geoprobe® needs to stay on to allow the fan(s) to cool the engine and fluids. Once both fans are turned off, the Geoprobe® is cool and can be turned off. 2. Turn the ignition key to the “OFF” position. **IMPORTANT: Familiarize yourself with the engine kill switches so in case of an emergency these switches can be easily used!!!**

HSSE CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.				
SOURCE	***HAZARDS***	***WHERE***	***HOW, WHEN, RESULT***	***CONTROLS***
CHEMICAL	Carbon Monoxide	Geoprobe®.	Employees could be exposed to carbon monoxide via inhalation when operating the Geoprobe®, resulting in adverse health effects.	Employees will make sure the Geoprobe® is started in an open area to provide good ventilation. If the Geoprobe® is started in the trailer, make sure both doors are open. Do Not work around the exhaust area (back of the rig) while the Geoprobe® is running. Non-essential personnel will maintain a 20-foot buffer zone around the equipment.
	Hydraulic fluid and diesel.	Geoprobe®.	Employees could be exposed to	Employees will wear work gloves and safety glasses, if contact with hydraulic

HSSE CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.				
			hydraulic fluid and or diesel via inhalation, ingestion and skin/eye contact, when operating the Geoprobe®, or if equipment malfunctions resulting in adverse health effects.	fluid/diesel is possible. In the event of a spill/leak, personnel will contain the fluid using the spill cleanup material available in the Geoprobe's trailer. Cleanup materials will be disposed of according to state's regulations. All components of the Geoprobe® will be inspected prior to and at the completion of the task. Non-essential personnel will maintain a 20-foot buffer zone around the equipment.
NOISE	Elevated noise levels.	Geoprobe®	Employees could be exposed to elevated noise levels when driving the Geoprobe® resulting in irritability, decreased concentration, and noise-induced hearing loss.	Personnel within a 20-foot buffer zone of the Geoprobe® will wear single hearing protection (e.g. earmuffs). Non-essential personnel will maintain a 20-foot buffer zone around the Geoprobe®.
ELECTRICAL	Defective electrical lines.	Geoprobe®	Contact with defective electrical lines could result in personal injury.	Inspect electrical lines of the Geoprobe® prior to and at the completion of the task.
BODY MECHANICS	Not applicable.			
GRAVITY	Falls from slips and trips.	Uneven terrain, slick, muddy/wet surfaces and steep slopes.	Walking 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. Employees will plan their path and walk cautiously. If conditions are wet/muddy, muck boots may be worn Keep work area free of tools/rods.

HSSE CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.				
WEATHER	Cold/heat stress	Outdoors.	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 (e.g. layers). 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.	Sites.	Electrocution, injury, death, or equipment damage could be caused by lightning strike.	Employees will follow the 30/30 rule during lightning storms. When the Geoprobe® is running, the Geoprobe helper will watch/listen for lightning and thunder.
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, Animals, Insects and Humans	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 in the work truck. Employees with allergies should notify their supervisor.
MECHANICAL	Not applicable.			
PRESSURE	Pressurized hydraulic lines.	Geoprobe®	Faulty pressurized hydraulic lines could burst	All components of the Geoprobe® will be inspected prior to and at the completion of the task. In the event of a

HSSE CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.				
			resulting in injury/exposure and hydraulic fluid release.	spill/leak, personnel will contain the fluid using the spill cleanup material available in the Geoprobe's trailer. Cleanup materials will be disposed of according to state's regulations. Non-essential personnel will maintain a 20-foot buffer zone around the equipment.
THERMAL	Not applicable.			
HUMAN FACTORS	Inexperience and improperly trained worker.	Sites.	Inexperience workers and improper training could cause incidents resulting in personal injuries and/or property damage.	Employees will be properly trained int his procedure and other applicable procedures. When starting/stopping for the first time, an experienced operator should be on site to help coach the process. All employees operating the Geoprobe® will be familiar with the basic controls of the machine including the Emergency kill switch button. 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	Level D PPE (hard hat, safety glasses, high-visibility work shirt or vest, long pants, steel toed boots), work gloves, and single hearing protection (e.g. earmuffs).
APPLICABLE SDS	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	
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**
SAFETY AND HEALTH MANAGER	**DATE**

Revisions:

Revision	Description	Date
1	Updates to SOP to reflect Geoprobe ® Model 7822DT	11/16/2020

PURPOSE	To provide standard instructions for driving and positioning the Geoprobe® for probing.
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
Driving and Braking Controls on the Advance 7822DT	***Brakes*** The Geoprobe® Model 7822DT is equipped with automatic track brakes. When the engine is not running the track brakes are automatically engaged. ***Hydraulic Steering Controls*** The Model 7822DT has two steering control levers on the remote control. There are two additional steering control levers on the control panel but to use these levers the safety enable button must also be engaged. The two steering controls levers control two independently controlled tracks. The left lever controls the left track and the right lever controls the right track. To move forward move both control levers forward. To move in reverse move both control levers towards the back of the machine. There are three types of turns the Model 7822DT can accomplish. These turns are listed and described below. 1. **Gradual Turn** This turn is used when the Geoprobe® is in motion. By moving the control levers in the same direction but to different degrees will produce a gradual turn. This turn is possible in both forward and reverse directions. 2. **Pivot Turn** This turn is used when the Geoprobe® is stationary. By moving one control lever and leaving the other control lever in neutral position will produce a pivot turn. The turn will center around the track that is stationary. This turn is used a lot when positioning the Geoprobe® over probe-hole locations. This turn is possible in both forward and reverse directions. 3. **Counter-Rotation Turn** This turn is used when the Geoprobe® is stationary. By moving both controls

<table>
<tr><td></td><td>but in opposite directions will produce a Counter-Rotation Turn. This turn will center around the center of the Geoprobe®. This turn is used widely in congested areas with limited room to turn.</td></tr>
<tr><td>Driving the Geoprobe® Model 7822DT</td><td>CAUTION: When driving the Geoprobe®, check job site for obstacles if not readily visible.

1. Start the Geoprobe® Model 7822DTas stated in the Starting and Stopping the Kubota Engine SOP (SOP-GEOPROBE-03).

2. Make sure to do a complete walk around to make sure the blade is in the upright position and that all other rig extremities are free of debris/obstacles.

3. Make sure the Geoprobe® is in transport position. Transport position is when the rig is completely folded up.

• The probe cylinder must be lowered all the way to the foot. To lower the foot, place the probe lever in the downward position until motion has halted.

• The foot must be completely raised up to the folding bracket. To raise the foot, place the foot lever in the upward position until motion has halted.

• The mast must be completely lowered to the folding bracket. To lower the mast, place the mast lever (in the downward position until motion has halted.

• In order to raise the mast, the winch must be lowered. Once the mast is raised, the slack can be taken out of the winch. The opposite happens when lowering the mast, and there will be slack in the winch line.

NOTE: Do Not pull all the winch line in. Allow a couple inches of slack in the winch line so the line or winch does not get damaged.

• The Geoprobe® should now be completely folded up. To fold up the Geoprobe®, place the fold lever in the upward position until motion has halted.

4. Move the Geoprobe® to the specified location using the Track Control Levers and turns as necessary. Use best judgement on type of terrain for travel speed, generally when moving to specific location medium speed is sufficient.</td></tr>
</table>

	5. Use a spotter when necessary to obtain the best and safest route to the probe-hole locations. **IMPORTANT: DO NOT SIDE HILL WITH THE RIG!! When traversing through mountainous and hilly areas drive straight up or down the terrain.**
Positioning the Geoprobe® Model 7822DT	1. After the Geoprobe® has been driven close to the new probe hole location (no farther than five feet away), unfold the derrick of the machine. To unfold the derrick, place the fold lever in the downward position until the foot of the machine is parallel to the existing ground. 2. Raise the mast completely up. To raise the mast, place the mast lever in the upward position until motion is halted. 3. Lower the foot until there is roughly six to twelve inches between the bottom of the foot and the existing ground. To lower the foot, place the foot lever in the downward position until the desired position is reached. 4. Raise the probe cylinder three to four feet off of the foot. To raise the probe cylinder, place the probe lever in the upward position until the desired position is reached. 5. Make sure the machine is extended in about half-way (six to seven and a half inches). To extend the machine in and out, place the extend lever in the upward position to move the machine in and place the extend lever in the downward position to extend out. 6. Level the machine using the oscillating head and moving the foot. Use the magnetic level. **CAUTION: When driving the Geoprobe®, check job site for obstacles if not readily visible.**

HSSE CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.				
SOURCE	***HAZARDS***	***WHERE***	***HOW, WHEN, RESULT***	***CONTROLS***
CHEMICAL	Hydraulic fluid and diesel.	Geoprobe®.	Employees could be exposed to hydraulic fluid and/or diesel via inhalation, ingestion, and skin/eye contact, when operating the Geoprobe®, or if equipment malfunctions resulting in adverse health effects.	Employees will wear work gloves and safety glasses, if contact with hydraulic fluid/diesel is possible. In the event of a spill/leak, personnel will contain the fluid using the spill cleanup material available in the Geoprobe® trailer. Cleanup materials will be disposed of according to state regulations. All components of the Geoprobe® will be inspected prior to and at the completion of the task. Non-essential personnel will maintain a 20-foot buffer zone around the equipment.
NOISE	Elevated noise levels.	Geoprobe®.	Employees could be exposed to elevated noise levels when driving the Geoprobe® resulting in irritability, decreased concentration, and noise-induced hearing loss.	Personnel within a 20-foot buffer zone of the Geoprobe® will wear single hearing protection (e.g. earmuffs). Non-essential personnel will maintain a 20-foot buffer zone around the Geoprobe®.
ELECTRICAL	Defective electrical lines.	Geoprobe®.	Contact with defective electrical lines could result in personal injury.	Inspect electrical lines of the Geoprobe® prior to and at the completion of the task.
	Overhead Power Lines	Sites.	Contact with overhead power lines could result in serious injury or property	Employees will maintain sufficient distance from any overhead power lines on the site. Employees will also not drive the Geoprobe® with the

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

			damage.	mast raised.
BODY MECHANICS	Not applicable.			
GRAVITY	Not applicable.			
WEATHER	Cold/heat stress. Lightning.	Outdoors. 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. Electrocution, injury, death, or equipment damage could be caused by lightning strike.	Training on the signs and symptoms of cold/heat stress is required. Personnel will wear appropriate clothing when working outdoors (e.g. layers). Employees will remain hydrated and will have sufficient caloric intakes during the day. Personnel will follow procedures outlines in applicable SSHASP and/or Pioneer corporate HASP. Employees will follow the 30/30 rule during lightning storms. When the Geoprobe® is running, the Geoprobe helper will watch/listen for lightning and thunder.
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, animals, insects and humans.	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 in the work trucks. Employees with allergies should notify their supervisor.
MECHANICAL	Driving on unstable ground	Sites.	Incidents could occur when	Employees will avoid side hilling in the Geoprobe® to

HSSE CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.				
	or sloped surfaces.		driving on unstable ground or sloped surfaces which could result in personal injury and/or property damage.	prevent tipping the machine. Employees will do a site walk around before mobilizing to the probing location to determine the best route to drive the Geoprobe®. Employees will use the remote control to move the Geoprobe®.
PRESSURE	Pressurized hydraulic lines.	Geoprobe®.	Faulty pressurized hydraulic lines could burst resulting in personal injury/exposure and hydraulic fluid release.	All components of the Geoprobe® will be inspected prior to and at the completion of the task. In the event of a spill/leak, personnel will contain the fluid using the spill cleanup material available in the Geoprobe's trailer. Cleanup materials will be disposed of according to state's regulations. Non-essential personnel will maintain a 20-foot buffer zone around the equipment.
THERMAL	Not applicable.			
HUMAN FACTORS	Inexperienced and improperly trained worker.	Sites.	Inexperience workers and improper training could cause incidents resulting in personal injuries and/or property damage.	Employees will be properly trained in this procedure and other applicable procedures. When driving the Geoprobe® for the first time, an experienced operator should be on site to help coach the driving process. All employees operating the Geoprobe® will be familiar with the basic controls of the machine including the Emergency Kill switch button. 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.

HSSE CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.	
REQUIRED PPE	Level D PPE (hard hat, safety glasses, high-visibility work shirt or vest, long pants, steel-toed boots), work gloves, and single hearing protection (e.g. earmuffs).
APPLICABLE SDS	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-GEOPROBE-03 Starting and Stopping the Kubota Engine
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**
SAFETY AND HEALTH MANAGER	**DATE**

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
1	Updates to SOP to reflect Geoprobe ® Model 7822DT	11/16/2020

PURPOSE	To provide standard instructions for constructing tool strings and sampling procedures using the Geoprobe® Model DT-22 Dual Sampling System.
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
DT-22 Expendable Cutting Shoe Tool String Set Up	The procedure for operating the Geoprobe® can be reviewed in SOP-GEOPROBE-07 (Operating the Geoprobe® During Probing Operations). Figure 1 depicts the DT-22 tool string diagram. The expendable cutting shoes are used to collect soil samples. When sampling is complete, tooling or materials (e.g., monitoring wells) can be placed or constructed inside the probe rod string. The following instructions describe how to set up the expendable cutting shoe tool string. 1. The expendable cutting shoe has two spaces on the neck portion of the tool. Lubricate a single O-ring with Liquinox soap solution. Place the lubricated O-ring on the top most groove. 2. Take the expendable cutting shoe, with the O-ring inserted, and place the cutting shoe into the expendable cutting shoe holder. 3. Thread the expendable cutting shoe holder onto the female end of the 2.25-inch probe rod. 4. Attach the 1.125-inch clear plastic core liner to the liner driver head. • Take a small piece of light weight inner rod and secure it in the pipe tri-stand. • Thread the liner driver head into the piece of lightweight inner rod. • Push the core liner onto the liner driver head and line up the hole on the top part of the core liner with the set screw hole on the liner drive head. • Place a set screw in the hole and tighten it down with a 3/32 allen wrench.

	5. Unscrew the liner drive head with the sample core liner attached and place it inside the probe rod. **NOTE:** if the bore hole is deeper than four feet, then additional light weight center rods need to be attached to the liner drive head so that four feet of lightweight center rod protrudes out of the outer probe rod in the ground. 6. Place an extra four feet of light weight center rod onto the center rods or sample drive head. 7. Place another outer probe rod over the light weight center rod and thread it onto the lower probe rod until the joint is tight. Tighten joint with a pipe wrench. 8. Place the rubber bumper onto the top light weight center rod or the liner drive head. 9. Place the drive cap over the threads of the probe rods. The tool string is now complete and ready for probing.
DT-22 Attached Cutting Shoe Tool String Set Up	The attached cutting shoes are used to collect soil samples. 1. Thread the attached cutting shoe onto the female end of the DT-22 probe rod. 2. Attach the 1.125-inch clear plastic core liner to the liner driver head. • Take a small piece of light weight inner rod and secure it in the pipe tri-stand. • Thread the liner driver head into the piece of lightweight inner rod. • Push the core liner onto the liner driver head and line up the hole on the top part of the core liner with the set screw hole on the liner drive head. • Place a set screw in the hole and tighten it down with a 3/32 allen wrench. 3. Unscrew the liner drive head with the sample core liner attached and place it inside the probe rod. **NOTE:** if the bore hole is deeper than four feet, then additional light weight center rods need to be attached to the liner drive head so that four feet of lightweight center rod protrude out of the probe rod in the ground. 4. Place an extra four feet of light weight center rod onto the center rods or sample drive head. 5. Place another outer probe rod over the light weight center rod and thread it onto the lower probe rod until the joint is tight. Use pipe wrench to

	tighten the joint. 6. Place the rubber bumper onto the top light weight center rod or the liner drive head. 7. Place the drive cap over the threads of the probe rods. The tool string is now complete and ready for probing.
DT-22 Expendable Point Tool String Set Up	The expendable points are used when collection of soil samples is not needed, but tooling or materials (e.g., monitoring wells) are to be placed or constructed inside the hole. 1. The expendable point has two grooves on the neck portion of the tip. Lubricate a single O-ring with Liquinox soap solution. Place the lubricated O-ring in the upper groove. 2. Take the expendable point, with the O-ring inserted, and place the cutting shoe into the expendable point holder. 3. Thread the expendable point holder onto the female end of the 2.25-inch probe rod. 4. Place the drive cap over the threads of the probe rods. The tool string is now complete and ready for probing.
Threaded Point Tool String Set Up	The threaded point is used when collecting samples is not needed and tooling or equipment (e.g., monitoring wells) will not be placed or constructed inside the hole. 1. Thread the attached point holder onto the female end of the 2.25-inch probe rod. 2. Place the drive cap over the threads of the probe rods. The tool string is now complete and ready for probing.
Cutting the DT-22 Sample Liners	1. Unfold and setup the sample table. 2. Place the aluminum sample core liner holder on the table and fasten the holder to the table with hand clamps. 3. Place the core liner that needs to be sampled in the aluminum holder tray. Place the liner so that the core catcher end of the liner slides over the sample tray retaining pin. 4. Place the DT-22 core liner cutter at the top of the core liner and pulled the length of the core liner. This operation will cut the core liner and make it possible to acquire the soil samples inside the core liner.

HSSE CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.				
SOURCE	***HAZARDS***	***WHERE***	***HOW, WHEN, RESULT***	***CONTROLS***
CHEMICAL	Contact with impacted soils and water.	Impacted sites, during sample collection and handling.	Adverse health effects could result from ingesting, inhaling, and/or skin/eye contact with impacted soils and water.	Personnel will practice proper personal hygiene – wash hands prior to eating/drinking and when leaving the site. Employees will wear nitrile gloves when collecting and handling samples. Employees will wear work gloves when handling probe rods. Work will be suspended during high wind conditions that produce large amounts of visible impacted dust.
	Hydraulic fluid and diesel.	Geoprobe®.	Employees could be exposed to hydraulic fluid and/or diesel via inhalation, ingestion, and skin/eye contact, when operating the Geoprobe®, or if equipment malfunctions resulting in adverse health effects.	Employees will wear work gloves and eye protection, if contact with hydraulic fluid/diesel is possible. In the event of a spill/leak, personnel will contain the fluid using the spill cleanup material available in the Geoprobe® trailer. Cleanup materials will be disposed of according to the appropriate regulations. All components of the rig will be inspected prior to and at the completion of the task. Non-essential personnel will maintain a 20-foot buffer zone around the equipment.
	Lubricating grease.	Probing location.	Employees could be exposed to lubricating grease via ingestion and skin/eye contact when assembling probe rods resulting in adverse health effects.	Employees will wear work gloves and eye protection when assembling probe rods.

	Liquinox	Probing location.	Employees could be exposed to Liquinox via ingestion and skin/eye contact when assembling probe rods resulting in adverse health effects.	Employees will wear work gloves and eye protection when assembling probe rods.
NOISE	Elevated noise levels.	Geoprobe®.	Employees could be exposed to elevated noise levels when operating the Geoprobe® resulting in irritability, decreased concentration, and noise-induced hearing loss.	Personnel within a 20-foot buffer zone of the Geoprobe® will wear single hearing protection (e.g. earmuffs or earplugs). Non-essential personnel will maintain a 20-foot buffer zone around the Geoprobe®.
ELECTRICAL	Defective electrical lines.	Geoprobe®.	Contact with defective electrical lines could result in personal injury.	Inspect electrical lines of the Geoprobe® prior to and at the completion of the task. Do not operate the Geoprobe® if defective electrical lines are found.
BODY MECHANICS	Lifting and moving rods.	Probing location.	Employees could be exposed to back or muscle strains or sprains when lifting or connecting the Geoprobe® rods.	Employees will follow good lifting techniques including lifting with the legs and not the back, get a good grip, and keep the load close to your body. Two employees will lift the rods if necessary.

GRAVITY	Falls from slips and trips.	Uneven terrain, slick/muddy/wet surfaces and steep slopes.	Walking 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. Employees will plan their path and walk cautiously. Keep work area free of tools/rods. If conditions are wet/muddy, muck boots may be worn. Site can be cleared of snow, if applicable.
	Falling rods.	Probing location.	Heavy rods could slip off of worker's hands while carrying and assembling tool strings causing personal injury.	Employees will use work gloves when assembling and handling rods. Two workers will carry rods, if necessary. All personnel will wear steel-toe boots.
WEATHER	Cold/heat stress	Outdoors.	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 (e.g. layers). 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.	Sites.	Electrocution, injury, death, or equipment damage could be caused by lightning strike.	Employees will follow the 30/30 rule during lightning storms. When the Geoprobe® is running, the Geoprobe helper will watch/listen for lightning and thunder.
RADIATION	Ultraviolet (UV) radiation.	Outdoors.	Employees could be exposed to UV radiation during summer months causing sun	Employees will wear sunscreen, long-sleeve work shirts and long pants. Employees will also use safety glasses with tinted lenses.

			burns, skin damage, and eye damage.	
BIOLOGICAL	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. All employees operating the Geoprobe® will be familiar with the basic controls of the machine including the Emergency Kill switch button.
	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. Avoid contact with plants, insects, and animals. First-aid kits will be available on site. Employees with allergies should notify their supervisor.
MECHANICAL	Improper body mechanics.	Assembling and handling rods/sample tubes.	Improper lifting, bending, squatting, and kneeling could result in muscle/back strains or other injuries.	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. Employees should stretch prior to starting work and they will take breaks when necessary.
	Pinch points.	During equipment assembly and when cutting sample liners.	Employees could be exposed to hand injuries such as lacerations, punctures, cuts, and pinched	Employees will wear work gloves when assembling probe rods and sample casings, using the liner cutter, and handling plastic core liners after they have been cut open.

			fingers when assembling probe rods and sample casings, and when using the liner cutter.	Workers will be trained on how to properly use the liner cutter.
	Flying debris.	Probing location.	Eye injuries could result from flying debris when assembling probe rods and sample casings.	Employees will wear safety glasses at all times during Geoprobe® operations.
PRESSURE	Pressurized hydraulic lines.	Geoprobe®.	Faulty pressurized hydraulic lines could burst resulting in personal injury/exposure and hydraulic fluid release.	All components of the rig will be inspected prior to and at the completion of the task.
THERMAL	Cold/heat stress.	Outdoors.	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. 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.
HUMAN FACTORS	Inexperience and improperly trained worker.	Sites.	Inexperience workers and improper training could cause incidents resulting in personal injuries and/or property damage.	Employees will be properly trained int his procedure and other applicable procedures. When starting/stopping for the first time, an experienced operator should be on site to help coach the process. All employees operating the Geoprobe® will be familiar with the basic

				controls of the machine including the Emergency kill switch button. 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	Level D PPE.
APPLICABLE SDS	SDSs will be maintained based on site characterization and contaminants. Hydraulic fluid, diesel, Liquinox, and lubricating grease.
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-GEOPROBE-07 Operating the Geoprobe® During Probing Operations
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**
SAFETY AND HEALTH MANAGER	**DATE**

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
1	Updates to SOP to reflect Geoprobe ® Model 7822DT	11/16/2020

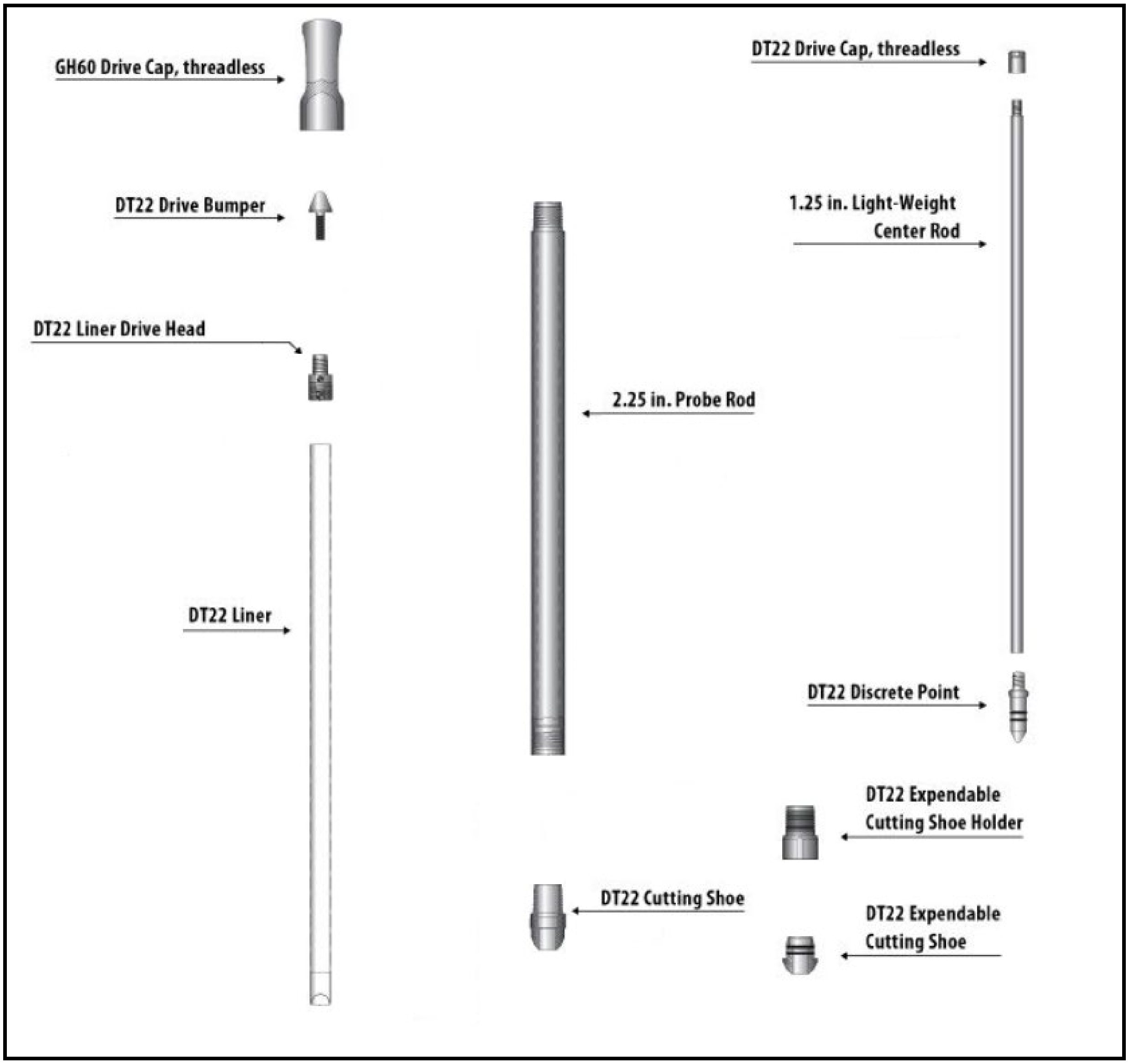

Figure 1 - The DT-22 Tool String Diagram

PURPOSE	To provide standard instructions for constructing tool strings and sampling procedures using the Geoprobe® DT-325/375 Dual Tube Sampling System and the 3.25 and 3.75-inch probe rod. Both the 3.25- and 3.75-inch rods follow the same procedure for set up and operation. Each system has unique cutting shoes, expandable points, etc. specific to the size probe rods being used, but set up and operations are identical. When using expendable points and shoes, wells may also be set.
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
DT-325/375 Expendable Cutting Shoe Tool String Set Up	The procedure for operating the Geoprobe® can be reviewed in SOP-GEOPROBE-07 (Operating the Geoprobe® During Probing Operations). Figure 1 depicts the DT-325/375 tool string diagram. The expendable cutting shoes are used to collect soil samples during probe string advancement. When soil sampling is complete, tooling or materials (e.g., monitoring wells) can be placed or constructed inside the probe rod string, leaving the expendable cutting shoe at the bottom of the probe hole as the probe rod is removed from the hole. The following instructions describe how to assemble the expendable cutting shoe tool string. 1. The expendable cutting shoe has two grooves on the neck portion of the cutting shoe. Lubricate a single O-ring with Liquinox soap solution. Place the lubricated O-ring on the top-most groove. 2. Take the expendable cutting shoe, with the O-ring installed, and push the cutting shoe into the expendable cutting shoe holder. Thread the expendable cutting shoe holder onto the female end of the 3.25/3.75-inch probe rod. 3. Prepare the soil sample sheath assembly using the following steps: • Press a DT-325/375 ring retainer onto the bottom end of the 2.1-inch diameter clear plastic core liner. • Slide the sample tube assembly into the sample sheath and thread the ring retainer into the sample sheath. If a core catcher is used, ensure it is on the end with the ring retainer. • Thread sheath drive head on top portion of the sample

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sheath.

Place the sample sheath assembly into the lead probe rod with the expendable cutting shoe.
Place the centering drive cap on the sheath drive head.
Place 3.25/3.75-inch drive cap on the outer probe string.
The tool string is now ready to drive and samples the first interval.

4. Drive the tool string to depth.

5. Remove outer drive cap and then the inner centering drive cap.

6. Thread the 1.25-inch Tee-handle on to the sheath drive head and pull the sample sheath from the outer rod.

7. Unthread the ring retainer to remove the plastic liner containing the soil core. Decontaminate the sample sheath and components as required and reassemble using a new plastic liner as described in step 3 above.

8. Place a four (or five) foot light weight center rod onto the sample drive head and lower the sampler back into the outer probe rod remaining in the ground until it seats into the outer rod assembly. This will leave a lightweight center rod sticking 4 (or 5) feet above the top of the outer rod.

9. Place another outer probe rod over the lightweight center rod and thread it onto the lower probe rod until the joint is tight. Tighten joint with a pipe wrench if necessary.

10. Place the inner drive cap onto the top of the lightweight center rod followed by the placement of the outer drive cap over the threads of the probe rods.

The tool string is now complete and ready to probe and sample the next interval. The process is repeated by adding a lightweight center rod and outer probe rod each interval until final depth is achieved. Installation of a well or other equipment can now proceed.
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<tr><td>DT-325/375 Threaded Cutting Shoe Tool String Set Up</td><td>
The threaded cutting shoes are used to collect soil samples. The fixed cutting shoe limits the size and placement of well materials, and therefore is typically used only for collecting soil cores. However, small diameter wells or piezometers can be placed through the center of the cutting shoe.

1. Thread the cutting shoe onto the female end of the DT-325/375 probe rod.

2. Prepare the sample sheath assembly using the following steps:
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Press a DT-325/375 ring retainer onto the bottom end of the 2.1-inch diameter clear plastic core liner.
Slide the sample tube assembly into the sample sheath and thread the ring retainer into the sample sheath. If a core catcher is used, ensure it is on the end with the ring retainer.
Thread sheath drive head on top portion of the sample sheath.
Place the sample sheath assembly into the lead probe rod with the threaded cutting shoe.
Place the centering drive cap on the sheath drive head.
Place 3.25/3.75-inch drive cap on the outer probe string.
The tool string is now ready to drive and samples the first interval.

<ol start="3">
Drive the tool string to depth.
Remove outer drive cap and then the inner centering drive cap.
Thread the 1.25-inch Tee-handle on to the sheath drive head and pull the sample sheath from the outer rod.
Unthread the ring retainer to remove the plastic liner containing the soil core. Decontaminate the sample sheath and components as required and reassemble using a new plastic liner as described in step 2 above.
Place a four (or five) foot light weight center rod onto the center rods or sample drive head and lower the sampler back into the outer probe rod remaining in the ground until it seats into the outer rod assembly. This will leave a lightweight center rod sticking 4 (or 5) feet above the top of the outer rod.
Place another outer probe rod over the lightweight center rod and thread it onto the lower probe rod until the joint is tight. Tighten joint with a pipe wrench if necessary.
Place the inner drive cap onto the top light weight center rod followed by the placement of the outer drive cap over the threads of the probe rods.

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<tr><td>DT-325/375 Expendable Point Tool String Set Up</td><td>
The expendable points are used when collection of soil samples is not needed, but tooling or materials (e.g., monitoring wells) are to be placed or constructed through the outer rods.

The expendable point has two grooves on the neck portion of the tip. Lubricate a single O-ring with Liquinox soap solution. Place the lubricated O-ring in the upper groove.

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	2. Take the expendable point, with the O-ring inserted, and place the point into the expendable point holder 3. Thread the expendable point holder onto the female end of the 3.25/3.75-inch probe rod. 4. Place the outer drive cap over the threads of the probe rods. The tool string is now ready for probing. 5. Drive the probe rod the full interval. 6. Continue to add a new 3.25/3.75-inch probe rod as the probe string is advanced each interval. 7. Continue driving the 3.25/3.75-inch rods until the desired depth is reached.
Threaded Point Tool String Set Up	The threaded point is used when collecting samples is not needed and tooling or equipment (e.g., monitoring wells) will not be placed or constructed inside the hole. 1. Thread the solid point onto the female end of the 3.25/3.75-inch probe rod. 2. Place the outer drive cap over the threads of the probe rods. The tool string is now complete and ready for probing.
Cutting the DT-325/375 Sample Liners	1. Unfold and setup the sample table. 2. Place the aluminum sample core liner holder on the table and fasten the holder to the table with hand clamps. 3. Place the core liner that needs to be sampled in the aluminum holder tray. Place the liner so that the core catcher end of the liner slides over the sample tray retaining pin. 4. Place the DT-325/375 core liner cutter at the top of the core liner and pull the length of the core liner. This operation will cut the core liner and make it possible to acquire the soil samples inside the core liner.

Pulling 3.25/3.75-inch rods from the ground using threaded pull cap	1. Thread pull cap on top of the rod string to be extracted from the ground. 2. Move Geoprobe head with rod puller into position to pull the rod. 3. Begin pulling rod out of ground until the pull cap is at full height. 4. Place rod clamp around rods at ground level and clamp tightly. 5. Relax the pull on the rods by moving the Geoprobe head down slightly, allowing the pull bar to be moved away from the pull cap. 6. Remove pull cap. 7. Remove upper rod from the rod string. 8. Replace threaded pull cap on remaining rod string and repeat the process until all the rods have been removed from the ground.
Pulling 3.25/3.75-inch rods from the ground using external rod grip system with well installation.	1. Well installation. If doing 1.5” well both 3.75” and 3.25” rods can be used. If doing 2” wells they need to be slim pre-pack and can only be used with the 3.75” system. Start with the well screen, and thread on a bottom cap. 2. With one person holding the screen down the well the next person will attach the next section of well casing typically a riser. Tighten riser hand tight and make sure it is flush and not cross threaded. Then one person will lower this piece down as the other person screws on another piece. This process is repeated until desired length is added to meet well construction specs. 3. Once you have your desired length an extra piece of riser will be added so you don’t drop the well and can lower it slowly to the bottom. Once this is reached the very last piece should not be threaded on tightly. This piece will be left loose so when you start the removal process of the outer casing you can separate this piece and pull it out. This makes it so you do not have to lift the outer casing above the well stickup. 4. Move Geoprobe head into position to where the leaf pull plates line up on rod. If the rod was originally driven to ground level, thread a 2-foot rod on the string to extend the string, allowing the rod grip system to grab the rod string. 5. Install rod grip tool by aligning the pull pins on the head with the tool. 6. Begin pulling rods from the ground. During this process one person should hold the well casing installed earlier down to make sure it does not begin coming up. If the well casing does begin to come up stop the process. Grab a hammer and begin tapping on the well casing as the other person pulls up to prevent the well casing from coming up. Do not hit the well casing to hard as it

can break the plastic well and pieces may come off.

7. Once you have almost reached the top of pulling out the first 5' rod, un-thread the last piece of casing and remove it. Then continue to pull the outer rods out all the way to the top. Install the rod clamp at ground level to secure the rod string.

8. Relax the pull of the Geoprobe head and remove the rod grip tool. You can relax the pull of the Geoprobe by lowering the head a little once the rods are clamped and secured.

9. Move the Geoprobe head back away from the rod and remove the upper rod.

10. Repeat the procedure starting from step 4 above until all rods have been removed from the ground. Once you have removed enough casing above the screen the well should stay in place. However, putting the extra well casing to make sure the well is staying down in place is good practice and should be done through the whole process until all rods are out of the ground.

11. Once rods have been removed, measure down with a tape measure to see how far down the hole is open to. Sand must be 2' above the screen or natural back fill. If you measure and the hole has collapsed 2' above the screen, one person should poor a little sand down the hole while the other person uses the tape measure moving it up and down. Moving the tape measure up and down will help prevent bridging of the sand. Once a little sand has been added see if the hole has filled up. If the hole has not filled up, keep adding sand until you raise the level by about an inch. This will let you know that voids have been filled and bentonite can now not reach the pre-pack screen and blind it off.

12. Once you have filled the hole with sand, bentonite can be added to ground surface or to spec. Some instances natural back fill must be used the last 3 feet or if a flush mount is to be installed the last foot should be left open for adding the flush mount and concrete.

13. Once well is installed cut to desired length.

14. If placing standup protective casing around well use at least a 5' long protective casing. Cut the well so there is 32" stickup. Mark the protective casing so when you open the lid the well will be flush. Center the protective casing over the well and use the Geoprobe to push the protective casing down make sure the protective casing is level. As you do this process a little bit of hammer may be necessary. Every so often you should check to make sure you are not pushing the well down, and it is still centered. Once the well is level with the open lid of the protective casing, place silica sand between the well

	and the protective casing. 15. If placing a flush mount use shovels to dig out the dirt around the well and place your flush mount. If in asphalt or concrete use a concrete saw to cut a chunk out and dig down to make the flush mount level. Once flush mount is level mix concrete according to the bag and poor around and smooth out the concrete around the well. You want to have a slight slope away from the well to keep running water from going into your well.

HSSE CONSIDERATIONS

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

SOURCE	*HAZARDS*	*WHERE*	*HOW, WHEN, RESULT*	*CONTROLS*
CHEMICAL	Contact with impacted soils and water.	Impacted sites, during sample collection and handling.	Adverse health effects could result from ingesting, inhaling, and/or skin/eye contact with impacted soils and water.	Personnel will practice proper personal hygiene – wash hands prior to eating/drinking and when leaving the site. Employees will wear nitrile gloves when collecting and handling samples. Employees will wear work gloves when handling probe rods. Work will be suspended during high wind conditions that produce large amounts of visible impacted dust.
	Hydraulic fluid and diesel.	Geoprobe®.	Employees could be exposed to hydraulic fluid and/or diesel via inhalation, ingestion, and skin/eye contact, when operating the Geoprobe®, or if equipment malfunctions resulting in adverse health effects.	Employees will wear work gloves and eye protection if contact with hydraulic fluid/diesel is possible. In the event of a spill/leak, personnel will contain the fluid using the spill cleanup material available in the Geoprobe® trailer. Cleanup materials will be disposed of according to the appropriate regulations. All components of the rig will be inspected prior to and at the completion of the task. Non-essential personnel will maintain a 20-foot buffer zone around the equipment.

HSSE CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.				
	Lubricating grease.	Probing location.	Employees could be exposed to lubricating grease via ingestion and skin/eye contact when assembling probe rods resulting in adverse health effects.	Employees will wear work gloves and eye protection when assembling probe rods.
	Liquinox	Probing location.	Employees could be exposed to Liquinox via ingestion and skin/eye contact when assembling probe rods resulting in adverse health effects.	Employees will wear work gloves and eye protection when assembling probe rods.
NOISE	Elevated noise levels.	Geoprobe®.	Employees could be exposed to elevated noise levels when operating the Geoprobe® resulting in irritability, decreased concentration, and noise-induced hearing loss.	Personnel within a 20-foot buffer zone of the Geoprobe® will wear single hearing protection (e.g. earmuffs or earplugs). Non-essential personnel will maintain a 20-foot buffer zone around the Geoprobe®.
PRESSURE	Pressurized hydraulic lines.	Geoprobe®.	Faulty pressurized hydraulic lines could burst resulting in personal injury/exposure and hydraulic fluid release.	All components of the rig will be inspected prior to and at the completion of the task.

HSSE CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.				
ELECTRICAL	Defective electrical lines.	Geoprobe®.	Contact with defective electrical lines could result in personal injury.	Inspect electrical lines of the Geoprobe® prior to and at the completion of the task.
BODY MECHANICS	Lifting and moving rods.	Probing location.	Employees could be exposed to back or muscle strains or sprains when lifting or connecting the Geoprobe® rods or installing well casing.	Employees will follow good lifting techniques including lifting with the legs and not the back, get a good grip, and keep the load close to your body. Two employees will lift the rods if necessary.
GRAVITY	Falls from slips and trips.	Uneven terrain, slick/muddy/wet surfaces and steep slopes.	Walking 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. Employees will plan their path and walk cautiously. Keep work area free of tools/rods. If conditions are wet/muddy, muck boots may be worn. Site can be cleared of snow, if applicable.
	Falling rods.	Probing location.	Heavy rods could slip off of worker's hands while carrying and assembling tool strings causing personal injury.	Employees will use work gloves when assembling and handling rods. Two workers will carry rods, if necessary. All personnel will wear steel-toe boots.
WEATHER	Cold/heat stress	Outdoors.	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 (e.g. layers). 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.		Electrocution, injury, death, or	Employees will follow the 30/30 rule during lightning

HSSE CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.				
		Sites.	equipment damage could be caused by lightning strike.	storms. When the Geoprobe® is running, the Geoprobe helper will watch/listen for lightning and thunder.
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 sunscreen, long-sleeve work shirts and long pants. Employees will also use safety glasses with tinted lenses.
BIOLOGICAL	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. All employees operating the Geoprobe® will be familiar with the basic controls of the machine including the Emergency Kill switch button.
	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. Wear Level D PPE and avoid contact with animals. Stop work if animals enter work area. Use insect repellant if necessary. First-aid kits will be available on site. Employees with allergies should notify their supervisor.
MECHANICAL	Improper body mechanics.	Assembling and handling rods/sample tubes.	Improper lifting, bending, squatting, and kneeling could result in muscle/back	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.

HSSE CONSIDERATIONS

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

			strains or other injuries.	Two people will lift, if necessary. Employees should stretch prior to starting work and they will take breaks when necessary.
	Pinch points.	During equipment assembly, well installation, and when cutting sample liners.	Employees could be exposed to hand injuries such as lacerations, punctures, cuts, and pinched fingers when assembling probe rods and sample or well casings, and when using the liner cutter.	Employees will wear work gloves when assembling probe rods and sample casings, using the liner cutter, and handling plastic core liners after they have been cut open. Workers will be trained on how to properly use the liner cutter.
	Flying debris.	Probing location.	Eye injuries could result from flying debris when assembling probe rods and sample casings.	Employees will wear safety glasses at all times during Geoprobe® operations.
PRESSURE	Pressurized hydraulic lines.	Geoprobe®.	Faulty pressurized hydraulic lines could burst resulting in personal injury/exposure and hydraulic fluid release.	All components of the rig will be inspected prior to and at the completion of the task.
THERMAL	Grass fire	Outdoors in dry season.	Parking or driving vehicle /Geoprobe on or near dry grass could cause a fire and equipment or environmental damage.	Personnel will avoid parking or driving in areas containing dry shrubs or tall grass during hot/dry weather conditions.

HSSE CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.				
HUMAN FACTORS	Inexperience and improperly trained worker.	Sites.	Inexperience workers and improper training could cause incidents resulting in personal injuries and/or property damage.	Employees will be properly trained int his procedure and other applicable procedures. When starting/stopping for the first time, an experienced operator should be on site to help coach the process. All employees operating the Geoprobe® will be familiar with the basic controls of the machine including the Emergency kill switch button. 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	Level D PPE.
APPLICABLE SDS	SDSs will be maintained based on site characterization and contaminants. Hydraulic fluid, diesel, Liquinox, and lubricating grease.
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-GEOPROBE-07 Operating the Geoprobe® During Probing Operations
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**
SAFETY AND HEALTH MANAGER	**DATE**

Revisions:

Revision	Description	Date
1	Update to SOP to reflect Geoprobe ® Model 7822DT	11/16/2020

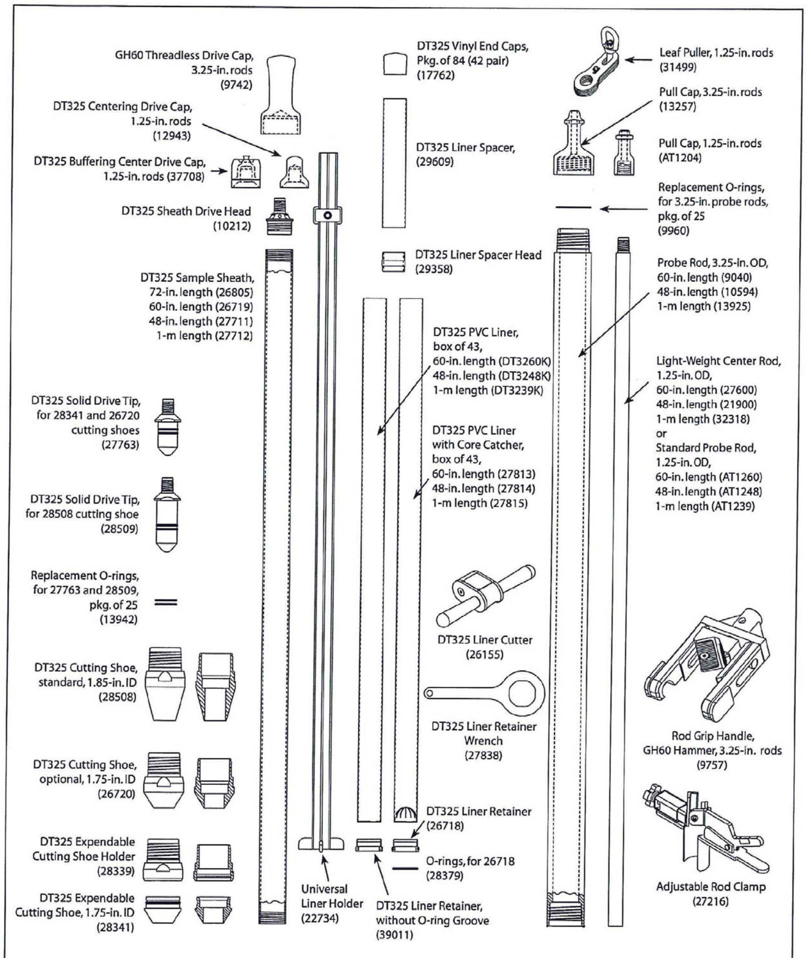


Figure 3.1
DT325 parts and accessories.

Standard Operating Procedure 7 DT325 Sampling System

Figure 1 - The DT-325 Tool String Diagram

PURPOSE	To provide standard instructions for operating the Geoprobe® Model 7822DT during probing operations.
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
Probe Operating Controls	***Probe*** The Probe Control Lever operates the probe cylinder. The probe control lever will lower and raise the probe cylinder and the hammer assembly. Place the probe control lever in the downward position to lower the probe cylinder and place the probe control lever in the upward position to raise the probe cylinder. The probe cylinder uses the static weight of the machine to push/hammer the rig tooling into the ground to either conduct sampling or install wells. ***Hammer/Rotation*** The Hammer/Rotation Control Lever activates and deactivates the hammer percussion and also will allow rotation when percussion is conducted. The Hammer/Rotation is used when the static weight of the machine is not enough force to push the tooling into the ground. Sometimes the hammer function is helpful when sampling and not getting very good recovery just with the static weight of the rig. The rotation is generally not used during probing operations. The rotation is typically used when using a special concrete bit to drill holes through concrete in a roto-hammer fashion. ***Auger*** The Auger Control Lever controls the speed and direction of the auger head. This tool is not used in Pioneer's probing operations. ***Regen (Two-Speed Pull System)*** The Regen Control Switch activates the regenerating probe cylinder circuit. By activating the circuit, the probe cylinder will move up and down much faster. With the low speed setting (full pulling power), the full pull stroke takes 11 seconds, while on the fast speed setting, the full stroke takes 5 seconds. When using the high-speed setting, the probe cylinder will lose a lot of its pulling force. This switch is mainly used on shallow holes or at the end of the tool string on deeper holes when heavy pulling is not required.

Probing Using Static Weight	When using static weight, the Geoprobe® only uses the weight of the unit to advance probe rods. 1. Drive and position the Model 7822DT at the desired sampling location. Refer to SOP-GEOPROBE-04 Driving and Positioning the Geoprobe® Model 7822DT for instructions. 2. Put a magnetic bullet level on the front of the derrick on the rig. Ensure the derrick is vertical in the fore and aft position. To plumb the derrick vertically, use the Fold Control Lever until the derrick is plumb. 3. Set up the tool string using the desired configuration for the DT-22 or the DT-325/375 dual tube systems. Refer to SOP-GEOPROBE-05 Geoprobe® DT-22 Dual Tube Sampling System and SOP-GEOPROBE-06 Geoprobe® DT-325/375 Dual Tube Sampling System for tool string diagrams and set-up procedures. 4. Position the initial pipe/tool string under the Geoprobe hammer. Lower the hammer onto the drive cap by placing the probe lever into the downward position. ***CAUTION:*** *do not hold onto the drive cap; make sure to hold onto the push rod when lowering the probe hammer onto the drive head. This will make sure that no appendages can be pinched between the metal.* 5. Place the magnetic bullet level on the front of the pipe. Use the extend lever to get the pipe plumb fore and aft. 6. Place the magnetic bullet level on the side of the pipe . Use the swing lever to get the pipe plumb from side to side. ***IMPORTANT:*** *ensure that the first pipe entering the ground is plumb. This will ensure there is no angle to the probe hole and will make for easier extraction when pulling the tool string out of the ground. It is best to initially check the pipe for level and then push the pipe approximately one foot into the ground and check the level again. In some instances, it may be necessary to check the rod plumb every half foot due to difficult probing conditions. Do not try to force the pipe level after the first pipe has entered the ground. This may damage the threads on the pipe and can break the pipe itself.* 7. When the first pipe/tool string is plumb, begin the push by pulling the probe lever down to start pushing the rod into the ground. Stop approximately one foot into the push and check for rod plumbness. Then continue to push the rod into the ground by pulling down on the probe lever. Check for rod plumb as necessary as the first rod is advanced. During static weight probing, the foot of the Geoprobe

	derrick may or may not slightly lift off of the ground. To get a feel for the machine and how hard the soil is, the operator should place their left foot on the front portion of the foot of the rig to provide feedback on how the push is progressing. **NOTE:** if the operator is recovering small soil samples, try to use the hammer lever slightly to try and vibrate the soil into the sample tube. It is very unlikely that just the static weight of the rig will be able to push the rod into the ground past four to eight feet. If the operator is collecting soil caps as per SOP-GEOPROBE-05 Geoprobe® DT-22 Dual Tube Sampling System and/or SOP-GEOPROBE-06 Geoprobe® DT-325/375 Dual Tube Sampling System. The remainder of the push will be completed following the appropriate SOP. If the operator is collecting soil cores, follow SOP-GEOPROBE-05 Geoprobe® DT-22 Dual Tube Sampling System and/or SOP-GEOPROBE-06 Geoprobe® DT-325/375. **NOTE:** as stated before, generally the static weight alone is not enough to reach the total depth of the hole. Do not just use static weight if one believes they have reached refusal. Refusal is when the piping will not go into the ground anymore.
Probing Using Percussion and Static Weight	The tool string cannot be advanced only of the Geoprobe weight in most soil formations. In these situations, hammer percussion must be employed as described in this section. 1. Follow steps in task “Probing using only the static weight of the Geoprobe” prior to starting probing using percussion. 2. Put a magnetic bullet level on the front of the derrick on the rig. Ensure the derrick is vertical in the fore and aft position. To plumb the derrick vertically, use the Fold Control Lever until the derrick is plumb. 3. Place the magnetic bullet level on the side of the derrick to check the verticality side to side. Use lever to rotate derrick until plumb. Position the initial pipe/tool string under the Geoprobe hammer. Lower the hammer onto the drive cap by placing the probe lever into the downward position. NOTE: Ensure that the first pipe entering the ground is plumb. This will ensure there is no angle to the probe hole and will make for easier extraction when pulling the tool string out of the ground. It is best to initially check the pipe for level and then push the pipe approximately one foot into the ground and check the level again. In some instances, it may be necessary to check the rod plumb every half foot due to difficult probing conditions. Do not try to force the pipe level after the first pipe has entered the ground. This may damage the threads on the pipe and can break the pipe itself.

	When the first rod/tool string is plumbed, begin to pull the probe lever and the hammer/rotation lever down simultaneously to start pushing and hammering the rod into the ground. Stop part way through the push of the rod and re-plumb the pipe. Then continue to push the rod into the ground by pulling down on the probe lever and hammer/rotation lever. During percussion probing, the foot of the derrick should be lifted roughly an inch off of the ground. To get a feel for the machine and how hard the soil is, the operator should place their left foot on the front portion of the foot of the rig. 4. ***NOTE:*** *the operator needs to make sure that the foot of the derrick comes off of the ground during percussion probing. If the foot is not coming off of the ground, the rubber bumpers will melt and deteriorate. This is because not enough static weight is being applied to the tool string.* 5. If the operator is collecting soil cores, the next step would be to pull off the drive caps and use the extraction "T" to pull the sample out of the outside casing as per SOP-GEOPROBE-05 Geoprobe® DT-22 Dual Tube Sampling System and/or SOP-GEOPROBE-06 Geoprobe® DT-325/375 Dual Tube Sampling System SOP-Geoprobe. The remainder of the push will be completed following the appropriate SOP. Note: Depending on subsurface conditions, there may be instances where probe refusal is encountered. Continued hammering on a rod that is not advancing can cause damage to the rod string. The Pioneer operator needs to recognize refusal and determine the best course of action. In some instances when the probe rod encounters a small subsurface cobble, hammering on the rod will break the cobble allowing the probe string will advance. Knowing subsurface stratigraphy in advance if possible will assist in making good field decisions when it comes to refusal.
Adding Probe Rods, Inner Rods, and Sample Liners or Sheaths	Probe rods must be added to the tool string to reach the desired depth below ground surface. 1. Using the probe control lever, raise the hammer assembly to its full height. 2. Using the extend lever, extend back as far as the rig will go. This will allow for easy access to the in-ground tool string and will allow for easy addition of probe rods and sampling equipment. 3. Remove the outer drive cap from the probe rod that was driven into the existing ground followed by removing rubber bumper and/or inner rod drive cap.

	4. Thread the extraction "T" to the inner rod string and use "T" to pull up to remove the inner rods and sample liner or sample sheath out of the existing probe rod string. The inner rods simply thread onto each other and to the sample core or sample sheath. Refer to SOP-GEOPROBE-05 to see the procedure and diagrams of how to set up the DT-22 Sample Core. Refer to SOP-GEOPROBE-06 to see the procedure and diagrams of how to set up the DT-325/375 Sample Sheath. 5. If retrieving cores, replace the sample core or sample sheath with a clean set and attach enough inner rod to leave an extra length of inner rod (4 feet) out of the in-ground probe rod. 6. Place a new piece of outer probe rod over the 4-foot length of inner rod sticking out of the existing hole and thread the new probe rod to the existing probe rod in the ground. Tighten the threaded joint with a pipe wrench. 7. Place inner rod drive cap and/or rubber bumper followed by the outer rod drive cap. Use the extend lever to extend the rig outward until the Geoprobe hammer is above the drive cap. 8. Slowly lower the probe cylinder onto the top probe rod with the probe control lever. 9. Advance the tool string into the ground. 10. Repeat steps 1- 9 until the desired sampling depth or refusal is reached. ***IMPORTANT:*** *do not continue probing if the tool string meets refusal. Prolonged hammering at refusal can cause damage to the tool string.*
Pulling Probe Rods with the Pull Cap	A pull cap is used to retract probe rods from an existing bore hole, when monitoring well materials through and the rods do not need to be lifted over the well casing are not being set 1. Raise the hammer assembly just high enough to provide access to the top probe rod. 2. Remove the drive cap from the top probe rod of the tool string. 3. Attach a pull cap to the top probe rod by threading the pull cap securely onto the probe rod. 4. Ensure that the probe foot is in contact with the ground surface. This provides support for the unit. The downward force resulting from pulling the rods may damage the unit if the foot is not supported.

	NOTE: if when pulling the probe rods out of the ground the foot begins to sink into the ground, then lengths of blocking should be placed under the foot to allow for more surface area to support the force on the ground. 5. Hold down on the probe control lever until the drive head is close to the pull cap. 6. Pull the pin upward to release the extraction latch and place it around the pull cap. 7. Retract the probe rod by placing the probe control lever in the upward position until motion has stopped. 8. Once the probe cylinder is all the way up and the first probe rod has been retracted, place the Kwik Klamp-pipe clamp on the lower section of the pipe. A pipe clamp is used to support the weight of the rod string so that when the extraction latch is taken off, the top piece of pipe can be unattached from the tool string without losing the rest of the tool string down the hole. 9. Lower the probe cylinder slightly so the extraction latch is free from the pull cap. Pull the extraction latch and lock it back into its locked position. 10. Place the section of pipe that was taken off of the tool string to the side or in the rod rack out of the way. 11. Repeat steps 3 through 10 until the entire tool string has been extracted from the ground. Note: The last rod out of the ground is relatively unsupported. Special care must be taken to avoid dropping the rod back down the hole. One method to prevent rod loss is to leave the Kwik Klamp tool on the rod until the rod is well away from the probe hole. If the rod slips, the Kwik Klamp prevents the rod from getting loose and falling back into the hole.
Pulling Probe Rods with the Rod Grip Pull System	The rod grip pull system is used when installing monitoring wells and other applications when the inside of the tool string needs to be available during extraction of the probe rods. There are three handle assemblies and jaws to accommodate the various rod sizes: 1.0-inch, 1.25-inch, 2.125-inch, 3.25-inch and 3.75-inch. ***Pulling Probe Rods*** In order to pull with this system, there must be enough exposed probe rod above the ground surface to allow the puller jaws to engage the outside of

the rod. Approximately 18 inches of exposed rod is needed. If the tool string is driven too far and the puller cannot fully engage the top probe rod, simply add another rod to the tool string and reattach the handle assembly.

IMPORTANT: it is very important that the puller jaws never grip over the threaded section of a probe rod. Severe damage to the threads will result. Furthermore, avoid placing the puller near rod joints as gripping is not as effective at this location and rod deformation can occur.

1. Lower the extraction latch so it will not bind up the pipe when extracting with the rod grips.

2. Position the hammer with the jaws directly behind the top probe rod and below the threads. Take the appropriate handle assembly (according to rod diameter) and orientate the jaw cutout toward the probe rod as shown in.

3. Hook the handle over the socket head cap screws on each side of the probe cylinder.

4. To start pulling, lower the end of the handle assembly and raise the probe cylinder. This tightly clamps the jaws of the handle and probe cylinder around the probe rod. If slipping occurs, step on the end of the handle assembly to encourage the gripping action.

5. Once fully raised, place a pipe vice on top of the probe rod string below the retracted rod connection and slightly lower the probe cylinder to release the pressure on the probe rod. Lift the end of the handle to rotate the assembly on the cap screws. This moves the handle jaw away from the probe rod and disengages the puller. The probe cylinder can now be lowered to pull another section of rod. Once the rod grip puller is engaged on the next rod, the rod above is removed. Alternatively, and especially if rod deviation took place during probing operations, the rod grip puller is removed, the Geoprobe is extended inward, and the hammer is lowered into the pulling position. The Geoprobe is then extended out until the rod grips are aligned with the probe rod. The rod grip puller then is installed and used to pull the next section of probe rod. In some cases, the rod grip handle gets very tight and does not want to loosen when ready for removal. In that case, a hammer can be used on the outer end of the handle with an upward motion to loosen the puller. Before extracting the next rod, the pipe clamp is loosened. One at the top of the pull, the pipe clamp is reattached to support the rod string before releasing the rod grip system.

6. Repeat steps 2 through 5 until the in-hole tool string is fully extracted.

Note: The last rod out of the ground is relatively unsupported. Special care must be taken to avoid dropping the rod back down the hole. One method

	to prevent rod loss is to leave the Kwik Klamp tool on the rod until the rod is well away from the probe hole. If the rod slips, the Kwik Klamp prevents the rod from getting loose and falling back into the hole.

HSSE CONSIDERATIONS

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

SOURCE	*HAZARDS*	*WHERE*	*HOW, WHEN, RESULT*	*CONTROLS*
CHEMICAL	Contact with impacted soils and water.	Impacted sites, during sample collection and handling.	Adverse health effects could result from ingesting, inhaling, and/or skin/eye contact with impacted soils and water.	Personnel will practice proper personal hygiene – wash hands prior to eating/drinking and when leaving the site. Employees will wear nitrile gloves when collecting and handling samples. Employees will wear work gloves when handling probe rods. Work will be suspended during high wind conditions that produce large amounts of visible impacted dust.
	Hydraulic fluid and diesel.	Geoprobe®.	Employees could be exposed to hydraulic fluid and/or diesel via inhalation, ingestion, and skin/eye contact, when operating the Geoprobe®, or if equipment malfunctions resulting in adverse health effects.	Employees will wear work gloves and eye protection, if contact with hydraulic fluid/diesel is possible. In the event of a spill/leak, personnel will contain the fluid using the spill cleanup material available in the Geoprobe® trailer. Cleanup materials will be disposed of according to the appropriate regulations. All components of the rig will be inspected prior to and at the completion of the task. Non-essential personnel will maintain a 20-foot buffer zone around the equipment.
	Lubricating grease.	Probing location.	Employees could be exposed to lubricating grease via ingestion and skin/eye contact when assembling probe rods resulting in adverse health effects.	Employees will wear work gloves and eye protection when assembling probe rods.

NOISE	Elevated noise levels.	Geoprobe®.	Employees could be exposed to elevated noise levels when operating the Geoprobe® resulting in irritability, decreased concentration, and noise-induced hearing loss.	Personnel within a 20-foot buffer zone of the Geoprobe® will wear single hearing protection (e.g. earmuffs or earplugs). Non-essential personnel will maintain a 20-foot buffer zone around the Geoprobe®.
ELECTRICAL	Defective electrical lines.	Geoprobe®.	Contact with defective electrical lines could result in personal injury.	Inspect electrical lines of the Geoprobe® prior to and at the completion of the task.
	Contact with overhead utilities.	Probing location.	Injury, death, or property damage could occur from contact with overhead utilities when the hammer assembly is raised to its highest position.	If overhead hazards are present, established overhead utility procedures will be followed. Probe locations will be moved to avoid working around overhead utilities. Employees will maintain the required minimal radial clearance distances based on voltage when working around overhead lines.
	Contact with underground utilities.	Probing location.	Injury, death or property damage could occur from contact with underground utilities when geoprobing.	Prior to starting work, employees will call for a utility locate (i.e., call 811). If underground utilities are present, established underground utility procedures will be followed. Probe locations will be moved to avoid working around underground utilities.
BODY MECHANICS	Lifting and moving rods.	Probing location.	Employees could be exposed to back or muscle strains or sprains when lifting or connecting the Geoprobe® rods.	Employees will follow good lifting techniques including lifting with the legs and not the back, get a good grip, and keep the load close to your body. Two employees will lift the rods if necessary.

GRAVITY	Falls from slips and trips.	Uneven terrain, slick/muddy/wet surfaces and steep slopes.	Walking 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. Employees will plan their path and walk cautiously. Keep work area free of tools/rods. If conditions are wet/muddy, muck boots may be worn. Site can be cleared of snow, if applicable.
	Falling rods.	Probing location.	Heavy rods could slip off of worker's hands while carrying and assembling tool strings causing personal injury.	Employees will use work gloves when assembling and handling rods. Two workers will carry rods, if necessary. All personnel will wear steel-toe boots.
WEATHER	Cold/heat stress	Outdoors.	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 (e.g. layers). 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.	Sites.	Electrocution, injury, death, or equipment damage could be caused by lightning strike.	Employees will follow the 30/30 rule during lightning storms. When the Geoprobe® is running, the Geoprobe helper will watch/listen for lightning and thunder.
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 sunscreen, long-sleeve work shirts and long pants. Employees will also use safety glasses with tinted lenses.

BIOLOGICAL	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. All employees operating the Geoprobe® will be familiar with the basic controls of the machine including the Emergency Kill switch button.
	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. Avoid contact with plants, insects, and animals. First-aid kits will be available on site. Employees with allergies should notify their supervisor.
MECHANICAL	Geoprobe® shifting.	Probing location, when probing with percussion and working on a sloped surface.	Personal injury and equipment damage could occur if the Geoprobe® shifts while probing with percussion and when working on a sloped surface.	When probing with percussion, do not raise the machine foot more than approximately 6 inches off the ground or the vehicle may become unstable and shift. When working on a sloped surface, position the rig so that it is facing upslope. In the event that the probe unit loses stability, it will roll away from the operator without causing injury.
	Struck by the Geoprobe®.	Operating the Geoprobe®.	Personnel could be injured if struck by the Geoprobe®.	Non-essential personnel will maintain a 20-foot buffer zone around the rig.
	Improper body mechanics.	Assembling, handling, and retrieving rods/sample tubes.	Improper lifting, bending, squatting, and kneeling could result in muscle/back strains or other	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

			injuries.	necessary. Employees will also use good body mechanics when retrieving rods/sample tubes: bend knees, lean slightly away from the object, keep back and wrists straight, use legs to move the objects. Employees should stretch prior to starting work and they will take breaks when necessary.
	Contact with rotating and moving parts of the Geoprobe®.	Operating the Geoprobe®.	Fingers/hands could become pinched or caught in moving/rotating parts of the Geoprobe® resulting in cuts, scrapes, and/or broken bones.	Employees will not touch moving/rotating parts of the rig. Personnel will tie back long hair and will not wear loose clothing when operating the machine. Work gloves are required when operating the rig. Operators will stand to the control side of the machine, clear of the probe foot and derrick, while operating the controls. Personnel will never reach across the probe assembly to manipulate the machine controls. All employees on site will be familiar with the basic controls of the machine including the Emergency Kill switch button.
	Pinch points.	During equipment assembly, advancing the Geoprobe®, and extracting probe rods.	Employees could be exposed to hand injuries such as lacerations, punctures, cuts, and pinched fingers when assembling probe rods and sample	Employees will always wear work gloves when operating the Geoprobe® and handling its components. Employees will never place their hands-on top of the tool string while raising or lowering the hammer. Workers will not place thumb or fingers between latch and hammer when raising

			casings, pulling probe rods and sampling devices with the hammer latch and/or the rod grip pull assembly, and when the Geoprobe hammer is in motion.	latch to pull probe rods and sampling devices from the ground. Grind or file sharp burrs that can be developed on the outside of probe rods if the rod grip puller is allowed to slip during tool retrieval.
	Flying debris.	Probing location.	Eye injuries could result from flying debris when driving tool strings into the ground.	Employees will wear safety glasses at all times during Geoprobe® operations.
PRESSURE	Pressurized hydraulic lines.	Geoprobe®.	Faulty pressurized hydraulic lines could burst resulting in personal injury/exposure and hydraulic fluid release.	All components of the rig will be inspected prior to and at the completion of the task.
THERMAL	Contact with hot drive head and caps.	Probing location.	The drive head and caps can become hot during probing operations and direct contact with these components could cause skin injuries.	Employees will let the drive head and caps cool down before removing them from the tool string. Workers will also wear work gloves when handling these components.
HUMAN FACTORS	Inexperience and improperly trained worker.	Sites.	Inexperience workers and improper training could cause incidents resulting in personal injuries and/or property damage.	Employees will be properly trained int his procedure and other applicable procedures. When starting/stopping for the first time, an experienced operator should be on site to help coach the process. All employees operating the Geoprobe® will be familiar with the basic controls of the

				machine including the Emergency kill switch button. 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	Level D PPE, earplugs, and earmuffs.
APPLICABLE SDS	SDSs will be maintained based on site characterization and contaminants. Hydraulic fluid, diesel, and lubricating grease.
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-GEOPROBE-04 Driving and Positioning the Geoprobe® Model 7822DT SOP-GEOPROBE-05 Geoprobe® DT-22 Dual Tube Sampling System SOP-GEOPROBE-06 Geoprobe® DT-325/375 Dual Tube Sampling System
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**
SAFETY AND HEALTH MANAGER	**DATE**

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
1	Updates to SOP to reflect Geoprobe ® Model 7822DT	11/16/2020

PURPOSE	To provide standard instructions for using a DH133 Automatic Drop Hammer to perform Standard Penetration Test (SPT).
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
Assembling and Driving the Outer and Inner Rods	An outer casing is first driven through the undisturbed soil with the probe unit hammer assembly to reach the top of the testing intervals. Specific instructions are listed below. 1. Align the probe unit hammer assembly by pulling the hammer pin and swinging the hammer over to the identified/applicable location. 2. Thread the SPT cutting shoe to the leading end of a heavy-weight outer probe rod (3.25-in. ODx60-in. length). 3. Thread the SPT solid drive tip to the leading end of a heavy-weight inner rod (1.25-in ODx60-in length). 4. Insert the heavy-weight inner rod into the outer rod until the solid drive tip partially extends from the bottom of the cutting shoe. 5. Slip a threadless drive cap to the top of the heavy-weight inner rod. 6. Place a threadless drive cap on top of the heavy-weight outer rod. 7. Raise the probe unit hammer assembly to its highest position by fully extending the probe cylinder until it stops. 8. Position the assembled rods directly under the probe unit hammer assembly with the cutting shoe centered between the probe foot. The heavy-weight outer rod should now be parallel to the probe derrick. A magnetic level should be placed on the heavy-weight rod to check rod verticality. 9. Start the probe unit hammer assembly using both down feed and hammer levers to advance the assembled rods into the ground until reaching the desired testing depth below ground surface.

Using the DH133 Automatic Drop Hammer	Once the rod assembly has been driven into the ground to reach the top of the desired testing interval, the operator can start using the DH133 Automatic Drop Hammer (drop hammer). Step by step instructions are listed below. 1. Remove the threadless drive cap on top of the heavy-weight outer rod. 2. Remove the threadless inner rod drive cap. 3. Remove the heavy-weight inner rod and remove the solid drive tip. 4. Assemble split spoon sampler and thread it to the bottom of the heavy-weight inner rod. 5. Insert the heavy-weight inner rod and the split spoon string into the outer rod that was previous driven into the ground. Add inner rod as necessary until the split spoon sampler is resting on bottom. 6. Using a marker, mark the desired testing intervals (typically 6', 12", 18" and 24") on the heavy-weight inner rod. 7. Unlatch and swing the Geoprobe® hammer directly above the heavy-weight inner rod. 8. Activate the drop hammer on by using the axillary hydraulic switch to advance the heavy-weight inner rod and split spoon into the ground until reaching the desired testing depth. The operator will count and record the number of blow counts that is takes to reach each testing interval previously marked on the heavy-weight inner rod. If the blow count reaches 50 and the full 6-inch interval has not been sampled, it will be called refusal and the hammer will be stopped. 9. Reposition the Geoprobe® hammer by the swing function. Adjust Geoprobe ® so the probe unit hammer assembly is directly above the heavy-weight inner rod. Using the probe machine and a threaded pull cap, pull up the heavy-weight inner rod and split spoon. The outer rod remains in the ground. 10. Remove the split spoon from the heavy-weight inner rod. Disassemble the split spoon sampler by removing the cutting shoe and adapter pin from either end of the split spoon. Open the split spoon and collect the soil sample. Then, decontaminate the split spoon components as necessary, assemble the two halves of the sample tube, and thread the cutting shoe

back onto the leading end of the split spoon and the adapter pin onto the opposite end.

11. Thread a solid drive tip onto the leading end of a heavy-weight inner rod and connect an additional heavy-weight inner rod to other end of the rod.

12. Place the threadless drive cap onto the top of the heavy-weight inner rod tool string.

13. Insert the assembled heavy-weight inner rod tool string into the 3.25” outer rod that was previously driven into the ground.

14. Using the overhead winch, raise a heavy-weight outer rod and feed it over the protruding heavy-weight inner rods. Thread the heavy-weight outer rod onto the outer rod that was previously driven into the ground.

15. Place a threadless drive cap on top of the heavy-weight outer rod tool string.

16. Using the probe unit hammer assembly, drive the assembled rods into the ground to the top of the next SPT sample interval.

17. Remove the threadless drive cap from the heavy-weight outer rods and the threaded drive cap from the heavy-weight inner rods.

18. Thread a loop pull cap onto the tool string of heavy-weight inner rods.

19. Connect the overhead winch to the loop pull cap and remove the heavy-weight inner rod tool string.

20. Remove the solid drive tip from the heavy-weight inner rods and thread a split spoon sampler onto the assembled heavy-weight inner rods.

21. Replace the loop pull cap on the heavy-weight inner rods with a threaded drive cap.

22. Insert the assembled heavy-weight inner rod tool string into the 3.25” outer rod that was previously driven into the ground until it rests on bottom. Once on bottom, mark the inner rod string for the proper SPT intervals

23. Reposition the Geoprobe® so the drop hammer is directly above the heavy-weight inner rods.

24. Activate the drop hammer on to drive the tool string of heavy-weight inner rods and split spoon into the ground until reaching the desired testing depth. The operator will count the number of blow counts that is takes to reach each testing interval marked on the heavy-weight inner rod.

Repeat steps 9 to 24 until reaching the end of the testing depth.

	Note: as the assembled rods get longer and heavier, use the probe machine, the overhead winch, and/or the adjustable rod clamp to facilitate the process of placing and retrieving rods.
Outer Casing Retrieval	The outer casing may be retrieved in two ways: 1. Entire casing string removed from the ground and remaining probe hole sealed from ground surface with granular bentonite. The outer casing may be pulled from the ground with the probe machine and a pull cap, if the probe hole is to be sealed with granular bentonite from the ground surface. This method is used for shallow probe holes in stable formations only. Such conditions allow the entire probe hole to be sealed with granular bentonite. 2. Casing pulled with probe hole sealed from bottom-up during retrieval. Bottom-up grouting should be performed during casing retrieval in unstable formations where side slough is probable. Such conditions create void spaces in the probe hole if granular bentonite is installed from the ground surface.

HSSE CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.				
SOURCE	***HAZARDS***	***WHERE***	***HOW, WHEN, RESULT***	***CONTROLS***
CHEMICAL	Contact with impacted soils and water.	Impacted sites, during sample collection and handling.	Adverse health effects could result from ingesting, inhaling, and/or skin/eye contact with impacted soils and water.	Personnel will practice proper personal hygiene – wash hands prior to eating/drinking and when leaving the site. Employees will wear nitrile gloves when collecting and handling samples. Employees will wear work gloves when handling probe rods. Work will be suspended during high wind conditions that produce large amounts of visible impacted dust.
	Hydraulic fluid and diesel.	Geoprobe®.	Employees could be exposed to hydraulic fluid and/or diesel via inhalation, ingestion, and skin/eye contact, when operating the Geoprobe®, or if equipment malfunctions resulting in adverse health effects.	Employees will wear work gloves and eye protection, if contact with hydraulic fluid/diesel is possible. In the event of a spill/leak, personnel will contain the fluid using the spill cleanup material available in the Geoprobe® trailer. Cleanup materials will be disposed of according to the appropriate regulations. All components of the rig will be inspected prior to and at the completion of the task. Non-essential personnel will maintain a 20-foot buffer zone around the equipment.
	Lubricating grease.	Probing location.	Employees could be exposed to lubricating grease via ingestion and skin/eye contact when assembling probe rods resulting in adverse health effects.	Employees will wear work gloves and eye protection when assembling probe rods.

NOISE	Elevated noise levels.	Geoprobe®.	Employees could be exposed to elevated noise levels when operating the Geoprobe® resulting in irritability, decreased concentration, and noise-induced hearing loss.	Personnel within a 20-foot buffer zone of the Geoprobe® will wear single hearing protection (e.g. earmuffs or earplugs). Non-essential personnel will maintain a 20-foot buffer zone around the Geoprobe®.
ELECTRICAL	Defective electrical lines.	Geoprobe®.	Contact with defective electrical lines could result in personal injury.	Inspect electrical lines of the Geoprobe® prior to and at the completion of the task.
	Contact with overhead utilities.	Probing location.	Injury, death, or property damage could occur from contact with overhead utilities when the hammer assembly is raised to its highest position.	If overhead hazards are present, established overhead utility procedures will be followed. Probe locations will be moved to avoid working around overhead utilities. Employees will maintain the required minimal radial clearance distances based on voltage when working around overhead lines.
	Contact with underground utilities.	Probing location.	Injury, death or property damage could occur from contact with underground utilities when geoprobing.	Prior to starting work, employees will call for a utility locate (i.e., call 811). If underground utilities are present, established underground utility procedures will be followed. Probe locations will be moved to avoid working around underground utilities.
BODY MECHANICS	Lifting and moving rods.	Probing location.	Employees could be exposed to back or muscle strains or sprains when lifting or connecting the Geoprobe® rods.	Employees will follow good lifting techniques including lifting with the legs and not the back, get a good grip, and keep the load close to your body. Two employees will lift the rods if necessary.

GRAVITY	Falls from slips and trips.	Uneven terrain, slick/muddy/wet surfaces and steep slopes.	Walking 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. Employees will plan their path and walk cautiously. Keep work area free of tools/rods. If conditions are wet/muddy, muck boots may be worn. Site can be cleared of snow, if applicable.
	Falling rods.	Probing location.	Heavy rods could slip off of worker's hands while carrying and assembling tool strings causing personal injury.	Employees will use work gloves when assembling and handling rods. Two workers will carry rods, if necessary. All personnel will wear steel-toe boots.
WEATHER	Cold/heat stress	Outdoors.	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 (e.g. layers). 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.	Sites.	Electrocution, injury, death, or equipment damage could be caused by lightning strike.	Employees will follow the 30/30 rule during lightning storms. When the Geoprobe® is running, the Geoprobe helper will watch/listen for lightning and thunder.
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 sunscreen, long-sleeve work shirts and long pants. Employees will also use safety glasses with tinted lenses.

BIOLOGICAL	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. All employees operating the Geoprobe® will be familiar with the basic controls of the machine including the Emergency Kill switch button.
	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. Avoid contact with plants, insects, and animals. First-aid kits will be available on site. Employees with allergies should notify their supervisor.
MECHANICAL	Geoprobe® shifting.	Probing location, when using the drop hammer and working on a sloped surface.	Personal injury and equipment damage could occur if the Geoprobe® shifts while using the drop hammer and when working on a sloped surface.	When using the drop hammer, do not raise the machine foot more than approximately 6 inches off the ground or the vehicle may become unstable and shift. When working on a sloped surface, position the rig so that it is facing upslope. In the event that the probe unit loses stability, it will roll away from the operator without causing injury.
	Struck by the Geoprobe®/drop hammer.	Operating the Geoprobe®/ drop hammer.	Personnel could be injured if struck by the Geoprobe®/drop hammer.	Non-essential personnel will maintain a 20-foot buffer zone around the rig.
	Improper body mechanics.	Assembling, handling, and retrieving	Improper lifting, bending, squatting, and	Personnel will use proper lifting techniques – get a good grip, keep the load close to the

		rods/sample tubes.	kneeling could result in muscle/back strains or other injuries.	body, lift with legs and not with back, and avoid lifting loads above shoulder height. Two people will lift, if necessary. Employees will also use good body mechanics when retrieving rods/sample tubes: bend knees, lean slightly away from the object, keep back and wrists straight, use legs to move the objects. Employees should stretch prior to starting work and they will take breaks when necessary.
	Back injuries.	Moving the drop hammer with hand dolly.	Back injuries and muscle/back strains could result when using the hand dolly to move the drop hammer.	Employees will inspect the hand dolly (including all wheels) before using it. Two employees will load the drop hammer on the hand dolly. Workers will use proper body mechanics when loading the drop hammer. Employees will make sure the weight is evenly distributed on all wheels of the hand dolly. Employees will always push a hand dolly to move the load, instead of pulling the hand dolly. Personnel will use a belt to keep the drop hammer from shifting or slipping.
	Contact with rotating and moving parts of the drop hammer.	When the drop hammer is in motion.	Fingers/hands could become pinched or caught in moving/rotating parts of the drop hammer resulting in cuts, scrapes, and/or broken bones.	Employees will not touch moving/rotating parts of the drop hammer. Work gloves are required when operating the drop hammer. Operators will stand to the control side of the machine, clear of the probe foot and drop hammer, while operating the

				controls. Personnel will never reach across the probe assembly to manipulate the machine controls. All employees on site will be familiar with the basic controls of the machine including the Emergency Kill switch button.
	Pinch points.	When mounting the drop hammer, while the drop hammer is in motion, assembling probe rods, and extracting probe rods.	Employees could be exposed to hand injuries such as lacerations, punctures, cuts, and pinched fingers.	Employees will always wear work gloves. Employees will never place their hands-on top of the tool string while raising or lowering the drop hammer.
	Flying debris.	Probing location.	Eye injuries could result from flying debris when driving tool strings into the ground with the drop hammer.	Employees will wear safety glasses at all times during Geoprobe® operations.
PRESSURE	Pressurized hydraulic lines.	Geoprobe®.	Faulty pressurized hydraulic lines could burst resulting in personal injury/exposure and hydraulic fluid release.	All components of the rig will be inspected prior to and at the completion of the task.
THERMAL	Cold/heat stress.	Outdoors.	Exposure to cold climates may result in cold burns, frostbites, and hypothermia. Exposure to high temperatures may result in	Training on signs and symptoms of cold/heat stress. Personnel will wear appropriate clothing when working outdoors. Employees will remain hydrated and will have sufficient caloric intakes during the day. Personnel will

			heat cramps, heat exhaustion, or heat stroke.	follow procedures outlined in applicable SSHASP and/or Pioneer corporate HASP.
HUMAN FACTORS	Inexperience and improperly trained worker.	Sites.	Inexperience workers and improper training could cause incidents resulting in personal injuries and/or property damage.	Employees will be properly trained int his procedure and other applicable procedures. When starting/stopping for the first time, an experienced operator should be on site to help coach the process. All employees operating the Geoprobe® will be familiar with the basic controls of the machine including the Emergency kill switch button. 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	Level D PPE, earplugs, and earmuffs.
APPLICABLE SDS	SDSs will be maintained based on-site characterization and contaminants. Hydraulic fluid, diesel, lubricating grease.
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	DH133 automatic drop hammer: hitch mounted basket, counterweights, hand dolly, pipe wrench, safety pin, machine vise, work table, and deionized water.
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**
SAFETY AND HEALTH MANAGER	**DATE**

Revisions:

Revision	Description	Date
1	Updates to SOP to reflect Geoprobe ® Model 7822DT	11/16/2020

PURPOSE	To provide standard instructions for equipment decontamination (inorganic contaminants – heavy metals).
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) or work plan, 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 Site-Specific Health and Safety Plan (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, one-time-use equipment should be used, and disposed of in accordance with the SAP, work plan, and SSHASP.

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
Remove gross contamination.	Remove gross contamination with a tap water rinse. If available, use pressurized or gravity flow tap water. If not, a 5-gallon bucket of tap water and a stiff brush may be used.
Wash equipment.	Wash equipment in a solution of soap (no phosphate) and tap water with a stiff brush.
Triple rinse equipment.	Triple rinse the equipment with tap water. Then, rinse the equipment with de-ionized or distilled water.
Rinse equipment with nitric acid/distilled water mixture.	If specified in the SAP, work plan, or SSHASP, rinse the equipment with a mixture of 10:1 nitric acid in distilled water (10 parts water to 1-part nitric acid). In many cases, the tap water and de-ionized water rinses will be sufficient. If a nitric rinse is used, rinse the equipment again with distilled water.

Air dry equipment.	Place equipment on plastic sheeting or foil to air dry.
Transport/ store equipment.	Wrap equipment in foil or plastic wrap to transport or store.
Triple rinse decontamination equipment.	Triple rinse equipment (i.e., brushes, buckets, tubs, etc.) used in the decontamination process with water, preferably pressurized.
Wash decontamination equipment.	Agitate the equipment used in the decontamination process in the soap/tap water solution. (The tub which holds the solution will only have the water rinse)
Triple rinse decontamination equipment.	Triple rinse equipment with tap water.
Store and label decontamination equipment.	Place equipment in appropriate areas, so they are used only for decontamination purposes. Label the equipment, if necessary.
Dispose of decontamination solutions.	Use a wastewater container to properly dispose of the soap/tap water solution, the tap water rinse, and the de-ionized water rinse. Use an organic solvent waste container to properly dispose of the solvent rinse. 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 as such. **Note:** when using other than the above-mentioned solutions, check with the Safety and Health Manager and the Project Manager. Some solvents must be evaporated.
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 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 dental erosion.	Employees will prevent skin/eye contact with nitric acid and they will wear nitrile gloves and eye protection when handling nitric acid and the nitric acid and distilled water mixture.
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 decontamination equipment.	Personnel will use proper lifting techniques – get a good grip, hold the load close to the body, lift with the legs and not with the back, and avoid lifting above shoulder height. Use two employees to lift equipment when necessary.
GRAVITY	Slips and falls.	Sites.	Slips and falls could occur while performing decontamination procedures due to slippery surfaces resulting in	Workers will wear work boots with good traction and ankle support. Keep work areas as dry as possible. Wear muck boots, as necessary.

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

			bruises, scrapes, or broken bones.	
WEATHER	Cold/heat stress.	Outdoors.	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). 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.	Outdoors.	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 sunscreen, long-sleeve work shirts and long pants. Employees will also use safety glasses with tinted lenses.
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. Avoid contact with plants, insects, and animals. First-aid kits will be available on site. Employees with allergies will notify their supervisor.
MECHANICAL	Struck by and/or caught in between heavy equipment or	Sites.	Personnel could be injured if struck by and/or caught in	When applicable, employees will communicate with the contact person of other contractors on the site.

HSSE CONSIDERATIONS

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

	vehicles.		between heavy equipment or vehicles while performing decontamination procedures.	Personnel will avoid working near heavy equipment/vehicles, when possible. High visibility clothing will be worn. When possible, personnel will park field vehicles or use traffic cones to prevent third party vehicles from coming into the work area.
PRESSURE	Not applicable.			
THERMAL	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. Employees will remain hydrated and will have sufficient caloric intakes during the day.
	Hypothermia/frostbite.	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.
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.

HSSE CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.				
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	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	
TOOLS	5-gallon bucket of tap water, stiff brush, soap, de-ionized or distilled water, nitric acid (if required), plastic sheeting or foil, tarps, decontamination tubs and buckets, and sprayers.
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**
SAFETY AND HEALTH MANAGER	**DATE**

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
1	Updates to SOP to reflect Geoprobe ® Model 7822DT	11/16/2020

PURPOSE	To provide standard instructions for decontamination of all personnel leaving a contaminated area.
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. Wash/ remove outer contaminated items.	**If wearing two layers of gloves, remove outer contaminated items. If task requires only one pair of gloves, skip to Step 2:** a. Remove nitrile or latex gloves by grasping the outside of the opposite glove near the wrist. b. Pull and peel the glove away from the hand, turning the glove inside out with the contaminated side now on the inside. c. Hold the removed glove in the opposite gloved hand. d. Slide one or two fingers of the ungloved hand under the wrist of the remaining glove. e. Peel off the glove from the inside, creating a bag for both gloves. **If wearing protective coveralls such as Tyvek suites**: a. Keep inner layer of nitrile or latex gloves on while decontamination process occurs. b. If in a designated decontamination zone*, brush built-up material off the suit. c. Unzip the coverall and begin rolling it outwards, rolling it down over your shoulders. d. Place both hands behind your back and pull down the sleeve of each arm until the arms are completely out of the sleeves. e. Sit down and remove each shoe. f. Roll the coveralls down (ensuring the contaminated side is not touched or does not come into contact with clothing) over your knees until completely removed. g. Place the coveralls into a designated bag for storage/transportation to proper disposal area. h. With soap (non-phosphate) and tap water, wash the outer, more heavily contaminated items, such as boots (if in a designated decontamination zone, there may be a specific place to rinse off boots). i. Rinse the outer items in tap water.

	*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 SSHASP.
2. Wash/remove inner contaminated items.	Remove the inner layer of nitrile or latex gloves following the procedure in Step 1. If necessary, wash with soap (non-phosphate) 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 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, polychlorinated biphenyls (PCB), perchloroethylene (PCE), etc., contact 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 (i.e., the contamination/exposure is the cause of needing medical treatment), decontamination must be performed immediately before medical treatment can be administered.
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 (i.e., the reason for medical treatment is not related to the contamination/exposure), 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. Once the victim is medically stable, decontamination should be performed as soon as possible for the victim and any affected medical personnel.

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 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; follow decontamination procedures as described in the SSHASP; and wear nitrile gloves and safety glasses when handling contaminated items.
NOISE	Not applicable.			
ELECTRICAL	Not applicable.			
BODY MECHANICS	Potential awkward, repetitive postures when performing decontamination tasks.	Sites.	Exposure to repeated postures, awkward postures when completing decontamination.	Stretch prior to completing task and break up tasks as necessary to reduce awkward and repetitive postures.
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.	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 area as dry as possible, and wear muck boots as necessary.
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 follow procedures outlined in applicable SSHASP and/or Pioneer Corporate HASP.

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**
	Hypothermia/ frostbite.	Sites where air temperature is 35.6 °F (2°C) or less.	Personnel whose clothing becomes wet during decontamination procedures may be exposed to hypothermia and/or frostbite.	If it becomes wet, personnel will change clothing.
	Lightning.	Outdoor sites.	Electrocution, injury, death, or equipment damage could result from 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.
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.
MECHANICAL	Not applicable.			
PRESSURE	Not applicable.			
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 injuries 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	**Personnel Protection Equipment** (PPE)**:** Safety glasses, high-visibility work shirt or vest, long pants, work boots, and nitrile or latex gloves.
APPLICABLE SDSs	**Safety Data Sheets** (SDSs) are available to Pioneer personnel on the internal website under Safety.
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	
TOOLS/ EQUIPMENT	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**
Kendra Overley **Kendra Overley**	**03/30/2022**
SAFETY AND HEALTH MANAGER	**DATE**
Tara Schleeman **Tara Schleeman**	**03/30/2022**

PURPOSE	To provide standard instructions for equipment decontamination.
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	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 at 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, WP, 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 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. Set up decontamination station.	a. Review the SAP or WP and determine if decontamination fluids need to be contained and the need for special decontamination requirements (i.e., chemical rinse). b. 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.

	c. If pressurized or gravity flow water is available, attach a hose or piping to reach the decontamination area. If no water is available, bring 5-gallon containers of tap and deionized water (DI) to the decontamination area to clean the equipment. d. Label empty 5-gallon buckets: *gross wash, soap wash, DI rinse, final rinse, and chemical rinse* (if required). e. Lay out clean plastic or foil to place cleaned equipment on to allow for air drying. f. If a chemical rinse is required, fill a spray bottle with the appropriate chemical and label the spray bottle with the chemical's name. g. Pour approximately 2.5 to 3 gallons of tap water into the buckets labeled: *gross wash* and *soap wash*. h. Add a **few drops** (1-3 drops) of Liquinox© soap to the bucket marked *soap wash*. i. Pour 2.5-3 gallons of DI water into the buckets labeled: *DI rinse* and *final rinse.* If a chemical rinse is required, pour DI water into the bucket labeled: *chemical rinse.*
2. Remove gross contamination.	Remove gross contamination using pressurized or gravity flow tap water, if available. If not, manually scrub the equipment using the 5-gallon bucket of 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.	In the bucket marked *DI rinse*, triple rinse the equipment with DI water to remove any soap residue.
5. Second rinse with deionized water.	Using DI water, triple rinse the equipment again in the bucket marked *final rinse* if a chemical rinse is not required.
6. Rinse equipment with chemicals.	In many cases, the tap water and DI water rinses will be sufficient. However, if specified in the SAP, WP, 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) may be specified. 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:** a. Hold the equipment over a collection container (5-gallon bucket or bowl). b. Make sure that all personnel and vehicles are upwind of the spray. c. Spray the piece of equipment inside and out starting at the top and working down to the bottom. d. 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.

7. Rinse equipment with deionized water.	After a required chemical rinse, rinse the equipment again with the DI water in the bucket marked *chemical rinse*. This DI water will need to be retained (i.e., do not dispose of this water on the 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. After the rinse in the *chemical rinse* bucket, triple rinse the equipment again in the bucket marked *final rinse.*
8. Air dry equipment.	Place equipment on plastic sheeting or foil to air dry.
9. Transport/ store equipment.	Wrap equipment in foil or plastic wrap to transport or store.
10. Clean decontamination equipment.	a. Triple rinse equipment from the *gross wash* and *soap wash* (brushes and buckets) with clean tap water, preferably with pressurized water. Soap can be used on particularly dirty equipment. b. Triple rinse all decontamination equipment with DI water, including *DI rinse* and *final rinse* buckets. c. Store decontamination equipment, labeled and in a clean location so they are used only for decontamination purposes.
11. Dispose of decontamination solutions.	Storage of contained decontamination fluids as required by the SAP, QAPP, or WP or of residue from a chemical rinse should have been arranged on site prior to sampling. Once the sampling and associated decontamination is complete, sampling of the stored fluids for hazardous waste criteria will be required. If the fluids are determined to be hazardous (e.g., meet the characteristics of a hazardous waste [ignitability, corrosivity, reactivity, or toxicity] or contain listed wastes from title 40 of the Code of Federal Regulations [CFR] in part 261.4), 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.
12. Measure effectiveness of procedures.	Measure the effectiveness of the decontamination procedures using field equipment rinsate blanks as discussed in the SAP, QAPP, or WP.

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 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); follow decontamination procedures as described above; and wear nitrile gloves and safety glasses when handling contaminated items.
	Chemical rinse (e.g., dilute nitric acid, methanol, and hexane).	Sites.	Personnel 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.	Personnel will check and follow safety procedures as outlined in the chemical-specific Safety Data Sheets. Personnel will prevent skin/eye contact with chemicals and they will wear nitrile gloves and eye protection when handling chemicals. Personnel will practice proper personal hygiene (wash hands prior to eating/drinking, after decontaminating equipment, and when leaving the site). All personnel and vehicles will stand upwind when spraying equipment with chemicals. Refer to the Chemical Flushing Guidelines available inside any Pioneer vehicle's first aid kit for first-aid procedures in case of contact with chemicals.
NOISE	Not applicable.			
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	Improper lifting.	Sites.	Back injuries and muscle/back strains could result when using improper techniques to lift and carry 5-gallon containers.	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 awkward/heavy tools and equipment.
GRAVITY	Falls from slips and trips.	Areas designated for decontamin-ation procedures.	Slips and falls could occur while performing decontamination procedures due to slippery surfaces resulting in bruises, scrapes, or broken bones.	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.
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, remain hydrated, and have sufficient caloric intakes during the day. Personnel will also 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 whose clothing becomes wet during decontamination procedures may be exposed to hypothermia and/or frostbite.	Personnel will change clothing if it becomes wet.

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*
	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.
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.
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 not set decontamination stations directly in the sun.

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 injuries 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	**Personnel Protection Equipment** (PPE)**:** Safety glasses, high-visibility work shirt or vest, long pants, work boots, and nitrile gloves.
APPLICABLE SDSs	**Safety Data Sheets** (SDSs) for corresponding chemicals used during chemical rinse will be maintained based on the site characterization and contaminants. Safety Data Sheets are available to Pioneer personnel on the internal website under Safety.
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	

TOOLS/ EQUIPMENT	Five empty 5-gallon buckets, tap water, stiff brushes, Liquinox soap, four 5-gallon containers of DI (or distilled water if DI water is not available), chemicals for chemical rinse (if required), small plastic swimming pool/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 **Julie Flammang**	**09/08/2020**
SAFETY AND HEALTH MANAGER	**DATE**
Tara Schleeman **Tara Schleeman**	**09/08/2020**

PURPOSE	To provide standard instructions to decontaminate pump equipment used to collect samples from wells.
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 Plan (SSHASP), and Pioneer Corporate Health and Safety Plan (HASP).

TASK	INSTRUCTIONS
Notes	All non-disposable or non-dedicated equipment used for sampling or monitoring activities must be decontaminated prior to leaving a site. Decontamination methods include removing contaminants through physical methods, chemical cleaning, or a combination of both methods. Personnel should complete decontamination of non-dedicated equipment wearing the same level of protection as worn during sampling. In some cases, personnel may be sufficiently protected during decontamination activities by wearing one level lower of the specified Personal Protection Equipment (PPE). Personnel will follow the requirements for site-specific equipment decontamination and personnel protection levels as detailed in the sampling and analysis plan (SAP), work plan (WP), or SSHASP. These decontamination procedures are for typical uncontrolled hazardous waste sites. Regarding specific or unusual contaminant, such as dioxins, the decontamination procedures should be discussed in the SAP, WP, and/or SSHASP. Decontamination procedures should be used in conjunction with storage methods that prevent contamination of cleaned sampling and monitoring equipment. It is preferred that personnel use one-time use equipment (disposable) if practical, and it should be disposed of in accordance with the SAP, WP, and/or SSHASP. Dedicated equipment should be used, when practical, for long-term sampling at a location. *Prior to the sampling event,* review the SAP and SSHASP to determine if purge and decontamination water needs to be contained, and if so determine the proper disposal and storage requirements. The SAP/SSHASP should specify if water from all stages of the decontamination procedure needs to be contained or if only water from initial stages of the process requires containment. The SAP/SSHASP should also provide information to allow an estimate of the amount of water that could be generated during the sampling event, and the type and concentrations of potential contaminants. Use this estimate as part of the planning process to determine a method for storage and disposal of purge and decontamination fluids, the amount of water that could be generated during the sampling

	event, and the type and concentrations of potential contaminants. If needed, make sure the proper equipment for either storage or disposal is available on the site at the start of sampling. Water can be contained at the sampling location or on the site in tanks, barrels or buckets for later disposal. Purge and decontamination water stored on the site can be sampled and analyzed so that the proper disposal method can be determined. Wastewater can be removed at the time of sampling with a pump truck to a disposal site.
Procedures to decontaminate inorganic contaminants.	1. Set up the decontamination *station*. If water used in the process needs to be contained, place a small swimming pool or a sheet of plastic on the ground in the decontamination area. If using plastic, wrap the edges of the plastic sheeting around pieces of polyvinyl chloride (PVC) or boards to form a small pool to prevent any spilled water from running onto adjacent ground. **All decontamination activities should take place within this confined area. If the fluids used in the process must be contained, set up a way to collect the fluid (i.e., bucket, hose, barrel, etc.).** 2. Based on the size of the pump and amount of tubing, set up a decontamination *container* within the station. The container can range from a stainless-steel pan that holds 1-2 gallons for a small 12-volt submersible pump with a small amount of tubing to a 5-gallon bucket or similar large container that will hold the larger pumps such as a Grunfos Redi-Flo II or larger submersible pump. The container should be tall enough to hold the submerged pump and still take on additional fluid. Non-dedicated tubing, such as that on the Grunfos Redi-Flo II, will be decontaminated on the reel. For smaller amounts of reusable tubing typically found on the 12-volt submersible pumps, coil the tubing and electric cord as it is removed from the well and place it in a bucket dedicated for decontamination. 3. Set up an appropriate storage area and refuse container to store cleaned equipment or dispose of disposable equipment. 4. Put on a new pair of nitrile gloves. 5. Remove the pump from the well making sure that the tubing and the pump do not contact the ground. If disposable tubing was used, remove the tubing from the pump and place it in the appropriate refuse container. If dedicated tubing was used, remove the tubing from the pump and place it in the appropriate storage container. 6. Next, attach a small, new piece of tubing to run water through the pump and clean the inside of the pump (Step 10 below). 7. Place the pump in the decontamination container. 8. If not done previously, don a new pair of nitrile gloves. 9. Pour tap water into the container to cover the pump.

10. To remove the well water from the pump, turn the pump on and continue pouring tap water into the container until all water from the well has been flushed from the pump and tubing. The amount will depend on the amount of tubing associated with the pump and can range from 1 gallon for the smaller pumps to 5 gallons for the Grunfos pumps.

    If the water purged from the well is turbid or colored, monitor the water flowing from the pump discharge to determine when the well water has been removed. If the water is to be contained, make sure it is discharged throughout the decontamination process into the appropriate container.

11. Add a **very** small pinch or drop of non-phosphate soap (use Liquinox© or Alconox©) to the container and turn on the pump. Continue pouring tap water into the container to flush the pump until the soapy water has been pumped through the entire length of tubing.

12. Turn the pump off and place it in a second container for a de-ionized (DI) water flush of the soapy water.

13. Pour DI water into the container to cover the pump. Turn the pump on and continue pouring DI water into the container until the soapy water has been flushed from the system. Discharge this water over any tubing that will be reinserted into the next well. Keep in mind that this process is to remove contaminants from the pump and tubing so that they are not introduced to the next well. Make sure that the tubing is thoroughly rinsed. Water from the next well will be run through the tubing prior to sampling and will flush remaining DI water from the tubing.

14. Turn the pump off, empty the water from the bucket containing tubing if necessary and place the pump and tubing into a bucket dedicated for pump storage.

15. Return the Grunfos Redi-Flow II pump to the pump holder on the reel; remember to rinse the pump holder with DI water between wells.

16. Keep tubing and pumps from touching the ground or other surfaces during transport and storage. A plastic bag can be placed over the container holding the pump or a dedicated plastic container can be used to transport or store the pump.

17. Dispose of water. If containment is required, empty the water remaining in the decontamination containers and station into the storage/disposal container.

    a. Cover the dedicated decontamination containers with plastic, foil, or a lid to prevent contaminants from entering the containers during transport or storage.
    b. Empty the water in the swimming pool or plastic into the storage container by scooping the water into the disposal container. Use a funnel dedicated to the project to help move the water into the container.

	If containment is not required, dispose of the water. Refer to the **Dispose of decontamination solutions** section.
Procedures to decontaminate organic contaminants.	**It is strongly recommended that disposable or dedicated tubing be used for all organic contaminant sampling.** **If a submersible pump is required for sampling, a stainless-steel pump that can be taken apart for cleaning is recommended.** **If free product is detected in a well, use disposable tubing or a bailer to collect the sample as purging large amounts of product through tubing makes it almost impossible to clean.** 1. Set up the decontamination *station*. If water used in the process needs to be contained, place a small swimming pool or a sheet of plastic on the ground in the decontamination area. If using plastic, wrap the edges of the plastic sheeting around pieces of PVC or boards to form a small pool to prevent any spilled water from running onto adjacent ground. **All decontamination activities should take place within this confined area. If the fluids used in the process must be contained, set up a way to collect the fluid (i.e., bucket, hose, barrel, etc.)**. 2. Based on the size of the pump and amount of tubing, set up a decontamination *container* within the station. The container can range from a stainless-steel pan that holds 1-2 gallons for smaller 12-volt submersible pumps with a small amount of tubing to a 5-gallon bucket or similar large container that will hold the larger pumps such as a Grunfos Redi-Flo II or larger submersible pump. The container should be tall enough to hold the submerged pump and still take on additional fluid. Non-dedicated tubing, such as that on the Grunfos Redi-Flo II, will be decontaminated on the reel. For smaller amounts of reusable tubing typically found on the 12-volt submersible pumps, coil the tubing and electric cord as it is removed from the well and place it in a bucket dedicated for decontamination. 3. Set up an appropriate storage area and refuse container to store cleaned equipment or dispose of disposable equipment. 4. Put on a new pair of nitrile gloves. 5. Remove the pump from the well making sure that the tubing and the pump do not contact the ground. If disposable tubing was used, remove the tubing from the pump and place it in the appropriate refuse container. If dedicated tubing was used, remove the tubing from the pump and place it in the appropriate storage container. 6. Don a new pair of nitrile gloves. 7. Wipe the pump with a paper towel wetted with DI or methanol (or solvent specified in the SAP/WP/SSHASP). Add a small piece of tubing to the pump. If tubing is to be reused, wet a paper towel with a small amount of DI or methanol (or other

solvent specified in the SAP/WP/SSHASP) and wipe the pump and the tubing as it is removed from the well.

8. Place the pump in the decontamination container.

9. If not done previously, don a new pair of nitrile gloves.

10. Pour tap water into the container to cover the pump.

11. To remove the well water from the pump, turn the pump on and continue pouring tap water into the container until all water from the well has been flushed from the pump and tubing. The amount will depend on the amount of tubing associated with the pump and can range from 1 gallon for the smaller pumps to 5 gallons for the Grunfos pumps.

    If the water purged from the well was turbid or colored, monitor the water flowing from the pump discharge to determine when the well water has been removed. If the water is to be contained, make sure it is discharged throughout the decontamination process into the appropriate container.

12. Add a **very** small pinch or drop of non-phosphate soap (use Liquinox© or Alconox©) to the container and turn on the pump. Continue pouring tap water into the container to flush the pump until the soapy water has been pumped through the entire length of tubing.

13. At this time, run a small amount of methanol or solvent through the pump, depending on the expected contaminants and as outlined in the SAP:

    a. Turn off the pump and place it into a container holding the appropriate solvent.
    b. Turn the pump on and run the solvent through the pump.
    c. Make sure that a container is available to catch and retain the used solvent. Turn off the pump.

14. If using a stainless-steel pump that can be taken apart, follow the manufacturer's directions to dissemble the pump and then wipe all parts of the pump with methanol, DI, or other solvent and reassemble.

15. Place the pump in a container for a DI water flush of the pump and tubing.

16. Pour DI water into the container to cover the pump. Turn the pump on and continue pouring DI water into the container until the solvent (methanol) has been flushed from the system. Discharge this water over any tubing that will be reinserted into the next well. Keep in mind that this process is to remove contaminants from the pump and tubing so that they are not introduced to the next well. Make sure that the tubing is thoroughly rinsed. Water from the next well will be run through the tubing prior to sampling and will flush remaining DI water from the tubing.

	17. Turn the pump off, empty the water from the bucket containing tubing if necessary and place the pump and tubing into a bucket dedicated for pump storage. 18. Return the Grunfos Redi-Flow II pump to the pump holder on the reel; remember to rinse the pump holder with DI water between wells. 19. Keep tubing and pumps from touching the ground or other surfaces during transport and storage. A plastic bag can be placed over the container holding the pump or a dedicated plastic container can be used to transport or store the pump. 20. Dispose of water. If containment is required, empty the water remaining in the decontamination containers into the storage/disposal container. a. Cover the dedicated decontamination containers with plastic, foil, or a lid to prevent contaminants from entering the containers during transport or storage. b. Empty the water in the swimming pool or plastic into the storage container by scooping the water into the disposal container. Use a funnel dedicated to the project to help move the water into the container. If containment is not required, dispose of the water. Refer to the **Dispose of decontamination solutions** section.
Clean equipment used for decontamination.	The containers used to decontaminate the pump need to be rinsed out. Typically, the process uses three stainless-steel tubs labeled gross, wash, and rinse. The gross and wash tubs use tap water, and the rinse tub uses DI water. In this case, clean the gross and wash tubs with tap water but do not use tap water on the rinse tub. 1. Rinse equipment used in the decontamination process with tap water, preferably pressurized. **Do not rinse the container labeled DI!** 2. Keep decontamination equipment separated so that it is only used for decontamination. Make sure it is labeled appropriately.
Dispose of decontamination solutions.	1. Dispose of the soap/tap water solution and the DI water rinse as detailed in the SAP, WP, or SSHASP. 2. Dispose of the solvent rinse residue into proper waste containers. Be sure to check with the health and safety officer and the project manager for disposal requirements. For example, some solvents can be evaporated.
Determine effectiveness of decontamination.	Measure the effectiveness of the decontamination procedures using field equipment rinsate blanks (see the site-specific Quality Assurance Project Plan and SOP-SA-03B Preparation of Equipment Rinsate Blanks for Submersible Pumps).

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 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, after decontamination procedures, and when leaving the site; follow decontamination procedures as described above; and wear nitrile gloves and safety glasses when handling contaminated items and decontaminating equipment.
	Methanol.	Sites.	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, and 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.

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***
	Liquinox©/ Alconox©	Sites.	Personnel could be exposed to Liquinox©/ Alconox© via ingestion and skin/eye contact during equipment decontamination resulting in adverse health effects.	Personnel will wear nitrile gloves and safety glasses during equipment decontamination.
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 containers, decontamination solutions, and tools/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 height. Two people will lift awkward or heavy tools/equipment, if necessary.
GRAVITY	Falls from slips and trips.	Areas designated for decontamin-ation procedures.	Slips and falls could occur while performing decontamination procedures due to slippery surfaces resulting in bruises, scrapes, or broken bones.	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, 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*
	Dropping decontamination solution containers.	Work truck and decontamin-ation site.	Moving, carrying, or pouring solution from containers can result in the container falling and striking personnel.	Personnel will wear steel-toed boots and be cautious when carrying/moving containers.
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 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 whose clothing becomes wet during decontamination procedures may be exposed to hypothermia and/or frostbite.	Personnel will change clothing if it becomes 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.

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. 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	Pinch points.	Pumps.	Personnel could be exposed to hand injuries such as pinched fingers when taking apart pumps for cleaning.	Personnel will wear gloves when taking apart pumps for cleaning.
PRESSURE	Not applicable.			
THERMAL	Contact with hot surfaces.	Foil and decontamin-ation equipment.	If foil and decontamination equipment (e.g., stainless-steel pans) are placed directly in the sun, they could get hot. Contact with hot surfaces could result in personal injuries.	Personnel will prevent setting decontamination stations directly in the sun.

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	**Personnel Protection Equipment** (PPE): Hard hat, safety glasses, high-visibility work shirt or vest, long pants, work boots, and nitrile gloves (liner gloves, during winter months).
APPLICABLE SDSs	**Safety Data Sheets** (SDSs): Methanol and Liquinox©/ Alconox©. Safety Data Sheets are available to Pioneer personnel on the internal website under Safety.
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-03B Preparation of Equipment Rinsate Blanks for Submersible Pumps.
TOOLS/ EQUIPMENT	Pump, small swimming pool or plastic sheeting, pieces of PVC or boards, tap water, stainless-steel pan or 5-gallon bucket/similar large container (to fit pump), Liquinox© or Alconox, DI water, and plastic bags. Optional: bucket, hose, barrel, etc. for water containment, funnel, and methanol.
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**
Kendra Overley (signature) **Kendra Overley**	**03/29/2022**
SAFETY AND HEALTH MANAGER	**DATE**
Tara Schleeman (signature) **Tara Schleeman**	**03/29/2022**

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	Pioneer Technical Services, Inc. (Pioneer) prepared this practice for the workforce and this Standard Operation 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 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 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, place water in a storage container (drum or tank), label storage container, 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 soil back to borehole.	Unless the soil is visibly contaminated, place soil and/or cuttings from monitoring well installation back in the borehole.
5. Collect/label/ store contaminated soil from installing wells.	If the soil is visibly contaminated, place soil in a storage container (drum or tank), label storage container, and store the soil/cuttings on site until shipping/disposal arrangements are made. Labelled storage containers that include soil from borings/well installations should be located in previously sampled areas that are known to be contaminated, or place storage containers in a specified containment area (review the SSHASP and/or consult the project manager). Leave these containers 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 used for sampling and dispose of it as a solid waste in the local landfill. Package the disposable equipment, place in storage drum, and label disposable equipment and PPE used 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.

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 and water/ decontamination fluids.	Sites.	Inadvertent exposure to contaminated soil and water/ decontamination fluids 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 handling contaminated items.
NOISE	Not applicable.			
ELECTRICAL	Not applicable.			
BODY MECHANICS	Improper shoveling techniques.	Sites.	Personnel could be injured if using improper shoveling techniques to store contaminated soil/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.
	Improper lifting.	Sites.	Back injuries and muscle/back strains could result when using improper techniques to lift and carry storage containers.	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.

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 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.
	Hypothermia/ frostbite.	Sites where air temperature is 35.6 °F (2°C) or less.	Personnel whose clothing becomes wet may be exposed to hypothermia and/or frostbite.	If it becomes wet, personnel will change clothing.
	Lightning.	Outdoor sites.	Electrocution, injury, death, or equipment damage could result from 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. 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	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 injuries 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	**Personnel 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) are available to Pioneer personnel on the internal website under Safety.
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	
TOOLS/ EQUIPMENT	Storage containers, garbage bags, 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**
Kendra Overley **Kendra Overley**	**04/12/2022**
SAFETY AND HEALTH MANAGER	**DATE**
Tara Schleeman **Tara Schleeman**	**04/12/2022**

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	**12/03/2014**
SAFETY AND HEALTH MANAGER	**DATE**
Tara Schleeman	**12/03/2014**

Revisions:

Revision	Description	Date

PURPOSE	To provide standard instructions for groundwater monitoring well design and construction.
SCOPE	This practice is 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 procedure described below.
NOTE	A set procedure for designing and constructing groundwater monitoring wells cannot be presented as a standardized operating procedure. Every location within a site may vary depending on contamination encountered, lithology of the subsurface, and depth to groundwater. A technique that may work at one location may be inappropriate at the next. The following sections discuss general guidelines for well design and construction, but actual well designs will depend on specific site conditions and the associated contaminants of concern. Wells drilled for a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) investigation will be designed to specifications suggested by the site being investigated, provided such design presents no conflict with investigation sampling objectives. This policy will permit the site to incorporate any new wells into on-going monitoring programs by ensuring that new wells are constructed in the same manner as existing wells. Conflicts may result when existing well construction is not suitable for the proposed sampling. For example, polyvinyl chloride (PVC) casing will not be used, if the site is contaminated with high-concentrations of organic compounds, even though existing wells contain PVC casings. Such conflicts will be resolved on a site-specific, case-by-case basis. The method of well construction and the materials used in the casing and screen affect the quality of the well, and its utility for groundwater monitoring, throughout its lifetime. The elements of proper monitoring well construction presented serve as guides for any wells constructed for the groundwater investigation. In addition, these guidelines can be applied to evaluate the adequacy of existing wells when sampling will be conducted from available wells.

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 Standard Operating Procedure (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. Coordinate utility locates.	Prior to starting work, the drilling subcontractor will have a utility locate and marking performed.
2. Conduct a site walk.	Verify utility locates have been performed. Walk through the site and determine any site-specific hazards associated with the work area. Discuss these hazards with site personnel and note them 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.
3. Select well diameter.	The diameter of the well casing will be the minimum that allows the sampling and/or monitoring equipment to be lowered to the desired depth. The diameter of the borehole into which the casing is placed must be large enough for the casing to fit and have sufficient annular space for the addition of a filter pack and well seal. The diameter of the borehole should be at least 4 inches larger than the casing to provide a minimum 2-inch annular space. When using direct push methods for well installation, the use of prepacked well screens and foam bridge/prepacked bentonite seals are necessary to install wells in smaller boreholes under saturated conditions.
4. Determine well depth.	Wells will be constructed to be depth discrete and to be sampled from one aquifer zone without interference from other zones. This requires provisions for grouting above, and if necessary, below the well screen on the outside of the casing. The location of the screen will be important for sampling since it has an impact on sampling of immiscible organics. Sampling of less dense or more dense organics, which float or sink, will require the screen to be placed at the appropriate depth.
5. Select well casings and screens.	Well casings and screens will be constructed of materials with the least potential for affecting the water quality parameters of the sample. Guidance/criteria regarding casing and screen material selection is presented in various U.S. Environmental Protection Agency (EPA) guidance documents. Well casings and screens will be cleaned and protected from contamination prior to their installation. Factory cleaned screen and casing stored in plastic protective wrap may be used instead of field decontamination of well materials. Selection of screen and slot style are important factors in screen selection. Saw-slot style screens offer less screen open area than the Vee-wire continuous wrap screens making the saw-slot screens far less efficient in terms of producing water. Pre-packed wells screens available from many vendors offer the alternative to set well screen and filter pack in one operation, guaranteeing accurate filter pack placement.
6. Define well drilling method.	Drilling method selection will be based on minimizing both the disturbance of the geologic materials penetrated, and the introduction of air, fluids, and muds. Additionally, some drilling methods are better at collecting soil samples during drilling operations for subsurface characterization. Rotary sonic is one such method that collects quality soil cores for logging and characterization purposes. The direct push technology has also become increasingly popular for the installation of small diameter wells that significantly decreases the volumes of investigation derived waste. Mud rotary drilling that utilizes either bentonite or a polymer-based drilling muds will be avoided. Advantages and disadvantages of various drilling methods are also discussed in EPA guidance documents.
7. Select monitoring well filter pack and annular sealant.	The materials used to construct the filter pack should be chemically inert (e.g., clean quartz sand, silica, or glass beads), well rounded, and dimensionally stable. Natural gravel packs are acceptable, provided that a sieve analysis is performed to establish the appropriate well screen slot size and determine chemical inertness of the filter

pack materials in anticipated environments. Typically, 10-20 mesh silica sand is used to construct most monitoring wells utilizing screens with slot sizes of 0.010 or 0.020 inches. The prepack well screen option typically uses 0.010-inch slotted screen with 20-40 mesh silica sand contained within an outer layer of 65 mesh stainless steel screen.

The materials used to seal the annular space must prevent the migration of contaminants from the surface or intermediate zones to the sampling zone and prevent cross contamination between strata. The materials should be chemically compatible with the anticipated contaminants to ensure seal integrity during the life of the monitoring well and chemically inert so they do not affect the quality of the groundwater samples. The permeability of the sealants should be one to two orders of magnitude less than the surrounding formation. An example of an appropriate use of annular sealant material is using a minimum of 2 feet of certified sodium bentonite pellets immediately over the filter pack when in a saturated zone. Bentonite pellets are best used in a saturated zone because they will sink in the column of water before hydrating and create an effective seal. Deep water columns may require the use of coated bentonite pellets to allow the bentonite to sink before hydrating. Coarse grit sodium bentonite is likely to hydrate in the water column and bridge before reaching the filter pack and therefore should only be used to install seals above the water table. A cement and bentonite mixture, bentonite chips, or anti-shrink cement mixtures may be used as the annular sealant in the unsaturated zone above the certified-bentonite pellet seal and below the frost line. The addition of bentonite to the cement admixture should generally be in the amount of 2 to 5 percent by weight of cement content. This will aid in reducing shrinkage and control time of setting. However, field experience has demonstrated that pure bentonite installed in the vadose zone forms a better well seal as opposed to the cement-based seals that are prone to fracturing over time. Again, the appropriate clay seal material must be selected on the basis of the environment in which it is to be used. In most cases, sodium bentonite is appropriate. Calcium bentonite may be more appropriate in calcic sediments/soils due to reduced cation exchange potential. Clays based seals should be pure (i.e., free of additives that may affect groundwater quality).

The untreated clay seal should be placed around the casing either by dropping it directly down the borehole or, if a hollow-stem auger is used, putting the bentonite between the casing and the inside of the auger stem. The use of a granular bentonite facilitates the installation of the well seal where the annular space is limited, and the use of bentonite chips presents bridging risks. In shallow monitoring wells, a tamping device or slender rod system should be used to reduce this potential of bridging. Generally, a spacing differential of 3 to 5 inches should exist between the outer diameter of the casing and the inner diameter of the auger, or the surface of the borehole to facilitate emplacement of filter pack and annular sealant. The actual volume of materials used should be recorded during well construction and compared to the calculated volume. Discrepancies between calculated volumes and volumes used require an explanation.

If a cement-bentonite seal mixture is specified, the mix should be prepared using clean water and placed in the borehole using a tremie pipe. The tremie method ensures good sealing of the borehole from the bottom.

	Upon completion of the well, installation of a suitable threaded or flanged cap or compression seal should be placed or locked in properly to prevent either tampering with the well or the entrance of foreign material into it. A ¼-inch vent hole pipe provides an avenue for the escape of gas, if a totally submerged well screen is installed. Placement of concrete or steel bumper guards around the well will prevent external damage by a vehicular collision with the exposed casing.
8. Design well screen.	The intake of the monitor well should be designed and constructed to: 1) allow sufficient groundwater flow into the well for sampling; 2) minimize the passage of formation materials (turbidity) into the well; and 3) ensure sufficient structural integrity to prevent the collapse of the intake structure. For wells completed in unconsolidated materials, the intake of a monitoring well should consist of a screen or slotted casing with openings sized to minimize the amount of formation material from passing through the well during development. Extraneous fine-grained material (e.g., clays and silts) that has been dislodged during drilling may be left on the screen and in the well water. These fines should be removed from the screen and filter pack during development of the well. Commercially-manufactured screens or slotted casings should be used; field slotting of screens is not acceptable.
9. Develop well.	After the installation of the monitoring well, the natural hydraulic conductivity of the formation should be restored, and all foreign sediment removed to ensure turbid-free groundwater samples. A variety of techniques are available for developing a well. To be effective, they require reversals or surges in flow to avoid bridging by particles, which is common when flow is continuous in one direction. These reversals or surges can be created by using surge blocks, bailers, or pumps. Formation water should be used for surging the well. Any contaminated waters produced during development will be containerized for proper disposal. In low-yielding water-bearing formations, an outside source of water may sometimes be introduced into the well to facilitate development. In these cases, this water should be chemically analyzed to evaluate its potential impact on in-situ water quality. The driller should not used air to develop the wells. All developing equipment and materials need to be decontaminated prior to developing the well. Refer to SOP-GW-12 Well Development Using a Modified Over-Pumping Technique for more information.
10. Document well design and construction.	Information on the design and construction of wells will be documented and may include: • Date/time of construction. • Drilling method and drilling fluid used. • Well location (± 0.5 feet). • Borehole diameter and well casing diameter.

- Well depth (± 0.1 feet).
- Drilling and lithologic logs.
- Casing materials.
- Screen materials and design.
- Casing and screen joint type.
- Screen slot size/length.
- Filter pack material/size, grain analysis (D10).
- Filter pack volume calculations.
- Filter pack placement method.
- Sealant materials (percent bentonite).
- Sealant placement method.
- Surface seal design/construction.
- Well development procedure.
- Type of protective well cap.
- Ground surface elevation (± 0.01 feet).
- Surveyor's pin elevation (± 0.01 feet) on concrete apron.
- Top of monitoring well casing elevation (± 0.01 feet).
- Top of protective steel casing elevation (± 0.01 feet).
- Detailed drawing of well (include dimensions).

Specialized Well Designs

There are two cases where special monitoring well design will be used:

- Where it has been decided to use dedicated pumps to draw groundwater samples.
- Where light and/or dense immiscible phases may be present.

If it is elected to use a dedicated system, it should be a fluorocarbon resin or stainless-steel bailer, or a dedicated positive gas displacement bladder pump composed of the same two materials. As other sampling devices that can perform at least equivalently become available, they may be employed as well.

The introduction of this pump, however, necessitates certain changes in the well. The principal change is the addition of a 2-inch diameter pump with fluorocarbon resin outlet tubing to the well. A 4-inch interior diameter outer well casing should easily accommodate this additional equipment. However, should a larger pump (e.g., 3 inches in diameter) be required because of greater well depth or yield, a larger outer casing may prove necessary (6-inch inside diameter). The pump should be positioned midway along the screened interval, and the top of its outlet pipe should extend into the well cap.

If light or non-aqueous phase liquids (L-NAPLs) or dense non-aqueous phase liquids (D-NAPLs) layers are presumed to be present, discrete samples must be obtained. The well system needs to be designed to allow sampling of light or dense phases by using a well screen that either extends from above the potentiometric surface for the L-NAPL sampling or slightly into the lower confining layer for DNAPL monitoring. Where well clusters are employed, one well in the cluster may

	be screened at horizons where floaters are expected, another at horizons where dense phases are expected, and others within other portions of the uppermost aquifer. A periodic check of the dedicated sampling system should be exercised to prevent damage and maximize efficiency. This inspection should include removal of samples for verification of proper function. The design of the dedicated sampling system should also allow access for regular testing of aquifer characteristics. It is also recommended that the well be periodically resurveyed using the protective casing and apron as points of reference. An option that can be exercised in constructing a monitoring well (e.g., dedicated sampler) is the use of fine sand at the top of the filter pack to reduce or minimize invasion.

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 water.	Sites.	Inadvertent exposure to contaminated soils and 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 contact with soils and water is possible.
	Exposure to hydraulic fluids.	Drilling operations.	Exposure to hydraulic fluids could occur while operating and working around the drill due to equipment malfunction/ failure resulting in personal injuries.	The operator will inspect the drill 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 around the drill.
	Contact with gasoline/diesel.	Fueling equipment.	Inadvertent exposure via inhalation and/or skin contact can result in adverse health effects and skin irritation.	Personnel will fuel the equipment in a well-ventilated area, stand up wind while fueling, and minimize splash hazards so skin contact does not occur.
	Exposure to annular sealant material (e.g., bentonite and cement).	Sealing the annular space of wells.	Personnel could be exposed to annular sealant material via inhalation of material dust and/or direct skin/eye contact, which could result in personal injuries such as irritation of the	To prevent exposure, pour material slowly, stay upwind, and wear work gloves and safety glasses. If contact occurs, personnel will thoroughly wash the affected area with water and flush their eyes.

CHEMICAL			respiratory system, skin, or eyes.	
NOISE	Elevated noise levels.	Drilling operations.	Personnel could be exposed to elevated noise levels when operating the drill and working near drilling operations resulting in hearing damage.	Personnel will wear hearing protection (e.g., ear plugs) when operating and working near the drill. Non-essential personnel will maintain a 20-foot buffer zone around the drill when possible. Hearing protection will be administered and used in accordance with the policies and procedures outlined in the Pioneer Corporate HASP.
ELECTRICAL	Contact with underground and/or overhead utilities.	Sites.	Injury, death or property damage could occur from equipment contact with underground and/or overhead utilities while drilling boreholes.	Personnel will follow the underground and overhead utilities procedures as outlined in the Pioneer Corporate HASP. Personnel will avoid areas with underground and overhead utilities hazards as much as possible.
BODY MECHANICS	Bending, squatting, and kneeling.	During fieldwork activities.	Bending, squatting, and kneeling during fieldwork activities could result in muscle/back strains or other injuries.	Personnel 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 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 workers will lift/handle heavy items.

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. They will plan their path and walk cautiously. If using bentonite as annular sealant, avoid bentonite contact with water on the ground. Pour the bentonite slowly to prevent spills and slippery surfaces.
WEATHER	Cold/heat stress.	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). Personnel will remain hydrated and will have sufficient caloric intakes during the day. Personnel will follow procedures outlined in the applicable SSHASP and/or Pioneer Corporate HASP.
	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.	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.	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 in company vehicles. Personnel with allergies will notify their supervisor.

MECHANICAL	Pinch points.	During fieldwork activities.	Personnel could be exposed to pinch points when opening and closing gates, vehicle doors, carrying cases, and well caps or when using hand tools and equipment resulting in personal injuries such as scrapes, cuts, and broken fingers.	Personnel will be aware of finger/hand placement and not put fingers/hands between objects. Personnel will also wear work gloves to protect against pinch-point injuries and inspect all tools/equipment prior to each use.
	Rotating parts of the drill.	Drilling operations.	Inadvertent contact with rotating parts could result in fingers/hands becoming pinched or caught causing scrapes, cuts, and/or broken bones.	Personnel will avoid touching rotating parts of the drill. The drill operator and helpers will not wear loose clothing/jewelry. Personnel will know the location of all emergency shutoffs on the drill. Non-essential personnel will maintain a 20-foot buffer zone around the drill when possible.
PRESSURE	Pressurized hydraulic hoses.	Drilling operations.	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 drill 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 around the drill.
THERMAL	Hot surfaces.	Drilling operations.	The equipment components could become hot during drilling operations and direct contact	Personnel will avoid contact with hot surfaces, and they will wear work gloves as needed.

			with these components could cause skin injuries.	
HUMAN FACTORS	Inexperienced and improperly trained worker.	Sites.	Inexperienced personnel and improper training could cause incidents resulting in adverse health effects and/or property damage.	Personnel will be properly trained in the procedure described above and other applicable procedures. Personnel will follow the stop work policy, if there are any issues.
SIMOPS	Not applicable.			

ADDITIONAL HSSE CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.	
REQUIRED PPE	**Personal Protective Equipment** (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) will be maintained based on the 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 well locations.
RELATED SOPs/ PROCEDURES/ WORK PLANS	SOP-GW-12 Well Development Using a Modified Over-Pumping Technique.
TOOLS	Varies depending on selected drilling technique.
FORMS/ CHECKLIST	Field logbook and well installation log.

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**
Ken Manchester	**04/23/2018**
SAFETY AND HEALTH MANAGER	**DATE**
Tara Schleeman	**04/23/2018**

PURPOSE	To provide standard instructions for well development and the removal of fine grained sediments from the vicinity of the well screen. Well development allows the water to flow freely from the formation into the well and reduces the turbidity of the water during groundwater sampling. Initial well development is critical to ensure that the well has the pumping volume required for future use.
SCOPE	This practice is 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 procedure described below. This Standard Operating Procedure (SOP) discusses well development using a modified over-pumping technique and can be used with the following pumps: peristaltic, low flow Grundfos, PROACTIVE 12-volt submersible, and Grundfos Redi-Flo II. Less vigorous methods of well development include bailers or manual surge blocks. These methods are addressed in other SOPs. If a well requires more vigorous development than over-pumping (e.g., soil types, chemicals used during installation, large required production volumes, etc.), a well installer or subcontractor may be required to complete the development.

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 Standard Operating Procedure (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. Select pump.	The table below summarizes the types of pumps Pioneer has readily available for well development. Personnel should select the appropriate pump for the well development required using the table below.

Pump/ Development Type	Well Diameter (inches)	Max Well Depth (ft)	Anticipated Production
Bailer[1]	1	100	Poor to Good
	≥2	100	Poor
Manual Surge Block[1]	1	100	Poor to Good
	≥2	100	Poor
Peristaltic Pump	1	25	Poor to Good
	2	25	Poor
Low Flow Grundfos	≥2	200	Poor to Good
PROACTIVE 12-volt Submersible Pump	≥2	80	Good
Grundfos Redi-Flo II	≥2	250	Good
Subcontractor/Well Installer	≥2	>250	Poor to Good

1. If a bailer or manual surge block is the only alternative, the modified over-pumping technique cannot be used. Instead, personnel should follow the appropriate, alternative SOP.

2. Gather information.	Review the Site Sampling and Analysis Plan (SAP) or Work Plan for purge water containment requirements. Compile the necessary equipment and well installation information (e.g., total depth, screen interval, etc.) prior to traveling to the site.
3. Set up equipment.	Upon arrival at the well/piezometer to be developed, place the containers that will be used to contain purge water (if required) in an accessible location. Set up the remainder of the equipment adjacent to the well, within spill containment if required.
4. Take and initial DTW reading.	Open the well/piezometer and take an initial depth to water (DTW) reading following the instructions outlined in SOP-GW-03 Depth to Water Level Measurements. Record the initial DTW in the field logbook and on the well development field data sheet.
5. Check the total depth of the well.	Check the total depth of the well by turning off the buzzer on the DTW meter and lowering probe to the bottom of the well. Record this information in the field logbook and on the well development field data sheet. Remove the DTW probe from the well. Record the screen depth and length (available from the well installation log).
6. Set up pump and tubing.	If needed, attach an appropriate length of disposable or decontaminated tubing to the pump outlet or put tubing in the pump head. Don a new, clean pair of gloves prior to handling the tubing. Lower pump or tubing into the well. The pump intake should be located near the bottom of the screened interval. If the screen extends to the bottom of the well, make sure the intake for the pump is located above any slurry that may be present in the bottom of the well, approximately 1/2 to 1 foot above the bottom if using the submersible pumps.

	If using a peristaltic pump, tubing can be located closer to the bottom of the well as slurry will only clog the tubing and not damage the pump itself. If using a submersible 12-volt pump without a controller, put a valve on the discharge end of tubing and securely fasten. Record the depth of the pump intake in the field logbook and on the well development field data sheet.
7. Measure DTW with the pump installed.	Put the DTW probe back in the well and make sure it is turned on. Record the DTW with the pump installed.
8. Turn the pump on and adjust water flow.	If using a 12-volt submersible pump, start the pump with the attached discharge valve all the way open. If using a Grundfos pump with a controller or a peristaltic pump, turn the pump on and raise the pumping rate slowly until water starts to flow. Monitor the DTW meter; the water elevation should drop until the tubing is full and water is flowing freely. If the water elevation continues to drop after water is flowing smoothly, turn flow down using either the discharge valve or the controller until the water elevation stabilizes. Record the time development starts, the stabilized water elevation, and an estimate of volume purged in the field logbook and on the well development field data sheet as "Initial Drawdown."
9. Measure the stabilized water flow rate.	Measure the stabilized water flow rate using an appropriately-sized container (e.g., graduated cylinder, marked beaker, marked bucket, etc.) and a stopwatch to determine the volume of water per minute being purged from the well. Record the water flow rate in the field logbook and on the well development field data sheet.
10. Record the characteristics of the purged water.	Record the color of water, presence of sand or silt, and any odors or sheen. If the water is not extremely dirty, run an initial turbidity measurement and record.
11. Track the volume of water being removed.	Track the volume of water being removed. Volume may be calculated by either multiplying the elapsed time by the water flow rate or multiplying the number of buckets/drums purged by the volume of the bucket/drum. Keep a record of time, water removed, turbidity measurements and DTW readings in the field logbook and on the well development field data sheet.
12. Measure and record the field parameters.	Once the water appears to be clear, begin measuring field parameters. At a minimum, measure temperature, pH, specific conductivity (SC), and turbidity. If required by the SAP or Work Plan, measure and record the oxidation reduction potential (ORP) and dissolved oxygen (DO). Depending on the water flow rate field parameter probes can be placed in a 5-gallon bucket, in a ½- to 1-liter beaker or in a flow thru cell. Turnover of water in the container should be quick (e.g., 1 to 2 minutes). As an example, if the water is purging

	at 4 gallons a minute, a 5-gallon bucket could be used, as turnover in the bucket would be about 1 minute. If water is purging at 1 to 2 gallons a minute, a liter beaker may be more appropriate. If the water is fairly clear, a flow through cell with appropriately sized bypass tubing can be used with any flow rate. The flow through cell allows the water in the bypass tubing to be discharged directly into a storage container or to the ground a safe distance downgradient from the well. Record parameter measurements every 5 to 10 minutes. Record DTW measurements and estimated volume along with the parameter readings in the field logbook and/or on the well development field data sheet.
13. Purge the well and monitor drawdown.	If possible, when turbidity falls below 50 Nephelometric Turbidity Unit (NTU), increase the flow by adjusting the discharge valve or turning up the controller. Purge the well at about twice the stabilized water flow rate determined in Steps 8 and 9. Monitor drawdown constantly as you do not want to purge the well dry. • The water elevation may stabilize at a level lower than the initial DTW reading. If so, record how long it took to stabilize at the lower level, the amount of water purged, and the new DTW elevation in the field logbook and on the well development field data sheet. • If the water elevation in the well drops to about 4 to 5 feet above the pump intake (the acceptable drawdown elevation should be adjusted based on the water column, screen length and depth of the well being developed; ideally you want to develop the well along the entire screen length), turn the discharge valve or controller below the starting flow rate and allow the well to “recover.” Record the duration, amount purged, and DTW when done with the initial over-pumping of the well. • If the pump is purging at maximum capacity, or if no drawdown occurs at a higher flow, turn the pump off, let the well “recover” for 1 to 5 minutes, and turn the pump back on. Record the duration of the stoppage and the new starting water level in the field logbook and on the well development field data sheet.
14. Continue monitoring turbidity and recording field parameters.	Turbidity may increase after the over-pumping or stopping. Continue recording field parameters unless the turbidity exceeds 1000 NTU. At this point, remove the field parameter probes and wait for the water to clear up before recording field parameters. Note this in the field logbook or on the well development field data sheet. Once turbidity measures less than 50 NTU, repeat Steps 12 and 13 until the clarity of water does not change significantly between lower and higher flows.
15. Adjust pump as needed.	If time permits (as designated in the SAP or Work plan) and the stabilized water level allows, raise the pump to the midpoint of the screen and repeat Steps 12 through 14, recording time, field parameters, volume purged, and DTW readings until turbidity readings are less than 50 NTU.
16. Continue monitoring turbidity and	The well is considered developed when 3 consecutive readings for turbidity are below the SAP or Work Plan designated requirements (e.g., the Clark Fork River Superfund Site Investigation SOP [ARCO, 1992] requires readings below 5 NTU, and the U.S.

field parameters to determine if the well is developed.	Environmental Protection Agency [EPA] well development protocol requires readings below 50 NTU) and the remaining required field parameters have stabilized. Water quality parameters are considered stable when three consecutive readings are as follows: • Temperature range is no more than +/- 1 degree Celsius (°C); • pH varies by no more than 0.1 pH units; and • SC readings are within 3% of the average.
17. Record the final DTW and calculate the total amount of water purged.	Before turning off the pump, record a final DTW. Calculate the total amount of water purged and record the volume in the field logbook and on the well development field data sheet.
18. Dispose of the purge water and tubing.	Dispose of the purge water and tubing as outlined in the SAP or Work 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 soils and water.	During well development.	Inadvertent exposure to contaminated soils and 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 contact with purge water is possible. Pour purge water from buckets into disposal area/containers used to contain purge water slowly to prevent splashes and skin contact. Keep control of high-flow discharge hoses to prevent water spraying and skin contact.
	Carbon monoxide (CO).	Generator.	Potential exposure to CO when working around the generator could result in irritated eyes, headache, nausea, weakness, and dizziness.	Personnel will stay up wind when working around the generator. The generator will not be operated indoors or near openings to any buildings that might be occupied.
	Contact with gasoline.	Fueling the generator.	Inadvertent exposure via inhalation and/or skin contact can result in adverse health effects and skin irritation if contact with gasoline occurs.	Personnel will fuel the generator in a well-ventilated area, stand up wind while fueling, and minimize splash hazards so skin contact does not occur. Wear nitrile gloves when removing the fuel cap and filter.

HSSE CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.				
NOISE	Elevated noise levels.	Using the generator.	Exposure to elevated noise levels from the generator may result in hearing damage.	Personnel will set up the generator away from the well development activities to prevent exposure to elevated noise levels.
ELECTRICAL	Improper use of the generator.	Sites (during we conditions).	Electrocution, shock, death, or equipment damage could be caused when using a generator during wet conditions.	If personnel must use a generator when it is wet outside, the generator will be protected from moisture and it will be equipped with a Ground Fault Circuit Interrupter (GFCI). Keep extension cord (if used) and connections as dry as possible. Place generator on a surface where water cannot puddle or drain under it. Personnel will dry hands, if wet, before touching the generator. Items will be connected to the generator using heavy-duty extension cords that are specifically designed for outdoor use.
	Improper use of the 12-volt battery.	Using the battery to power the 12-volt submersible pump.	Personal injuries could result from improper use and maintenance of a 12-volt battery. Example are: shocks, acid burns on skin or eyes, skin burns from electrical charge transfer through a tool and into a metal ring or watch, and battery explosions.	Personnel will remove all jewelry before working with a 12-volt battery. Personnel will disconnect the negative cable first and re-connect it last to prevent getting a shock from current overflow. Personnel will use the battery in well-ventilated areas and inspect the battery before and after each use. Personnel will wear leather gloves and safety glasses when handling the battery.

HSSE CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.				
BODY MECHANICS	Improper lifting.	During well development.	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 workers will lift/handle heavy items.
	Bending, squatting, and kneeling.	During well development.	Bending, squatting, and kneeling during work activities could result in muscle/back strains or other injuries.	Personnel 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.	Personnel will wear work boots with good traction and ankle support. Personnel will be aware of walking/working surfaces and choose a path to avoid hazards. Keep work areas as dry as possible. If conditions are wet or muddy, wear muck boots.
WEATHER	Cold/heat stress.	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. 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.	Personnel 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.	Outdoor sites.	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.	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 the site. Personnel with allergies will notify their supervisor.
MECHANICAL	Pinch points.	Well caps.	Personal injury could result from fingers getting pinched in well caps.	Personnel will wear leather gloves when removing well caps.
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 the procedure described above and other applicable procedures. Personnel 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	**Personal Protective Equipment** (PPE): Hard hat, safety glasses, high-visibility work shirt or vest, long pants, work boots, nitrile gloves, and work gloves.
APPLICABLE SDS	**Safety Data Sheets** (SDSs) will be maintained based on the 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	
RELATED SOPs/ PROCEDURES /WORK PLANS	SOP-GW-03 Depth to Water Level Measurements
TOOLS	DTW meter, pump and tubing (see step 1 for pump selection), turbidity meter, container to measure water flow rate (e.g., graduated cylinder, marked beaker, marked bucket, etc.), stopwatch, field parameter meters, and containers to contain purge water (if required).
FORMS/ CHECKLIST	Field logbook, well development field data sheet, and well installation log.

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**	**04/10/2018**
SAFETY AND HEALTH MANAGER	**DATE**
Tara Schleeman **Tara Schleeman**	**04/10/2018**

PURPOSE	To provide standard instructions for the process of abandoning groundwater monitoring wells in accordance with the Montana Department of Natural Resources and Conservation (DNRC) regulations (Administrative Rules of Montana [ARM] 36.21.810).
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	Wells which have not been monitored for more than three years shall be deemed abandoned unless written permission is obtained from the board to maintain the well. Monitoring wells that have outlived their useful purpose shall be abandoned by one of the following methods: 1. Leaving the casing and screen in place, and sealing the casing and screen from the bottom up. 2. Removing the casing and/or screen, and filling the hole with sealing material from the bottom up, as the casing and/or screen is removed. 3. Other methods for abandonment with prior board approval. Instructions and general information for methods 1 and 2 are provided 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).

Method 1. Leaving the casing and screen in place, and sealing the casing and screen from the bottom up.

TASK	INSTRUCTIONS
1. Seal the casing and screen from the bottom up.	If the casing and screen are left in place, seal the casing and screen from the bottom up by the following methods: a. Using a pump and hose or tremie pipe to conduct the sealing material to the bottom of the well; or b. By filling the casing and screen with bentonite pellets or chips placed in a manner that will prevent bridging. Metal casings shall be cut off three feet below the ground surface and the last three feet backfilled with naturally occurring soils.

Method 2. Removing the casing and/or screen, and filling the hole with sealing material from the bottom up, as the casing and/or screen is removed.

TASK	INSTRUCTIONS
2. Fill the hole with sealing material	The department recommends that the casing be removed in all possible instances.

as the casing and/or screen is removed.	If the casing and/or screen are removed, fill the hole with sealing material, concrete, or bentonite pellets or chips from the bottom up, as the casing and/or screen is removed. From six to three feet from the surface, add bentonite to the well. Fill the last three feet with naturally occurring soils.
Additional Information	The sealing material shall be bentonite pellets or chips, bentonite clay grout, neat cement grout, or concrete. The material may contain non-biodegradable fluidizing admixtures, provided they will not contaminate the groundwater. Sealing materials which settle shall be topped to provide a continuous column of grout to within three feet of the surface. For flowing wells, the abandonment procedures outlined in ARM 36.21.671 shall apply. A properly abandoned well shall not produce water nor serve as a channel for movement of water. A water well log report, fully describing all abandonment procedures, shall be submitted to the Ground Water Information Center (GWIC) of the MBMG within 60 days of abandoning the well.

HSSE CONSIDERATIONS

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

SOURCE	***HAZARDS***	***WHERE***	***HOW, WHEN, RESULT***	***CONTROLS***
CHEMICAL	Contaminated soils and groundwater.	Sites and wells.	Inadvertent exposure to contaminated soils and groundwater could lead to adverse health effects.	Personnel will practice proper personal hygiene – wash hands prior to eating/drinking and leaving the site. Personnel will wear nitrile gloves and safety glasses if contact with contaminated soils, groundwater, and tools/equipment is possible.
	Bentonite.	Mixing the bentonite grout. Sealing the casing/screen or well's hole with bentonite (pellets or chips).	Exposure to bentonite via inhalation of dust and/or skin contact can result in adverse health effects.	Personnel will pour bentonite slowly, stay upwind, and wear work gloves and safety glasses. If contact with bentonite occurs, personnel will thoroughly wash the affected area with water and flush their eyes.
	Cement.	Preparing the concrete and neat cement grout. Sealing the well's hole with concrete or neat cement grout. Filling the surface of the abandoned well with cement.	Skin and eye contact with concrete/neat cement grout could result in chemical burns. Inhalation of cement dust is also possible when mixing the concrete/neat cement grout, which could result in adverse health effects.	Personnel will wear work gloves and safety glasses when mixing and handling concrete/neat cement grout. Personnel will also stay upwind and avoid breathing dust when mixing the concrete/neat cement grout. If contact direct contact occurs, personnel will thoroughly wash the affected area with water and flush their eyes.
	Cold patch asphalt.	Filling the surface of the abandoned well with cold patch asphalt.	Direct contact with cold patch asphalt could result in adverse health effects and injuries.	Personnel will wear work gloves and safety glasses when handling the cold patch asphalt.

HSSE CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.				
NOISE	Elevated noise levels.	Power-operated hand tools (e.g., rotary hammer and concrete saw).	Exposure to elevated noise levels could occur when using power-operated hand tools to remove concrete/asphalt around the well's casing.	Personnel will wear hearing protection (e.g., earplugs) if necessary.
ELECTRICAL	Power-operated hand tools (e.g., rotary hammer and concrete saw).	Removing concrete/asphalt around the well's casing.	Improper use and/or malfunction of power-operated hand tools may result in electric shock, fire, and serious personal injuries.	Personnel will practice the following: • Inspect the tool before and after each use. • Power tool plugs must match the outlet. • Avoid body contact with earthed or grounded surfaces, such as pipes, radiators, and ranges. • Do not expose the tool to rain or wet conditions. • Never use the cord for carrying, pulling or unplugging the tool. Keep cord away from heat, oil, sharp edges or moving parts.
	Generator.	Sites.	Generators pose a risk of shock and electrocution, especially if they are operated in wet conditions.	If personnel must use a generator when it is wet outside, the generator will be protected from moisture. The generator will also be equipped with a Ground Fault Circuit Interrupter (GFCI). Appliances will be connected to the generator using heavy-duty extension cords that are specifically designed for outdoor use.

HSSE CONSIDERATIONS

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

BODY MECHANICS	Awkward body positioning.	Well abandonment.	Bending, squatting, and kneeling for extended periods of time could result in muscle/back strains and fatigue.	Personnel should stretch prior to starting work and they will take breaks when necessary.
	Improper lifting techniques.	Lifting/carrying tools, equipment, and sealing materials.	Using improper lifting techniques when handling bags/containers with sealing materials (e.g., bentonite chips) and tools/equipment could result in back and muscle injuries.	Personnel will practice the following lifting techniques: get a good grip; keep the load close to the body; lift with legs and not with back; avoid twisting body while lifting; and avoid lifting loads above shoulder height. Two people will lift awkward/heavy items.
	Improper shoveling techniques.	Digging material around the well's casing with a hand shovel.	Using improper shoveling techniques could result in muscle and back injuries.	Personnel will practice the following shoveling techniques: keep feet wide apart; place front foot close to shovel; put weight on front foot, use leg to push shovel and shift weight to rear foot; keep the load close to the body; and turn feet in direction of throw.
GRAVITY	Uneven terrain.	Sites. Accessing wells.	Walking on uneven terrain could result in slips and falls causing personal injuries.	Personnel will wear work boots with good traction and ankle support, be aware of walking surfaces, choose a path to avoid hazards, and walk cautiously.

HSSE CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.				
GRAVITY (cont.)	Bentonite spills.	Mixing the bentonite grout. Sealing the casing/screen or well's hole with bentonite (pellets or chips).	If bentonite contacts water on the ground, the area could become slippery. Personnel could slip and fall resulting in personal injuries.	Personnel will pour bentonite slowly to prevent spills. If a spill occurs, thoroughly clean the area immediately.
WEATHER	Cold/hot temperatures.	Outdoor sites.	Exposure to cold temperatures may result in cold burns, frostbite, and hypothermia. Exposure to hot 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, insulated gloves, etc.), remain hydrated, and have sufficient caloric intakes during the day. Personnel will use their field truck to take breaks, when needed. Personnel will also follow the procedures outlined in the Pioneer Heat/Cold Stress Program.
	Lightning.	Outdoor sites.	Electrocution, personal injuries, 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 when working outdoors 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.

HSSE CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.				
BIOLOGICAL	Plants, insects, and animals.	Outdoor 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.
MECHANICAL	Sharp edges.	Cutting tools and equipment (e.g., hand saw and concrete saw).	Personnel could be exposed to sharp edges when using cutting tools/equipment resulting in hand/finger injuries.	Personnel will visually inspect the cutting tools/equipment before each use, follow the manufacturer's safety recommendations, ensure the tool's protective guards are in place, wear work gloves, and watch for hand placement to avoid contact with cutting areas.
	Pinch points.	Wells and hand tools.	Personnel can be exposed to pinch points when removing well covers and using hand tools, which could result in hand/finger injuries.	Personnel will be aware of hand/finger placement and not put hands/fingers between object; they will wear work gloves if necessary. Personnel will inspect hand tools before each use and wear work gloves when using them.
	Flying debris.	Removing concrete/asphalt around the well's casing.	Exposure to flying debris is possible when using power-operated tools to remove/cut concrete/asphalt around the well's casing.	Personnel will wear safety glasses, ensure the tool's protective guards are in place, and keep face away from cutting operations.

HSSE CONSIDERATIONS

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

MECHANICAL (cont.)	Rotating/moving parts.	Power-operated hand tools (e.g., rotary hammer and concrete saw).	Direct contact with rotating/moving parts from power-operated hand tools could result in hand/finger injuries.	Personnel will practice the following: • Do not use power-operated hand tools while you are tired. • Prevent unintentional starting. Ensure the switch is on the off positon before connecting to the power source, picking up or carrying the tool. • Do not overreach. Keep proper footing and balance at all times. • Do not wear loose clothing or jewelry. Keep your hair, clothing and gloves away from moving parts.
	Heavy equipment.	Removing the well's casing with heavy equipment.	Ground personnel could be struck by/caught between heavy equipment resulting in serious personal injuries.	Ground personnel will practice the following: • Be aware of your surroundings and watch out for moving equipment. • Maintain a safe distance from moving equipment. • Before approaching the equipment, communicate with the operator by establishing eye contact and waving. • Approach equipment only when it is not in motion and it is safe to approach. For example, when the bucket of excavator is on the ground and the operator has signaled that it is safe to approach.

HSSE CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.				
PRESSURE	Pressurized lines.	Heavy equipment.	Exposure to pressurized hydraulic lines from heavy equipment is possible. Failure or malfunction of lines could result in injuries.	Heavy equipment contractor will inspect the equipment daily. Ground personnel will maintain a safe distance from active heavy equipment.
	Pressurized grout mixture.	Grout pump.	Direct contact with pressurized grout mixture when pumping grout down the well could result in personal injuries.	Personnel will pump the grout mixture down the well carefully and will avoid contact with the pump's discharge.
THERMAL	Hot surfaces.	Power-operated hand tools (e.g., rotary hammer and concrete saw).	Power-operated hand tools may get hot during use and direct contact with hot surfaces could cause skin injuries.	Personnel will wear work gloves and avoid contact with hot surfaces.
HUMAN FACTORS	Inexperienced and improperly trained personnel.	Conducting work activities.	Inexperienced personnel and improper training could cause incidents resulting in injuries and/or property damage.	Personnel will be properly trained in this procedure and other applicable procedures. Personnel will also implement stop work procedures when necessary.
	Public/ unauthorized people.	Sites.	Interaction with the public/ unauthorized people is possible, which could interfere with work activities and result in personal injuries and/or	If members of the public/unauthorized people enter the work area, personnel will stop work. Work will not resume until they have left the area. If necessary, personnel will delineate the work area with traffic cones and caution tape.

HSSE CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.				
			property damage.	
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 gloves, and steel-toed boots.
APPLICABLE SDS	Bentonite, cement, and cold patch asphalt. 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	
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**
Charles Peterson	**03/17/2017**
SAFETY AND HEALTH MANAGER	**DATE**
Tara Schleeman	**03/17/2017**

Revisions:

Revision	Description	Date

PURPOSE	To provide standard instructions for sampling soil from a liner using a Geoprobe® unit.
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
Preparation	
1. Check of liner materials.	Make sure that the liner used to contain the soil in the Geoprobe® probe rods is made of material compatible with the contaminants being analyzed.
2. Verify utility locates and conduct site walk.	Confirm that the Pioneer Geoprobe® operators or the Geoprobe subcontractor has placed a utility locate ticket that covers the area to be sampled. Confirmation number needs to be provided to the Pioneer field team leader 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 drilling activities. 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 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. Adjust sample locations based on this information. Before probing activities begin, verify that the ground has been marked with the location of underground utilities listed on the locate ticket. If needed, adjust sample locations based on identified or potential utility locations. See the Trenching, Excavation, and Ground Disturbance Program information in Pioneer's Corporate HASP to identify safe distances for drilling when adjacent to specific buried utilities.

3. Set up the sample and staging area.	Cover a folding table with plastic. The table should be at least as long as the liners to be sampled. A tailgate covered with plastic can also be used. If the only available surface is the ground, place several layers of plastic a couple of feet longer than the liners. Secure the layers of plastic so they do not blow around during sampling. In addition to the sampling area, a staging area for unsampled core needs to be designated. This area should also be covered with plastic to keep the liners clean before placement on the sampling area.
4. Mark the liners.	As the Geoprobe® operator removes core (liners) from the probe rods, mark with a waterproof marker the "top" and "bottom" of the liner as well as the interval that the liner represents. Cap the liner ends with vinyl or Teflon end caps. Move core to the staging area.
5. Record information provided by the operator.	If possible, confer with the Geoprobe® operator for any issues associated with probing each interval. Potential problems they may report: • A loss of material due to a rock blocking the tube. • A section that drilled extremely easy indicating material that was easily compressed such as clay or debris. • The presence of a potential void. • A problem with recovery due to saturated soil. • Heaving sands, which could result in overestimation of the width or depth of a layer due to re-coring of the same interval. • Recognition of slough into the hole prior to drilling the next interval. Record any information provided by the operator in the field logbook or on the field data sheet. This information can be referenced when logging the core.
Sampling of Soil for Inorganic Constituents	
1. Cut the plastic liner lengthwise.	The Geoprobe® operator and/or helper will cut the top portion of the plastic liner lengthwise. The opening along the top should be at least 2 inches wide. Care should be taken when handling and working around the cut liner as the cut edges are sharp.
2. Place the liner on the prepared sampling surface.	Place the liner on the prepared sampling surface and take the cut portion off. The portion of the liner marked "top" should be placed in the same direction on the sample surface each time. Place the index cards marked "top" and "bottom" on the appropriate ends of the liner. Place an extended tape measure adjacent to the liner. Index cards marked with appropriate intervals can also be used. Take a picture of the exposed soil. Do not move the tape measure or core after the photo. If the core does not need to be photographed, and it is **NOT** being analyzed for organics, mark the liner at the appropriate foot intervals with a Sharpie®.

3. Measure and record material in the core.	Measure and record the number of inches of material in the core, this will be recorded in the field logbook or on the field data sheet as “length recovered” (e.g., 36 inches from a 4-foot push or 18 inches from a 2-foot push). This measurement should not include any material that appears to have sloughed from an upper interval (i.e., leaves or topsoil present at the top of deeper subsurface cores). Record this information in the field logbook or on a field data sheet as specified in the Sampling and Analysis Plan (SAP). Evaluate the recovery of the core based on the operator’s comments. The preferred method is to determine the amount of material that represents 1 foot of the profile. For example, 36 inches of recovered soil from a 4-foot probe may indicate 9 inches were recovered per foot. An alternate method for determining interval depth is to assume that the 36 inches represents 36 inches from either the top or bottom of the probed interval and that there was no recovery for 4 inches of the interval. These are not precise ways to determine how far below ground surface a soil horizon lies, as different soil types and moisture levels will compress or expand differently when pushed with the probe. There is no way to determine where or whether compression / expansion in the soil profile occurred. Choose one of the methods and be consistent throughout the project. Another scenario that may occur is if the operator indicates an obstruction was encountered that may have blocked soil from entering the liner at the 2-foot interval in a probe. If there is only 24 inches of soil and a large rock present in the liner, this may represent only the 0-2 foot interval in that core and should be recorded that way in the field logbook or on the field data sheet along with the operator’s comment.
4. Log the core.	Examine and log the material in the liner. Check the project specific documents for the amount of detail or type of information required from the core log. Pioneer has developed several different field data sheets to aid in collecting the correct information during core logging. Keep in mind that due to smearing of soil during probing, a coating of wet or fine material may be present on the outside of the soil core. Using a gloved finger, make indentations down the core noting differences in texture, color, staining, or odor; to avoid cross contamination, change fingers as you make indentations. Record this information in the field logbook or on the field data sheet.
5. Determine sample intervals.	Determine sample intervals as described in the SAP or Work Plan (WP). If the material is **NOT** being sampled for organics, the sample intervals can be marked on the liner using a Sharpie®. An alternate method would be to separate the sample intervals so that a gap exists between the intervals. This makes it easier to get the appropriate intervals in the sample if the tape measure is moved during sampling activities.
6. Collect soil samples.	Slide the tube to the end of the table or sampling surface. Using a new plastic disposable scoop, slide the appropriate marked sample interval into a new disposable foil pan, stainless steel bowl, or resealable plastic bag. Alternately, instead of a scoop

	you can use a gloved finger or a clean screwdriver. A screwdriver is particularly helpful if portions of the soil are hardpacked or compressed. Mix the material in the pan/bowl thoroughly and remove rock and debris greater than 0.5 inches. If more material is required to fill sample containers, a second hole can be probed immediately adjacent to the first and material from the second liner from the same interval can be added to the pan/bowl and mixed. Repeat this process for all intervals to be sampled. Decontaminated bowls and screwdrivers and new foil pans, new resealable plastic bags, and new disposable scoops should be used for each interval sampled. Be aware of the potential for cross contamination and if needed change gloves between intervals.
7. Put samples in containers.	Prepare the appropriate sample containers with a label as described in the SAP or the Quality Assurance Project Plan. Fill the sample containers with homogenized material from the pan/bowl using the associated sampling tool. After sampling, place the samples in a cooler with ice until they can be transported to the laboratory for analysis as described in SOP-SA-01 Soil and Water Sample Packaging and Shipping.
8. Record sampling information.	Record appropriate information about the sample collection (sample number 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.
9. Store or dispose of remaining core	Disposal or storage information should be available in the project-specific SAP/WP. In most cases, soil can be returned to the drill hole from which it came. If the information is not available in the SAP, discuss disposal requirements with the project manager.
Sampling of Soil for Organic Constituents	
1. Preparation prior to screening for volatile organic vapors in drill or Geoprobe® drill core.	**Photoionization detector (PID) meter readings are taken immediately upon opening the core, prior to any other sampling or logging activities. Soil samples can show significant losses in volatile organic compound (VOC) concentrations within only seconds of opening soil cores.** If measurements using an organic vapor detector, PID, are required, please refer to SOP-FM-01 Field Headspace Analysis and VOC Measurements with PID for information on calibrating and using a PID for headspace analysis and VOC measurements.
2. Place caps on the end of the core tubes.	Ensure that the Geoprobe® operator and/or helper place caps on the end of the core tubes immediately after removing the liner from the probe rod so that no VOCs escape prior to cutting open the core. Store capped core in the shade or on ice to avoid additional volatilization of VOCs. **Do not** have the operator/helper cut the tubes until just before core will be sampled.

3. Prepare the sample containers.	Based on information provided in the SAP/WP, prepare and label the appropriate sample containers. If samples are required, sample intervals may have been assigned in the SAP/WP, or samples may be collected based on PID or headspace readings or the presence of odor or staining. The sampler needs to understand sample collection protocol prior to opening the core liner. This is particularly important in collecting samples for VOC, volatile petroleum hydrocarbon (VPH), and/or extractable petroleum hydrocarbon [EPH] analysis. Ensure required sampling supplies are close at hand prior to opening core.
4. Cut the plastic liner lengthwise.	Have the Geoprobe® operator and/or helper cut the top portion of the plastic liner lengthwise. The opening should be at least 2 inches wide. **DO NOT REMOVE THE CUT PORTION OF THE LINER**. Care should be taken when handling and working around the cut liner as the cut edges are sharp.
5. Place the liner on the prepared sampling surface.	Place the liner on the prepared sampling surface. **Do not** remove the cut portion. Place the portion of the liner marked "top" in the same direction on the sample surface each time. Place the index cards marked "top" and "bottom" on the appropriate ends of the liner. Place an extended tape measure adjacent to the liner. Index cards marked with appropriate intervals can also be used.
6. Measure and record material in the core.	**Prior** to removing the cut portion of the liner, measure and record the number of inches of material in the core. See discussion in Step 3 of Sampling of Soil for Inorganic Constituents to determine how depth of sample intervals will be determined.
7. Take a picture of the exposed soil.	Remove the cut portion of the liner. Quickly take a picture of the exposed soil. Do not move the tape measure or core after the photo.
8. Conduct PID readings if required.	**The VOC and VPH samples need to be collected as quickly as possible after opening the tube.** If specified in the SAP/WP, use a PID to take readings of the length of the core, refer to SOP-FM-01 Field Headspace Analysis and VOC Measurements with PID for information on calibrating and using a PID for headspace analysis and VOC measurements.
9. Collect soil samples for VOC / VPH / EPH.	Collect the required VOC, VPH, or EPH samples directly from the tube using a plastic disposable scoop, gloved hand, or screwdriver. After VOC, VPH, and EPH samples are collected from all tubes/cores, collect inorganic (metals) samples if needed. The tape measure can be used to identify the intervals. Gaps from removed sample material should be left so that logging of the remaining core material can be completed. Place the soil directly into the sample container and fill the jar to the top allowing no head space (or as the laboratory directs). Be aware of the potential for cross contamination and if needed change gloves between intervals. New disposable scoops and a clean screwdriver should also be used for each sample interval. Immediately place the sample containers in a cooler with ice. Keep samples at 4 degrees Celsius (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.
10. Record PID readings and VOC sample information in Logbook.	If PID screening is conducted, record results of the screening in the field documentation (project logbook or field data sheets) and include the highest reading from each interval, the actual location in the core (i.e., 10 inches from the bottom), and the calculated interval depth. Record the sample information for the VOC, VPH, or EPH samples in the logbook and include time, date, and type of containers collected.
11. Continue sampling cores for VOCs.	Once the VOC samples have been collected from a section of core, replace the end caps and put the cut portion of the liner back on the core. The core can then be moved back to the staging area so that the next section of core can be screened and sampled for VOCs as quickly as possible. Process all available core for VOC samples prior to collecting inorganic samples or logging the core.
12. Log the core.	Once all the VOC samples have been collected. Logging the core can begin. Move a piece of core to the sample table and remove the cut portion of the liner, *being careful to keep it horizontal so as not to shift "gap" areas*. Realign the tape measure with the bottom and top of the tube. Examine and log the material in the liner. Check the project-specific documents for the amount of detail or type of information required regarding the core log. Pioneer has developed several different field data sheets to aid in collecting the correct information during core logging. If the initial measurement of the length of core (Step 6 above) included slough, adjust the information on the field data sheet or logbook to reflect the actual length of core. Include information on material removed for VOC samples, as determined during sampling. Keep in mind that due to smearing of soil during probing, a coating of wet or fine material may be present on the outside of the soil core. Using a gloved finger, make indentations down the core and record the information in the field logbook or on the field data sheet; to avoid cross contamination, change fingers as you make indentations.
13. Prepare soil samples for additional analytes.	Sample intervals that are not going to be submitted for VOC, VPH, or EPH analysis can be sampled once logging of the core is completed. Ensure that all information from logging the core is recorded in the field logbook or on the field data sheet. Determine the intervals to be sampled for additional analytes. Separate the sample intervals for the inorganic samples, so that a gap is present between the intervals. This makes it easier to get the appropriate sections into the sample if the tape measure or core is moved. Record sample information and include interval sampled and associated sample number in the field logbook or on the field data sheet.

14. Collect soil samples.	Slide the tube to the end of the table or sampling surface. Using a new plastic disposable scoop, slide the appropriate marked sample interval into a new disposable foil pan or stainless steel bowl. Alternately, instead of a scoop you can use a gloved finger or a clean screwdriver. The screwdriver is particularly helpful if portions of the soil are hardpacked or compressed. Mix the material in the pan/bowl thoroughly and remove rock and debris greater than 0.5 inches. If more material is required to fill sample containers, a second hole can be probed immediately adjacent to the first and material from the second liner from the same interval can be added to the pan/bowl and mixed. Fill the sample containers with the homogenized materials from the pan/bowl using the associated sampling tool. Repeat this process for all intervals to be sampled. Be aware of the potential for cross contamination and if needed change gloves, screwdriver, or scoops between intervals.
15. Label the sample containers and store them in a cooler.	Make sure all sample containers are labeled correctly. These sample containers should also be placed in a cooler with ice (if required). Samples should be kept at 4 ºC or less (if required by the analytical method) and under chain of custody protocols until transport to the laboratory as described in SOP-SA-01 Soil and Water Sample Packaging and Shipping.
16. Record sampling information.	Record appropriate information about the sample collection (sample number 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.
17. Store or dispose of remaining core.	Disposal or storage information should be available in the project-specific SAP/WP. Soil with potential organic contamination will need to be contained for testing and potential landfarm treatment or disposal at an approved facility. If the information is not available in the SAP, discuss disposal requirements with the project manager. Removed soil may also be returned to the drill hole from which it came.
Decontamination of Equipment following both Organic or Inorganic Sampling	
1. Clean the plastic placed over the sample area.	Between each core, sweep or wipe down the plastic using paper towels wetted with deionized water (DI). If a particularly muddy core was sampled, the plastic may need to be replaced or a new piece placed over the sample area.
2. Decontaminate equipment.	Decontaminate the cutting tool, tape measure, and screwdrivers using paper towels wetted with a Liquinox/water mixture and the DI water spray bottle to rinse. If sampling for organics, use paper towels wetted with methanol for a final wipe down. If stainless steel bowls, spoons, and trowels were used, please follow instructions in SOP-DE-02 Equipment Decontamination.

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 and groundwater.	Sites.	Inadvertent exposure to contaminated soil and groundwater 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 contact with soil and groundwater is possible. Sampling will be conducted outdoors or in a trailer with open doors.
	Exposure to hydraulic fluids.	Geoprobe® operations.	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® 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 around the Geoprobe®.
	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® operations.	Personnel could be exposed to elevated noise levels when working near the Geoprobe® operations resulting in hearing damage.	Personnel will wear hearing protection (e.g., ear plugs) when working near the Geoprobe®. Non-essential personnel will maintain a 20-foot buffer zone around the Geoprobe®, when possible. Hearing protection will be administered and used in accordance with the policies and procedures outlined in the Pioneer Corporate HASP.
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 fieldwork activities.	Bending, squatting, and kneeling during fieldwork activities could result in muscle/ back strains or other injuries.	Personnel should stretch prior to starting work and they will take breaks when necessary.
	Improper lifting / handling of heavy items.	During field work activities.	Back injuries and muscle/back strains could result when using improper techniques to lift/carry heavy coolers and containers with core pieces.	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 workers will lift/handle heavy items as needed.
	Flying debris.	Geoprobe® operations.	Eye injuries could result from flying debris when working around Geoprobe® operations.	Personnel will wear safety glasses when working around Geoprobe® operations. Non-essential personnel will maintain a 20-foot buffer zone around the Geoprobe® when possible.
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. They will plan their path, walk cautiously, and keep work areas as dry as possible. Personnel will 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***
WEATHER	Cold/heat stress.	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). Personnel will remain hydrated and will have sufficient caloric intakes during the day. Personnel will follow procedures outlined in the applicable SSHASP and/or Pioneer corporate HASP.
	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 sites.	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.	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 in company vehicles. 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	Sharp edges and cutting tool.	Plastic liners and cutting tool.	Personal injury could result while cutting the plastic liners open to collect the soil samples. The plastic liners could also have sharp edges after they are cut. Cuts and scrapes could result from direct contact with sharp edges.	Personnel will use a specialized tool to cut the plastic liners and they will wear work gloves to prevent hand injuries. Personnel will use a tray and clamp to hold the plastic liner in place and keep it from moving around. Personnel will be aware of hand placement to prevent exposure to sharp edges and cutting tool.
PRESSURE	Pressurized hydraulic hoses.	Geoprobe®.	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® 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 around the Geoprobe®.
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 the procedure described above and other applicable procedures. Personnel will follow the stop work policy if there are any issues.

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***
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, nitrile gloves, and leather gloves.
APPLICABLE SDSs	**Safety Data Sheets** (SDSs) will be maintained based on the site characterization and contaminants. Safety Data Sheets are available to Pioneer personnel on the internal website under Safety.
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-FM-01 Field Headspace Analysis and VOC Measurements with PID, SOP-SA-01 Soil and Water Sample Packaging and Shipping, SOP-DE-02 Equipment Decontamination (Inorganic Contaminants), and SOP-SA-05 Project Documentation.
TOOLS/ EQUIPMENT	Sample area – plastic sheeting, folding table (1 or 2), tape to secure plastic, tape measure, index cards to indicate top and bottom, camera, PID (if required), plastic disposable scoops or stainless steel spoons or spatulas, screwdrivers, filled DI water spray bottle, filled Liquinox/water spray bottle, methanol, paper towels, foil disposable pans or stainless steel bowls, sample containers, cooler, ice, dual blade cutter, and liner holders.
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	11/18/2020
SAFETY AND HEALTH MANAGER	**DATE**
Tara Schleeman	11/18/2020

PURPOSE	To provide standard instructions for sampling soil cores generated during sonic drilling.
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.
DISCUSSION	Sonic drilling is accomplished by maintaining resonance of the drill string using an oscillator (the sonic drill head). As the resonance occurs, the soil immediately adjacent to the tooling is loosened and can move freely. Sonic drilling is particularly effective in areas where conventional drilling techniques might have problems, such as the presence of abundant cobbles or boulders, extremely dense till or cemented sands and gravels. The steps to soil collection using a sonic drill rig are as follows: 1. Sonically advance a core barrel into undisturbed soil. Runs are typically 10 feet, but longer or shorter runs are also possible. 2. Sonically override the core barrel with casing to the same depth. 3. Remove the core barrel to the surface and extrude the sample into a plastic sleeve in short sections for easy handling.

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
Preparation	
1. Verify utility locates and conduct site walk.	Confirm that the drilling 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 drilling activities. 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 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. Adjust sample locations based on this information. Before drilling activities begin, verify that the ground has been marked with the location of underground utilities listed on the locate ticket from the drilling subcontractor. If needed, adjust sample locations based on identified or potential utility locations. See the Trenching, Excavation, and Ground Disturbance Program information in Pioneer's Corporate HASP to identify safe distances for drilling when adjacent to specific buried utilities.
2. Set up the sample area.	Designate an area near the drill rig that can be used for sampling and logging of core. The location should be out of the way of the drillers, but close enough to facilitate movement of the core to the area. Lay out sheets of plastic (visqueen) that are at least 15 feet long for 10-foot runs of core. Enough plastic should be laid out that all the core from the drill hole can be accommodated. The plastic sleeves containing the core need to be laid out with space between them to allow access (walkways) for sampling and logging. Alternatively, core can be transferred to core boxes from the core sleeve prior to any logging or sampling activities. In that case, cover a folding table with plastic. The table should be at least as long as the sleeves to be sampled. A tailgate covered with plastic can also be used. If the only available surface is the ground, place several layers of plastic a couple of feet longer than the liners on the ground. Secure the layers of plastic so they do not blow around during sampling. In addition to the sampling area, a staging area for unsampled core needs to be designated. This area should also be covered with plastic to keep the sleeves clean before placement on the sampling area.
3. Determine the length of the cores.	Discuss with the drilling crew the length of core they will be providing in each plastic sleeve. In most cases, this will be about 10 feet. If volatile organic compounds (VOC)/volatile petroleum hydrocarbon (VPH) or other air sensitive analytes are being considered, a shorter length of core (e.g., 2 feet) might be appropriate for the best results.
4. Mark the core.	As the drilling crew brings the plastic sleeve containing core to the sampling area, they should identify the top of the interval and place it on the sheet of plastic in the appropriate location to keep the core in order from top to bottom.
5. Record information provided by the operator.	If possible, confer with the sonic drill operator for any issues associated with coring each interval. Potential problems they may report: • A loss of material due to a rock blocking the core barrel. • A section that drilled extremely easy indicating material that was easily compressed such as clay or debris. • The presence of a potential void. • A problem with recovery due to saturated soil. • Heaving sands, which could result in overestimation of the width or depth of a layer due to re-coring of the same interval. • Their recognition of slough into the hole prior to drilling the next interval.

	Record any information provided by the operator in the field logbook or on a field data sheet. This information can be referenced when logging the core.
Sampling Soil for Inorganic Constituents	
1. Slice the plastic along the top.	Using a utility knife or something similar, slice the plastic along the top. Be aware that if the soil is saturated it may flow out of the plastic. Additionally, water from saturated core may need to be "blocked" from flowing onto other sections of core (potential cross contamination). Place index cards or some other marker at intervals along the core. If possible (and the plastic is not wet), intervals can be marked on the plastic. Place a reel type tape measure along the core, so it can be easily referenced but out of the way. If core boxes are being used, prior to opening the sleeve, cut (using a utility knife) the core sleeve into sections that will fit in the core boxes in logical intervals (2 feet, 2.5 feet, etc.). Make sure that each core box is marked with "top" and "bottom" and the order of boxes (1, 2, etc.) for the core being placed in the box so that they can be correctly arranged for logging and sampling activities.
2. Split the core and take pictures of the core.	If the core is cohesive, split the core lengthwise into 2 subsamples using a new disposable plastic spatula and/or stainless-steel blade. Photograph the complete length of the core in approximately 2-foot segments from directly overhead using parallel camera movement and a high-resolution setting. These photographs can be stitched together later to provide a continuous photographic record of the core. Take additional photographs of subsamples for documentation as necessary. If required, take an overview picture of the exposed soil.
3. Measure and record material in the core.	Evaluate the recovery of the core based on the operator's comments. Be aware that once the core is cut open and released from the plastic, there may be some expansion. Recovery in general from sonic drill rigs is fairly complete. If there was trouble with the recovery, the operator should indicate in general where that might have occurred. Record any additional information in the field logbook or on a field data sheet. Measure and record the number of inches of material in the core. This will be recorded in the field logbook or on the field data sheet as "length recovered" (e.g., 36 inches from a 5-foot run or 96 inches from a 10-foot run). This measurement should not include any material that appears to have sloughed from an upper interval such as leaves or topsoil present at the top of deeper subsurface cores. If heaving sands are present, the actual measurements of the new interval may be difficult to determine; confer with the driller as to where material from the new interval may start. Record this information in the field logbook or on a field data sheet as specified in the Sampling and Analysis Plan (SAP). The preferred method for determining interval depths is to determine the amount of material that represents 1 foot of the profile. For example, 26 inches of recovered soil from a 2-foot interval may indicate that 13 inches of core represents 1 foot. An alternate method for determining interval depth is to assume that 96 inches actually represents 96 inches from either the top or the bottom of a 120-inch interval and that there was no recovery for 12 inches of the interval. These are not precise ways to determine how far below ground surface a soil horizon lies, as different soil types and moisture levels will

	compress or expand differently when drilled and then released with the opening of the sleeve. There is no way to determine where or whether compression/expansion in the soil profile occurred. Choose one of these methods and be consistent throughout the project. Another scenario that may occur would be if the operator indicates that an obstruction was encountered that may have blocked soil from entering the casing at a specific depth. If there is only 60 inches of soil and a large rock present in the sleeve, this may represent only the 0-to-5 foot interval in that core and should be recorded that way in the field logbook or on the field data sheet along with the operator’s comment. If core boxes are being used, mark the calculated interval for the core in each box, on both top and bottom portions of the box.
4. Log the core.	Examine and log the material in the core. Check the project specific documents for the amount of detail or type of information required from the core log. Pioneer has developed several different field data sheets to aid in collecting the correct information during core logging. Keep in mind that sonic-generated samples are not “undisturbed.” The oscillation during drilling causes movement in the soil immediately adjacent to the core barrel. In softer bedrock, this may open fractures or round off edges of the material. Material closer to the center of the core should be used for logging and sampling. Using a gloved finger or scoop, make indentations down the core noting differences in texture, color, staining or odor if needed. The core may be unconsolidated enough that this is not required. Record information in the field logbook or on a field data sheet. Be aware of potential cross contamination when logging intervals that may be sampled. Change gloves or scoops as required. If required by the SAP or Work Plan (WP), photograph areas of interest.
5. Determine sample intervals.	Determine sample intervals as described in the SAP or WP. Using the extended tape measure, identify the intervals to be sampled. Record the sample interval information and associated sample number in the field logbook or on a field data sheet. If required in the SAP/WP, photograph sample intervals.
6. Collect soil sample.	For composite samples: Don clean nitrile gloves and use a new plastic disposable scoop for each composite sample. Place an equal aliquot of soil from each area to be composited into a new disposable foil pan, stainless-steel bowl, or resealable plastic bag. Samples covering an extended core interval (0-1 foot, 0-2 feet, etc.) should also be collected as composite samples. Mix the material thoroughly removing rock and debris greater than 0.5 inches. Fill the appropriate sample containers. If a lot of containers need to be filled, a larger sample interval may require compositing. For grab samples: Don clean nitrile gloves and use a new plastic disposable scoop for each sample. If more than 1 jar is required, place the material to be sampled in a new disposable foil pan, stainless-steel bowl, or resealable plastic bag. Mix the material thoroughly and remove rock and debris greater than 0.5 inches. Fill the appropriate sample containers. Alternately, a new scoop can be used to place material directly in the jar. Sample

	carefully so no particles larger than 0.5 inches are included in the sample. Grab sampling may occur when there is a small, stained area or a small amount of a material of interest in a soil profile.
7. Put sample in container.	Prepare the appropriate sample containers with a label as described in the SAP or the Quality Assurance Project Plan (QAPP). Fill the sample containers with homogenized material from the pan/bowl/bag using the associated sampling tool. After sampling, place the samples in a cooler with ice (if required). Samples should be kept at 4 degrees Celsius (ºC) or less (if required by the analytical method or SAP) 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.
8. Repeat this process as needed.	Repeat this process, Steps 1 through 7, for each sleeve until the drill hole is complete.
Sampling Soil for Organic Constituents	
1. Preparation prior to screening for volatile organic vapors in drill core.	**Photoionization detector (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.** If measurements using an organic vapor detector, PID, are required please refer to SOP-FM-01 Field Headspace Analysis and VOC Measurements with PID for information on using the PID.
2. Prepare the core.	Ensure that the drill operator and/or helper seals the ends of the plastic sleeve by tying or taping immediately after removing the core from the drill rod so that no VOCs escape prior to cutting open the core. Store sealed sleeves in the shade to avoid additional volatilization of VOCs. Evaluate the plastic sleeve of core to be sampled but **DO NOT** cut the plastic. If the soil is saturated, water or soil may flow out of the plastic after it is cut. Saturated core may need to be “blocked” from flowing onto other sections of core, to prevent cross contamination. Place index cards or some other marker at intervals along the core. If possible (and plastic is not wet), intervals can be marked on the plastic. Place a reel type tape measure along the core so it can be easily referenced but out of the way.
3. Prepare the sample container.	Based on information provided in the SAP/WP, prepare and label the appropriate sample containers. If samples are required, sample intervals may have been assigned in the SAP/WP, or samples may be collected based on PID or headspace readings or the presence of odor or staining. The sampler needs to understand sample collection protocol prior to opening the plastic core sleeve. This is particularly important in collecting samples for VOCs, VPH, and/or extractable petroleum hydrocarbon (EPH). Ensure required sampling supplies are close at hand prior to opening the core.

4. Measure material in the core.	Prior to cutting the plastic sleeve, measure and record the number of inches of material in the core. See discussion in Step 3 under **Sampling Soil for Inorganic Constituents** to determine how depth of sample intervals will be determined.
5. Cut the plastic sleeve.	Once the sample collection supplies are organized, use a utility knife or something similar and slice the plastic along the top. If core boxes are being used, label core boxes prior to dividing core. Boxes should be labeled with "top" and "bottom" and the order of boxes (1, 2, etc.) for the core being placed in the box so that they can be correctly arranged for logging and sampling activities. Cut the sleeve, using a utility knife, into sections that will fit in the core box in logical intervals (2 feet, 2.5 feet, etc.). Move quickly during the dividing process so minimal VOCs are lost.
6. Split the core.	If needed quickly split the core lengthwise into 2 subsamples using a new disposable plastic spatula, plastic scoop, and/or stainless-steel blade.
7. Conduct PID readings if required.	**The VOC and VPH samples need to be collected as quickly as possible after opening the plastic.** If specified in the SAP/WP, use a PID to take readings of the length of the core, refer to SOP-FM-01 Field Headspace Analysis and VOC Measurements with PID for information on using the PID. If volatiles are detected, return to those areas and record the highest reading as well as the amount of core involved. Evaluate the core for staining or other indications of organic contamination. Photographs can be taken of areas of interest prior to sampling, however, keep in mind that time is of the essence if samples are to be collected.
8. Prepare and collect soil samples for VOC/VPH/ EPH.	Collect the required VOC, VPH, or EPH samples directly from the core using a plastic disposable scoop or gloved hand. Sampling for non-organic constituents can be completed later. The tape measure can be used to identify the intervals. Gaps from removed sample material should be left so that logging of the remaining core material can be completed. Place the soil directly into the sample container and fill the jar to the top allowing no head space (or as the laboratory directs). Be aware of the potential for cross contamination and if needed change gloves or scoops between intervals. Immediately place the sample containers in a cooler with ice. Samples should be kept 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.
9. Record PID readings and VOC sample information in logbook.	If PID screening is conducted, record results of the 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. Record the sample information for the VOC, VPH, or EPH samples in the logbook including sample interval and associated sample number, time, date, and type of containers collected.

10. Complete VOC sampling.	All VOC sampling of all core should be completed as soon as possible after core comes out of the ground. Once VOC samples have been collected from a section of core, set it aside or move on to the next section of core. Once **ALL** the core has been processed for VOC samples, then return to each core box or section and complete logging and additional sampling requirements.
11. Take pictures of the core.	If not already done, and if required by the SAP/WP, photograph the complete length of each core in approximately 2-foot segments from directly overhead using parallel camera movement and a high-resolution setting. These photographs can be stitched together later to provide a continuous photographic record of the core. Take additional photographs of subsamples for documentation as necessary. If required, take an overview picture of the entire length of core.
12. Complete any other required logging and sampling.	Follow Steps 4 through 8 under **Sampling Soil for Inorganic Constituents** to finish each core section.
Decontamination of Equipment following both Organic or Inorganic Sampling	
1. Decontaminate equipment.	Decontaminate the cutting tool and tape measure, as well as any other reusable equipment using paper towels wetted with a Liquinox/water mixture and the deionized (DI) water spray bottle to rinse. If sampling for organics, use paper towels wetted with methanol for a final wipe down. If stainless-steel bowls, spoons, and trowels were used, please follow the SOP-DE-02 Equipment Decontamination.
2. Clean the plastic placed over the sample area.	If a table is used, between each core, sweep or wipe down the plastic using paper towels wetted with DI water. If a particularly muddy core was sampled, the plastic may need to be replaced or a new piece placed over the sample area.

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 and groundwater.	Sites.	Inadvertent exposure to contaminated soil and groundwater 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 contact with soil and groundwater is possible. Sampling will be conducted outdoors or in a trailer with open doors.
	Exposure to hydraulic fluids.	Drilling operations.	Exposure to hydraulic fluids could occur while working around the drill due to equipment malfunction/failure resulting in personal injuries.	The operator will inspect the drill 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 around the drill.
	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.	Drilling operations.	Personnel could be exposed to elevated noise levels when working near the drilling operations resulting in hearing damage.	Personnel will wear hearing protection (e.g., ear plugs) when working near the drill. Non-essential personnel will maintain a 20-foot buffer zone around the drill when possible. Hearing protection will be administered and used in accordance with the policies and procedures outlined in the Pioneer Corporate HASP.
ELECTRICAL	Not applicable.			
BODY MECHANICS	Bending, squatting, and kneeling.	During fieldwork activities.	Bending, squatting, and kneeling during fieldwork activities could result in muscle/back strains or other injuries.	Personnel should stretch prior to starting work and they will take breaks when 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*
	Improper lifting/ handling of heavy items.	During field work activities.	Back injuries and muscle/back strains could result when using improper techniques to lift/ carry heavy coolers and containers with core pieces.	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 workers will lift/handle heavy items as needed.
	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.
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. They will plan their path, walk cautiously, and keep work areas as dry as possible. Personnel will wear muck boots as necessary.
WEATHER	Cold/heat stress.	Outdoor 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 the applicable SSHASP and/or Pioneer corporate HASP.
	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.

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 sites.	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.	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 in company vehicles. Personnel with allergies will notify their supervisor.
MECHANICAL	Blade from cutting tool.	Cutting tool.	Direct contact with the blade of the cutting tool used for slicing the plastic sleeves could result in cuts and scrapes.	Personnel will inspect the cutting tool prior to each use and be aware of hand placement to prevent exposure to the blade. Personnel will also wear work gloves.
PRESSURE	Pressurized hydraulic hoses.	Drilling operations.	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 drill 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 around the drill.
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 the procedure described above and other applicable procedures. Personnel will follow the stop work policy if there are any issues.
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, nitrile gloves, and leather gloves.
APPLICABLE SDSs	**Safety Data Sheets** (SDSs): Liquinox and Methanol. Safety Data Sheets are available to Pioneer personnel on the internal website under Safety.
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, and SOP-FM-01 Field Headspace Analysis and VOC Measurements with PID.
TOOLS/ EQUIPMENT	Sample area – plastic sheeting, tape measure, index cards to indicate top and bottom, camera, PID meter (if required), plastic disposable scoops or stainless-steel spoons or spatulas,

	screwdrivers, DI water spray bottle, Liquinox/water spray bottle, methanol, paper towels, foil disposable pans or stainless-steel bowls, sample containers, and cutting tool (e.g., utility knife).
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	**11/16/2020**
SAFETY AND HEALTH MANAGER	**DATE**
Tara Schleeman	**11/16/2020**

PURPOSE	This Standard Operating Procedure (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	Pioneer prepared this practice for the workforce and this 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	Please be very aware that logbooks are a **LEGAL** document. As such, they can and most likely will be placed into the public domain with any final reports to clients. They can also be used as evidence for a trial or lawsuit. They can be used to ask questions and to respond in a deposition. They will be used by other Pioneer personnel for data validation, report writing, and for referencing project- or sample-specific information. Beyond being used and reviewed by the client and agencies, they also might be shared with other consulting firms. Be very careful in what and how any information is written. The language used in the logbook should be factual and objective. Logbooks will contain a complete description of field activities, so that the event can be recreated without having to rely on field team memories. Decision making parameters and consultation with clients, subcontractors, or agency personnel should always be recorded. Any deviations from a Sampling and Analysis Plan (SAP)/Quality Assurance Project Plan (QAPP)/Work Plan (WP) or contract requested by agencies, client, subcontractors, property owners, or any stake holder should always be recorded in detail. Any deviation from the SAP/QAPP/WP or contract due to a decision of field personal should also be recorded. If any deviation will result in a change of scope, require additional compensation, or affect the quality of the samples or information to be collected the Project Manager should be notified. The conversation and decision by the Project Manager will also need to be recorded in the logbook. **Refer to the PowerPoint presentation available on the Pioneer SharePoint Field Sampling site, *Logbook and Decontamination Requirements Review Presentation* 20XX – where XX is the most recent year).** The presentation details the logbook and field data sheet requirements and includes checklists of required elements to ensure collection of proper field information.

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. Logbooks.	A designated field logbook will be used for each field project. The logbooks will be bound and have consecutively numbered pages. If requested by the Project Manager, use a separate field logbook for each field task within a larger project. Label each logbook cover with the project name, dates that it covers, and logbook number. Use a waterproof marker, such as a Sharpie©, to write down the information. Write relevant project personnel names and phone numbers, such as the Project Manager, Pioneer safety personnel, client representative, field team leaders, agency contacts, and subcontractor names on the first page of the logbook, so they can be easily referenced. The information recorded in these logbooks must be written **legibly** in **black** indelible ink. Begin a new page for each day's 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 through any blank spaces of three lines or more and add your initial and the date to prevent unauthorized entries. All corrections will consist of a single strike-out 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 always be factual and objective. Add the following entries into the project logbook for each field day: 1. On the logbook cover: project name, dates that logbook covers, and logbook number. 2. On the first page: relevant project personnel names and phone numbers, such as the Project Manager, Pioneer safety personnel, client representative, field team leaders, agency contacts, and subcontractor names. 3. A description of the field task (i.e., monthly groundwater level monitoring). 4. Time and date fieldwork started. 5. 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. 6. Names and company affiliations of field personnel.

7. Name, company affiliation or address, and phone number of any field contacts or official site visitors.

8. Meteorological conditions at the beginning of fieldwork and any ensuing changes in these conditions.

9. Details of the fieldwork performed and reference to field data sheets, if used.

10. Deviations from the task-specific SAP, WP, or SOP.

11. All field measurements performed. If field data sheets are used to record field measurements or observations (logging of drill core, blow counts, water quality parameters) the specific field data sheet needs to be referenced in the logbook. If associated with a specific sample, for example groundwater collected from a well, the final water quality stabilization parameters should be listed with the sample information in the logbook.

12. Any field analytical results (such as X-ray fluorescence [XRF] or field iron tests) should be recorded in the logbook. If this information is recorded on field data sheets or maps, those sheets or maps should be referenced. If information from one of these documents is used for decision making (i.e., to stop boring), the result and decision should be recorded in the logbook.

13. Personnel and equipment decontamination procedures, if appropriate.

For field samples, the following entries will be made for **every sample collected**, whether or not the sample is submitted to a laboratory:

1. Sample location and field sample identification number for every sample collected.
2. The number and type of sample containers collected for the sample (1 - 1L Poly, etc.).
3. Type of sample preservation and or preparation (i.e., raw, filtered, sieved) for each sample container.
4. Analytes or analytical method associated with each sample container.
5. If the analytical laboratory requests additional containers from a natural sample to complete their quality assurance and control (record this with the sample container). A laboratory will often ask for additional volume for their matrix spike or duplicate analysis.
6. Date and time of sample collection; the start time for the collection of each sample should be recorded. This start time will also be recorded on the sample containers and the chain of custody form for the laboratory. The start time for collection of the sample starts the clock on the analytical holding time. If a sample takes a long time to collect due to the number of sample containers or the sample collection procedure, the sample completion time should also be recorded.

7. If the sample is a composite sample, the start and end time of sample collection should be recorded.

   Information about the number of aliquots included in the sample should also be recorded (i.e., samples from 8 holes from 0-6 inches were collected or 4 locations along 10 feet of stream were sampled and mixed).

8. Field quality control sample identification (i.e., field duplicate of [associated field sample number], field blank, or equipment rinsate blank). For equipment rinsate blank, the equipment "rinsed" for the blank should be identified. The method of collection for this sample also needs to be described. For example:

   a. For a field blank: deionized (DI) water poured directly into sample bottles (bottle code from DI water container should be recorded).
   b. For a duplicate sample: fill sample bottles immediately following natural sample or collect sample from the same sample hole immediately following collection of natural sample into separate pan; mix each and place in appropriate bottles.
   c. For an equipment rinsate: DI water (record DI water container code) poured or ran through [identify which piece of equipment] into appropriate sample containers.

   Information on preparing field quality control samples is discussed in Pioneer SOP-SA-03A Field Quality Control Samples for Water Sampling and SOP-SA-03B Preparation of Equipment Rinsate Blanks for Submersible Pumps.

9. Split samples taken by other parties. Note the type of sample, sample location, time/date, name of individual for whom the split was collected, that individual's company, and any other pertinent information. How the split sample was collected should also be recorded. Was it collected as a duplicate sample (separate collection) or as a replicate sample (all material collected and then mixed and divided into individual containers)? Replicate soil and surface water samples are more appropriate for this type of sample.

10. Sampling method, particularly any deviations from the SAP and SOP. A generalized description of the sampling procedure can be described at the beginning of the project logbook and then the page can be referenced for succeeding sampling days, if sampling protocol will be the same for every sample. If referencing a description, make sure that any deviations associated with the individual sample are recorded, such as refusal in hole 2 and 4 at 5 inches.

11. 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.

12. The laboratory where the samples will be sent. Note that this might be container specific (i.e., organic sample containers may be going to one laboratory and inorganic

	samples may be shipped to a different laboratory). If this is the case, the laboratory performing analysis should be listed with the analytical method/analyte descriptions as discussed above. 13. Chain of Custody Form: Information on sample submittal to laboratories needs to be recorded in the logbook to maintain chain of custody for the samples. This information will include the following: a. The samples shipped to each laboratory: the samples can be listed individually or listed as a general description of the samples shipped (i.e., all EPH, TPH samples collected on specific dates). b. The method shipped (i.e., FedEx Overnight, UPS ground, or hand delivered). c. Any tracking numbers associated with the shipment. d. Number of shipping containers shipped or delivered. e. Date and time sample containers were relinquished. Any documentation from the transport company (receipts or tracking numbers) and copies of chain of custody forms included in the shipping containers will be placed in the project record file and retained to prove chain of custody was maintained. Further information on preparing samples for shipping is detailed in Pioneer SOP-SA-01 Soil and Water Sample Packaging and Shipping and SOP-SA-04 Chain of Custody Forms for Environmental Samples. No bound field logbooks will be destroyed or thrown away even if they are illegible or contain inaccuracies that require a replacement document. If the logbook is replaced, write REPLACED on the cover of the logbook and reference the new logbook and number. The original logbook should be referenced at the beginning of the replacement logbook along with the reason the original was replaced. Keep in mind that any information not recorded in a logbook or on a field data sheet or comparable document is not part of the project documentation and **cannot be used**. If a sample is not recorded in the logbook or associated documentation it **does not exist** and cannot be used for decision making purposes.
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 are not recommended; if you take these types of photographs, they should be identified as such. The following items will be recorded in the bound field logbook or on a field data sheet for each photograph taken: 1. The photographer's name, the date and 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 will 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 will be photocopied and placed in the task files to accompany the photographs once the field activities are complete.

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	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 (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): None Required
APPLICABLE SDSs	**Safety Data Sheets (**SDSs) will be maintained based on site characterization and contaminants. Safety Data Sheets are available to Pioneer personnel on the internal website under Safety.
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-SA-01 Soil and Water Sample Packaging and Shipping SOP-SA-03A Field Quality Control Samples for Water Sampling SOP-SA-03B Preparation of Equipment Rinsate Blanks for Submersible Pumps SOP-SA-04 Chain of Custody Forms for Environmental Samples
TOOLS/ EQUIPMENT	Field logbook, Sharpie©, black pen, and digital camera.
FORMS/ CHECKLIST	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**
Patricia Olson **Patricia Olson**	**04/14/2022**
SAFETY AND HEALTH MANAGER	**DATE**
Tara Schleeman **Tara Schleeman**	**04/14/2022**

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:

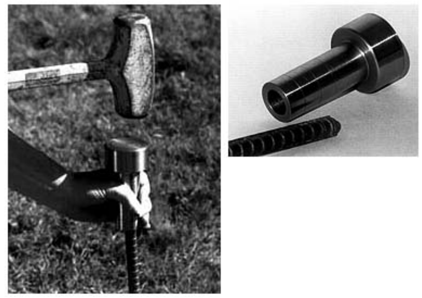
- After determining the position of the hub/stake/lath, determine the soil condition.
- If soil is loose or non-compacted, simply drive the hub/stake/lath into the ground until the hub/stake/lath is stable.

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.).

	 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.
6. Checking points daily.	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.
7. Using point ranges.	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.

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.

<table>
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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.
</td>
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<tr>
<td>9. Painting and flagging of survey marks.</td>
<td>

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.
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<tr>
<td>10. Placing control points.</td>
<td>
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.
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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

Attachment B
Field Forms

Geoprobe Soil Log

Project:

Hole No:

Contactor: Pioneer Technical Services

Geoprobe:

Date:

Operator:

Logged By:

Weather:

Core:	Depth Core Represents	Actual Measured Length	Inches per 1 foot	Photo Number/ Description	Drillers Notes	Core Start Time	Samples Collected (XRF/LAB)

Measured Length (in)	**Length Represented**	**Color**	**Description**	**Time**	**PID Reading**

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

<u>Thread Test</u>:

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 ≥ 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

Corrective Action Report/ Corrective Action Plan

Project ID	Project Name	Document ID

Preparer's Signature/Submit Date	Submitted to:

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

Corrective Action Report/
Corrective Action Plan

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

Attachment C
Montana Well Abandonment Report

MONTANA WELL ABANDONMENT REPORT

1. EXISTING GWICID: ____________________

2. WELL OWNER:

Name______________________________________

Mailing address______________________________

____

3. WELL LOCATION: List ¼ from smallest to largest

_______ ¼ ______ ¼ ______ ¼ ______ ¼, Section _________

Township ___ N/S Range ___ E/W County ________________

Lot _____ , Tract/Blk ____ Subdivision Name _______________

Well Address ____________________________________
GPS ☐ Yes ☐ No
Latitude ____________________ Longitude _______________

Error as reported by GPS locator (+ feet) _________________

Horizontal datum ☐ NAD27 ☐ WGS84

4. WELL USE: ☐ Domestic ☐ Stock ☐Irrigation

☐ Public water supply ☐ Monitoring Well

☐ Geothermal ☐ Closed System ☐ Open System

☐ Reinjection ☐ Extraction ☐ Other: ____________________

5. TYPE OF WELL BEING ABANDONDED:

☐ Drilled ☐ Bored ☐ Jetted ☐ Hand Dug ☐ Other: __________

6. TYPE OF CASING:

☐ Steel Dia.__________in.

☐ Plastic Dia. _________in.

☐ Concrete Dia.__________in.

☐ Other Dia.__________in.

If other, type :________________________

Was any casing removed? ☐ yes ☐ no
If yes, type (steel, pvc, etc.) ______________________
Amount removed ___________ ft.

If more than one type: ___________________________
Amount removed ___________ft.

Was casing driven down ward? ☐ yes ☐ no
If yes, feet below ground surface _____________ ft.

Was casing Ripped or Perforated? ☐ yes ☐ no

7. WELL DATA:
Depth of well: _________ ft.

Static water level ___________ ft.

Closed-in artesian pressure _______ psi.

Was well disinfected before decommissioning? ☐ yes ☐ no

If yes, type and amount of disinfectant used:__________

____

8. WELL LOG: Record sealing material used and depth(s)

Depth, Feet		Material type of material used to seal well (example: neat cement, bentonite chips, naturally occurring soils).
From	To	
		☐ Neat Cement
		☐ High-solids Bentonite Grout
		☐ Bentonite Chips
		☐ Other (describe under remarks)

9. DATE WELL DECOMMISSIONED: ________________

10. REMARKS: ____________________________________

____

____

____

____

11. DRILLER/CONTRACTOR:
All work performed and reported in this decommissioning log is in compliance with the Montana well abandonment standards. This report is true to the best of my knowledge.

Name, firm, or corporation (print)___________________________

Address____

Signature____

Date _______________________ License no. __________________

License type: ☐ MWC ☐ WWC ☐ WWD

This report can be emailed to GWIC@mtech.edu, faxed to the GWIC office at (406) 496-4343, or sent to:

Ground Water Information Center
1300 W. Park St.
Butte, MT 59701-8997

Montana Bureau of Mines and Geology
The University of Montana
1300 West Park Street
Butte, MT 59701

Attachment D
Montana Well Log Report

MONTANA WELL LOG REPORT

Form No. 603 R2-04

Well ID# ____________________

This log reports the activities of a licensed Montana well driller and serves as the official record of work done within the borehole and casing and describes the amount of water encountered. **This form is to be completed by the driller and filed with MBMG within 60 days of completion of the work.** **Acquiring Water Rights is the well owner's responsibility and is not accomplished by the filing of this report.**

Well log information is stored in the Groundwater Information Center at the Montana Bureau of Mines and Geology (Butte) and water right information is stored in the Water Rights Bureau records (Helena).

For fields that are not applicable, enter NA. Record additional information in the REMARKS section.

1. WELL OWNER:

Name ____

Mailing address ______________________________________

____

2. WELL LOCATION: List ¼ from smallest to largest

_______ ¼ ______ ¼ ______ ¼ ______ ¼, Section____________

Township____ N/S Range____ E/W County _________________

Lot _____ , Tract/Blk ____ Subdivision Name __________________

Certificate of Survey ______________________________________

Well Address ____

GPS ☐ Yes ☐ No

Latitude_____________________ Longitude ___________________

Error as reported by GPS locator (± feet) ___________________

Horizontal datum ☐ NAD27 ☐ WGS84

3. PROPOSED USE: ☐ Domestic ☐ Stock ☐ Irrigation

☐ Public water supply ☐ Monitoring Well

☐ Geothermal ☐ Closed System ☐ Open System ☐ Reinjection

☐ Extraction H_2O Temp ______ Number of Wells in System ______

☐ Other: __________________________

4. TYPE OF WORK:

☐ New well ☐ Deepen existing well ☐ Abandon existing well

Method: ☐ Cable ☐ Rotary ☐ Other: ____________________

5. WELL CONSTRUCTION DETAILS:

Borehole:

Dia. ______________in. from ____________ ft. to _____________ ft.

Dia. ______________in. from ____________ ft. to _____________ ft.

Dia. ______________in. from ____________ ft. to _____________ ft.

Casing:

Steel: Wall thickness ___________ ☐ Threaded ☐ Welded

Dia. ______________in. from ____________ ft. to _____________ ft.

Dia. ______________in. from ____________ ft. to _____________ ft.

Casing Shoe: ☐ Yes ☐ No

Plastic: Pressure Rating__________ lbs. ☐ Threaded ☐ Welded

Dia. ______________in. from ____________ ft. to _____________ ft.

Perforations/Slotted Pipe:

Type of perforator used_____________________

Size of perforations/slots _______ in. by___________in.

______no. of perforations/slots from _________ ft. to___________ ft.

______no. of perforations/slots from _________ ft. to___________ ft.

Screens: ☐ Yes ☐ No

Material_____________________

Dia. __________ Slot size _________ from_________ft. to _______ ft.

Dia. __________ Slot size _________ from ________ft. to _______ ft.

Gravel Packed: ☐ Yes ☐ No

Size of gravel _________

Gravel placed from ________________ ft. to_________________ ft.

Packer: ☐ Yes ☐ No

Type _____________________ Depth(s)______________________

Grout: Material used_________________________

Depth from ________ft. to _________ ft. OR ☐ Continuous feed

6. WELL TEST DATA:

A well test is required for all wells. (*See details on well log report cover.*)

☐ Static water level__________ft. below top of casing **or**

☐ Closed-in artesian pressure _______ psi.

How was test flow measured:

bucket/stopwatch, weir, flume, flowmeter, etc _________________

Test - 1 hour minimum

Drawdown is the amount water level is lowered below static level.
All depth measurements shall be from the top of the well casing.
Time of recovery is hours/minutes since pumping stopped.

Air test*

________gpm with drill stem set at________ ft. for ______ hours

Time of recovery _______ hrs/min. Recovery water level _____ ft.

OR Bailer test*

______gpm with _____ ft. of drawdown after_______hours

Time of recovery _______ hrs/min. Recovery water level _____ ft.

OR Pump test*

Depth pump set for test ________ft.

____gpm pump rate with_____ ft. of drawdown after ____ hrs pumping

Time of recovery ______ hrs/min. Recovery water level _____ ft.

OR Flowing Artesian*

_________ gpm for _________ hours

Flow controlled by _______________

**During the well test the discharge rate shall be as uniform as possible. This rate may or may not be the sustainable yield of the well. Sustainable yield does not include the reservoir of the well casing.*

Yellowstone Controlled Groundwater Area - Water Temperature_______°F

☐ AQUIFER TEST DATA FORM ATTACHED

7. WELL LOG: Record depth(s) that water is encountered.

Depth, Feet		Material: color/rock and type/descriptor (example: blue/shale/hard, or brown/gravel/water, or brown/sand/heaving)
From	To	

☐ ADDITIONAL SHEETS ATTACHED

8. DATE WELL COMPLETED: ________________

9. REMARKS: ____

____

10. DRILLER/CONTRACTOR'S CERTIFICATION:

All work performed and reported in this well log is in compliance with the Montana well construction standards. This report is true to the best of my knowledge.

Name, firm, or corporation (print) ______________________________

Address ____

Signature ____

Date______________________ License no. _____________________

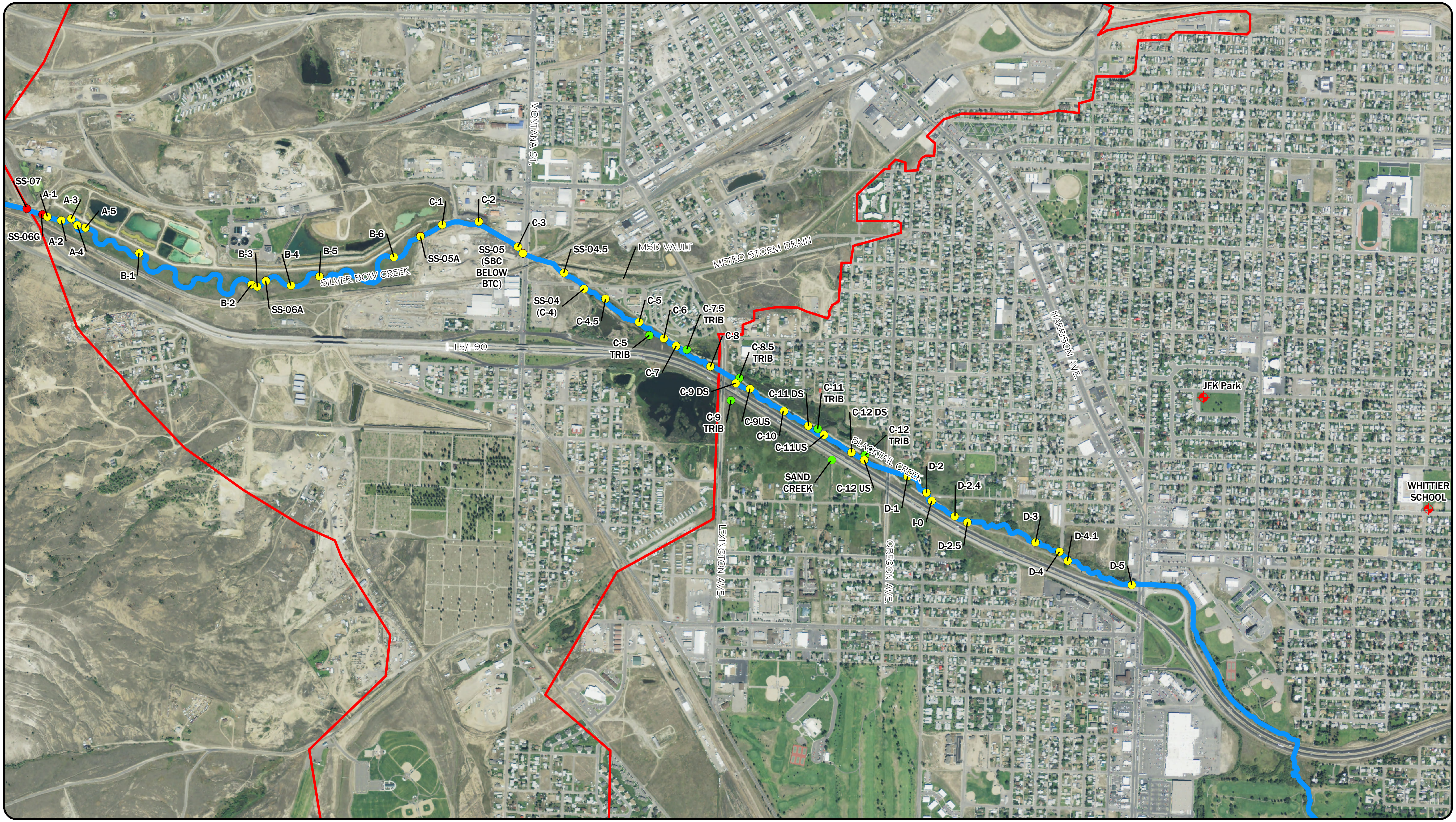
License type: ☐ MWC ☐ WWC ☐ WWD

Montana Bureau of Mines & Geology
The University of Montana
1300 West Park Street
Butte, MT 59701

Appendix C
Select Figures from Previous Investigations

Appendix C.1
Select Figures from the Radon Tracing Study

Silver Bow Creek/Butte Area NPL Site, Butte Priority Soils Operable Unit, Final 2011 Blacktail Creek and Silver Bow Creek Radon Tracing and Thermal Imaging Survey Technical Memorandum (Atlantic Richfield Company, 2016)



MONITORING WELL LOCATIONS
BLACKTAIL AND SILVER BOW CREEK SAMPLE LOCATIONS
TRIBUTARY SAMPLE LOCATIONS
SURFACE WATER MONITORING LOCATIONS
BPSOU BOUNDARY (ROD 2006)

N

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

0 500 1,000 2,000
Feet

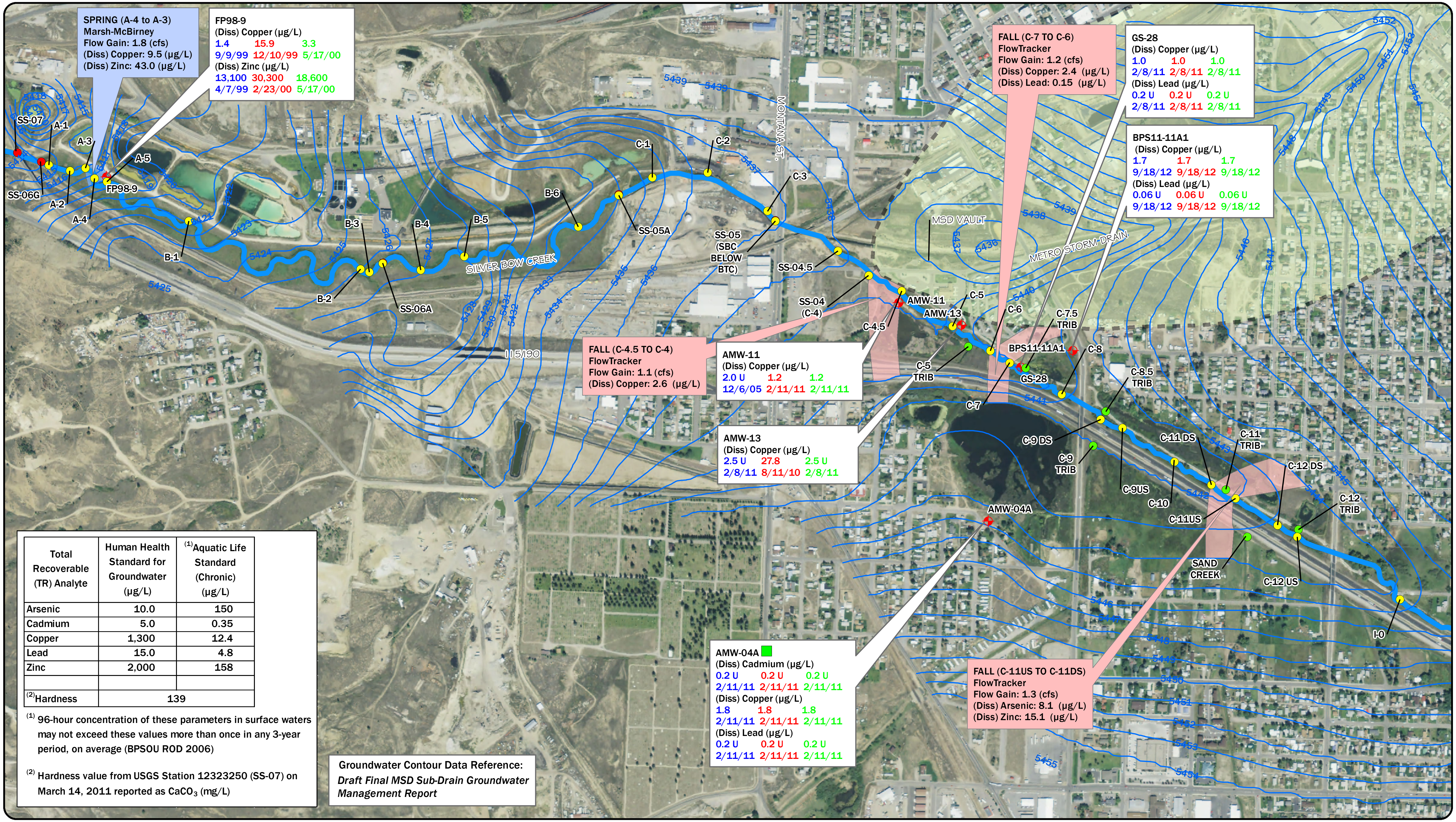
FIGURE 1

PIONEER TECHNICAL SERVICES, INC.

SAMPLE LOCATIONS ALONG BLACKTAIL CREEK AND SILVER BOW CREEK

DATE: 7/1/2015

Path: \\192.168.254.15\project$\ARCO\BUTTE\BPSOU\2015\Final_2011BTC_SBC_RnTracingThermalImgTM\Figures&Tables\ArcMap\BTSBC_RDT_GI_OPH_001-14.mxd



Total Recoverable (TR) Analyte	Human Health Standard for Groundwater (µg/L)	[1] Aquatic Life Standard (Chronic) (µg/L)
Arsenic	10.0	150
Cadmium	5.0	0.35
Copper	1,300	12.4
Lead	15.0	4.8
Zinc	2,000	158
[2] Hardness	139	

(1) 96-hour concentration of these parameters in surface waters may not exceed these values more than once in any 3-year period, on average (BPSOU ROD 2006)

(2) Hardness value from USGS Station 12323250 (SS-07) on March 14, 2011 reported as $CaCO_3$ (mg/L)

Groundwater Contour Data Reference:
Draft Final MSD Sub-Drain Groundwater Management Report

BLACKTAIL AND SILVER BOW CREEK SAMPLE LOCATIONS
TRIBUTARY SAMPLE LOCATIONS
OTHER SURFACE WATER MONITORING LOCATIONS
MONITORING WELL LOCATIONS
GROUNDWATER CONTOURS (MAY 2010) (1-FT INTERVALS)
MSD SUB-DRAIN SHALLOW CAPTURE ZONE (2012)

SURFACE WATER GAIN
SPRING
FALL

SPRING AND FALL CALLOUTS USE BACK-CALCULATED DISSOLVED CONCENTRATIONS

DISSOLVED CONCENTRATIONS IN MONITORING WELL:
MINIMUM CONCENTRATION SHOWN IN BLUE
MAXIMUM CONCENTRATION SHOWN IN RED
CONCENTRATION CLOSEST TO 2011 SURVEY SHOWN IN GREEN
(U = BELOW DETECTION LIMIT)
: COMPARED TO NEARBY TRIBUTARY (TABLE 5)

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

0 350 700 1,400
Feet

FIGURE 3a
COMPARISONS OF DISSOLVED COC CONCENTRATIONS IN BASE FLOW SURFACE WATER GAINS AND ADJACENT GROUNDWATER WELLS

PIONEER TECHNICAL SERVICES, INC.
DATE: 7/1/2015

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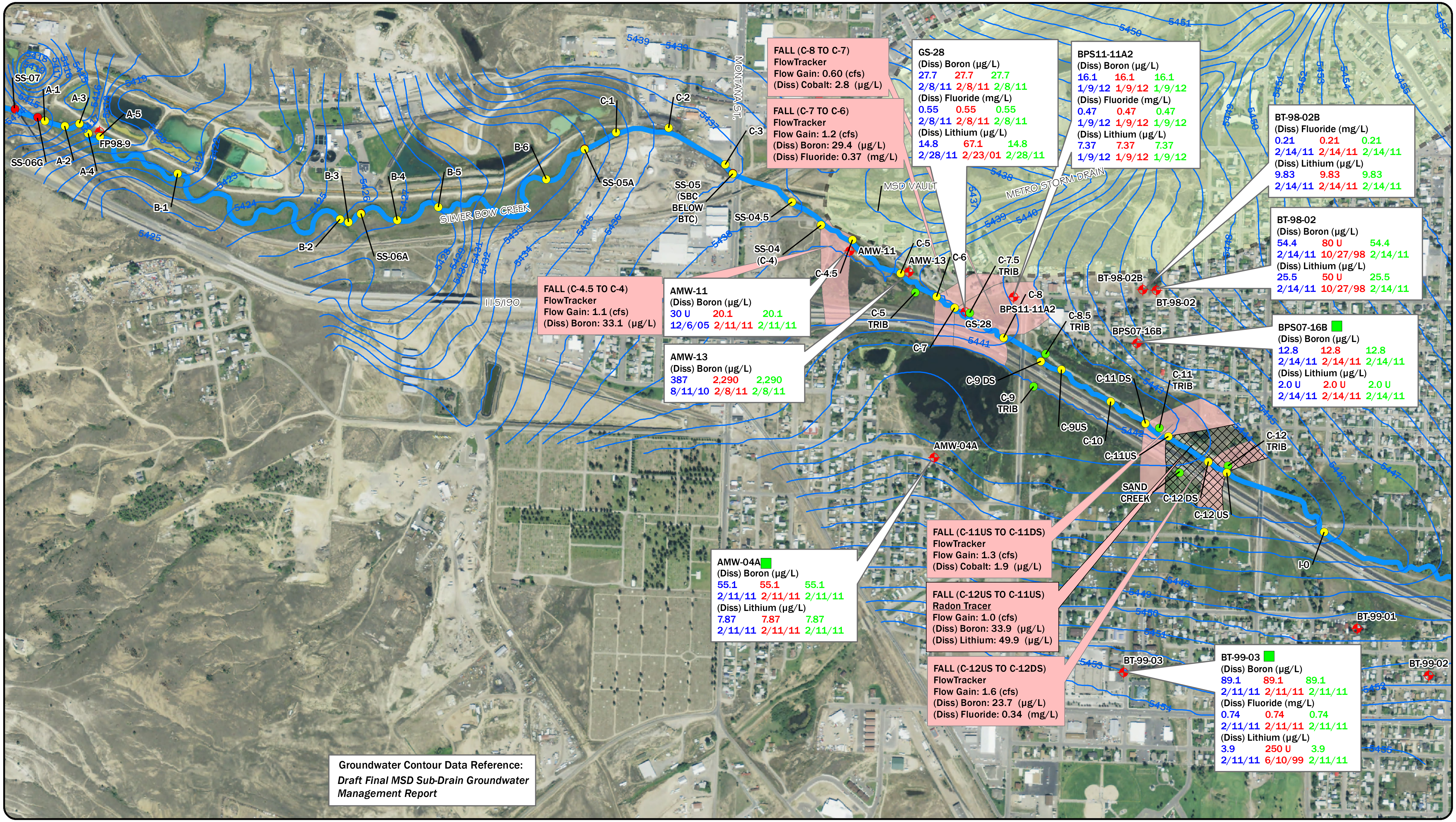

- BLACKTAIL AND SILVER BOW CREEK SAMPLE LOCATIONS
- TRIBUTARY SAMPLE LOCATIONS
- OTHER SURFACE WATER MONITORING LOCATIONS
- MONITORING WELL LOCATIONS
- GROUNDWATER CONTOURS (MAY 2010) (1-FT INTERVALS)
- MSD SUB-DRAIN SHALLOW CAPTURE ZONE (2012)

SURFACE WATER GAIN
- SPRING
- FALL

SPRING AND FALL CALLOUTS USE BACK-CALCULATED DISSOLVED CONCENTRATIONS

DISSOLVED CONCENTRATIONS IN MONITORING WELL:
MINIMUM CONCENTRATION SHOWN IN BLUE
MAXIMUM CONCENTRATION SHOWN IN RED
CONCENTRATION CLOSEST TO 2011 SURVEY SHOWN IN GREEN
(U = BELOW DETECTION LIMIT)
: COMPARED TO NEARBY TRIBUTARY (TABLE 5)

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

0 350 700 1,400
Feet

FIGURE 3b
COMPARISONS OF DISSOLVED TRACE ELEMENT CONCENTRATIONS IN BASE FLOW SURFACE WATER GAINS AND ADJACENT GROUNDWATER WELLS

PIONEER TECHNICAL SERVICES, INC.
DATE: 7/1/2015

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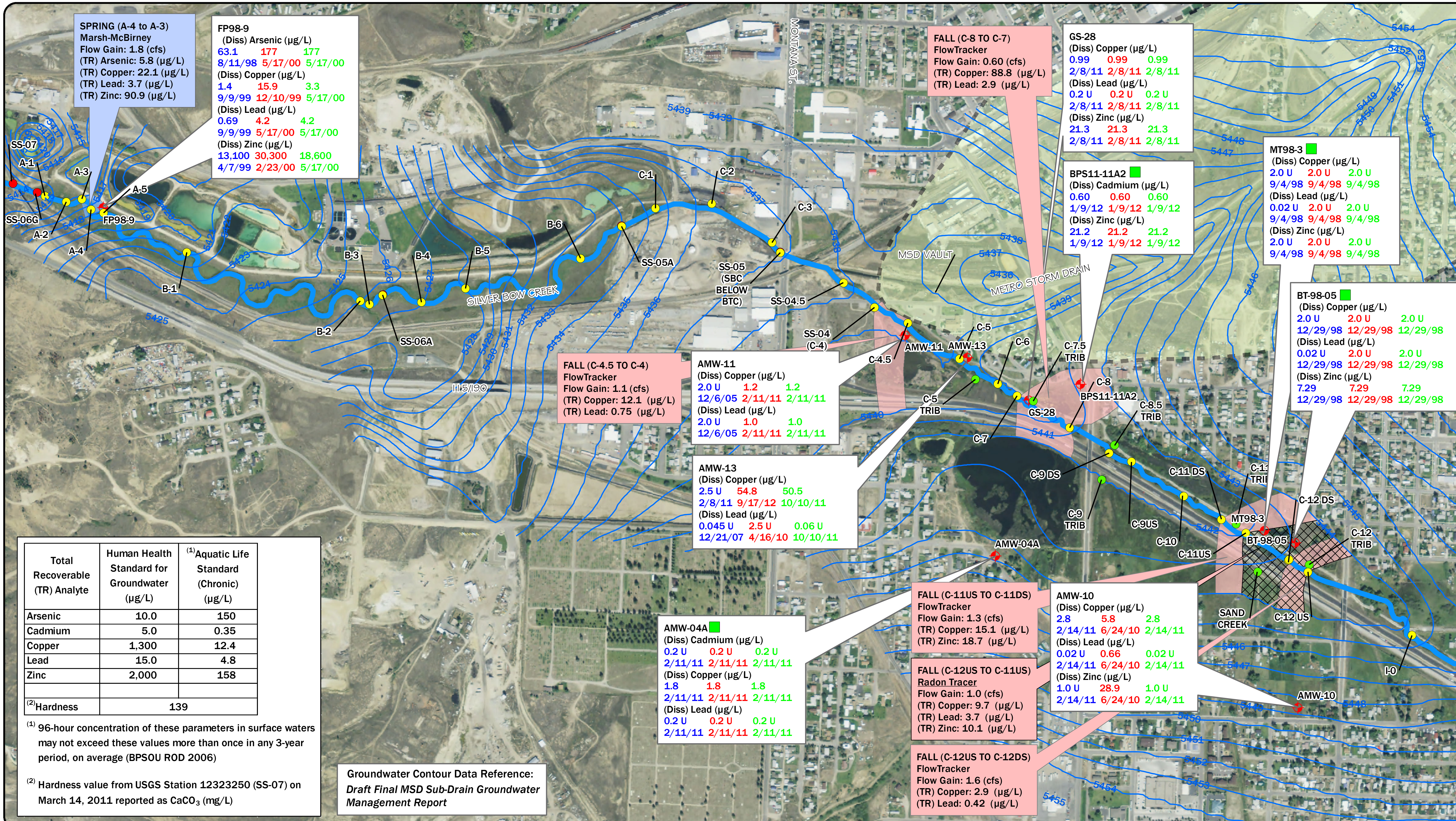

Total Recoverable (TR) Analyte	Human Health Standard for Groundwater (µg/L)	(1) Aquatic Life Standard (Chronic) (µg/L)
Arsenic	10.0	150
Cadmium	5.0	0.35
Copper	1,300	12.4
Lead	15.0	4.8
Zinc	2,000	158
(2) Hardness	139	

(1) 96-hour concentration of these parameters in surface waters may not exceed these values more than once in any 3-year period, on average (BPSOU ROD 2006)

(2) Hardness value from USGS Station 12323250 (SS-07) on March 14, 2011 reported as $CaCO_3$ (mg/L)

Groundwater Contour Data Reference:
Draft Final MSD Sub-Drain Groundwater Management Report

BLACKTAIL AND SILVER BOW CREEK SAMPLE LOCATIONS
TRIBUTARY SAMPLE LOCATIONS
SURFACE WATER MONITORING LOCATIONS
MONITORING WELL
GROUNDWATER CONTOURS (MAY 2010) (1-FT INTERVALS)
MSD SUB-DRAIN SHALLOW CAPTURE ZONE (2012)

SURFACE WATER GAIN
SPRING
FALL
SPRING AND FALL CALLOUTS USE BACK-CALCULATED TOTAL RECOVERABLE CONCENTRATIONS

DISSOLVED CONCENTRATIONS IN MONITORING WELL:
MINIMUM CONCENTRATION SHOWN IN BLUE
MAXIMUM CONCENTRATION SHOWN IN RED
CONCENTRATION CLOSEST TO 2011 SURVEY SHOWN IN GREEN
(U = BELOW DETECTION LIMIT)
: COMPARED TO NEARBY TRIBUTARY (TABLE 5)

N

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

0 350 700 1,400
Feet

FIGURE 4a

COMPARISONS OF TOTAL RECOVERABLE COC CONCENTRATIONS IN BASE FLOW SURFACE WATER GAINS AND ADJACENT GROUNDWATER WELLS

PIONEER TECHNICAL SERVICES, INC.

DATE: 7/1/2015

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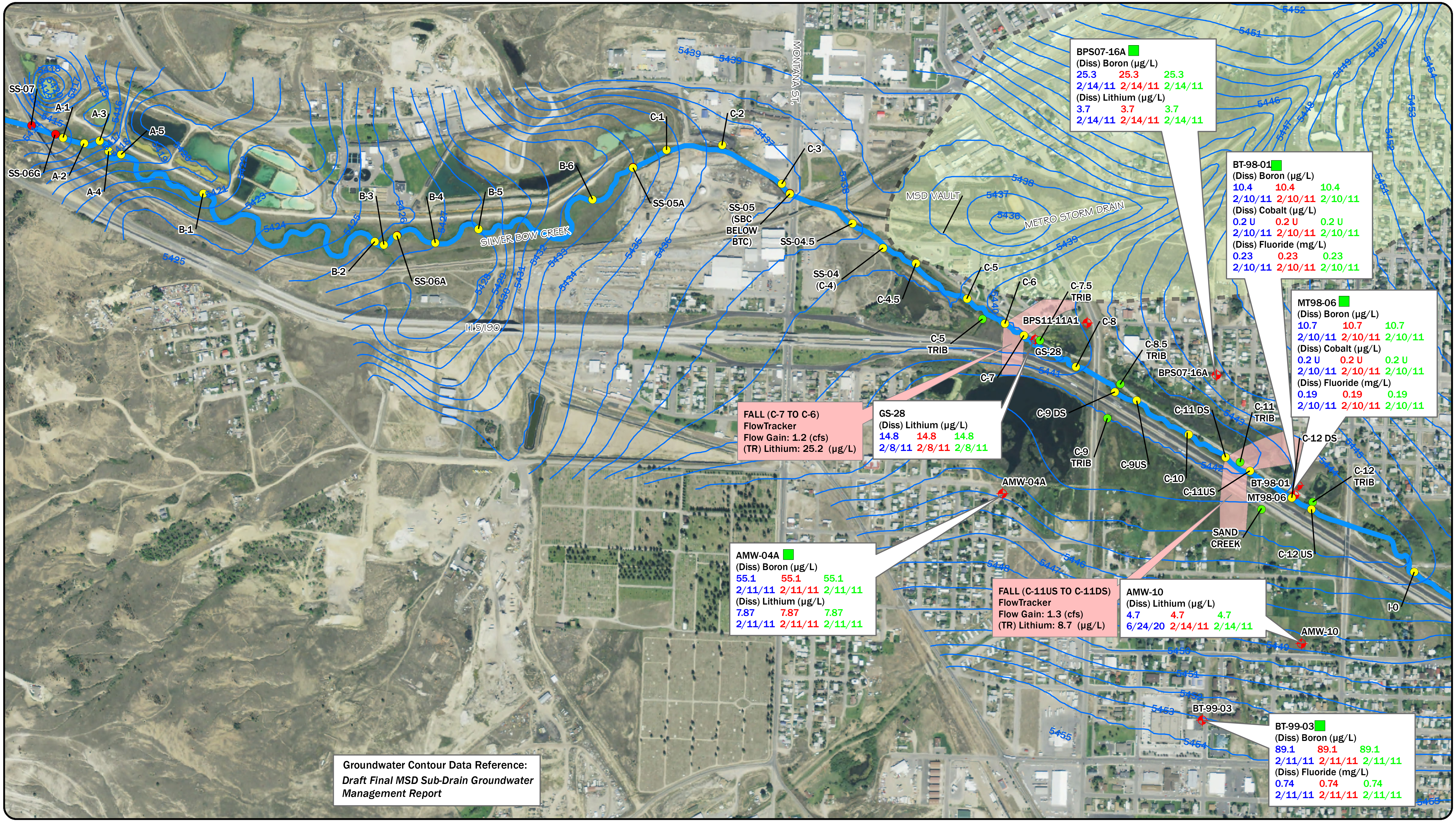

BLACKTAIL AND SILVER BOW CREEK SAMPLE LOCATIONS
TRIBUTARY SAMPLE LOCATIONS
SURFACE WATER MONITORING LOCATIONS
MONITORING WELL
GROUNDWATER CONTOURS (MAY 2010) (1-FT INTERVALS)
MSD SUB-DRAIN SHALLOW CAPTURE ZONE (2012)

SURFACE WATER GAIN
SPRING
FALL
SPRING AND FALL CALLOUTS USE BACK-CALCULATED TOTAL RECOVERABLE CONCENTRATIONS

DISSOLVED CONCENTRATIONS IN MONITORING WELL:
MINIMUM CONCENTRATION SHOWN IN BLUE
MAXIMUM CONCENTRATION SHOWN IN RED
CONCENTRATION CLOSEST TO 2011 SURVEY SHOWN IN GREEN
(U = BELOW DETECTION LIMIT)
: COMPARED TO NEARBY TRIBUTARY (TABLE 5)

N

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

0 350 700 1,400
Feet

FIGURE 4b

COMPARISONS OF TOTAL RECOVERABLE TRACE ELEMENT CONCENTRATIONS IN BASE FLOW SURFACE WATER GAINS AND ADJACENT GROUNDWATER WELLS

PIONEER TECHNICAL SERVICES, INC.

DATE: 7/1/2015

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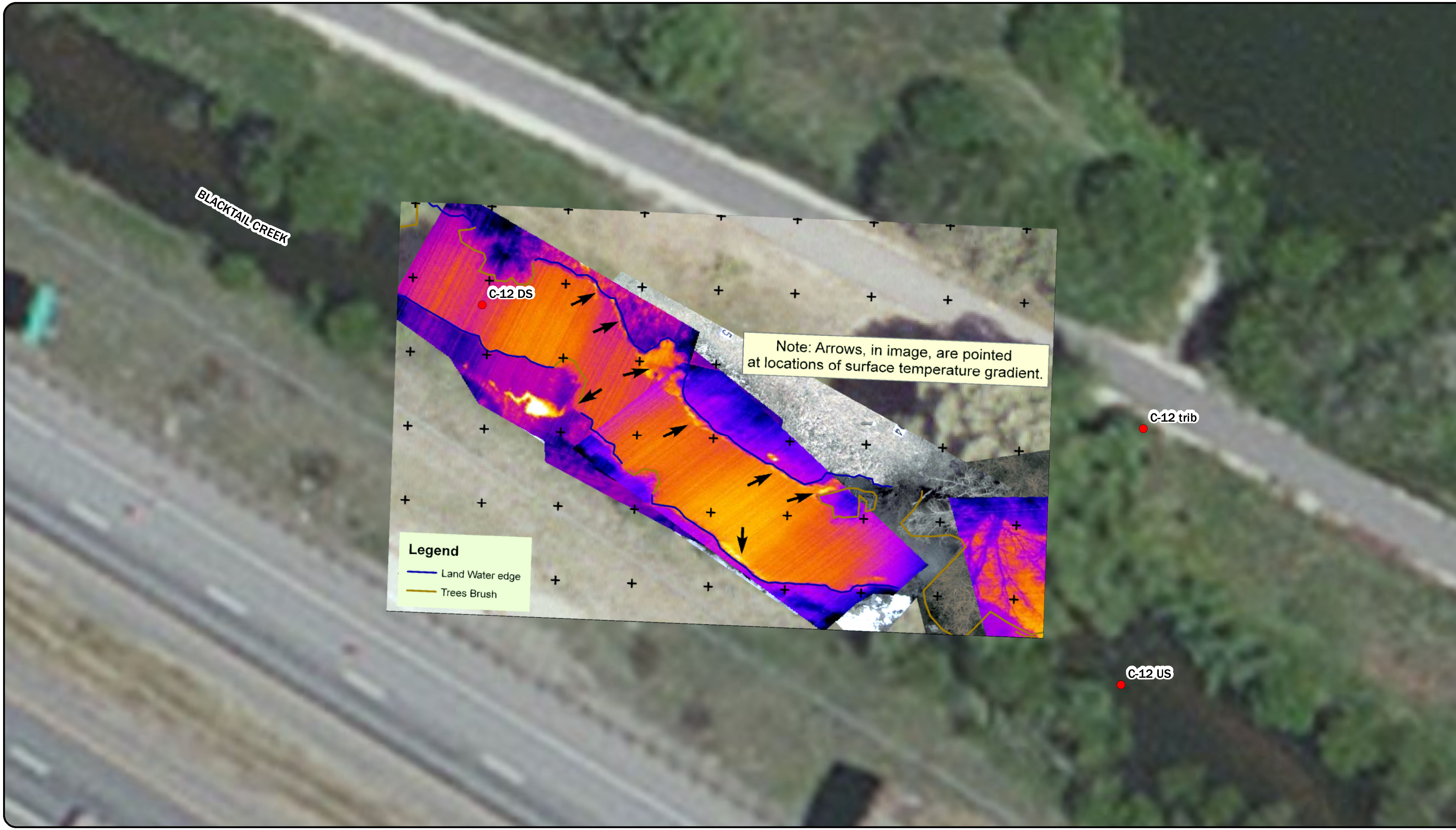


LEGEND

- BLACKTAIL CREEK SAMPLE LOCATIONS

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

0 10 20 40
Feet

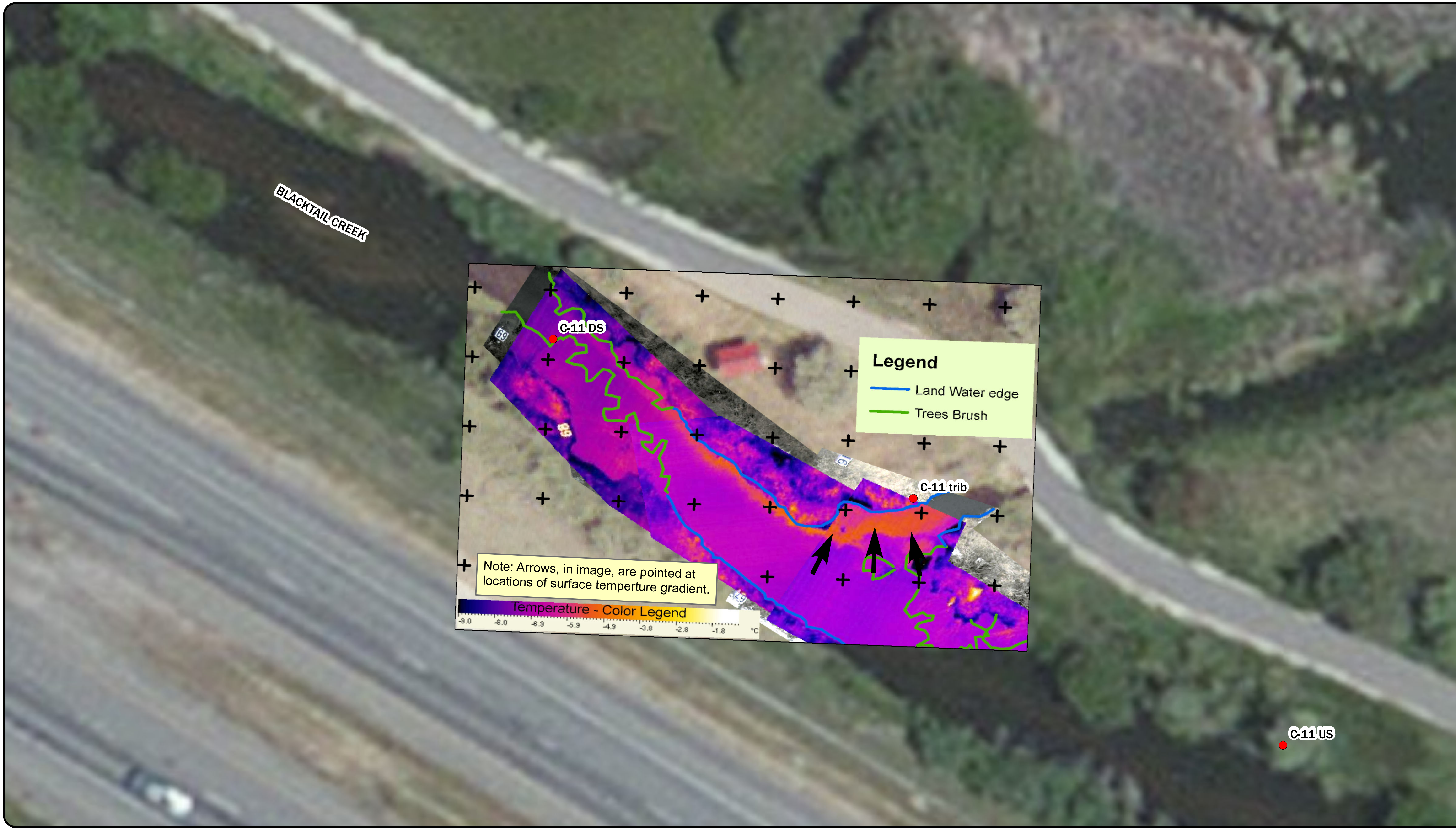
FIGURE 5a

SURFACE WATER AND GROUNDWATER GAIN TO BLACKTAIL CREEK ALONG THE LEXINGTON TO OREGON REACH THERMAL IMAGE

PIONEER TECHNICAL SERVICES, INC.

DATE: 1/7/2015

Path: \\192.168.254.15\project$\ARCO\BUTTE\BPSOU\2015\Draft_Final_Revised2011BTC_SBC_RnTracingThermalImgTM\Figures&Tables\ArcMap\BTSBC-RDT-GI-OPH-008-13_msp.mxd



LEGEND

● BLACKTAIL CREEK SAMPLE LOCATIONS

N

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

0 12.5 25 50
Feet

FIGURE 5b

PIONEER TECHNICAL SERVICES, INC.

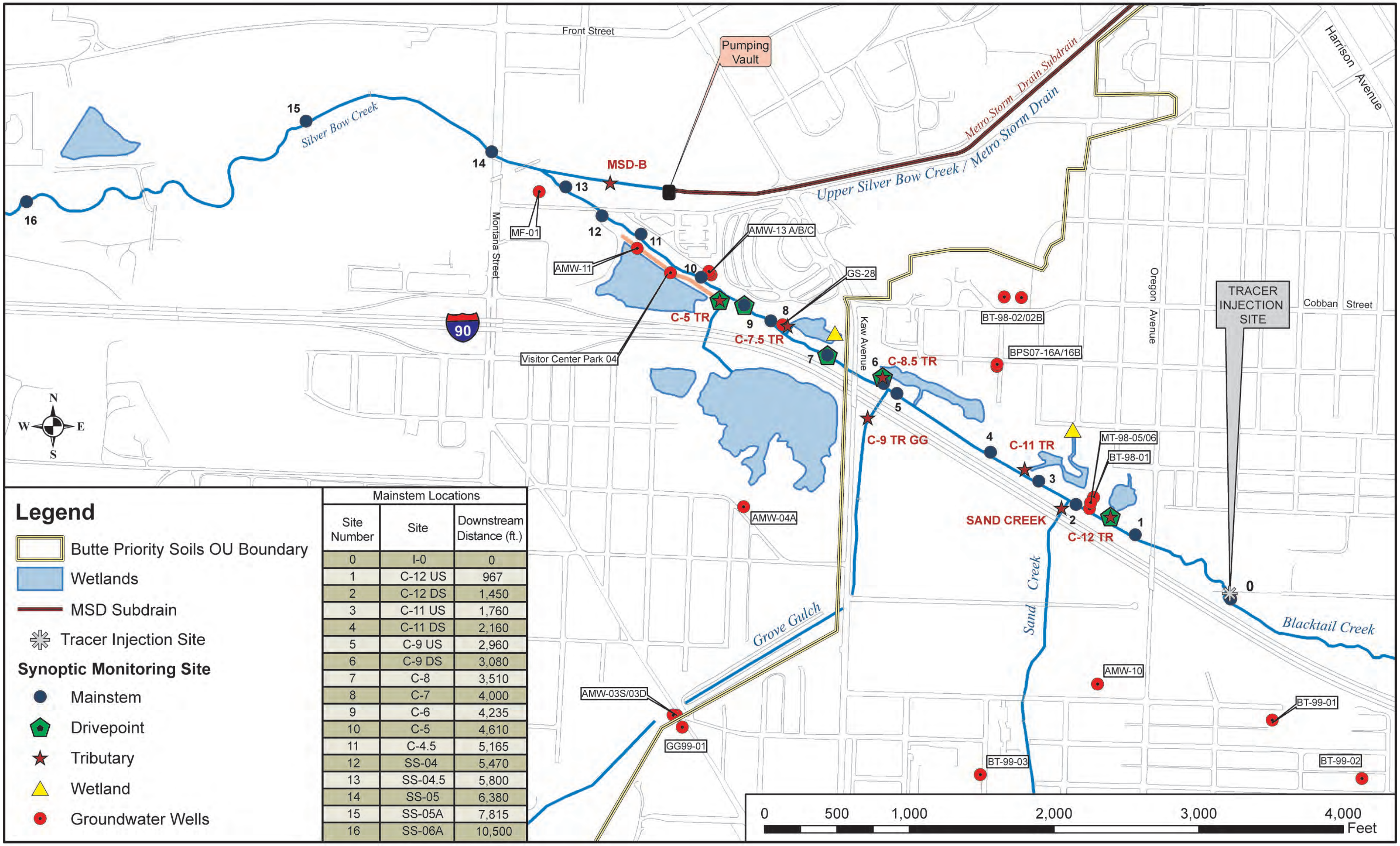
SURFACE WATER GAIN TO BLACKTAIL CREEK ALONG THE LEXINGTON TO OREGON REACH THERMAL IMAGE

DATE: 1/7/2015

Path: \\192.168.254.15\project$\ARCO\BUTTE\BPSOU\2015\Draft_Final_Revised2011BTC_SBC_RnTracingThermalImgTM\Figures&Tables\ArcMap\BTSBC-RDT-GI-OPH-007-13.mxd

Appendix C.2
Select Figures from the Bromide Tracing Study

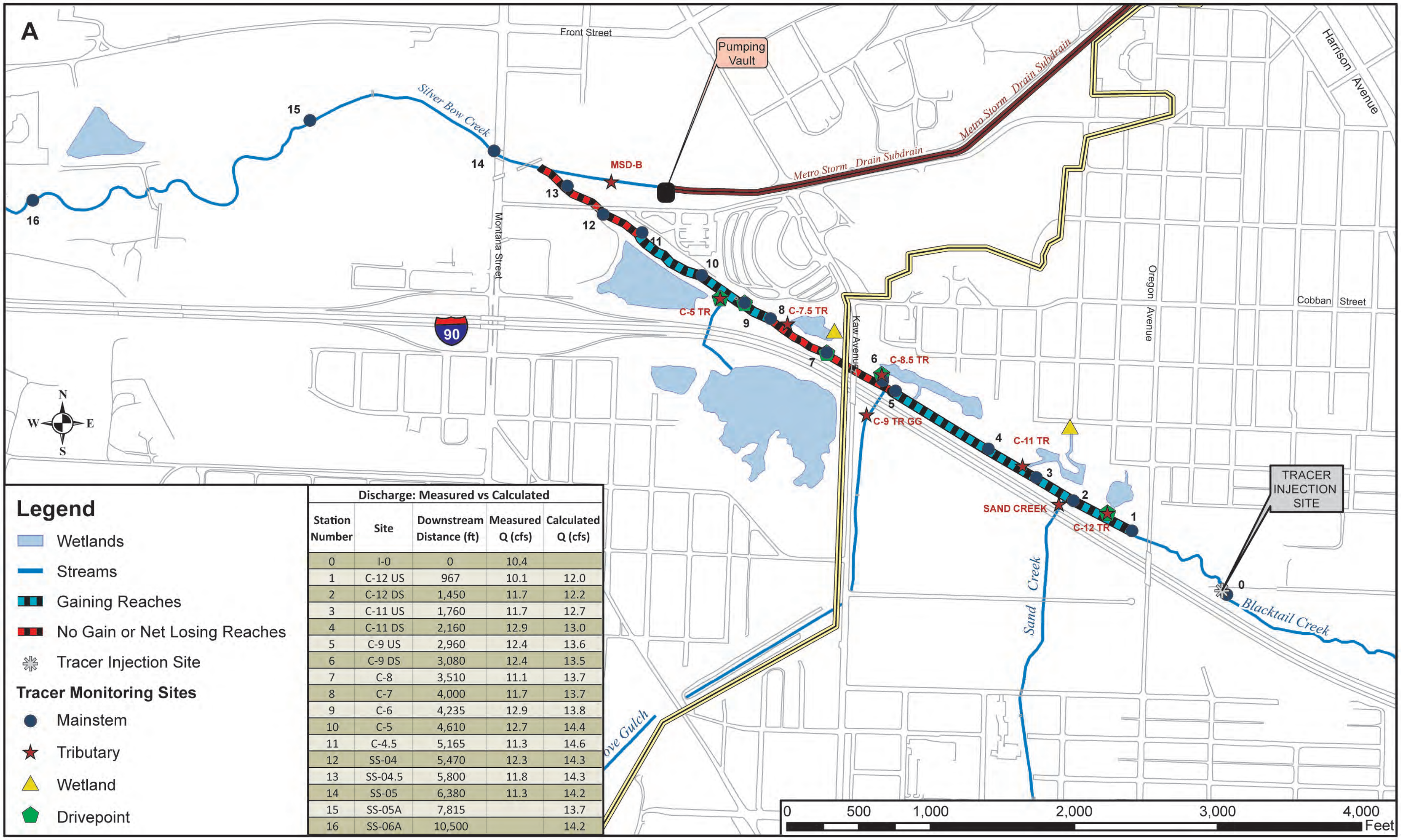
Stream Characterization of Blacktail and Silver Bow Creeks: A Continuous Tracer Injection Investigation Conducted During Baseflow Conditions in an Urban Area Impacted by Mining: Butte, Montana (MBMG, 2014)



Mainstem Locations

Site Number	Site	Downstream Distance (ft.)
0	I-0	0
1	C-12 US	967
2	C-12 DS	1,450
3	C-11 US	1,760
4	C-11 DS	2,160
5	C-9 US	2,960
6	C-9 DS	3,080
7	C-8	3,510
8	C-7	4,000
9	C-6	4,235
10	C-5	4,610
11	C-4.5	5,165
12	SS-04	5,470
13	SS-04.5	5,800
14	SS-05	6,380
15	SS-05A	7,815
16	SS-06A	10,500

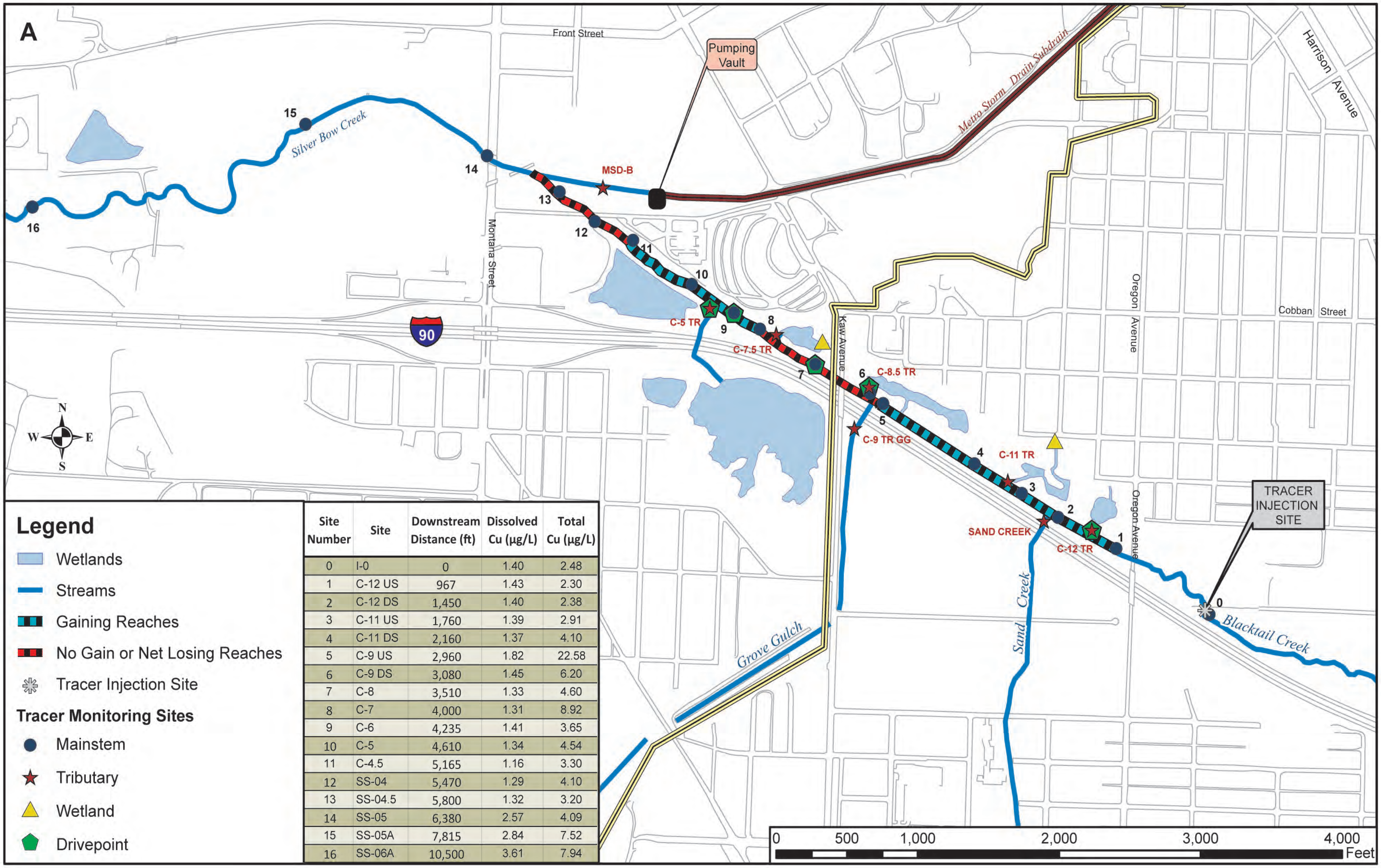
Figure 1. Location map showing tracer injection site, synoptic sampling locations, and groundwater monitoring wells. Mainstem site numbers labeled with black text. Tributary synoptic sampling sites labeled with dark red text. Survey source data: MBMG Navigational Grade GPS. Imagery: 2009 NAIP, Silver Bow County. Projection: NAD 83 Decimal Degrees.



Discharge: Measured vs Calculated

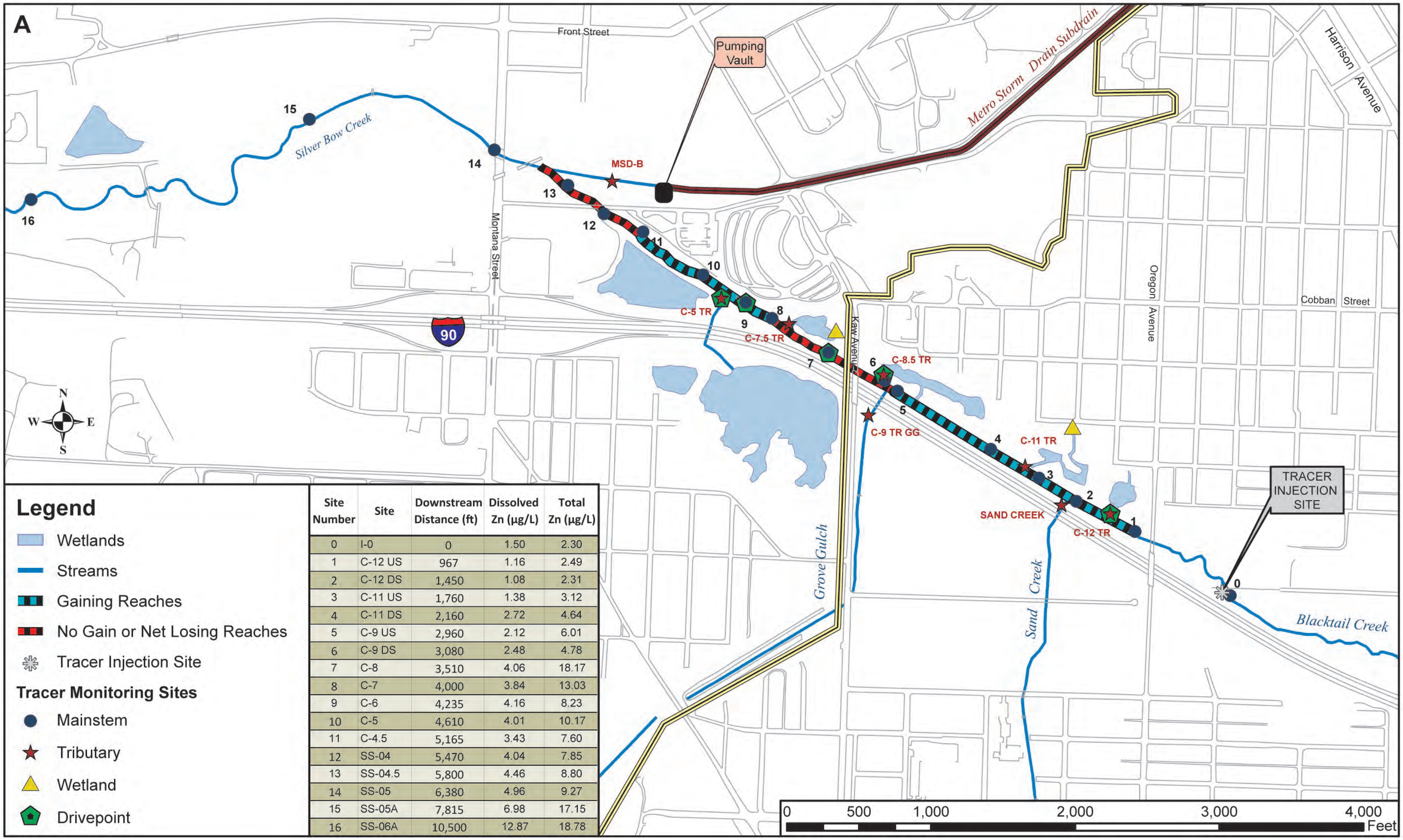
Station Number	Site	Downstream Distance (ft)	Measured Q (cfs)	Calculated Q (cfs)
0	I-0	0	10.4	
1	C-12 US	967	10.1	12.0
2	C-12 DS	1,450	11.7	12.2
3	C-11 US	1,760	11.7	12.7
4	C-11 DS	2,160	12.9	13.0
5	C-9 US	2,960	12.4	13.6
6	C-9 DS	3,080	12.4	13.5
7	C-8	3,510	11.1	13.7
8	C-7	4,000	11.7	13.7
9	C-6	4,235	12.9	13.8
10	C-5	4,610	12.7	14.4
11	C-4.5	5,165	11.3	14.6
12	SS-04	5,470	12.3	14.3
13	SS-04.5	5,800	11.8	14.3
14	SS-05	6,380	11.3	14.2
15	SS-05A	7,815		13.7
16	SS-06A	10,500		14.2

Figure 8. Map of study area (A), with bromide concentrations in primary, tributary, drivepoint, and wetland synoptic samples (B), and calculated vs. measured discharge (C) during tracer injection. Distance from tracer injection (B and C) are plotted in reverse order, consistent with the direction of streamflow. BTC ID numbers are provided on A, B, and C for comparison. Calculated charges (C) obtained via tracer dilution method using known tracer injection rates and in-stream concentrations of bromide. Gaining reaches are depicted in A. Measured discharges (C) obtained via SonTek FlowTracker flowmeter.



Site Number	Site	Downstream Distance (ft)	Dissolved Cu (µg/L)	Total Cu (µg/L)
0	I-0	0	1.40	2.48
1	C-12 US	967	1.43	2.30
2	C-12 DS	1,450	1.40	2.38
3	C-11 US	1,760	1.39	2.91
4	C-11 DS	2,160	1.37	4.10
5	C-9 US	2,960	1.82	22.58
6	C-9 DS	3,080	1.45	6.20
7	C-8	3,510	1.33	4.60
8	C-7	4,000	1.31	8.92
9	C-6	4,235	1.41	3.65
10	C-5	4,610	1.34	4.54
11	C-4.5	5,165	1.16	3.30
12	SS-04	5,470	1.29	4.10
13	SS-04.5	5,800	1.32	3.20
14	SS-05	6,380	2.57	4.09
15	SS-05A	7,815	2.84	7.52
16	SS-06A	10,500	3.61	7.94

Figure 11. Map of study area (A), with dissolved and total recoverable Cu concentrations (B), and Cu loading analysis (C) for mainstem, tributary, wetland, and drivepoint samples. Site ID numbers are plotted onA, B, and C for comparison purposes. Gaining reaches of Blacktail Creek are shown. Dissolved and total recoverable Cu concentrations are shown in table. Distance from tracer injection are plotted (B and C) in reverse order. Hardness-based DEQ-7 acute and chronic aquatic-life standards presented in B. Cu loading analyses (C) were calculated using calculated discharges from tracer dilution method.



Site Number	Site	Downstream Distance (ft)	Dissolved Zn (µg/L)	Total Zn (µg/L)
0	I-0	0	1.50	2.30
1	C-12 US	967	1.16	2.49
2	C-12 DS	1,450	1.08	2.31
3	C-11 US	1,760	1.38	3.12
4	C-11 DS	2,160	2.72	4.64
5	C-9 US	2,960	2.12	6.01
6	C-9 DS	3,080	2.48	4.78
7	C-8	3,510	4.06	18.17
8	C-7	4,000	3.84	13.03
9	C-6	4,235	4.16	8.23
10	C-5	4,610	4.01	10.17
11	C-4.5	5,165	3.43	7.60
12	SS-04	5,470	4.04	7.85
13	SS-04.5	5,800	4.46	8.80
14	SS-05	6,380	4.96	9.27
15	SS-05A	7,815	6.98	17.15
16	SS-06A	10,500	12.87	18.78

Figure 12. Map of study area (A), with dissolved and total recoverable Zn concentrations (B) and Zn loading analysis (C) for mainstem, tributary, wetland, and drivepoint samples. Site ID numbers are plotted in A, B, and C for comparison purposes. Gaining reaches of Blacktail Creek are shown. Dissolved and total recoverable Zn concentrations are shown in table. Distance from tracer injection are plotted (B and C) in reverse order. Hardness-based DEQ-7 acute and chronic aquatic-life standards presented in B. Zn loading analyses (C) were calculated using calculated discharges from tracer dilution method.

Appendix C.3
Select Figures from the BTL Stress Test

BTC-PW-01 Construction Log Collected Under Final BTL Stress Test QAPP (Atlantic Richfield, 2021). XRF data presented is raw and to be validated under this BTC Pumping Test QAPP.

Pumping Well Log

Well Name: BTC-PW-01

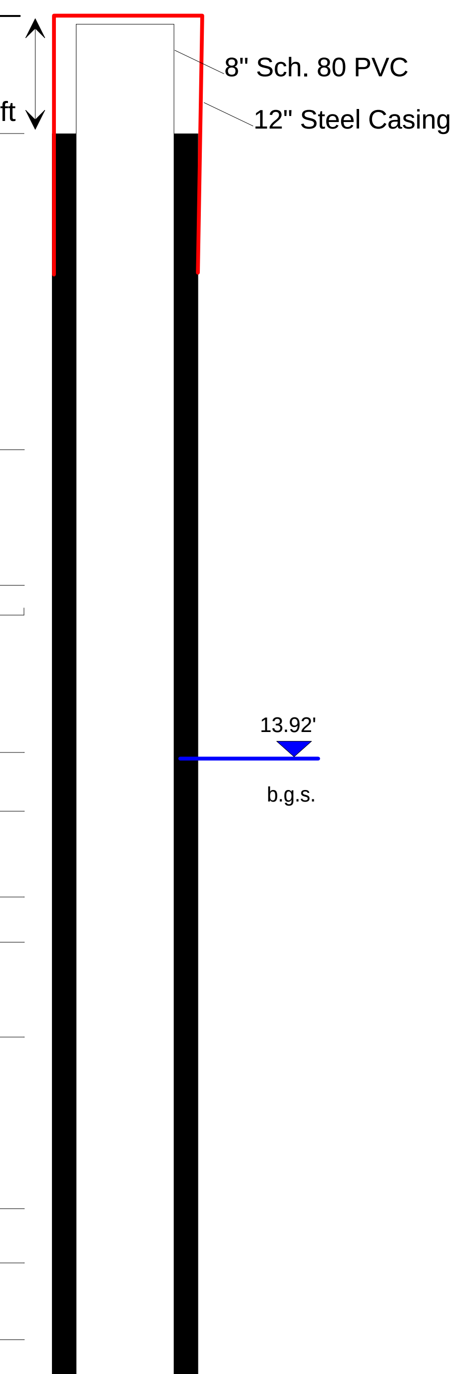
PIONEER TECHNICAL SERVICES, INC.

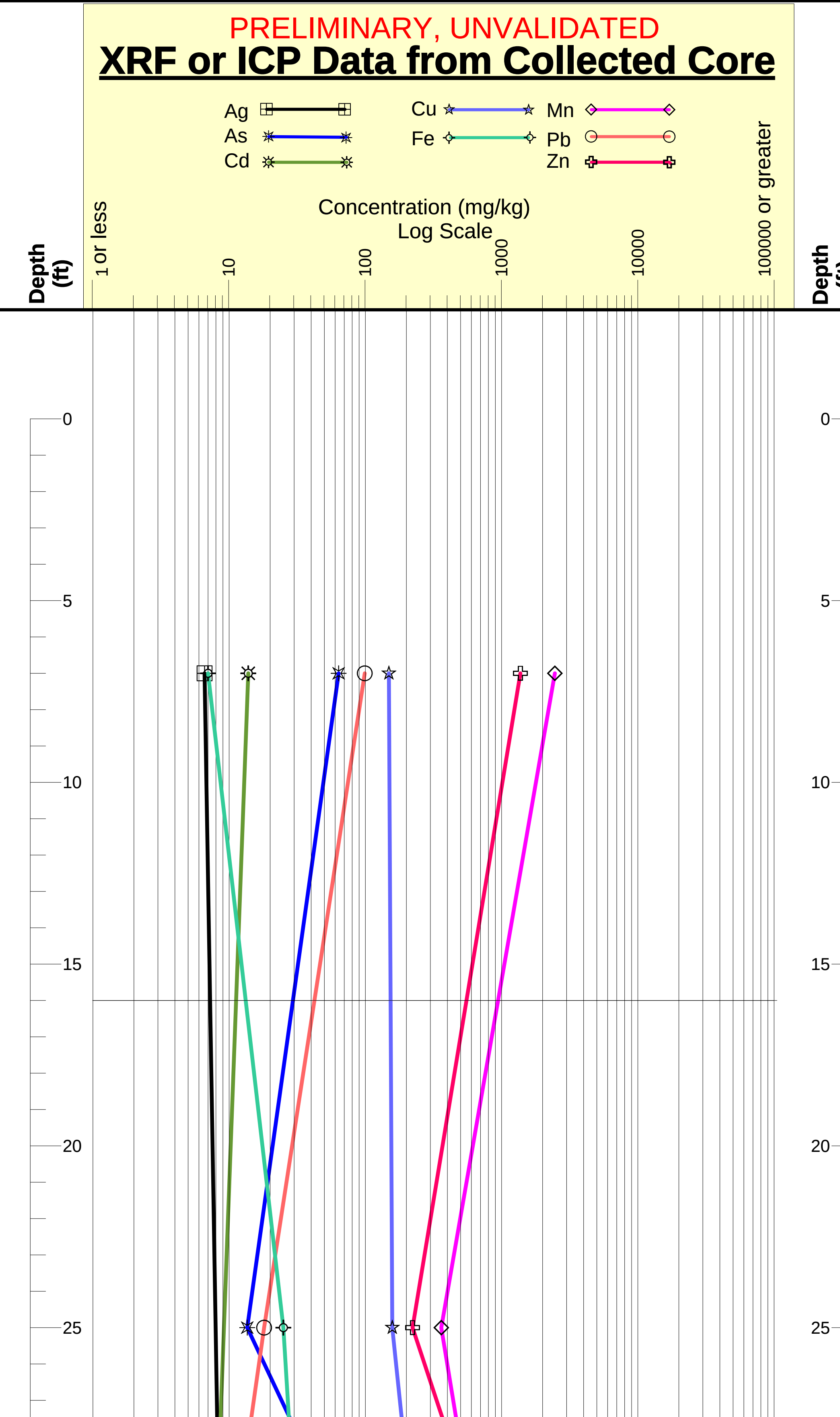
Project: BTL Stress Test	Location: Butte, MT
Well Owner: Atlantic Richfield Co.	Depth to Water (bgs): 13.92 ft Water Level from MP: 16.34 ft Date:8/27/2021 Time:8:13

Logged By: D. Conrady, K. Jackson	Date Drilled: 8/26/2021	Casing Type/Dia: Sch. 80 PVC/8"	Borehole Diameter: 12"
Drilling Company: Boland Drilling	Drilling Method: Mud Rotary	Screen Type/Length: Stainless Steel Vee Wire Wrap/10'	

Top of PVC Casing: M.P. 5460.15 ft (NAVD 88)
Ground Elevation: 5457.7 ft (NAVD 88)

Depth (ft.)	USCS Class	Lithology Log
0–7	N/A	Hydro-excavated by Hunter Construction
7–10	SW	SAND, with some sub-angular gravel, gray-brown
10–10.7	SW	SAND, with some sub-angular gravel, gray-brown
10.7–13.7	SW--SC	SAND, well graded sand with clay and sub angular gravel, brown
13.7–15	ML	SILTY CLAY, with some sand, broken glass present, black
15–17	ML	SILT, black, with very fine sand
17–18	SW	SAND, fine to medium, brown
18–20	ML	SILT, black, with very fine sand
20–24	ML	SILT with sand, black
24–25	SW-SM	SAND, fine to medium with some organics, black--gray, well graded
25–26.7	SW--SM	SAND, fine to medium with some organics, gray to red-brown, well graded
26.7–	CH	CLAY layer, fat, wit very fine sand, brown





Driller:C. Boland
Monitoring Well License: #482

Note: Marker for XRF or ICP data marks concentration of top of material.

Filter Pack Interval:40.50-52.50 ft
Screen Interval:42.50-52.50
ft below ground surface
(b.g.s.)

Lithology

Bedrock, Clay, Clayey Silt, Gravel, Sand, Silt, Silty Clay, N/A

Well Construction

0 Wrap, Screen, Bentonite, Formation Packer, Slough, PVC Casing, Natural Filter Pack, Steel Protective Casing

Latitude: 45.9943289657 (NAD 83) Decimal Degrees
Longitude:-112.5343167501 (NAD 83) Decimal Degrees
Northing: 650914.22 IF
Easting: 1197810.32 IF
Ground Elevation: 5457.7 ft (NAVD 88)
Measuring Point Elevation: 5460.15 ft (NAVD 88)
T3N R8W S24

Pumping Well Log

Well Name: BTC-PW-01

PIONEER TECHNICAL SERVICES, INC.

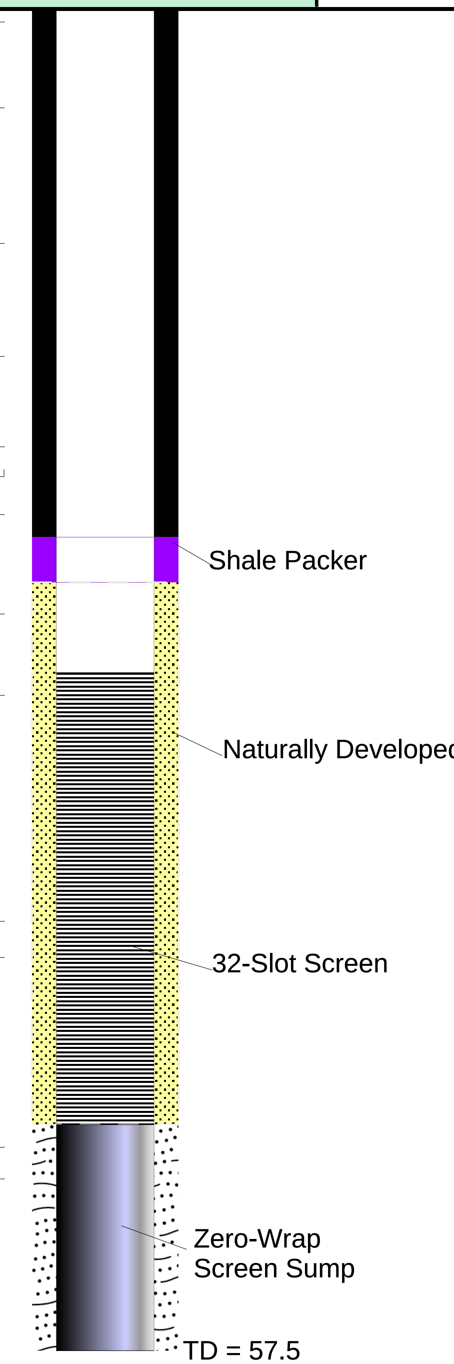
Project: BTL Stress Test	Location: Butte, MT
Well Owner: Atlantic Richfield Co.	Depth to Water (bgs): 13.92 ft Water Level from MP: 16.34 ft Date:8/27/2021 Time:8:13
Logged By: D. Conrady, K. Jackson	Date Drilled: 8/26/2021
Casing Type/Dia: Sch. 80 PVC/8"	Borehole Diameter: 12"
Drilling Company: Boland Drilling	Drilling Method: Mud Rotary
Screen Type/Length: Stainless Steel Vee Wire Wrap/10'	

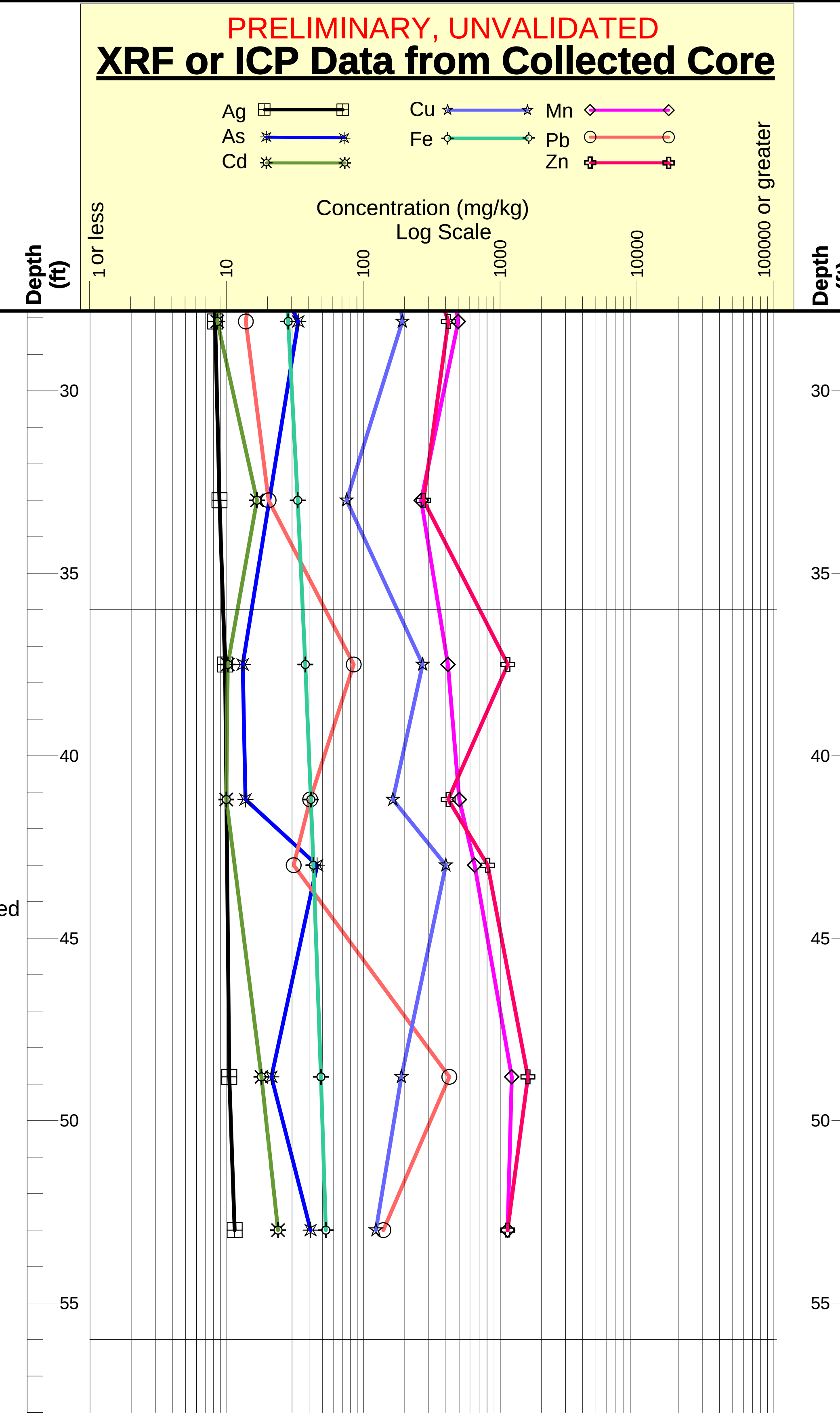
Top of PVC Casing: M.P. 5460.15 ft (NAVD 88)
Ground Elevation: 5457.7 ft (NAVD 88)

USCS Class	Lithology Log
SW	SAND, very fine, brown, well graded
N/A	No sample to due heaving sands
SW	SAND, very fine to fine, brown
CH	CLAY, fat, brown, with some rounded gravel
SW	SAND, with some rounded gravel, brown, iron staining
SW	SAND with rounded gravel, brown
CH	CLAY, fat, with very fine sand, brown
SW	SAND, with rounded gravel, fine to medium, slight iron staining
SW	SAND, fine to medium with iron staining, brown
SW	SAND, very fine, brown
SW-SC	SAND, fine to very fine, with some clay, red-brown
SW-SC	SAND, fine to very fine, with some clay, red-brown
CL	CLAY, lean sandy clay, brown

Elev. (NAVD 88): 5428, 5426, 5424, 5422, 5420, 5418, 5416, 5414, 5412, 5410, 5408, 5406, 5404, 5402, 5400

Depth (ft.): 30, 35, 40, 45, 50, 55





Driller:C. Boland
Monitoring Well License: #482

Note: Marker for XRF or ICP data marks concentration of top of material.

Filter Pack Interval:40.50-52.50 ft
Screen Interval:42.50-52.50
ft below ground surface
(b.g.s.)

Lithology

Bedrock, Gravel, Silty Clay, Clay, Sand, N/A, Clayey Silt, Silt

Well Construction

0 Wrap, Slough, Screen, PVC Casing, Bentonite, Natural Filter Pack, Formation Packer, Steel Protective Casing

Latitude: 45.9943289657 (NAD 83) Decimal Degrees
Longitude:-112.5343167501 (NAD 83) Decimal Degrees
Northing: 650914.22 IF
Easting: 1197810.32 IF
Ground Elevation: 5457.7 ft (NAVD 88)
Measuring Point Elevation: 5460.15 ft (NAVD 88)
T3N R8W S24

Appendix D
Field Forms

FIELD SAMPLE DATA SHEET

Page ____ of ____

Project Name: BTC Pumping Test

WELL/STATION ______________________ DATE ________________ TIME ______________

SAMPLERS ______________________ WEATHER CONDITIONS ________________________

PURGE DATA:

PURGE METHOD ____________________

START PURGING ____________________

PURGE RATE __________ GPM or mL/minute

RATE CHANGE 1) Time ______ Rate _________

2) Time ______ Rate _________

SAMPLE TIME ____________________

WELL DEPTH ________________ Feet

DEPTH TO WATER ________________ Feet

COLUMN DEPTH ________________ Feet

CASING DIAMETER ________________ Inch

PUMP SET AT ________________ Feet

TOTAL PURGE VOLUME ________________ Gallons

SCREEN INTERVAL ________________ Feet

SAMPLE DATA:

SAMPLE #	VOLUME	CHECK IF FILTERED	PRES.	ANALYSIS REQUESTED

FIELD PARAMATERS:

TIME	Amount Purged Gal	Temp °C	pH	SC µS/cm	ORP mV	DO mg/L	Turbidity NTU
FINAL FIELD PARAMETERS PRIOR TO SAMPLING							

FIELD REMARKS: ____

PUMPING WELL FIELD PARAMETER DATA SHEET

Page ____ of ____

PROJECT NAME: BTC Pumping Test

WELL/STATION: ______________________

SAMPLERS: ______________________

DATE: ______________________

FIELD PARAMATERS:

TIME	Amount Purged Gal	Temp °C	pH	SC µS/cm	ORP mV	DO mg/L	Turbidity NTU	DTW
FINAL FIELD PARAMETERS								

FIELD REMARKS:

____

FIELD SAMPLE DATA SHEET

PROJECT NAME: ____________________
WELL/STATION ____________________ DATE ____________ TIME ____________
SAMPLERS ____________________ WEATHER CONDITION ____________________

PURGE DATA:

PURGE METHOD ____________________
START PURGING ____________________
PURGE RATE __________ GPM or mL/minute
RATE CHANGE 1) Time ______ Rate _________
2) Time ______ Rate _________
SAMPLE TIME ____________________

WELL DEPTH ____________ Feet
DEPTH TO WATER ____________ Feet
COLUMN DEPTH ____________ Feet
CASING DIAMETER ____________ Inch
PUMP SET AT ____________ Feet
TOTAL PURGE VOLUME ____________ Gallons
SCREEN INTERVAL ____________ Feet

SAMPLE DATA:

SAMPLE #	VOLUME	CHECK IF FILTERED	PRES.	ANALYSIS REQUESTED

FIELD PARAMATERS:

TIME	Amount Purged Gal	Temp °C	pH	SC µS/cm	ORP mV	DO mg/L	Turbidity NTU	DTW
FINAL FIELD PARAMETERS PRIOR TO SAMPLING								

FIELD REMARKS: ____________________

Geoprobe Soil Log

Project:		Hole No:	
Contactor:	Pioneer Technical Services	Geoprobe:	
Date:		Operator:	
Logged By:		Weather:	

Core:	Depth Core Represents	Actual Measured Length	Inches per 1 foot	Photo Number/ Description	Drillers Notes	Core Start Time	Samples Collected (XRF/LAB)

Measured Length (in)	**Length Represented**	**Color**	**Description**	**Time**	**PID Reading**

Pumping Test Drawdown Data Sheet

Pumping test drawdown data sheet for:____ (include well name)

☐ Pumping well ☐ Observation well, include well ID plate number (if available):__________ and distance to pumping well:_____ ft or m (circle) Type of pumping test: ☐ Constant rate ☐ Step ☐ Other (specify): ____

Date and time at start of pumping (YYYY/MM/DD; hh:mm):______________________ Static water level prior to pumping:__________ ft

Water level at end of pumping:__________ft

Date/Time	Time since pumping started (min) (enter to the nearest minute)	Measured water level (m or ft)	Drawdown (m or ft)	Measured pumping rate (USgpm, Igpm, l/s) (enter pumping rate before re-adjusting)	Remarks or observations (e.g., pumping rate adjusted, field water quality observations, weather observations, water sample collected)

Notes: Drawdown is the difference between the measured water level during pumping and the static water level prior to pumping.

Pumping Test Recovery Data Sheet

Pumping test recovery data sheet for:____ (include well name)

☐ Pumping well ☐ Observation well, include well ID plate number (if available):__________ and distance to pumping well:_____ ft or m (circle) Type of pumping test: ☐ Constant rate ☐ Step ☐ Other (specify): ____

Date and time at end of pumping (YYYY/MM/DD; hh:mm):_____________________ Static water level prior to pumping:___________ft

Water level at end of pumping:___________ft

Date/Time	Time since pumping started (min) (enter to the nearest minute)	Time since pumping stopped (min) (enter to the nearest minute)	Time since pumping started Time since pumping stopped	Measured water level (m or ft)	Residual drawdown (m or ft)	Remarks or observations (e.g. weather observations)

Notes: Residual drawdown is the difference between the measured water level during recovery and the static water level prior to pumping.

Observation Well Data Sheet

Pumping test drawdown data sheet for:____ (include well name)

☐ Pumping well ☐ Observation well, include well ID plate number (if available):__________ and distance to pumping well:_____ ft or m (circle)

Type of pumping test: ☐ Constant rate ☐ Step ☐ Other (specify): ____

Date and time at start of pumping (YYYY/MM/DD; hh:mm):____________________ Static water level prior to pumping:__________ ft

Water level at end of pumping:__________ft

Date/Time	Time since pumping started (min) (enter to the nearest minute)	Measured water level (m or ft)	Drawdown (m or ft)	Remarks or observations (e.g., pumping rate adjusted, field water quality observations, weather observations, water sample collected)

Notes: Drawdown is the difference between the measured water level during pumping and the static water level prior to pumping.

Laboratory Management Program (LaMP) Chain of Custody Record

Soil, Sediment and Groundwater Samples

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

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

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

BP/RM PM:	**Sample Details**	**Requested Analyses**	**Report Type & QC Level**
			Limited (Standard) Package ____
PM Phone:			Limited Plus Package ____
PM Email:			Full Package ____

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

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

Special Instructions:

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

BP LaMP Soil/H2O COC July 2018

Corrective Action Report/
Corrective Action Plan

Project ID	Project Name	Document ID

Preparer's Signature/Submit Date	Submitted to:

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

Corrective Action Report/
Corrective Action Plan

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

Appendix E
Data Validation Checklists

Stage 2A Data Validation Checklist for General Chemistry Sample Analysis

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:	______________________	______________________

Stage 2A Data Validation Checklist for Metals 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(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
Name: **Reviewed by:**

Signature: ______________________________ ______________________________

Date: ______________________________ ______________________________

Data Validation Checklist XRF Sample Analysis

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)

*Reference for Holding Times –

Were any data flagged because of holding time? Y [ ] N [X]
What sample preparation steps were performed (i.e. drying, sieving etc.)?
Were the samples prepped according to the SAP/QAPP? Y [X] N [ ]

Describe Any Actions Taken:

Comments:

2. Energy Calibration (System Check)

Was the energy calibration performed at the frequency of once per day? Y [ ] N [ ]
Was the energy calibration Resolution below 195? Y [ ] N [ ]
Did the energy calibration run for at least 50 seconds? Y [ ] N [ ]

Describe Any Actions Taken:

Comments:

3. SiO_2 Standards

Was the SiO_2 Standard analyzed at the beginning of analysis? Y [ ] N [ ]
Was the SiO_2 Standard analyzed at the frequency of 1 per 20 natural samples? Y [ ] N [ ]
Were the SiO_2 Standard results within the control limits? Y [ ] N [ ]
Were any data flagged because of the SiO_2 Standard results? Y [ ] N [ ]

Describe Any Actions Taken:

Comments:

4. Calibration Check Samples

Were the appropriate Calibration Check Samples (CCS) analyzed at the beginning of analysis? Y [ ] N [ ]
Were the appropriate CCS analyzed at the frequency of 1 per 20 natural samples? Y [ ] N [ ]
Were CCS results within the control limits? Y [ ] N [ ]
Were any data flagged because of CCS problems? Y [ ] N [ ]

Describe Any Actions Taken:

Comments:

5. Duplicate Sample Results

Were Duplicate Samples analyzed at the frequency of 1 per 20 natural samples?	Y ☐	N ☐
Were Duplicate Sample results within the control window of ≤ 35% RPD?	Y ☐	N ☐
Were any data flagged because of duplicate sample results?	Y ☐	N ☐

Describe Any Actions Taken:

Comments:

6. Replicate Sample Results

Were Replicate Samples analyzed at the frequency of 1 per 20 natural samples?	Y ☐	N ☐
Were replicate sample results within the control window of ≤35% RPD?	Y ☐	N ☐
Were any data flagged because of replicate sample results?	Y ☐	N ☐

Describe Any Actions Taken:

Comments:

7. Overall Assessment

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

If so, explain:

Comments:

8. Authorization of Data Validation

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

Level A/B Screening Checklist

1. General Information

Site:
Project:
Client:
Sample Matrix:

2. Screening Result

Data are:
1. Unusable ______
2. Level A ______
3. Level B ______

I. **Level A**

Criteria – The following must be fully documented.	Yes/No	Comments
1. Sampling date		
2. Sampling team or leader		
3. Physical description of sampling location		
4. Sample depth (soils)		
5. Sample collection technique		
6. Field preparation technique		
7. Sample preservation technique		
8. Sample shipping records		

II**. Level B**

Criteria – The following must be fully documented.	Yes/No	Comments
1. Field instrumentation methods and standardization complete		
2. Sample container preparation		
3. Collection of field replicates (1/20 minimum)		
4. Proper and decontaminated sampling equipment		
6. Field custody documentation		
7. Shipping custody documentation		
8. Traceable sample designation number		
9. Field notebook(s), custody records in secure repository		
10. Completed field forms		