Spring 4-19-2022

Request for Change (RFC) to the Draft Ground Water Monitoring Well Installation Plan (RFC-BPSOU-2022-04)

Josh Bryson

TREC Inc., A Woodard and Curran Company

Atlantic Richfield Company

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April 19, 2022

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RE: Request for Change (RFC) to the Draft Ground Water Monitoring Well Installation Plan (RFC-BPSOU-2022-04)

Agency Representatives:

I am writing you on behalf of Atlantic Richfield Company (Atlantic Richfield) to submit the request for change (RFC) to the *Draft Ground Water Monitoring Well Installation Plan* (RFC-BPSOU-2022-04) for your review and approval. The Ground Water Monitoring Well Installation Plan was submitted to Agencies in November 2011 by Trec, Inc. This RFC provides the procedures and protocols necessary for Atlantic Richfield Company to preferentially repair or abandon and replace existing damaged monitoring well BPS11-10A on Atlantic Richfield property. Fieldwork is anticipated to begin concurrently with additional piezometer installation for the Blacktail Creek Pumping Test in 2022.

The report may be downloaded at the following link:

https://pioneertechnicalservices.sharepoint.com/:f:/s/submitted/Ev12-RYxmkJNmH_FsOeWXgABbQGTL-ufoWW42ODdrPy-3g

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

Sincerely,

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

Cc: Patricia Gallery / Atlantic Richfield - email
Chris Greco / Atlantic Richfield - email
Mike Mc Anulty / Atlantic Richfield - email
Loren Burmeister / Atlantic Richfield - email
Dave Griffis / Atlantic Richfield - email
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Joe Vranka / EPA - email
David Shanight / CDM - email
Curt Coover / CDM - email
James Freeman / DOJ - email
John Sither / DOJ - email
Jenny Chambers / DEQ - email
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Carolina Balliew / DEQ - email
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Wil George / DEQ - email
Jim Ford / NRDP - email
Pat Cunneen / NRDP - email
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John Gilmour / Kelley Drye - email
Leo Berry / BNSF - email
Robert Lowry / BNSF - email
Brooke Kuhl / BNSF - email
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Brandon Warner / BSB - email
Abigail Peltomaa / BSB - email
Eileen Joyce / BSB - email
Sean Peterson/BSB - email
Gordon Hart / BSB - email
Jeremy Grotbo / BSB - email
Karen Maloughney / BSB - email
Josh Vincent / WET - email
Craig Deeney / TREC - email
Scott Bradshaw / TREC – email
Joel Thompson / Stantec - email
Brent Lucyk / Stantec - email
Tom Madsen / Stantec - email
Brad Archibald / Pioneer - email
Pat Sampson / Pioneer - email
Joe McElroy / Pioneer - email
Andy Dare / Pioneer - email
Karen Helfrich / Pioneer - email
Leesla Jonart / Pioneer - email
Randa Colling / Pioneer - email
Ian Magruder/ CTEC- email
CTEC of Butte - email
Scott Juskiewicz / Montana Tech - email

File: MiningSharePoint@bp.com - email
BPSOU SharePoint - upload

ATLANTIC RICHFIELD COMPANY

RFC - REQUEST FOR CHANGE

DATE April 19, 2022	RFC NO. RFC-BPSOU-2022-04	CONTRACTOR Pioneer Technical Services, Inc. (Pioneer)	RFP NO. N/A
CONTRACT DESCRIPTION: Modifications to the Ground Water Monitoring Well Installation Plan (Attachment A)		ATTENTION OF: Nikia Greene, Remedial Project Manager, EPA, Region 8 Daryl Reed, Project Officer, Montana DEQ	
SUBJECT: BPS11-10A Monitoring Well Abandonment/Replacement ❍ ELECTRICAL ❍ MECHANICAL ❍ CIVIL ❍ STRUCTURAL/ARCHITECTURAL ❍ INSTRUMENTATION ☒ ENVIRONMENTAL			
OPERABLE UNIT: Butte Priority Soils Operable Unit MAJOR WORK TASKS: BPS11-10A Monitoring Well Repair or Abandonment/Replacement		REFERENCE DWG., P.O., TAG, SPECIFICATION NO. (FOR DEVIATIONS OR DEFICIENCIES) ETC.: N/A	

BACKGROUND/PROBLEM DESCRIPTION:
Monitoring well BPS11-10A was installed in 2011 under the *Draft Ground Water Monitoring Well Installation Plan* (Atlantic Richfield, 2011) (included as Attachment A). Monitoring well BPS11-10A was struck by a vehicle in August 2020, and the casing was bent, rendering the monitoring well unusable.

Repairing or abandoning and replacing BPS11-10A is necessary to achieve Data Quality Objectives outlined in the *Draft Final Blacktail Creek Remediation and Contaminated Groundwater Hydraulic Control Site Pumping Test Quality Assurance Project Plan (QAPP)* (Atlantic Richfield, 2021a). Additionally, requirements for continuous level monitoring and semi-annual water quality monitoring of BPS11-10A are included in the *2022 Final BPSOU Interim Site-Wide Groundwater Monitoring QAPP* (Atlantic Richfield, 2021b) and the *Silver Bow Creek/Butte Area NPL Site BPSOU Draft Final Parrot Removal Monitoring Sampling and Analysis Plan* (Atlantic Richfield, 2018).

PROPOSED CHANGE:
This request for change (RFC) provides the procedures and protocols necessary for Atlantic Richfield Company (Atlantic Richfield) to assess damage and preferentially repair monitoring well BPS11-10A. 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 2.) 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, cutting the internal casing below the damaged section, and gluing on a new section of 2-inch Schedule 40 polyvinyl chloride (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.
- 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 existing configuration of the well prior to being damaged as closely as possible (see Figure 2) as outlined below.

Monitoring well repair or abandonment and replacement activities will take place on Atlantic Richfield property within the Diggings East (DE) Site in conjunction with the piezometer installation activities for the Blacktail Creek (BTC) Pumping Test. Field activities will be risk-assessed under the internal BTC Pumping Test Site-Specific Health and Safety Plan (BTC SSHASP), which will be updated to include unique hazards that could materialize during field activities for repair or abandonment/replacement of monitoring well BPS11-10A. This work is anticipated to occur over a two-day period in 2022, upon approval of this RFC, and will follow Standard Operating Procedures (SOP) included in Attachment B.

Decontamination
All drilling 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.

Decontamination water will be transported via a holding tank to the drying beds at Butte Treatment Lagoons (BTL) following procedures outlined in SOP-DE-03 Investigation Derived Waste Handling (SOPs are in Attachment B).

Well Abandonment

If repair is not feasible, monitoring well abandonment will be completed according to the requirements of Administrative Rules of Montana (ARM) 36.21.810, permanent abandonment of wells, and according to Pioneer's SOP-GW-18 Groundwater Monitoring Well Abandonment (Attachment B). 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 below ground surface (bgs). The well casing will be sealed from the top of the filter pack to surface 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.

Well Installation

If repair is not feasible, the replacement well (BPS11-10AR) will be installed a minimum of 10 feet away from the original structure (see Figure 3) 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 ARM 36.21.8, monitoring well construction standards. The replacement well will be constructed of 2-inch diameter, schedule 40 polyvinyl chloride (PVC) well casing with a 10-foot section of screened casing set from 11 to 21 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, will have a factory pre-pack screen, and additional sand completion to about 3 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 feet bgs) of the existing BPS11-10A well. Lithology will be logged to confirm subsurface conditions at the new location and compare to the existing, damaged well. The target depth for the well screen is 11 to 21 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 the Ground Water Monitoring Well Installation Plan (Attachment A).

Well Development

The repaired or replaced well will be developed to remove any sediment accumulated at the bottom of the well following the general procedures detailed in SOP-GW-12 Well Development Using a Modified Over-Pumping Technique (Attachment B). The well will be considered developed when 3 consecutive readings for turbidity are below 5 Nephelometric Turbidity Units (NTUs) and are within 10% of each other, and water quality parameters are stable, or the well has been developed for 4 hours. 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 (°C).
- pH varies by no more than 0.1 pH units.
- Specific Conductance (SC) readings are within 3% of the average.

Development 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 B).

Well Survey and Documentation

After development is completed, the repaired or replaced well will be surveyed. A licensed monitoring well constructor will submit a Montana Well Log Report (Attachment D) to the MBMG within 60 days of completion of the well 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.

Oversight Personnel

Atlantic Richfield will provide oversight personnel to oversee all field activities for repair or abandonment/replacement of BPS11-10A. Any deviations from this RFC will be brought to the attention of oversight personnel. If the deviation is first determined by field crew 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 this RFC, the deviation and the reasons for the deviation will be noted and then signed by the agency personnel.

REFERENCES:

Atlantic Richfield, 2021a. Silver Bow Creek/Butte Area NPL Site Draft Final Blacktail Creek Remediation and Contaminated Groundwater Hydraulic Control Site, Pumping Test Quality Assurance Project Plan (QAPP). October 20, 2021.

Atlantic Richfield, 2021b. Silver Bow Creek Butte Area NPL Site 2022 Final Butte Priority Soils Operable Unit Interim Site-Wide Groundwater Monitoring Quality Assurance Project Plan (QAPP). December 30, 2021.

Atlantic Richfield, 2018. Silver Bow Creek/Butte Area NPL Site Butte Priority Soils Operable Unit Draft Final Parrot Removal Monitoring Sampling and Analysis Plan. April 4, 2018.

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

Figures:

Attachments:

	❍Design Deficiency ❍ Engineering Change Request ❍ Agency Directive ❍ Construction Deficiency ❍ Schedule	❍ Material Substitution ❍ Vendor Material Deficiency ☒ Scope ☒ Additional Data Collection ❍ Clarification/Information ❍ Other	

RESPONSE/DIRECTIVE

1. Approve repair or abandonment/replacement of monitoring well BPS11-10A.

Project Manager ______________________ Date 4/19/2022 .

Atlantic Richfield Co. Representative __________________________ Date 4/19/2022 .

EPA Representative ____ Date ________________.

DEQ Representative ____ Date ________________.

CC: See Cover Letter

Figures

LEGEND

- Ⓦ Pumping Well
- BPSOU Monitoring Wells
- 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

0 125 250 500
Feet

FIGURE 1

PIONEER TECHNICAL SERVICES, INC.

DATE: 2/15/2022

BPS11-10A
MONITORING WELL
LOCATION

Path: Z:\Shared\Active Projects\ARCO\BPSOU\BTCPumpingTest\GIS\RFC\BPS11-10aRFC_001_22.mxd

Well Log

Well Name: BPS11-10A

PIONEER TECHNICAL SERVICES, INC.

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

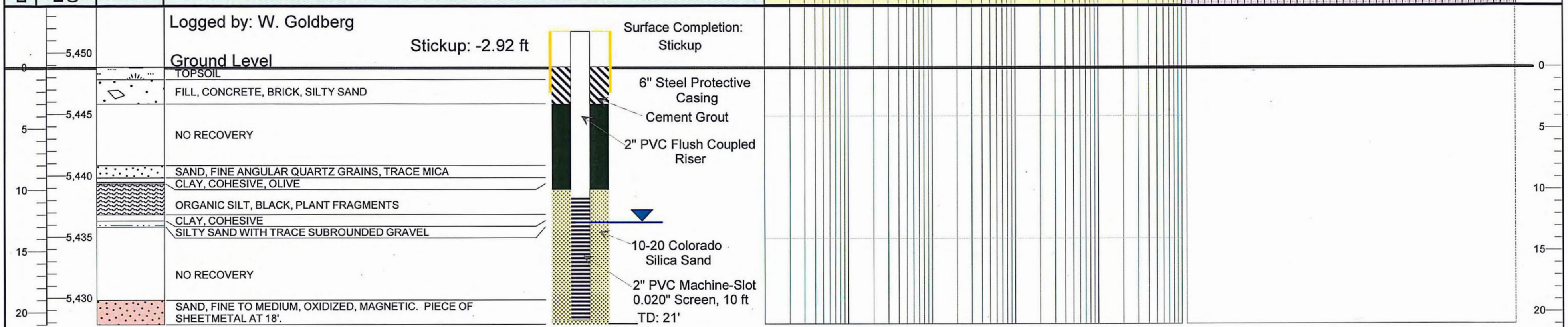
Concentration (mg/kg) Log Scale: 1, 10, 100, 1000, 10000, 100000

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)



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

Pg. 1 of 1

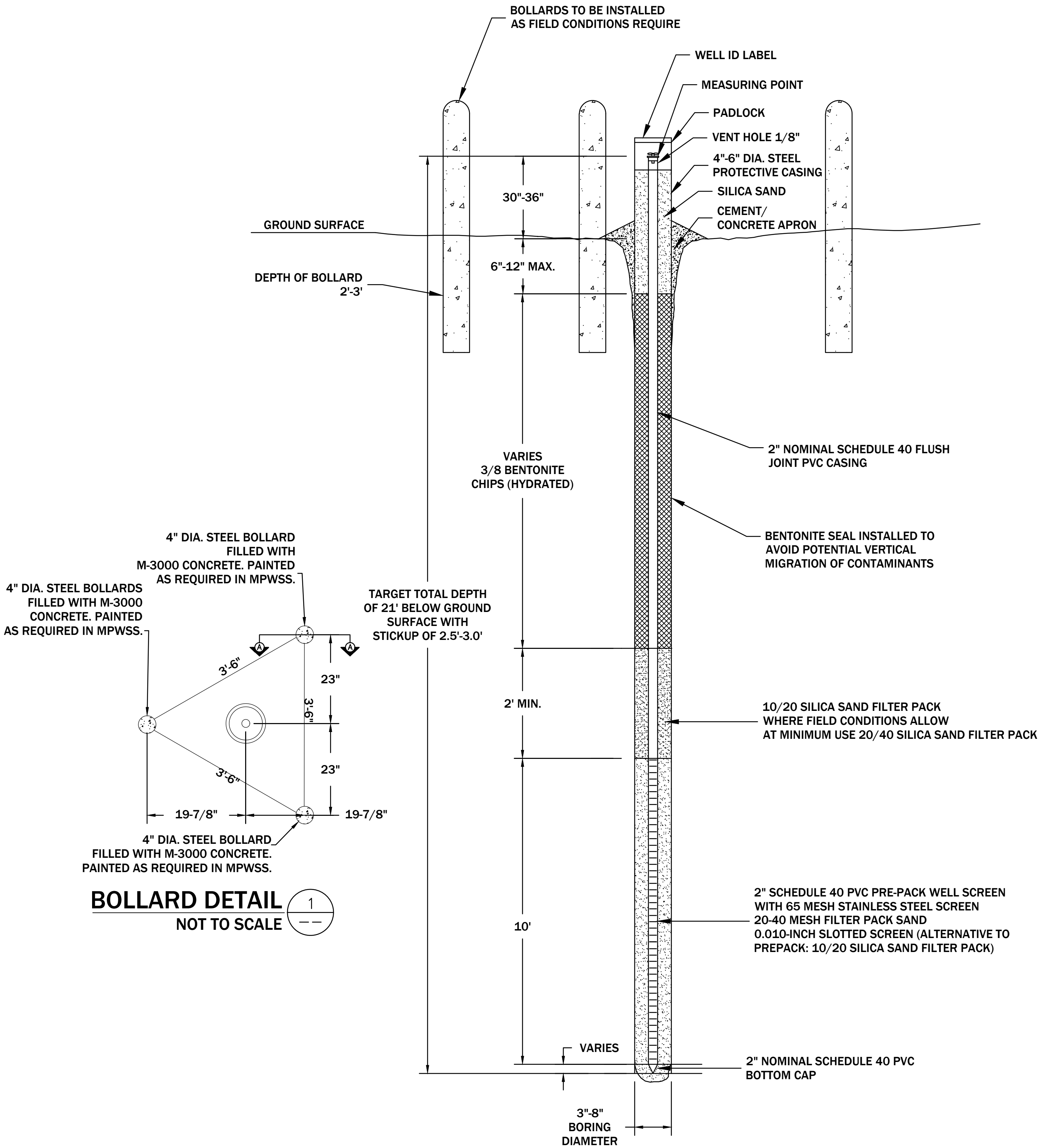
GWIC ID # 264087

FIGURE 2

BPS11-10A MONITORING WELL LOG

PIONEER TECHNICAL SERVICES, INC.

DATE: 3/9/2022



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

SCALE IN FEET
0 NTS

FIGURE 3

PIONEER TECHNICAL SERVICES, INC.

MONITORING WELL CONSTRUCTION DETAIL CONFIGURATION

DATE: 2/2022

z:\shared\active projects\arco\bpsou\brw\cadd\figures\phaseiii_qapp\brw_fg_pln_001.dwg

Attachment A
2011 Draft Ground Water Monitoring Well Installation Plan

Butte Priority Soils Operable Unit

Silver Bow Creek/Butte Area Superfund Site

Draft Ground Water Monitoring Well Installation Plan

Prepared For: Atlantic Richfield Company

Prepared By: TREC. Inc.

November 2011

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1.0 INTRODUCTION

1.1 Purpose

The purpose of this Draft Ground Water Monitoring Well Installation Plan (MWIP) is to outline the procedures for the installation of new monitoring wells in the Butte Priority Soils Operable Unit (BPSOU). The monitoring wells are to be included in the BPSOU interim ground water monitoring network. Monitoring will be conducted under the BPSOU Revised Interim Ground Water Monitoring Plan (GWMP) (EPA, 2011).

1.2 General Scope of Work

The Revised Interim GWMP has identified the goals of post-Record of Decision (ROD) ground water monitoring in the BPSOU and is upheld by law under the Unilateral Administrative Order (UAO) (EPA, 2011). The Revised Interim GWMP contains the following requirements regarding new monitoring plans:

"The ground water monitoring program will include installing additional wells, regular measurement of water quality and water levels in a monitoring network, and shall provide thorough monitoring that includes, but is not limited to, ground water in upper and lower [Metro Storm Drain] MSD, ground water near the southern extent of the [Technical Impracticability] TI zone, [and] between the MSD and [Lower Area One] LAO capture systems…"

This MWIP includes the installation of 24 new wells that are intended to satisfy these requirements. Specifically, the work to be conducted under this MWIP will include:

- Abandoning and replacing four monitoring wells in the vicinity of the Metro Storm Drain (MSD) capture system (GS-08, GS-09, GS-11 and BPS07-22) and abandoning without replacing one monitoring well (an unknown well near GS-11);
- Installing six additional new monitoring wells in the vicinity of the MSD capture system (AMC-23B, BPS07-22B and C, BPS11-10A, B, and C);
- Installing three new monitoring wells within the Point of Compliance (POC) Boundary (BPS11-11A, B, and C);
- Installing eleven new monitoring wells within the area between the MSD capture system and the Lower Area One (LAO) capture system (BPS07-13B, FP98-1B, and BPS11-01 through 09); and

If additional wells are required in the interim network, they will be installed under an addendum or separate installation plan.

Table 1 of this MWIP identifies the new wells that shall be installed to provide additional monitoring data for the BPSOU. The screened intervals and target aquifer zones shown in Table

1 are subject to change based on field conditions and observations. Figure 1 highlights the locations of the new and replacement monitoring wells identified on Table 1.

Geochemical analyses will be performed on core samples collected at selected well boring locations to further characterize the alluvium properties. These geochemical analyses are not required by the UAO and they are defined in a separate work plan entitled "Geochemical Analysis of Sonic Drilling Core Samples" (Formation, 2011). Specific methodologies for collecting the core samples are presented in the "Sample Collection and Preservation Procedure – Drilling Procedures and Anoxic Core Sampling Procedures for the BPS-OU Drilling Project" (MBMG, 2011).

2.0 WELL LOCATION, SITE ACCESS AND SEQUENCING OF WORK

The locations of the proposed wells to be installed and abandoned are shown on Figure 1 and the proposed new monitoring wells are listed in Table 1. The proposed well locations are subject to change based on field conditions, site access considerations, general feasibility, and/or third party cooperation. The installation sequencing of individual monitoring wells locations will be based on the availability of access agreements and/or location within BPSOU. Sequencing will generally start with wells on Atlantic Richfield (AR) property, while access agreements with third parties are finalized. If access agreements are in place for all well locations, the sequencing will be determined with AR management and agency personnel in the field. Atlantic Richfield will acquire access agreements for wells not located on AR property.

Table 2 shows the proposed well sequencing. Sequencing is also subject to change in the field based on general feasibility, lithology characterization, access issues, and site considerations. At nested well locations, the deeper 'C' well will be drilled first to identify the lithologic characteristics and interval(s) for core sampling, where applicable. Wells from which core samples will be collected for geochemical analysis will be drilled and constructed later in the project to increase familiarity with the sonic drilling procedure and sampling procedure.

3.0 PROCEDURES FOR CORE SAMPLING & MONITORING WELL INSTALLATION

There is currently no Clark Fork River Superfund Site Investigation Standard Operating Procedure (CFRSSI SOP) established for sonic drill core sampling, however, where applicable, the procedures set forth in *CFRSS SOP SS-1Soil Sampling from Borings* (ARCO, 1992) shall be followed. The collection of core samples will be in adherence to applicable portions of the general protocols set forth in *CFRSS SOP SS-5 Prep of Soil Core Samples* (ARCO, 1992), and installation of the monitoring wells shall follow the guidelines established in *CFRSS SOP GW-3 Monitoring Well Design and Construction* (ARCO, 1992). Copies of these SOPs are provided in Attachment A.

Boreholes for the new monitoring wells shall be 6 inches in diameter, resulting in a sample diameter of 4 inches and a well casing/screen diameter of 2 inches. Monitoring well construction shall consist of polyvinyl chloride (PVC) well casing and well screen for all monitoring wells. The PVC well material is appropriate because there are no organic constituents of concern (COCs) or analytes considered in the BPSOU Interim GWMP. Figure 2 provides a typical well construction diagram.

All 24 of the new monitoring wells are anticipated to be drilled and constructed using a sonic drilling rig, however an air-rotary rig may be utilized for some of the shallow boreholes in the paired wells. The high-quality core expected to be provided by the sonic drilling method will allow for detailed lithologic characterization of the subsurface materials at each new well location. As previously discussed, subset of the core samples will be collected for geochemical analysis. It is anticipated that the following four wells will be sampled for geochemical analysis unless conditions in the field change: GS-09R, BPS11-10B, BPS07-22B, and BPS07-13B. Core samples will be collected from the Middle Alluvial Unit (MAU) and any overlying and/or underlying fine grained units, if present, at each of these locations. Core samples for geochemical analyses may be collected from additional locations, at the discretion of field oversight personnel.

The deeper boreholes (C suffixes) will be extended to competent bedrock or a maximum depth of 200 feet below ground surface (bgs), unless field conditions provide reason to drill deeper and the drill rig is able. The intent of the B and C wells is to place the B screen interval in the MAU and the C interval below the MAU, within the Lower Alluvial Unit (LAU). Based on the available information, the MAU is present in the vicinity of the MSD capture system and has typically been characterized as a gravelly, coarse sand layer that usually contains ground water with significantly higher concentrations of dissolved metals and/or specific conductance than overlying and underlying alluvial materials.

New wells FP98-1B, BPS07-13B, and AMC-23B are intended to be screened in the MAU and the borehole will be advanced to bedrock or a maximum of 200 feet bgs, unless otherwise determined in the field. If the MAU is not encountered during drilling at any of these locations, an on-site geologist will determine whether a new well should be constructed and the screen depth of the new well. This will be based on if another water producing unit is observed, other than the shallow alluvial groundwater unit. Triple well nests shall be installed at three other locations (BPS07-22, BPS11-10 and BPS11-11), with well names containing an A, B, or C suffix corresponding to completions above the MAU, within the MAU, and below the MAU, respectively. At these triple well nest sites, the deeper (C) well will be constructed first. This will allow for the characterization of the alluvial profile at the site and identification of any MAU material encountered during the drilling. Textural observations of core samples will be used to identify the MAU (if present), and UAU. In addition, field monitoring equipment and Chemetrics© tests for copper, ferrous iron, total iron, and zinc may be used as supplemental tools to identify the presence of ground water with chemical characteristics of the MAU (i.e., relatively higher specific conductance, etc.) at select depths. The specific details and procedures for the use of field analytical tests will be provided in the Sample Collection and Preservation Procedure (MBMG, 2011) and/or the work plan detailing the Geochemical Analysis of Sonic Drilling Core Samples (Formation, 2011).

At the remaining 9 locations, BPS11-01 through BPS11-09, borings for the wells will be drilled to bedrock and one well will be completed in each boring. The well screen interval will be selected based on the preferential lithologic characteristics for groundwater flow (i.e. coarser grained strata) and the results of groundwater quality analyses on samples collected during drilling. Any excess boring below the well screen interval will be plugged with coated bentonite chips or bentonite pellets prior to extraction of the advance casing.

Groundwater samples will be taken during drilling using a pump that is lowered into the borehole/casing. The type of pump will be dependent on the depth to water in a given well. The purpose of sampling will typically be to indicate field parameters at a certain alluvial zone. Purging during this type of sampling will typically be required. At least three casing volumes will be purged prior to sample collection.

3.1 General Procedures for Core Sampling & Installing Monitoring Wells

The following procedures will be performed at each monitoring well location and depth intervals where core samples are not being collected for geochemical analysis. The items specific to MAU core sampling for purposes of geochemical analysis are separately described in the "Sample Collection and Preservation Procedure – Drilling Procedures and Anoxic Core Sampling Procedures for the BPS-OU Drilling Project" (MBMG, 2011) with supplemental information provided in the work plan entitled "Geochemical Analysis of Sonic Drilling Core Samples" (Formation 2011). The following is not intended to be a complete list.

- Drillers prepare sonic drill rig for operation. This includes but is not limited to decontamination of the drill rig tools and sampling equipment, leveling the rig, preparing the down-hole tool, and establishing the drill over the location. Depending on the site, the target depth will be one of four general locations;

- Ten feet below the depth where alluvial ground water is first encountered;
- Depth beyond the initial alluvial groundwater level where a more transmissive material is encountered (e.g., the MAU) ;
- The LAU; and/or
- Maximum depth of 200 feet (unless determined otherwise in the field) or when competent bedrock is encountered.

- Begin advancing the core barrel. At well replacement sites, advance the drill as close to the original well as possible. Once the full length of the barrel has been deployed (10 feet), override the barrel with the sonic casing.
- Prior to use, and between samples, wash all utensils with a detergent solution, followed by a tap water rinse, a dilute acid rinse, and a final rinse with distilled/deionized water.
- Decontaminate the drill rig core barrel between samples by rinsing with tap water using a high pressure washer.
- Open the core sleeve and lay out the core samples in order on strips of visqueen where the boring depth footage has been pre-labeled.
- Split the core lengthwise into two subsamples using a plastic spatula and stainless steel blades. Photograph the complete length of the core in 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 photo record of the core. Take additional photographs of subsamples for documentation as necessary.
- After recovery of the sample, add a drill rod to the drill string to advance core barrel beyond sonic casing. Repeat these steps to advance the drill to the desired depth.
- Upon reaching the initial alluvial ground water, the water will be sampled to determine if the significant COCs are present. This will be estimated initially by field measurements, including but not limited to specific conductance. These field measurements will be conducted on water samples obtained from the appropriate depths and will be collected using a submersible pump or another approved method.
- Additional groundwater samples may be collected as needed during drilling using a submersible pump. The pump will be placed within 5 feet of the bottom of the advance casing and the groundwater sample collected after the removal of a minimum of three casing volume of groundwater from the advance casing.

- After reaching the target depth, the well screen interval will be selected according to the objectives for the well location. Any over-drilled boring will be backfilled with hydrated bentonite chips or bentonite pellets to a depth of 2 feet below the expected total depth of the well.
- Each well will consist of 10 feet of 2-inch schedule 40 flush-threaded PVC well screen with a slot size of 0.020-inches with 2-inch schedule 40 flush-threaded PVC blank casing extending to approximately 2 feet above the ground surface or finished as a flush-mount at locations where an above ground surface finish is not possible (e.g., roads, parking lots, etc.). Install a 2-inch schedule 40 slip-fit cap on top of the PVC blank casing before installing the filter pack and other components described below.
- Install the filter pack (10-20 Mesh Colorado Silica Sand) to at least 3 feet above the top of the screen.
- Install the annular seal of hydrated bentonite chips from the top of the filter pack to 3 feet below ground surface.
- Install grout from 3 feet bgs to six inches bgs.
- Install a 6-inch steel surface casing from approximately 2.5 feet bgs to approximately 2.5 feet above ground surface.
- Install 10-20 mesh Colorado Silica Sand from six inches bgs to approximately 2 inches below the top of the 2-inch diameter PVC.
- Install a 2.5-foot by 2.5-foot by 6-inch thick concrete pad around the surface casing.
- Provide a locking steel cap for each monitoring well.

3.2 General Procedures for Monitoring Well Development

Upon final completion, each monitoring well must be developed. Procedures for monitoring well development are outlined in the *CFRSS SOP GW-4 Well Development* (ARCO, 1992). This SOP is provided in Attachment A. Development must continue until the water clarity meets or is less than five Nephelometric Turbidity Units (NTUs) or the development continues for a minimum of four hours. In addition to turbidity, physical parameters including temperature, pH, and specific conductance will be measured. These parameters should be stabilized or changing by less than 10 percent between readings taken on a 5-15 minute interval at the end of development. Development methods such as air lifting, surging, pumping, and bailing may be used and each is briefly described in SOP GW-4.

3.3 Groundwater Sampling

New wells will be sampled upon completion of installation, utilizing the procedures outlined in the sampling plan for ground water wells in the Silver Bow Creek/Butte Area NPL Site, Rocker Timber Framing and Treating Plant Operable Unit, Operations and Maintenance Plan. Following well development, final field parameters and two samples will be collected from each monitoring well—one for Atlantic Richfield (AR) and one for MBMG. Field parameters will include pH, oxidation-reduction potential (Eh), ferrous iron, specific conductance, temperature, and dissolved oxygen (DO). The first sample will be collected by MBMG for purposes of fingerprinting the water from each well, and the second sample will be collected by Atlantic Richfield for purposes of collecting data under the Contract Laboratory Protocol (CLP) guidance. The sample collected by Atlantic Richfield will be sent to Pace Analytical Laboratory for analysis. Table 3 provides a list of analyses that will be performed by MBMG and AR.

Following the initial sampling, the new wells will be incorporated into the Revised Interim GWMP and will be sampled for the COCs and field parameters listed in Section 2.3.1 of the GWMP and on the schedule as outlined in the Revised Interim GWMP.

3.4 Sample Core Analyses

Core samples obtained at a minimum of four well locations (GS-09R, BPS07-13B, BPS07-22B, and BPS11-10B) and one bore hole location (BPS11-BH01) will be preserved using techniques described in the "Sample Collection and Preservation Procedure – Drilling Procedures and Anoxic Core Sampling Procedures for the BPS-OU Drilling Project" (MBMG, 2011). Details of the geochemical analyses procedures are provided in the "Geochemical Analysis of Sonic Drilling Core Samples" (Formation, 2011).

3.5 Other Considerations

The use of drilling mats or other means to provide stable conditions for a drill rig may be necessary. Based on visual inspection or other means, it may be determined that drill cuttings may need to be contained for disposal or storage at a location on-site or within the BPSOU. This determination will be made by the EPA in consultation with the Montana Department of Environmental Quality (DEQ) and AR field personnel.

4.0 PROCEDURES FOR WELL ABANDONMENT

The procedure for abandoning monitoring wells will follow Montana Rule 36.21.810 established by the Montana Department of Natural Resources and Conservation (DNRC). There are four monitoring well locations that will be abandoned and replaced (GS-11, GS-08, GS-09, and BPS07-22) and one well that will be abandoned without replacement (unknown well near GS-11). Well abandonment will be implemented before the corresponding replacement wells are drilled and constructed. For each location, the replacement well will be installed as close as possible to the original structure. The sealing material used for the abandoned wells shall be bentonite pellets, bentonite chips, or bentonite clay grout. 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 3 feet of the surface and filled to ground surface with naturally occurring soils.

The following procedures are required to be performed for the abandonment at each location; however, this is not intended to be a complete list.

4.1 General Procedures for Monitoring Well Abandonment

A water well log report (Attachment B), fully describing all abandonment procedures, shall be submitted to the Ground Water Information Center (GWIC) of the Montana Bureau of Mining and Geology (MBMG) within 60 days of abandoning the well.

4.2 Specific Procedures for Abandonment of the GS-08, GS-09, GS-11 and Unknown wells

The well nest consisting of GS-08, GS-09, GS-11 and the unknown well near GS-11 will be abandoned because, based on their well construction details, the annular spaces in the wells were filled with pea gravel. Since these nested wells were installed to monitor specific depth intervals within the alluvium, there is concern that the pea gravel material may serve as a conduit for vertical ground water flow between alluvial aquifer units, potentially compromising the ability to accurately sample and characterize each unit. Abandonment of these wells will therefore need to include the removal of the outer pea gravel (along with the well screen and casing, as indicated above) so that the more highly permeable material is not left in the drill hole.

5.0 DECONTAMINATION

All drilling and related equipment required to complete this scope of work will be decontaminated by the drilling contractor prior to the project. The decontamination procedure consists of steam cleaning equipment with clean water to ensure that no foreign material is brought onto the site. The AR field representative will be responsible for inspecting the cleanliness of the equipment prior to commencing drilling. Prior to the drilling of each new monitoring well, all tooling and equipment will be decontaminated as described above.

6.0 DRILLING OVERSIGHT

Atlantic Richfield will provide a geologist(s) and/or engineer(s) to oversee all drilling, core sampling/evaluation, monitoring well installation, and development activities. The geologist and/or engineer will be responsible for logging the borehole, collecting the appropriate samples, completing well logs, and completing well construction diagrams. SOP GW-3 (provided in Attachment A) identifies the information regarding well construction and completion that shall be documented. Attachment B contains a blank well report and Figure 2 details a construction diagram. A daily log will be maintained by the drilling contractor and will be signed by AR's field representative at the end of each day or prior to commencing work the following day.

Contact Information:

Pioneer Technical Services
Will Goldberg, Geologist
65 W. Broadway
Butte, MT 59701
(406) 782-5177

Pioneer Technical Services
Mike Borduin
65 W. Broadway
Butte, MT 59701
(406) 782-5177

7.0 REPORTING

Atlantic Richfield will submit a well installation Construction Completion Report (CCR) upon the completion of well construction. The CCR will include drilling oversight well logs, and well construction completion diagrams, survey data and initial sample data for the newly installed monitoring wells.

8.0 HEALTH AND SAFETY

All work completed by AR contractors and subcontractors during execution of this Work Plan will be performed in accordance with all necessary and pertinent Atlantic Richfield guidelines, including Remediation Management (RM) Control of Work (CoW) Defined Practices and Site Technical Practices. The contractor will be responsible for developing a Health and Safety Plan that meets applicable defined practices, which may include, but are not limited to, the following list: Working at Heights, Confined Space, SIMOPs (Simultaneous Operations), Work Risk Assessment and Daily Toolbox. The Health and Safety Plan will identify all hazards and risk associated with the scope of work outlined in this document and the applicable control measures for identified hazards. AR contractors and subcontractors are required to follow Control of Work procedures prior to drilling and sampling activities begin, as well as to operate under their Site Specific HASP throughout sampling activities.

Prior to performing any major task work, contractors or subcontractors shall complete a work risk assessment, including Task Safety and Environmental Analyses (TSEAs), tailgate safety meetings, and compliance with any potential permitted activities, as required. All personnel participating in well installation must attend tailgate safety meetings each day they will participate. These meetings, along with development of Work Risk Assessments (WRA) and TSEA's will assist in identifying potential hazards and safety concerns specific to well installation and sampling.

9.0 PROJECT SCHEDULE

The start date will be determined by the contractor (MBMG) and their driller. The work is anticipated to begin November 7, 2011 and to continue for approximately 4 to 6 weeks. The sonic driller has outlined a schedule of 10 days on with 4 days off, and it is anticipated that approximately 8 to 10 wells will be completed during each 10 day shift. Drilling activities will stop during the Thanksgiving holiday week (Nov. 20-26, 2011) and recommence on Nov. 28, 2011.

10.0 REFERENCES

AERL, 2000. Silver Bow Creek/Butte Area NPL Site Rocker Timber Framing and Treating Plant Operable Unit Operations and Maintenance Plan. July, 2000.

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

Atlantic Richfield, 2007. Silver Bow Creek/Butte Area NPL Site Butte Priority Soils Operable Unit (BPSOU) BPSOU RD/M&M Health and Safety Plan (HASP). August, 2006.

Atlantic Richfield, 2007. Butte Priority Soils Operable Unit Ground Water Monitoring New Well Installation Plan, November 2007.

Atlantic Richfield, 2007. Butte Priority Soils Operable Unit Interim Ground Water Monitoring Sampling and Analysis Plan, November 2007.

EPA, 2006. Butte Priority Soils Operable Unit Record of Decision. September 2006.

EPA, 2011. Revised Interim Ground Water Monitoring Plan. July 2011.

EPA, 2011. Unilateral Administrative Order. July 2011.

Formation Environmental, LLC, 2011. Geochemical Analysis of Sonic Drilling Core Samples. October, 2011.

MBMG, 2011. Sample Collection and Analysis Procedure. October 2011.

US EPA/MDEQ, 2011. Butte Priority Soils Operable Unit Revised Interim Ground Water Monitoring Plan Silver Bow Creek/Butte Area NPL Site Butte-Silver Bow County, Montana. July, 2011.

TABLES

TABLE 1. NEW ALLUVIAL GROUNDWATER MONITORING WELLS FOR INSTALLATION

MONITORING WELL	COORDINATES[1]	APPROXIMATE SCREEN INTERVAL[2] (in feet)	TARGET AQUIFER ZONE	GROUND WATER AOC
PHASE I WELLS				
AMC-23B	N: 651612 E: 1198879	50-60	Mid-Level	Metro Storm Drain (MSD) Capture System
BPS07-22R	N: 651262 E: 1197908	15-25	Shallow	
BPS07-22B	N: 651263 E: 1197877	50-60	Mid-Level	
BPS07-22C	N: 651263 E: 1197877	60-90	Deep	
BPS11-10A	N: 651171 E: 1198777	20-30	Shallow	
BPS11-10B	N: 651171 E: 1198777	50-60	Mid-Level	
BPS11-10C	N: 651171 E: 1198777	70-100	Deep	
GS-08R	N: 651619 E: 1200372	140-160	Deep	
GS-09R	N: 651614 E: 1200379	70-80	Mid-Level	
GS-11R	N: 651610 E: 1200373	15-25	Shallow	
BPS11-01	N: 652046 E: 1196506	15-25	Shallow	Area Between MSD and LAO Capture Systems
BPS11-02	N: 651678 E: 1196493	15-25	Shallow	
BPS11-03	N: 651515 E: 1197333	15-25	Shallow	
BPS11-04	N: 650857 E: 1197362	15-25	Shallow	
BPS11-05	N: 651322 E: 1196506	15-25	Shallow	
BPS11-06	N: 651447 E: 1195988	15-25	Shallow	
BPS11-07	N: 652003 E: 1195833	15-25	Shallow	
BPS11-08	N: 652300 E: 1196074	15-25	Shallow	
BPS11-09	N: 651048 E: 1197017	15-25	Shallow	
BPS07-13B	N: 651642 E: 1196227	40-70	Mid-Level	
FP98-1B	N: 651472 E: 1195238	40-70	Mid-Level	
BPS11-11A	N: 650447 E: 1198995	20-30	Shallow	Point of Compliance (POC) Boundary
BPS11-11B	N: 650447 E: 1198995	50-60	Mid-Level	
BPS11-11C	N: 650447 E: 1198995	80-100	Deep	
BPS11-BH01	N: 652557 E: 1201154	N/A	Mid-Level	Boring only for geochemical analysis

Notes: [1] These are approximate coordinates and are subject to change based on field conditions

[2] Screen intervals will be adjusted based on the ground water elevations at the time of well installation.

TABLE 2. PROPOSED WELL INSTALLATION SEQUENCING

MONITORING WELL	OLD NAME	PROPOSED ORDER
BPS11-01		1
BPS11-11C	BPS07-28C	2
BPS11-11B	BPS07-28B	3
BPS11-11A	BPS07-28A	4
BPS11-09		5
BPS07-22R		6
BPS07-22C		7
BPS11-10C	BPS07-26C	8
GS-08R		9
GS-11R		10
BPS11-06		11
BPS11-05		12
BPS11-04		13
BPS11-03		14
BPS11-02		15
BPS11-08		16
BPS11-07		17
FP98-1B		18
AMC-23B		19
BPS11-10A	BPS07-26A	20
BPS11-10B	BPS07-26B	21
BPS07-22B		22
GS-09R		23
BPS11-BH01		24
BPS07-13B		25

NOTE: Well sequencing for general guidance only and is subject to change in the field

TABLE 3. CHEMICAL ANALYSES BY RESPONSIBLE PARTY

MBMG			
Parameter	**Units**	**Parameter**	**Units**
pH		Nd	(ug/L)
SC	(UMHOS)	Pd	(ug/L)
HARDNESS	(MG/L)	Pr	(ug/L)
ALKALINITY	(MG/L)	Rb	(ug/L)
	Ca	Tl	(ug/L)
PERCENT MEQ/L	Mg	Th	(ug/L)
Ca	(mg/L)	Sn	(ug/L)
Mg	(mg/L)	Ti	(ug/L)
Na	(mg/L)	W	(ug/L)
K	(mg/L)	Br	(ug/L)
Fe	(mg/L)	PO_4	(mg/L)
Mn	(mg/L)	PO_4^{3-}	(mg/L)
SiO_2	(mg/L)	Total Organic (Carbon)	(mg/L)
HCO_3	(mg/L)	Diss. Organic (Carbon)	(mg/L)
CO_3	(mg/L)		
Cl	(mg/L)		
SO_4	(mg/L)		
NO_3-N	(mg/L)		
F	(mg/L)		
Al	(ug/L)		
Ag	(ug/L)		
As	(ug/L)		
B	(ug/L)		
Ba	(ug/L)		
Be	(ug/L)		
Cd	(ug/L)		
Co	(ug/L)		
Cr	(ug/L)		
Cu	(ug/L)		
Hg	(ug/L)		
Li	(ug/L)		
Mo	(ug/L)		
Ni	(ug/L)		
Pb	(ug/L)		
Se	(ug/L)		
Sr	(ug/L)		
U	(ug/L)		
Zn	(ug/L)		
Ce	(ug/L)		
Cs	(ug/L)		
Ga	(ug/L)		
La	(ug/L)		
Nb	(ug/L)		

Atlantic Richfield	
Parameter	**Units**
HARDNESS	MG/L
Ca	mg/L
Mg	mg/L
Na	mg/L
K	mg/L
MnTr	mg/L
SiO_2	mg/L
HCO_3	mg/L
CO_3	mg/L
Cl	mg/L
SO_4	mg/L
N	mg/L
F	mg/L
PO_4^{3-}	mg/L
AsDis	ug/L
AsTr	ug/L
CdDis	ug/L
CdTr	ug/L
CuDis	ug/L
CuTr	ug/L
PbDis	ug/L
PbTr	ug/L
FeDis	ug/L
FeTr	ug/L
ZnDis	ug/L
ZnTr	ug/L

FIGURES

MONITORING WELL	COORDINATES[1]	APPROXIMATE SCREEN INTERVAL[2] (in feet)	TARGET AQUIFER ZONE	GROUND WATER AOC
PHASE I WELLS				
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BPS11-10B	N: 651171 E: 1198777	50-60	Mid-Level	
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GS-11R	N: 651610 E: 1200373	15-25	Shallow	
BPS11-01	N: 652046 E: 1196506	15-25	Shallow	Area Between MSD and LAO Capture Systems
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BPS11-03	N: 651515 E: 1197333	15-25	Shallow	
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BPS11-06	N: 651447 E: 1195988	15-25	Shallow	
BPS11-07	N: 652003 E: 1195833	15-25	Shallow	
BPS11-08	N: 652300 E: 1196074	15-25	Shallow	
BPS11-09	N: 651048 E: 1197017	15-25	Shallow	
BPS07-13B	N: 651642 E: 1196227	40-70	Mid-Level	
FP98-1B	N: 651472 E: 1195238	40-70	Mid-Level	
BPS11-11A	N: 650447 E: 1198995	20-30	Shallow	Point of Compliance (POC) Boundary
BPS11-11B	N: 650447 E: 1198995	50-60	Mid-Level	
BPS11-11C	N: 650447 E: 1198995	80-100	Deep	
BPS11-BH01	N: 652557 E: 1201154	N/A	Mid-Level	Boring only for geochemical analysis

Notes: [1] These are approximate coordinates and are subject to change based on field conditions.
[2] Screen intervals will be adjusted based on the ground water elevations at the time of well installation.

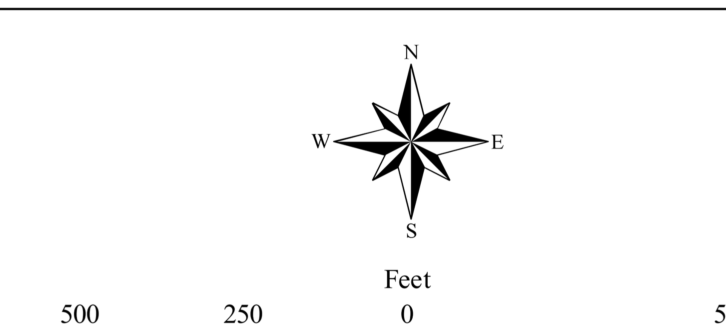
Notes:
1.) The user of this map is responsible for determining its suitability for his or her intended use or purpose. There is no guarantee for the accuracy of the material herin contained.
2.) Aerial Photography flown August 2009 for U.S. Farm Services Agency National Agricultural Imagery Program (NAIP), 1-meter resolution.

REV#	BY	DATE	FILE
0	DRH	16-Sep-2011	Map for Driller.mxd
1	DRH	7-Nov-2011	

LEGEND
GW Area of Capture, Target Aquifer Zone

- Metro Storm Drain (MSD) Capture System, Shallow
- Metro Storm Drain (MSD) Capture System, Mid-Level
- Metro Storm Drain (MSD) Capture System, Deep
- Point of Compliance (POC) Boundary, Shallow
- Point of Compliance (POC) Boundary, Mid-Level
- Point of Compliance (POC) Boundary, Deep
- Area Between MSD and LAO Capture Systems, Shallow
- Lower Area One (LAO) Capture System, Mid-Level
- Boring, Mid-Level

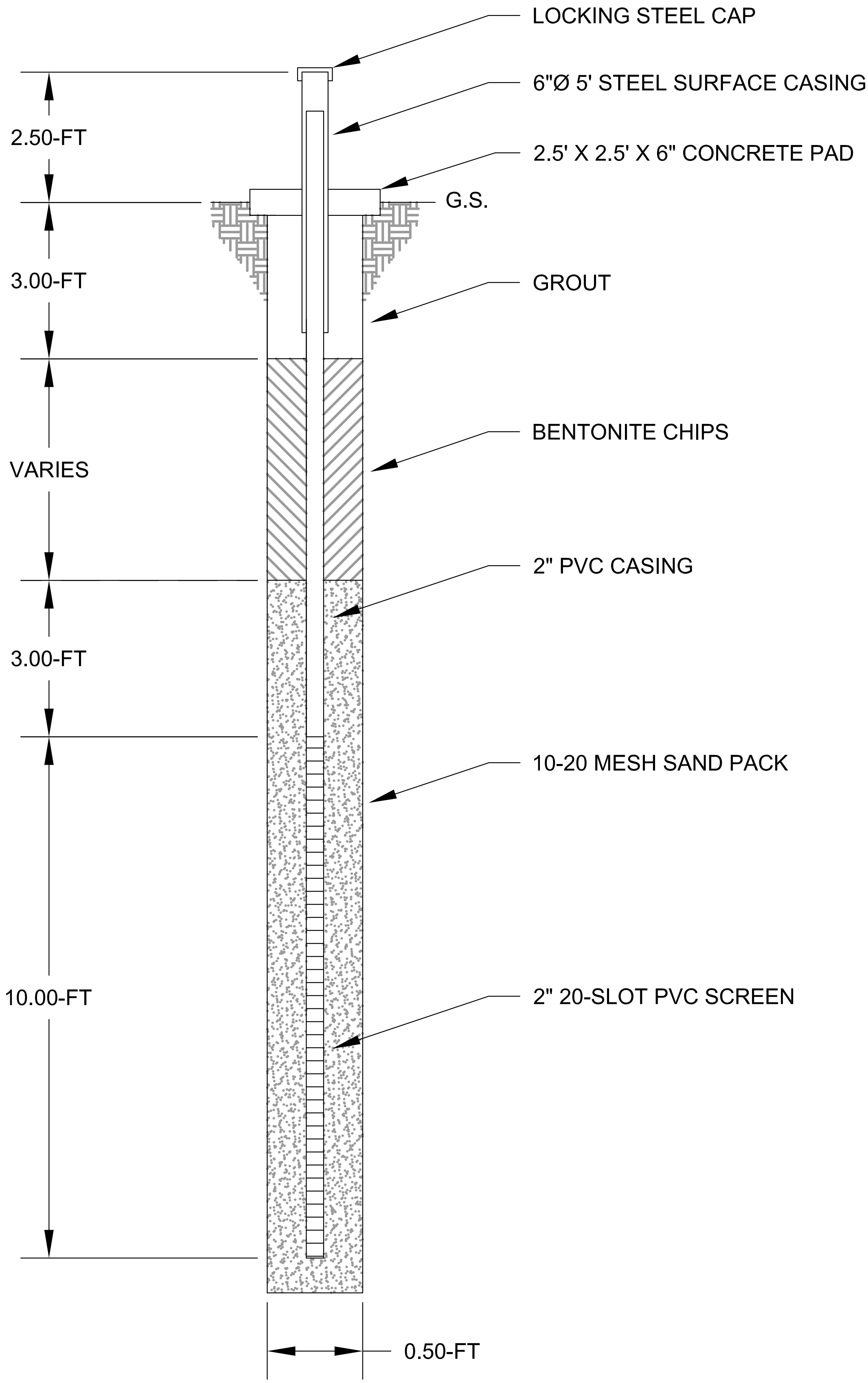
PREPARED FOR:
Atlantic Richfield Company
A BP affiliated company



DRAFT

FIGURE
1

BUTTE PRIORITY SOILS OPERABLE UNIT
PROPOSED WELLS AND REPLACEMENT WELLS



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TYPICAL MONITORING WELL
CONSTRUCTION DIAGRAM
BUTTE PRIORITY SOILS OPERABLE UNIT
NEW MONITORING WELL INSTALLATION PLAN

Drawn: STH
Checked:
Approved:

FIGURE 2

Rev. #	Description	Date

DRAWING: z:\current_projects\0131 bpsou\groundwater\gw monitoring plans\mwip\2011\020-cad\figures\0131-f002-monitoring_well_diagram.dwg

Print Date: 10/11/2011 2:31 PM

ATTACHMENT A

STANDARD OPERATING PROCEDURE SS-1

SAMPLE COLLECTION FROM SOIL BORINGS, EXCAVATIONS, AND HAND DUG PITS
SOP SS-1

SOIL BORING PROCEDURES

The following procedures are designed to be used during the operation of auger type drill rigs during soil sampling operations. The procedures listed below may be modified in the field by the agreement of the lead site sampler and drill operators based on field and site conditions after appropriate annotations have been made in the appropriate bound field logbook. All utilities (gas and electric, telephone, sewer, etc.) will be located by the utilities (in some instances a utilities locator may be necessary) prior to drilling or excavating.

1. Locate the site as directed in the site-specific Sampling and Analysis Plan (SAP).

2. Drillers prepare rig for operation. This includes but is not limited to decontamination of the drill rig tools and sampling equipment, leveling the rig, preparing the downhole tool, preparing the auger "flights", and establishing the drill over the location.

3. Mount the split tube sampler to the drive stem.

4. Prior to using the split spoon sampler, sample the surface increment to a depth in accordance with the site-specific SAP.

5. Place split spoon sampler on the ground surface and advance sampler to the desired depth using the rig hammer.

6. After driving the split spoon sampler its entire length (18 inches) or upon refusal of advancement, recover the split spoon sampler. Refusal is defined as 100 blows with the rig

hammer and less than 6 inches advancement of the split spoon sampler. Less than 100 blows may be defined as refusal if there is no split spoon advancement. This decision will be made at the discretion of the field sampler.

7. After recovery of the split spoon sampler, open the spoon and place the spoon containing the soil sample into a holding device, maintaining the intervals as sampled.

8. Sampling personnel will then describe the soil sample based on the site-specific SAP instructions, and fill out the appropriate bound field logbooks, field profile sheets, field site sheets, and quality assurance/quality control documentation.

9. Decontaminate the split spoon sampler according to procedures presented in the SOP G-8.

10. Repeat steps 3 to 9 until sampling is completed.

11. The drill rig tools and sampling equipment will be decontaminated prior to moving onto the next site. The drill rig will be left in a safe and secure fashion at the end of each shift.

BACKHOE PIT EXCAVATIONS

The following procedures are designed to be used during the operation of backhoe equipment to excavate sites prior to soil sampling operations. The procedures listed below may be modified in the field by the agreement of the lead site sampler and backhoe operators based on field and site conditions after appropriate annotations have been made in the appropriate bound field logbook.

1. Locate the site as directed in the site-specific SAP. Identify locations of underground utilities.

2. Place the backhoe tractor in a safe position. This will be based on the operators judgment and site conditions.

3. Begin backhoe excavation. Place excavated materials a sufficient distance from the excavation to prevent the return of excavated materials to the pit. Topsoil will be determined by the technical field support, removed, and segregated from the underlying soils.

4. Continue excavation of the pit to the required depth. This depth shall not exceed 5 feet from the ground surface unless the proper pit exit trenches, shoring, and sloping excavations have been excavated to prevent accidental burials of sampling crew and to meet or exceed all OSHA Construction Standards (29 CFR 1926; Appendix A) for entrance by sampling personnel.

5. Sampling personnel may enter the pit after all excavation is complete and the excavation is deemed safe to occupy. The site safety officer shall be the oversight authority and will determine what is safe and what is not safe. "Safe" for backhoe pit excavations is defined as meeting or exceeding all OSHA Construction Standards (29 CFR 1926; Appendix A), for entrance by sampling personnel.

6. Soil profile descriptions shall be made from a hand cleaned surface along the pit wall using the Unified Soil Classification System.

7. Soil sampling will follow soil profile description and establishment of sampling intervals based on the site-specific SAP. Soil samples will be collected with decontaminated stainless steel or plastic sampling tools and bowls from the appropriate intervals. A sample collected from a depth increment shall be a representative composite of the entire interval and not biased by sample mass collected largely from the top or bottom of the increment.

8. All pertinent field quality assurance/quality control documentation, bound field logbooks, sample labels, profile sheets, and field site sheets shall be completed prior to refilling the pit.

9. After items 1 through 8 have been completed to the satisfaction of the lead sampler, the

site pit shall be refilled with the previously excavated materials. The earthen materials are to be replaced in the same order they were excavated with topsoil placed on top of the filled pit. There will be some unavoidable mixing of soil during the excavation.

10. Decontaminate all sampling equipment (SOP G-8).

11. Move to the next site. If the previous site was the last site of the day, decontaminate the backhoe bucket, secure, and park the backhoe tractor rig for the evening.

HAND DUG PITS

The following procedures are designed to be used during the operation of hand tools to excavate sites prior to soil sampling operations. The procedures listed below may be modified in the field by the agreement of the lead site sampler and field personnel based on field and site conditions after appropriate annotations have been made in the appropriate bound field logbook.

1. Locate the site as directed in the site-specific SAP.

2. Select the appropriate orientation for the excavation. This will be based on the lead field sampler's judgment and site conditions.

3. Begin pit excavation. Place excavated materials a sufficient distance from the excavation to prevent the return of excavated materials to the pit. Topsoil is to be placed separately from the underlying soils. Placement of excavated materials on a sheet of plastic is recommended to facilitate returning excavated material to the pit.

4. Continue excavation of the pit to the required depth. This depth shall not exceed 24 inches from the ground surface.

5. Soil profile descriptions shall be made from a hand cleaned surface along the pit wall using the Unified Soil Classification System.

6. Soil sampling will follow soil profile description and establishment of sampling intervals based on the site-specific SAP. Soil samples will be collected with decontaminated stainless steel or plastic sampling tools and bowls from the appropriate intervals. A sample collected from a depth increment shall be representative composite of the entire interval and not biased by sample mass collected largely from the top or bottom of the increment.

7. All pertinent field quality assurance/quality control documentation, bound field logbooks, sample labels, profile sheets, and field site sheets shall be completed prior to refilling the pit.

8. After items 1 through 8 have been completed to the satisfaction of the lead sampler, the site pit shall be refilled with the previously excavated materials. The earthen materials are to be replaced in the same order they were excavated with topsoil placed on top of the filled pit. There will be some unavoidable mixing of soil during the excavation.

9. Decontaminate all sampling equipment (SOP G-8).

10. Move to the next site. If the previous site was the last site of the day, decontaminate the field sampling equipment, secure all equipment, and exit the site.

STANDARD OPERATING PROCEDURE GW-3

MONITORING WELL DESIGN AND CONSTRUCTION
SOP GW-3

A universal, set procedure for designing and constructing monitoring wells cannot be listed. Every location within a site may vary depending on contamination encountered, lithology of the subsurface, and depth to ground water. A technique that may work at one location may be inappropriate at the next. The following section discusses general guidelines for well design and construction, but actual well designs will depend on site conditions and should be addressed in site-specific SAP and SOP.

Wells drilled for an RI/FS 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 resulting from RI activities into ongoing 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 shall not be used if the well samples are to be analyzed for organics, 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 may affect the quality of the well, and its utility for ground water monitoring, throughout its lifetime. The elements of proper monitoring well construction presented in this SOP serve as guidelines for wells constructed for the ground water investigation. In addition, these guidelines can be applied to evaluate the adequacy of existing

wells when RI sampling will be conducted from available wells. Typical well completion details are shown on Figures GW-3-1 and GW-3-2.

WELL DIAMETER

The diameter of the well casing will be the minimum that allows the sampling tool to be lowered to the desired depth. The diameter of the borehole, in unconsolidated formations, into which the casing is placed must be at least 4 inches larger than the casing to provide a minimum 2 inches of annular space for placement of sand pack and seal. The diameter of the borehole in consolidated formations shall also be a minimum of 4 inches larger than the casing if installation of the seal is expected.

WELL DEPTH

Wells shall be constructed to be depth discrete, with the well screened in only one aquifer, zone, or layer. This allows the sampling of the area of interest without interference from other layers. This requires provisions for grouting above, and if necessary, below the well screen on the outside of the casing.

WELL CASINGS/SCREENS

Well casings and screens will be constructed of materials with the least potential for affecting the quality parameters of the sample. Guidance regarding casing and screen material selection criteria is presented in Table GW-3.1. Well casing and screen shall be steam cleaned and protected from contamination prior to their installation.

WELL DRILLING

Drilling method selection shall be based on minimizing both the disturbance of the geologic materials penetrated, and the introduction of air, fluids, and muds. Organic drilling muds or additives shall be avoided. Advantages and disadvantages of various drilling methods are presented in Table GW-3.2.

SCREEN ZONE DESIGN

The screen zone of the monitor well shall be designed and constructed to: (1) allow sufficient ground water flow to the well for sampling; (2) minimize the passage of formation materials into the well; and (3) ensure sufficient structural integrity to prevent the collapse of the screen 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 ensure that formational material is prohibited from passing through the well during development. The annular space between the face of the formation and the screen or slotted casing should be filled to minimize passage of formation materials into the well. The driller should, therefore, install a sand pack in each monitoring well. It is recommended that aquifer material from the screen zone be analyzed for grain size in order to determine the correct sand pack and screen slot size.

SCREEN SIZE SELECTION

The screen slot size is determined after the filter pack material has been selected. The screen slot size for a well with a designed filter pack should be selected to retain 90 percent or more of the filter pack material. See the references at the end of the SOP for further detail.

SELECTING THE FILTER PACK

The purpose of selecting the proper filter pack is to 1) stabilize the aquifer material around the well, 2) provide an annular zone with high permeability, and 3) permit the use of the largest possible size of screen openings.

The selection of the filter pack is a vital step in completing a useable well. The design and selection of a proper filter pack is an issue which has many factors to be considered and which cannot be given satisfactory explanation in this SOP. A person designing a well should select and read one of the excellent reference books available on the subject. See the reference list at the end of this SOP.

The following information gives the general guidelines used in selecting the well filter pack. For a detailed explanation of the filter pack selection, refer to the references provided at the end of this SOP.

1.Perform a sieve analysis on the natural aquifer material.

2.Select a filer pack whose grain size is 4 to 10 times larger than the 30 percent of the finer natural aquifer material.

3. The filter pack grain size should have a uniformity coefficient around 2.5.

4. The filter pack material shall be a siliceous material such as quartz sand, have well-rounded grains, and contain less than 5 percent not-siliceous material.

PLACEMENT OF THE FILTER PACK MATERIAL

The selected filter pack will be introduced into the annular space adjacent to the screen through a tremie pipe. A minimum 1 1/2-inch diameter tremie pipe is suggested. The end of the tremie pipe should be positioned within 5 feet of the bottom of the borehole before treming in the filter material. As the filter material is tremied into the annular space, the tremie pipe should be raised periodically but kept within 5 feet of the top of the filter pack. This 5-foot interval minimizes bridging and segregation of the filter pack as it is placed. The filter pack placement will continue until the filter pack is 3 feet above the top of the screen.

The top of the sand pack should be measured periodically and recorded in the bound logbook. The total volume of filter material used should also be recorded.

A fine silica sand (70-100 sieve size) shall be placed from the top of the filter pack to 3 feet above the filter pack. This fine sand prevents the migration of cement grout into the filter pack. The top of the fine sand pack shall be measured and then recorded in the bound logbook, along with the volume of material used.

ANNULAR SEAL

The materials used to seal the annular space must prevent the migration of contaminants to the sampling zone from the surface or intermediate zones and prevent cross contamination between strata. The materials should be chemically compatible with the anticipated waste to ensure seal integrity during the life of the monitoring well and chemically inert so they do not affect the quality of the ground water 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 two feet of certified sodium bentonite pellets immediately over the silica sand when in a saturated zone. The pellets are most appropriate in a saturated zone because they will swell in the column of water to create an effective seal. A cement and bentonite mixture or antishrink cement mixtures should be used as the annular sealant in the unsaturated zone above the bentonite pellet seal and below the frost line.

Cement-bentonite grout shall also be used to seal the annuler space between the casing and borehole wall and between the surface formation and the conductor casing, if such is used. At the surface, the grout shall have positive slope away from the well or piezometer to prevent water from ponding and entering around the casing.

The grout shall be composed of Class B or G Portland cement, fresh water, and 2 to 4 percent bentonite. The grout shall be mixed in the following proportions: 6.5 gallons of water, 94 pounds (1 sack) of cement, and 2 percent (1.88 pounds, dry weight) of bentonite, or 7.8 gallons of water, 94 pounds (1 sack) of cement, and 4 percent (3.76 pounds, dry weight) of bentonite. The bentonite will improve the workability of the grout and reduce shrinkage as the cement sets.

Emplacement of the grout shall be by tremie pipe via gravity feed or pumping. The end of tremie pipe shall be set 5 feet above bottom of filled interval.

After installation of the cement slurry, a minimum of 24 hours of curing time shall elapse prior to resuming any construction operations at the particular borehole.

WELL HEAD INSTALLATION

The well or piezometer casing shall extent approximately 3 feet above ground surface. A vented casing cap with marked well or piezometer designation shall be placed on top of the surface casing. A steel protection casing shall be welded to the conductor casing and shall extend to at least 2 inches above the top of the casing cap. The protective casing shall be fitted with a locking cap and also marked with the well or piezometer designation. A concrete apron, extending at least 3 feet away from the casing and sloping away from the well, shall be constructed around the base of the protective casing. In high-traffic areas, four bumper guards shall be installed around the well. The bumper guards shall be brightly painted posts of 3-inch steel pipe filled with concrete and set in the concrete apron.

DOCUMENTATION OF WELL DESIGN AND CONSTRUCTION

Information on well design and completion will be documented when drilling and constructing the well, and will include, but not be limited to:

1. Date/time of construction.
2. Weather conditions.
3. Drilling method and drilling fluid used.
4. Sketch of well location.
5. Bore hole diameter and well casing diameter.
6. Well depth (± 0.1 foot).
7. Drilling and lithologic logs.
8. Casing materials.
9. Screen materials and design.
10. Casing and screen joint type.
11. Screen slot size/length.
12. Filter pack material/size, grain analysis.
13. Filter pack volume calculations.
14. Filter pack placement method.
15. Sealant materials (percent bentonite).
16. Sealant placement method.
17. Date/time began grouting well.
18. Date/time of well completion.

19. Surface seal design/construction.
20. Well development procedure.
21. Type of protective well casing.
22. Ground surface elevation (0.01 ft.).
23. Top of monitoring well casing elevation (0.01 ft.).
24. Detailed drawing of well (include dimensions).

References:

F.G. Driscoll, Groundwater and Wells, Second Edition, St. Paul, Minnesota, Johnson Filtration Systems, Inc., 1986.

U.S. Department of the Interior, Ground Water Manual, Water Resources Technical Publication, 1977.

U.S. Environmental Protection Agency, Handbook of Suggested Practices for the Design and Installation of Ground Water Monitoring Wells, National Water Well Association, 1989.

TABLE GW-3.1

WELL CASING AND SCREEN MATERIALS

Type	Advantages	Disadvantages
Polyvinyl chloride (PVC)	Excellent chemical resistance to weak alkalies, alcohols, aliphatic hydrocarbons, and oils	May absorb some constituents from ground water
	Good chemical resistance to strong mineral acids, concentrated oxidizing acids, and strong alkalies	May react with and leach some constituents into ground water
Polypropylene	Excellent chemical resistance to mineral acids	May react with and leach some constituents into ground water
	Good to excellent chemical resistance to alkalies, alcohols, ketones, and esters	May react with strong oxidizing acids
	Good chemical resistance to oils	
	Fair chemical resistance to concentrated oxidizing acids, aliphatic hydrocarbons, and aromatic hydrocarbons	
Teflon (Teflon is a registered trademark of DuPont, Inc.)	Outstanding resistance to chemical attack; insoluble in all organics except a few exotic fluorinated solvents	High cost relative to other materials
Carbon steel	Strong and rigid, temperature sensitivity not a problem	May react with and leach some constituents into ground water
		Not as chemically resistant as stainless steel
Stainless steel	Excellent resistance to corrosion and oxidation	Heavier than plastics
		May corrode and leach some chromium in very acidic waters
		May act as a catalyst in some organic reactions

TABLE GW-3.2

DRILLING METHODS FOR MONITORING WELLS

Type	Advantages	Disadvantages
Hollow stem auger	No drilling fluid is used, minimizing contamination problems Formation waters can be sampled during drilling by using a screened lead auger or advancing a well point ahead of the augers Hole caving can be overcome by emplacing screen and casing before augers are removed	Can be used only in unconsolidated materials Limited to depths of 100 to 150 feet, formation samples may not be completely accurate, depending upon how they are taken
Mud rotary	Can be used in both unconsolidated and consolidated formations Core samples can be collected Capable of drilling to any depth Casing not required during drilling Flexibility in well construction	Drilling fluid is required ·Contaminants are circulated with the fluid ·The fluid mixed with the formation, water invades the formation, and is sometimes difficult to remove ·Bentonite fluids may absorb metals and may interfere with some other parameters ·Organic fluids may interfere with bacterial analyses and/or organic-related parameters No information on location of the water table and only limited information on water producing zones, is directly available during drilling Formation samples may not be accurate
Air rotary	No drilling fluid is used, minimizing contamination problems Can be used in both unconsolidated and consolidated formations Capable of drilling to any depth Formation sapling ranges from excellent in hard, dry formations to nothing when circulation is lost in formations with cavities Formation water is blown out of the hole along with cuttings making it possible to determine when the first water-bearing zone is encountered	Casing is required to keep the hole open when drilling in soft, caving formations below the water table When more than one water-bearing zone is encountered and hydrostatic pressures are different, flow and possible cross-contamination can occur from one water-bearing zone to another between the time drilling is completed and the hole can be properly cased and grouted off

TABLE GW-3.2

DRILLING METHODS FOR MONITORING WELLS
(Continued)

Type	Advantages	Disadvantages
	Collection and field analysis of water blown from the hole can provide enough information regarding changes in water quality for parameters such as chlorides for which only large concentration changes are significant	
Cable tool	Only small amounts of drilling fluid (generally water with no additives) are required Can be used in both unconsolidated and consolidated formation; well suited when caving, large gravel type formations with large cavities above the water table are encountered Formation samples can be excellent with a skilled driller When water is encountered, changes in potentiometric levels are observable Relative permeabilities and rough water quality data from different zones penetrated can be obtained by skilled operators Good seal between casing and formation if flush jointed casing is used	Potential contamination by drilling fluid Relatively large diameters are required (minimum 4-inch casing) Steel drive pipe must be used

STANDARD OPERATING PROCEDURE GW-4

WELL DEVELOPMENT
SOP GW-4

The monitoring wells, pumping wells, and piezometers shall be developed after construction is completed. The purpose of the development is to remove any remnants of drilling fluid and fine-grained material and to restore the natural permeability of the screened formation. At a minimum, the following development techniques shall be available to develop the wells.

1. Surging with plunger

2. High velocity jetting

3. Airlift pumping

4. Overpumping and backwashing with submersible pump

5. Bailing

The development methods will be selected in the field by the supervising hydrogeologist. This decision will be based primarily on the condition of each well after construction. A description of the methods is provided below.

The duration of the development process will be determined by the supervising hydrogeologist. The amount of turbidity in the discharge water will be used as a guide to determine that development is complete. The turbidity shall be measured in the wells with a turbidimeter and shall not exceed five nephelometric turbidity units (NTU). In addition to turbidity, physical parameters including temperature, pH, and specific conductivity will be measured. Use of the field test equipment will be found in SOP HG-7 for conductivity and temperature, SOP HG-8 for pH, and SOP HG-10 for turbidity. These parameters should be stabilized or changing by less than 10 percent between readings at the end of development. In the piezometers, visual observation may be used to determine that the discharge water is clear. Water produced during development will be discharged in accordance with the site-specific SAP. Personnel will wear protective clothing and use equipment specified in the site-specific Health and Safety Plan.

All procedures used and measurements taken during development will be recorded in the field logbook. This information will include time required, volume of water removed, turbidity readings, pumping rate, and observations made during the development process.

All development equipment must be decontaminated in accordance with SOP G-8.

SURGING WITH PLUNGER

The surging shall be done by solid surge plunger. The belting discs shall be cut to form a free fit in the casing.

Before starting to surge, water should be bailed or pumped from the well to make sure that some water will flow into the well. For operation, the surge plunger shall be lowered into the casing about 15 feet below the water level. The plunger shall be operated up and down in the well casing to exert equal or approximately equal force on the inward and outward movement of the water through the screen. A surge plunger should not be run in a plugged well. In no case shall the surge plunger be operated below the top of the screen.

The surging shall be started slowly at first and the speed increased as the work progresses until it reaches the fastest limit at which the tools will drop and rise without excessive slap of the cable. Periodically, the plunger will be removed and the amount of fines accumulated at the bottom of the well will be measured using a weighted steel tape. If fines have been drawn into the well and have blocked 10 percent or more of the total screen length, the well shall be bailed or otherwise cleaned to the bottom between the surge plunger runs. The bottom of the well should be cleaned by bailer or air lift after surge development is completed.

HIGH-VELOCITY JETTING

This method should be used at the beginning of well development, so that any water introduced into the formation during jetting would be removed during later stages of the development. Development of the well shall be accomplished by high-velocity horizontal jetting with potable water of known chemistry. The jetting shall proceed from the bottom of the screen to the top. The outside diameter of the jetting tool shall be 1 inch less in diameter than the screen inside diameter. The maximum exit velocity of the jetting water at the jet nozzle shall be 150 feet per second. The jetting tool shall be rotated at a speed of less than 1 revolution per minute. It shall be positioned at one level for not less than two minutes and then shall be moved to the next level, moving more than 6 inches upward from the preceding jetting level.

AIR LIFT PUMPING

Development of the well shall be conducted by utilizing an air line and an air and water eductor pipe. The air line will be placed inside the eductor pipe with the end of the line near, but not extending below, the end of the pipe. Discharge of air from the air line shall always occur within the eductor pipe to prevent clogging of the filter pack and/or formation with air bubbles. Air lift development procedures should begin by determining that ground water can flow freely into the screen. Application of too much air volume in the well when the formation is clogged can result in a collapsed screen. To minimize the initial pumping rate, the air line and eductor pipe should be placed at shallow submergence. Once uninhibited flow to the screen has been established, the air line and eductor pipe should be lowered to approximately 5 feet above the bottom of the screen. Air will then be pumped through the air line causing displacement of the water in the eductor pipe and flow of water into the well. Development will continue by raising the air line/eductor pipe at approximate 5-foot intervals until the entire screen length has been pumped.

For the piezometers, which are not foreseen for sampling ground water, an alternate method of air lift may be used because of the small casing diameter. This method uses only an air line, and the well casing acts as the eductor pipe. The air line shall be placed at lease 5 feet above the screen, or at the bottom of the well within the sump. At no time during development should the air line be moved into within the screen area. Maintaining the air line above or below the screen prevents charging the filter pack and/or formation with air, which can cause clogging.

The compressors, air lines, hoses, fittings, etc, shall be of adequate size to pump the well by the air lift method. Pressurized air from air compressor(s) needs to be specifically filtered so that oil from the compressor does not contaminate the well.

Air lift pumping development produces best results when the submergence ratio of the air line is about 60 percent, wells 200 feet or less in depth (Ground Water and Wells, Johnson, 1972). The percent pumping submergence can be calculated as follows:

Install Equation Editor and double-click here to view equation.

The desirable drawdown is from static water level to the top of screen. The pumping rate will be estimated from available drawdown and pumping submergences.

OVERPUMPING AND BACKWASHING WITH SUBMERSIBLE PUMP

The pumping shall be done with a submersible pump capable of pumping at rates up to two times the estimated well capacity (well yield per unit drawdown). The pumping should be carried out in at least five steps including pumping rates of 0.25, 0.5, 1, 1.5, and 2 times the estimated well capacity with no check valve nor foot valve present. Pumping shall be conducted in five-minute cycles and shall continue until acceptable standards as explained at the beginning of this SOP are attained.

BAILING

Where the nature of the formation and/or well construction make development of the well infeasible using pumps or air lift, bailers shall be utilized to evacuate water and fine sediments and/or fine formation particles from the well. Bailers should be of a diameter allowing free-fall inside the well casing and should be equipped with a check valve at the bottom. The frequency of bailing trips shall depend on the ability of the well to recover.

DURATION OF DEVELOPMENT

The required duration for development will be determined using different criteria for the wells and piezometers. These criteria are:

Monitoring and Pumping Wells

Turbidity measured with a turbidimeter equal to or less than 5 NTU.

Piezometers

Visual observation that the turbidity has cleared and verification, using a simplified slug test, that water is flowing into the well.

Operating procedures for the turbidimeter are provided in SOP HG-10. Procedures for verification of development in the piezometers are provided below.

The purpose of developing the piezometers is to ensure that water can move freely from the formation and into the casing through the filter pack and screen. A simplified slug test will be conducted at the end of development to verify that water can move freely into the piezometer. The slug test will consist of either adding or removing a slug of water from the piezometer and then recording the change in water level in response to the slug. Based on the rate of change of water level, the supervising hydrogeologist will determine whether development is complete or whether additional cleaning is required.

STANDARD OPERATING PROCEDURE SS-5

PREPARATION OF SOIL CORE SAMPLES FOR LABORATORY ANALYSIS
SOP SS-5

FIELD LABORATORY PROCEDURES

Figure SS-5-1 illustrates the preparation of core sections for analysis. The procedures outlined below are for the preparation of core samples for analyses of inorganic chemicals.

Samples obtained for analyses of organic chemicals will be shipped directly to the laboratory in the sealed brass tube in which they were collected. No preparation is necessary.

1. Ensure samples are well-sealed with paraffin and store them in a cool area.

2. Prior to use, and between samples, wash all utensils with a detergent solution, followed by a tap water rinse, a dilute acid rinse, and a final rinse with distilled/deionized water.

3. Spread clean plastic under the sample holder to catch any sample which may spill during cutting.

4. Place the length of core section selected for analysis in the core holder.

5. Using a stainless steel knife, cut the core sections lengthwise into two subsamples, using the top edges of the core holder as a guide.

6. Split the core lengthwise into two subsamples using a plastic spatula and stainless steel blades.

7. Photograph the subsamples of the core section.

8. If the core section is not entirely filled with material, the contents of the core should be split in half as best as possible. Note in the bound field logbook any sections that were not filled, and describe how the material was divided. The mixing bowl and utensils should be stainless steel or plastic.

9. After mixing as well as possible, remove approximately 40 g of material from the core half that is to be sent to the laboratory. Use this 40 g of material for field laboratory analyses of slurry pH (refer to SOP SS-9), and percent moisture (refer to SOP SS-8). Remove 8-ounces of materials from every tenth sample to perform duplicate slurry pH and percent moisture analyses.

10. Send remaining material in the half-core section to the laboratory in a 16-ounce wide-mouth jar, or if the sample is too large for the jar, place in a plastic zip-lock bag. To guard against leakage, be sure to double-bag all samples. The laboratory requires a minimum of 200 g (dry weight) of sample. The standard 16-ounce jar is sufficient size to contain 200 g sample of typical soil material.

    Note: The sample analysis request form provides the sample numbers and quantity of sample to be sent by the laboratory to the EPA or the reference laboratory after drying and grinding. Note which sample numbers are to be composited after grinding for whole core analysis.

11. Wrap the remaining half of the core section with plastic wrap ensuring it is well-sealed with tape. Label and store in a cool secured area.

ATTACHMENT B

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 _________________

Yellowstone Controlled Groundwater Area - Water Temperature________°F

☐ AQUIFER TEST DATA FORM ATTACHED

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.*

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

____

Attachment B
Pioneer Standard Operating Procedures

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

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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

	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.
Driving the Geoprobe® Model 7822DT	**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.

	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

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	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.

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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.
</td></tr>
<tr><td>DT-22 Attached Cutting Shoe Tool String Set Up</td><td>
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
</td></tr>
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	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

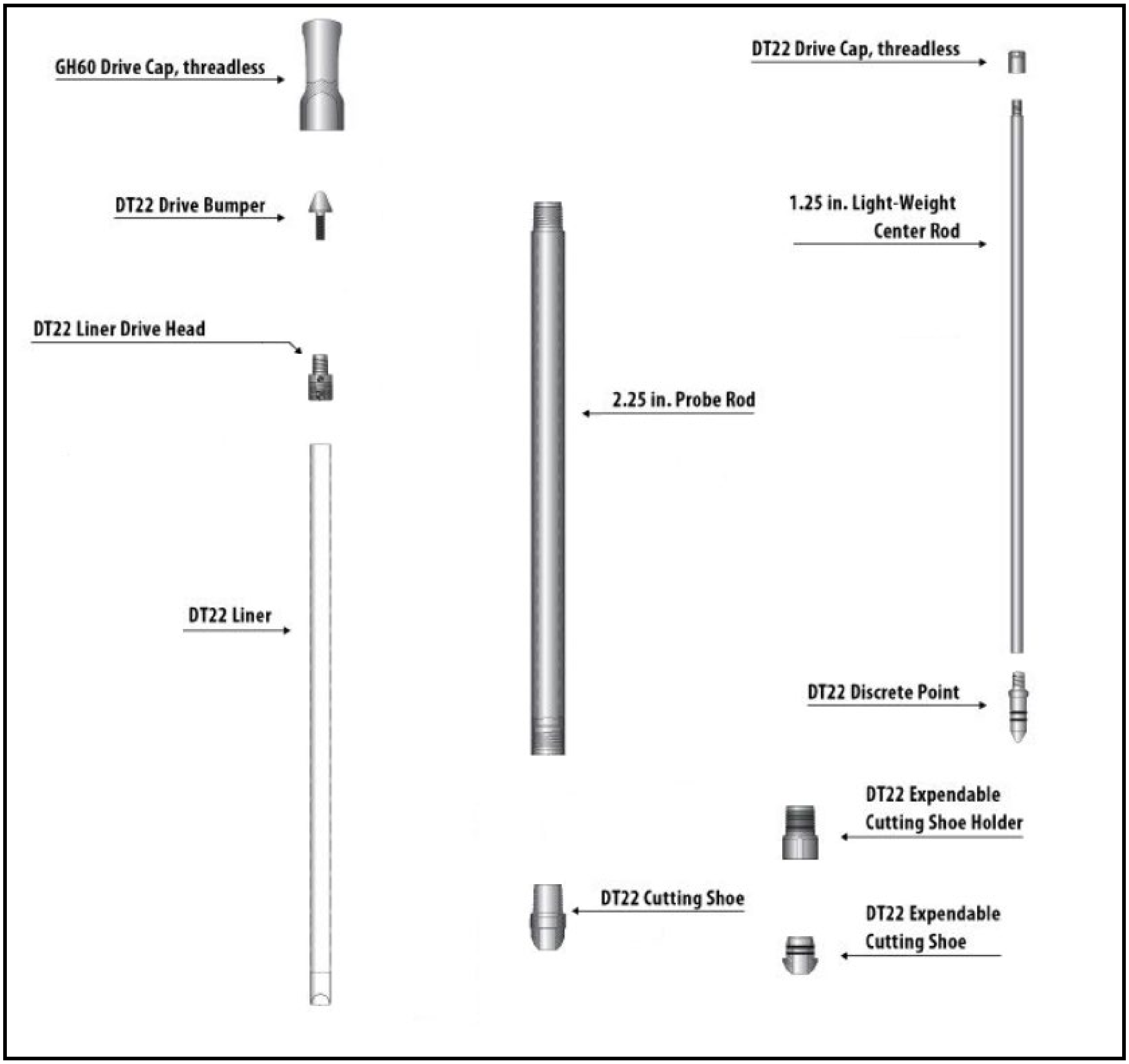

Figure 1 - The DT-22 Tool String Diagram

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

	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.
DT-325/375 Threaded Cutting Shoe Tool String Set Up	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:

	• 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. 3. Drive the tool string to depth. 4. Remove outer drive cap and then the inner centering drive cap. 5. Thread the 1.25-inch Tee-handle on to the sheath drive head and pull the sample sheath from the outer rod. 6. 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. 7. 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. 8. 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. 9. 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.
DT-325/375 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 through the outer rods. 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 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

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	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.

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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

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		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

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			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

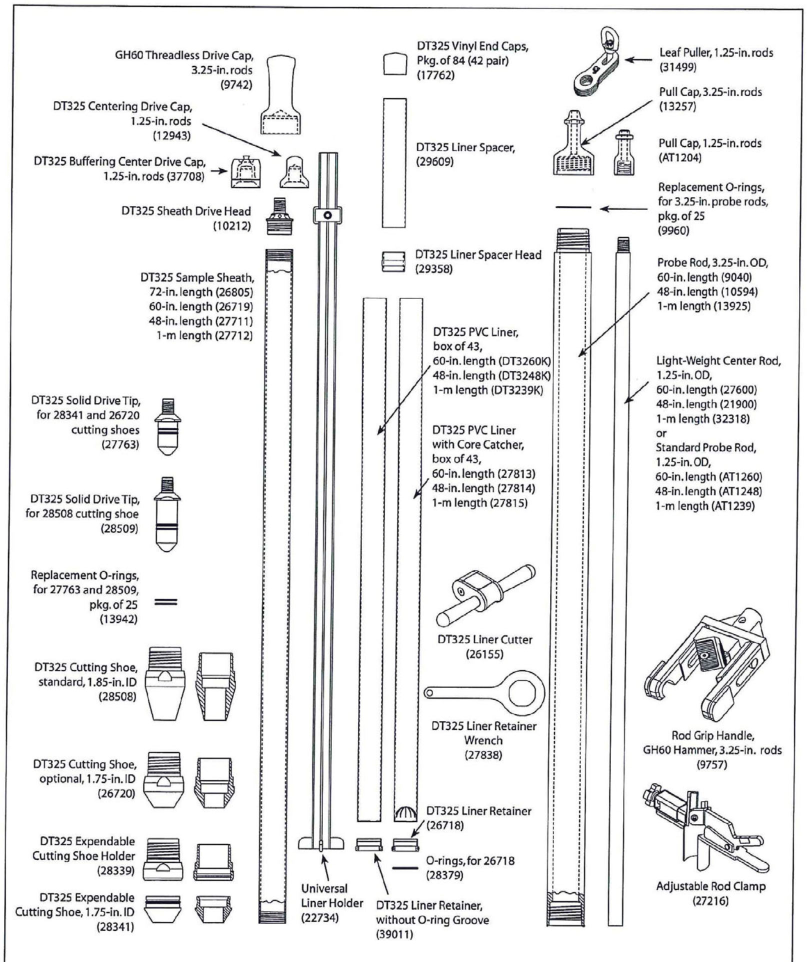

Figure 3.1
DT325 parts and accessories.

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

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

WORK INSTRUCTIONS

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

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

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

HSSE CONSIDERATIONS

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

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

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

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

ADDITIONAL HSSE CONSIDERATIONS This section to be completed with concurrence from the Safety and Health Manager.	
REQUIRED PPE	Hard hat, safety glasses, high-visibility work shirt or vest, long pants, work boots, and nitrile gloves.

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

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

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

Revisions:

Revision	Description	Date

PURPOSE	To provide standard instructions for 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.	
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. Lightning.	Outdoor sites. 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. Electrocution, personal injuries, 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, 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. 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

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