FINAL

Butte Area One – Data Gap Investigations

Silver Bow Creek and Blacktail Creek Corridors SAP

Tetra Tech Project No. 114-570986.300

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PRESENTED TO

Natural Resource Damage Program
1720 9th Avenue
Helena, MT 59601

PRESENTED BY

Tetra Tech, Inc.
2525 Palmer Street
Suite 2
Missoula, MT 59808

P +1-406-543-3045
P2 +1-406-327-5228
tetratech.com

Prepared by:

William Craig, LG, LHG — Date
Hydrogeologist

Authorized by:

Kirk Miller — Date
Western Montana Offices Manager

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1.0 INTRODUCTION

This Sampling and Analysis Plan (SAP) outlines the technical requirements for conducting soil, groundwater, and waste characterizations to address data gaps and satisfy design needs for the integration of restoration with remedy of mining and mineral processing wastes in the SBC and BTC Corridors **(Figure 1; Appendix A)** and to support integration of restoration design. Removal of wastes is described in the 2006 Butte Priority Soils Operable Unit (BPSOU) Record of Decision (ROD) Section 12.3.3.2 (EPA 2006a) which requires excavation of contaminated sediment, streambanks, and floodplain wastes from the reach of Blacktail Creek just above the confluence with upper Silver Bow Creek down to the reconstructed floodplain and stream channel in Lower Area One, and the 2015 Preliminary Conceptual Restoration Plan (Confluence, 2015).

The nature of the investigations outlined by this SAP are similar to previous work conducted throughout the Butte Priority Soils Operable Unit, Streamside Tailings Operable Unit, and Clark Fork River Operable Unit. The following documents were reviewed while preparing this SAP and attached Quality Assurance Project Plan (QAPP) and Health and Safety Plan:

- Butte Area One Final Restoration Plan (BNRC and NRDP 2012);
- Preliminary Conceptual Restoration Plan for Butte Area One (NRDP 2015);
- Clark Fork River Master SAP (CDM 2009);
- Tailings/Impacted Sediment Delineation of the Diggings East, Blacktail Creek Berm and Northside Tailings Areas (MBMG 2014a); and
- Butte Priority Soils Operable Unit Record of Decision (EPA 2006).

This SAP provides procedures and methodologies common to site investigations performed by Tetra Tech for specific project areas under the guidance of the Natural Resource Damage Program (NRDP).

1.1 BACKGROUND

In 1983, the State of Montana filed a lawsuit in federal District Court against the Atlantic Richfield Co. (ARCO) for injuries to the natural resources in the Upper Clark Fork River Basin, which extends from Butte to Milltown, Montana. The Montana v. ARCO lawsuit, brought under federal and state Superfund laws, sought damages from ARCO, contending that decades of mining and smelting in the Butte and Anaconda areas had greatly harmed natural resources in the basin and deprived Montanans of the use of these resources.

The state settled Montana v. ARCO through a series of settlement agreements, or consent decrees, completed and approved by the court in 1999, 2005 and 2008. One of the three injured areas in the Upper Clark Fork River Basin covered under the 2008 settlement agreement was the Butte Area One (BAO) injured groundwater and surface water site.

The 2008 Montana v. ARCO Consent Decree allocated $28.1 million, plus interest, to restore, replace or acquire the equivalent of the injured groundwater and surface water of BAO. Then-Governor Schweitzer created the Butte Natural Resource Damage Restoration Council (BNRC) to give the citizens of Butte a strong voice in how this fund should be spent. The nine member volunteer council, with assistance from the NRDP, developed the 2012 Butte Area One Final Restoration Plan (BNRC 2012) to guide the expenditure of these funds. It was approved by the governor in January 2013.

Injury to groundwater in BAO has been demonstrated by the occurrence of concentrations of contaminants (including cadmium, zinc, iron, lead, copper, arsenic and sulfate) that exceed drinking water standards in the alluvial aquifer. The areal extent of the known contamination above drinking water standards of the alluvial aquifer is about one square mile and extends from the Parrot Tailings area down gradient along the SBC channel. The highest known concentrations of dissolved contaminants in groundwater coincide with wastes from the Parrot

Tailings area and the BRW. Other waste areas known as the Diggings East and Northside Tailings also contain waste materials that are leaching contaminants into the groundwater which discharges to adjacent surface waters. In Lower Area One (LAO), west of Montana Street, some of the mine waste tailings were previously removed by ARCO; however, some slag, tailings, and other wastes from the BRW and Colorado Smelter remain in place and have the potential to leach contaminants to ground and surface water.

The discharge of contaminated mine wastes, groundwater and surface water to SBC and BTC in BAO results in floodplain, surface water and instream sediment contamination. Surface runoff from storms and snowmelt carry hazardous substances from waste sources to the Creeks through surface drainages and the stormwater collection system.

The BAO Plan calls for removal of mine wastes left in place along the floodplain of upper Silver Bow Creek through BAO, with an allocation of $10 million towards that removal. The BAO Plan identifies these wastes, which include the Parrot Tailings, Diggings East, Northside Tailings, and other isolated areas of mine wastes in the Blacktail and Upper Silver Bow Creek floodplains, as the primary sources supplying inorganic contaminants to the alluvial groundwater, surface water, and in-stream sediment resources within the Upper Silver Bow Creek corridor. The 2015 Preliminary Conceptual Restoration Plan (PCRP), issued by NRDP for public input in February 2015, focused on the Upper Silver Bow Creek corridor. The June 2016 draft Parrot Tailings Waste Removal Amendment addresses the removal of the Parrot Tailings waste. This technical memorandum presents results related to the BTC Berm area and historical floodplain deposits associated with the BTC and SBC riparian corridors.

1.2 SITE DESCRIPTION

BTC receives the majority of its base flow contributions from Summit Valley groundwater in Butte, Montana. The stream intersects both the BAO injured area restoration site and BPSOU, and is a focal point for past and current remediation and restoration activities. The SBC and BTC Corridors study area that is the focus of this data gap investigation extends from below the LAO boundary on lower SBC (west of Montana Street), through the BAO and the confluence of BTC, and continues upstream above the BAO along BTC to Father Sheehan Park above Harrison Avenue (**Figure 1; Appendix A**).

In 1879, the first large-scale mineral processing smelter (Colorado Smelter) was built on SBC, at the west end of the valley. Between 1879 and 1888, at least three more smelters of consequence (BRW, Parrot Smelter and Montana Ore Purchasing Company (M.O.P)) were constructed upstream of the Colorado Smelter, which significantly altered the geomorphology and hydrology of both SBC and the lower portion of BTC. A fifth smelter of consequence, the Bell Smelter, located west of present day Harrison Avenue on the north bank of BTC, was constructed in 1881; and reached a peak production of approximately 30 tons per day in 1883 (primarily silver ore). Production quickly tapered and the smelter was dismantled sometime in the early 1890s.

Water demands during this period increased dramatically, and the stream channels were altered significantly to keep up with the demand. At least three dams were constructed on upper SBC and the confluence area for tailings impoundment and water clarification. The dam at Montana Street (Weed, 1904) was constructed for settlement of tailings from upstream smelters and resulted in significant ponding on both sides of the stream.

Over time, mining and smelting waste materials aggraded in the SBC and BTC channels and floodplain, causing frequent and substantial flooding (Meinzer, 1914). In an attempt to mitigate flooding issues, berms made mostly of readily available waste were constructed throughout the confluence area. The known waste area referred to as the BTC Berm, is an historic remnant of these flood control berms.

1.3 PREVIOUS SITE INVESTIGATIONS

Data characterizing contaminated materials in the vicinity of the Blacktail berm are limited. In May 2013, the Montana Bureau of Mines and Geology (MBMG) conducted trenching, test pit, and borehole investigations in known and suspected mine waste areas of the BTC and SBC confluence in Butte (MBMG 2014a). In particular, the BTC Berm area was evaluated for contaminant concentrations and volumes of impacted sediments. This work was done to quantify the aerial extent and depth of tailings and impacted sediments. Its purpose was to provide an updated characterization and volume estimate of tailings and mining impacted sediments for the State of Montana. Five soil borings were advanced in the BTC Berm to characterize the subsurface material.

The MBMG 2014a report concluded the following:

- The BTC Berm contained tailings/impacted soils (T/IS) that exceeded criteria for constituents of concern (COC) concentrations established in the 2013 MBMG study's SAP.
- T/IS in the BTC Berm is not overlain by thick units of fill material as those at the Diggings East Tailings site. They are closer to the surface, and surficial at times.
- The majority of soil samples collected just above the water table in the BTC Berm, exceeded the COC criteria. Therefore, it was recommended that any potential future removal boundaries include soils down to the water table.
- The majority of organic silt samples met the classification of impacted sediment.
- The average concentrations of arsenic and lead in tailings samples from the BTC Berm area were comparable to the average concentrations of arsenic and lead in Parrot Tailings samples (Tucci, 2010). However, concentrations of average copper concentrations in tailings samples from the BTC Berm, as well as zinc concentrations, were greater than the average copper and zinc concentrations in Parrot Tailings samples.
- In total, T/IS and potential removal volumes for the BTC Berm was estimated at 14,000 cubic yards.

During baseflow conditions in 2011, the MBMG conducted a continuous bromide tracer injection in the BTC and upper SBC confluence area on behalf of the NRDP (MBMG 2014b). The work evaluated streamflow, chemistry, metals loading, and groundwater and surface-water interactions in a reach of stream impacted by more than a century of mining and milling related activities, land development, land use change, and streambed manipulation. The continuous tracer injection test was performed using a sodium bromide solution with a bromide concentration of 22.5 percent wt./wt. to obtain creek bromide concentrations of roughly 3 milligrams per liter (mg/L). Manual measurements of discharge were obtained at 15 sites over a total stream length of 10,500 feet using a SonTek Flow Tracker®. Steady-state conditions with respect to bromide were reached after 11 hours of injection. The tracer results were combined with synoptic sampling of main stem, tributary, and drive point piezometer data. Samples from 30 groundwater wells, 17 main stem locations, 8 tributary locations, and 5 drive point piezometer locations in the BTC streambed and two wetland sites were analyzed for bromide, common cations and anions, and 36 minor and trace analytes. The MBMG 2014b report concluded the following:

- Results from the tracer injection and manual Flow Tracker® measurements were consistent, and suggest that discharge in BTC between Oregon Avenue and George Street increased by 2.2 cubic feet per second (cfs); approximately 22 percent.
- Wetlands located adjacent to BTC received the majority (99 percent) of recharge from local groundwater sources, and contributed 39 percent of the flow increase observed in the studied reach of BTC (Oregon Avenue to George Street).
- The remaining baseflow contributions (61 percent) in BTC were groundwater inputs into the stream.
- Results of the tracer study also indicate that two reaches of BTC are non-gaining reaches, and may be net-losing reaches (MBMG 2014b). Gains in stream flow were not observed in SBC, from a point just downstream of Slag Wall Canyon at surface sample site SS-06 to the pumping vault on upper SBC.
- Results from metals loading assessments indicate that while there appears to be source areas for copper and zinc loading to the stream, concentrations of contaminants of concern (arsenic, cadmium, copper, lead, and zinc) remained below Circular DEQ-7 (DEQ 2012) acute and chronic life standards for dissolved concentrations throughout the study area (MBMG 2014).
    - Total recoverable copper and zinc concentrations were elevated in surface water samples collected from the BTC reach from near the Lexington Avenue overpass to the confluence of BTC with SBC.
    - Surface water samples collected from one main stem, one wetland, and two tributary samples exceeded Circular DEQ-7 acute and chronic life standards for total copper, while the two tributary samples exceeded Circular DEQ-7 acute and chronic life standards for total zinc.
    - The sources of total recoverable copper and zinc to this area of BTC are thought to be either bed sediment loads or nearby streambank sediment (i.e., BTC Berm) or loading from historic Grove Gulch discharges.
- Surface water samples collected from the two wetlands, located along BTC in the BTC Berm area, exhibited water quality with elevated concentrations of copper and zinc. Both of the wetlands contributed measurable flow into BTC and are potential point sources.
- Concentrations of contaminants in the groundwater that recharges the wetlands near Lexington Avenue were not assessed during this investigation. Therefore, groundwater entering the wetlands could not be ruled out as a potential source.

1.4 DATA GAPS

In order to fill data gaps in information concerning the extent and magnitude of T/IS and to obtain additional data necessary for integration of restoration with remedy, Tetra Tech will conduct a limited soil, surface water and groundwater investigation within the SBC and BTC Corridors focused on the following data gaps identified in the Preliminary Conceptual Restoration Plan (PCRP) (Confluence 2015):

- Further define extent and magnitude of T/IS within floodplain soils to assess waste areas and depths;
- Characterize the near-surface aquifer to quantify construction dewatering requirements;
- Evaluate COCs in the in-stream and pond sediments, surface water and the stream banks within the SBC and BTC Corridors to identify potential contaminant loading;
- Collect additional groundwater quality data to define the extent of alluvial impacts and their potential impacts on post-restoration groundwater and surface water quality; and
- Evaluate metals loading from alluvial aquifers to SBC and BTC riparian corridors.

2.0 PURPOSE AND OBJECTIVES

The purpose and objectives of the SBC and BTC Corridors investigation are to:

- Evaluate surface water, in-stream and pond sediment, and floodplain soils in areas within the SBC and BTC Corridors that were not previously investigated;
- Confirm the lateral and vertical extent of the contamination that may require remedial action(s);
- Complete groundwater monitoring of selected monitoring wells to gather pre-construction aquifer and groundwater quality data; and
- Evaluate contaminant loading to SBC and BTC riparian corridors.

In order to meet the site investigation purpose and objectives, this SAP was developed to address data gaps and obtain and analyze data to make sound decisions regarding the restoration efforts within the SBC and BTC Corridors. Section 3.0 presents the Field Sampling Plan (FSP). The FSP presents the sampling approach, procedures, instrumentation, and analytical requirements for each location and media that will be sampled. Soil sample results will be compared to Streamside Tailings Operable Unit (SST OU) field screening criteria. The SST OU is adjacent to BPSOU, addressing SBC after it leaves BPSOU. Surface water quality sample results will be compared to Montana Department of Environmental Quality Circular DEQ-7 standards. In-stream and pond sediment pore water samples will compared to DEQ-7 surface water and groundwater standards. Sediment sample results will be compared to the EPA Region 3 Biological Technical Advisory Group (BTAG) Freshwater Sediment Screening Benchmarks, which serve as a Tier 1 screening tool to indicate if sediment contaminant concentrations may indicate potential adverse effects. Montana is located within EPA Region 8, which currently has no sediment screening numbers and uses many of the same reference values relied upon by Region 3 BTAG. Groundwater sample results will be compared to DEQ-7 groundwater standards.

The site-wide QAPP (**Appendix B**) defines the data quality objectives (DQOs) for this and similar projects that are and will be conducted for NRDP for BAO and related work. **Appendix B** also presents the project-specific Health and Safety Plan. The Health and Safety Plan and QAPP will be updated, as needed to reflect the work being conducted on future projects within the BAO and related areas.

3.0 FIELD SAMPLING PLAN

This section of the SAP is intended to function as the FSP. Under the direction of NRDP, Tetra Tech will ensure a coordinated and efficient field data collection effort. Tetra Tech will be responsible for coordinating all aspects of field data collection as well as providing NRDP with site information and data.

The primary information covered in this section of the SAP for the data gap investigation at the SBC and BTC Corridors is focused on four environmental media: mine waste/soil, stream bed sediments, surface water and groundwater. Field methods covered in the FSP include the following: soil and mine waste sampling, monitoring well installation, well development, sediment sampling, surface water sampling and groundwater sampling. Detailed descriptions of sample designation, sampling methods, field note taking, completing field forms, sample packaging, sample shipment, equipment decontamination, field and laboratory quality assurance/quality control (QA/QC), surveying/GPS, and data management are also described.

3.1 FIELD NOTES

All field observations will be recorded in project-dedicated field notebooks in accordance with Tetra Tech's SOP-12 (Sample Documentation) **(Appendix B)**. The standard project field books used by all personnel will be the equivalent of the pocket-sized "Rite in the Rain"® All-weather Transit Notebook No. 301 (4-5/8 x 7" with numbered pages). Each field book will be labeled on the front cover with the project name, beginning entry date, final entry date, and general contents of notes (for example, groundwater sampling).

The field team leader is responsible for recording information such as weather conditions, field crew members, visitors to the site, samples collected, the date and time of sample collection, procedures used, any field data collected, problems encountered in the field, and any deviations from this SAP. The field notebook will be the master log of all field activities. As such, in addition to standard field notations (such as field conditions, date, time, weather, field personnel, sample station number), information entered into the field notebook will include the number and type of measurements taken, the location and types of data recorded by another means (field forms, data recorder, or portable computer), the number of samples collected each day, sample packaging and shipping summaries (number and type of shipping containers, shipping carrier, date and time of shipment), and any other information relevant to the field event.

3.2 SURVEY AND GPS DOCUMENTATION

Soil boring locations and installed aquifer test wells will be surveyed by a licensed surveyor registered in the State of Montana as defined under Title 37, chapter 67, Montana Codes Annotated. The vertical elevation will be based on the National Geodetic Vertical Datum of 1929 as referenced from a nearby U.S. Geological Survey marker, U.S. Coast and Geodetic Survey marker, or other similar marker if available. The horizontal survey will be based off of the NAD 1983 horizon datum. The vertical survey of the monitoring wells themselves must be accurate to the Fourth Order Class A (0.10 feet x square root of total distance of level loop in miles) with a measurement precision of 0.01 feet.

All test pit excavations, existing monitoring well sample locations, surface water and pore water sample locations, stream bank and opportunity sample locations, stream bed and wetland pond sediment sampling locations will be marked with a hand-help GPS device with other pertinent information recorded in the project field book(s).

Field personnel will place a stake at each sampling location. The stake will be marked on both sides in indelible ink and survey flagging. The location will also be surveyed using a Trimble GeoXT handheld global positioning satellite (GPS) receiver so that the locations can be located for future work. Field personnel will allow the GPS unit to receive 8 to 10 location readings (at the corner points if a polygon area such as a test pit) before recording the location. The GPS unit will be set to record latitude and longitude. Field personnel will also photo-document each soil boring, test pit, the co-located surface water,pore water and sediment collection location and monitoring well location. Each photograph number and description will be documented in the field book.

3.3 MINE WASTE, SOIL AND STREAM BANK SAMPLING

This section describes borehole sampling and analysis procedures that will be used to gather data during this data gap site investigation. Mine waste and soil samples will be obtained from test pits and direct push technology (DPT) borings. Field work will commence with field personnel staking the proposed test pit locations and coordinating a utility locate request to Montana One Call (811) prior to the start of intrusive activities. Utility location coordination and site access notification will comply with the signed access agreements between Montana Department of Justice and property owners.

3.3.1 Test Pits, Stream Bank, and Opportunity Samples

The following investigation locations are proposed:

- Up to 15 test pit locations will be excavated in the BTC Berm area (**Figure 2A**);
- Up to 15 test pit locations excavated at Butte Silver Bow property at the park area west of the BTC Berm and the Butte Reduction Works/Butte Silver Bow Asphalt Plant (**Figure 3**); At the time of this draft revision, NRDP is still considering this optional scope of work task.

- Up to 9 stream bank samples collected by hand excavation using stainless steel hand trowels from the 0- to 12-inch depth interval within the BTC Berm area. The sample locations are approximately distributed along the BTC in this area. Samples will be collected from materials such as the bank materials exposed along the walking path, creek and areas that may be difficult to access with an excavator or DPT rig. Field personnel will document which bank the sample was collected from; northern (N), southern (S), eastern (E) or western (W). (**Figure 2A and 2B**).
- Up to 10 opportunity sample test pit, DPT or hand sample locations along the remainder of the BTC corridor (**Figure 2B**). The opportunity samples may be excavated in the upper reach of BTC between Oregon Avenue and Harrison Avenue. Sample collection will be based on field observations of surrounding soils during stream sediment sampling discussed below (Section 3.4). In the event the field crew observes potential mine waste deposits coincident with stream bed sampling, samples may be collected to obtain representative samples of the material. Indications of mine waste material may include minimal or complete lack of vegetation, textural differences, etc. Potential mine waste material will be confirmed with an XRF prior to committing to sample the location.

It is anticipated that the depth of excavation for test pits will extend from ground surface down through extent of mine waste, tailings deposit and impacted soil (IS) to at least the water table. Based on well logs completed in the areas of this site investigation, depths could extend from 15 to 20 feet bgs. The media proposed for sampling in each test pit includes near surface materials (overburden/fill, slag fill, native alluvium, or wetland sediments); tailings/mine waste; organic silt/clay (native soil horizon); and alluvium.

It is anticipated that a single sample from each stream bank sample location (to be collected using stainless steel hand trowels from the 0 to 12 inch depth interval) will suffice to confirm the presence of mine waste or tailings along the banks. It is anticipated that up to two grab samples will be collected from each opportunity sample location (one sample from the mine waste/IS and one of the underlying unimpacted material) as collected via either test pit, DPT, or hand sample collection (stainless steel hand trowels). Stream bank and opportunity samples will be analyzed for the same constituents as the soils collected from test pit excavation.

Select samples from test pits and opportunity samples will be field prepared and analyzed using an XRF. Section 3.3.3 discusses XRF field analysis. Section 3.3.4 presents a list of required analyses and methods. Below are specific requirements for test pit, stream bank and opportunity samples.

Grab samples from each of the major lithology types (up to four, if present) in each test pit, DPT, or opportunity sample, and stream bank samples will be will be submitted to Energy Laboratories, Inc. (ELI) in Helena, Montana for analysis.

A select group of soil samples (from each major lithologic unit, from up to 40 test pits, 9 stream bank, and 10 opportunity sample locations) will be analyzed for Synthetic Precipitation Leaching Procedure (SPLP) of metals arsenic, cadimium, chromium, copper, iron, lead, manganese, mercury and zinc. These samples will also be analyzed for acid base accounting (ABA), net acid generating potential (NAG-pH), saturated paste EC and pH, and TOC. Sufficient material will be provided to the lab for the additional SPLP analysis and those samples selected for blind duplicate analysis. All splitting of field samples for duplicates and SPLP analysis will be made in the field by Tetra Tech prior to submittal to ELI.

The number of SPLP and acid-generating potential samples will be based on approximately 20 percent (29 samples) of the number of total metals sampled (149 natural samples) and will consist of a minimum of two samples per lithologic unit; the remaining count of SPLP and acid generating potential samples will be discretionary to be decided by the field geologist/geochemist logging with the XRF. Selection of the investigation samples that receive SPLP analysis will be based on the number of soil screening criteria that are exceeded, lithology, the XRF concentration of metals that exceed those criteria, XRF sulfur content of those samples, and site observations.

3.3.2 DPT Borings

Wetland sediment and subsurface soils will be collected using a DPT rig at three locations within the footprint of the 9.5-acre wetland area between the I-90 right of way and BTC as indicated on **Figure 2A**. The extent of contamination will be identified using laboratory analysis for metals. Boring locations were selected in areas not previously investigated, either laterally or vertically and are intended to investigate wetland sediment and underlying materials associated with the large pond south of the BTC Berm and north of the interstate right-of-way. In the event a sampling location is inaccessible because of drilling refusal, a new nearby location will be chosen and an attempt will be made to advance another borehole to the target depth pertinent to the sample location.

The primary activities associated with this FSP for mine waste and soil sampling in borings includes:

1. Identify, locate, and clearly mark soil boring locations according to the borehole numbering system presented in Section 3.3.1.1. Each location will get pre-cleared to drill by an on-site utility locator. Final drilling locations will be approved by the project management team;
2. Drill and log borings advanced with the DPT rig and characterized by subsurface soil with respect to previous investigation lithologic descriptions (overburden/fill, black slag, yellow/orange (oxidized) tails, black (reduced) tails, black silt/clay layer (native soil horizon), sand and gravel alluvium);
3. If present, document the approximate depth to groundwater in each of the soil borings;
4. If present, document the thickness of tailings material;
5. Sieve a small portion of each potential sample material type to a No. 10 mesh in preparation of XRF analysis. Analyze soil samples using a field XRF analyzer to screen which samples will be analyzed for total metals, SPLP, ABA, and NAG pH;
6. Analyze soil samples for metals, nitrate content, saturated paste pH/electrical conductance (EC) and total organic carbon (Section 3.3.5);
7. Analyze select soil samples for SPLP, NAG pH and ABA;
8. Construct shallow groundwater sample points (piezometers) in each borehole and develop with surge block/bailer until relatively clear of sediment; and
9. Archive remaining samples.

Continuous DPT boring soil samples will be collected using open-barreled samplers lined with new disposable Lexan liner over 2-foot intervals to an estimated depth of 25 feet bgs. Samplers from each sample interval will be opened and percentage recovered noted in the field book and drilling log and photographed with horizontal scale. Borehole depths will be determined by a combination of field XRF screening, visual observations and the ability of the equipment to advance the boring. The total depth of the boring and sample collection will be dependent upon the material encountered, relative metals content (via XRF screening results), and the depth to groundwater.

Boreholes will be advanced at depth until one of the following conditions is met:

- Field XRF screening results for unsaturated native alluvium (sands, sand and gravel mixtures) underlying the black silt/clay marker layer (native soil horizon) “pass” or are less than the initial screening criteria as described in Section 3.3.4;
- The borehole intersects saturated native alluvium (sands, sand and gravel mixtures) underlying the black silt/clay marker layer (native soil horizon) and extends the requisite depth into the water table sufficient to install a 5-foot piezometer screen; or
- The boring cannot be advanced any further due to lithologic or equipment limitations.

DPT samples will be treated as soil samples not sediment samples; meaning they will be screened to a No. 60 mesh by the laboratory for all extractable metals except mercury, which will be screened by the laboratory to a No. 10 mesh screen prior to analysis. A portion of the DPT core samples will be screened with an XRF in the field, similar to test pit soil samples; requiring a field screen of the material to a No.10 mesh.

Up to five samples (one for each potential material type in each borehole, including native alluvium), will be selected for submittal to ELI for laboratory analysis (Section 3.3.5). A select group of soil samples (from each major lithologic unit) will be analyzed for SPLP analysis of metals. These samples will also be analyzed for ABA, NAG-pH, saturated paste EC and pH, and TOC. The number of SPLP and acid generating potential samples will be based on approximately 20 percent (3 samples) of the number of total metal samples analyzed (15 natural samples). Selection of the investigation samples that receive SPLP analysis will be based on the number of soil screening criteria that are exceeded, lithology, the XRF concentration of metals that exceed those criteria, the XRF sulfur content of those samples, and site observations.

3.3.3 Sample Designations

3.3.3.1 Mine Wastes

Mine waste and soil samples will be designated by the letters "SBC- or BTC-", for the Silver Bow Creek and Blacktail Creek riparian corridors, "AP-" for Butte Reduction Works Asphalt Plant area, and "PK-" for BSB Park area immediately west of the BTC Berm area; followed by the letters "TP-" for test pits, "DPT-" for DPT soil borings, and "HS-"for hand sampled locations; followed by the boring number; then the sampling interval in feet in parentheses; and finally by the soil media descriptor. Recognized soil media types include but are not limited to:

- Overburden/Fill (OB/FILL);
- Wetland Sediment, organic silt/clay or peat (WS);
- Slag Fill (SLAG);
- Tails/Impacted Soil, yellow/orange oxidized (YT/IS);
- Tails, black/grey reduced (BT/IS);
- Black Clay/Silt or equivalent (brown clay/silt) (BC); and
- Sand and gravel alluvium (AL).

Some of the recognized lithology types maybe combined later for simplicity purposes for estimating in-place removal volumes or when more refined descriptive terms are unwarranted or non-apparent such as color distinction.

An example of this designation scheme for a soil boring is BTC-DPT-01(5-6')-OB. This example sample would be collected from the overburden or fill unit in the first boring at the BTC corridor area, collected from a depth of 5 to 6 feet below ground surface.

3.3.3.2 Stream Bank

Tetra Tech will collect soil samples from a minimum of nine (9) hand-excavated locations along the stream bank in the BTC Berm area (**Figure 2A**). Stream bank samples will be designated by the letters "BTC-", for Blacktail Creek riparian corridor; a stream bank sample designation "SBS-"; followed by consecutive numbers of the sample beginning with 01, then bank location - northern (N), southern (S), eastern (E) or western (W), and lastly followed by the sample interval (measured in inches, as appropriate). In most cases the stream bank samples will be collected from 0- to 12-inch depth interval. For example, the stream bank sample obtained from the first sample location along the northern bank of BTC at the sample interval of 0 to 12 inches would be designated as BTC-SBS-01N (0-12").

3.3.3.3 Opportunity Samples

Field personnel will use their discretion as to which of the above two types of sample designations are required for each opportunity sample collected.

3.3.4 XRF Field-Screening Protocol

Materials from each sample location (except stream bed and wetland pond sediment samples) will be field-screened using a portable Niton XL 3T XRF analyzer in accordance with EPA Method 6200 (**Appendix B**). The method provides procedures for both in-situ readings (direct from split spoon) and field-prepared sample readings. The in-situ field XRF screening method will be used. The same XRF soil screening criteria utilized in previous BAO site investigations and Streamside Tailings OU SAP will be used in this data gap investigation (Pioneer 2011).

Samples will be placed on a clean sheet of butcher paper or clean plastic sheeting in as intact a manner as possible. Sample documentation will follow procedures outlined in Section 3.2 and SOP-12. Samples will be oriented so that depth and direction can be readily determined. This procedure will be repeated for each sample interval.

Samples of distinct material type will be collected and sieved in the field with a No. 10 mesh sieve and field-analyzed for select metals (arsenic, cadmium, copper , chromium , iron, lead, manganese, mercury, zinc) and sulfur content using a handheld X-ray fluorescence (XRF) detector. Field screening results will be compared to the values in **Table 1**, below, to aid in selection of samples submitted for laboratory analyses. Cadmium and mercury will be evaluated based on zinc and lead concentrations, respectively (Pioneer 2011). The XRF analytical results will be assigned “pass”, “uncertain”, or “fail” for each of the six COC. Results are assigned a “pass” if the XRF concentration is below the lower 95 percent confidence limit concentrations, “fail” if the concentration is above the upper 95 percent confidence limit concentrations, and “uncertain” if the concentration is between the upper and lower 95 percent confidence limit concentrations.

Table 1. Field XRF[1] Sample Screening Criteria

COC[2]	Soil Screening Criteria[3] (mg/kg)[4]	XRF Pass Criteria (mg/kg)	XRF Failure Criteria (mg/kg)	XRF Ceiling Criteria (mg/kg)
Arsenic	200	< 160	> 241	958
Cadmium	20	Zinc < 1,390	Zinc > 3,020	NA
Copper	1,000	< 620	> 1,240	1,650
Lead	1,000	< 804	> 1,090	2,220
Mercury	10	Lead < 883	Lead > 1,600	NA
Zinc	1,000	< 545	> 1,330	2,100

[1] x-ray fluorescence
[2] COC=Contaminants of Concern
[3] Soil screening criteria utilized in previous BAO site investigations from *Field Screen Criteria and Procedures Phase 7 and * Remedial Action, SST OU Subarea 4, Reaches R and S* (Pioneer 2011);
[4]mg/kg = milligrams per kilogram

If four of the six COCs pass the field-screening criteria listed in **Table 1**, the sample will be considered to be above the top or below the base of T/IS or to be outside the lateral extent. If three of the six COCs exceed the “failure” criteria listed in **Table 1**, the sample will be considered to be T/IS (fail). Sample screening criteria will be applied to field-identify the base and lateral extents of T/IS and will aid in the selection of laboratory sample selections.

3.3.5 Laboratory Analysis Sample Selection

Upon completion of field-XRF screening each borehole, test pit, and hand sample location sample will be selected for laboratory analysis based on pass or fail criteria established in Section 3.3.3. The total metals method and analysis will provide a means to correlate total metals as determined by the lab and total metals measured with a field XRF. A few samples will be selected from each material type that are clean of mine waste or impacted soils in order to provide good correlation across a range of values for XRF screening results, total metals, and SPLP results.

Samples that are selected for laboratory analysis will be analyzed by ELI for the constituents in **Table 2** (total metals, nitrate as nitrogen saturated paste pH/electrical conductance (EC), and TOC).

3.3.5.1 Sample Collection and Preparation

All soil and mine waste samples will be collected according to SOP-22 (Soil Sample Collection); with the exception that the laboratory will perform the sample sieving prior to analysis (**Table 2**). All samples will be placed in a cooler and chilled to <4°C using doubled re-sealable bags filled with ice. All samples selected for laboratory analysis will be containerized in clean laboratory-supplied sample jars or in clean heavy duty zip-loc baggies.

Approximately half of the material in the XRF field screening bags will be kept for additional laboratory testing (ABA, SPLP, and NAG pH) or, if not analyzed, will be archived as described in Section 3.3. Up to four samples from each test pit (up to 120 samples in total, assuming the 15 optional test pits for the Aphalt Plant and BSB Park are completed), up to five samples from each DPT borehole (up to 15 samples in total), nine bank samples, and up to two sample intervals from opportunity samples (up to 20 samples), for a total of 164 natural samples will be submitted for laboratory analyses for total metals, nitrate, pH, and TOC.   Up to 32 samples (20 percent of the total metals samples from the test pits and DPT borings) will be analyzed for SPLP, ABA, NAG, saturated paste pH, and EC.

At a minimum, each soil type described above will be analyzed for SPLP, ABA, NAG at least once; otherwise, leaching analysis for samples will be selected based on the results of XRF screening, observations of the materials encountered and borehole conditions, and professional judgement. It may be necessary to repeat the boring location and depth intervals for the DPT sampling in order to get enough material for the SPLP analysis. It is the intent that the distribution of the proposed soil boring locations will allow some SPLP and total metals samples to be collected from depths and locations on the site that have been minimally affected by releases of the contaminants being assessed. This will maximize the likelihood that the SPLP results versus the corresponding total metals concentrations will provide a sufficient scatter of data points allowing for clear interpretation of where the leachability threshold exists. As a matter of professional judgment, other sampling intervals may be appropriate depending on site-specific conditions and will take into account soil profile characteristics that are expected to influence the retention or concentration of contaminants.

3.3.5.2 Soil Laboratory Analysis

All solid sample laboratory results will be reported as per dry weight analysis. Each sample will be analyzed for the constituents listed in **Table 2**.

Table 2. Soil & Mine Waste Analytical Methods

Parameter	Method[1]	PQL[2]
Screen to 60 mesh (250 micron) on all extractable metals (except Hg) and SPLP metals	Standard Laboratory Procedure	
Screen to 10 mesh (2000 micron) on all mercury extractables	Standard Laboratory Procedure	
Saturated Paste pH & Electrical Conductance and Electrical Conductivity	MSU Modified Sobek Procedure & MSU Electrical Conductivity Procedure	s.u. & mmhos/cm
Total Organic Carbon	Leco (ASA 29-2)	0.1%
Metals by ICP/ICPMS, Total		
Total Arsenic	[3]SW-846 6010B/6020	1 mg/kg
Total Cadmium	[3]SW-846 6010B/6020	0.5 mg/kg
Total Copper	[3]SW-846 6010B/6020	2.5 mg/kg
Total Chromium	[3]SW-846 6010B/6020	1 mg/kg
Total Iron	[3]SW-846 6010B/6020	10 mg/kg
Total Lead	[3]SW-846 6010B/6020	1 mg/kg
Total Manganese	[3]SW-846 6010B/6020	1.5 mg/kg
Total Zinc	[3]SW-846 6010B/6020	6 mg/kg
Mercury in Solids by CVAA	SW7471B	0.5 mg/kg
Nitrate as Nitrogen, KCL extract	ASA 33-8	1 mg/kg
Digestion, Mercury by CVAA	SW7471B	
Digestion, Total Metals	SW3050B	
ADDITIONAL ANALYSES – ABA, NAG pH and SPLP analyses will be performed on select samples of the soil and mine waste		
Acid-Base Potential w/ Sulfur Forms	Sobek	0.01 t/kt
NAG pH	Miller & Donahue	kg CaCO3/t
Mercury, SPLP	SW7470A extraction/ EPA 245.1	0.00005** mg/L
Metals by ICP/ICPMS, SPLP		
Arsenic	[3] EPA 200.7/200.8	0.001* mg/L
Cadmium	[3] EPA 200.7/200.8	0.00003* mg/L
Chromium	[3] EPA 200.7/200.8	0.01* mg/L
Copper	[3] EPA 200.7/200.8	0.002* mg/L
Iron	[3] EPA 200.7/200.8	0.02* mg/L
Lead	[3] EPA 200.7/200.8	0.0003* mg/L
Manganese	[3] EPA 200.7/200.8	0.015 mg/L
Zinc	[3] EPA 200.7/200.8	0.008* mg/L
Preps for SPLP Metals		

Parameter	Method[1]	PQL[2]
Lime Percentage	USDA23c	
SPLP Extraction, Regular	SW-846 1312	

Note: XRF Screening will compare results to SST OU Soil Screening Criteria (Table 1)

1. USDA Handbook 60 - Diagnosis and Improvement of Saline and Alkali Soils (USDA, 1954)
Sobek - Field and Laboratory Methods Applicable to Overburdens and Mine Soils (EPA, 1978)
Miller & Donahue - Advances in Acid Drainage Prediction using the Net Acid Generation (NAG) Test, ProcInternational Conference on Acid Rock Drainage, Vancouver, BC, 0533-549.
ASA- Methods of Soil Analysis - American Society of Agronomy, Parts I and II. Monograph No. 9 (1982)
SW-846 Method 6010- Inductively Coupled Plasma-Atomic Emission Spectrometry, Test Methods for Evaluating Waste-Physical Chemical Methods (EPA, 1986)
SW-846 Method 6020- Inductively Coupled Plasma-Atomic Emission Spectrometry, Update 5, Revision 2, (EPA, 2014)

2. PQL = Practical quantitation limit (reporting limit)

3. For the metals analysis ELI runs 6010B and 6020 and EPA200.7/200.8 concurrently. By doing this it allows ELI to evaluate the analyte, concentration and performance of the analyte to provide the lowest reporting limit possible. ELI is able to evaluate the duplicate data from both methodologies and the analyst reports the data based on concentration and evaluate for any potential interferences. ELI finds this approach allows the laboratory to better meet project objectives.

* Required reporting value (RRV) is the Montana DEQ's selection of laboratory reporting limit that is sufficiently sensitive to meet the most stringent numeric water quality standard.

** The RRV set by Montana DEQ is unattainable using the standard methods employeed by Montana laboratories. The surface water numeric water quality standard (0.05 µg/L) and the groundwater numeric water quality standard (2 µg/L) will be substituted for the RRV, respectively

3.4 STREAM SEDIMENT AND WETLAND POND SEDIMENT SAMPLING

3.4.1 Stream and Wetland Pond Sediment Sample Locations

Tetra Tech will collect stream sediment samples at 18 co-located sediment and surface water stations.

Stream Sediment:

- Stream sediment sample locations will be sampled from two depths; 0- to 12-inches below the base of the stream channel and from 24- to 36-inches below the base.
- Stream center at 16 sediment sample stations on SBC and BTC: Collect stream sediment samples from the central portion of the stream at 16 stations. Stream sediment samples will be taken from the approximate centerline of the stream channel (the same location as the associated surface water sample).
- Northern and sourthern banks at two (2) of the stream sediment sample stations: Two (2) stream sediment sample stations, one on the main stem of SBC and one on the main stem of BTC will be randomly selected for collection of co-located sediment samples with pore water samples. The two locations will include collection of samples from sediment nearest to the south bank and one sample collected nearest to the north bank and collected adjacent to the pore water sample location (Section 3.6.3). Sediment sample depths will correspond with the pore water sample depths of 12 and 36 inches below the top of the bed sediment (see below).

  The two (2) co-located sediment and pore water stations amount to approximately 10 percent of the stream sediment locations and is intended to provide a mesure of chemical variability in stream sediments across the stream channel.
- Tributary sediment samples at two (2) stream sediment sample stations on Grove Gulch and Sand Creek: Because these two tributaries are narrow, sediment will only be collected from one station location placed just upstream from the mouth on the tributary channel in a location that is accessible to the field sampling crew.

Wetland Sediment:

Field personnel will collect wetland pond sediment from three wetland ponds (**Figures 2A and 2B**). These include:

- The approximately 3-acre wetland and pond area located between the BTC Berm and the I-90 right-of-way;
- The wetland pond located adjacent to the KOA campground north of BTC and west of Lexington Avenue (one pond sediment location); and
- The wetland pond located east of Lexington Avenue and north of BTC (one pond sediment location).

The sediment samples will be co-located with the surface water sample and pore water sample location. Pond sediment samples will be collected from a wadeable section of the pond where the AMS™ probe can be extended into the pond sediment in a safe and practical manner. Sediment samples will be collected from the 0- to 12-inch and 24- to 36-inch depth intervals.

3.4.2 Sediment Sample Method

All sediment sample locations will be documented with a labeled wooden stake with survey flagging and the coordinates recorded with a hand-held GPS device, and the depth of water noted in the field log.

Stream sediment and pond sediment samples will be collected using an AMS multi-stage sludge and sediment sampler. Sediment samples will be collected from the 0- to 12-inch and 24- to 36-inch depth intervals at each sample location. Several sample attempts at each stream sediment sampling location may be necessary depending on the stream bed substrate, ease of penetration, and amount of material available for sample analysis after screening the coarse size fraction out to collect sufficient sample volume for laboratory analysis.

Stream and pond sediment samples will be screened by the laboratory as received (i.e. wet) to a No. 230 mesh (<63 µm) fraction for metals analysis prior to drying for moisture content and extraction. All other sample preparation procedures performed by the laboratory will follow the prescribed method for each sample type.

It is important to note that extra material for each stream sediment sample will be required in order for the laboratory to have sufficient sample volume post-screening. It is estimated that <u>at least</u> 1,000 cubic meters (cm^3) (approximately 1 gallon size re-sealable bag) of wet sediment will be needed per sediment sample for laboratory sieving and metals extraction. Extra stream and pond sediment materials will also be collected for the SPLP analysis at a frequency of approximately 20 percent (9 SPLP stream and pond sediment samples) of the total metals stream sediment samples (46 samples total). Also note that stream and pond sediment samples will not be field screened with an XRF.

3.4.3 Sample Designations

3.4.3.1 Stream Sediment Designations

Stream sediment samples will be designated by the letters “SBC-, BTC-”, for either Silver Bow Creek or Blacktail Creek Corridors area, “GG-“ for Grove Gulch, and “SC-“ for Sand Creek; followed by a stream sediment “SS-” designation; followed by a consecutive number beginning with 01 at the furthest downstream sampling location (the next stream sediment and surface water sampling location upstream from that point will be 02, followed by 03, and so on sequentially); followed by a depth interval designation (in inches).

For example, the first stream sediment sample (location nearest monitoring well FP98-1) collected from a depth interval of 0 to 12 inches below the stream bed surface (**Figure 2A**) will be designated SBC-SS-01 (0-12”). Stream sediment locations will be located with a hand-held GPS device and the depth of the stream channel noted in the field log.

Samples collected from the co-located pore water locations near the stream edges will also include designations to distinguish whether the sample was collected from the northern (N) or southern (S), eastern (E), or western (W) banks, which will be determined by viewing the location on site maps. The designation will also include the sample depth interval (0-12") or (24-36"). For example, a co-located sediment sample with pore water sample, collected from adjacent to the northern bank of SBC and from the 0- to 12-inch depth interval at station 01 would have the designation of SBC-SS-01N (0-12").

3.4.3.2 Wetland Area and Wetland Pond Sediment Designations

The DPT wetland area sediment samples will be designated by the letters " BTC-", for Blacktail Creek area; followed by a wetland sediment designation "WS-"; followed by a consecutive sample number starting with "01" followed by the sample depth interval (measured in feet). For example the first DPT wetland sediment sample location from the 9.5-acre wetland area located south of the BTC Berm area collected from a depth interval of 4 to 6 feet below ground surface (bgs) will be designated as BTC-WS-01(4-6').

Pond sediment samples will be collected with the same device as the stream sediment samples (AMS multi-stage sludge and sediment sampler). The pond sediment samples will be designated by the letters "PS-"; followed by a consecutive sample number starting with "01" followed by the depth interval (measured in inches). For example the second pond sediment sample location in the small wetland north of Blacktail Creek, west of Lexington Avenue, and adjacent to the KOA, collected at a depth interval of 24 to 36 inches below the base of the pond bottom would be designated as BTC-PS-02(24-36"). Pond sediment samples will be co-located (if possible) with pond sediment interstitial pore water sampling and collected from the same associated depths.

3.4.4 Laboratory Analysis

Stream sediment and wetland pond sediment samples will be analyzed for total metals (arsenic, cadimium, chromium, copper, iron, lead, manganese, and zinc), nitrate as nitrogen, saturated paste pH/ EC, and TOC (**Table 3**). There will also be a SPLP analysis of these same metals (arsenic, cadimium, chromium, copper, iron, lead, manganese, and zinc), for for ABA, and NAG pH. Table 3, below, specifies the laboratory analytical requirements.

Table 3. Stream and Wetland Pond Sediment Analytical Methods

Parameter	Method(1)	PQL(2)
Screen to 230 mesh (63 micron) on all extractable metals and SPLP metals as received (i.e. wet)	Standard Laboratory Procedure	
Screen to 60 mesh (250 micron) on all other laboratory analytes as per the method as necessary	Standard Laboratory Procedure	
Saturated Paste pH & Electrical Conductance and Electrical Conductivity	MSU Modified Sobek Procedure & MSU Electrical Conductivity Procedure	s.u. & mmhos/cm
Total Organic Carbon	Leco (ASA 29-2)	0.1%
Metals by ICP/ICPMS, Total		
Total Arsenic	(3)SW-846 6010B/6020	1 mg/kg
Total Cadmium	(3)SW-846 6010B/6020	0.5 mg/kg
Total Copper	(3)SW-846 6010B/6020	2.5 mg/kg
Total Chromium	(3)SW-846 6010B/6020	1 mg/kg
Total Iron	(3)SW-846 6010B/6020	10 mg/kg

Parameter	Method(1)	PQL(2)
Total Lead	(3)SW-846 6010B/6020	1 mg/kg
Total Manganese	(3)SW-846 6010B/6020	1.5 mg/kg
Total Zinc	(3)SW-846 6010B/6020	6 mg/kg
Mercury in Solids by CVAA	SW7471B	0.5 mg/kg
Nitrate as Nitrogen, KCL extract	ASA 33-8	1 mg/kg
Digestion, Mercury by CVAA	SW7471B	
Digestion, Total Metals	SW3050B	
ADDITIONAL ANALYSES – ABA, NAG pH and SPLP analyses will be performed on select samples of the soil and mine waste		
Acid-Base Potential w/ Sulfur Forms	Sobek	0.01 t/kt
NAG pH	Miller & Donahue	kg CaCO3/t
Mercury, SPLP	SW7470A extraction/ EPA 245.1	0.00005** mg/L
Metals by ICP/ICPMS, SPLP		
Arsenic	EPA 200.8/A3114B	0.001* mg/L
Cadmium	(3) EPA 200.7/200.8	0.00003* mg/L
Chromium	(3) EPA 200.7/200.8	0.01* mg/L
Copper	(3) EPA 200.7/200.8	0.002* mg/L
Iron	(3) EPA 200.7/200.8	0.02* mg/L
Lead	(3) EPA 200.7/200.8	0.0003* mg/L
Manganese	(3) EPA 200.7/200.8	0.015 mg/L
Zinc	(3) EPA 200.7/200.8	0.008* mg/L
Preps for SPLP Metals		
Lime Percentage	USDA23c	
SPLP Extraction, Regular	SW-846 1312	

Note: Stream and Wetland Pond Sediment Samples will not be screened with an XRF or compared to SST OU Soil Screening Criteria (Table 1)

1. USDA Handbook 60 - Diagnosis and Improvement of Saline and Alkali Soils (USDA, 1954)
Sobek - Field and Laboratory Methods Applicable to Overburdens and Mine Soils (EPA, 1978)
Miller & Donahue - Advances in Acid Drainage Prediction using the Net Acid Generation (NAG) Test, ProcInternational Conference on Acid Rock Drainage, Vancouver, BC, 0533-549.
ASA- Methods of Soil Analysis - American Society of Agronomy, Parts I and II. Monograph No. 9 (1982)
SW-846 Method 6010- Inductively Coupled Plasma-Atomic Emission Spectrometry, Test Methods for Evaluating Waste-Physical Chemical Methods (EPA, 1986)
SW-846 Method 6020- Inductively Coupled Plasma-Atomic Emission Spectrometry, Update 5, Revision 2, (EPA, 2014)

2. PQL = Practical quantitation limit (reporting limit)

3. For the metals analysis ELI runs 6010B and 6020 and EPA200.7/200.8 concurrently. By doing this it allows ELI to evaluate the analyte, concentration and performance of the analyte to provide the lowest reporting limit possible. ELI is able to evaluate the duplicate data from both methodologies and the analyst reports the data based on concentration and evaluate for any potential interferences. ELI finds this approach allows the laboratory to better meet project objectives.

* Required reporting value (RRV) is the Montana DEQ's selection of laboratory reporting limit that is sufficiently sensitive to meet the most stringent numeric water quality standard.

** The RRV set by Montana DEQ is unattainable using the standard methods employeed by Montana laboratories. The surface water numeric water quality standard (0.05 µg/L) and the groundwater numeric water quality standard (2 µg/L) will be substituted for the RRV, respectively

3.5 SURFACE WATER SAMPLING AND ANALYSIS

Tetra Tech proposes sampling surface water at co-located stream bed sediment stations indicated on **Figure 2A** and **Figure 2B**. All surface water sample locations will be marked with a hand-held GPS device and a description noted in the field log. Surface water samples will be obtained in accordance with SOP-03 (Surface Water Quality Sampling). For dissolved constituents, samples will be filtered through a 0.45-micron disposable in-line filter using a peristaltic pump or bailer. Sample collection will be initiated at the most downstream location then proceed in an upstream direction to avoid possible contamination of downstream samples due to upstream sampling activities. Surface water samples will be collected as follows:

Stream Samples:

- <u>Stream center at 16 surface water sample stations on SBC and BTC</u>: Collect stream water samples from the central portion of the stream at 18 stations. Stream sediment samples will be taken from the approximate centerline of the stream channel (the same location as the associated stream sediment samples).
- <u>Tributary samples at two (2) of the 18 surface water sample stations on Grove Gulch and Sand Creek</u>: Collect surface water from approximate center of the channel. The sample location on each tributary will be placed just upstream from the mouth on the tributary channel.

The surface water samples will be collected beginning on SBC near the Slag Canyon Wall and Asphalt Plant area west of Montana Street, and proceeding east to the confluence with Blacktail Creek, then continuing on Blacktail Creek from the confluence to a point just east of Harrison Avenue at the Father Sheehan Park (**Figure 2A and Figure 2B**).

One surface water sample will be obtained from Grove Gulch and another from Sand Creek immediately upstream of their confluences with BTC at locations accessible to the field sampling crew (**Figure 2B)**. Note the tributary sample locations are superimposed over the main-stem confluence sample locations and do not have their own sample location symbols on the map.

Wetland Surface Water:

Field personnel will collect wetland pond surface water from three wetland ponds (**Figures 2A and 2B**). The surface water locations will be co-located with pond sediment and pore water sample locations (Section 3.6.3). These include:

- The approximately 3-acre wetland/pond located between the BTC Berm and the I-90 right-of-way;
- The wetland pond located adjacent to the KOA campground north of BTC and west of Lexington Avenue (one pond sediment location); and
- The wetland pond located east of Lexington Avenue and north of BTC (one pond sediment location).

Three pond water samples will also be collected from each of the three principal wetland ponds along the BTC corridor (**Figure 2A**).

3.5.1 Sample Designations

Surface water samples will be labeled with the same "SBC-, BTC-, GG- or SC-" prefix, followed by either a "SW-" designation for surface water or a "PD-" designation for pond water samples, followed by a consecutive number beginning with 01 at the furthest downstream sampling location. For example, a pond water sample collected from the furthest upstream pond water sample location, which is located on the north side of BTC, and just east of Lexington Avenue overpass would be designated BTC-PD-03

3.5.2 Laboratory Analysis

All surface water samples will be collected in clean laboratory-supplied bottles in accordance with the sampling and preservation requirements shown in **Table 4**. **Table 5** summarizes surface water field parameters and **Table 6** summarizes analytical methods. Surface water samples will be analyzed for total and dissolved metals (arsenic, cadmium, chromium, copper, iron, manganese, mercury, and zinc), nitrate+nitrite, major cations and anions, and other physical parameters. Field parameters will also be determined in the field at the time of sampling and include pH, temperature, dissolved oxygen, Eh, Specific Conductivity (SC), and turbidity.

Table 4. Surface Water, Pore Water, and Groundwater Sampling and Preservation Requirements

Parameter	Preservation(1)	Bottle Size/Type
Physiochemical	Cool to 4°C	100 milliliter polyethylene
Total Metals	Cool to 4°C	250 milliliter polyethylene
Dissolved Metals	Filtered through 0.45 micron filter; HNO3 to pH < 2; Cool to <4°C	250 milliliter polyethylene
Common Cations	HNO3 to pH < 2; Cool to <4°C	100 milliliter polyethylene
Common Anions	Cool to 4°C	100 milliliter polyethylene
Nitrate/Nitrite	H2SO4 to pH <2; Cool to <4°C	500 milliliter polyethylene
Total Organic Carbon	No headspace; H2SO4 to pH <2; Cool to <4°C	125 millimeter glass

[1]HNO_3 = nitric acid

Table 5. Surface Water Field Parameters

Parameter	SOP Number(1)	SOP Title
Specific Conductance	SOP-05	Field Measurement of Specific Conductance
pH	SOP-06	Field Measurement of pH
Temperature	SOP-07	Field Measurement of Water Temperature
Oxidation-Reduction Potential	SOP-28	Field Measurement of Redox Potential (Eh)
Dissolved Oxygen	SOP-08	Field Measurement of Dissolved Oxygen

[1]Tetra Tech Standard Operating Procedures (**Appendix C**)

Table 6. Surface Water Analytical Methods

Parameter	PQL (mg/L)(1)	EPA Method No.	Max. Holding Time
Physiochemical			
Specific Conductivity	1	A2510B	28 days
pH	0.1 s.u.	A4500-H B	Upon arrival at lab
Nitrate/Nitrite	0.02*	EPA 353.2	28 days
Turbidity (NTU)	0.1	180.1/A2130B	48 hours

Parameter	PQL (mg/L)[1]	EPA Method No.	Max. Holding Time
Hardness as CaCO3	1	A2340B	14 days
Alkalinity, total as CaCO3, HCO3, CO3	4	A2320B	14 days
Acidity, total as CaCO3	1	A2310B	14 days
Total Dissolved Solids	10	A2540C	7 days
Total Suspended Solids	10	A2540D	7 days
Total Organic Carbon	2	SW9060	14 days
Total Metals			
Mercury	0.00005**	EPA 245.1	28 Days
Metals by ICP/ICPMS			
Arsenic	0.001* mg/L	EPA 200.8/A3114B	6 months
Cadmium	0.00003* mg/L	(2) EPA 200.7/200.8	6 months
Chromium	0.01* mg/L	(2) EPA 200.7/200.8	6 months
Copper	0.002* mg/L	(2) EPA 200.7/200.8	6 months
Iron	0.02* mg/L	(2) EPA 200.7/200.8	6 months
Lead	0.0003* mg/L	(2) EPA 200.7/200.8	6 months
Manganese	0.015 mg/L	(2) EPA 200.7/200.8	6 months
Zinc	0.008* mg/L	(2) EPA 200.7/200.8	6 months
Total Metals Digestion	-	EPA 200.2	-
Dissolved Metals[3]			
Mercury	0.00005**	EPA 245.1	Filter within 15 minutes/Analyze 28 days
Arsenic	0.001*	EPA 200.8/A3114B	Filter within 15 minutes/Analyze 6 months
Cadmium	0.00003*	(2) EPA 200.7/200.8	Filter within 15 minutes/Analyze 6 months
Chromium	0.01* mg/L	(2) EPA 200.7/200.8	Filter within 15 minutes/Analyze 6 months
Copper	0.002*	(2) EPA 200.7/200.8	Filter within 15 minutes/Analyze 6 months
Iron	0.02*	(2) EPA200.7/200.8	Filter within 15 minutes/Analyze 6 months
Lead	0.0003*	(2) EPA 200.7/200.8	Filter within 15 minutes/Analyze 6 months
Manganese	0.015	(2) EPA 200.7/200.8	Filter within 15 minutes/Analyze 6 months
Zinc	0.008*	(2) EPA 200.7/200.8	Filter within 15 minutes/Analyze 6 months
Common Cations[2]			
Calcium	1.0	EPA 200.7	6 months
Magnesium	1.0	EPA 200.7	6 months
Potassium	1.0	EPA 200.7	6 months
Sodium	1.0	EPA 200.7	6 months

Parameter	PQL (mg/L)(1)	EPA Method No.	Max. Holding Time
		Common Anions(2)	
Sulfate	1.0	EPA 300.0	28 Days
Bicarbonate	None	EPA 310.1	14 Days
Carbonate	None	EPA 310.1	14 Days
Bromide	0.5	EPA 300.0	28 Days
Chloride	1.0	EPA 300.0	28 Days
Fluoride	0.1	A4500-F C	28 days

1. PQL = Practical Quantitation Limit in milligrams per liter (mg/L) unless otherwise noted.
2. For the metals analysis ELI runs 6010B and 6020 and EPA200.7/200.8 concurrently. By doing this it allows ELI to evaluate the analyte, concentration and performance of the analyte to provide the lowest reporting limit possible. ELI is able to evaluate the duplicate data from both methodologies and the analyst reports the data based on concentration and evaluate for any potential interferences. ELI finds this approach allows the laboratory to better meet project objectives.
3. Surface water parameters will be analyzed for both total and dissolved constituents as filtered through a 0.45 micron filter

* Required reporting value (RRV) is the Montana DEQ's selection of laboratory reporting limit that is sufficiently sensitive to meet the most stringent numeric water quality standard.

** The RRV set by Montana DEQ is unattainable using the standard methods employeed by Montana laboratories. The surface water numeric water quality standard (0.05 µg/L) and the groundwater numeric water quality standard (2 µg/L) will be substituted for the RRV, respectively

3.6 GROUNDWATER SAMPLING AND ANALYSIS

Tetra Tech will conduct a groundwater baseline assessment at the site in order to provide water quality data relative to subsurface mine waste and soils investigation results. In addition, the baseline will provide a qualitative data set from which to monitor potential future removal and restoration efforts. Three DPT borings, described in Section 3.3.2, will be completed as piezometers. Groundwater monitoring will consist of sampling the existing monitoring wells shown below in **Table 7** and the three (3) proposed DPT piezometers. In addition to sampling monitoring wells and piezometers interstitial pore water samples will be analyzed with the same constituents as groundwater samples.

Table 7. Existing Groundwater Monitoring Wells

Well Designation		
BPS07-8A	BPS07-25	BPS07-15A
GS-29S	GS-29D	BPS07-21B
BPS07-21C	AMW-11	AMW-13A
AMW-13B	AMW-13C	AMC-23
AMC-24	AMC-24B	AMC-24C
MF-10	BPS-07-24	MF-1
BPS11-19A2	BPS11-19B	BT-98-02B
BPS07-16A	BPS07-16B	MT98-3
MT98-5	MT98-6	BT98-1
BT98-4	BT98-5	BT99-1
FP98-1B	BPS07-14A	

Groundwater sampling will involve measuring field parameters and collecting water samples for laboratory analysis. The following subsections describe these elements.

3.6.1 Piezometer Installation

This task involves completing the three DPT borings shown on **Figure 2A** as piezometers. Each piezometer will be installed according to Tetra Tech SOP-16 and State of Montana requirements, including the requirement that drillers file well logs with the Department of Natural Resources and Conservation.

Each piezometer is anticipated to be constructed of 1-inch diameter schedule 40 polyvinylchloride (PVC) with a 5-foot 0.020-inch factory-slotted well screen. Each piezometer will be completed with: 1) 10-20 silica sand to two feet above top of slotted screen; 2) bentonite seal from top of sand pack to within 1 foot of grade; and 3) a flush-grade manhole well set in concrete.

Each piezometer will be developed according to Tetra Tech SOP-17. Development water will be disposed of according to DEQ's Purge Water Disposal Flowchart. In general, since development water will not be considered a RCRA-listed or -characteristic waste as defined by EPA, development water will be land-applied in the vicinity of the well in a manner that does not cause surface water discharge or damage to vegetation near the wellhead.

In addition, each well will be surveyed by a licensed surveyor registered in the State of Montana as defined under Title 37, chapter 67, Montana Codes Annotated. The vertical elevation will be based on the National Geodetic Vertical Datum of 1929 as referenced from a nearby U.S. Geological Survey marker, U.S. Coast and Geodetic Survey marker, or other similar marker if available. Horizontal survey will be based on NAD 1983 horizon datum. The vertical survey of the monitoring wells themselves must be accurate to the Fourth Order Class A (0.10 feet x square root of total distance of level loop in miles) with a measurement precision of 0.01 feet.

3.6.2 Groundwater Sampling

Tetra Tech will complete a baseline groundwater monitoring event consisting of 32 existing wells and the three proposed DPT piezometers (Section 3.6.1) located in the SBC and BTC Corridors area (**Figures 2A, 2B, & 3**). Depth to water and total depth of each well will be gauged prior to purging and sampling the well using an electronic water level probe. In general, since purge water will not be considered a RCRA-listed or -characteristic waste as defined by EPA, purge water will be land applied in the vicinity of the well in a manner that does not cause surface water discharge or damage to vegetation near the wellhead. It may be necessary to containerize and label well sampling development water on some properties involved in this investigation, as per owner requests. If so, Tetra Tech will work with NRDP on the disposal options and documentation necessary to dispose of the investigation-derived waste water.

A number of methods can be used to collect groundwater samples, including the use of disposable hand bailers, hand pumping, and submersible pumping. The method used for groundwater sampling will depend on well depth, well completion details, accessibility and may vary from well to well. However, the preferred method of sampling will be to use a submersible pump with dedicated disposable tubing. Groundwater samples will be collected according to SOP-18 (Groundwater Sampling).

Groundwater that will be analyzed for dissolved metals will be field-filtered through a 0.45-micron disposable in-line filter. All samples will be collected in clean laboratory-supplied bottles in accordance with the requirements listed in **Table 4**. Non-disposable sampling equipment will be decontaminated between monitoring wells according to SOP-11 (Equipment Decontamination) as well as the special decontamination procedures specified in section 3.3.4.1.

3.6.2.1 Sample Designations

Groundwater samples will be obtained from 32 existing monitoring wells and 3 newly installed piezometers. Groundwater monitoring will also include collecting interstitial pore water samples from three wetland/pond areas, and collecting interstitial pore water samples along the SBC and BTC stream channels. Groundwater monitoring well samples will be designated according to their well/piezometer name. For example a groundwater sample from well FP98-1B would be labeled FB98-1B.

3.6.2.2 Groundwater Field Parameters

Table 8 lists standard field parameters that will be measured during the groundwater and pore water sampling. Field parameters will be measured according to the referenced Tetra Tech SOPs. Appropriate field forms will be filled out in accordance with SOP-10 (Field Forms). A groundwater field parameter form is included in **Appendix B**.

Table 8. Groundwater Field Parameters

Parameter	SOP Number(1)	SOP Title
Specific Conductance	SOP-05	Field Measurement of Specific Conductance
pH	SOP-06	Field Measurement of pH
Temperature	SOP-07	Field Measurement of Water Temperature
Oxidation-Reduction Potential	SOP-28	Field Measurement of Redox Potential (Eh)
Dissolved Oxygen	SOP-08	Field Measurement of Dissolved Oxygen
Depth to Water	SOP-20	Field Measurement of Groundwater Level

[1]Tetra Tech Standard Operating Procedures (**Appendix C**)

3.6.2.3 Groundwater Analytical methods

Table 9 summarizes laboratory groundwater analytical parameters, holding times, EPA Analytical Method Number, and required detection limits.

Table 9. Groundwater & Pore Water Analytical Methods

Parameter	PQL (mg/L)(1)	EPA Method No.	Max. Holding Time
Physiochemical			
Specific Conductivity	1	A2510B	7 days
pH	0.1 s.u.	A4500-H B	Upon arrival at lab
Turbidity (NTU)	0.1	180.1/A2130B	48 hours
Hardness as CaCO3	1	A2340B	14 days
Alkalinity, total as CaCO3, HCO3, CO3	4	A2320B	14 days
Acidity, total as CaCO3	1	A2310B	14 days
Nitrate/Nitrite	0.02*	EPA 353.2	28 days
Total Dissolved Solids	10	A2540C	7 days
Total Suspended Solids	10	A2540D	7 days
Total Organic Carbon	2	SW9060	14 days
Metals(2)			
Mercury, dissolved	0.002**	EPA 245.1	28 Days

Parameter	PQL (mg/L)(1)	EPA Method No.	Max. Holding Time
Metals by ICP/ICPMS, dissolved		EPA 200.2	-
Arsenic	0.001*	EPA 200.8/A3114B	Filter within 15 minutes/Analyze 6 months
Cadmium	0.00003*	(2) EPA 200.7/200.8	Filter within 15 minutes/Analyze 6 months
Chromium	0.01* mg/L	(2) EPA 200.7/200.8	Filter within 15 minutes/Analyze 6 months
Copper	0.002*	(2) EPA 200.7/200.8	Filter within 15 minutes/Analyze 6 months
Iron	0.02*	(2) EPA 200.7/200.8	Filter within 15 minutes/Analyze 6 months
Lead	0.0003*	(2) EPA 200.7/200.8	Filter within 15 minutes/Analyze 6 months
Manganese	0.015	(2) EPA 200.7/200.8	Filter within 15 minutes/Analyze 6 months
Zinc	0.008*	(2) EPA 200.7/200.8	Filter within 15 minutes/Analyze 6 months
Common Cations(2)			
Calcium	1.0	EPA 200.7	6 months
Magnesium	1.0	EPA 200.7	6 months
Potassium	1.0	EPA 200.7	6 months
Sodium	1.0	EPA 200.7	6 months
Common Anions(2)			
Sulfate	1.0	EPA 300.0	28 Days
Bicarbonate	None	EPA 310.1	14 Days
Carbonate	None	EPA 310.1	14 Days
Bromide	0.5	EPA 300.0	28 Days
Chloride	1.0	EPA 300.0	28 Days
Fluoride	0.1	A4500-F C	

1. PQL = Practical Quantitation Limit in milligrams per liter (mg/L) unless otherwise noted
2. Groundwater parameters will be analyzed for dissolved constituents as filtered through a 0.45 micron filter

* Required reporting value (RRV) is the Montana DEQ's selection of laboratory reporting limit that is sufficiently sensitive to meet the most stringent numeric water quality standard.

** The RRV set by Montana DEQ is unattainable using the standard methods employeed by Montana laboratories. The surface water numeric water quality standard (0.05 µg/L) will be substituted for the RRV.

3.6.3 Interstitial Pore Water Sampling from Streams and Wetland Ponds

Interstitial pore water of the streams and wetland ponds will be collected using a push point sampler. The sample locations are co-located with surface water and sediment sampling stations. The pore water sample stations are as follows:

Stream Pore Water Locations:

- Edge of stream channel near both banks at 16 surface water sample stations on SBC and BTC: Collect water samples from near edge of stream channel on both sides of the stream at 18 stations (northern and southern sides). Pore water will be collected from depths of 12 inches and 36 inches below the top of the bed sediment at each location. The most downstream stations will be located near the "Slag Wall

Canyon" section of the LAO. Field personnel will then proceed upstream to its confluence with BTC and continue along BTC to the last sample station upstream of Father Sheehan Park (**Figures 2A & 2B**).

- Tributary samples at two (2) of the 18 surface water sample stations on Grove Gulch and Sand Creek: For each tributary, collect water from one pore water location at edge of stream channel (one pore water location on northern side). The sample location for each tributary will be placed just upstream from the mouth on the tributary channel. Pore water will be collected from depths of 12 inches and 36 inches below the top of the bed sediment at each location.

Wetland Porewater Locations:

Field personnel will collect wetland pond pore water from three wetland ponds (**Figures 2A and 2B**). These include:

- The approximately 3-acre wetland pond located between the BTC Berm and the I-90 right-of-way;
- The wetland pond located adjacent to the KOA campground north of BTC and west of Lexington Avenue (one pond sediment location); and
- The wetland pond located east of Lexington Avenue and north of BTC (one pond sediment location).

Pore water will be collected using a push-point interstitial water sampler "wand" at two sample depths per sample location; one at 12 inches below the base of the pond (soil and water interface) and one at 36 inches below the base of the pond. Pore water samples from the wetland ponds will be co-located with the pond sediment and surface water samples from a wadeable section of the ponds where the "wand" can be extended into the pond sediment in a safe and practical manner.

The push point sampler will be inserted into the sediment to a depth of 12-inchesbelow the top of the sediments. The deeper sampling depth of 36-inches will be advanced in a separate push in a location adjoining the first 12-inch push point location. The purpose of this method is to collect two interstitial pore water samples; one as close to the surface water interface as possible and one from as deep as possible in order to determine if chemical gradients exist with changing pore water chemistry. This dual sampling approach will be repeated in each sample point location and will require two direct pushes in order to sample each interval independently.

Upon reaching the sampling depth, the guard rod will be removed from the body without disturbing the position of the sampler. Once the guard rod has been removed it should not be reinserted into the device until the boreholes are thoroughly cleansed of all sand, silt and other debris. In addition, once the guard rod has been removed from the sampler, the sampler should not be pushed further into the sediments. This may damage the screened zone or plug the sampler with sediment.

The sampling crew will measure and record the depth of surface water and measure the length of the sampler that is not immersed in the sediment. The sample location and GPS coordinates will be recorded prior to collecting the sediment pore water sample.

Samples will be collected with a peristaltic pump attached to the sampler port using a length of disposable tubing. Pore water will be evacuated at a low-flow sampling rate (50-200 ml/min) until extracted water becomes non-turbid. Adequate amounts of pore water sample water will then be withdrawn via the peristaltic pump and transferred to laboratory-provided sample containers. Non-disposable sampling equipment will be decontaminated before collecting the next sample as per SOP-11 and the special decontamination procedures outlined in this SAP (Section 3.8). The six pore water wetland pond samples will be analyzed in the field for the parameters listed in **Table 8** and for dissolved metals, major anions and cations, and physical parameters listed in **Table 9**.

3.6.3.1 Sample Designations

Stream Pore Water Designations:

Each stream pore water sample will be designated by the letters “SBC- or BTC-”, for Silver Bow Creek and Blacktail Creek Corridors area; “SPW-” for the stream pore water sample; followed by the number of the sample labeled consecutively from 01 to 18; then either “N” for northern bank or “S” for southern bank, etc.; followed by the depth designation of the sample (in inches ”).

For example, the pore water sample collected from the first stream pore water sample location on the northern bank on SBC at the shallow depth of 12 inches below the base of the channel will be designated SBC-SPW-01N(12”).

Each pore water sample collected from the tributaries will be designated by the letters “GG- or SC-”, for tributaries Grove Gulch and Sand Creek; “SPW-” for the stream pore water sample; followed by the location number of the sample labeled consecutively from 01 to 18; then the bank location “N”, “S”, “E”, “W”.; followed by the depth designation (in inches). For example, the pore water sample collected from the upper-most tributary, Sand Creek just upstream from its confluence with BTC at the deeper sample depth of 36 inches will be SC-SPW-13S (36”).

Wetland Pore Water Designations:

Each interstitial pore water sample will be designated by the letters “BTC-”, for the Blacktail Creek area, “WPPW-” for wetland pond pore water, then the number of the sample labeled consecutively from 01 to 03; followed by the sample depth (measured in inches). For example, the pore water sample obtained from the first wetland pond sample location collected from a depth of 36 inches will be designated BTC-WPPW-01(36”).

3.7 AQUIFER TESTING AND ANALYSIS

In order to determine shallow aquifer properties, Tetra Tech will conduct a short-duration (8-hour or less) constant discharge aquifer test on existing berm well AMW-11 (**Figure 2A**). A submersible pump will be temporarily installed in the well. The pumping well will be monitored for drawdown versus elapsed time on a logarithmic scale according to Tetra Tech SOP-26 (**Appendix B**). Additionally, Tetra Tech will intall each of the three (3) proposed piezometers on the periphery of the BTC Berm wetland area with pressure transducers to monitor the shallow aquifer’s response to sustained withdrawal.

Additional monitoring wells around the BTC Berm area may be monitored by hand measurement if an aquifer response is expected (for example the AMW-13 nested wells). All nearby monitoring wells that have the potential to be affected by the aquifer test will be gaged for depth to water prior to the inception of the aquifer test; upon initial startup; and then on a periodic basis after startup if a response is noted or expected. Discharge from the pumping well will be measured periodically throughout the test and routed to either the wetland pond or BTC, whichever is more convenient or approved. Aquifer test data will be recorded on field forms.

3.8 SAMPLE SHIPPING

Media samples obtained during this investigation will be hand delivered to ELI (or equivalent other laboratory) in Helena, Montana, for analysis or shipped from Butte using a transport courier in accordance with SOP-09 (Sample Packaging and Shipping). Samples will be chilled to <4°C in coolers filled with doubled re-sealable bags filled with ice and secured with a chain-of-custody seal. Chain-of-custody forms will accompany each cooler to the laboratory. The chain-of-custody forms will include the project name, field worker’s name, sample number, date and time of sampling, number and type of bottles, and analytical parameter and method list. The chain-of-custody form that will be used for the project is included in **Appendix B**.

3.9 EQUIPMENT DECONTAMINATION

All non-disposable sampling equipment will be decontaminated between sample collection according to SOP-11 (Equipment Decontamination); however due to the presence of high soil concentrations of metals found in portions of the site investigation area, a multi-staged procedure for decontamination has been developed for use during this project as follows:

- Step 1 – Mechanical brushing off of any soil and organic matter or metal coatings, which may have developed on exposed surfaces during sample collection. For non-disposable water sampling equipment the equipment will be wiped clear of any water or sediment with a paper towel;
- Step 2 – Spray-washing of all surfaces exposed to soil and water sample collection with a tap water rinse to remove as much of remaining soil or organic matter remaining;
- Step 3 – Washing and scrubbing equipement using a 5-gallon bucket containing Alconox soap and tap water;
- Step 4 – Acid bath immersion in 10 percent nitric acid/tap water solution contained in a 5-gallon bucket with mechanical scrubbing, immerse as long as feasible;
- Step 5 – Immersion in a distilled or de-ionized water bath (5-gallon bucket) or spray-wash;
- Step 6 – Air drying or wiping with clean paper towels;
- Step 6 – Storing equipment between usage in plastic zip-loc baggies or plastic bags to prevent cross contamination.

Decontamination water and water-mixes will be replaced daily or sooner, as needed. Note that a special emphasis on decontamination is needed for this project due to macro-contamination of metals (in particular copper and zinc) over much of the investigation area. Additional effort to thoroughly scrub, wash and rinse the sample equipment prior to and after the acid bath will also be emphasized.

3.10 FIELD QUALITY CONTROL

QC samples will be collected during each sampling event according to Tetra Tech SOP-13 (QC Samples). The project quality assurance project plan (QAPP) provides additional quality Assurance QA/QC details and requirements (**Appendix B**). The following QC samples will be collected for groundwater and soil and mine waste samples (as noted):

Table 10. Field QC Frequency and Analysis

QC Type	Frequency	Purpose & Collection Procedure	Analysis
Field Blanks	1 per 20; Max. 1 per day	Evaluate introduction of contaminants during sampling procedures. Collected by pouring deionized or distilled decontamination source water into sample container in the field under field conditions.	All media: Total metals (As, Cd, Cr, Cu, Fe, Pb, Mn, Hg, Zn)
Equipment Rinsate Blanks	1 per 20; Max 1 per day	Evaluate introduction of contaminants during sampling and decontamination procedures. Collected by passing water through or pouring over decontaminated sampling equipment.	Soil/sediment: Total metals (As, Cd, Cr, Cu, Fe, Pb, Mn, Hg, Zn) Surface water: Total & dissolved metals (As, Cd, Cr, Cu, Fe, Pb, Mn, Hg, Zn) Groundwater/pore water: Dissolved metals (As, Cd, Cr, Cu, Fe, Pb, Mn, Hg, Zn)

Field Duplicates	1 per 20; Max. 1 per day	Used to assess laboratory and field precision. Collected, prepared, and handled consistent with associated natural sample.	Analyzed for same suite of parameters as the associated natural sample. See above tables for each media type.

The intent of the QC sampling is to monitor the effectiveness of decontamination and sampling procedures, as such, blank samples will be collected in an even time-wise fashion across the duration of the field sampling period for each matrix. This temporal process is intended to allow for assumptions about the quality control surrounding groups of samples collected between decontamination procedures or QC sample points.

Field personnel will record QC sample identification in field forms and in field notebooks. The quality control sample will be submitted blind to the lab and differentiated from the natural sample by adding the following codes at the end of the sample designation number:

- Field Blank "FB"
- Rinsate Blank "RB"
- Field Duplicate "DUP"

The samples will include the date of collection (MMDDYY) followed by the above designation. Field personnel will document the actual time of collection in the field notebook, and for duplicates, field personnel will document the corresponding natural sample number, so the samples can be related back to the associated natural samples collected. Examples of quality control sample designations are provided below.

- 031216-FB (deionized or distilled water field blank collected at groundwater well BPS07-8A sampling)
- 030416-RB (rinsate blank sample from decontaminated sampling equipment at stream sediment sampling location 1).
- 032116-DUP (blind field duplicate sample with fake monitoring well name). Field personnel would note in the field log from which monitoring well the blind duplicate was collected).

3.11 LABORATORY QUALITY CONTROL

Laboratory QC samples will consist of calibration standards, laboratory control samples, method blanks, laboratory duplicates and matrix spikes. Laboratory QC samples will be prepared and analyzed at a frequency that is in accordance with the specified analytical method. The project QAPP provides additional Laboratory QC details and requirements (**Appendix B**).

3.12 DATA MANAGEMENT

Tetra Tech will transfer existing site data and the data from this data gap site investigation into a new site-specific database format that is easy to understand, query, and transfer the necessary data to the NRDP. The database will incorporate existing site monitoring data and new site investigation data (field position and important reference elevations such as geologic contact and subsurface features) and sampling results using the software program ARCGIS Geostatistical Analyst and laboratory electronic data deliverables. Well logs and field notes will be scanned and stored electronically.

4.0 DATA ANALYSIS/RESULTS

Site investigation data will be summarized into one or more Data Gap Site Investigation Report(s). The report(s) will present field and laboratory analytical data in a short, concise format and will include a site-specific electronic database. The report(s) will contain revised volume estimates for each type of subsurface material impacted by mine waste specific to sampling locations along the SBC and BTC Corridors and update vertical and horizontal boundaries for these materials, as needed. These volume and boundary updates will be summarized into tables and illustrative figuresshowing extent and magnitude of impacts, and the distribution of COCs in soil, stream sediment, surface water and groundwater. Of particular interest to the NRDP is the potential of metals loading to surface water and sediment via impacted groundwater and chemical interaction along the riparian corridors.

5.0 REFERENCES

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

APPENDIX A - FIGURES

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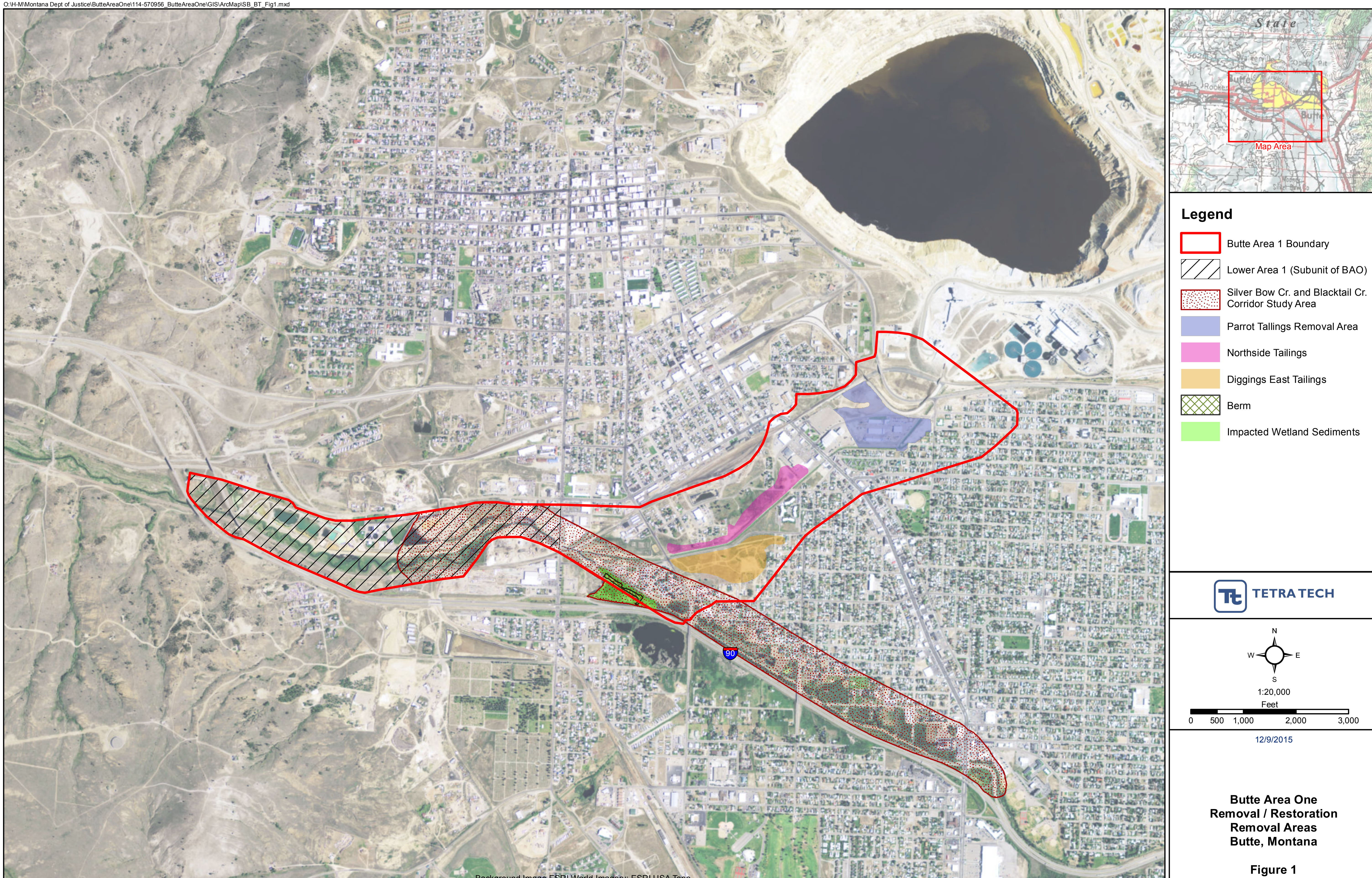

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3/31/2016

Silver Bow Creek and Blacktail Creek Corridors

Figure 2A

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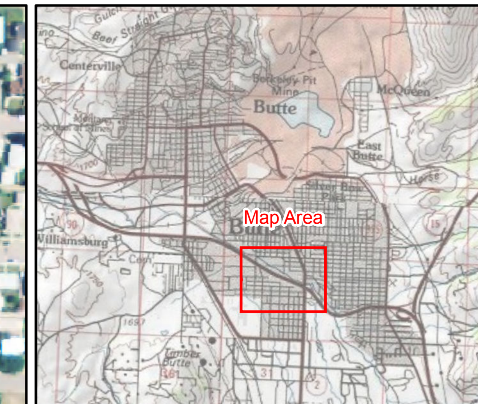

Legend

- Existing Monitoring Well
- Berm Sample
- Pore Water, Surface Water, and Wetland Sediment Sample
- Piezometer
- Pore Water, Streambed, and Surface Water Samples
- Stream Bank Sediment Sample
- Test Pit
- Wetland Sediment Sample (DPT)
- Berm
- Impacted Wetland Sediments

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Silver Bow Creek and Blacktail Creek Corridors

Figure 2B

APPENDIX B – QAPP AND HASP

QUALITY ASSURANCE PROJECT PLAN

FOR

BUTTE AREA ONE REMOVAL/RESTORATION – DATA GAP INVESTIGATION

SILVER BOW CREEK AND BLACKTAIL CREEK CORRIDORS

Prepared for:

State of Montana- Department of Justice
Natural Resource Damage Program
1720 9th Avenue
Helena, MT 59601

Prepared by:

Tetra Tech, Inc.
2525 Palmer Street, Suite 2
Missoula, MT 59808

JULY 2016

LIST OF QAPP APPENDICES

LIST OF ACCRONYMS

%R	Percent Recovery
bgs	Below Ground Surface
BTAG	Biological Technical Advisory Group (BTAG)
C	Completeness
CERCLA	Comprehensive Environmental Response Compensation Liability Act
CLP	Contract Laboratory Program
COC	Contaminants of Concern
DQO	Data Quality Objectives
EPA	United States Environmental Protection Agency
GPS	Global Positioning System
HASP	Health and Safety Plan
LCS	Laboratory Control Sample
MBMG	Montana Bureau of Mines and Geology
MS	Matrix Spike
MS/MSD	Matrix Spike/Matrix Spike Duplicate
NRDP	Natural Resource Damage Program
P	Number of measurements/data points planned
PARCC	Precision, Accuracy, Representativeness, Completeness, and Comparability
PQL	Practical Quantitation Limit
QA	Quality Assurance
QA/QC	Quality Assurance and Quality Control
QAPP	Quality Assurance Project Plan
QC	Quality Control
RPD	Relative Percent Difference
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure
V	Number of valid measurements/data points obtained

1.0 INTRODUCTION

Tetra Tech, Inc. (Tetra Tech) prepared this Quality Assurance Project Plan (QAPP) to guide quality assurance and quality control (QA/QC) procedures for the Data Gap Investigations on Silver Bow Creek (SBC) and Blacktail Creek Corridors (BTC) SAP. This project is being completed for the State of Montana - Natural Resource Damage Program (NRDP) to further characterize tailings and other impacted materials from historical mining practices in the upper Silver Bow Creek and Blacktail Creek watersheds and to assess their impacts on groundwater, surface water, and in-stream sediments.

This QAPP is a comprehensive document to guide site assessment. Assessment activities for this project will include the collection of surface and subsurface soil samples, surface and groundwater samples to evaluate environmental conditions associated with former mining and smelting operations associated with the Site. The results of the site investigation will be summarized in a technical memorandum to the NRDP. Ultimately, the results of this investigation will be utilized along with results of investigations completed in the remaining study areas of the Butte Area One (BAO) to satisfy design needs for the integration of restoration with remedy of mining and mineral processing wastes in the SBC and BTC Corridors (Figure 1; Appendix A) and to support integration of restoration design.

There are several organizations directly participating in this project. These include the NDRP, Butte Natural Resource Damage Restoration Council (BNDRC) Tetra Tech, and the members of the public. Effective project management will ensure that stakeholders agree upon a well-defined assessment approach and that sufficient data are collected to make decisions related to site restoration.

The sections in this introduction present the project organization and define the responsibilities of various project participants. This section also describes data quality objectives (DQOs) for the assessments (overall goals of the project) defined to guide identification of specific tasks that will be used to collect the data necessary to support decision-making.

1.1 PROJECT ORGANIZATION

The description below summarizes key project personnel and their associated responsibilities:

NRDP BAO Project Manager – Jim Ford

Responsibilities: Coordination of project team, notification, budget approvals, and review of all project planning and reporting documents.

Project Manager/Coordinator – Bill Craig, Tetra Tech

Responsibilities: Project coordination and liaison with the NRDP; assist in field planning; problem solving and decision-making; quality assurance during project activities; review and preparation of project documents; review of all chain-of-custody forms and analytical data and ensure analytical data meet current standards for accuracy and precision.

Assistant Project Manager/Quality Assurance Officer – Natalie Morrow, Tetra Tech

Responsibilities: Project coordination; assist in field planning; problem solving and decision-making; quality assurance during project activities and preparation of documents; review of all chain-of-custody forms and analytical data and ensure analytical data meet current standards for accuracy and precision.

1.2 PROJECT OBJECTIVES

The purpose and objectives of the SBC and BTC Corridors investigation are to:

- Evaluate surface water, in-stream and pond sediment, and floodplain soils in areas within the SBC and BTC Corridors that were not previously investigated;
- Confirm the lateral and vertical extent of the contamination that may require remedial action(s);
- Complete groundwater monitoring of selected monitoring wells to gather pre-construction aquifer and groundwater quality data; and
- Evaluate contaminant loading to SBC and BTC riparian corridors.

This site-wide QAPP defines the data quality objectives (DQOs) for this and similar projects that are and will be conducted for NRDP for BAO and related work. This QAPP will be updated, as needed to reflect the work being conducted on future projects within the BAO and related areas.

1.2.1 Project Schedule

Tetra Tech anticipates proceeding with the field investigation effort by late-December 2015 or early January 2016. Tetra Tech anticipates that the soil and groundwater investigation can be completed within a 3-week period. Typical turnaround for laboratory analyses is 3 weeks. Based on this schedule, we expect to submit a draft technical memorandum for NRDP review by late-March 2015. We anticipate submitting a final report in mid-April 2016.

The actual project schedule will depend on several factors, such as completion and approval of the site-specific SAP, this QAPP, and a Health and Safety Plan (HASP). The schedule will also depend upon the date assessment activities commence, unanticipated field and weather conditions, the need for further assessment, turn-around-time on analytical results, subcontractor availability, additional requirements by NRDP, and the length of the NRDP review and comment period.

1.2.2 Project Description

BTC receives the majority of its base flow contributions from Summit Valley groundwater in Butte, Montana. The stream intersects both the BAO injured area restoration site and BPSOU, and is a focal point for past and current remediation and restoration activities. The SBC and BTC Corridors study area that is the focus of this data gap investigation extends from below the LAO boundary on lower SBC (west of Montana Street), through the BAO and the confluence of BTC, and continues upstream above the BAO along BTC to Father Sheehan Park above Harrison Avenue (Figure 1; Appendix A). In 1879, the first large-scale mineral processing smelter (Colorado Smelter) was built on SBC, at the west end of the valley. Between 1879 and 1888, at least three more smelters of consequence (BRW, Parrot Smelter and Montana Ore Purchasing Company (M.O.P)) were constructed upstream of the Colorado Smelter, which significantly altered the geomorphology and hydrology of both SBC and the lower portion of BTC. A fifth smelter of consequence, the Bell Smelter, located west of present day Harrison Avenue on the north bank of BTC, was constructed in 1881; and reached a peak production of approximately 30 tons per day in 1883 (primarily silver ore). Production quickly tapered and the smelter was dismantled sometime in the early 1890s..

Water demands during this period increased dramatically, and the stream channels were altered significantly to keep up with the demand. At least three dams were constructed on upper Silver Bow Creek and the confluence area, for tailings impoundment and water clarification. The dam at Montana Street

(Weed, 1904) was constructed for settlement of tailings from upstream smelters and resulted in significant ponding on both sides of the stream.

Over time, waste material aggraded in SBC and BTC channels and floodplain, frequent and substantial flooding began to become a serious issue (Meinzer, 1914). In an attempt to mitigate flooding issues, berms made mostly of readily available waste were constructed throughout the confluence area. The known waste area referred to as the BTC Berm, is an historic remnant of these flood control berms.

Tetra Tech has also prepared a site-specific SAP and health and safety plan (HASP) for assessment activities. Tetra Tech will implement this investigation upon approval by the NRDP.

1.3 DATA QUALITY OBJECTIVES

Data Quality Objectives (DQOs) for this investigation were developed to ensure data quality and to define procedures for data collection. In addition, site-specific DQOs are identified in the SAP. DQOs were developed following the recommendations in an EPA guidance document (EPA 2006). The DQO process allows Tetra Tech to determine the level of data quality required for specific data collection activities and to estimate the costs associated with the activities.

1.3.1 Problem Statement

In order to fill data gaps in information concerning the extent and magnitude of T/IS and to obtain additional data necessary for integration of restoration with remedy. Tetra Tech will perform a limited soil, sediment, surface water and groundwater investigations at the SBC and BTC corridors area. The focus of this site investigation will be to provide this additional data and close data gaps in the following areas identified in the Preliminary Conceptual Restoration Plan (PCRP) (Confluence 2015):

- Further define extent and magnitude of tails/impacted soils to better define removal area and depths;
- Characterize the near surface aquifer to quantify construction dewatering requirements;
- Evaluate COCs in the stream bed, surface water and the stream bank within the SBC and BTC corridor to identify potential contaminant loading;
- Collect additional groundwater quality data to define the extent of alluvial impacts and their potential impacts on post-restoration groundwater and surface water quality; and
- Evaluate contaminants loading from upper, middle, and deep alluvial aquifers to SBC and BTC riparian corridors.

1.3.2 Decision Statements

Inorganic compounds in tailings, soils and stream sediments in the SBC and BTC Corridors Area are the primary concern for injury to alluvial groundwater in the upper Silver Bow Creek watershed. Even though groundwater treatment is not part of the PCRP, soil removal actions at problem areas are anticipated to improve groundwater and surface water quality in BAO.

In assessing and managing risks where inorganic contaminants are present in soils, soil sample results will be compared to Streamside Tailings Operable Unit (SST OU) field screening criteria. The SST OU is adjacent to BPSOU, addressing SBC after it leaves BPSOU. Surface water quality sample results will be compared to Montana Department of Environmental Quality Circular DEQ-7 standards. In-stream and pond sediment pore water samples will compared to DEQ-7 surface water and groundwater standards. Sediment sample results will be compared to the EPA Region 3 Biological Technical Advisory Group (BTAG) Freshwater Sediment Screening Benchmarks, which serve as a Tier 1 screening tool to indicate if sediment contaminant concentrations may indicate potential adverse effects. Montana is located within EPA Region 8, which currently has no sediment screening numbers and uses many of the same reference values relied upon by Region 3 BTAG. Groundwater sample results will be compared to DEQ-7 groundwater standards.

1.3.3 Decision Inputs

Considerable data exists on the distribution of inorganic contaminants in soils, stream sediment, surface water and groundwater in the SBC and BTC corridors from previous studies conducted by ARCO, the Montana Bureau of Mines and Geology, EPA, the State of Montana and others. Additional data is necessary to support engineering design of a removal action (e.g., development of site specific soil screening criteria, formulate accurate soil removal volumes, assess shallow aquifer properties for potential dewatering methods, and conceptualize land surface reconstruction).

Specific decision inputs for this investigation are summarized in the table below.

COLLECTION TYPE, DATA PARAMETERS, AND DATA USES		
Source Materials	**Typical Data Parameters**	**Data Uses**
Soil & Mine Waste	Field parameters consisting of total metals screening using a portable Niton XL3p 722 XRF analyzer. Laboratory parameters consisting of saturated paste pH and EC, total organic carbon, total metals, acid-base potential, NAG pH and SPLP.	Compare soil results to SST OU soil screening criteria to identify horizontal and vertical extent of contaminated materials in some portions of the site. Determine leaching potential of contaminated soil to groundwater.
Stream Sediment	Laboratory parameters consisting of saturated paste pH and EC, total organic carbon, total metals, acid-base potential, NAG pH and SPLP.	Measure contaminants to determine potential loading to stream sediments and help identify sources. Compare results to the EPA Region 3 BTAG Freshwater Sediment Screening Benchmarks, which serve as a Tier 1 screening tool to indicate if sediment contaminant concentrations may indicate potential adverse effects.
Surface Water	Stream flow measurements at 15 stations on main-stem of SBC/BTC and 2 locations of tributaries Field parameters: specific conductance, pH, temperature,	Provide pre-construction water quality data. Evaluate contaminant contributions in two tributaries to BTC. Compare contaminant concentrations to surface water screening levels and identify potential gaining sections within the riparian corridor based on

	oxidation-reduction potential, and dissolved oxygen Laboratory parameters: specific conductance, pH, turbidity, hardness as CaCO3, total alkalinity as CaCO3, HCO3 and CO3, total acidity as CaCO3, total dissolved solids, total suspended solids, total organic carbon, total metals; common cations and common anions	the presence of surface water quality impacts relative to streambed sediment impacts and groundwater impacts
Groundwater and Pore Water	Field parameters: depth to water, specific conductance, pH, temperature, oxidation-reduction potential, and dissolved oxygen Laboratory parameters: specific conductance, pH, turbidity, hardness as CaCO3, total alkalinity as CaCO3, HCO3 and CO3, total acidity as CaCO3, NO2/NO3, total dissolved solids, total suspended solids, total organic carbon, dissolved metals, common cations and common anions	Provide pre-construction water quality data. Compare contaminant concentrations to Montana surface water and groundwater quality standards. Use water level elevations to estimate groundwater flow direction(s) and gradient. Determine potential gaining reaches within the riparian corridor based on comparison to stream sediment and surface water impacts.
Aquifer Testing	Field parameters; depth to water measurements, pumping well discharge rate	Evaluate hydraulic properties of the alluvial aquifer needed to support design of a dewatering program to allow removal of saturated soils and excavation backfilling.

1.3.4 Study Boundary

The horizontal boundary of this study will begin upstream of reclaimed stream channel of SBC, extend upstream to the confluence of SBC and BTC, then upstream on BTC to the area near Father Sheehan Park (**Figures 2A and 2B**). With the exception of existing middle alluvial unit and deep alluvial unit monitoring wells, the vertical boundary for this investigation will be within the zone of first-encountered groundwater. Direct Push Technique (DPT) will be used to advance three borings and obtain continuous soil samples at select locations to an approximate depth of approximate 25 feet bgs. Wells installed as part of the aquifer testing program will be completed a minimum of 5 to 10 ft below the approximate top of the static water level.

1.3.5 Decision Rule

Screening levels for solid media will be based upon XRF field screening criteria developed for Streamside Tailings Operable Unit (SST OU) removal actions for arsenic, cadmium, copper, lead, mercury and zinc. Screening criteria are listed in the following table:

COC[1]	Screening Criteria[2] (mg/kg)[3]
Arsenic	200
Cadmium	20
Copper	1,000
Lead	1,000
Mercury	10
Zinc	1,000

[1] COC=Contaminants of Concern; [2] Screening Criteria utilized in previous BAO site investigations from *Field Screen Criteria and Procedures Phase 7 and * Remedial Action, SST OU Subarea 4, Reaches R and S* (Pioneer 2011); [3]mg/kg = milligrams per kilogram

1.3.6 Tolerable Limits of Decision Errors

Decision errors are incorrect conclusions about a site caused by using data that are not representative of site conditions due to sampling or analytical error. Limits on decision error are typically established to control the effect of sampling and measurement errors on decisions regarding a site, thereby reducing the likelihood that an incorrect decision is made. The null hypothesis is that a site is clean. A false positive decision error is one that decides a site is clean when, in actuality, it is not clean. A false negative decision error is one that decides a site requires cleanup when, in actuality, it requires no cleanup. False positive and negative decision errors should be minimized as much as possible during this project.

Formal limits on decision error are not necessary in areas where the goal of the assessment is to define the boundaries of known contamination. This QAPP identifies specific field and laboratory methods and sampling strategies that reduce sampling error. The total study error will be reduced by collecting an appropriate number of environmental samples, as deemed necessary by the assessment team, to represent the range of concentrations present at each site in question. The sampling program is designed to reduce sampling error by specifying an adequate number and distribution of samples to meet project objectives. An individual SAP for this investigation will be prepared that specifies the sampling and analytical methods and protocols to reduce field error. It also specifies the requirements for collection of field quality control (QC) samples to facilitate assessment of data accuracy and precision.

1.3.7 Sampling Design

A site specific SAP has been prepared that outlines the assessment design for the SBC and BTC Corridors Area data gaps investigation. The SAP will specify sampling protocols, analytical methods and the types and numbers of samples to be collected during the assessment. The assessment design is based on a review of historical data and/or previous investigations completed at each site and recognized environmental conditions identified during previous investigation. The general sampling design for soil/mine waste, surface water and groundwater is described below.

Soil/Mine Waste Sampling – Field and laboratory analytical results will be used to evaluate concentrations of COCs in soil/mine waste at the site.

Stream Sediment Sampling – Field and laboratory analytical results will be used to evaluate potential loading of COCs in stream sediment.

Stream Flow Measurements – Stream flow measurements will be used to assess gaining and losing reaches of stream and will be used to assess contaminant load in surface water.

Surface Water Sampling – Surface water sample results will be used to characterize concentrations of COCs in surface water at the SBC and BTC Corridors Area and in two tributaries to BTC (that may be contributing to surface water quality data.

Groundwater Sampling – Groundwater sample results will be used to evaluate concentrations of COCs in groundwater at the SBC and BTC Corridors Area and provide pre-construction groundwater quality data.

Aquifer Testing – Aquifer testing results will be used to obtain hydraulic properties of the aquifer to evaluate dewatering requirements during removal of impacted soils within the inundated mine waste.

2.0 MEASUREMENT DATA ACQUISITION

The following section describes tasks related to data acquisition. This includes the sampling process, quality control procedures and requirements, equipment operation, data management, and record keeping.

2.1 SAMPLING PROCESS

Detailed sampling process is provided in the SAP for the SBC and BTC Corridors data gaps investigation. Field personnel will collect soil and mine waste samples during this investigation using a variety of methods including decontaminated hand tools, powered excavation equipment and a truck-mounted direct-push technology (DPT) rig. Samples will be handled under standard preservation and chain-of-custody procedures in accordance Tetra Tech's SOPs included in Appendix C.

2.2 QUALITY CONTROL

QC samples will include both field and laboratory samples, as described in the following sections below.

2.2.1 Field Quality Assurance/Quality Control Sampling

Three types of field QC samples will be collected during the assessment. QC samples will include field duplicates, field blanks, and rinsate blanks. The purpose of analyzing QC samples is to meet DQOs specified in Section 1.3, above. Each QC sample type is discussed below.

2.2.1.1 Field Duplicates

Field duplicate water samples will consist of blind field duplicates collected at a frequency of one for every 20 natural samples. Duplicates will be collected for the purposes of determining project sample precision. The field duplicate samples will be containerized and preserved consistent with the field sample and analyzed for the same constituents as the field sample and submitted blind to the laboratory.

Duplicate soil samples will not be collected due to the high variability and varying adsorption properties of soil that make comparability for quality control purposes not appropriate.

For example, if 22 field soil samples and 5 surface water field samples are collected, only one surface water duplicate will be collected. The purpose of duplicate collection is to evaluate analytical precision. Field duplicates will be submitted as blind duplicates to the laboratory. The field duplicate samples will be containerized and preserved consistent with the field sample and analyzed for the same constituents as the field sample.

2.2.1.2 Field Blanks

Field blank samples will be collected/prepared in the field and samples analyzed for the same parameters as the field samples. Field blank samples will be prepared by pouring de-ionized water in sample bottles to verify that the field conditions and procedures do not introduce contamination to samples. Field blanks will be prepared and analyzed for the contaminants of concern on the site. Field blanks will collected at a ratio of one blank per 20 natural samples; however only one blank will be collected per day if over 20 natural samples are collected.

Laboratory data from the field blanks will be used to verify that the de-ionized water does not contain target analytes.

2.2.1.3 Equipment Rinsate Blanks

Equipment rinsate blanks will not be collected when disposable equipment is used. If sampling equipment is used that will need to be decontaminated, rinsate blanks will be collected at a frequency of one per 20 natural samples, not to exceed one blank per day. Equipment blanks will be prepared and analyzed for the contaminants of concern on the site.

Laboratory data from the rinsate blanks will be used to verify that the decontamination procedures are adequate in removing any contamination.

2.3 LABORATORY QUALITY ASSURANCE/QUALITY CONTROL

Energy Laboratories, Inc. (Energy) will be used to provide analytical services for this project. Documentation of Energy's quality assurance procedures are presented in Appendix B and is available on-line at https://www.energylab.com/wp-content/uploads/2012/04/Billings-QA-Manual-2015_final1.pdf

2.4 EQUIPMENT OPERATION, CALIBRATION, AND STANDARDIZATION

All field and laboratory equipment will be operated, maintained, calibrated, and standardized in accordance with EPA and manufacturers' recommended procedures. Tetra Tech's applicable SOPs and a copy of EPA Method 6200 (field XRF Methods) that specify field equipment operation, maintenance, calibration, and standardization procedures are contained in Appendix C. The selected analytical method(s) define QC requirements and how the laboratory must analyze each sample.

2.5 DATA MANAGEMENT

Analytical data will be provided to Tetra Tech in both electronic and hard copy. Hard copy reports will be stored in the project files. Analytical laboratory data for the project will be downloaded directly into a Microsoft Access or Excel database from electronic-formatted laboratory data. Tetra Tech will manually enter field parameter measurements into the database. Backups will be created prior to entry of new data in the database to prevent loss of data during the data reduction process. Any electronic survey or global positioning system (GPS) data will be archived in the same manner as electronic analytical data.

Field descriptions of lithologic characteristics, observations, and other site data will be entered onto appropriate field forms during the field investigation and filed in designated project files in Tetra Tech's office. The QA Officer will maintain quality control of data transfer into the database by verifying the accuracy of a minimum of 10% of the entries placed in the database.

2.6 DOCUMENTS AND RECORDS

The QA Officer will be responsible for ensuring that project personnel have the current versions of the SAP and QAPP and other project planning documents. The Tetra Tech project manager will also maintain current project files and project documents.

3.0 ASSESSMENT AND OVERSIGHT ELEMENTS

The Project Coordinator will be responsible for assessment and oversight of project activities. The Project Coordinator will provide NRDP with project status reports. The Quality Assurance Officer may perform an internal audit of field procedures. If completed, the internal audit will include reviews of procedures selected for the sampling program, the QA/QC samples required, and training requirements. The laboratory is required to have written procedures addressing internal QA/QC as specified in the Comprehensive Environmental Response Compensation Liability Act (CERCLA) Contract Lab Program (CLP) protocol.

Corrective actions will be taken promptly upon identification of potential problems with data acquisition or measurement. Field equipment malfunctions will be identified promptly and corrected by the field team leaders. Corrective actions will be documented in the field notes. Laboratory equipment malfunctions are handled according to EPA analytical method specifications. Laboratory QC samples (calibration samples, method blanks, matrix spike samples, laboratory control samples, and laboratory duplicates) will be handled according to EPA analytical method specifications and the Contract Lab Program protocol. Laboratory corrective actions will be included on analytical laboratory reports.

4.0 DATA REVIEW, VERIFICATION, AND VALIDATION

4.1 DATA REDUCTION

Data reduction, the result of grouping similar QC samples and calculating and reporting their recoveries, will be performed on laboratory data while still in the laboratory. Tetra Tech personnel will work directly with the laboratory's data QA Officer who will review all analytical data associated with each sample. Tetra Tech will receive all QA/QC reports from the analytical laboratory.

The types of laboratory QC data reviewed will include calibration standards, calibration verification, laboratory controls, laboratory duplicates, and laboratory spikes. When EPA methods are used, the applicable data reduction procedures called for in the EPA methods will be used. The assessment reports will include the raw data and a summary of QC data reduction.

4.2 DATA REVIEW

The ability of data to meet DQOs is evaluated with a precision, accuracy, representativeness, completeness, and comparability (PARCC) statement. A PARCC statement is generated during data evaluation. The following sections define the terms used in the PARCC statement.

4.3 PRECISION

Precision is the amount of scatter or variance that occurs in repeated measurements of a particular analyte. Precision acceptance and rejection for this project will be based on the relative percent difference (RPD) of the field duplicates. Tetra Tech will evaluate analytical results for the field and duplicate soil samples using the RPD between the two samples when both values of the field/duplicate pair are greater than five times the practical quantitation limit (PQL) for a given analyte.

The RPD is given by:

$$\text{RPD (\%)} = \frac{2\,|S_1 - S_2|}{S_1 + S_2} \times 100$$

Where: | | = absolute value of $S_1 – S_2$

S_1 = measured field sample concentration; and
S_2 = measured duplicate sample concentration.

When duplicate analysis results exceed 35% RPD for aqueous solutions and 50% RPD for soil and the analyte concentration in the sample is greater than five times the PQL, all results for the analyte exceeding the RPD in the sample delivery group will be considered estimated.

4.4 ACCURACY

Accuracy is defined as the ability of the analytical procedure to determine the actual or known quantity of a particular substance in a sample. Accuracy acceptance or rejection will be based on the percent recovery (%R) of the matrix spike (MS) for soil samples, and will be based on the percent recovery of the laboratory control sample (LCS) for solid samples. To determine accuracy, the %R for each matrix spike or LCS will be compared to the acceptable range as specified in the applicable laboratory method. Equipment and laboratory blanks may also be analyzed to quantify artifacts introduced during sampling, transport, or analysis that may affect the accuracy of the data. In addition, initial and continuing calibration results may be used to verify that the sample concentrations are accurately measured by the analytical instrument.

The percentage recovery for MS samples is given by:

$$\text{Recovery (\%)} = \frac{A - B \times 100}{T}$$

Where: A = measured concentration of the spiked sample;
B = concentration of unspiked sample; and
T = amount of spike added.

The percent recovery for surrogate standards and LCSs are given by:

$$\text{Recovery (\%)} = \frac{A}{T} \times 100$$

Where: A = measured concentration of the surrogate or LCS; and
T = known concentration.

Field sample results associated with percent recoveries outside acceptable limits will be considered estimated. Field sample results associated with percent recoveries of less than 50% will be considered rejected, as recommended by EPA (2010). An overall assessment of accuracy will be made upon completion of the project. Overall accuracy will be stated as the mean %R. Because of the small number of matrix spike and laboratory control samples anticipated, no confidence interval will be calculated. The range of acceptable accuracy is presented in Table B-4 (QAPP Appendix B).

4.5 REPRESENTATIVENESS

The objective in addressing representativeness is to assess whether information obtained during the investigation accurately represents site conditions. Laboratory water blanks, field blanks, and rinsate blanks are used to assess representativeness. Field results associated with contaminated blanks will be considered estimated with a high bias when the field sample result is greater than the practical quantification limit, but less than five times the contaminant concentration, as recommended in EPA (2010).

If a laboratory blank contains detectable levels of common laboratory contaminants, then the sample results will be considered as positive only if the concentrations in the sample exceed 10 times the maximum amount detected in any blank. If the concentration in the sample is less than 10 times the blank concentration, we will conclude that the chemical was not detected in the sample and will consider the blank-related concentrations of the chemical to be the quantification limit for the chemical in that sample. If all samples contain levels of a common lab contaminant at less than 10 times the contamination noted in the blank, then the analyte will be eliminated from the set of sample results.

4.6 COMPLETENESS

The objective in addressing completeness is to assess whether enough data have been collected and enough data are valid to meet the investigation needs. Completeness is assessed by comparing the number of valid sample results to the number of samples collected. The completeness goal of the project is 90%.

Percentage completeness (C) is given by:

$$C\ (\%) = \frac{V}{P} \times 100$$

Where: V = number of valid measurements/data points obtained; and
P = number of measurements/data points planned.

4.7 COMPARABILITY

The objective in addressing comparability is to assess whether one set of data can be compared to another set of data. Comparability is assessed by determining if an EPA-approved analytical method was used, values and units are sufficient for the database, specific sampling points can be established and documented, and field collection methods were similar.

4.8 DATA VALIDATION AND EVALUATION

Data validation consists of completing a review of data using the raw analytical data. The laboratory will validate raw laboratory data using EPA Contract Laboratory Program (CLP) National Functional Guidelines (EPA, 2010) and according to specific analytical method requirements. Data evaluation consists of completing a review of laboratory analytical reports that have already had internal laboratory validation of raw data. The objective of data validation and evaluation is to identify any unreliable or invalid laboratory measurements and qualify data for interpretive use. For this project, the analytical laboratory will perform data validation on raw analytical data prior to preparing a final analytical report. Once the laboratory has prepared and submitted a final analytical report, project personnel will complete an evaluation of the data. The data evaluation will include review of field QA/QC data and additional review of qualifiers assigned to the data by the analytical laboratory. Additional qualifiers will be assigned to the data as necessary based on, but not limited to, precision and accuracy of results, blank contamination, and holding time exceedances.

Project personnel will complete data evaluation checklists. The checklists provide a guide for review of the laboratory and field procedures and data collected. The review will evaluate whether the following were completed according to SAP/QAPP requirements, EPA guidelines, and/or method specifications:

- Chain-of-custody procedures;
- Cooler temperatures;
- Holding times;
- Laboratory QA/QC (method blanks, control samples, duplicates, MS/MSD); and,
- Field QA/QC (sample handling, duplicates, and field and equipment blanks).

Knowing the limitations of the data assists the data user when making interpretations. Data with limitations are usable for evaluation as long as the limitations are considered. Evaluation of other field data (pH meter and specific conductivity meter, for example) is not possible because these data have very limited statistical control limits. Professional judgment is required and will be used to assess the impact of field QC on the overall quality and usability of the field data.

4.9 DATA RECONCILIATION

Data reconciliation is performed in the office after data validation is complete. Data reconciliation is the generation of the PARCC statement that assesses the data relative to meeting the DQOs. Tetra Tech will perform this reconciliation as part of the data evaluation and completion of the data evaluation checklist. Using the PARCC statement as a basis, reconciliation of data evaluation will be done by comparing evaluation results with project objectives. If data user requirements are not met, the Tetra Tech project manager and quality assurance manager will confer with the NRDP on how issues will be resolved and how limitations of the data will be reported.

5.0 REFERENCES

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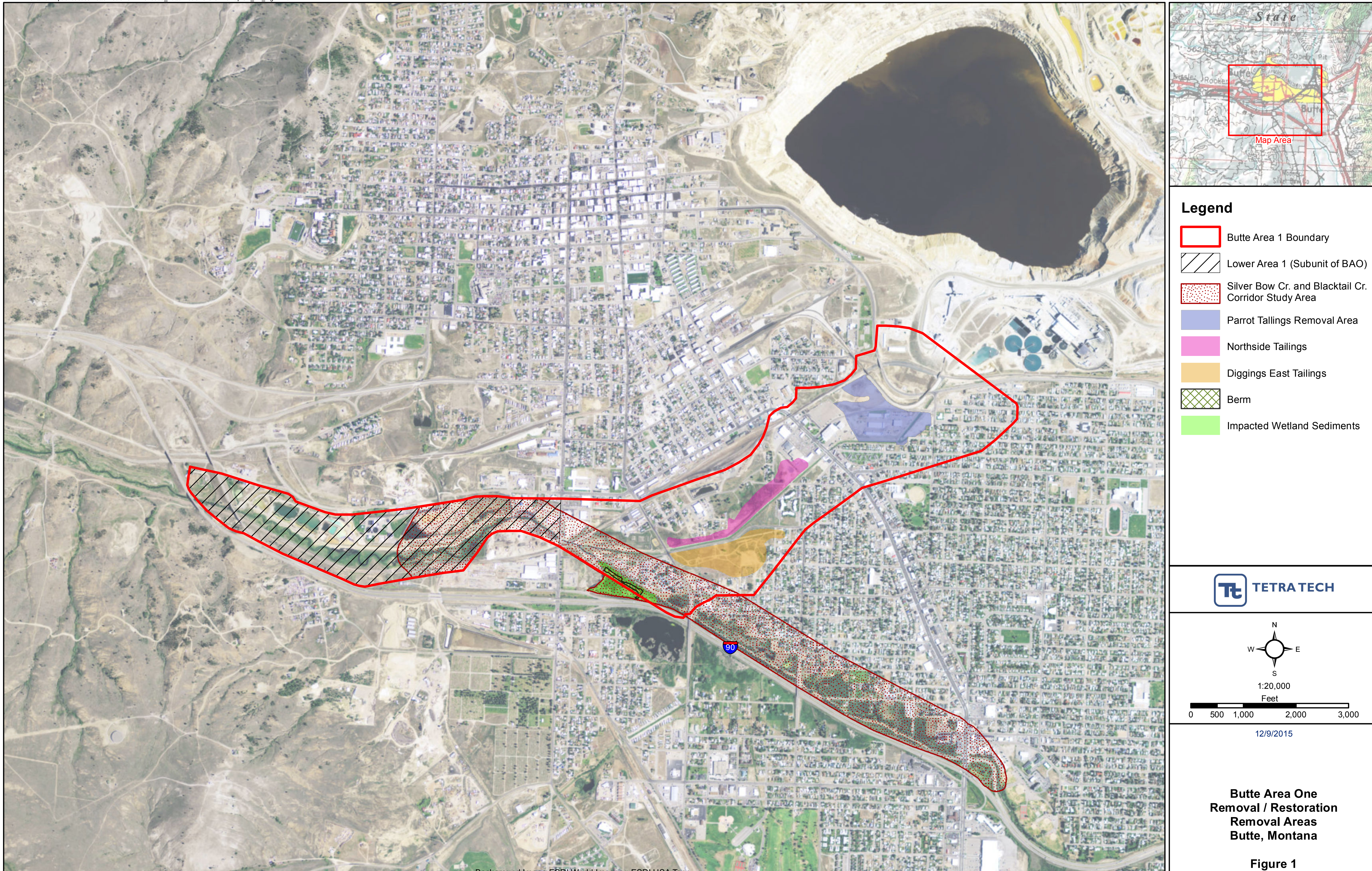
QAPP APPENDIX A

FIGURES

O:\H-M\Montana Dept of Justice\ButteAreaOne\114-570956_ButteAreaOne\GIS\ArcMap\SB_BT_Fig1.mxd



Butte Area One
Removal / Restoration
Removal Areas
Butte, Montana

Figure 1

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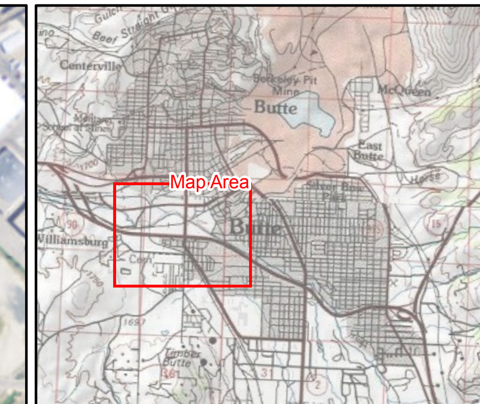

Legend

- Existing Monitoring Well
- Berm Sample (2014 Boring)
- Pore Water, Surface Water, and Wetland Sediment Sample
- Pore Water, Streambed, and Surface Water Samples
- Stream Bank Sediment Sample
- Test Pit
- DPT Boring and Piezometer
- Berm
- Impacted Wetland Sediments

TETRA TECH

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3/31/2016

Silver Bow Creek and Blacktail Creek Corridors

Figure 2A

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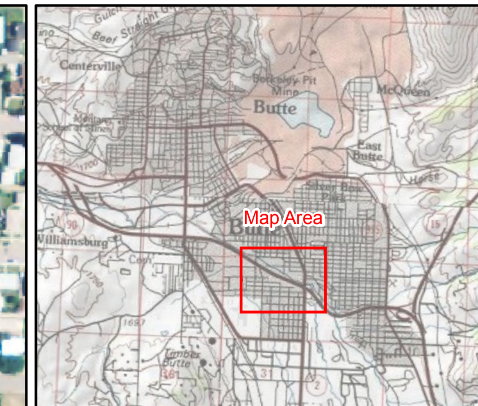

Legend

- Existing Monitoring Well
- Berm Sample
- Pore Water, Surface Water, and Wetland Sediment Sample
- Piezometer
- Pore Water, Streambed, and Surface Water Samples
- Stream Bank Sediment Sample
- Test Pit
- Wetland Sediment Sample (DPT)
- Berm
- Impacted Wetland Sediments

TETRA TECH

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2/22/2016

Silver Bow Creek and Blacktail Creek Corridors

Figure 2B

QAPP APPENDIX B

LABORATORY QUALITY ASSURANCE MANUAL

ENERGY LABORATORIES-BILLINGS, MT
QUALITY ASSURANCE MANUAL

Revision May 4, 2015

Energy Laboratories, Inc.
1120 South 27th Street
PO Box 30916
Billings, Montana 59107

Toll Free: (800) 735-4489
Local: (406) 252-6325
Fax: (406) 252-6069
E-Mail: eli@energylab.com

William T Brown
President

Digitally signed by Bill Brown
DN: dc=com, dc=bl2000, ou=BL, ou=Admin, cn=Bill Brown
Date: 2015.05.14 17:16:38 -06'00'

President:

Cindy Rohrer
Laboratory Manager

Digitally signed by Cindy Rohrer
DN: dc=com, dc=bl2000, ou=BL, ou=Metals, cn=Cindy Rohrer, email=crohrer@energylab.com
Date: 2015.05.15 08:00:40 -06'00'

Laboratory Manager

Cornelius A Valkenburg Jr
Corporate Quality Assurance Officer

Digitally signed by Andy Valkenburg
DN: dc=com, dc=bl2000, ou=BL, ou=Analysis, cn=Andy Valkenburg, email=avalkenburg@energylab.com
Date: 2015.05.15 09:17:56 -06'00'

Quality Assurance Officer:

www.energylab.com

TABLE OF CONTENTS

ELI COMMITMENT

Energy Laboratories, Inc. Strives Toward:

1. Being highly skilled in the field of analytical chemistry.
2. Delivering quality and service with integrity.
3. Encouraging the professional development of our staff.
4. Offering our employees a safe and positive work environment.
5. Being profitable and using resources wisely for a sustainable future.

INTRODUCTION

Energy Laboratories, Inc. provides chemical, industrial hygiene, and environmental analytical services to private industry, agricultural industry, engineering consultants, government agencies, and private individuals. Analytical services include: analysis of waters and soils for inorganic and organic constituents, aquatic toxicity testing, hazardous waste analysis, radiochemistry, industrial hygiene, microbiology, soils and water physical parameters, and petroleum analysis.

Founded in 1952, Energy Laboratories currently incorporates five separate testing laboratories. The corporate headquarters are located in Billings, MT, with branch laboratories located in Casper, WY; Gillette, WY; College Station, TX; and Helena, MT.

ELI, as a coordinated company of five participating branches, has developed a QA program that takes into account the various method types and EPA programs, while also considering sample matrices, to develop a single comprehensive set of QA guidance. We have used scientific approaches, Good Laboratory Practices, EPA Methods and Guidance documents, and accreditation audit guidance to develop our overall QA Program.

The Quality Assurance Program establishes acceptable performance criteria for all routine analytical procedures being performed by laboratory personnel. The Quality Assurance Assessment Program provides a formal system for evaluating the quality of data being generated and reported. The ELI Laboratory Safety Manual & Chemical Hygiene Plan defines the safety and monitoring procedures used by laboratory personnel in laboratory operations. These, in addition to the experience and expertise of our analysts, provide a comprehensive Quality Assurance Program. Energy Laboratories, Inc., in Billings, Montana, is certified under the Safe Drinking Water Act by Region VIII EPA for Wyoming, and the States of Montana, Idaho, Colorado, Nevada, Texas, North Dakota, and South Dakota. ELI-Billings also holds accreditation for Clean Water Act, Safe Drinking Water Act and Resource Conservation Recovery Act (RCRA) parameters through the National Environmental Laboratory Accreditation Program (NELAP), which is supported by the EPA. The NELAP certification is maintained through the state of Florida. Individual State approval for RCRA and CWA (NPDES) is managed through the Federal/State DMRQA program or through reciprocal certifications when required by a specific state. ELI obtains these certifications either through reciprocal recognition of ELI's primary Montana State or NELAP certification. To perform radon testing, ELI is certified under the National Radon Proficiency Program administered by the National Environmental Health Association. Branch laboratories of ELI are certified in their own state and in additional states. Copies of ELI's certificates for all laboratories are maintained on ELI's website: www.energylab.com.

The ELI Quality Assurance Manual and the ELI Technical Services and Fee Schedule together are used to outline the ELI Quality Assurance/Quality Control Program. This Quality Assurance Manual is appropriate to all departments of Energy Laboratories-Billings. The procedures discussed or referenced in this manual describe our day-to-day laboratory practices and adhere to USEPA Safe Drinking Water Act, and TNI (The NELAC Institute) requirements as well as Good Laboratory Practices (GLPs). Information on the ELI-Billings and all other ELI branch labs applicable accreditations and certifications are maintained on the ELI website at www.energylab.com.The primary NELAC accreditation for the ELI Billings laboratory can be found in Appendix A of this plan. Where possible, ELI uses EPA, AOAC, ASTM, APHA, NIOSH, OSHA, or published analytical methods and follows the procedures with strict adherence to described protocol and recommended QA/QC parameters. The analytical methods approved and in use are described in Standard Operating Procedures, and are available for review at the laboratory. Vital parts of our Quality Assurance Program, Quality Control and Quality Assessment programs are outlined in Chapters One and Two of this manual.

To generate data that will meet project-specific requirements, it is necessary to define the type of decisions that will be made and identify the intended use of the data. Data Quality Objectives (DQOs) are an integrated set of specifications that define data quality requirements and the intended use of the data. Project-specific DQOs will be established as needed for both field and lab operations. Through the DQO process, appropriate reporting limits, extraction/digestion methods, clean-up methods, analytical methods, target analytes, method quality control samples, sample security requirements, quality control acceptance ranges, corrective action procedures, reporting formats and reporting limits can be specified. Professional laboratory project managers are available to assist clients in specifying appropriate laboratory analyses and reporting procedures necessary to meet project requirements.

Client-specific DQOs can be coordinated with the laboratory through our Project Managers via quotations or contracts, or with relevant documentation provided to the laboratory prior to (or at time of) sample receipt. Client-specific requirements are communicated to analysts and final report validators through the laboratory LIMS system. By default, our methods, analytes, and QC parameters are set up to meet the DQOs specified in the referenced method and/or federal/state regulations. ELI encourages clients to provide ELI documentation of any client-specific, regulatory or project monitoring requirements.

Certain types of requests may not be suitable to standardized analytical methods. These custom requests are handled individually with laboratory management and staff scientists. Project-specific methods and reporting packages are available. Attention to documentation of the analytical procedure and use of suitable QC parameters is maintained according to good scientific discipline and Good Laboratory Practice guidelines.

The ELI-Billings laboratory manager, or their designee, will evaluate all new contracts to determine that the laboratory is capable of performing the requested work. This process includes ensuring that the laboratory maintains the required accreditation, equipment and resources. In the event that sample analysis is not performed at our Billings location, clients are notified on the laboratory analytical report if the work is subcontracted to a qualified branch laboratory or an outside laboratory (See Subcontracting Policy – Chapter 6 in this QA Manual).

This Quality Manual and related quality documentation meet requirements of the National Environmental Laboratory Accreditation Program (NELAP), which is an EPA approved accreditation program.

CHAPTER 1 – QUALITY CONTROL PROGRAM

Quality Policy Statement

Energy Laboratories, Inc. is committed to producing laboratory data of known and documented quality that is scientifically valid, meets method specifications, satisfies regulatory requirements, and accomplishes the data quality objectives of the client and project. Management ensures that the laboratory maintains current certifications and is in compliance with accreditations through USEPA, State Agencies, and NELAP. Those method, regulatory, and client requirements (as well as the policies, procedures, and all referenced documents) are incorporated into our Quality Assurance Program; which is outlined within this Quality Assurance Manual. Our Quality Systems are designed to comply with the standards as defined by the most current version of the NELAC accreditation standard and ISO 17025 standards. To ensure compliance with these standards, all laboratory personnel are required to be familiar with quality documentation and implement those policies and procedures in their work. ELI is dedicated to the continual improvement of the management system's effectiveness by providing appropriate corporate resources to set objectives, offering training opportunities, and monitoring the quality performance of our staff. ELI also provides facilities and equipment adequate and appropriate to these objectives.

Quality Assurance Program

The purpose of the Quality Assurance Program is to ensure that the analytical services provided by Energy Laboratories are of high quality, data is within established accuracy and precision limits (required by the referenced method or Standard Operating Procedure), and each analytical result produced meets or exceeds our accreditation requirements. Management ensures that the integrity of the management system is maintained. The Technical Director, or their designee, ensures that changes to the management system are planned, implemented and documented.

Management establishes and maintains data integrity by providing the following to ELI's data integrity system:

1) Data Integrity Training (Including the highest standards of ethical behavior)
2) Periodic review of data integrity procedural documentation
3) Annual review of data integrity procedures with updates as needed
4) Periodic, in-depth monitoring of data integrity
5) Maintenance of signed data integrity documentation for all laboratory employees

All employees are expected to implement and follow the policies contained within the Quality Assurance Program. Internal documents (controlled and associated with the Quality Assurance Program) are listed in Appendix B.

The quality systems in the program consist of the policies and procedures, and all referenced documents, described in this Quality Assurance Manual. The Quality Control Program also functions to maintain the laboratory's compliance with accreditations through USEPA, State Agencies, and NELAP.

The Quality Control Program requires that the following points be met for each applicable analytical method:

- Performance of any analytical method requires that the proper equipment and instrumentation are available. A list of major equipment is listed in Appendix F. The procedure for operation of an analytical instrument is described in the equipment manufacturer's operating manual, and may also be supplemented with a specific Standard Operating Procedure (SOP) for the instrument and/or the method.

- Specific SOPs cover operation of the instrument including the sequence of operations involved in instrument start-up, calibrating, analyzing, and shutting down. Chapter Thirteen of this manual includes recommended preventative maintenance, and/or a list of parameters used to identify other types of maintenance. SOPs outline any special safety precautions for operation of the instrument.

- SOPs of well-detailed EPA, ASTM, NIOSH, APHA, OSHA, or published procedures include, as appropriate, a list of any method-specific items or variances, a list of QC parameters and their recommended method performance ranges, recommended or example analytical sequences, specific or unique safety information, method references, and a signed signature page. SOPs details, and format of method SOPs, follow NELAP requirements. Detailed SOPs may be prepared for those procedures that do not have published methods. Further details of SOP format and information required in method SOPs can be found in the ELI SOP, *Preparation, Numbering, Use, and Revision of Standard Operating Procedures.* Written Standard Operating Procedures referenced within this manual are available at the laboratory for review. (ELI SOPs are considered confidential proprietary information and ELI does not allow copies to be removed).

- For radiochemical analysis performed at ELI's branch labs, each method undergoes Method Validation as outlined in EPA's specific method and/or the Multi-Agency Radiological Laboratory Analytical Protocols Manual (MARLAP), Chapter 6.

- The required detection level (RDL) for radiochemical analysis of drinking water samples is calculated based on the requirements in 40 CFR 141.25(c), which is a sample specific determination. The equation is specific for each method and noted in the method-specific SOP.

- The initial test method evaluation for chemical analysis involves Method Detection Limit (MDL) studies, (refer to ELI SOP, *Determination of Method Detection Limits (MDL) and Quantitation Limits*), confirmation of the Limit of Detection (LOD) and/or Practical Quantitation Limit (PQL), also known as the Limit of Quantitation (LOQ), an evaluation of method performance (using four or more replicates of quality control samples), evaluation of the selectivity of the method, and any additional method-specific requirements

- ELI demonstrates that laboratory staff is qualified and capable of performing the method. Analysts are assigned duties based on their skills and experience. Training records are maintained for all analysts. Curricula vitae of supervisory and senior analysts are described in Appendix E.

- It is the responsibility of the analyst to become thoroughly familiar with the methodology and instrument operation before performing the analysis. It is the responsibility of the person providing training to monitor all laboratory results generated for a reasonable time. The amount of time necessary may vary depending on the method and the experience of the analyst. At a minimum, the analyst's performance is to be monitored until the analyst demonstrates the ability to generate results of acceptable accuracy and precision according to the method.

- All analysts are required to demonstrate and maintain a record of proof of competency by routinely analyzing quality control samples appropriate to the analytical procedures they perform. Competency in analyzing these control samples is documented in analysts' training files per NELAP requirements (for more information, see ELI SOP, *Personnel Training and Training Records*). For those analyses where external proficiency testing (PT) samples are not routinely analyzed, competency is documented by including the results of routine analysis of method-specific quality control samples (prepared by laboratory staff) and/or a verifying statement of procedural review by a supervisor or trained analyst.

- Each analytical method is subjected to quality control monitoring. The purpose is to demonstrate that results generated meet acceptable accuracy and precision criteria for the method. Precision and bias are determined for standard and non-standard methods. Precision and bias are determined for standard methods through control charting of data from quality control samples. Precision and bias using non-standard, modified standard or laboratory-developed methods are compared to the criteria established by the client (when requested), the method, or the laboratory.

- Quality control requirements are outlined in the methods and ELI, at a minimum, follows the guidelines specified in the methods used. Additional QC requirements are also added as appropriate. Statistical method performance is periodically evaluated against method requirements using control charts.

- Quality control monitoring to measure accuracy for each method generally requires that five to ten percent of all samples analyzed be fortified (spiked) with a known concentration of target analytes tested by the method. The percent recovery is then calculated. This provides a means for monitoring method accuracy and evaluating sample matrix effects. Where appropriate, surrogates are included in the method to monitor method performance on each individual sample. Blank spike samples replace matrix spike samples for certain methods, or when there is insufficient sample for a matrix spike analysis. Historical, routine batch QC sample performance can be used to estimate the precision and accuracy of the method.

- Quality control monitoring to measure precision for each method requires replicate samples be prepared and analyzed when appropriate. Actual requirements are outlined in the specific SOP. When replicate samples or matrix spike duplicates are analyzed, relative percent difference is calculated and used to monitor precision of the method. In instances where there are no specific method requirements, it is the policy of this laboratory to analyze five to ten percent of all samples in duplicate. Duplicate test results must be within the control limits established for each analysis type or data is qualified. Acceptance limits generally follow specifications listed in the method. Matrix spike duplicates replace sample duplicates for most methods.

- When not defined in the method, and as appropriate, method blanks and/or instrument blanks are analyzed one in every 20 samples at a minimum. Method blanks are used to verify that contamination from laboratory reagents and glassware is not present in the analytical sample process. Generally, the method blank should be less than the reporting limit, or 10 times less than the concentration amount in the sample, for the analytical parameter being tested, whichever is greater.

- When not defined in the method, and as appropriate, method spikes (blank spikes) are analyzed one in every 20 samples, at a minimum.

- Calibration standards are analyzed and calibration curves are developed for all applicable methods. For additional information on instrument calibration, see Chapter Seven of this QA manual.

- The initial calibration is continuously monitored by analyzing a continuing calibration standard every 10 to 20 samples, or within a specified time frequency, and at the end of each analytical sequence; depending on the method and instrumentation. Results must be within an established range as described by the method SOP. Initial calibrations are verified against a standard from a second source.

- Proficiency testing samples and further quality control check samples may be required for various methods. Refer to Chapter Two of this QA manual for further details.

Estimation of Uncertainty

The estimation of uncertainty consists of the sum of the uncertainties of the individual steps or processes of an analytical procedure. The variability of the sampling plan, sample heterogeneity, extraction procedure, instrument calibration, instrument drift, systematic bias, and many other factors all contribute to the uncertainty of a measurement or result.

ELI estimates uncertainty utilizing Confidence Intervals defined as $\pm 2\sigma$ (95%) and $\pm 3\sigma$ (99%) where σ is the standard deviation of the recovery of quality control samples. The confidence intervals calculated from these QC samples are based on the spike level concentrations for each method. Uncertainty at low concentrations may be one to three times the quantitation limit. Real world samples, depending on matrix interferences, may have a greater amount of uncertainty associated. Due to limitations in assessing the uncertainty for each matrix type, the confidence intervals calculated from method QC samples provides an estimate of uncertainty.

Energy Laboratories, Inc. uses the procedures outlined in ELI SOP, *Control Chart Generation and Maintenance*, for the purpose of evaluating estimation of uncertainty for chemical analyses and uses the determination of uncertainty on a sample-specific basis for all radiochemistry measurements. These estimates of uncertainty have formulas documented in the individual SOP.

Maintenance of Performance Records

All quality control monitoring is recorded and documented. Quality control data is recorded in laboratory notebooks, electronic summary files, and/or analysis sheets. Generally, review of QC data and trends is managed within the Laboratory LIMS system. QC data management and control chart generation, maintenance, and usage are described in ELI SOP, *Control Chart Generation and Maintenance*. It is the responsibility of the analyst to see that all results are recorded in a timely manner.

All quality control data is filed and available for inspection and assessment by analysts, supervisors, management, and quality control personnel.

Method Quality Control Specifications

Summaries of Quality Assurance/Quality Control specifications for a selected subset of procedures offered by ELI are outlined in Appendix C. These types of tables are available upon request for our clients to use in the preparation of Quality Assurance Project Plans (QAPPs). Exact details of method QC can be found in the applicable method SOPs.

CHAPTER 2 – QUALITY ASSESSMENT PROGRAM

The function of the Quality Assessment Program is to provide formal evaluation of the quality of data being generated and reported by the laboratory. External and internal quality control measures are used in this assessment. These measures include proficiency testing samples, laboratory quality control check samples, and routine internal and external audits on methodology and documentation procedures.

Proficiency Testing (PT) Samples

PT samples are supplied by an outside entity and contain known amounts of constituents. The laboratory does not have access to known values of the samples. Only the PT provider has knowledge of constituent levels prior to the formal publishing of the test results.

PT samples are received on a routine basis, with results sent to the providing entity for evaluation. Proficiency Testing (PT) samples for USEPA, NELAP and various State certifications are Water Pollution Study samples (WP or DMRQA), Water Supply Study samples (WS), and LPTP Soil PT samples provided by either Resource Technology Corporation (RTC) and/or Environmental Resource Associates (ERA); both being NELAP approved PT providers. Routine participation in LPTP, WS and WP PT sample studies is used to maintain certifications for Safe Drinking Water Act (SDWA), Clean Water Act (CWA), National Pollutant Discharge Elimination System (NPDES), Discharge Monitoring Report Quality Assurance (DMRQA), permit monitoring analyses, Resource Conservation and Recovery Act (RCRA) analyses, as well as other states and projects requiring method accredited parameter analyses. The samples are analyzed in the same manner as any routine sample in the laboratory. Acceptable results are those that fall within a defined range as determined by the vendor/EPA/ NELAP; based on multi-laboratory study results. The provider sends results to USEPA and other certifying agencies as requested by ELI-Billings. PT study results are posted on the ELI website www.energylab.com.

A copy of the certificate for our primary certifications to perform drinking water analyses issued by the State of Montana and the NELAP certificate from Florida Department of Health are included in Appendix A. The Montana certification includes a list of parameters/methods for which drinking water certification has been granted. The NELAP certificate also includes RCRA methods used for hazardous waste characterizations and CWA parameters/methods which are used for NPDES monitoring permits. ELI also participates in the Federal/State DMRQA programs for clients which require/request this with their NPDES permits. Reciprocal accreditation in other states is based on either of these, or both, depending on specific state certification requirements/parameters. A list of current certifications is maintained on the ELI website at www.energylab.com.

Proficiency testing samples for Radon Proficiency testing certification are from the National Environmental Health Association (NEHA), an EPA approved commercial Radon testing certification association. Our own radon sampling canisters are submitted to NEHA for known levels of radon exposure. Acceptable results are those that fall within a defined range based on multi-laboratory study results.

Blind Quality Control Check Samples are samples submitted as regular lab samples and are processed through the system in the same manner as any other sample. The analysts do not know the true values of these samples when performing the analyses. Method performance reports are returned to the analysts. Clients occasionally submit these types of samples for their QAPP.

Inter-Laboratory comparison samples are samples containing known/unknown quantities of analytes that are split and analyzed by more than one laboratory.

Quality Control Check Samples

Quality Control Check Samples are performance evaluation samples used for routine method performance monitoring. As appropriate, analytical procedures include the analysis of a quality control sample with every sample batch analyzed. The materials are obtained from a commercial source when available, or they may be prepared in-house. Acceptable results are within a defined range based on certified ranges, or against statistically determined control limits, method-defined criteria or client defined Data Quality Objectives. Routinely used methods not subjected to PT sample monitoring are evaluated with Quality Control Check Samples, as appropriate.

QC samples are processed through the system in the same manner as any other sample, except the analyst is aware of the source, concentration, and acceptance ranges of target analytes and calculates analyte recoveries to evaluate method performance in real time.

Quality Assurance Audits

Quality Assurance Audits consist of internal and external laboratory inspections designed to monitor adherence to Quality Systems and quality control requirements. These audits check general laboratory operations, overall Quality Systems, adherence to QA program requirements, sample tracking procedures, sample holding times, storage requirements, adherence to procedures during analysis, calculations, completion of required quality control samples within the group surrounding the sample, and proper record-keeping.

Internal quality control audits are conducted or coordinated by the Quality Assurance Officer of the laboratory. See ELI SOP, *Internal Quality Assurance Audits*, for further information. ELI conducts internal inspections on a regular basis to monitor adherence to quality control requirements. Results of formal audits are given to management with possible recommendations for corrective action in the event any discrepancies are found. As necessary, a follow-up review is conducted to determine that identified problems have been addressed. Annually, the overall quality systems of the laboratory are reviewed and a summary report is prepared.

Per NELAP/ISO 17025-2005 requirements, the management of the laboratory will conduct an annual review of the Quality System, including policies, procedures and environmental testing activities. This is done to ensure the continuing suitability and effectiveness of the QA systems, as well as provide the opportunity to introduce necessary changes or improvements. The review shall take into account, at a minimum, the following:

- The suitability of policies and procedures
- Reports from managerial and supervisory personnel
- The outcome of recent internal audits
- Corrective and preventative actions
- Assessments by external bodies
- The results of inter-laboratory comparisons or proficiency tests
- Changes in the volume and type of work
- Client feedback
- Complaints
- Recommendations for improvement
- Other relevant factors, such as quality control activities, resources and staff training

The findings from management reviews and the corrective actions that arise from these findings shall be recorded. The management shall ensure that any corrective actions are carried out within an appropriate, pre-determined time frame.

ELI also conducts Peer Audits as part of an internal auditing program established within the company. This process utilizes analysts and supervisors from other branch laboratories to evaluate a designated ELI branch. The Peer Audits serve to not only address conformance issues, but also provide ELI with a tool to continuously improve process and consistency throughout the company. The goals of the Peer Audits are to:

- Encourage relationships between analysts
- Transfer technical knowledge between peers
- Establish consistency of analytical process/method between branch laboratories
- Identify the depth of analysts' knowledge at each position by observing what analysts are doing at the bench
- Determine training needs of personnel
- Document process/method and verify that issues are being corrected when found
- Work with, and in support of, QA department efforts

Depending on the size of the laboratory, a large number of methods and processes are examined during a Peer Audit. Results from these audits are provided to the branch management, as well as Corporate Management. Corrective Action Plans of a Peer Audit are initiated with the assistance of the Corporate Quality Assurance Officer for resolution of any findings.

ELI welcomes external Quality Assurance Audits, by qualified outside auditors, for review and comment on the overall QA program. To maintain certifications, accrediting authorities from the State of Montana, USEPA, and NELAP conduct periodic comprehensive external audits. External audits to meet Quality Assurance Project Plans (QAPPs), as applicable to environmental remediation projects, or for major industries, are conducted as requested. For more information, see ELI SOP, *External Quality Assurance Audits*.

CHAPTER 3 – LABORATORY FACILITIES

The facility for Energy Laboratories, Inc. – Billings, MT consists of multiple buildings with over 35,000 square feet of total space; these buildings are located in Billings at 1120 South 27th Street, Billings MT 59101.

The phone number for Billings Energy Laboratories, Inc. is (406) 252-6325, the fax number is 406-252-6069, the toll free number is 800-735-4489, and the email address is eli@energylab.com.

Laboratory space includes adequate bench top and floor space to accommodate periods of peak work load. Working space includes sufficient bench top area for processing samples; storage space for reagents, chemicals, glassware, bench and portable equipment items; floor space for stationary equipment; and adequate associated area for cleaning glassware. Laboratory departments are organized and the facilities are designed for specific laboratory operations in order to protect the safety of analysts and to minimize potential sources of contamination between and within department areas (for more information, see ELI SOP, *Facility Description, Access, and Security*).

The laboratory is appropriately ventilated and illuminated, and is not subject to excessive temperature changes. Specific laboratory areas are temperature and humidity controlled as required. Ample cabinets, drawers and shelves are available for storage and protection of glassware. Exhaust fume hoods are available as needed for use during preparation, extraction, and analysis of samples. Employee exposure monitoring is conducted to provide a safe working environment.

To maintain security, all visitors must enter their name on the ELI sign-in log at the front desk and wear a visitor's badge.

The laboratory has provisions for the disposal of chemical and microbiological wastes. These provisions are described in Standard Operating Procedures as well as outlined in the Laboratory Safety Manual & Chemical Hygiene Plan along with other safety and health guidelines. For more information, see ELI SOP, *General Laboratory Waste Disposal*.

CHAPTER 4 – PERSONNEL REQUIREMENTS AND LABORATORY ORGANIZATION

Relationship between Management, Technical Operations, Support Services and the Quality System

Laboratory Organization

The corporate organization of the five ELI laboratories located in Montana (2), Wyoming (2), and Texas is provided in Appendix D. The Billings laboratory is the center for all corporate functions. Each laboratory is managed and operated individually under the supervision of a Laboratory Manager. Branch laboratories have fiscal and QA/QC responsibilities to Corporate, as well as general operating policies and goals. Quality Assurance Manuals are prepared individually for each branch and follow the QA/QC program outlined in the ELI-Billings QA manual.

The ELI-Billings Organizational Chart is also included in Appendix D with curricula vitae of key ELI-Billings laboratory personnel maintained in Appendix E of this manual.

Quality Assurance receives direct support from senior management. Branch Quality Assurance Officer reports directly to the Corporate Quality Assurance Officer as well as the Laboratory Manager. Quality Assurance Officers provide independent oversight of Quality Systems within the overall Energy Laboratories structure. When Quality Assurance Officers fill more than one role within the organization, they operate independently of direct environmental data generation while fulfilling quality assurance responsibilities. Quality Assurance Officers facilitate development of and maintain the branch Quality Assurance Manual, provide assistance to personnel on quality assurance / quality control issues, maintain a quality assurance training program, and review quality documentation including SOPs.

Management ensures the development and implementation of programs and policies to continuously improve the effectiveness of ELI's QA Program and Management Systems. Management performs an annual review of the laboratory's Quality System (policies, procedures, work instructions) to assure their continuing suitability and effectiveness (See ELI SOP: *Management Reviews*, for detailed procedures). As appropriate, management identifies and implements any necessary changes or improvements. Corrective and preventive actions are detailed in a Corrective Action Report and filed with the QA Department. (Refer to ELI SOP: *Nonconformance Procedures and Corrective/Preventive Action Reports,* for detailed procedures.) In addition, management performs meetings with supervisory and key staff members throughout the year. Supervisors and QA personnel provide input on their specific areas of responsibility and evaluate the following:

1) Client-Related Items
2) Internal and External Audit Reports
3) Proficiency Testing Results
4) Review of Performance by Department

5) Corrective and Preventive Actions
6) Personnel Training Needs
7) Quality System Policies and Procedures
8) Resources including Personnel, Equipment and Facilities

Laboratory Management Review findings are compiled into a summary report. The report includes deficiencies identified and areas for improvement. The QA department ensures items from the Management Review are tracked, including actions that must be addressed, assignment of parties responsible for the actions to be taken, and recommendations on improvements to the Quality System. The Technical Director, Laboratory Manager, Quality Assurance Officer or designee, shall assign specific persons to address management review findings and establish deadlines for their completion. The Technical Director, Laboratory Manager, Quality Assurance Officer or designee, reviews and approves all QA documents issued to personnel in the laboratory as part of the management system. The Technical Director, or designee, has overall responsibility for the technical operations of the laboratory. Any procedural deviations to SOPs that are client or project-specific must receive approval either from the Technical Director, Laboratory Manager, or Quality Assurance Officer. Work is stopped when identification of any of the following is made: unapproved departures from the management system, unauthorized deviations from the procedures for performing tests and/or calibrations, and data quality or data integrity issues. The Technical Director, Laboratory Manager, QA Officer, or designee, is responsible for providing authorization for the work to resume once the identified issue has been addressed.

Personnel Requirements

ELI maintains experienced staff and management. Below is a summary of the primary roles, responsibilities and qualifications for the designated positions. Laboratory experience can be substituted for academic requirements. At ELI's smaller laboratory operations, the technical director may serve multiple roles. Detailed job descriptions are maintained by the Human Resources department. Specific titles of employees are at the discretion of the Laboratory Manager.

Laboratory Manager

The Laboratory Manager is required to have education equivalent to a Bachelor of Science degree in Chemistry or a related science. Five years of relevant laboratory experience is required.

The Laboratory Manager is responsible for all operations, client management, analysis scheduling, equipment acquisition, as well as compliance with all employment, safety, environmental and NELAP/ISO 17025 regulations. The Laboratory Manager may delegate daily activities of these work aspects to appropriate personnel. The Laboratory Manager reports directly to the Corporate Director of Operations. All Laboratory Managers have both technical and management responsibilities.

Quality Assurance Officer

The Quality Assurance Officer is required to have an education or experience equivalent to a Bachelor's of Science degree in Chemistry or a related science. Five years of relevant laboratory experience is preferred.

The Quality Assurance is responsible for quality systems development, implementation, and management. The Quality Assurance Officer is also responsible for maintaining and improving compliance with all applicable state and federal regulations as well as maintaining compliance with NELAP/ISO 17025 regulations regarding Quality Systems. The Quality Assurance Officer or his/her designee manages the laboratory's certification programs to meet government regulatory requirements. The QA program is implemented in cooperation with all levels of management and staff. Quality Assurance Officers report directly to the Corporate Quality Assurance Officer. The Laboratory Manager will direct daily laboratory-specific QA/QC requirements.

Technical Director

The Technical Director is required to have a Bachelor of Science degree in Chemistry or a related science. Five years of relevant laboratory experience is required.

The Technical Director is responsible for ensuring compliance with all laboratory policies and that the analyses conducted under their supervision are compliant with all state, EPA, and NELAC/ISO17025 standards. The Technical Director reports directly to the Laboratory Manager.

The Technical Director may serve multiple roles. Laboratory Managers serve as one of the branch Technical Directors.

Laboratory Supervisor

A Laboratory Supervisor is required to have education equivalent to a Bachelor of Science degree in Chemistry or related science. Two years of relevant laboratory experience is required.

ELI's Laboratory Supervisors are responsible for the day-to-day operation of the laboratories: scheduling testing, assigning work, and completing the technical review of laboratory data. Supervisors are responsible for ensuring compliance with all laboratory policies and ensure that the analyses conducted under their supervision are compliant with all state, EPA, and NELAC/ISO17025 standards. They report directly to the Laboratory Manager.

Analysts

Analysts are required to have an education equivalent to a Bachelor of Science degree in Chemistry (or related science), or a High School diploma with experience as an analyst in training. New analysts require a minimum of six months of on-the-job training, under direct supervision of a qualified analyst, in the measurements being considered for certification. After the initial training period, and on a continuing basis thereafter, the analyst must demonstrate acceptable skills through the successful participation in the analysis of applicable performance evaluation and quality control samples.

Analysts perform the following duties: Preparation of samples and reagents, analysis and preliminary data input, as well as various other tests. Analysts are responsible for complying with all laboratory policies and procedures.

Laboratory Technicians

Laboratory Technicians are required to have a High School Diploma or equivalent. Laboratory Technicians work under the supervision of the primary analyst performing general laboratory tests.

Under the supervision of a primary analyst, Laboratory Technicians perform the following duties: preparation of samples and reagents, analysis, and preliminary data input, as well as various other tests.

Laboratory Technicians are responsible for complying with all laboratory policies and procedures.

Approved Signatories

Signatures for policies are based on appropriate individuals, roles and responsibilities as determined by the policy being reviewed and approved. A list of significant signatories is included below. Additional signatures may be required for specific procedures.

- Laboratory Manager
- Technical Director
- Quality Assurance Officer
- Corporate Officer- Board of Directors

A master list including signatures and initials for all employees is maintained for reference and signature verification.

CHAPTER 5 – SAMPLING PROCEDURES

Private individuals or companies, who are responsible for using proper collection procedures, collect most of the samples processed in this laboratory. Members of the staff are acquainted with proper sample collection and handling procedures and advise those who need help in this area. Instructions and forms for initiating Chain-of-Custody are available from ELI. Laboratory procedures for logging in samples for analysis and maintaining Chain-of-Custody are described in ELI SOP, *Sample Receipt, Login, and Labeling*.

When the laboratory has been assigned the responsibility of sample collection, there is strict adherence to correct sampling protocols, initiation of chain-of-custody, sampling documentation, complete sample identification, and prompt transfer of sample(s) to the laboratory. Procedures are described in ELI SOP, *Field Sampling*.

This laboratory provides proper sample containers and preservatives as specified for the procedure. Certified sample bottles may be ordered upon request. Sample containers, preservatives, coolers for shipping, re-sealable plastic bags for ice containment, trip blanks for monitoring contamination during shipping, temperature blanks for accurately monitoring sample receiving temperatures, Chain-of-Custody forms, Chain-of-Custody seals, sample bottle labels, instructions for sampling, sample labeling, sample preservation, and sample packaging/shipping are provided upon request. Sample container type, sample volume, preservation requirements, and maximum holding times, are detailed for each analyte/method in the ELI Technical Services and Fee Schedule. See the ELI website, www.energylab.com for the current pricing.

Energy Laboratories maintains a strict Sample Acceptance Policy. The client is immediately notified (as appropriate) upon sample receipt if there is any doubt concerning the sample's suitability for testing, including but not limited to, when:

- Samples are out of temperature compliance;
- Samples are received in unacceptable containers;
- Samples have not been properly preserved*;
- Samples have labels or chain-of-custody procedures that are incomplete;
- Samples cannot be analyzed within method recommended holding time; or
- The custody seal has been broken.

Notification of sample receipt condition is available through the final report, Energy Source, Email, telephone and/or voice.

Samples not collected or documented properly can be rejected for any regulatory-based analysis with re-sampling recommended. If re-sampling is not possible, or the client cannot be contacted, the sample may be analyzed, and if analyzed, the sample will be clearly qualified in the data package.

The laboratory will preserve samples at the time of sample login if samples are unpreserved and preservation is required by the methodology. Aqueous samples for volatile analysis are checked for preservation at the time of analysis. Samples for microbiological analysis are collected in pre-sterilized 120 mL plastic bottles containing sodium thiosulfate.

Sample preservation should be performed immediately upon sample collection. For composite samples, each aliquot should be preserved at collection. Refer to ELI Technical Services and Fee Schedule for detailed information on sample preservation requirements per applicable method and regulatory requirements.

The laboratory initiates a sample condition report titled Workorder Receipt Checklist at the time of sample receipt. The sample condition report contains Chain-of-Custody procedures, sample preservation status, carrier used for sample shipment, sample receipt temperature, and provides general comments concerning sample condition. The sample condition report is provided with the analytical data report package. For more information, see ELI SOP, *Sample Receipt, Login, and Labeling*.

When any sample is shipped by common carrier or sent through the United States Mail, it must comply with the Department of Transportation Hazardous Materials Regulations (49 CFR Part 172). The person offering such material for transportation is responsible for ensuring such compliance. For the preservation requirements as described in the ELI Technical Services and Fee Schedule, the Office of Hazardous Materials, Material Transportation Bureau, and Department of Transportation has determined the Federal Hazardous Materials Regulations do not apply to the following:

A) Hydrochloric Acid - (HCl) in water solutions of 0.04 % by weight or less (pH of 1.96 or greater).
B) Nitric Acid - (HNO_3) in water solutions of 0.15 % by weight or less (pH of 1.62 or greater).
C) Sulfuric Acid - (H_2SO_4) in water solutions of 0.35% by weight or less (pH of 1.15 or greater).
D) Sodium Hydroxide - (NaOH) in water solutions of 0.080% by weight or less (pH of 12.30 or less).

For regulatory compliance monitoring, it is required that all samples be analyzed within the prescribed holding times. Holding times are the maximum times allowed between sampling and analysis for results to still be considered valid. Samples should be delivered to the laboratory as soon as possible following collection to assure that holding times can be met. Samples are analyzed as soon as possible after sample receipt. When maximum holding times cannot be met, re-sampling is requested. If samples are analyzed out of hold, data is appropriately qualified.

To ensure that drinking water analysis for radiochemistry is met, the requirements for sample handling, preservation, and instrumentation for radiochemical analysis are included in ELI SOP: "*Sample Receipt, Log-In and Labeling*". (For additional information, refer to "Manual for the Certification of Laboratories Analyzing Drinking Water", Table VI-2: Sample Handling, Preservation, and Instrumentation, EPA 5th Edition, January 2005).

CHAPTER 6 – SAMPLE HANDLING

The ELI laboratory utilizes a sample tracking policy that includes client-initiated chain of custody. Upon receipt, the security of the samples is maintained by the implementation of the laboratory access and security policies. See ELI SOP, *Facility Description, Access and Security*.

Sample Receipt

All samples arriving at the laboratory are logged in the Laboratory Information Management System (LIMS). Each sample container is given a unique laboratory sample number. The sample receipt checklist evaluates Chain-of-Custody procedures, sample preservation status, carrier used for sample shipment, sample temperature, and provides general comments concerning sample condition. The completed checklist is provided with the analytical report package. Chain-of-Custody forms are checked for pertinent information. If necessary information has been omitted, the collector is notified, if possible, and the missing information is requested.

Samples requiring preservation are checked to determine if the client performed preservation. If requested, ELI staff will preserve or filter samples as appropriate. Samples that degrade quickly or cannot be opened (such as aqueous samples for volatiles) are not preserved at the time of sample login. If samples are improperly preserved, or the maximum holding times are exceeded upon arrival at the laboratory, the client is notified and re-sampling is requested.

Samples are stored per method specifications, or as method/parameter storage requirements are updated per later EPA guidance in Federal Regulations posted in 40CFR (Method Update Rules).

During sample login, all sample information such as sample description, client name and address, analyses requested, special requirements, etc. are entered into the computer database of the Laboratory Information Management System (LIMS). Requested analysis parameters and special requirements are communicated to the analysts via their LIMS work lists. Project-specific requirements are maintained in the LIMS for any samples received from a special project. This process ensures that individual requirements are maintained.

Chain-of-Custody

Evidence level internal chain-of-custody (COC) procedures are available on a project-specific basis. For these procedures, internal COC sample custody is maintained down to the individual analyst level. When transferring the possession of the samples, the transferee must sign and record the date and time on the chain-of-custody record. Every person who takes custody must fill in the appropriate section of the chain-of-custody record. When received by ELI, sample identification information on the sample containers is compared to the custody report form. The sample is inspected and information regarding the condition of the sample and seal (if used) is recorded on a report form; the method of shipping is also documented on the report form. A copy of the report form is kept with the sample data file and a copy is sent to the client with the analysis report. Internal chain-of-custody forms are used to document the progress of the sample through the laboratory. ELI's routine COC policy is maintained at the laboratory level through our laboratory access and security policies. See ELI SOP, *Facility Description, Access, and Security*.

Sample Tracking

Samples are tracked through the analytical process by the LIMS. Completed analyses, which have been approved by the appropriate reviewer as valid data, are reported in the LIMS. When all analyses are complete, the data is reviewed as a whole to ensure results pass data quality checks. The completed report is signed by an approved signatory. The signed report is sent to the client via requested delivery format. Generation of the invoice automatically completes the work order in the LIMS and removes the samples from the status report. For more information, see ELI SOP, *Document and Record Management, Control and Archiving*.

Sample Disposal

It is preferred that remaining hazardous sample material be returned to the originator (client) for disposal. When this is not possible or reasonable, ELI will dispose of remaining hazardous sample materials with a waste disposal surcharge added to the cost of the analysis.

The disposal of laboratory wastes will be performed in accordance with local, state, and federal regulations which apply to such activities. Each method SOP addresses waste minimization and management specific to the method procedure. See ELI SOP, *General Laboratory Waste Disposal,* for more information.

Subcontracting Policy

The ELI Billings laboratory utilizes the expanded branch laboratory capability and expertise to provide comprehensive analytical services. This occurs when the laboratory is requested to perform an analysis outside of the laboratory's capabilities (If sample overload is experienced; if equipment is out of service; or when the laboratory is not accredited for the particular analysis). Upon completion of the analyses, the branch laboratories report the sample results, and their quality control package, to the primary laboratory. The results are reviewed before being reported.

Branch laboratories are certified to perform drinking water analysis in their state and in neighboring states. Samples are forwarded to our branch laboratories only if the laboratory is certified in the state from which the sample originated. Individual branch laboratory Quality Assurance Programs are consistent with the Corporate Quality Assurance Program and are monitored through internal laboratory audits.

To support Energy Laboratories, Inc. Billings analytical services, ELI branch laboratories (which maintain specific instrumentation for specialized analysis) are utilized to provide complete analytical services. Refer to Appendix A for the certificates detailing routine analyses performed by the Billings branch. All branch laboratory certificates are also available on the Energy Laboratories website at www.energylab.com.

ELI Billings routinely subcontracts the following parameters/methods to branch laboratories:

Total Organic Halogens (TOX) by SW-846 9020
Total Arsenic CVAA by ASTM 3114
Low level EDB and DBCP by EPA 504
Carbamates by EPA 531.1
Glyphosate by EPA 547
Diquat by EPA 549.2
Total Organic Carbon (TOC/DOC) by A5310 C or A5310B, and SW-846 9060
Oil & Grease by SW-846 1664A
All Radiochemistry except Radon in air

In the event that ELI is dependent on the service of an outside laboratory for analyses not available through our facility or our branch laboratories, the client is notified t that their samples are subcontracted to an outside laboratory. The outside laboratory reports the results to ELI and these results become part of the final report. Any external or internal subcontracted analyses that require accredited analyses will be performed by a laboratory accredited for those parameters in the State from which the sample originated. All final reports indicate where the analyses were performed.

CHAPTER 7 – INSTRUMENT OPERATION AND CALIBRATION

Laboratory instruments and equipment are operated and calibrated according to the manufacturer's instructions and according to the requirements of the method being used. Exact calibration procedures are outlined in the appropriate SOP. For most instruments, a calibration curve composed of three to five standards covering the concentration range of the samples is prepared. The acceptance criteria for the calibration curves are listed in the individual methods. Unless otherwise specified in the method, at least one of the standards is at or below the practical quantitation limit (PQL) of the method. Routine PQLs for each method are given in the ELI Technical Services and Fee Schedule. Calibration standards are routinely compared to second source calibration standards to verify accuracy. These second source standard results must fall within an established range, as described by the SOP, to be accepted. Whenever possible, the laboratory uses calibration standards prepared from certified stock standards. Initial instrument calibration curves are verified and routinely monitored by analyzing a continuing calibration standard every 10 to 20 samples (or within a specified time frequency) and at the end of every analytical sequence, depending on the analysis method and instrumentation. When applicable to the method, high-level samples, which produce an analytical response outside the calibrated range of the instrument, are diluted (or reduced in mass) and re-analyzed until a response within the calibrated range is obtained and/or the result is appropriately qualified.

System cleanliness is verified through the analysis of reagent/instrument blanks prior to analysis, between highly contaminated samples, and at regular intervals during the analysis.

Use of measuring equipment and reagents (glassware, water, chemical reagents, and industrial gases) conform to Good Laboratory Practice guidelines. Good Laboratory Practices (GLPs) are laboratory guidelines which were established by the Food and Drug Administration and published in the Federal Register (21 CFR, part 58). The GLP guidelines were adopted by the Environmental Protection Agency. SOPs are developed in accordance with GLP and NELAP guidelines. Laboratory volumetric glassware conforms to National Institute of Standards and Technology (NIST), American Society for Testing and Materials (ASTM) Class A or B standards. All mechanical pipettes are calibrated at least quarterly. Laboratory balances are serviced annually and calibrated by certified technicians. Calibration checks of balances are performed each day of use, using ASTM Class 1 or 2 weights. Laboratory thermometers are calibrated annually against a NIST traceable thermometer and routinely checked for accuracy. Laboratory drying ovens, incubators, freezers, refrigerators, and water bath temperatures are monitored and recorded each working day, or at frequencies as described in the specific SOP. Laboratory pure water is generated by commercial water purification systems and is monitored and documented each working day in accordance with specifications needed for applicable methods. The routine analysis of laboratory blanks is used to verify laboratory water quality and the suitability of sampling containers. Chemical reagents and gases meet or exceed purity requirements for their intended uses. Laboratory stock and working standards are derived from ISO 17025 and/or 9001 (or equivalent-certified) commercially available primary standards whenever possible. Standard preparation notebooks document the reagent/standard type, source, purity, content, concentrations, preparation date, and analyst. All calibration standards are documented in each daily analytical sequence such that they are uniquely identified and traceable to stock standards and their source.

Standard Operating Procedures (SOPs) detail the sequence of operations involved in instrument start-up, calibration, analysis, shut-down, and routine maintenance. Suggestions for corrective action are included with the SOPs and parameters are identified which dictate certain types of maintenance. Instrument and method detection limit studies are performed at the method required frequency or whenever there is a significant change in instrumentation. Method Detection Limits are determined according to EPA guidelines found in 40 CFR, part 136, Appendix B for general chemistry and 40 CFR 141.25 (c) for radiochemistry (except for the few methods that are not amenable to MDLs). Refer to ELI's Technical Services and Fee Schedule for practical quantitation limits (method reporting limits). Acceptable instrument response/performance criteria are based upon the manufacturer or the analytical method specifications. SOPs exist for all major pieces of analytical equipment/methods.

Instrument logbooks are used to document instrument maintenance and repairs. Instruments that are no longer being utilized are documented in the applicable instrument logbook as "out-of-service" with the date the instrument was taken out of use noted. All out-of-service instruments are labeled with an out-of-service tag that identifies the effective date the instrument was taken out of use.

Laboratory analysts record and document all instrumental runs in Laboratory Instrument Logbooks or computer files. Instrument Logbooks and/or dated computer files record instrument performance data, analytical sequences, instrument maintenance, calibration standards data, and any other additional information pertinent to operation of the instrument.

CHAPTER 8 – RECORDS AND REPORTING

Document Management

Energy Laboratories Inc. QA manages three types of documents: 1) controlled, 2) approved, and 3) obsolete.

A CONTROLLED document is one that is uniquely identified, issued, tracked, and kept current as part of the Quality System. Controlled documents may be internal documents or external documents. A list of ELI's controlled documents is listed in Appendix B. All ELI controlled documents are written and reviewed by personnel technically competent to perform that procedure and approved for use by the Laboratory Manager as well as the Quality Assurance Officer.

APPROVED documents have been reviewed, signed and dated by the technical reviewer, the Quality Assurance Officer and the Laboratory Manager.

OBSOLETE documents are documents that have been superseded by more recent versions. Obsolete documents are retained for legal use or historical knowledge preservation. Old or archived SOPs are available for review using the laboratory's electronic document system. ELI's OBSOLETE document records are maintained for at least ten years.

Documents are reviewed on an annual basis to ensure their contents are suitable and in compliance with the current quality systems requirements, and accurately describe current operations. SOPs include a Record of Review/Revision page, which details revisions or reviews. The Branch Quality Assurance Officer/Officer maintains a master list of controlled documents (which include title, author, and date of issue).

Procedures for identification, collection, access, filing, storage, and disposal of records are found in ELI SOP, *Document and Record Management Control and Archiving*.

Laboratory Notebooks

Several different types of Laboratory Notebooks are maintained at the ELI Laboratory. These include, but are not limited to, the following:

- Method/Parameter Notebooks
- Project Notebooks
- Instrument/Equipment Use and Maintenance Notebooks
- Standard Preparation Logbooks
- Balance Calibration Logbooks
- Pipet Calibration Logbooks
- General Logbooks

The general purpose of maintaining each of these Laboratory Notebooks is to record the details that may be important in repeating a procedure, interpreting data, or documenting certain operations. Entries in the notebook may include data such as standard and sample weights, pH measurements, instrument operating parameters, preparation of calibration curves, analytical run sequences, calculations, recording of instrument operating parameters, sample condition, etc. The analyst's notebook is particularly important in documenting analyses that deviate in any way from routine or standard practices. It can also be an important training record. All pertinent data is to be recorded directly in the notebook. Some notebooks or data records are maintained in electronic format (LIMS, spreadsheets, or databases). Electronic data records are duplicated using hardcopy and/or alternate electronic backup techniques.

It is the responsibility of each analyst to maintain a laboratory notebook according to Good Laboratory Practices (GLP) Guidelines. All physical laboratory notebooks are assigned a unique logbook control number and are assigned to an analyst and/or supervisor. These notebooks remain the responsibility of the ELI staff member's supervisor to whom they are assigned until they are formally transferred to another staff member, until they are completely filled and returned to the ELI QA Department for archiving, or until the staff member resigns and returns them as a part of the check-out process. ELI staff members, other than the individual to whom the laboratory notebook is issued to, may make entries in the notebook as long as those entries are consistent with the intended use of the notebook and such entries are initialed and dated. Procedures for use and maintenance of laboratory notebooks are detailed in ELI SOP, *Laboratory Notebooks*.

Records

The laboratory maintains records of all chemical analyses, including all quality control records, for a minimum of ten years. In the event that Energy Laboratories, Inc., or any individual laboratory transfers ownership or goes out of business, the records will be transferred to the new owners. If a branch laboratory is closed, records will be maintained by Energy Laboratories Corporate office in Billings, Montana. Energy Laboratories, Inc. reserves the right to offer the records to the clients in the event of complete closure. Details are described in ELI SOP, *Document and Record Management, Control and Archiving*.

Data Reduction

Data reduction refers to the process of converting raw data to reportable units. The reporting units used and analytical methods performed are described in the ELI Technical Services and Fee Schedule.

Wherever possible, the instrument is calibrated to read out directly in the units reported. In this case, the value is recorded directly into a laboratory notebook, logbook, bench sheet, or electronic file and presented for review.

In cases such as titration, gravimetric measurements, or other techniques that require calculation prior to reporting, raw data is recorded in the appropriate laboratory notebook or electronic file, or on the appropriate laboratory form. The calculations specified in the methods are used to determine the reported value. That value is also entered into the laboratory notebook or bench sheet. Most calculations are automated to reduce the chance of arithmetic or transcription errors.

Wherever possible, electronic data results are transmitted throughout the laboratory via the LIMS computer network. This process is intended to minimize manual data transcriptions within the laboratory. Additional advantages include the opportunity for rapid comprehensive data validation by supervisors, and more rapid data reporting.

Validation

Data validation includes the procedures used to ensure that the reported values are consistent with the raw data, calculated values, sample type, sample history, and other analysis parameters requested.

The data recorded is validated with several review steps. The analyst who submits the analytical results checks all the values reported for omissions and accuracy. Elements of this review also evaluate all instrument and method QC results. Automated data management programs are designed with an interactive step allowing data review by the analyst. Results to be reported are approved by the analyst.

The report is reviewed for the suitability of the data according to project and method performance specifications. Analytical results for each requested parameter may be evaluated against other requested parameters, project specifications, other samples within the set, historical files associated with the project/client, and/or any other information provided with the sample.

The reports are generated, proofread, and reviewed by designated reporting staff.

Laboratory managers, project managers, supervisors, QA managers or their designees, may also examine the data included in the final report.

Internal and external laboratory audits review selected sets of data to ensure that the analytical results are correct and accurate, analytical methods are appropriate, documentation and record keeping procedures are complete, and that there is compliance to the overall objectives of the Quality Assurance Program. Data integrity is being monitored on an on-going basis. See ELI SOP: *Assessment of Data Integrity*, for details.

All controlled automated programs used to process and report data are initially verified using manually calculated results. Whenever a modification is performed to a program, re-verification of overall software function is performed.

One step of the Quality Control process involves data outlier detection; data that falls outside of established limits. If an outlier is observed, corrective action is taken as appropriate, to investigate and/or correct the cause. Actions to correct these causes may include, but are not limited to, inspection of the instrumentation, checking calibrations, checking sample numbers or dilutions, re-analyzing samples or calibrations.

Reporting

One copy of the report is distributed to the client, via requested delivery format, after the report is validated and signed. A standardized report format is used unless otherwise specified. Client-specified report formats are available upon request. Results can be sent via physical media, email, EDD, website FTP and/or FAX when requested by the client. Energy Laboratories, Inc. offers its clients access to electronic records through our Energy Source Portal.

Various levels of data reporting are available. All analytical results, regardless of the level of reporting used, have record keeping procedures which allow an appropriate "data validation package" to be produced. Note that a comprehensive "data validation package" is most easily generated at the time of sample analysis. Example data packages are available upon request.

Safe Drinking Water Act (SDWA) compliance monitoring samples for microbiological and chemistry samples that exceed the SDWA maximum contaminant level (MCL) may require notification to the appropriate state agencies. Generally, notification to the client, and to the state, of any SDWA MCL exceedance must be within 24 hours of completion of analysis/review, or by noon the next business day. If requested by the client, additional copies of the report will be sent to a specified address or person.

The final copy of a completed report is maintained in an electronic format. An electronic copy of this file is available upon request. Energy Source is a client resource of ELI that provides secure online access for clients to view their data and documents. Clients are able to access their electronic files through ELI's secure website at https://energysource.energylab.com/. For more information, see ELI SOP, *Document and Record Management, Control and Archiving*.

In addition to traditional ink signatures, Energy Laboratories has approved the use of electronic signatures within our company-produced PDF documents. These signatures comply with Title 15 of the US Code Section 101 regarding legal requirements of a digital signature.

Electronic signatures verify that the document has not changed after it was produced. Upon opening the document, notifications automatically display to inform the recipient of the validity of the sender's electronic signature and all included certificates. Should any changes be detected, an alert message is automatically displayed, noting that the signatures cannot be validated due to changes made to the document. Detailed instruction on how to view/validate ELI's electronic signatures is available.

CHAPTER 9 – GENERAL LABORATORY PRACTICES

Chemicals and Reagents

When available and appropriate, chemicals used in the laboratory are analytical reagent grade (AR) chemicals purchased from reliable suppliers. Reagents are prepared, standardized, and made fresh as mandated by the method, their stability, and according to Good Laboratory Practices. Procedures for purchasing of materials may be found in ELI SOP, *Property Procurement, Inventory, and Control*.

Normalized standards are checked regularly against independently prepared reference materials.

All standards and reagents are dated when received, opened, or prepared, and each is labeled with an expiration date when applicable. Standards and reagents are checked for discoloration or signs of degradation and are discarded if these are observed.

Certified primary standards are obtained from ISO accredited commercial sources when available. Standards used for calibration are verified against second source standards. Secondary and working standards are accurately prepared with volumetric flasks, or other calibrated glassware, from primary standards and stored in appropriate containers.

ELI has determined 5 years to be a reasonable expiration date for stable salts where the manufacturer does not supply such information. Titrants, standards, and other solutions used for analytical purposes are frequently standardized upon preparation with certified or traceable standards. Method SOPs specify if standardization is necessary. The date and analyst's initials must be recorded on the container whenever re-standardized and these records are maintained in a laboratory notebook or in the LIMS.

Individual SOPs may also provide additional details for reagent requirements.

Reagent Interference

To determine the extent of reagent interference, method blanks are analyzed prior to sample analysis whenever appropriate.

If any interference cannot be eliminated, the magnitude of the interference is considered when calculating the concentration of the specific constituent in the sample, but only when permitted within the applicable method.

If reagents, materials, or solvents contain substances that interfere with a particular determination, they are replaced.

Individual method SOPs may also provide additional requirements for handling reagent interferences.

Glassware Preparation

All glassware used for inorganic and radiochemical analysis is washed in warm detergent solution and thoroughly rinsed in tap water. Glassware is then rinsed well three times with laboratory-purified water. This cleaning procedure is sufficient for many analytical needs, but individual SOPs detail additional procedures when necessary. Glassware washing procedures for inorganic analysis are described in ELI SOP, *Cleaning of Glassware Used in Inorganic Analyte Sample Preparation and Analysis*.

All glassware used for organic analysis is washed in warm synthetic detergent solution and thoroughly rinsed in tap water. The glassware is then rinsed well with laboratory-purified water, followed by rinses with acetone to remove any residual organics. Prior to use, the glassware is rinsed three times with the organic solvent to be used with the glassware. Glassware washing procedures for cleaning glassware for organic analysis are described in ELI SOP, *Cleaning of Glassware Used in Volatile and Semivolatile Analyte Sample Preparation and Analysis*.

All glassware used for microbiological analysis is washed in warm detergent solution. The detergent must be proven to contain no bacteriostatic or inhibiting substances. The glassware is rinsed thoroughly with laboratory-purified water. Specific details are described in SOPs.

Disposable, glassware/plasticware is preferred for many procedures in the laboratory. The cleanliness and suitability of disposable glassware/plasticware is continuously evaluated for each test with the routine analysis of method blanks.

All volumetric glassware used in precise measurements of volume is Class A or laboratory calibrated.

Laboratory Pure Water

Laboratory-purified water is used in the laboratory for dilution, preparation of reagent solutions and final rinsing of glassware. For organic analysis, organic-free water is prepared and used. Energy Laboratories, Inc. uses water purification systems that are designed to produce deionized water that meets the requirements of the methods. Use and maintenance of laboratory reagent water systems are described in ELI SOP, *Use and Maintenance of the Milli-Q Water System*.

Water quality is monitored for acceptability in the procedure in which it is used. Specific details are listed in the appropriate SOPs.

Employee Training

All new ELI employees and contract personnel are given an initial general orientation and tour of the laboratory facilities. Personnel are shown the locations of safety equipment such as safety showers, eye wash fountains, fire extinguishers, and first aid supplies. Personal protective equipment such as lab coats, disposable gloves, and safety glasses (if applicable) are issued at this time.

Safety considerations are a vital part of the training process. All hazards associated with the performance of a procedure or with the operation of an instrument are to be understood by the trainee before training can be considered complete. General laboratory safety procedures are a part of the new and current employee training. Specific safety procedures are outlined in SOPs and in instrument Operator's Manuals. Training in use of protective clothing, eye protection, ventilation, and general safety are provided to each employee. Each employee is required to read and sign the *Laboratory Safety Manual & Chemical Hygiene Plan*.

All new and existing employees must demonstrate capability prior to performing an analytical procedure independently (see Chapter One). Method performance on Quality Control Samples is used to document employee training and work quality. Employees are required to read the Quality Assurance Manual and all appropriate SOPs. Employees are required to sign a Quality Assurance Manual Acknowledgement form which states that they have read, understood, and will comply with the requirements of the Quality Assurance Manual. Employees also are required to sign, for all applicable SOPs, a Record of Acknowledgement Form that states they have read, understood, and agree to abide by the SOP. In the case of method SOPs, the employees sign a Record of Acknowledgement form that states they have read, understood, and agree to abide by the SOP using the latest method technology.

Employees also receive training on general laboratory policies including ethics and conflict of interest. All employees are required to read, understand and comply with the Corporate Compliance & Ethics Manual. Data integrity training is provided for all employees initially upon hire and annually thereafter. In addition to the *Corporate Compliance & Ethics Manual*, the ELI Quality Assurance department maintains a *Laboratory Ethics & Data Integrity Manual*, which supplements the corporate manual and provides specific training on data integrity. All employees are required to read, understand and comply with the ELI *Laboratory Ethics & Data Integrity Manual*. An annual Ethics training course is given to all laboratory employees. Attendance is required and is recorded with a signature attendance sheet or other form of documentation that demonstrates all staff have participated and understand their obligations related to data integrity and ethics policies. For details pertaining to ethics training and additional ethical procedures and policies refer to ELI SOP, *Personnel Training and Training Records*.

ELI encourages attendance at courses, workshops and other forms of continuing education available from on-site seminars, private institutions, local schools, and State and Federal regulatory agencies. Staff and department meetings are held routinely to communicate company policies and procedures. All training on procedures and policies is documented, per NELAP guidelines, in employee training files. For more information see ELI SOP, *Personnel Training and Training Records*.

Data Integrity

In order to provide for the integrity of ELI and client data, the laboratory has multiple controls on the network, LIMS and applications used. These controls limit access to and the ability to change data as well as provide for redundancy in case of loss.

These include but are not limited to:

- Users connecting to ELI computer systems are authenticated through a user name and password combination.
- Passwords are required to be changed on a regular basis.
- Permissions within ELI applications are role based with different roles having various levels of access and control. Users (analysts, supervisors, and managers) are assigned to these roles.
- In the LIMS, analytical data locks after a period of time and cannot be modified without special handling.
- Certain information has been identified for additional tracking and logging. Changes to this information is not only tracked in an audit log but also reported to select personnel.
- Information on ELI servers including the ELI LIMS system is backed up and recoverable.

Standard Operating Procedures

Laboratory operations and procedures are documented in Standard Operating Procedures (SOPs). SOPs provide information on the consistent and safe operation of the laboratory. For analytical methods, SOPs provide information on the details of the analysis that is not specified in a published analytical method. For routine procedures other than analytical methods, SOPs define the steps required in accomplishing a given task. All SOPs are reviewed and updated periodically to reflect any changes in laboratory operations. Method SOPs follow NELAP requirements. For more information on generation and distribution of SOPs, see ELI SOP, *Preparation, Numbering, Use, and Revision of Standard Operating Procedures*.

Client Confidentiality

Each employee has the responsibility to maintain confidentiality in all matters pertaining to our clients, samples submitted, and Energy Laboratories, Inc. Information obtained during employment with this laboratory, regarding the specific business of this laboratory, or its clients shall at no time be revealed to any outside sources without permission from the owner of the data.

Sample submittal, analysis and the report contents are considered confidential information of the client. When requested to provide results (either in person, via telephone or email), the employees shall verify that the requestor is either the person associated with the project, on the COC, or on a list provided by the client who are authorized to receive data. If a person who is not associated with the project personnel (or is not on the approved list), the base client will be contacted to inquire about authorization to release data. These contacts are documented and associated with the work order in the LIMS system to provide archival proof of authorization to release data. If the client does not authorize a release of data, the requestor will be contacted and told of this decision.

Client confidentially is maintained electronically through the use of password-protected logins on all laboratory computer systems. Additionally, the laboratory maintains network security such as anti-virus programs and firewalls that prevent any unauthorized outside access. All copies of the original report are stored on the laboratory's document archival system, which is also protected from unauthorized use by the network security systems. Raw data, reports, and LIMS records are kept in a secure location of the laboratory or off-site. All client confidential paper waste, including printouts, is shredded.

CHAPTER 10 – QUALITY CONTROL MONITORING

Routine Monitoring

Temperatures of incubators, water baths, refrigerators, and ovens are checked and recorded according to a prescribed schedule using a continuous monitoring system.

Conductivity of the laboratory-purified water is continuously monitored using an automated monitoring system and as method blanks in routine analytical runs.

Reagents are dated and initialed at the time of receipt. Expirations dates are assigned as a fundamental component of their receipt and/or preparation. Reagents are not used after manufacturer's expiration date is exceeded.

Balances are checked daily, or as required, against ASTM Class 1 or 2 NIST traceable weights and are calibrated and serviced by certified technicians annually.

SOPs are reviewed periodically for accuracy.

Laboratory Notebooks are reviewed periodically for correctness and accuracy by supervisors.

Proficiency Testing (PT) Samples are analyzed as required (See Chapter Two of this QA Manual).

Quality Control Check Samples are analyzed with each analytical batch.

Internal and external audits are performed as specified or requested (See Chapter Two of this QA Manual for additional discussion).

Additional monitoring requirements may also be specified in individual SOPs.

The Laboratory maintains an active fraud protection program that is implemented through the laboratory ethics policy. Additionally, the potential of fraud is monitored through analyst supervision, management supervision, regular internal audits, PT study participation, and an active quality assurance program.

Instruments/Methods

Calibration is performed as outlined in Chapter Seven of this QA Manual.

Generally, and depending on method requirements, the standard curve is verified with a known second source reference sample. The reference sample results must fall within the appropriate target range for the calibration to be accepted.

In most cases, the calibration stability is checked by analyzing a continuing calibration standard every 10 to 20 samples, depending on the analysis and instrumentation. The verification standard results must fall within an established range as described by the SOP.

All laboratory instruments are subjected to preventive maintenance schedules. Preventive maintenance schedules are specified in instrument maintenance logbooks.

As appropriate, instrument and/or method detection limits are determined annually, or more frequently if changes in instrument performance are noted or per method requirements. Procedures for the determination of instrument detection and method detection limits are described in ELI SOP, *Determination of Method Detection Limits (MDL) and Quantitation Limits*.

Precision and accuracy requirements for each method are specified in the SOPs. General guidelines are given below.

- Each analytical batch will contain QC samples to measure the accuracy of the method. Each QC sample result is monitored to be within QC specifications of the method. Results of blank spiked sample analysis must be within the established control limits. Quality Control Limits are specified in the SOPs and meet recommended QC limits as described in the referenced method.

- Each analytical batch will contain QC samples to measure the precision of the method. (See Chapter One for discussion on duplicate sample analysis.) Criteria for duplicate sample acceptance are found in the SOP and are generally taken from the referenced method.

- Each analytical batch will contain QC samples to measure the performance of the method on the sample matrix. These are typically identified as a matrix spike analysis and may be performed in duplicate to assess method precision. Typically the sample is fortified with a known amount of target analyte and spike recoveries are calculated. Results outside of method QC guidance are flagged. Quality control limits and appropriate corrective actions steps are specified in the method SOP.

- Several methods are considered to be concurrent methods in that they are either nearly identical or are identical to a method with a different citation. Even if two methodologies are identical in procedure, slight differences in the QC requirements might be the only difference between the two methodologies. These types of methods may also be considered "concurrent" if the procedures are identical and the more stringent of the two method criteria are used. During data reduction and reporting, the referenced method specifications and criteria will always take priority.

As appropriate, the performance trends of QC sample results are evaluated with Quality Control Charts. Suitability of existing QC limits is evaluated and possibly adjusted, but not to exceed method specification.

CHAPTER 11 – CORRECTIVE ACTION

When the quality control checks indicate that an analysis is not within the established control limits, corrective action is needed. This section gives general guidelines for corrective action. Corrective actions for each method or instrument are detailed in individual SOPs. Records are maintained of non-conformances requiring corrective action to show that the root cause(s) was investigated, and includes the results of the investigation. The QA Manager/Officer will monitor implementation and documentation of the corrective action to assure that the corrective actions were effective.

Method QC samples that fail to fall within QC control limits may be analyzed again to verify if a problem exists. However, matrix spike or matrix spike duplicate QC samples are not required to be re-analyzed if the performance can be attributed to matrix effects; data results are then reported and flagged.

If the repeat analysis is not within control limits, the particular instrument or procedure is checked according to the specific protocols outlined in the method or according to the instrument manufacturer's guidelines. Once results are within control limits, analysis of all samples that were analyzed while the procedure was out of control are repeated, i.e., all analyses are repeated back to the previous acceptable control sample. In the case of radiochemical analysis, the term “analyze again” means to recount the final sample on the same (or different) detector.

If the analyst is unable to achieve acceptable results after following the corrective action guidelines detailed in the SOP, a supervisor is consulted. If necessary, the appropriate service personnel are contacted if the problem is determined to be due to instrument error, and cannot be resolved. It is also possible that the result is due to statistical variation of the results based on the tolerable error rate that has been determined for the analysis (usually 0.05). In certain cases, where control limits are exceeded, it is possible that problems cannot be corrected to satisfy QC criteria. This could be due to problems such as matrix interference, instrument problems, lack of sufficient sample, missed holding times, high blank contamination, etc. If all possible solutions available to correct the problem are examined and the sample results are still considered valid, qualifying comments are attached to the sample report describing the non-compliance and probable cause.

In the case of a single radiochemistry detector being returned to service, this refers only to the samples counted on that detector. For example, an individual gas proportional counter instrument may have up to 16 detectors; if only one does not pass the QC check the others are still valid and sample analyses performed on the others do not need to be repeated.

In the event that a QC audit or other informational review shows an analysis report to be incorrect, incomplete, or adversely compromised, a revised report and explanation is submitted to the client within ten business days unless otherwise communicated to the client with another time period. The report will clearly be identified as a revised report. As appropriate, an explanation submitted to the client should give a detailed review of the problem and document any unapproved deviations from the regulations, standard operating procedures, or project-specific scope of work that may have caused it. The explanation to the client may include, but not be limited to, the following components:

1) What actions have been taken regarding the affected data set(s),
2) Identification of the cause, and
3) Corrective action(s) taken to prevent future occurrence.

In the event that a QC check fails, the analyst will follow the procedures outlined in the QA/QC summary of the SOP.

Quality Control Checks for each method or instrument may vary. Energy Laboratories Inc. follows the QC checks set by each governing method. Due to the wide variations between methods, specifics are listed within each SOP for the given method. Please reference the SOP for specific QC checks for the given method. The QC checks may include: ICV, MB, CCV, CCB, LCS, LCSD, LOD, MS, MSD or others specific to that method.

The following table lists the typical actions to be taken upon discovery of a QC sample failure. The purpose of this table is not to supersede the actions stipulated in the method SOP or the Method criteria.

QA Indicator	Frequency	Acceptance Criteria	Corrective Action For Failure	Comments
ICV	At the beginning of the sequence, immediately after the ICAL.	Usually ± 10%. Method Dependent. Some methods have more stringent criteria.	**Option 1** – Re-analyze the ICV. **Option 2** – Stop analysis and re-calibrate the instrument.	-Evaluates calibration accuracy and method performance. Must be prepared from Second source standard. Know and follow any method specifications regarding the ICV.
CCV	At the beginning of sequence, and every ten samples. Must have a closing CCV at the end of the sequence.	Typically ± 10% recovery. Very method dependent. See SOP & Method.	**Option 1** – Immediately re-analyze CCV upon failure. **Option 2** –Invalidate all samples not bracketed by passing CCVs, recalibrate, and re-analyze all invalidated samples.	-Evaluates instrument drift throughout analytical sequence. Typically uses midpoint calibration standard. Know and follow any method specifications regarding the CCV.
CCB	Every ten samples	CCB<PQL	**Option 1** – Stop analysis, invalidate all samples not bracketed by passing CCBs. Re-calibrate and re-analyze samples.	-Evaluates baseline drift, contamination in the analytical system, and analyte carryover. – Know and follow any method specifications regarding the CCB.

QA Indicator	Frequency	Acceptance Criteria	Corrective Action For Failure	Comments
LCS	One per sample batch of 20, or less if tighter criteria specified in the published method.	Typically ± 10% recovery. Very method dependent.	**Option 1** – Re-analyze LCS for recovery. **Option 2** – Stop analysis, recalibrate, re-extract and/or re-analyze all samples.	- Evaluates overall method accuracy/bias for the Preparatory Batch. Know and follow any method specifications regarding the LCS.
MS	One per sample batch of 20, or less if tighter criteria specified in the published method	Typically ± 30% recovery. Very method dependent.	**Option 1** - Report Spike as analyzed. LCS/LFB must be passing. Flag sample for possible matrix effects. **Option 2** –Re-analyze MS/MSD, only if there was an error making the MS, for either recovery or RPD failure.	-Evaluates effect of matrix on method performance. Know and follow any method specifications regarding the MS.
MSD	One per sample batch of 20, or less if tighter criteria specified in the published method.	Typically ± 30% Recovery. Very method dependent. 10-30% RPD –Check method for exact specifications.	Same as for MS.	-MSD also evaluates method precision. Know and follow any method specifications regarding the MSD.
MBLK	One per sample batch of 20, or less if tighter criteria specified in the published method.	MBLK< PQL	**Option 1** – Re-analyze the entire analysis. All organic analyses with blank detections must be re-analyzed. **Option 2** – Flag data on report as having compound in blank.	-Evaluates overall method including possible contamination in reagents and glassware utilized in preparatory batch. Know and follow any method specifications regarding the MBLK.
DUP	One per sample batch of 20, or less if tighter criteria specified in the published method. (The DUP can be satisfied by a MS/MSD).	10-30% RPD –Check method for exact specifications.	**Option 1** – Re-analyze sample. **Option 2** – Flag analysis as having a failing DUP RPD for reporting.	Evaluates method precision. MSD duplicate analyses preferred on some methods.

*Deviation from the method or SOP shall be documented in laboratory records.

Procedure for Dealing with Complaints

DEFINITIONS

Complaint: For the purposes of this procedure, a complaint comes from a client, a user of our data, or employee. The complaint might cover issues about the quality of our data, sample turnaround time, method used, pricing, or other expectations.

Client: The client is a person or company that ordered and paid for the services.

Procedure: The staff person receiving the complaint exercises judgment in deciding the severity and disposition of every complaint. The judgment must be used to decide whom, if anyone, is alerted to the complaint and what actions are appropriate. The complaint issued should be handled with a high degree of discretion and tact by the supervisor or manager involved. The individual handling the complaint is instructed to follow ELI's guidelines provided in this section on how to handle the complaint. This involves listening to the client and getting adequate information so the complaint can be investigated and resolved. The appropriate laboratory staff is notified and a solution to the problem, as well as a timeline for action, is given.

After the complaint is investigated or resolved, as necessary, the client is made aware of the results and determination is made as to what further actions are needed. Complaints and investigations may result in the need to submit a revised report or invoice. Complaints that are straightforward and can be resolved using the resources available to the person handling the complaint should be resolved there. These include such things as minor revisions of reports or invoices. If other decisions need to be made, the appropriate person should be contacted.

It may be appropriate to initiate or prepare a non-compliance report. This report should be completed with the intention of informing the affected staff about the problem so that everyone can learn from it, it can be used as a training tool, change our procedures and improve our service. A procedure to document non-compliance reports is documented in ELI SOP, *Nonconformance Procedures and Corrective/Preventive Action Reports.*

If an employee or former employee sees an issue, they are encouraged to report concerns regarding Quality Systems, unethical behavior, and/or financial mismanagement. This issue should initially be brought to the attention of their supervisor. The supervisor will take appropriate action to resolve the concern. If the employee is uncomfortable with approaching their supervisor or feels that the issue was not properly dealt with, they may approach higher levels of management with their issue.

Energy Laboratories, Inc., has also implemented a program to facilitate confidential reporting to upper management. This tool allows employees to report situations or behaviors that they consider to be unethical, immoral, or improper. It also allows the reporting of suggestions or comments. The program has been implemented at ELI so that anyone reporting a situation can be assured that there will not be retaliation for reporting. It is meant to encourage parties to communicate with upper management when there appears to be no alternative for resolving the types of issues already described. . Access to the program is available on the ELI internal website.

Penalty for Improper, Unethical or Illegal Actions

Energy Laboratories, Inc. employees are expected to work in an ethical, proper, and legal manner. They are expected to perform laboratory analyses according to the cited method(s) and in conjunction with the SOP and the Quality Assurance Plan. Employees are expected and required to report any violations of this policy. All employees are mandated to participate in an ethics-training program as part of their orientation upon hire.

Improper, unethical, or illegal actions by an employee will be addressed on a case-by-case basis as determined by the seriousness of the offense. Corrective actions may include disciplinary action up to and including discharge.

CHAPTER 12 – MANAGEMENT OF CHANGE

Management of change is the process used to review and manage proposed changes to materials, technology, equipment, procedures, personnel and facility operations. These changes may be permanent or temporary depending on circumstances. Change is managed, communicated, and documented as appropriate to the level of change, by the Laboratory Manager and the Supervisors of each department. Significant revisions to controlled documents may require employees to sign a record of acknowledgement.

- New Equipment Validation – Documented in the Instrument Maintenance Module. Supporting studies are documented in the LIMS.
- Implementation of new test methods and method updates – Documented in the method SOP and Instrument Maintenance Module. Supporting studies are documented in the LIMS.
- The QA Manual and SOPs – Documented in the Record of Revision and stored in the Document Control Software.
- Work order changes are documented in the work order report and stored in the LIMS or Document Control Software.
- LIMS changes - documented in a version control repository.
- Personnel changes - documented in employee training records or personnel records.

CHAPTER 13 – MAJOR EQUIPMENT AND METHODS

A summarized listing of major instrumentation utilized in the laboratory is included in Appendix F. See attached NELAP certificate in Appendix A for a complete list of accredited methods and analytes that ELI performs to support SDWA, RCRA and CWA regulated methods. Refer to the ELI Technical Services and Fee Schedule, located on the ELI website at www.energylab.com, for a list of all methods and analyte parameters that Energy Laboratories, Inc. as a company performs for comprehensive services.

CHAPTER 14 – PREVENTIVE MAINTENANCE

Preventive maintenance is performed on laboratory equipment according to the manufacturer's guidelines and our operational experience. Repairs and maintenance are accomplished in-house by experienced laboratory personnel whenever possible. Other than consumable equipment items, an inventory of spare parts is not maintained. Spare parts are available from outside vendors on an as needed basis. (To ensure method capability, some methods have more than one instrument available). An example of maintenance performed follows:

Instrument	**Maintenance**	**Frequency – Note that Daily is based on use.**
Balances	Check with Class 1 weights	Daily
	Independent Service	Annually
Pipettes	Check volume	Quarterly/Daily
IC	Change Bed supports	Weekly
	Change Guard Column	As Needed
	Change Analytical Column	As Needed
	Calibrate	After maintenance or as needed
	Clean Stator Plate	Annually
	Change tubing	As needed
	Calibrate Conductivity Cell	Every 6 months
	Backup Data	Monthly
ICP-Atomic Emission	Check Pump Tubing	Daily
	Check Coolant Levels	Monthly
	Lubricate Autosampler	As needed
	Air Filter	Quarterly
	Optics Servicing	As needed
ICP-Mass Spectrometry	Check Pump Tubing	Daily
	Check Coolant Levels	Monthly
	Check Electron Multiplier	Daily
	Lubricate Autosampler	As needed
	Air Filter	Quarterly
Gas Chromatograph	Change Septum	As needed
	Check Injection Liner	Daily
	Clean Detector	As needed
	Change Gas Cylinders	At 200 psi
	Change Column	As needed
Auto Analyzers		
	Check For Leaks	Daily
	Change Tubing	When wear is visible
	Lubricate Pumps	Annually
	Lubricate Sampler	Annually
Man-tech Auto-titrator	Visually inspect all probes/ stirrer/ thermometer and fill probes	Daily/As needed
	Flush pH probe/ Fluoride probe	Every 15 days
	Calibrate sample dosing pump	Quarterly
	Replace Tubing	Annually/ As needed
	Clean out titration vessel and rinse station	Quarterly/ As needed
	Clean buret	Quarterly
	Calibrate buret	Monthly

Instrument	Maintenance	Frequency – Note that Daily is based on use.
	Replace pH/ Fluoride probe	As needed
	Replace Tubing	As needed
	Change Lip seals gland washers on dosing pump	As needed
Man-tech Auto-titrator	Visually inspect all probes/ stirrer/ thermometer and fill probes	Daily/As needed
Metrohm-automated pH, conductivity, ion electrode analyzer	Visually inspect all probes/ stirrer/ thermometer and fill probes	Daily/As needed
	Flush pH probe/ change storage solution	Monthly/ As needed
	Replace Tubing	As needed
	Calibrate buret	Monthly
	Replace pH probe	As needed
Mass Spectrometers	Monitor Vacuum Pressures	Daily
	Monitor Background Levels	Daily
	Monitor Electron Multiplier	Daily
	Change Pump Oil	As Needed
Microbiology	Monitor Room Temperature	Twice daily
	Monitor Incubator Temperature	Twice daily
	Autoclave Maintenance	Annually
	Monitor Water Bath Temperature	Twice daily
Reagent Water Systems	Change/Check Cartridges	Quarterly, or as needed
Compressed Gases	Change Gas Cylinders	At 50 psi, monitor daily
Liquid Chromatograph	Flush System	Daily
	Change Filters	As needed
	Replace Seals	As needed
Continuous Monitoring System	Check Temperatures	Daily, calibrated annually

CHAPTER 15 - REFERENCES

ANSI N42.23-1996, American National Standard Measurement and Associated Instrument Quality Assurance for Radioassay Laboratories.

ASTM Annual Book of Standards, Part 31 (water), American Society for Testing and Materials.

ASTM D 7282-06 Standard Practices for Set-up, Calibration, and Quality Control of Instruments Used for Radioactive Measurements.

Handbook for Analytical Quality Control in Water and Wastewater Laboratories, Environmental Protection Agency. EPA 600/4-79-019

ELI Technical Services and Fee Schedule, Current Revision, Energy Laboratories, Inc.

Manual for the Certification of Laboratories Analyzing Drinking Water, 5th Ed., EPA 815-R-05-004, 2005.

Manual for the Certification of Laboratories Analyzing Drinking Water, Supplement to 5th Ed., EPA 815-F-08-006, June 2008.

Methods for Chemical Analysis of Water and Wastes Environmental Protection Agency, 600/4-79-020.

Methods for the Determination of Metals in Environmental Samples – Supplement I, EPA/600/R-94-111, May 1994.

Methods for the Determination of Inorganic Substances in Environmental Samples, EPA/600/R-93-100, August 1993.

Methods for the Determination of Organic Compounds in Drinking Water, EPA/600/4-88/039, December 1998.

Methods for the Determination of Organic Compounds in Drinking Water – Supplement I, EPA/600/4-90/020, July 1990.

Methods for the Determination of Organic Compounds in Drinking Water – Supplement II, EPA/600/R-92/129, August 1992.

NELAC Chapter 5: Quality System Standard, 2003 or most current version approved by Florida and Texas NELAC Accreditation program.

NELAP, National Environmental Laboratory Accreditation Program http://www.nelac-institute.org/newnelap.php

Standard Methods for the Examination of Water and Wastewater; 20th, 21st and -22nd Editions, APHA.

Technical Notes on Drinking Water Methods, EPA/600/R-94/173, October 1994.

Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW846), Environmental Protection Agency. http://www.epa.gov/epawaste/hazard/testmethods/sw846/online/index.htm

TNI Standard, Volume 1 (EL-V1-2009), The NELAP Institute.

CHAPTER 16 – GLOSSARY OF TERMS

Accuracy - The degree of agreement between an observed value and an accepted reference value.

Analyst - The designated individual who performs the “hands-on” analytical methods and associated techniques and who is the one responsible for applying required laboratory practices and other pertinent quality controls to meet the required level of quality.

Analytical Sample - Any solution or media introduced into an instrument on which an analysis is performed, excluding instrument calibration, initial calibration verification, initial calibration blank, continuing calibration verification, and continuing calibration blank.

Audit or Assessment- A systematic evaluation to determine the conformance to quantitative specifications of some operational function or activity.

Batch - Environmental samples that are prepared and/or analyzed together with the same process and personnel, using the same lot(s) of reagents. A preparation batch is composed of one to twenty environmental samples of the same matrix, meeting the criteria above. An analytical batch is composed of prepared environmental samples, extracts, digestates, or concentrates, which are analyzed together as a group.

Blank (BLK) - A sample of clean water that accompanies the samples through different aspects of sampling and/or sample preparation. It is used to monitor contamination during sampling, transport, storage or analysis. The blank is subjected to the usual analytical and measurement process to establish a zero baseline or background value. There are various types of blanks: equipment blank, field blank, instrument blank, method blank, and reagent blank.

Blank Spike - See Laboratory Fortified Blank.

Blind QC Check Samples - Samples whose analyte concentrations are not known to the analyst. That the sample is a QC check sample may or may not be known to the analyst.

Calibration - The set of operations that establish, under specified conditions, the relationship between values indicated by the measuring instrument and the corresponding known value of the property being measured.

Calibration Blank - A volume of reagent water fortified with the same matrix as the calibration standards, but without the analytes, internal standards, or surrogate analytes.

Calibration Check Standard - See Check Standard.

Calibration Curve – The graphical relationship between the known values and the instrument responses for a series of calibration standards.

Calibration Standard - A solution of known concentration used in the calibration of an analytical instrument.

Chain of Custody Form- A record that documents the possession of the samples from the time of collection to receipt in the laboratory. This record generally includes: the number and types of containers; the mode of collection; collector; time of collection; preservation; and requested analyses.

Check Standard - A material of known composition that is analyzed concurrently with test samples to evaluate a measurement process.

Clean Water Act - Public Law PL 92-500. Found at 40 CFR 100-140 and 400-470. The act regulates the discharge of pollutants into surface waters.

Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) - The enabling legislation (42 USC 9601 - 9675 et seq., as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), 42 USC 9601 et seq.), to eliminate the health and environmental threats posed by hazardous waste sites.

Continuing Calibration Blank (CCB) – See Check Standard.

Continuing Calibration Standard - See Check Standard.

Continuing Calibration Verification (CCV) - See Check Standard.

Control Limits - A range within which specified measurement results must fall to be compliant.

Control Standard - See Check Standard.

Corrective Action (CA) - An action taken to eliminate the causes of an existing nonconformity, defect, or other undesirable situation in order to prevent recurrence.

Data Quality Objectives (DQO) - An integrated set of specifications that define data quality requirements and the intended use of the data.

Demonstration of Capability (DOC) - A procedure to establish the ability of the analyst to generate data of acceptable quality.

Detectability – For radiochemical analysis, detectability as a Lower Limit Detection (LLD) or Minimum Detection Concentration (MDC), is assessed based on the requirements of 40 CFR 141.25(c) and is a sample-specific determination. The equation is specific for each method and noted in the method SOP.

Detection Limit - See Practical Quantitation Limit and Method Detection Limit. Reporting of detection in radiochemistry is based on specific formulas identified in individual procedures.

Single activity point standards are used for efficiency calibration. When required, multiple energy emitters are used for energy calibration.

Document Control - The act of ensuring that documents and revisions are proposed, reviewed for accuracy, approved for release by authorized personnel, distributed properly and controlled to ensure use of the correct version at the location where the prescribed activity is performed.

Duplicate (DUP) - A second aliquot of a sample that is treated the same as the original sample to determine the precision of the method.

Duplicate Sample - See Duplicate.

Fortified Sample - See Matrix Spike.

Holding Times (Maximum Allowable Holding Times) - The maximum time that samples may be held prior to analysis and still be considered valid or not compromised.

Initial Calibration Verification (ICV) - A sample of known concentration, from a source other than that of the calibration standards, analyzed following calibration to demonstrate validity of the calibration.

Instrument Blank - See Calibration Blank.

Internal Standard – A known amount of standard added to a test portion of a sample as a reference for evaluating and controlling the precision and bias of the applied analytical method.

Laboratory Control Sample (LCS) – A sample with a known concentration prepared and/or analyzed as a measure of accuracy for the method.

Laboratory Fortified Blank (LFB) – An aliquot of reagent water to which known quantities of specific compounds are added and which is analyzed as a measure of method recovery.

Laboratory Inter-comparison Sample - A performance evaluation sample analyzed by numerous laboratories. Acceptance criteria are often based statistically on the analysis results.

Limit of Detection (LOD) - For chemical analysis, the LOD is an estimate of the minimum amount of a substance that an analytical process can reliably detect. An LOD is analyte and matrix specific and may be laboratory-dependent.

Limit of Quantitation (LOQ) – For chemical analysis, the LOQ is an estimate of the minimum amount of a substance that can be reported with a specified degree of confidence. An LOQ is an evaluation of precision and bias.

LIMS - Laboratory Information Management System.

Matrix – The substrate of a test sample.

Matrix Spike - (MS) – An aliquot of a sample to which known quantities of specific compounds are added, and which is carried through the entire analytical process to determine the effect of the matrix on the methods recovery efficiency.

Matrix Spike Duplicate (MSD) – A second aliquot of a sample to which known quantities of specific compounds are added, and which is carried through the entire analytical process to determine the effect of the matrix on the method's recovery efficiency and the precision of the method.

Maximum Contaminant Level (MCL) – Regulatory action levels for a contaminant of concern.

Method Blank (MBLK)- A clean sample processed simultaneously with, and under the same conditions as, samples being tested for an analyte of interest through all steps of the analytical procedure.

Method Detection Limit (MDL) - A measure of the limit of detection for an analytical method determined according to the procedure given in 40 CFR Part 136 Appendix B.

Method Validation - The confirmation by examination and the provision of objective evidence that the particular requirements for a specific intended use are fulfilled (NELAC 2003) (MARLAP 2004 for radiochemical methods).

NELAC - National Environmental Laboratory Accreditation Conference.

NELAP - National Environmental Laboratory Accreditation Program.

NPDES - National Pollutant Discharge Elimination System- A discharge permit system authorized under the Clean Water Act.

Performance Evaluation (PE) Sample - A sample with a composition unknown to the analyst that is provided to test whether the analyst/laboratory can produce analytical results within specified limits.

Practical Quantitation Limit (PQL) – The lowest concentration or amount of the target analyte that can be identified, measured and reported with confidence that the analyte concentration is not a false positive value.

Precision - The degree to which a set of observations or measurements of the same property conform to themselves.

Preservation - Refrigeration and/or reagents added at the time of sample collection to maintain the chemical and/or biological integrity of the sample.

Proficiency Testing (PT) Sample - A sample with a composition unknown to the analyst which is provided to test whether the analyst/laboratory can produce analytical results within specified limits.

Quality Assurance – An integrated system of activities involving planning, quality control, quality assessment, reporting and quality improvement to ensure that a product or service meets defined standards of quality with a stated level of confidence.

Quality Assurance Project Plan (QAPP) - A formal document describing the detailed quality control procedures pertaining to a specific project. For environmental clean-up projects, this is typically produced by an engineering firm with references to include a laboratory's Quality Assurance Manual.

Quality Control – The overall system of technical activities whose purpose is to measure and control the quality of a product or service so that it meets the needs of users.

Quality Control Sample – A sample used to assess the performance of all, or a portion, of the measurement system.

Replicate - See Duplicate.

Reporting Limit (RL) –. The lowest level of concentration reported for an analyte.

Resource Conservation and Recovery Act (RCRA) - The enabling legislation under 42 USC 321 et seq. (1976) that gives EPA the authority to control hazardous waste.

Safe Drinking Water Act (SDWA) - The enabling legislation, 42 USC 300f et seq. (1974), which requires the USEPA to protect the quality of drinking water in the U.S. by setting maximum allowable contaminant levels, monitoring, and enforcing violations.

Sample (SAMP) - A portion of material to be analyzed.

Spiked Sample – See Matrix Spike.

Standardization - See Calibration.

Standard Operating Procedure (SOP) - A written document which details the method of an operation, analysis or action whose techniques and procedures are thoroughly prescribed and which is accepted as the method for performing certain routine or repetitive tasks.

TNI – The NELAC Institute

Traceability – The property of a result of a measurement whereby it can be related to appropriate standards.

Trip Blank - One type of Field Blank. An aliquot of analyte-free water or solvent transported to the field in a sealed container and returned to the laboratory with the sample containers.

Acronyms and Abbreviations

AA	-	Accrediting Authority
AB	-	Accrediting Body
ANSI	-	American National Standards Institute
AOAC	-	The Scientific Association Dedicated to Analytical Excellence
APHA	-	American Public Health Association
ASQC	-	American Society for Quality Control
ASTM	-	American Society for Testing and Materials
Bq	-	Becquerel
BLK	-	Blank
Bg	-	Background
°C	-	Degrees Celsius
Cal	-	Calibration
CAS	-	Chemical Abstract Service
CCB	-	Continuing Calibration Blank
CCV	-	Continuing Calibration Verification
COC	-	Chain of Custody
DOC	-	Demonstration of Capability
DO	-	Dissolved Oxygen
DQO	-	Data Quality Objectives
DMRQA	-	NPDES Discharge Monitoring Report Quality Assurance
DUP	-	Duplicate
ELI	-	Energy Laboratories, Inc.
EPA	-	Environmental Protection Agency
FDA	-	Food and Drug Administration
g/L	-	Grams per Liter
GC	-	Gas Chromatography
GC-MS	-	Gas Chromatography-Mass Spectrometry
ICP-AES	-	Inductively Coupled Plasma Atomic Emission Spectrophotometry
ICP-MS	-	Inductively Coupled Plasma-Mass Spectrometry
ICV	-	Initial Calibration Verification
ISO	-	International Organization for Standardization
LCS	-	Laboratory Control Sample
LFB	-	Laboratory Fortified Blank
LIMS	-	Laboratory Information Management System
LLD	-	Low Limit Detection
LOD	-	Limit of Detection
LOQ	-	Limit of Quantitation
MDC	-	Minimum Detection Concentration
MDL	-	Method Detection Limit
MBLK	-	Method Blank
MS/MSD	-	Matrix Spike/Matrix Spike Duplicate
NEHA	-	National Environmental Health Association
NELAC	-	National Environmental Laboratory Accreditation Conference
NELAP	-	National Environmental Laboratory Accreditation Program
NIOSH	-	National Institute for Occupational Safety and Health
NIST	-	National Institute of Standards and Technology
NPDES	-	National Pollutant Discharge Elimination System
OSHA	-	Occupational Safety and Health Administration

pCi/L	-	Picocuries per Liter
PT	-	Proficiency Testing
QA/QC	-	Quality Assurance / Quality Control
QS	-	Quality Systems
QAM	-	Quality Assurance Manual
RDL	-	Required Detection Level
RCRA	-	Resource Conservation and Recovery Act
RL	-	Reporting Limit
RPD	-	Relative Percent Difference
RSD	-	Relative Standard Deviation
SOP	-	Standard Operating Procedure
SPK	-	Spike
Std	-	Standard
SVOC	-	Semi-Volatile Organic Compound
TNI	-	The NELAC Institute
ug/L	-	Micrograms Per Liter
UV/VIS	-	Ultraviolet/Visible Spectroscopy
VOC	-	Volatile Organic Compound
WET	-	Whole Effluent Toxicity

APPENDIX A

Laboratory Certifications

The following are included in this Appendix:

- Montana State Drinking Water Certificate

MT State Drinking Water Certificate

- NELAP Accreditation Certificate
- NELAP Accredited Analyte List

Nelap Certification and List

Certifications and performance evaluation studies are available at www.energylab.com website and include:

- North Dakota State Certification
- South Dakota State Certification
- Wyoming State Certification (EPA Region VIII)
- Idaho State Certification
- Colorado State Certification
- Nevada State Certification
- Recent EPA WS and WP/DMRQA Study Results
- Recent NELAC Water/Soil Study Results

APPENDIX B

Quality Systems Controlled Documents

APPENDIX C

Quality Assurance / Quality Control Specifications

APPENDIX D

Organizational Charts

Corporate Organizational Chart
Billings Branch Lab Organizational Chart

APPENDIX E

Curricula Vitae of Key Laboratory Personnel

APPENDIX F

Equipment and Methods List

QAPP APPENDIX C

STANDARD OPERATING PROCEDURES

SOP#	
1	Streamflow Measurement and Wading Technique
3	Surface Water Quality Sampling
4	Field Sample Filtration
5	Field Measurement of Electric of Specific Conductance (EC/SC)
6	Field Measurement of pH
7	Field Measurement of Water Temperature
8	Field Measurement of Dissolved Oxygen
9	Sample Packaging and Shipping
10	Field Forms
11	Equipment Decontamination
12	Sample Documentation
13	QC Samples
17	Monitoring Well Development
18	Groundwater Sampling
20	Field Measurement of Groundwater Level
22	Soil Sampling Collection
23	X-ray Fluorescence Spectrometer (XRF Use and Calibration
24	Soil Sample Preparation and Preservation
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SOP#EH-03, Sediment Porewater Sampling Using Micro Push Point, East Helena Site, Montana

USEPA 6200 Field Portable X-ray Fluorescence

Butte Area One - HASP

STANDARD OPERATING PROCEDURE

STREAMFLOW MEASUREMENT; WADING TECHNIQUE

1. Visually check wading rod, current meter (pygmy or AA types), and headsets for damage. Repair damage to equipment and replace batteries in headsets as necessary.

2. Evaluate reach of stream to determine type of meter necessary to make flow measurement. For shallow, low velocity streams, use a pygmy-type current meter; for relatively deep, higher velocity streams, use a standard AA-type meter.

3. Perform spin test on selected meter; the cups on the pygmy meter should spin continuously for at least 30 seconds; on the AA meter, the cups should spin for at least two minutes. If the current meter fails the spin test, lubricate and adjust as necessary to achieve desired results.

4. Attach current meter and head set to wading rod. Check the electric connection between the current meter and headset by spinning cups on the current meter and listening for clicks in the head phone. Adjust equipment as necessary such that a clear click is heard upon every revolution of the cups.

5. Anchor surveyor's tape tautly across the stream perpendicular to the direction of streamflow and attach on either side of the stream. Provide at least one foot of clearance between the water surface and surveyor's tape.

6. Divide the stream cross-section into an appropriate number of sections with approximately equal flow in each section. Concentrate measurements in areas of most flow. A very small stream may have only a few sections; a river should have 20 to 30 sections.

7. Person wading in stream calls out to data recorder on shore the location of the first measuring point with respect to the surveyor's tape. Person in stream measures water depth at that vertical, using wading rod, to the nearest one-hundredth of a foot, if possible.

8. Data recorder calls out height(s) above the streambed at which velocity measurements are to be made. If the water is more than 2.5 feet deep, measurements should be made at 20 and 80 percent of the water column height. For water columns less than 2.5 feet deep, a single measurement of velocity at 40 percent of the water column height will suffice. Person wading adjusts height of current meter on the wading rod accordingly.

9. Person wading stands downstream of the surveyor's tape, facing upstream, holding the wading rod vertical in the water with the current meter facing directly into the current. Person should not stand directly behind the meter but either to the left or right so as not to influence velocity readings.

10. Person wading counts clicks at each vertical for a minimum of 40 seconds and calls final tally of both number of clicks and time to data recorder. Click count should correlate with velocity chart provided with each meter.

11. Repeat procedure at each vertical.

12. Data recorder reduces data on-site and records other appropriate information on the field form.

13. Streamflow measurement data are reduced using the attached form. Further information can be found in: Rantz et al, 1982. Measurement and Computation of Streamflow: Volume 1 - Measurement of

Stage and Discharge, Volume 2 - Computation of Discharge. U. S. Geological Survey Water-Supply Paper 2175.

STANDARD OPERATING PROCEDURE NO. 4
FIELD SAMPLE FILTRATION

1. Filtration equipment should include either disposable 0.45 micron filters or glassware to field filter water samples through a 0.45 micron filter paper. Visually inspect filtration equipment for damage. Replace parts or repair equipment as necessary.

2. Vacuum-type filtration apparatus will be decontaminated in accordance with SOP-11.

3. Place 10-15 milliliters of 10% dilute nitric acid into filter apparatus containing 0.45 micron filter. Apply vacuum, discard filtered solution.

4. Repeat above procedure three times using sample water. Discard filtrate. If unable to repeat three times, use a pre-filter before using the 0.45 micron filter.

5. Fill filter vessel with sample water and apply vacuum. Use small quantities of filtered water to rinse sample container three times.

6. Fill labeled sample container to appropriate level with filtered sample and mark level with permanent marker. Add appropriate preservative, if necessary. Invert sample container several times to insure complete sample - preservative mixing.

7. Place sample container into cooler; package and ship in accordance with SOP-09.

8. If extremely turbid sample water is obtained, use same procedure using a pre-filter (usually 3.0 or 5.0 micron paper) followed by 0.45 micron filtration.

9. Decontaminate all equipment in accordance with SOP-11 following use.

TETRA TECH

STANDARD OPERATING PROCEDURE NO. 5
FIELD MEASUREMENT OF ELECTRIC OR SPECIFIC CONDUCTANCE (EC/SC)

INSTRUMENT CALIBRATION (for non-temperature compensating meters)

At the beginning each day of making measurements, determine the cell constant for the meter in the field or lab.

1. Turn on machine and check red line and zero point on meter. Adjust as necessary. If unable to reach red line, or zero point, replace D cell batteries.

2. Plug probe into jack, and rinse probe with deionized water.

3. Measure conductivity and temperature of two KCl solution standards which best bracket the expected EC/SC of the sample.

4. Calculate EC/SC using the following chart to adjust conductivity measurement for temperature correction.

TEMPERATURE CORRECTION TABLE

TEMP °C	FACTOR	TEMP °C	FACTOR	TEMP °C	FACTOR
-1	1.89	8	1.46	17	1.18
0	1.84	9	1.42	18	1.15
1	1.79	10	1.38	19	1.13
2	1.74	11	1.35	20	1.10
3	1.68	12	1.32	21	1.08
4	1.63	13	1.29	22	1.06
5	1.58	14	1.26	232	1.04
6	1.54	15	1.23	24	1.02
7	1.50	16	1.20	25	1.00

5. Use the following procedure to calculate cell factor:

SC of Standard_______________(a)   Temperature of Standard ________________

Instrument Reading___________   Temperature Correction Factor (from above table)

Temp. Corrected SC__________(b)   Cell Correction Factor _________________________
[divide (a)/(b)]

6. The cell factor is calculated for each standard and then averaging the values from the two standards. The cell correction factor is the ratio of the actual conductivity of the standard KCl solution(a) to the computed conductivity(b). Use the averaged value of the two standards to adjust the measured field conductivity for each sample taken during the day.

FIELD PROCEDURE

1. Turn on machine and check red line and zero point on meter. Adjust as necessary. If unable to reach red line, or zero point, replace D cell batteries.

2. Rinse decontaminated glass beaker with approximately 50 milliliters of sample water three times.

3. Place approximately 150 ml. of sample in decontaminated glass beaker.

4. Rinse probe with deionized water and place conductivity probe in sample water.

5. Immerse conductivity probe in sample so that vent hole is submerged. Move probe around in sample to displace any air bubbles. The probe should not be touching the sides of the beaker. Turn instrument to appropriate scale for sample being analyzed. Multiply reading by the correct multiplier from the dial and record to the nearest ten micromhos/centimeter. Measure sample temperature to nearest 0.5°C from conductivity meter.

6. Record temperature and conductivity reading on the sample field form. Compute the adjusted specific conductivity using the following procedure:

   Water Temp. ______________________ Observed SC (a)_____________

   Temperature Correction (from table) (b) ___________________________
   Cell Correction Factor (from above) (c) ___________________________
   Adjusted Sample SC [multiply (a)(b)(c)] ___________________________

7. Remove probe from sample and rinse probe with DI water. Store probe in deionized water to protect coating.

MAINTENANCE

1. Store meter in its case during transport. Store probe immersed in deionized water (a poly bottle with rubber stopper works well).

2. Check batteries before taking meter into the field. Carry spare batteries and screwdriver.

3. Inspect conductivity electrodes regularly for cracks or other damage.

4. If platinum black has flaked off, a sharp end point cannot be achieved or readings are erratic. Return probe to factory so it can be replatinized.

TETRA TECH

STANDARD OPERATING PROCEDURE NO. 6
FIELD MEASUREMENT OF pH

INSTRUMENT CALIBRATION

Calibrate pH meter before leaving for the field and each day in the field when pH will be measured. Calibrate using following procedure:

1. Rinse pH electrode and temperature probe with distilled water.
2. Immerse electrode and temperature probe in bottle of commercial calibration solution of pH buffer 7.0. Calibrate meter to within 0.1 standard unit (s.u.).
3. Remove electrode and temperature probe from solution, rinse with distilled water.
4. Immerse electrode and temperature probe in second pH calibration buffer having a pH of 3 units higher or lower than the first, bracketing the expected range of natural sample pH.
5. The pH meter should be recalibrated during the field day, especially when air temperatures are changing by 5 or more degrees. To recalibrate pH meter, measure pH of the 7.0 buffer solutions. If the measured value differs from expected value by more than 0.1 units, recalibrate meter using according to meter instructions.

FIELD PROCEDURES

1. Rinse decontaminated glass beaker with approximately 50 milliliters of sample water three times.
2. Rinse pH electrode with deionized water.
3. Check meter using 7.0 pH buffer. Re-calibrate meter, if not within 0.1 pH units.
4. Fill beaker with sample water.
5. Immerse electrode and temperature probe in sample, agitate probes to provide thorough mixing. Continue to agitate until reading has stabilized. Read pH to nearest 0.1 s.u.
6. Record the sample pH. Note any problems such as erratic readings.
7. Rinse probe with DI water and store according to manufacturer's directions.

MAINTENANCE

1. Store meter in its case with electrode immersed in a KCl or pH 7.0 buffer solution.
2. If meter is not used often, inspect bi-weekly to make sure electrode is immersed in one of the solutions described above.
3. Check batteries each time meter is used. Carry a spare battery pack and a screwdriver into the field in the pH meter case.
4. It is wise to keep an additional pH electrode available in case of probe malfunction or breakage. Usually probes are replaced as their sensitivity becomes weakened. If stabilized readings take an unusually long time to reach, or the meter cannot be calibrated.

TETRA TECH

STANDARD OPERATING PROCEDURE NO. 7
FIELD MEASUREMENT OF WATER TEMPERATURE

1. Carry two NBS-calibrated thermometers (inside their cases) into the field.*

2. Check thermometer for cracks or gaps in the solution. Do not use thermometers if either cracks or gaps are visible. (Some gaps can be closed by submersing tip in a beaker of boiling water, or placing thermometer in a freezer).

3. When possible, measure temperature of surface water at midstream submersing the thermometer for approximately one minute or until temperature stabilizes. Temperatures should be collected from moving water, avoiding still pools which may be warmer than actual conditions.

4. When in situ temperature measurements are not possible, draw sample of at least 200 mL into a decontaminated beaker or sample bottle as soon after sampling as possible.

5. Place thermometer in sample. Do not allow thermometer bulb to touch sides of beaker. Allow to equilibrate (about 1 minute).

6. Record temperature to nearest 0.5°C in field log book or on field data sheet.

7. Rinse thermometer with deionized water.

8. On a quarterly basis, check field thermometers against a NBS-certified laboratory thermometer. Agreement should be within 0.5°C.

* Alternately, an electronic multi-meter equipped with a temperature probe may be used. If a multi-meter is used, the accuracy of its temperature probe should correspond within 0.5°C of an NBC-calibrated thermometer.

TETRA TECH

STANDARD OPERATING PROCEDURE NO. 8
FIELD MEASUREMENT OF DISSOLVED OXYGEN

1. Inspect dissolved oxygen (DO) meter for damage. The probe end should be examined to be sure the membrane is intact. Repair as necessary according to manufacturer's instructions.

2. Rinse probe and cable with Deionized water.

3. Prepare probe and DO meter in accordance with instrument manufacturer's operating procedures (in meter box). Make certain probe contains sufficient electrolyte and the oxygen sensor membrane is in good repair.

4. Calibrate probe and meter using the fresh water - air calibration method. Correct calibration value for temperature and altitude; adjust meter accordingly.

5. When possible place probe directly into the stream, or water to be measured. If not possible, place probe into beaker filled with sample. Manually raise and lower probe through sample about 1 foot/second. Allow sufficient time for probe to stabilize to sample temperature and dissolved oxygen concentration.

6. Read dissolved oxygen value. Record appropriate data on field forms.

TETRA TECH

STANDARD OPERATING PROCEDURE NO. 9
SAMPLE PACKAGING AND SHIPPING

All environmental samples collected should be packaged and shipped using the following procedures:

PACKAGING

1. Label all sample containers with indelible ink (on the side, not on the cap or lid). Place labeled sample bottles in a high quality cooler containing an adequate amount of ice and/or frozen blue ice (appropriate for the season), making sure the cooler drain plug is taped shut.

2. Place the samples in an upright position and wrap the samples with absorbent, cushioning material for stability during transport. Samples should not be loose; the cooler should be able to withstand rough handling during shipment without sample breakage.

3. Fill out the appropriate shipping forms, and place the paperwork in a ziploc bag and tape it to the inside lid of the shipping container. Shipping forms usually include: 1) a chain-of-custody form, documenting the samples included in the shipment; 2) an analysis request form, specifying the laboratory analyses for each sample. If more than one cooler is used per chain of custody, put a photocopy in the other coolers and mark them as a copy.

4. Close and seal the cooler using fiberglass strapping tape.

5. Secure the shipping label with address, phone number, and return address clearly visible.

SHIPPING HAZARDOUS MATERIALS/WASTE

Hazardous materials need to be shipped using procedures specified under Federal Law. Samples need to be shipped in ziploc bags or paint cans filled with vermiculite, depending on the level of hazard. Special package labeling may be needed. Consult the project manager for specific shipping procedures.

STANDARD OPERATING PROCEDURE NO. 10
FIELD FORMS

All pertinent field investigations and sampling information shall be recorded on a field form during each day of the field effort and at each sample site. The field crew leader shall be responsible for ensuring that sufficient detail is recorded on the field forms. No general rules can specify the extent of information that must be entered on the field form. However, field forms shall contain sufficient information so that someone can reconstruct all field activity without relying on the memory of the field crew. All entries shall be made in indelible ink weather conditions permitting. Each day's or site's entries will be initialed and dated at the end by the author.

At a minimum, entries on the field sheet or in field notebook shall include:

- Date and time of starting work and weather conditions.
- Names of field crew leader and team members
- Project name and type
- Description of site conditions and any unusual circumstances.
- Location of sample site, including map reference, if relevant
- Equipment ID numbers
- Details of actual work effort, particularly any deviations from the field work plan or standard operating procedures
- Field observations
- Any field measurements made (e.g., pH)

For sampling efforts, specific details for each sample should be recorded using Maxim Technologies, Inc. standardized field forms. Surface water and groundwater field forms contain fill-in-the-blank type information in order that all pertinent information shall be recorded. In addition to the items listed above, the following information is recorded on field forms during sampling efforts:

- Time and date samples were collected
- Number and type (natural, duplicate, QA/QC) of samples collected
- Analysis requested
- Sampling method, particularly deviations from standard operating procedures

Strict custody procedures shall be maintained with the field forms. Field forms shall remain with the field team at all times, while being used in the field. Upon completion of the field effort, photocopies of the original field forms will be made and used as working documents; original field forms shall be filed in an appropriately secure manner.

TETRA TECH

STANDARD OPERATING PROCEDURE NO. 11
EQUIPMENT DECONTAMINATION

The purpose of this section is to describe general decontamination procedures for field equipment in contact with mine/mill tailings, soil, or water. During field sampling activities, sampling equipment will become contaminated after it is used. Sampling equipment must be decontaminated between sample collection points if it is not disposable. Field personnel must wear disposable latex or vinyl gloves while decontaminating equipment at the project site. Change gloves between every sample. Every precaution must be taken by personnel to prevent contaminating themselves with the wash water and rinse water used in the decontamination process. Table A-1 lists equipment and liquids necessary to decontaminate field equipment.

The following should be done in order to complete thorough decontamination:

1. Set up the decontamination zone upwind from the sampling area to reduce the chances of windborne contamination.

2. Visually inspect sampling equipment for contamination; use stiff brush to remove visible material.

3. The general decontamination sequence for field equipment includes: wash with Liquinox or an equivalent degreasing detergent; deionized water rinse; 10% dilute nitric acid rinse; deionized water rinse; rinse with sample water three times.

4. Rinse equipment with methanol in place of the nitric rinse if sampling for organic contamination. Follow with a deionized water rinse.

5. Decontaminated equipment that is to be used for sampling organics should be wrapped in aluminum foil if not used immediately.

6. Clean the outside of sample container after filling sample container.

Alternatively, field equipment can be decontaminated by steam cleaning, rinsing with 10% dilute nitric acid, and rinsing with deionized water.

All disposable items (e.g., paper towels, latex gloves) should be deposited into a garbage bag and disposed of in a proper manner. Contaminated wash water does not have to be collected, under most circumstances.

If vehicles used during sampling become contaminated, wash both inside and outside as necessary.

TABLE A-1. EQUIPMENT LIST FOR DECONTAMINATION

5-gallon plastic tubs	Liquinox (soap)
5-gallon plastic water-container	Hard bristle brushes
5-gallon carboy DI water	Garbage bags
1-gallon cube of 10% HNO_3	Latex gloves
1-gallon container or spray bottle of 10% Methanol or pesticide grade acetone for organics	Squeeze bottles
	Paper towels

STANDARD OPERATING PROCEDURE NO. 12
SAMPLE DOCUMENTATION

Sample documentation is an important step to ensure the laboratory, project manager, and field personnel are informed on the status of field samples. Depending on the specifics required for each project, a number of forms will need to be filled out. Most sample documentation forms are preprinted carbonless triplicates, enabling copies to be filed or mailed from labs or offices. The forms will be completed by field personnel, who have custody of the samples. The office copy will be kept in the project file and subsequent copies sent to the laboratory, or other designated parties. The responsibility for the completion of these forms will be with each field crew leader. It is important the field crew leader is certain field personnel are familiar with the completion process for filling out forms, and the expected information is included.

Potential documents to be completed clearly in ink for each sample generated include:

- Field Form
- Chain-of-Custody
- Custody Seal

If working on Superfund activities, the following additional forms will also be prepared:

- EPA Sample Tags
- SAS Packing Lists
- Sample Identification Matrix Forms
- Organic Traffic Report (if applicable)
- Inorganic Traffic Report (if applicable)

STANDARD OPERATING PROCEDURE NO. 13
QUALITY CONTROL SAMPLES

Quality Control (QC) samples are submitted along with natural samples to provide supporting laboratory data to validate laboratory results. QC samples are submitted blind, and do not have any unique identifying codes that would enable the lab or others to bias these samples in any way. Usually, the time or sampling location is modified in a way which will separate blank and standard samples from the rest of the sample train. QC samples are identified only on field forms and in field notebooks. The following codes are typically used:

N - Natural Sample	Soil, water, air, or other of interest material from a field site
SP - Split Sample	A portion of a natural sample collected for independent analysis; used in calculating laboratory precision
D - Duplicate Sample	Two samples taken from the same media under similar conditions; also used to calculate precision
BB - Bottle Blank	Deionized water collected in sample bottle; used to detect contamination sampling containers
CCB - Cross Contamination	Deionized water run through decontaminated equipment and analyzed for Blank residual contamination and deionized water contamination
BFS - Blind Field Standard	Certified materials of known concentration; used to determine laboratory accuracy
TB - Travel or Trip Blank	Inert material (deionized water or diatomaceous earth) included in sample cooler; sent by the lab, the sample is used to determine if contamination by volatiles is present during collection or shipping

In general, selected QC samples will be inserted into the sample train within a group of twenty samples. Unless otherwise specified, QC samples will be prepared in the field. Deionized water blanks will be collected from carboys and cubitainers used in the field. An exception to field preparation of QC samples is the preparation of some blind field standards. Since the concentration of analytes in the sample is to be mixed according to specific manufacturer's instructions, field conditions may not provide the needed laboratory atmosphere. This is especially true for volatile organic compounds, which need to be prepared just before analyzing. Under these circumstances, standards will be shipped to the laboratory for preparation, keeping the concentration or manufacturer's QC Lot Number as blind as possible.

The number and types of samples submitted for each group of natural samples will be determined by the project manager and others, including state or Federal agencies, and will be defined in the project work plan. Each field crew leader will be responsible for all QC samples prepared by that crew.

Methods for computing data validation statements can be found in EPA documents or obtained from the Maxim Technologies, Inc. laboratory.

STANDARD OPERATING PROCEDURE

MONITORING WELL DEVELOPMENT

1. Visually inspect all well development equipment for damage - repair as necessary.

2. Decontaminate all stingers, air hoses, surge blocks by scrubbing with brush and Liquinox solution, rinsing with dilute nitric acid solution, and rinsing with deionized water. If sampling for organics, replace the nitric acid rinse with 10% methanol as per SOP 11.

3. If using compressed air method for well development, make certain compressor utilized does not produce air laden with hydraulic fluid for lubricating purposes. This may affect the integrity of the monitoring well for producing viable water quality data.

4. Develop well by using surging techniques (surge block or bailer) followed by well evacuation. Repeat this procedure until evacuated water is visibly clean and essentially sand-free. In most cases, evacuated water can be disposed of on-site.

5. If specified in the project workplan, during evacuation process, collect water samples for field determinations of temperature, specific conductivity, and pH. Continue developing well until field parameters stabilize to within $\pm$5% on three consecutive measurements.

6. Report field observations and volume of water removed on standard form.

TETRA TECH

STANDARD OPERATING PROCEDURE NO. 18
GROUNDWATER SAMPLING

EQUIPMENT:

five gallon bucket graduated in gallons	pH meter/thermometer (optional)
coolers and ice	specific conductance meter (optional)
sample bottles	bailer(s)
preservatives	bailer rope or teflon reel
filter apparatus	field sampling forms
decontamination equipment & fluids	indelible marker
water level probe	stop watch
purge pump(s)	generator
discharge hose	fuel

All sampling equipment shall be inspected for damage, and repaired if necessary, prior to arriving on-site.

GENERAL PROCEDURE - PURGING

Purging must be performed on all wells prior to sample collection. If required by the project workplan, the stability of pH, specific conductivity, and temperature will be evaluated. A minimum of three volumes of groundwater in the well casing shall be withdrawn prior to sample collection. The volume of water present in each well shall be computed using the length of water column, monitoring well inside diameter, and casing diameter. The total volume of water in the well (gallons) can be approximated using the following formula (depth and water level measurements in feet; borehole diameter in inches):

$$(1/25)(\text{Total Depth - Measured Water Level})(\text{Casing Diameter})^2 = \text{gallons}$$

Several general methods are used for well purging. Well purging may be achieved using bailers, bladder pumps and submersible pumps. The specific pumping method shall be chosen based on depth to groundwater, diameter of well, existing well configuration and contaminant(s) of concern. Specific conductance, pH, temperature, and purge volume values will be entered on the Field Sampling Forms. If sampling for hydrocarbon compounds, wells shall be checked for the presence of free product prior to purging and sampling.

If specified by the project workplan, field parameters will be measured periodically during well purging. The well is ready for sampling when either or both of the following conditions are met: 1) measured field parameters stabilize at plus or minus five percent of the reading, over three successive readings or, 2) three to five casing volumes have been evacuated from the well.

If the recovery of a low-yield well exceeds two hours after purging, the sample shall be extracted as soon as sufficient volume is available in the well for a sample to be extracted. At no time will a monitoring well be pumped dry if the recharge rate causes formation water to cascade down the well casing causing an accelerated loss of volatiles and change in pH.

COLLECTING WATER QUALITY SAMPLES

1. Generally, wells shall be sampled from the least contaminated to the most contaminated, if known. Open well and measure water level (SOP-20).

2. Decontaminate sampling equipment using the following procedure: scrub with brush and Liquinox solution; rinse with 10% dilute nitric acid; rinse with methanol, if sampling for organic compounds; rinse three times with deionized water. Use disposal latex or vinyl gloves throughout decontamination and sampling procedure and new gloves for each sampling point.

3. Sampling Monitoring Wells

   a. To collect a water quality sample, use a decontaminated disposable polypropylene, stainless steel, or teflon bailer and a spool of polypropylene rope or equivalent bailer cord (teflon-coated stainless steel cable). Tie a bowline knot through the bailer loop to secure.

   b. Slowly lower bailer or other sample collection device to the bottom of the well and remove an additional 5 feet of rope from the spool. Secure end of rope to steel well casing or wrist.

   c. Purge well by bailing or pumping, collecting evacuated water in a graduated 5 gallon bucket to measure the total volume discharged.

   d. Collect a sufficient quantity of water using the bailer or pump into a decontaminated one gallon sample container to fill all sample bottles.

4. Sampling Domestic Wells

   a. Turn-on household fixture (preferably an outside faucet without a hose connected) that is on the well-side of any household water conditioning device.

   b. Using the above equation, calculate the volume of water to be evacuated. Measure the discharge rate from the faucet in a graduated 5 gallon bucket, or other suitable container, to compute the rate of discharge. Calculate the time needed to evacuate the predicted volume from the well. Record all measurements and calculations on field forms.

   c. Samples should be collected directly from hydrant or faucet and prior to entry of the water through any water conditioning devices. Do not collect samples through rubber hoses.

5. If specified by the project work plan, measure pH and specific conductance (SOP-05 and SOP-06). Continue monitoring field parameters (pH and specific conductance) periodically during purging process. The well is ready for sampling when either or both of the following conditions are met: 1) the purged volume is equal to three to five casing volumes and/or, 2) measured field parameters are within plus or minus five percent ($\pm$ 5%) over three successive readings.

6. If sampling for dissolved metals, field filter sample according to SOP-04.

7. Label each sample container with project number, sample location, well owner, date, military time, sampler's initials, preservative, and analysis required. For inorganics samples, rinse sample containers, without preservatives, three times with sample water before final collection. Do not rinse containers for organics analysis.

8. Pour the sample into the appropriate sample containers and and any needed preservatives in

accordance with SOP-42. Also see ("Handbook for Sampling and Sample Preservation of Water and Wastewater", EPA-600/4-82-029; "Guidelines Establishing Test Procedures for the Analyses of Pollutants Under the Clean Water Act", 40 CFR 136; and "Test Methods for Evaluating Solid Wastes," EPA SW-846). A few common sample preservatives are listed below:

Dissolved Metals	Add 3-4 ml. Nitric Acid to 500 ml. sample
Nutrients	Refrigerate to 4°C. Add 3-4 ml. Sulfuric Acid to 500 ml.sample
Common Ions	Refrigerate to 4°C
Hydrocarbon VOA	Refrigerate to 4°C. Add 3-4 drops HCl*
Diesel Range Organics	Refrigerate to 4°C. Add 80 drops (4ml) HCl
Fluorescent Tracer Dye	Refrigerate to 4°C. Prevent exposure to light

For additional bottling and sample preservation information, consult the Maxim Technologies, Inc. laboratory.

9. For volatile analyses add preservative to sample vial and fill vials at the rate of 100 milliliters per minute (24 seconds for 40 milliliter vial); form positive meniscus over vial brim and cap. After capping, invert vial, gently tap and look for air bubbles. If bubbles are present, un-cap vial, add more water and repeat procedure.

10. If required by the project workplan, perform field parameter tests including pH, SC, Eh, and temperature on water sampled from the well. Record field measurements on field forms.

11. Complete the necessary shipping and handling paperwork, and record all pertinent information on Field Sampling Form in accordance with SOP-10.

TETRA TECH

STANDARD OPERATING PROCEDURE NO. 20
FIELD MEASUREMENT OF GROUND WATER LEVEL

1. Calibrate well probe to a steel tape prior to and following each data gathering episode. Note any corrections to well probe measurements on field forms.

2. Check well probe prior to leaving for field for defects by placing probe in water and testing buzzer and light. Repair as necessary. Make certain the well probe, a tape measure calibrated to tenths of feet and extra batteries are in the carrying case.

3. Measure all wells (monitoring and domestic) from the top of the well casing in the north quadrant or from a designated measuring point, as appropriate. Measure and record distance from measuring point to ground level. Make sure measuring point is labeled on well, so future measurements can be made from the same location.

4. Obtain a depth to water from measuring point to the nearest hundredth of a foot. Record data on appropriate field forms.

5. Decontaminate well probe between each measurement by rinsing with deionized water. Additional decontamination, such as liquinox scrubbing, may be required for certain wells; consult the project work plan.

STANDARD OPERATING PROCEDURE

SOIL SAMPLE COLLECTION

This SOP describes the field equipment and sampling methods for surface and subsurface sampling of soil material. Methods explained in this SOP may be different from those identified in the project specific Sampling and Analysis Plan (SAP) and the project specific SAP should be referenced for additions or deletions to the methods noted below. All sampling equipment should be cleaned before arriving on site.

FIELD EQUIPMENT

- Sharp shooter and clean-out shovel
- Stainless steel mixing bowl and sampling trowel
- Dilute (10%) hydrochloric acid
- Hand lens (10) power
- Steel tape (10 foot)
- pH and electrical conductivity meters (if required)
- Munsel color book (if required)
- No. 10 sampling screen
- Field forms and field book
- Bucket augers

SURFACE SAMPLING

Surface soil/tailings samples are collected from the surface to a depth of one inch unless otherwise specified in the project specific SAP. Sufficient sample will be collected for the analysis that will be performed but generally this will be on the order of one gallon. Soil samples will be collected in either wide mouth glass jars or resealable polyethylene bags (ziploc or equivalent).

Samples should be described according to the procedures outlined in the Unified Soil Classification System (USCS; method ASTM D2487) or the Soil Conservation Service (SCS) classification system. Soil texture should be classified by either the USCS or U.S. Department of Agriculture (USDA) classification. Descriptions shall be recorded in field books or on standard morphological description logs as provided in the SAP.

Samples should be collected from an area of approximately six square feet by digging up the top inch with the sampling trowel and placed in the mixing bowl. The sample should be screened with the 10 mesh sieve if coarse fragments are to be excluded from the sample. If a sod or duff layer is present, this layer should be pealed back to the top of the mineral soil.

The sample placed in the mixing bowl shall be well mixed and then a portion of the sample placed in the sample container. To select a sample from the mixing bowl, quarter the sample in the bowl and place an equal volume of soil from each quarter in the sample container. When sampling soil for organics, the samples should not be mixed.

All equipment used in the sampling of surface soils will be decontaminated using the procedures in SOP-11. All necessary paperwork will be filled out in accordance with SOP-12.

SUBSURFACE SAMPLING

Subsurface sampling will be completed using a bucket auger, split spoon sampler, or hand dug or backhoe excavated pits. Sampling procedures for each type of equipment is described below. Sample collection, homogenation, and transfer to sampling containers should follow the same procedures as outlined for collection of surface samples.

<u>Bucket Auger</u>

1. Arrive on-site equipped with stainless steel auger rod and several sizes of stainless steel bucket augers (e.g. 2-inch, 4-inch, 6-inch, etc.).

2. Bucket auger holes can be drilled as one size or in a telescoping manner if contamination between sample intervals is a concern. If a single sized, advance the bucket auger to the desired sampling interval depth and empty the contents of the auger in a stainless steel mixing bowl. For the telescoping method, advance the largest auger to an approximate depth of three feet, collecting specified depth increment samples as the auger is advanced. Install temporary decontaminated PVC casing with a diameter slightly smaller than the borehole to keep the hole open and reduce possible cross-contamination between depth intervals. Using the next size smaller bucket auger, repeat the process.
3. Select sample intervals for packaging for laboratory analysis in accordance with procedures described in the SAP.

4. Fill out appropriate paper work and bottle labels as necessary prior to leaving site.

5. Decontaminate all equipment between sample locations.

<u>Split Spoon Sampler</u>

1. Arrive on-site equipped with at least two standard 1.4 inch inside diameter split spoon samplers. If geotechnical information is desired, a 140 pound drive hammer is required.

2. Install sampler into borehole and advance to the desired depth with the 140 pound drop hammer or equivalent means. Record number of blow counts to complete sampling over each 18-inch interval, as necessary. Retrieve sampler and place on work table. Using the other sampler, repeat this sequence.

3. Record lithology and percent recovery from cores retrieved from split spoon sampler.

4. Based upon the project work plan or sampling and analysis plan, composite like core intervals by mixing in stainless steel bowl in a similar manner as described for surface sampling. When sampling for organics, the sample should not be mixed.

5. Decontaminate sampling equipment between each interval sampled if required by the SAP. Decontaminate sampling equipment between sampling sites.

<u>Backhoe or Hand Dug Excavations</u>

1. Locate the site to be sampled and insure that equipment can safely access the site. Minimize off road travel to prevent off site damage to surrounding vegetation.

2. Orient excavation to maximize use of the angle of the sun to illuminate the pit for photographs. Place excavated material a sufficient distance from the excavation.

3. Excavate to the prescribed depth. If the pit exceeds five feet in depth, OSHA construction standards for shoring or sloping must be observed to prevent accidental burials. Sampling personnel should enter the pit with care during and after excavation.

4. Soil profile descriptions shall be made from a hand cleaned surface along the pit wall. Complete profile descriptions and take photographs before pit is sampled.

5. Soil samples shall be collected from depth intervals specified in the SAP. When a depth interval is sampled, an equal volume of soil should be collected from the entire interval exposed on the pit wall. Soil samples will be collected with the stainless steel trowel and mixing bowl according to methods described for surface soil sampling. When sampling for organics, the sample should not be mixed.

6. After sampling is completed, the pit should be backfilled with excavated material in the reverse order that it was excavated so that topsoil material is returned to the top of the pit. When backfilling is complete the area should be cleaned-up to its original condition.

7. Decontaminate sampling equipment between sampling sites. Excavation equipment should be cleaned between sites with water (where possible) or with a shovel to remove accumulated dirt and mud.

STANDARD OPERATING PROCEDURE

X-RAY FLUORESCENCE SPECTROMETER (XRF) USE AND CALIBRATION

The chemical characterization of soil samples in the field will be determined by the field portable X-ray fluorescence (XRF) Spectrometer ATX-100 instrument manufactured by Aurora Tech, Inc, Salt Lake City, Utah. The instrument uses low level self-contained and shielded radioactive sources that produce spectral peaks whose position (energy level) is specific to an individual element and whose peak height or area which is indicative of the concentration of that element within the area exposed to the source. Two sources will be used, cadmium-109 (15 millicuries) and Iron-55 (100 millicuries) emplaced by the manufacturer. These sources allow semiquantitative determination of the copper, zinc, arsenic, iron, manganese and lead concentrations. Additional elements that will be monitored include chromium, barium, cobalt, nickel, selenium, and molybdenum.

The detection limit for each parameter is a function of source strength, geometry/particle size, counting time, and the concentration of other elements. Since the source strength and instrument geometry are constants, the detection limit is dependent on geometry/particle size, counting time, and concentration. It has been demonstrated that 80 mesh particle size dominantly composed of a siliceous or calcareous skeletal matrix will give analytical results within 20 percent. The larger the particle size, the larger the error. A rock made up of fine-grained minerals, however, will essentially have the same precision and accuracy as a finely ground sample.

Soil samples will be screened and all particles greater than 2 mm (No. 10 sieve) will be removed.

The counting time also affects the detection limit. In general, the longer the counting time, the lower the detection limit, and certainly the higher the precision and accuracy. The instrument has controllable time units of 10, 30, 100, 300, and manual control seconds. The 30 second counting time will likely be the standard for this test. The time may change for either or both sources depending on the actual sample matrix encountered in the field.

The primary operator will receive one day's training on the proper use of the instrument particularly for health and safety purposes. The manufacturer's statement on radiation safety is also attached. Each operator will have a gamma film badge service (monthly) and will have the dates and times used logged in the record book specifically kept for this purpose.

Calibration of the unit will be provided by the following method.

The XRF will be calibrated before being taken in the field by developing response curves of index values verses actual concentrations of metals in soils. Numerous samples have been analyzed through the CLP program for metals content and splits of these samples are archived in Helena. These splits will be used to develop the response curves so that the index values that are generated in the field can be converted into concentrations. These concentrations will then be used to help direct the soil sampling program for laboratory samples. The XRF will also be calibrated using the internal standards as recommended by the manufacturer. This internal calibration will be performed, each day of use, in the morning, at noon and at the end of the day. Time, temperature and calibration data will be noted during each calibration in the field logbook.

Data for Cu, Zn, Fe, Mn, Pb, As, and Ni will be recorded in the field logbook or on standard forms.

To obtain the best quantitative XRF results, a uniform volume of soil material of generally the same particle size will be used. The sample should be prepared in the following manner: (1) Disaggregate and homogenize field moist sample, foreign objects such as rocks, twigs, roots, etc.; (2) Dry sample preferably overnight in an over set at approximately 105^{o}C; (3) Cool sample to room temperature; (4) Sieve sample through a 2 mm nonmetallic sieve; (5) homogenize sieved sample; and, (6) Place sample in a 2-inch petri dish.

The soil material will be well packed in the petri dish and the top surface should be uniformly smoothed to the level of the petri dish edges. The head of the XRF should then be placed over the petri dish.

If soil is sticking to the XRF, place a piece of Saran Wrap over the petri dish. If any dust sticks to the head of the XRF, clean it with a fine-bristle paint brush.

SOP-24

STANDARD OPERATING PROCEDURE

SOIL SAMPLE PREPARATION AND PRESERVATION

This SOP applies to EPA Superfund Projects.

The Document Control Officer (DCO) will direct all packaging and shipping procedures in the field. Each of the three field scientists will be responsible for a specific task to ensure consistency.

Procedure

1. All soil sampling, decontamination, QA/QC samples, sample splits, and pH and SC measurement should be completed for each sample.

2. Upon filling a soil sample container, a field scientist will place a completed EPA custody seal over the top of the container. The custody seal serves two purposes. It secures custody of the sample and it secures the lid of the container.

3. An EPA sample tag is completed by a field scientist, and is taped securely to the sample container.

4. The soil samples will then be placed into a cooler labeled "SOIL SAMPLES", with the site identification and date also written on the cooler top. Since soil samples will be in glass ICHEM jars, they will be packed with vermiculite to prevent breakage. The cooler will be packed full, so there is no empty space for the contents to move about.

5. When the cooler is full, or when the sample collection is complete, the correct Chain-of-Custody, Inorganic Traffic Report (ITR) and Special Analytical Service (SAS) packing list can be completed at a later date. A pre-numbered airbill will be assigned to that cooler.

6. The DCO will double check the forms to assure those samples mentioned on the COC, ITR and SAS are all present and accounted for in the cooler. He/she will document this on the ITR, SAS Packing List and Sample ID Matrix.

7. The cooler will be clearly marked "FRAGILE/THIS SIDE UP" on all four sides and the top as appropriate.

8. The DCO will then place the proper COC, and SAS, SIDM, and Packing Lists in a ziplock bag, taped to the inside roof of the cooler.

9. The DCO or field scientist will then close the cooler and affix the airbill to the top of the cooler.

10. The DCO or field scientist will then seal the cooler and place the appropriate custody seals (one in front and one in back), signed and dated, on the cooler.

11. The field scientist will then place fiberglass tape over the custody seals and around the cooler, making sure everything is secure.

12. The cooler will be labeled as to type of samples and date of sampling, with a large felt-type pen. A label should also be placed on top of the cooler so the laboratory will return the cooler to you.

13. The cooler(s) will then be transported to a secure storage facility, where they can be kept under custody until they are shipped.

STANDARD OPERATING PROCEDURE

AQUIFER TESTING

EQUIPMENT REQUIRED

Aquifer Test Field Forms	Fuel Cans
Weather-Proof Notebook	Rope
Well Logs	Sample Bottles
Electric Well Probe	Pipe Wrenches
100 Foot Measuring Tape	Screwdrivers
Generator	Ratchet Set
Control Box w/Electrical Cable	Allen Wrenches
Submersible Pump w/Check valve	Wire Splice Kit
Standpipe	Tape Measurer (0.01 ft. increments)
Discharge Hose	Cooler
Assortment of Valves, Elbows, Fittings	Pocket Knife
Teflon Tape	Shovel
Electrical Tape	S.C. Meter
Laptop Computer w/Communication Software	Discharge Measurement Device(s)
Pressure Transducers w/Manual	pH Meter
Digital Recorder w/Manual	Thermometer
Watch	Solid Cylinders (Slug)

PUMPING TESTS

1. Measure water levels in the pumping well and all observation wells daily for several days prior to the test to document water table fluctuation. It may be appropriate to install continuous water level recorders in selected wells to obtain this information.

2. Arrive on-site with all necessary equipment decontaminated and in good repair.

3. Set-up equipment; insure discharge hose/piping is directed away from test area such that the discharge will not influence the test. Obtain discharge permits if necessary.

4. Choose pump capacity based on expected well yield reported from previous pumping tests or from the well development logs. It is important to stress the aquifer during the pumping test yet have enough available drawdown for the expected duration of the test. It's better to use an oversized pump rather than an undersized pump. A one-way check valve should always be attached to the top of the pump.

5. Measure water levels in the pumping well and all observation wells prior to setting the test pump. Record all data on standardized field forms.

6. Calibrate pressure transducers in accordance with manufacturer's recommendations. Use the most sensitive transducersin observation wells and the least sensitive transducer in the pumping well, if applicable. If transducers are used, secure transducer immediately above

check valve with electrical tape. While lowering the pump into the well, secure transducer cable and electrical cable to the standpipe every 10 feet with electrical tape. Be sure to include a shroud over the pump if the pump intake is below the lowest screened interval.

7. Plumb a valve into the discharge line at the well head to facilitate flow rate adjustments. It may also be appropriate to plumb a sample port into the discharge line near the well head.

8. Lay out discharge hose in a manner that will not subject the hose to disruption thoughout the duration of the test.

9. Begin trial pumping test by maintaining a constant discharge rate and measuring drawdown in the pumping well with an electric well probe or a pressure transducer. Determine if pumping rate is appropriate for the length of the test by plotting trial test data on semi-log or log-log graphs. Adjust discharge rate as necessary. Terminate trial pumping test and allow water levels to recover to prepumping elevations.

10. Prepare for constant discharge test by coordinating all personnel involved. Be sure that the generator is fully fueled. If a digital recording device is used to record time/water level data, configure the device so that water level data are recorded every 30 seconds for the first half hour of the test and every ten minutes for the remainder of the test. If a digital recorder is not used, measure depth to water in the pumping well and all observation wells every 30 seconds for the first five minutes of the test, every minute for the next five minutes, every two minutes for minutes 10 through 20 of the test, every five minutes for minutes 20 through 40, every 10 minutes for minutes 40 through 60, every 15 minutes for minutes 60 through 100, every 30 minutes for minutes 100 through 300, and every 60 minutes for the remainder of the test.

11. Following termination of the constant discharge test, collect water level recovery data in a sequence similar to that above with the most frequent measurements obtained early in the recovery tests.

12. During the constant discharge test, obtain measurements of discharge periodically (at least every hour) and record on field forms. Be aware that flow rates may decrease as drawdown in the pumping well increases. Adjust discharge as necessary to maintain consistency. Measure field parameters, including pH, SC, and temperature at the time of discharge measurements.

13. Record all data on standard field forms and plot drawdown and recovery curves in the field in accordance with methods described in Lohman (1972) or other appropriate techniques as conditions or aquifer type warrant. Note any irregularities noticed during the test on field forms.

14. Upon completion of aquifer testing, decontaminate all equipment prior to exiting the project area.

References: Lohman, S.W. 1972. Ground Water Hydraulics. U.S. Geological Survey Professional Paper 708. Washington.

SLUG TESTING

1. Arrive on-site with all equipment decontaminated and in good repair.

2. Calibrate pressure transducer (if applicable) prior to conducting the test in accordance with manufacturer's recommendation.

3. Lower transducer into the well to be tested and allow to stabilize. Measure and record static water level prior to initiation of test. Be sure to set transducer at a depth where it will not be disturbed when the slug is installed. Secure the transducer cable to the well head to prevent movement of the transducer in the well bore during the test.

4. Perform test by either withdrawing a known volume of water from the well with a bailer or by inserting a solid cylinder of know dimensions. Record water level recovery data at frequent intervals on a standardized field form. Measurement frequency should be similar to that described for aquifer tests. It is preferable to use a continuously recording pressure transducer to record recovery data as data obtained early in the test are typically the most valuable data for slug testing. Record data until recovery is about 95 percent complete.

5. Analyze time/water level data in the field using methods described in U.S. Department of the Navy (1974), Hvorslev (1951), Bouwer (1989) and/or any other appropriate techniques for the type of aquifer being tested.

6. Note any irregularities in test procedures on the field forms.

7. Decontaminate all field equipment prior to leaving each site.

References:

Bouwer, H. 1989. The Bouwer and Rice Slug Test - An Update. Ground Water, Volume 27, No. 3. May-June, 1989.

Hvorslev, J.M. 1951. Time Lag and Soil Permeability in Ground Water Observations. Bulletin 36. U.S. Corps of Engineers, Waterways Exp. Sta., Vicksburg, MS.

U.S. Department of the Navy. 1974. Naval Facilities Engineering Command

SOP #EH-03

Sediment Porewater Sampling using a Micro Push Point

TABLE OF CONTENTS

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide a standardized method for collection of sediment porewater samples from micro Push Points or mini piezometers, to be used by employees of USEPA Region 8, or contractors and subcontractors supporting USEPA Region 8 projects and tasks. This SOP describes the equipment and operations used for sampling sediment porewater in areas which will produce data that can be used to support risk evaluations. Deviations from the procedures outlined in this document must be approved by the USEPA Region 8 Remedial Project Manager, Regional Toxicologist or On-Scene Coordinator prior to initiation of the sampling activity.

2.0 RESPONSIBILITIES

The Field Project Leader (FPL) may be an USEPA employee or contractor who is responsible for overseeing the sediment porewater sampling activities. The FPL is also responsible for checking all work performed and verifying that the work satisfies the specific tasks outlined by this SOP and the Project Plan. It is the responsibility of the FPL to communicate with the Field Personnel regarding specific collection objectives and anticipated situations that require any deviation from the Project Plan. It is also the responsibility of the FPL to communicate the need for any deviations from the Project Plan with the appropriate USEPA Region 8 personnel (Remedial Project Manager, Regional Toxicologist or On-Scene Coordinator).

Field personnel performing sediment porewater sampling are responsible for adhering to the applicable tasks outlined in this procedure while collecting samples. The field personnel should have limited discretion with regard to collection procedures, but should exercise judgment regarding the exact location of sample collection, within the boundaries outlined by the FPL.

3.0 EQUIPMENT

- Micro Push Point (PP) Samplers - in lengths of 14" and 27" (referred to as PP14 and PP27).
- Syringe Assemblies - 50 ml, 100% polyethylene/polypropylene syringes configured to taigon tubing (1/4" OD x 1/8" ID) with clamps (to secure tubing to sampling port) and a stopper.
- Peristaltic Pump - either battery-powered or with AC car-adapter unit.
- Collection Containers and Preservative - as specified in the QAPP.

- Meter Stick - used to measure water depth, and water level.
- Decontamination Equipment - used to backflush cleaning solution through the PP samplers for decontamination.
- Gloves - for personal protection and to prevent cross-contamination of samples. May be plastic or latex; should be disposable and powderless.
- Sampling Flags - used for identifying porewater sampling locations.
- Field Notebook - a bound book used to record progress of sampling effort and record any problems and field observations during sampling.
- Permanent Marking Pen - used to identify sample containers and for documentation of field logbooks and data sheets.
- Cleaning Solution - used to decontaminate the PP samplers after use.
- Deionized Water - used to rinse cleaning solution from the PP samplers during decontamination.
- Trash Bag - used to dispose of gloves and any other non-hazardous waste generated during sampling and decontamination.
- Plastic Waste Bottle - used to dispose of decontamination waste.

4.0 POREWATER SAMPLE COLLECTION

Push point samplers consist of two pieces: a guard rod and a sampler (see Figure 1). The sampler is a rigid 1/8-inch diameter probe made of 316 stainless steel, with a short screened zone at one end (with approximately 20% open area) and a sample port at the other end. The guard rod is inserted into the sampler body to provide support and prevent plugging during insertion into sediments. A syringe or taigon tubing is attached to the sample port for measurement of head and/or collection of a porewater sample. Push point samplers are available in various lengths; for the purposes of this project two lengths are available - 14" (PP14) and 27" (PP27). Water depth at the sampling location and the desired depth of sample collection determine the necessary length of the sampler.

4.1 Preparation for Sample Collection

The sampling team will wade to the specified sampling location and mark the location with a pin flag on the shore. The sample location and GPS coordinates will be recorded prior to collecting the sediment porewater sample. Insert the guard-rod into the mini piezometer body so that the guard rod and handle are squeezed together (Figure 2). Holding the device in this manner, push the push point sampler into the sediment to the desired depth using a gentle twisting motion. When the desired depth or refusal is reached, remove the guard rod from the body without disturbing the position of the deployed sampler. The sampler shall be placed at a minimum depth of 10 cm. In no case shall the sampler be entirely immersed in water.

After reaching the desired depth, remove the guard rod from the Push Point Sampler. Once the guard rod has been removed it SHOULD NOT be reinserted into the device until the bore holes are thoroughly cleansed of all sand, silt and other debris. In addition, once the guard rod has been removed from the sampler, the sampler should not be pushed further into the sediments. This may damage the screened zone and/or plug the sampler with sediment.

Using the meter stick record the depth of the water (distance from the sediment bottom to the top of the surface water) and the length of the sampler that is not immersed in the sediment (distance from the sediment to the top of the sampler). Record this information in the field log book.

4.2 Collection of Groundwater Flux Measurements

After insertion into the sediment, the sampler can then be used as a mini-piezometer to determine the potential direction of groundwater flux. Connect a piece of taigon tubing to the sample port (see Figure 3). Be sure to place a clamp at the mouth of the sampler tubing to ensure a good seal at the sampling port of the sampler.

Pump out any remaining air in the sampler and/or tubing by extending 50 ml syringe and inserting it into the open end of the taigon tubing. Squeeze the syringe to blow any air and/or water out of the tubing and the micro Push Point Sampler. Slowly remove the syringe from the Taigon Tubing and hold the tubing as diagramed in Figure 3. Allow the water to rise to its static level. When the water level appears to have stabilized, record on the field data sheet a “positive” or “negative” groundwater flux observation at the respective sampling location. Using the meter stick, measure the distance between the water level in the tubing and the surface water and record this measurement on the field data sheet.

A positive flux measurement indicates that the groundwater is moving towards the surface water body, or the surface water body is “gaining” groundwater. A negative flux measurement indicates that the groundwater is moving away from the surface water body, or the surface water body is “losing”water to the groundwater.

4.3 Collection of Sediment Porewater Samples for Analysis

Attach a "syringe assembly" (a pre-assembled 50 ml, 100% polyethylene/polypropylene syringe clamped to Taigon tubing) or peristaltic pump to the sampler port using a length of Taigon tubing. Be sure to place a clamp at the mouth of the sampler tubing to ensure a good seal at the sampling port. Withdraw water at a low-flow sampling rate (50-200 ml/min) until extracted water becomes non-turbid. Withdraw adequate amounts of porewater and transfer the sample into a labeled sample collection container as specified in the QAPP.

If sampling equipment is to be re-used, follow the appropriate decontamination procedures before collecting the next sample.

5.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

Once samples have been collected, the following procedures should be followed:

- Transfer the sample(s) into suitable, labeled sample containers specific for the analyses to be performed.
- Preserve the sample, if appropriate, or use pre-preserved sample bottles. Do not overfill bottles if they are pre-preserved.
- Cap the container securely, place in a resealable plastic bag, and cool to 4ºC on wet ice.
- Record all pertinent data in the site logbook and/or on field data sheets.
- Complete the Chain of Custody record.
- Attach custody seals to cooler prior to shipment.
- Decontaminate all non-dedicated sampling equipment prior to the collection of additional samples.

6.0 INTERFERENCES AND POTENTIAL PROBLEMS

Care should be taken to avoid tracking sediment and/or silt from one area to another. As samples are taken sequentially, care should also be taken not to contaminate an area yet to be sampled with the residue of the sample that is currently being taken. In general one should move in a single direction through the sampling area. If an area is known or suspected of having a higher concentration of contaminants, all other considerations being equal, it should be sampled last to prevent cross contamination.

There are two primary interferences or potential problems associated with sediment porewater sampling. These include cross contamination of samples and improper sample collection.

Cross contamination problems can be eliminated or minimized through the use of dedicated or disposable sampling equipment. If this is not possible or practical, then decontamination of sampling equipment is necessary.

Improper sample collection can involve using contaminated equipment, equipment that is potentially not compatible with the contaminants of concern, disturbance of the stream or impoundment substrate, and sampling in an obviously disturbed or non-representative area. Be sure to use sampling equipment of an appropriate composition based upon the suspected contaminants and analyses to be performed.

Following proper decontamination procedures, minimizing disturbance of the sample site, and careful selection of sampling locations will eliminate these problems. Proper timing for the collection of samples must be taken into consideration due to tidal influences and low or fast-flowing streams or rivers.

7.0 RECORD KEEPING AND QUALITY CONTROL

There are no specific quality assurance activities which apply to the implementation of these procedures. However, the following general procedures apply:

✓ All data must be documented on field data sheets or within site logbooks.

✓ All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment calibration activities must occur prior to sampling/operation and they must be documented.

Descriptions of any deviations and the reason for deviations from the site QAPP or this SOP should be noted in the field notebook, as necessary. In addition, the logbook should track pertinent sample collection information such as: sample date/time, personnel, weather conditions, and sample identification information. Samples taken from areas with visible staining or other indications of non-homogeneous conditions should be noted.

Field personnel will collect the proper type and quantity of quality control samples as prescribed in the QAPP.

8.0 DECONTAMINATION

Because decontamination procedures are time-consuming, having a quantity of sampling tools sufficient to require decontamination at a maximum of once per day is recommended. All sampling equipment must be decontaminated prior to reuse. Equipment decontamination will consist of the following 4 steps:

1) Cleaning Solution
2) Deionized water rinse
3) Acetone rinse
4) Deionized water rinse

Begin decontamination of the push point sampler by thoroughly removing all sand, silt etc. from the guard rod and the exterior of the sampler. Prepare three dedicated decontamination syringes with cleaning solution, deionized water, and acetone, respectively. Connect the cleaning syringe filled with cleaning solution to the end of the sampler port. Push the contents of the cleaning syringe through the sampler into a waste receptacle. Gently push the guard rod all the way into the bore of the Push Point sampler to dislodge any bridged material. Re-rinse the Push Point sampler with cleaning solution. Follow this with a distilled water/and or acetone rinse. Rinse the guard rod with cleaning solution, followed with a distilled water rinse then and acetone rinse followed by a second distilled water rinse. Reinsert the guard-rod into the push point sampler and the device is ready for re-use.

> *Note: Before the guard-rod is reinserted into the push point sampler, all small bends in both the guard-rod and in the sampler should be removed. Use caution when straightening the screened-zone, it is somewhat delicate without the guard-rod inside it, and can be broken through repeated bending. It is sometimes helpful when straightening the screened zone to insert the guard rod or the cleaning rod to the area of the bend in the screened zone. Gently unbend the portion of the screened zone nearest the rod and carefully advance the rod to the next bend. After the rod has been fully inserted into the screened zone perform the final screened zone straightening fine-tuning until the guard rod slides freely through it.*

All marker flags (if reused) should be decontaminated by wiping off with towels and/or baby wipes before re-use.

9.0 SITE CLEAN-UP

Disposable personal protective equipment and other non-hazardous waste generated during sampling and decontamination activities will be placed in a trash bag and taken to a waste receptacle at the field office to prevent disturbance by animals and dispersion by wind. All non-hazardous waste will be disposed of in municipal waste bins.

10.0 REFERENCES

Henry, M. 2000. MHE Push Point Sampling Tools. Proceedings of the Ground-Water/ Surface-Water Interactions Workshop. July 2000.
http://www.gsiwebpage.net Accessed: July 2001.

MHE Products. 2001. Operators Manual and Applications Guide. MHE-PP27" and MHE-PP14". Version 1.06. February 3, 2001.

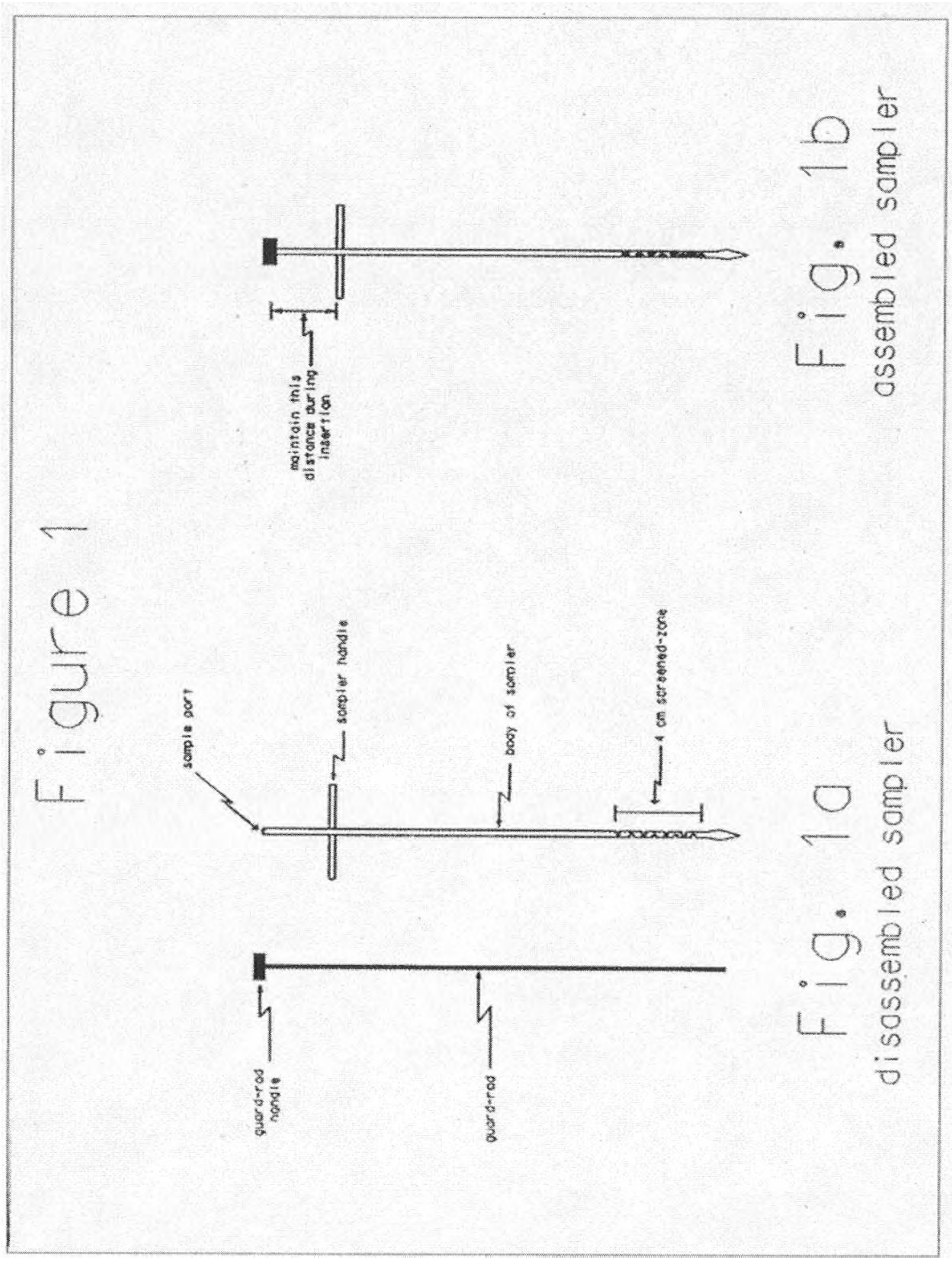
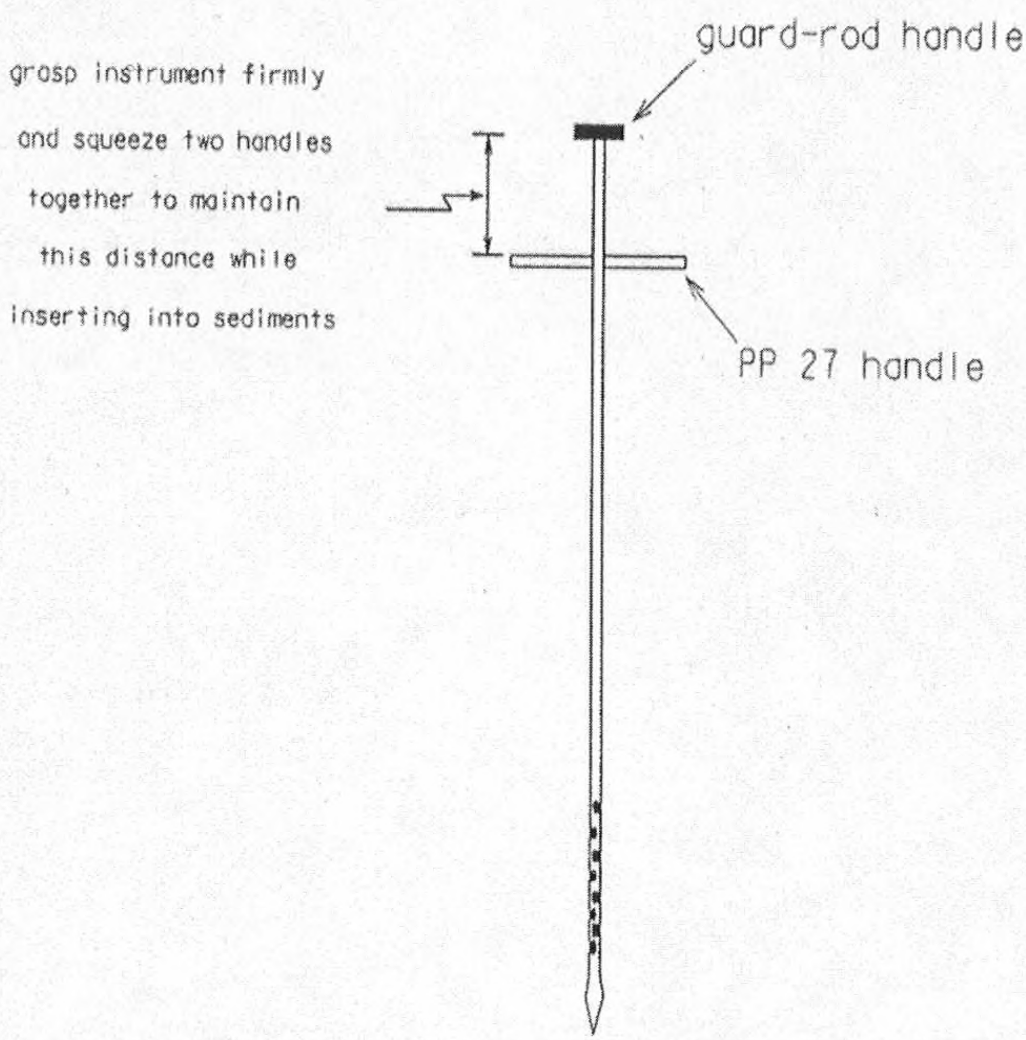


Figure 1
sample port
sampler handle
body of sampler
4 cm screened-zone
guard-rod handle
guard-rod
maintain this distance during insertion
Fig. 1a
disassembled sampler
Fig. 1b
assembled sampler

Figure 2


guard-rod handle
grasp instrument firmly
and squeeze two handles
together to maintain
this distance while
inserting into sediments
PP 27 handle

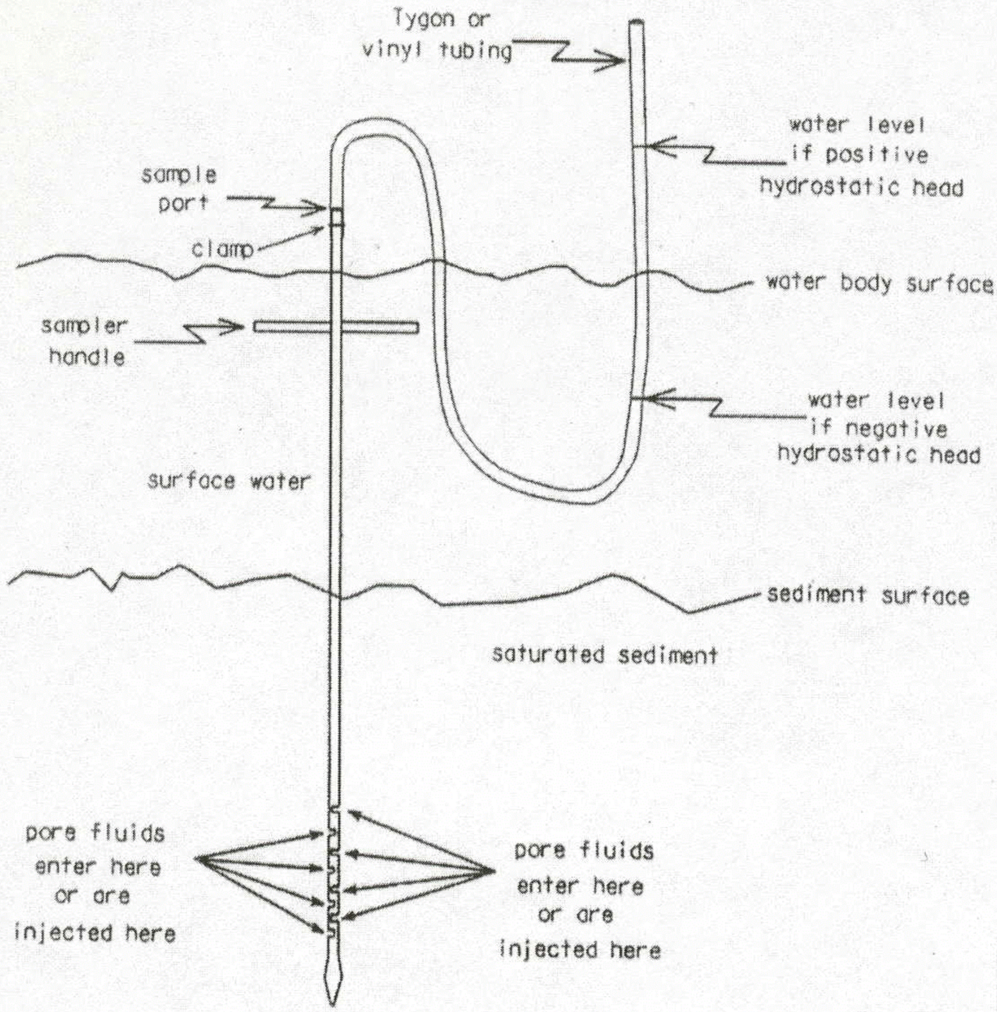

Tygon or
vinyl tubing
water level
if positive
hydrostatic head
sample
port
clamp
water body surface
sampler
handle
water level
if negative
hydrostatic head
surface water
sediment surface
saturated sediment
pore fluids
enter here
or are
injected here
pore fluids
enter here
or are
injected here

Figure 3

USEPA Method 6200 and Field Portable X-ray Fluorescence

Overview:

These training notes provide a brief introduction to x-ray fluorescence (XRF) analysis of soils. XRF has been used to characterise a broad range of materials for over twenty years. Recent advances in digital electronics and semi-conductor technology has yielded very portable XRF analysers for field analysis of many sample types including soils. These notes will cover the following subjects:

1. Introduction to XRF, basic theory of operation

2. EPA Method 6200

3. Field use of XRF analysers for soil
   - In-situ testing
   - Prepared sample (or ex-situ) testing

4. Basic quality assurance and sample preparation strategies

During the training session, most of the time will be spent performing measurements on prepared and unprepared soil samples with XRF instruments provided.

1. Introduction to XRF

Basic Atomic Structure:

A model of an atom is shown in Figure 1. In this model, the atom consists of a nucleus occupied by protons and neutrons. Surrounding this nucleus are negatively charged particles called electrons. This is known as the Bohr model of the atom, because it assumes the electrons orbit around the nucleus of the atom in fixed orbits, much like the planets orbit the sun. While this model is not exactly correct, it is perfectly satisfactory to explain most of the principles encountered in x-ray fluorescence analysis. For an uncharged atom, the number of electrons equals the number of protons. For each element, the electrons are orbiting the nucleus at different energy levels. These "orbits" or "shells" each contain a specific number of electrons. The shells closest to the nucleus get filled first and the shells get filled from the inner-most to the outer-most shell. Shells are named with the inner-most being the K-shell, then L-shell, etc., alphabetically named. The K-shell electrons can be thought of as having the lowest level of stored energy. The further out the electron shells are, the higher the energy level they have stored (the L-shell electrons have more stored energy than the K-shell electrons, the M shell electrons have more stored than the L shell, etc.).

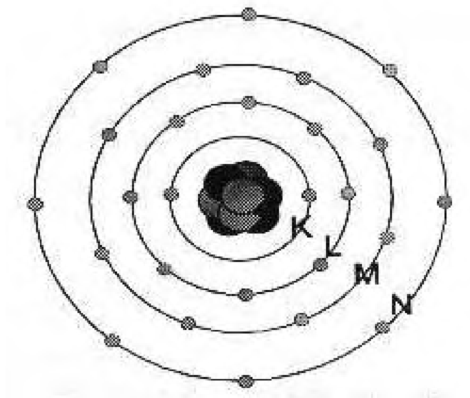


Figure 1. Bohr model of the atom, with nucleus of protons and neutrons.
Nucleus is surrounded by electrons in orbit, much like the planets orbit the sun.

What is X-ray Fluorescence?

X-ray fluorescence can be viewed as a three step process. In the first step, as shown in Figure
2, the atom is struck by an x-ray or gamma-ray (also called a photon) from a radioactive source.

In the second step, provided the x-ray or gamma-ray has sufficient energy either a K-shell or L-shell electron is knocked out of the atom, depending on the atom. For "light" atoms like chromium, arsenic, cadmium, a K-shell electron is knocked out. For "heavy" atoms like lead, mercury or uranium, an L-shell atom is removed. In the NITON XRF, the photons of energy that cause fluorescence is provided by either a cadmium-109 and/or an americium-241 radioactive source in the instrument. The cadmium-109 is a source of photons at 22.1 keV, 24.9 keV, and 88.0 keV. The americium-241 source provides 59.6 keV gamma-rays. For lead atoms, the 22.1 and 24.9 keV photons eliminate L-shell electrons, which cause L-shell fluorescence, which is used for soil analysis. The 88.0 keV gamma-rays eliminate k-shell electrons from lead atoms, which cause k-shell fluorescence, which is used for lead in paint measurements.

In the third and final step, the vacancy that is created from the electron being ejected is filled by a more outer shell electron. In dropping to the lower energy level, the electron gives off energy in the form of an x-ray. If a k-shell electron was ejected, the electron that jumps down to fill the vacancy emits a k-shell x-ray, if an L-shell electron was ejected, then the next highest electron in orbit emits an L-shell x-ray in order to jump down and fill the L-shell vacancy, etc.

The choice of radioactive source depends on what elements you are trying to measure. Cadmium-109 sources are suitable for excitation of the K-shell or L-shell energies of many other elements. Examples include five of the eight RCRA metals - arsenic, chromium, selenium via their K-shell x-rays and lead and mercury via their L-shells and K-shells. Other elements often tested with a cadmium-109 source include zinc, copper, nickel, iron via the K-shell x-rays and gold, uranium via the L-shell x-rays and K-shell x-rays. Americium-241 is used for K-shell fluorescence of cadmium, silver, barium, tin and antimony, but other elements are possible. For environmental purposes, XRF instruments with both sources - cadmium and americium - are ideal since they produce x-rays from all eight RCRA metals.

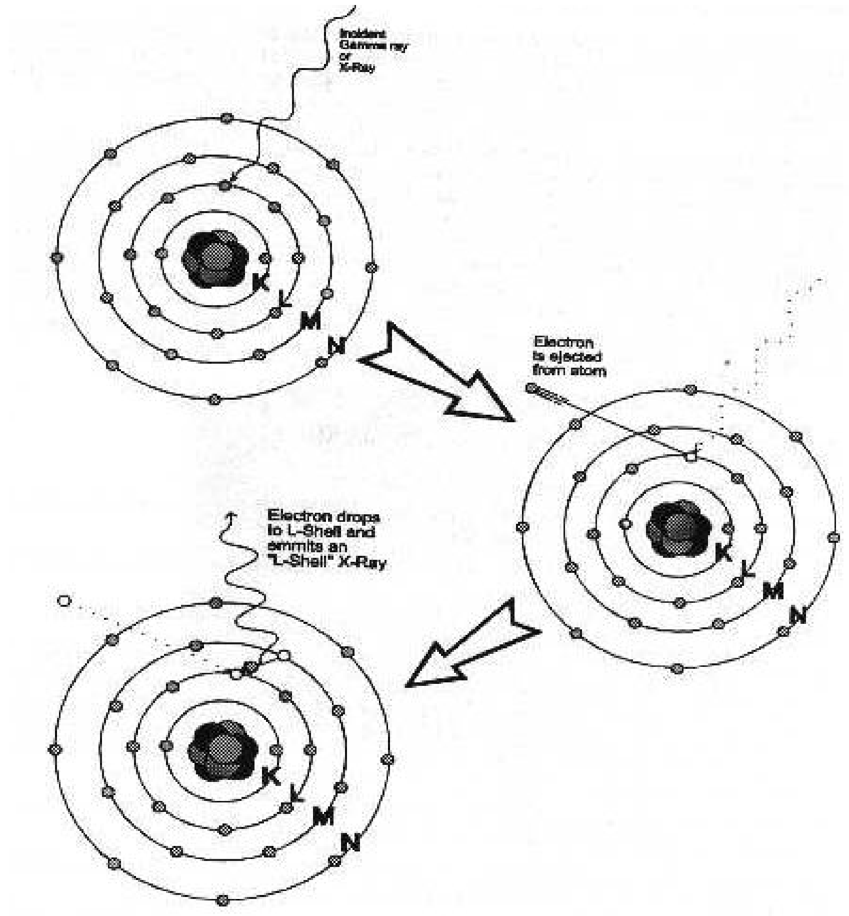


Figure 2. The three step process describing x-ray fluorescence.

Turning the x-ray fluorescence into something useful:
During testing, all the various metals within a soil sample are fluorescing. The XRF instrument must use this fluorescence to identify what elements are present and their concentrations in the sample.

XRF analysers use x-ray detectors, electronics, and on-board microprocessors to quantify various levels of elements in a sample. Remember, each element produces a fluorescence x-ray at a unique frequency (or energy). Detectors respond differently to different frequencies of x-rays. The electronics connected to the detector use this differing response to determine the frequency of every x-ray that enters the detector, and how many x-rays at each frequency strike the detector. By determining the frequency, the XRF device knows what element emitted the x-ray since elements all have unique x-ray emission frequencies. By determining the total number of x-rays at a particular frequency during a given amount of time, the device can determine the concentration of that particular element in the sample.

2. Regulatory Status - USEPA Method 6200

A USEPA Reference Method, incorporated into SW486 under RCRA, is now available for field portable XRF analysis of soils and sediments:

Method 6200 "Field Portable XRF Spectrometry for the Determination of Elemental
Concentrations in Soil and Sediment.

Features of this method:

- It is a field screening method, for analysis of in-situ or bagged samples. Developers of the method cite field studies indicating that variability in contaminate concentrations over small distances greatly exceeds instrument measurement variability. Thus, the method is used to thoroughly characterise a site. A large number of screening-level measurements provide a better characterisation than a small number of measurements produced by sample removal and analytical analysis.

- The method provides basic quality assurance methods, including calibration verification, determination of instrument precision, accuracy and limit of detection.

- The method recognises the some XRF instruments do not require site-specific calibrations by the operator, that is, the factory calibration provides appropriate data quality.

- The method recommends that a minimum of 5% of all samples tested by XRF be confirmed by an outside laboratory using a total-digestion USEPA analytical reference method.

- The method **does not** provide a technique for sample preparation (NITON Corporation is authoring an ASTM Method for sample preparation), or a method to determine data quality of in-situ testing results. Refer to section 4 of this paper or the NITON Manual for more detail.

3. Field Use of XRF Analysers for Soil:

Field portable XRF is generally used in three ways to test for metals in soil:

- In-situ soil testing,
- Bagged soil sample testing
- Testing prepared soil samples

In general, in-situ and bagged sample testing are considered field screening methods. *In-situ testing is still a very valuable technique because it is a very rapid testing method and screening methods can generate a great deal of data very quickly.* Common usage and benefits of in-situ testing are provided on the next page, in **Advantages of Field Screening with XRF.**

To achieve analytical-grade data quality operators usually (but not always) must prepare the sample by sieving and perhaps grinding it. It is important to understand your data quality objectives (DQO) in order to determine the appropriate mix of field screening versus prepared sample testing. Illustrations of in-situ and prepared sample testing are shown in Figures 3 and 4.

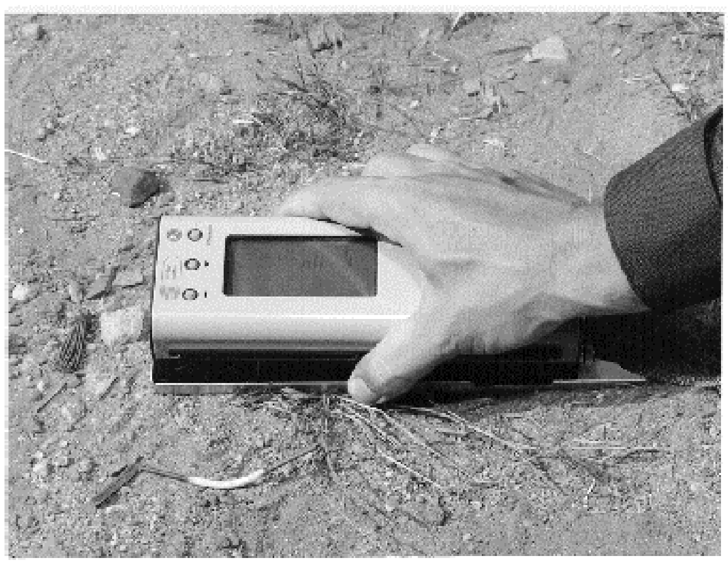


Figure 3. In-situ testing of soil by placing XRF directly onto the ground. This type of testing is generally screening level data quality.

In-situ testing usually only provides screening level data quality. This is because analytical testing always requires a uniform, homogeneous sample matrix. A laboratory achieves this by digesting the sample into a hot acid before analysis. Testing directly on the ground does not ensure uniformity is met. Two methods often used to determine the data quality of in-situ testing, relative to well-prepared samples, is given in the section titled **Basic Quality Assurance.**

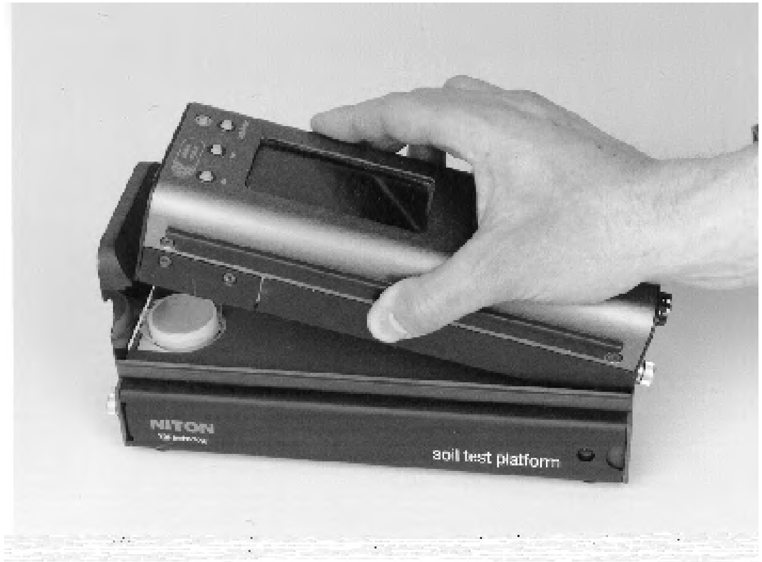


Figure 4. Prepared sample testing using XRF.
With proper sample homogenisation, analytical grade testing data is usually achieved.

Advantages of Field Screening with XRF

1. Focus sampling for laboratory analysis.
Operators can profile a site with in-situ testing in order to determine a sampling plan. Sources of contamination can be located very quickly. Contamination boundaries can be established. Regions of low and high contamination can be delineated. Even main analytes of interest can be determined. Sample collection can then be concentrated in regions where contaminants are below or near clean-up levels. There is little need for off-site analysis of samples that the XRF reports as being above the clean-up levels. The cost reduction in off- site analysis easily justifies the up-front price of the XRF.

2. Assure site meets clearance levels before contractors leave the site.
By combining in-situ and prepared-sample XRF testing, you can eliminate failed clearance tests. Before samples are sent to the lab for final clearance, XRF operators can prepare and test the same samples on-site because XRF is non-destructive. Provided the XRF reports levels below clean-up standards, operators can be assured that the lab will concur. XRF operators should always use prepared samples for this analysis. This procedure virtually guarantees clearance criteria will be met. Benefits include:

- The contractors can leave the site earlier thus reducing costs.

- Pre-testing prepared samples with XRF has assured that the lab will report levels below clean-up criteria, which reduces cost since the contractor will not be called back to the site for additional clean-up.

3. Minimise volume of hazardous waste for treatment or disposal.
Samples can be constantly evaluated on-site with field portable XRF to be sure only soils with contaminant levels in excess of clean-up levels are being treated or removed. Also, samples can be analysed on-site to determine if waste will pass/fail TCLP testing. Soils that pass this procedure can be disposed at a non-hazardous waste landfill, generating enormous savings.

4. Basic Quality Assurance and Sample Preparation Strategies

This section is intended to provide basic quality assurance steps for XRF testing. This is mainly on overview. The NITON manual covers these topics in depth.

Two Important Rules of Thumb:

- Never report XRF results as being below clean-up levels based solely on in-situ XRF test results. Always perform some sample preparation to support these results. It is a good idea to confirm at least 5% of results via laboratory testing. In general in-situ XRF results will be lower than results from prepared samples, or from laboratory results. EPA Method 6200 recommends a minimum of 5% confirmatory analysis.

- Always evaluate the data quality of in-situ testing results using one of the methods described in detail below.

Quality assurance can be broken into three main areas:

1. Proper verification of instrument operation

2. Determining data quality of in-situ testing, and amount of sample preparation required to achieve analytical data quality.

3. Proper sample preparation and testing for comparison to reference laboratory analysis.

1. Instrument verification:
Quality assurance here constitutes testing of known standards to verify calibration, testing of blank standards determine limits of detection and to check for sample cross-contamination or instrument contamination. EPA Method 6200 provides a detailed procedure.

2. Determining data quality of in-situ testing:
For operators relying extensively on in-situ testing, it is extremely important to determine the data quality of this testing at a given site. XRF operators generally follow one of two procedures to determine data quality of in-situ testing:

- Direct comparison of in-situ test results to laboratory results to determine correlation curve.

- For subset of samples perform stepwise sample preparation to determine the effect of sample preparation on XRF testing results, and compare XRF test of fully prepared sample to laboratory analysis of the same sample.

Method (1) for determining data quality of in-situ test results:

Direct comparison of in-situ testing to laboratory testing
Operators will pick a number of testing locations and take several in-situ XRF measurements in that location. Or a sample can be collected and bagged, with several XRF tests performed directly into the bag. A sample is then collected from the testing region and sent to a laboratory for homogenisation and analysis. (Or the bagged sample is sent). The average result from this series of XRF tests is plotted against the laboratory result. A correlation curve is determined, and this curve is used to "correct" future in-situ testing results from the site in question. The correlation curve developed from this analysis incorporates bias in the XRF result due to the lack of sample preparation. In this way, the bias from in-situ testing is removed, on average, from the in-situ test results.

As an example, in-situ testing data for zinc in soil is shown in Figure 5. A direct comparison of the in-situ XRF results to the laboratory results reveals a consistent bias in the XRF data. Based on the least squares fit shown in the graph, the laboratory result is on average about 35% greater than the XRF result. This bias exists because the soil was not prepared before XRF testing, and particles like small pebbles in the soil surface "shielded" the zinc x-rays from reaching the detector. However, the comparison reveals a well-behaved correspondence between XRF and laboratory results. For this site, operators relied on extensive in-situ XRF analysis, but used the correction factor of 1.35 to correct in-situ results. This is a good example of using a direct comparison between initial in-situ XRF data and laboratory analysis to then gather a large amount of in-situ XRF data for off-line correction.

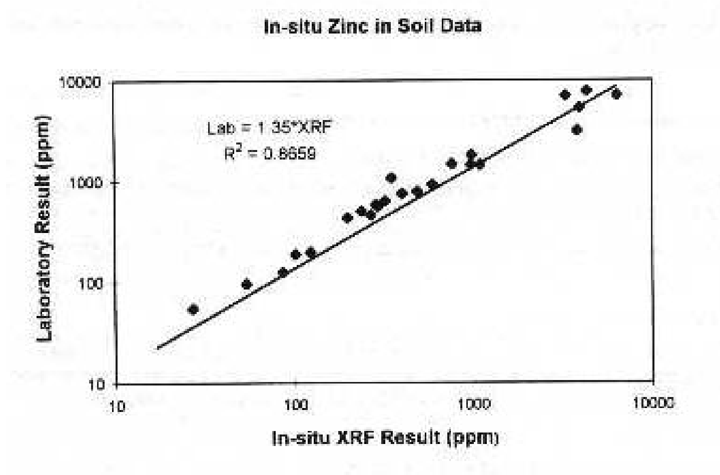


Figure 5. Comparison of in-situ XRF results for zinc in soil to laboratory results.

Method (2) for determining data quality of in-situ test results:

Stepwise sample preparation to determine data quality of in-situ testing.
The purpose of this protocol is to determine the amount of sample preparation required to get quantitative, as opposed to screening level, data quality. The basic strategy is to perform increasingly rigorous levels of sample preparation, followed by XRF analysis each time, until the XRF result stops changing. *This protocol is not intended for every sample, but rather for a small percentage of samples considered representative of the site.* If the operator can demonstrate that quantitative data is achieved with little or no sample preparation, then the site characterisation will be completed much more quickly but correctly.

For example, an operator may be able to demonstrate that the XRF result changes considerably when samples are passed through a 2 mm sieve, but that XRF results do NOT change appreciably upon finer sieving. In this case the operator can conclude that good XRF data is achievable with only 2 mm sieving. Sieving only to this level requires far less time than a more robust sample preparation. A protocol to determine the appropriate level of sample preparation is the following:

1. Delineate a region of soil approximately 10 cm x 10 cm.

2. Perform several in-situ tests in this area, or collect the top (approximately) 25 mm of soil from this region, bag the soil, test through the bag. In either case, average the results.

3. If you did not bag the in-situ test sample, collect the top (approximately) quarter inch of soil from this region and sieve through the 2 mm sieve provided. Otherwise sieve the bagged sample used for the in-situ test. Thoroughly mix the sieved sample, and place some of the sieved material into an XRF cup, and perform a test of this sample.

4. If the results of this prepared sample differ less than 20% with the average in situ result, this indicates the soil in this region is reasonably homogeneous. The data quality in this case is probably at the semi-quantitative level, rather than just screening data.

5. If the results differ by more than 20%, this indicates the soil is not very homogeneous, and there are serious particle size effects affecting your in-situ measurements.

6. In this case, sieve the sample through the 250 ∝m sieve. Mix this sample and place a sub-sample into an XRF cup for testing. If this result differs from the previous by less than 20% then this indicates that at a minimum the 2mm sieving is necessary to achieve higher data quality.

7. If this result differs by more than 20% from the sample sieved through 2 mm, and then particle size effects are still affecting the XRF result. In this case samples should be sieved through 125 ∝m to assure data quality at the quantitative level. In our experience, sieving through 125 ∝m is always adequate to assure a quantitative data quality level.

Comparison of prepared XRF samples to laboratory analysis.

As shown in Figure 6, comparison of XRF analysis of prepared soil samples generally yields very good agreement with laboratory analysis, provided proper sample preparation and handling is performed. The data shown is from a NITON 700Series XRF used within the USEPA lead laboratory accreditation program (ELPAT). In this program participant laboratories (including field operators) receive quarterly samples for analysis. Results are reported, and compared to reference laboratory results as a means for laboratories to gauge their measurement accuracy.

The data shown below are several rounds of analysis where NITON operators participated in this program, to demonstrate that field portable XRF can routinely meet USEPA lead laboratory accreditation requirements for prepared samples. It is important to note that samples sent to participant laboratories are homogenised and ground to 125 ∝m particle sizes or less.

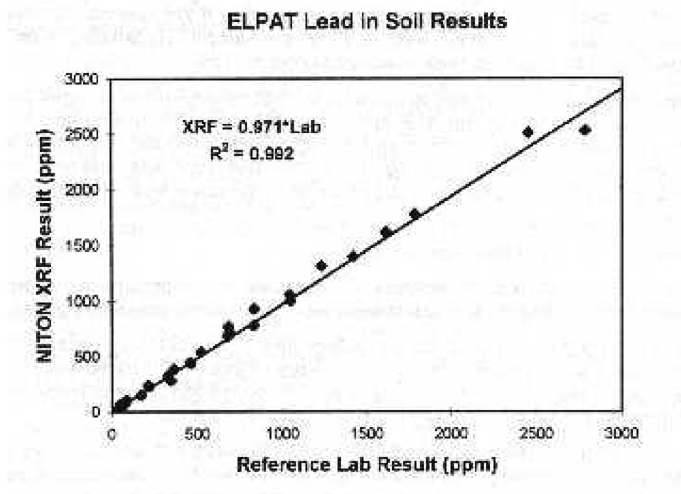


Figure 6. Comparison of XRF results to laboratory results for prepared soil samples.

Some XRF operators compare prepared XRF analysis to laboratory analysis to demonstrate the accuracy of XRF analysis. This is most often done to satisfy regulatory or client demands for defensible data. Please note this is different than the previous comparison of in-situ results to lab results. In that case it is expected that the results will differ, and the goal is to determine an overall correction factor. For prepared samples the operator is attempting to make a direct comparison of the absolute XRF result to the laboratory result to show no further corrections to the data are required.

JBS Environmental has showed the same strong performance in the Quality Control Technology (QCT) Soils, Dusts and Sediments program and the findings form the primary evidence demonstrated to NATA registration due later this year (Figures 7 & 8). Soils, dusts and sediments collected from a range of "real life" environmental sources then homogenised and two samples are distributed to each participant at the beginning of each month. QCT programs are recognised by National Association of Testing Authorities, Australia (NATA).

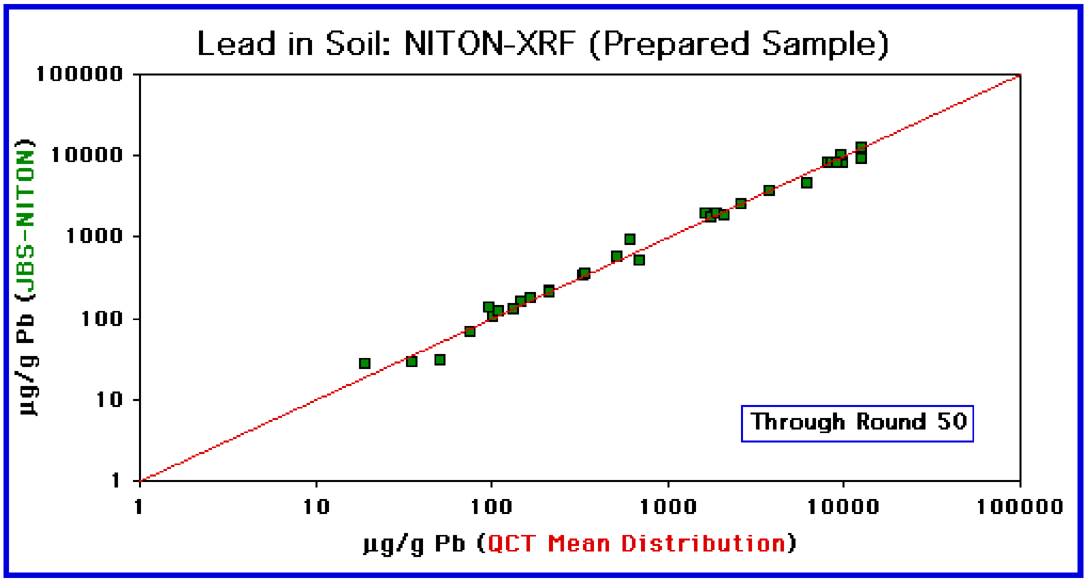


Figure 7 Comparison of XRF results to laboratory results for prepared samples (r^2=0.997)

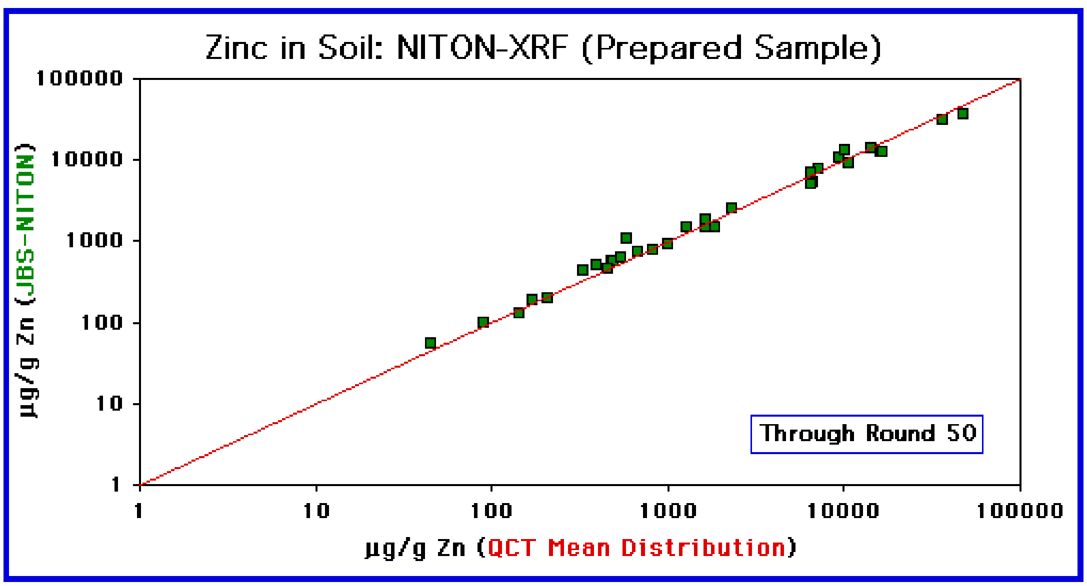


Figure 8 Comparison of XRF results to laboratory results for prepared samples (r^2=0.994)

Sample preparation protocol.

When comparing XRF results to laboratory performance always use thoroughly prepared samples before XRF testing. One possible sample preparation protocol is described in Figure 9. This protocol guarantees that the test results are being compared properly. Without such a preparation protocol there is no way to assure that the samples being compared are identical. Use of this protocol for prepared-sample XRF analysis generally provides analytical-level data quality.

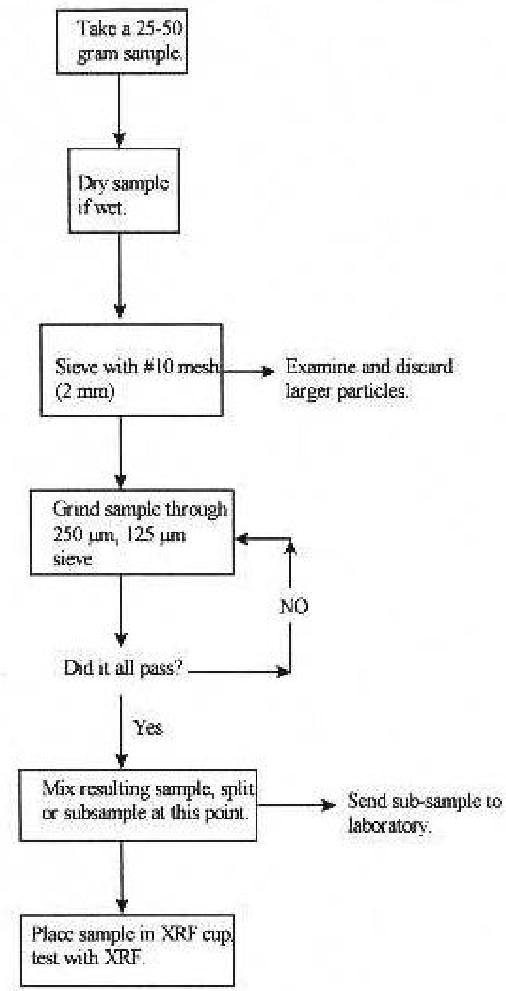


Figure 9 Detailed soil preparation procedure

TETRA TECH

Safety Excellence

HEALTH AND SAFETY PLAN (HASP)

PREPARED BY TETRA TECH
FOR SERVICES PROVIDED TO
Natural Resource Damage Program

SITE NAME:	**Butte Area One - Silver Bow Creek and Black Tail Creek Corridors**
SITE LOCATION:	**Butte, Montana**
DATE PREPARED:	**March 3, 2016**

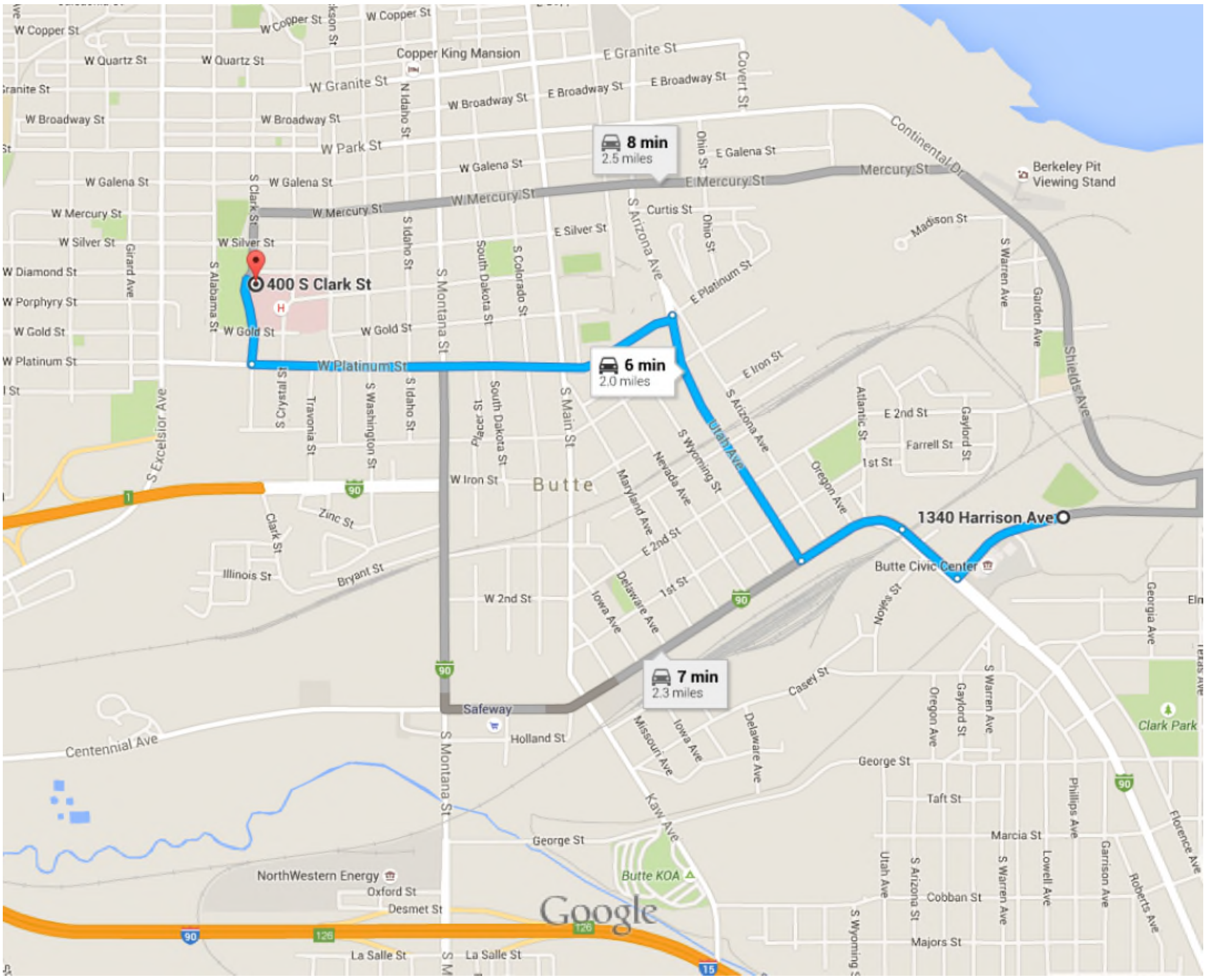
EMERGENCY CONTACT INFORMATION

NOTE: Information entered into the emergency section of this HASP will automatically be entered onto this cover page.

24 Hour Ambulance:	**911**
Police Department:	**911**
Fire Department:	**911**
US Poison Control Centers:	**1-800-222-1222**
Tt Project Emergency Contact:	**Kirk Miller** **1-406-461-0234**
Tt Corporate Emergency Contact:	**Yvonne Freix** Office: 715-845-4100 Mobile: 888-297-8552 Home: 715-355-4193
Name of Closest Hospital:	**Central MT Medical Center**
Route:	Exit site on Civic Center Rd heading west. Turn Right onto Harrison Ave. Proceed under railroad overpass. Take 4th right onto Utah Ave. Continue north on Utah and take 5th left onto East Platimun St. Continue west on Platinum St. and take 9th right onto South Crystal St. Follow Crystal north to hospital. AN OCCUPATIONAL CLINIC SHOULD BE

Google 1340 Harrison Avenue, Butte, MT to 400 South Clark Street, Butte, MT

Drive 2.0 miles, 6 min



Map data ©2015 Google 1000 ft

via E Platinum St **6 min**

6 min without traffic · 2.0 miles

Details

TABLE OF CONTENTS

Note: The sections highlighted in yellow are required for all health and safety plans with the other sections optional depending on the project, tasks and associated hazards. If this template is used for sites without chemical hazards, the following sections may be eliminated as well; H&S Evaluation Chemicals of Concern, Hazard Evalution of Chemicals of Concern and Precautions for Chemicals of Concern; and Decontamination Plan.

Forms Attached

Worker / Visitor Sign-In Form	√
Daily Tailgate Meeting Form	√
Field Audit Form	√
Drill Rig Pre-Shift Inspection Form	√
Other ____________________	√
Other ____________________	√
Other ____________________	√

Safety Excellence

HEALTH AND SAFETY PLAN (HASP)

Butte Area One - Silver Bow Creek and Black Tail Creek Corridors AT Butte, Montana

Prepared By:	Jim Maus	**Date:**	March 3, 2016
	Helena, Montana	**Tt Project No:**	114-570956

Project Identification:

Service Type:	Environmental Sciences	**Site Name:**	Butte Area One - Silver Bow Creek and Bl
Client Name:	NRDP	**Site Location:**	Butte, Montana
Client Contact:	Jim Ford	**Client Phone No:**	406.444.4034

Site History: The site was historically used as a smelter which generated both slag and tailinigs. Tailings are documented to contain leachable heavy metals.

Scope of Work: Conduct a soils/mine waste investigation to better define the aerial and vertical extent of tailings. Conduct a limited groundwater and surface water evaluation to determine the current water quality condition, and perform an aquifer test to determine the near surface aquifer properties.

Site Regulatory Status:

CERCLA/SARA		RCRA		OSHA		OTHER FEDERAL	
US EPA:	Yes	**US EPA:**	No	**1910:**	Yes	**Dept of Energy (DOE):**	n
State:	No	**state:**	No	**1926:**	Yes	**Dept of Trans (DOT):**	n
NPL site:	Yes	**NRC**		**state:**	Yes	**USATHAMA:**	n
		10CFR20:	No			**Air Force:**	n

NPL - US EPA National Priorities List
NRC - Nuclear Regulatory Commission
USATHAMA - US Army Toxic and HazMat Agency
OSHA 1910 - General Industry Standards and Regulations
OSHA 1926 - Construction Standard and Regulations
OSHA state - site located in a state that has its own OSHA regulations

Review and Approval Documentation

Reviewed By:

Name: Jerry Armstrong Signature: [signature]
Title: Office Heath and Safety Representative Date: 3/3/2016

Name: ______ Signature ______
Title: ______ Date: ______

Reviewer signature also certifies that the PPE selected for this project was based on a hazard assessment of the tasks to be performed and selected according to the requirements established by OSHA in 29 CFR 1910.132 (d).

Project Dates		HASP Amendment Dates:	
Project Start Date:	March 3, 2016	1	Enter date
Project End Date:	June 30, 2016	2	Enter date
This site HASP must be reissued/reapproved for		3	Enter date
activities conducted after:	June 30, 2016	4	Enter date

HEALTH AND SAFETY PLAN (HASP)

Butte Area One - Silver Bow Creek and Black Tail Creek Corridors AT Butte, Montana

Tetra Tech Representatives

Branch Address and Phone		Name/Title	Role and Responsibilities
Tetra Tech	406-543-3045	Bill Craig	Project Manager
2525 Palmer St Suite 2		Natalie Morrow	Asst. Project Manager/Field Invest Oversight
Missoula, MT 59808		Jerry Armstrong	Field Invest Oversight
		Danny Earnst	Project support / Field Investigation
		Don May	Project support / Field Investigation
		Rhianna Reeds	Project support / Field Investigation
		Brooks Quanitance	Project support / Field Investigation

Tetra Tech Subcontractors

Organization/Address and Phone	Name/Title	Role and Responsibilities
WET 480 E. Park Street Butte, MT 59702	TBD	DPT borings and well installation
Drilling and well installation	Contractor will install seevral direct push soil borings and complete three as groundwater monitoring wells.	

Organization/Address and Phone	Name/Title	Role and Responsibilities
Scope of Work		

Client / Tetra Tech / Subcontractor H&S Program & Policy Bridging Section

Identify which specific H&S programs will be followed for the designated scope of work.

H&S Program	Specify Program To Be Used	Comments
Emergency Evacuation Procedures	☐ Client X Tetra Tech ☐ Sub ☐ Other	All site personnel will follow the evacuation procedures detailed by Tetra Tech for this site
Drilling and subsurface structure locates	☐ Client X Tetra Tech ☐ Sub ☐ Other	The ERD Safety Guidance Document will be utilized for identifying potential subsurface structures prior to drilling
Other	☐ Client ☐ Tetra Tech ☐ Sub ☐ Other	
Other	☐ Client ☐ Tetra Tech ☐ Sub ☐ Other	
Other	☐ Client ☐ Tetra Tech ☐ Sub ☐ Other	
Other	☐ Client ☐ Tetra Tech ☐ Sub ☐ Other	

Tetra Tech's policy is to provide a safe working environment for all employees and contractors so that work may be conducted in a safe and efficient manner.

Tetra Tech employees and subcontractor employees working at the specific project covered by this HASP shall adopt and adhere to this HASP and the above referenced programs/policies by following all requirements stated in the safe work practices applicable to their work. No work is so urgent or important that we cannot take the time to do it safely. **ALL** personnel on site including subcontractor's have the right and responsibility to stop the work if they feel a safety protocol is not being followed or if they feel an unsafe condition exists.

Site Specific Health and Safety Personnel

Rhianna Reeds has been designated **Site Health and Safety Coordinator (SHSC)** for activities to be conducted at this site. The SHSC has total responsibility for ensuring that the provisions of this HASP are adequate and implemented in the field. Changing field conditions may require decisions to be made concerning adequate protection programs. Therefore, the personnel assigned as SHSCs are experienced and meet the additional training requirements specified by OSHA in 29 CFR 1910.120.

Don May has (have) been designated as the **alternate SHSC(s)**.

HEALTH AND SAFETY PLAN (HASP)

Butte Area One - Silver Bow Creek and Black Tail Creek Corridors AT Butte, Montana

Activities Covered Under This Plan

Task	Name	Schedule	Description
1	Mine Waste/Soil sampling	March 3 - June 30, 2016	Collect soil samples from test pits, stream bank, and other sampling locations along the BTC berm, stream banks and other sites in the corridor. Samples will be collected by excavator, direct push technology, or hand depending on access. Potential mine waste material will be confirmed using an XRF.
2	DPT Borings	March 3 - June 30, 2016	Wetland and subsurface soils will be collected using DPT. The samples will be collected for laboratory analysis of metals.
3	Stream Sampling	March 3 - June 30, 2016	Collect stream sediment samples from the center line of the stream with a hand held soil sampler, collect surface water samples, and at designated location co-collect pore-water samples from the stream bed.
4	Wetland Pond Sampling	March 3 - June 30, 2016	Collect pond sediment samples from a wadeable section if the pond with a hand held soil sampler, collect surface water samples, and at designated location co-collect pore-water samples.
5	Groundwater Sampling	March 3 - June 30, 2016	Collect groundwater samples for analysis of major cationa/anions, total and dissolved metals, and physical parameters
6	Piezometer Installation	March 3 - June 30, 2016	Install 1-inch diameter piezometers with DPT and completed with five foot of screen. Piezometers will be sampled and follow the procedures for groundwater sampling.
7	Aquifer Testing	March 3 - June 30, 2016	Conduct short term constant discharge aquifer test on well AMW-13 to characterize the near surface aquifer. Nearby wells will be monitored periodically.

Types and Sources of Hazards

Physiochemical

Flammable:	N
Explosive:	N
Corrosive:	N
Reactive:	N
O2 Rich:	N
O2 Deficient:	N

Radiation

Ionizing:	X-Ray from XRF machine
Non-Ionizing:	UV sunlight exposure

Other

Physical Hazards:	Y
Construction Activities:	Y

Chemically Toxic

Inhalation:	Y
Ingestion:	Y
Absorption:	N
Carcinogen:	Y
Mutagen:	N
Teratogen:	N
OSHA listed:	Y

Biological

Etiological Agent:	N
Other:	N
(plant, insect, animal)	Y

Specific OSHA Standards: 1910.120 general; arsenic, 1910.1008; lead 1910.1025;chromium, 1910.1026

Etiological - disease causing agent

Chemical toxicity information (such as routes of enry and whether or not a chemical is carcinogenic, mutagenic, etc) can be found in the Chem worksheet of this template, on the chemicals of concern page under target organs, or in the NIOSH pocket guide.

HEALTH AND SAFETY PLAN (HASP)

Butte Area One - Silver Bow Creek and Black Tail Creek Corridors AT Butte, Montana

Direct Sources of Hazards				Indirect Sources (Describe)
Air:	Y	**Other:**		None other than those listed
Groundwater:	Y			
Soil:	Y			
Surface Water:	Y			

Health and Safety Evaluation - Chemicals of Concern

Chemical Name	Entry Route	Carc*	Symptoms	Target Organs
Arsenic (inorganic compounds a	Inh, Abs, Ing, Con	y	Ulceration of nasal septum, dermatitis, GI disturbances, peripheral neuropathy, respiratory irritation, hyperpigmentation of skin, cancer.	Liver, kidneys, skin, lungs, lymphatic system (lung and lymphatic cancer).
Copper (dusts, mists, and fumes	Inh, Ing, Con	n	**Dusts and mists** - Irritant (eyes, nose, pharynx), nasal perforation, metallic taste, dermatitis. **Fume**-Irritant (eyes, upper respiratory system), metal fume fever, chills, muscle ache, nausea, fever, cough, exhaustion, metallic/sweet taste, discoloration	Eyes, skin, respiratory system, liver kidneys. (Increased risk of Wilson's disease)
Cadmium (dust and fumes)	Inh, Ing (dust)	y	Pulmonary edema, dyspnea, cough, tight chest, substernal pain, headache, chills, muscle aches, nausea, vomiting, diarrhea, loss of smell, emphysema, proteinuria, mild anemia, cancer.	Respiratory system, kidneys, prostate, blood (prostate and lung cancer).
Lead (elemental and other comp	Inh, Ing, Con	n	Weakness, exhaustion, insomnia, facial pallor, anorexia, weight loss, malnutrition, constipation, abdominal pain, colic, anemia, tremor, wrist and ankle paralysis, encephalopathy, kidney disease, eye irritation, hypotension.	Eyes, GI tract, central nervous system, kidneys, blood, gingival tissue.
Zinc Oxide (dust and fume)	Inh	n	Metal fume fever, chills, muscle ache, nausea, fever, dry throat, cough, weak, exhaustion, metallic taste, headache, blurred vision, low back pain, vomiting, fatigue, tight chest, dyspnea, decreased pulmonary function.	Respiratory system.

Health and Safety Evaluation - Hazard Evaluation of Chemicals of Concern

Chemical Name	LEL/UEL (%)	Flam	OT (ppm)	IDLH	Exposure Limits
Arsenic (inorganic compounds a	NA	n	-	5 mg/m3	**OSHA-PEL-TWA** = 0.01 mg/m3; **ACGIH-TLV-TWA** = 0.01 mg/m3; **NIOSH-REL-Ceiling** = 0.002 mg/m3
Copper (dusts, mists, and fumes	NA	n	-	100 mg/m3	**OSHA-PEL-TWA** = 1 mg/m3 (dusts & mists); 0.1 mg/m3 (fume); **ACGIH-TLV-TWA** = 1 mg/m3 (dusts & mists);
Cadmium (dust and fumes)	NA	n	-	9 mg/m3	**OSHA-PEL-TWA** = 0.005 mg/m3; **ACGIH-TLV-TWA** = 0.01 mg/m3 (total); 0.002 mg/m3 (respirable);
Lead (elemental and other comp	NA	n	-	100 mg/m3	**OSHA-PEL-TWA** = 0.05 mg/m3; **ACGIH-TLV-TWA** = 0.05 mg/m3; **NIOSH-REL-TWA** = 0.05 mg/m3
Zinc Oxide (dust and fume)	NA	n	-	500 mg/m3	**OSHA-PEL-TWA** = 5 mg/m3 (fume/respirable dust)*; 15 mg/m3 (total dust)*; **ACGIH-TLV-TWA** = 2 mg/m3 respirable;

Health and Safety Evaluation - Chemicals of Concern / Precautions

PRECAUTIONS

INGESTION: All listed chemicals have the potential for accidental ingestion, however in work place settings it is not considered a primary route of entry. All accidental ingestions should be addressed by referring to the MSDS and seeking immediate medical attention.

INHALATION: Listed chemicals capable of inhalation routes of entry should be maintained below the established exposure limits. If there is indication that the exposure limits are being exceeded, appropriate respiratory protection should be used. If appropriate PPE has not been

ABSORBANCE/CONTACT: Listed chemicals presenting an absorbance or contact hazards should be handled only with the use of appropriate PPE.

NOTE: Overexposure to any chemical via any route of entry should be addressed by referring to the MSDS and seeking immediate medical attention. Avoid contact with all chemical hazards when possible and consult MSDS before any exposure may occur.

OTHER PRECAUTIONS

none

ABBREVIATIONS

LEL= Lower Explosive Limit

UEL = Upper Explosive Limit

ppm = parts per million

mg/m3 = milligram per cubic meter

TWA = Time Weighted Average

STEL = Short Term Exposure Limit

Flam = Flammable

IDLH = Immediately Dangerous to Life and Health

OT = Odor Threshold

NOTE: Odor Thresholds were obtained from the American Industrial Hygiene Association's (AIHA) publication on Odor Thresholds. The listed thresholds are best estimates based on existing experimental data. (d) indicates the threshold for detection and (r) indicates the threshold for recognition.

NOTE: * In 1989, OSHA published new exposure limits (in most cases lower) for some chemical compounds. However, in 1993, under a court decision, these newly established limits were vacated and reverted back to the previous limit or to none if a limit was not previously established for the chemical compound. The limits listed in the table are the older, enforceable OSHA limits. It is recommended that the most conservative exposure limit listed be used in assessing exposures and determining controls and safety measures.

HEALTH AND SAFETY PLAN (HASP)

Butte Area One - Silver Bow Creek and Black Tail Creek Corridors AT Butte, Montana

Health and Safety Evaluation - Physical / Construction Hazards of Concern

HAZARD	Task No(s)	Protection Procedure
Noise	All	Wear hearing protection during high noise activities
Heat - Ambient Air - See SWP 5.23	All	Frequent intake of fluids and adequate work-rest schedule
Cold	All	Warm clothing; if symptoms develop - go to warm area
Rain	All	Wear rain gear; watch footing on wet surfaces
Snow	All	Warm clothing - watch footing on slippery surfaces
Electrical Storms	All	Discontinue operations
Heavy Lifting / Moving	All	Utilize proper lifting techniques
Rough Terrain	All	Watch footing
Housekeeping	All	Maintain order
Neighborhood	All	Awareness of area; comply with contingency / ER plans
Traffic	All	Obey traffic regulations; implement traffic control
Heavy Equipment Operation	1,2	Only qualified operators; inspections and back-up alarms
Materials Handling	All	Determine safest physical means of handling material
Hazardous Materials Use / Storage	1,3	Consult MSDS and Tt Safe Work Practices
Flammable Liquids / Gases	3	Consult MSDS and Tt Safe Work Practices
Corrosives	All	Consult MSDS and Tt Safe Work Practices
Utilities - Underground	1,2	Have located before any work commences
Utilities - Overhead	1,2	Keep objects more than 20 feet from power lines
Hand Tools	1	Use appropriate tools for the task-inspect prior to use

Task Based Risk Analysis and Protection Plan

The preceding tables have identified the known and suspected hazards to be present in performing the tasks required to complete this project. Below is a breakdown by task of the hazards, likelihood of exposures, and protective protocols to be used to minimize risk.

Task: 1 Mine Waste/Soil sampling

Associated Hazards:	**CHEMICAL**	Chemical exposure to the metals listed in this HASP as a result of skin contact during sampling activities from dust, soil and groundwater. Possible inhalation of fine particle dust during field activities.
	PHYSICAL	traffic around municipal shop, public roads and parking lots, cold heat stress, slip, trip, fall, pinch points, heavy lifting, inclement weather, loud equipment.
	BIOLOGICAL	stinging insects and dogs are frequently found in the area.
	OTHER	None.
Exposure Potential:	**CHEMICAL**	Moderate
	PHYSICAL	Moderate
	BIOLOGICAL	Low
	OTHER	None
PPE:	Level D	Steel toed boots; chemical resistant nitrile gloves when sampling; hearing protection must be utilized when working in immediate proximity of loud equipment. Leather gloves (or equivalent) worn when working with tools or performing tasks around identified pinch points.
Air Monitoring Plan	None	
Air Monitoring Equipment	None	

Precautions:	**CHEMICAL**	Use chemical resistant gloves. Safety glasses must be worn at all times. Work up wind of dusty conditions.
	PHYSICAL	Practice proper lifting techniques when lifting heavy objects and use obtain help if items are awkward or greater than 50 lbs. Identify Slip/Trip/Fall hazards prior to starting work and either remove or identify to all project members, practice proper housekeeping to prevent creating hazards while working. Identify pinch points on equipment prior to conducting work activities. Wear appropriate clothing for weather conditions present and always wear high visible outer layer. This task will require hard hat, steel toe boots, long pants, leather or nitrile gloves and hearing protection and safety glasses while working alongside the drill rig. Position vehicles to defend work space.
	BIOLOGICAL	Use caution when approaching neighborhood dogs, wear long sleeves or bug spray if needed to prevent against bites, suncreen recommended.
	OTHER	NA

HEALTH AND SAFETY PLAN (HASP)

Butte Area One - Silver Bow Creek and Black Tail Creek Corridors AT Butte, Montana

Task: 2	DPT Borings	
Associated Hazards:	**CHEMICAL**	Chemical exposure to the metals listed in this HASP as a result of skin contact during sampling activities from dust, soil and groundwater. Possible inhalation of fine particle dust during field activities.
	PHYSICAL	traffic around municipal shop, public roads and parking lots, cold heat stress, slip, trip, fall, pinch points, heavy lifting, inclement weather, loud equipment.
	BIOLOGICAL	stinging insects and dogs are frequently found in the area.
	OTHER	None
Exposure Potential:	**CHEMICAL**	Moderate
	PHYSICAL	Moderate
	BIOLOGICAL	Low
	OTHER	NA
PPE:	Level D	Steel toed boots; chemical resistant nitrile gloves when sampling; hearing protection must be utilized when working in immediate proximity of loud equipment. Leather gloves (or equivalent) worn when working with tools or performing tasks around identified pinch points.
Air Monitoring Plan	None	
Air Monitoring Equipment	None	
Precautions:	**CHEMICAL**	Use chemical resistant gloves. Safety glasses must be worn at all times. Work up wind of dusty conditions.
	PHYSICAL	Practice proper lifting techniques when lifting heavy objects and use obtain help if items are awkward or greater than 50 lbs. Identify Slip/Trip/Fall hazards prior to starting work and either remove or identify to all project members, practice proper housekeeping to prevent creating hazards while working. Identify pinch points on equipment prior to conducting work activities. Wear appropriate clothing for weather conditions present and always wear high visible outer layer. This task will require hard hat, steel toe boots, long pants, leather or nitrile gloves and hearing protection and safety glasses while working alongside the drill rig. Position vehicles to defend work space.
	BIOLOGICAL	Use caution when approaching neighborhood dogs, wear long sleeves or bug spray if needed to prevent against bites, suncreen recommended.
	OTHER	NA

Task: 3	Stream Sampling	
Associated Hazards:	CHEMICAL	Chemical exposure to the metals listed in this HASP as a result of skin contact during sampling activities from sediment and groundwater. Preservatives for samples.
	PHYSICAL	Loose sediment/rocks when wading in water, cold heat stress, slip, trip, fall, pinch points, heavy lifting, inclement weather, loud equipment.
	BIOLOGICAL	water borne diseases, stinging insects and dogs are frequently found in the area.
	OTHER	NA
Exposure Potential:	CHEMICAL	Moderate
	PHYSICAL	Moderate
	BIOLOGICAL	Low
	OTHER	NA
PPE:	Level D	Hip waders; chemical resistant nitrile gloves when sampling; hearing protection must be utilized when working in immediate proximity of loud equipment. Leather gloves (or equivalent) worn when working with tools or performing tasks around identified pinch points. Wear safety glasses to prevent material from splashing into eyes.
Air Monitoring Plan	None	
Air Monitoring Equipment	None	
Precautions:	CHEMICAL	Use chemical resistant gloves. Safety glasses must be worn at all times.
	PHYSICAL	Use caution walking in the stream and ensure firm footing before staring to sample. Identify path in/out of stream and in stream hazards prior to starting work. Travel along the bank between sampling points. Practice proper lifting techniques when lifting samples and use obtain help if items are awkward or greater than 50 lbs. Practice proper housekeeping to prevent creating hazards while working. Identify pinch points on equipment prior to conducting work activities. Wear appropriate clothing for weather conditions present and always wear high visible outer layer. This task will require hip waders, long pants, nitrile gloves and safety glasses.
	BIOLOGICAL	Use caution to prevent ingesting water and do not put writing instruments in mouth. Wash hands after sampling and before drinking/eating, approach neighborhood dogs with caution, wear long sleeves or bug spray if needed to prevent against bites, suncreen recommended.
	OTHER	NA

Task: 4	Wetland Pond Sampling	
Associated Hazards:	CHEMICAL	Chemical exposure to the metals listed in this HASP as a result of skin contact during sampling activities from sediment, surface water and groundwater. Preservatives for
	PHYSICAL	Loose sediment/rocks when wading in water, cold heat stress, slip, trip, fall, pinch points, heavy lifting, inclement weather, loud equipment.
	BIOLOGICAL	water borne diseases, stinging insects and dogs are frequently found in the area.
	OTHER	None
Exposure Potential:	CHEMICAL	Moderate
	PHYSICAL	Moderate
	BIOLOGICAL	Low
	OTHER	NA
PPE:	Level D	Hip waders; chemical resistant nitrile gloves when sampling; hearing protection must be utilized when working in immediate proximity of loud equipment. Leather gloves (or equivalent) worn when working with tools or performing tasks around identified pinch points. Wear safety glasses to prevent material from splashing into eyes.
Air Monitoring Plan	None	
Air Monitoring Equipment	None	
Precautions:	CHEMICAL	Use chemical resistant gloves. Safety glasses must be worn at all times.
	PHYSICAL	Use caution walking in the stream and ensure firm footing before staring to sample. Identify path in/out of stream and in stream hazards prior to starting work. Travel along the bank between sampling points. Practice proper lifting techniques when lifting samples and use obtain help if items are awkward or greater than 50 lbs. Practice proper housekeeping to prevent creating hazards while working. Identify pinch points on equipment prior to conducting work activities. Wear appropriate clothing for weather conditions present and always wear high visible outer layer. This task will require hip waders, long pants, nitrile gloves and safety glasses.
	BIOLOGICAL	Use caution to prevent ingesting water and do not put writing instruments in mouth. Wash hands after sampling and before drinking/eating, approach neighborhood dogs with caution, wear long sleeves or bug spray if needed to prevent against bites, suncreen recommended.
	OTHER	NA

HEALTH AND SAFETY PLAN (HASP)

Butte Area One - Silver Bow Creek and Black Tail Creek Corridors AT Butte, Montana

Task: 5		Groundwater Sampling
Associated Hazards:	CHEMICAL	Heavy metals in groundwater. Gasoline for generator and pump. Preservatives for samples
	PHYSICAL	traffic around municipal shop, public roads and parking lots, cold heat stress, slip, trip, fall, pinch points, heavy lifting, inclement weather, loud equipment.
	BIOLOGICAL	stinging insects and dogs are frequently found in the area.
	OTHER	None
Exposure Potential:	CHEMICAL	Moderate
	PHYSICAL	Moderate
	BIOLOGICAL	Low
	OTHER	NA
PPE:	Level D	Steel toed boots; chemical resistant nitrile gloves when sampling; hearing protection must be utilized when working in immediate proximity of loud equipment. Leather gloves (or equivalent) worn when working with tools or performing tasks around identified pinch points.
Air Monitoring Plan	None	
Air Monitoring Equipment	None	
Precautions:	CHEMICAL	Use chemical resistant gloves. Safety glasses must be worn at all times.
	PHYSICAL	Practice proper lifting techniques when lifting heavy objects and use obtain help if items are awkward or greater than 50 lbs. Identify Slip/Trip/Fall hazards prior to starting work and either remove or identify to all project members, practice proper housekeeping to prevent creating hazards while working. Identify pinch points on equipment prior to conducting work activities. Wear appropriate clothing for weather conditions present and always wear high visible outer layer. This task will require hard hat, steel toe boots, long pants, leather or nitrile gloves and hearing protection and safety glasses. Position vehicles to defend work space.
	BIOLOGICAL	Use caution when approaching neighborhood dogs, wear long sleeves or bug spray if needed to prevent against bites, suncreen recommended.
	OTHER	NA

Task: 6		Piezometer Installation
Associated Hazards:	CHEMICAL	Chemical exposure to the metals listed in this HASP as a result of skin contact during sampling activities from dust, soil and groundwater. Possible inhalation of fine particle dust during field activities.
	PHYSICAL	traffic around municipal shop, public roads and parking lots, cold heat stress, slip, trip, fall, pinch points, heavy lifting, inclement weather, loud equipment.
	BIOLOGICAL	stinging insects and dogs are frequently found in the area.
	OTHER	None
Exposure Potential:	CHEMICAL	Moderate
	PHYSICAL	Moderate
	BIOLOGICAL	Low
	OTHER	NA
PPE:	Level D	Steel toed boots; chemical resistant nitrile gloves when sampling; hearing protection must be utilized when working in immediate proximity of loud equipment. Leather gloves (or equivalent) worn when working with tools or performing tasks around identified pinch points.

Air Monitoring Plan	None	
Air Monitoring Equipment	None	
Precautions:	CHEMICAL	Use chemical resistant gloves. Safety glasses must be worn at all times.
	PHYSICAL	Practice proper lifting techniques when lifting heavy objects and use obtain help if items are awkward or greater than 50 lbs. Identify Slip/Trip/Fall hazards prior to starting work and either remove or identify to all project members, practice proper housekeeping to prevent creating hazards while working. Identify pinch points on equipment prior to conducting work activities. Wear appropriate clothing for weather conditions present and always wear high visible outer layer. This task will require hard hat, steel toe boots, long pants, leather or nitrile gloves and hearing protection and safety glasses. Position vehicles to defend work space.
	BIOLOGICAL	Use caution when approaching neighborhood dogs, wear long sleeves or bug spray if needed to prevent against bites, suncreen recommended.
	OTHER	NA
Task: 7	**Aquifer Testing**	
Associated Hazards:	CHEMICAL	Heavy metals in groundwater. Gasoline for generator and pump.
	PHYSICAL	traffic around municipal shop, public roads and parking lots, cold heat stress, slip, trip, fall, pinch points, heavy lifting, inclement weather, loud equipment.
	BIOLOGICAL	stinging insects and dogs are frequently found in the area.
	OTHER	None
Exposure Potential:	CHEMICAL	Low
	PHYSICAL	Moderate
	BIOLOGICAL	Low
	OTHER	NA
PPE:	Level D	Steel toed boots; chemical resistant nitrile gloves when sampling; hearing protection must be utilized when working in immediate proximity of loud equipment. Leather gloves (or equivalent) worn when working with tools or performing tasks around identified pinch points.
Air Monitoring Plan	None	
Air Monitoring Equipment	None	
Precautions:	CHEMICAL	Use chemical resistant gloves. Safety glasses must be worn at all times.
	PHYSICAL	Practice proper lifting techniques when lifting heavy objects and use obtain help if items are awkward or greater than 50 lbs. Identify Slip/Trip/Fall hazards prior to starting work and either remove or identify to all project members, practice proper housekeeping to prevent creating hazards while working. Identify pinch points on equipment prior to conducting work activities. Wear appropriate clothing for weather conditions present and always wear high visible outer layer. This task will require hard hat, steel toe boots, long pants, leather or nitrile gloves and hearing protection and safety glasses. Position vehicles to defend work space.
	BIOLOGICAL	Use caution when approaching neighborhood dogs, wear long sleeves or bug spray if needed to prevent against bites, suncreen recommended.
	OTHER	NA

Personal Protective Equipment Level Definitions

Level D

Level D protection is assigned when minimal protection is warranted. Level D offers protection from nuisance contamination only and is made up of a typical work uniform for the work to be performed. Level D protection includes the following:

Hard hat, safety glasses, high visibility vest, hearing protection (as required), gloves, and steel toe boots.

Level C protection is assigned when the type's) and concentration's) of contaminants is known and the criteria for using an air-purifying respirator are met. Level C is an upgrade from level D and in addition to the requirements of level D, the

The level of protection required for a person assisting with decontamination is:

LEVEL: D

Modification: (upgrade or downgrade) will be made under the following conditions:

If conditions arise such that upgrading to Level C may be required, personnel will stop work, move away from the area of concern, assess the situation and contact the project manager prior to proceeding with work.

CARTRIDGE CHANGEOUT SCHEDULE

Cartridge Changeout Schedule:	NA
Method Used to Determine Schedule:	NA

Personal Decontamination

The section outlining task by task risk assessment and protection plan specifies the level of protection required for each task.

Consistent with the level of protection required, step by step procedures for decontamination for each level of protection are given below.

Nitrile gloves will be disposed of after use, respirator cartridges will be disposed of after use, if worn the respirator will be rinsed with warm water.

Levels of Protection Required for Decontamination Personnel

The level of protection required for a person assisting with decontamination is:

LEVEL: D

Modification: (upgrade or downgrade) will be made under the following conditions:

Staff will not require decontamination assistance.

Disposition of Contaminated Wastes

The following outlines the protocol to be followed for contaminated wastes that are encountered:

Some contaminated soil may be encountered in drill cuttings. Remaining soils after sampling will be disposed of downhole in soil borings. Purgewater from well development and sampling will be broadcast onsite. Disposable equipment will be disposed in a waste receptacle for disposal at a sanitary landfill.

Sampling Equipment Decontamination

The following outlines the protocol to be followed for decontamination of sampling equipment:

Non-disposable sampling equipment will be washed with 10% liquinox solution and rinsed with 10% nitric solution followed by a distilled water rinse.

Non-Sampling Equipment Decontamination

The following outlines the protocol to be followed for decontamination of non-sampling equipment:

Steam washing of any coring or drill rigs will be performed by subcontractor according their Tetra Tech approved SOPs. Soil and sediment adhering to non-disposable PPE will be removed and the equipment rinsed prior to leaving the facility. Large areas of mud adhering to vehicles will be removed prior to leaving the facility.

Contingencies

Emergency Contacts and Phone Numbers

Agency		Contact	Phone Number
Tt Project Emergency Contact		Kirk Miller	1-406-461-0234
24 Ambulance Service		A-1 Ambulance	911
Fire Department		Butte	911
Police Department		Butte	911
US Poison Control Center			1-800-222-1222
Onsite Coordinator		Don May/Rhianna Reeds	1-406-370-6095/406-422-7457
Site Telephone		Individual field crew members	Individual field crew members
Nearest Telephone		Cell Phones	
In the event of an incident, the TT-MM reporting protocol requires that a corporate contact be notified as soon as possible.	**Yvonne Freix**	**Office:** 715-845-4100 **Mobile:** 888-297-8552 **Home:** 715-355-4193	
	Nancy Garreaud	**Office:** 801-364-2027 **Mobile:** 801-550-0894	
	Jenn Fullmer	**Office:** 801-364-1064 **Mobile:** 801-712-5425	

Local Medical Emergency Facility(s)

Name of Hospital:	St. James Community Hospital	**Distance:**	2 miles
Address:	400 South Clark, Butte	**Time:**	10 minutes
Type of Service:	Emergency service, trauma		

Route: Exit site on Civic Center Rd heading west. Turn Right onto Harrison Ave. Proceed under railroad overpass. Take 4th right onto Utah Ave. Continue north on Utah and take 5th left onto East Platimun St. Continue west on Platinum St. and take 9th right onto South Crystal St. Follow Crystal north to hospital. AN OCCUPATIONAL CLINIC SHOULD BE UTILIZED WHENEVER POSSIBLE FOR NON-EMERGENCY INJURIES. (Work Care 1-800-455-6155)

In the case of a **SERIOUS OR LIFE-THREATENING EVENT** (any injury, accident or near-miss event):
1. Seek emergency medical treatment immediately
2. Once the injured person(s) is appropriately cared for, call a corporate contact listed on the emergency wallet card and update the employee's supervisor and project manager as soon as possible.

See Attached

Secondary Provider (Occupational Health Clinic)

Name of Occ Clinic:		**Distance:**	
Address:		**Time:**	
Type of Service:			

Route:

In the case of a **NON-EMERGENCY/NON-LIFE THREATENING INCIDENT** (any injury, accident or near-miss event) call one of the corporate contacts listed on the wallet card (and above) prior to an Employee visiting a physician and implementing the following procedure:
1. Administer first aid immediately.
2. Tetra Tech employees call WorkCare (Tetra Tech contracted physicians) at 1-800-455-6155 for a triage call/discussion with an Occupational Health Nurse (OHN).
3. Mention that this is regarding an injury. At this point the nurse/physician will assist the employee/supervisor/H&S Coordinator to determine the best treatment plan. For example, he/she will recommend first aid or urgent care.
4. WorkCare will require the following information when a call is placed: Name of person calling, phone number, location, name of person injured, Social Security number, date and type of injury.

Response Plans

Medical - General

First Aid Kit:	**Type:**	Portable	**Special First Aid Precautions:**	
	Location:	Field vehicle	**Hydrofluoride on Site:**	N
Eye Wash:	**Required?:**	Y	**Cyanides on Site:**	N
	Location:	Field vehicle	**Other:**	
Safety Shower:	**Required?:**	No	None	
	Location:	NA		

Special Procedures: Consult MSDS for appropriate first aid measures related to chemical exposures. Seek immediate medical attention when incidents warrant anything beyond minor first aid response.

Location is in City of Butte and is not isolated. Workers may work alone utilizing proper check-in protocol indicated in this HASP. Sub-contractors will not be allowed to work onsite without oversight from Tetra Tech

Fire/Explosion

Special Procedures: Use available fire extinguisher to extinguish small fires. For any fire beyond the control of a portable fire extinguisher contact the local firefighting authorities as listed in the emergency contact section of this plan.

Fire Extinguisher:
Type: Standard portable
Location: In vehicle

Spill Response

Special Procedures: Contractor is required to have a 5-gallon bucket (or equivalent) with sorbent pads and/or socks, heavy duty garbage bags for spill cleanup. Use sorbent pads, build dirt barrier to contain spill. Place contaminated soil in waste container.

Special Gear:
Type: Sorbent pads while heavy machinery onsite.
Location: Drill rig

Weather/Natural Disaster Emergency

Special Procedures: Cease work immediately and seek shelter in vehicle. If travel is not possible seek immediate shelter as available. Monitor weather conditions throughout day and stop work if lightening is observed.

HEALTH AND SAFETY PLAN (HASP)

Butte Area One - Silver Bow Creek and Black Tail Creek Corridors AT Butte, Montana

Site Control Measures

Work Zones

Exclusion Zone:	A formal exclusion zone will not be utilized during the implementation of tasks identified in this HASP; however, work will be stopped if unidentified or unauthorized persons are observed in the general vicinity of the project work area.
Decon Zone:	No formal Decon Zone will be utilized during field activities.
Support Zone:	N/A
Other Zones:	N/A

Methods for Delineating Zones

Work Zone Delineation Plan	Cones will be placed around immediate work area; however, work will be stopped if unidentified or unauthorized persons are observed in the general vicinity of the project work area.
Delineation Equipment	Traffic cones and candles.

Security Measures

In this section describe any additional security measures the will be taken at the site including details on locking and securing the site after hours, thrid party professional security if appropriate, client specific security that might be in place, etc.

Security Related Contacts

Agency	Contact Name	Phone Number

Site Map

In this section reference a site map attached or sketch out the defined zones if applicable. = NA

HEALTH AND SAFETY PLAN (HASP)

Butte Area One - Silver Bow Creek and Black Tail Creek Corridors AT Butte, Montana

Site Personnel and Certification Status

Name:	Don May	**Medical Current:**	y
Title:	Tetra Tech Field Manager	**HAZWOPER Current:**	y
Task(s):	All	**Fit Test Current:**	N
CPR/First Aid:	Yes, American Red Cross		
Other:	NA		
Name:	Natalie Morrow	**Medical Current:**	y
Title:	Health & Safety Officer	**HAZWOPER Current:**	y
Task(s):	All	**Fit Test Current:**	qual
CPR/First Aid:	Yes, American Red Cross		
Other:	NA		
Name:	Jerry Armstrong	**Medical Current:**	y
Title:	Health & Safety Officer	**HAZWOPER Current:**	y
Task(s):	All	**Fit Test Current:**	N
CPR/First Aid:	Yes, American Red Cross		
Other:	NA		
Name:	Brooks Quantance	**Medical Current:**	y
Title:	Field Services	**HAZWOPER Current:**	y
Task(s):	All	**Fit Test Current:**	N
CPR/First Aid:	Yes, American Red Cross		
Other:	NA		
Name:	Rhianna Eads	**Medical Current:**	y
Title:	Field Services	**HAZWOPER Current:**	y
Task(s):	1,2	**Fit Test Current:**	y
CPR/First Aid:	Yes, American Red Cross		
Training Current:	All personnel, including visitors entering the exclusion or contamination reduction zones must have certifications of completion of training in accordance with OSHA 29 CFR 1910.120.		
Fit Test Current:	All personnel, including visitors entering any area requiring the use or potential use of any negative pressure respirator must have at a minimum, a qualitative fit test administered in accordance with OSHA 29 CFR 1910.134 or ANSI within		
Note:	These requirements should be verified for any subcontractor personnel assigned to the site.		

Training and Briefing Topics

Note: The following topics will be covered as indicated (i.e., the initial site training, daily, monthly or periodically). Delete the X's corresponding to the topics that do not apply to this site. Indicate the frequency for the topics that do apply.

Site characterization and analysis (29 CFR 1910.120 i)	X	daily
Drilling Safety	X	daily
Site Control (29 CFR 1910.120 d)	X	daily
Engineering Controls and Work Practices (29 CFR 1910.120 g)	X	daily
Level D - Personal Protective Equipment	X	daily
Other:	X	Initial, daily, monthly, or periodically?

Drilling Considerations

Unfilled Bore-holes

Will bore-holes be drilled and need to be left unfilled for a period of time? No

If yes, length of time before filled or well installed.

Safe guarding requirements: Should circumstances arise in which boreholes must be left open, the hole will be demarcated by using poles or stakes and rope or barricade that prevents access by people or large animals. Also, a traffic cone will be placed over the borehole to prevent animal entry. NOTE: All holes must be marked to make individuals aware that there is a potential hazard.

Filling Bore-holes

Will bore-holes be drilled which require filling? Yes

Procedure for backfilling of bore-holes: Boreholes must be filled in in such a manner that settlement will not occur presenting a hazard. The method chosen can be based on the site and should be detailed in this section. Acceptable methods include: 1) Ensuring that tremie holes are full or 2) Installing a concrete cap much larger than the borehole.

Other Site Specific Drilling Concerns:

NA

Intrusive Activities Checklist

Will intrusive activities be performed for work under this HASP? Yes

If yes, describe the type(s) of intrusive activity. soil borings and well installation

Subsurface Structures Present

Type	Present?	Located ?	Method Used/To Be Used for Locating
Electrical	Possible	Will be prior to project	One Call
Gas	Possible	Will be prior to project	One Call
Product Tank	Not Expected		
Other			

Shut-Offs Located

Type	Location of Shut-Off
Electrical	unknown
Gas	unknown
Water	unknown
Product	NA
Other	NA

Emergency Contacts for Subsurface Structure Repair

Type	Appropriate Contact for Emergency Repair of Specific Subsurface Structure Type/Material
Electrical	Northwestern Energy 1-888-467-2669
Gas	Northwestern Energy 1-888-467-2669
Water	Butte Silver Bow 406-497-6540
Communication Lines	Century Link, 800-283-4237
Other	

Procedure for Ensuring Unknown Substructures Identified

Although potential known and unknown subsurface structures are identified per the above sections, there is always the potential for unkown subsurface structures to be encountered during intrusive activities. Therefore, a protocol needs to be established for each particular site. For this site, the following procedures will be followed for the intrusive activities identified above: (Delete the X's in front of the procedure(s) that do not apply to this site.)

X	"One Call" or equivalent utility locate per the local system for the site will be made (this is mandatory on all sites)
X	Follow up with one-calls (i.e. document who will be contacted with respect to the one call service along with their phone numbers and place and document calls to those orginizations that did not repsond). Form for one call follow
X	Line locate using a geophysical subcontracted service (should be considered for intrusive work on all private properties where there is the potential for unidentified subsurface structures)

Other Specific Subsurface Identification Requirements for this Site

NA

HEALTH AND SAFETY PLAN (HASP)

Butte Area One - Silver Bow Creek and Black Tail Creek Corridors AT Butte, Montana

Required PPE and Equipment Checklist

Delete the X's corresponding to the PPE/Equipment that does not apply to this site.

HARD HAT		X	
STEEL-TOED BOOTS		X	when workling near heavy eqiup
GLOVES	TYPE: Nitrile and Leather	X	
HIGH VISIBILITY WEAR	TYPE:	X	
FIRE EXTINGUISHER		X	
EYE WASH BOTTLE		X	
FIRST AID KIT		X	
WASH WATER		X	
UV PROTECTION		X	

FIELD AUDITS

A field auditing program should be determined for the project based on the scope of work, duration of the project and degree of hazards associated with the tasks involved.

During the course of this project a minimum number of field audits will be conducted as follows:	1
The following person is responsible for ensuring the audits and associated corrective actions are completed:	Rheanna Reed

HAZARDOUS MATERIALS / DANGEROUS GOODS PACKAGING AND SHIPPING

Will known or suspect hazardous materials / dangerous goods be packaged and shipped?	No

If shipping materials classified or suspected as hazardous materials or dangerous goods attach and follow SWP 5.38 entitled "SHIPPING HAZARDOUS MATERIALS". NOTE: DOT HAZMAT training is required to package, label, prepare paper work and ship hazardous materials. TtMM personnel typically do not maintain this training and therefore these tasks typcially need to be subcontracted to trained personnel.

CONFINED SPACES

Are there any identified or potential confined spaces associated with the project?	No
Will the project involve any confined space entry?	No

If confined space entry is involved in the project, a confined space entry and permitting procedure needs to be identified here and attached to this HASP. If there are confined spaces present but they will not be entered, the spaces should be identified here and an indication provided as to how they will be labeled/marked to prevent entry. If neither apply, both answers can be indicated as no and an NA entered in this field.

TRAFFIC CONTROL

Is there exposure to traffic at this site during any of the designated work activities?	Yes
For which task(s) will traffic be an issue of concern ?	All
Will the project require an extensive or formal traffic control plan?	No

Traffic Control Sketch

FATIGUE MANAGEMENT

Is the work extensive or out of the ordinary typical work schedule with the potential to result in worker fatgiue that could increase the potential for incidents to occur during work tasks or travel to/from the site? Yes

Describe situations or circumstances that have to potential to significantly impact worker fatigue.

Potential for greater than 8 hour work period in extreme weather.

Define precautions that will be taken to minimize worker fatigue and eliminate/minimize its impact on safety.

Workers will wear appropriate clothing and PPE, as well as stay hydrated and take period breaks when necessary. Do not travel when fatigued.

PROVISIONS FOR LONE WORKERS

Will Tetra Tech employees or subcontractor employees be required to or have the potential to work alone? Yes

For which task(s) will a site worker be or have the potential to be working alone? 3,4

List the type of employees that will be permited to work alone and under what conditions: Tetra Tech

A surveyor will work alone to survey wells, the field technician sampling the wells and conducting aquifer test may also work alone.

Note: Personnel should not be allowed to work alone if there is high hazard potential associated with the site and/or task they will be performing, including but not limited to high physical hazard potential (such as heavy equipment operation, high voltage, intrusive activities, etc.), potential for

Lone Worker Check-In Procedure

Detail a daily check-in procedure for all site personnel who will be working alone. Note: There may be a need to detail different check-in procedures for different tasks, personnel etc.

Form of communication to be used for check-in: Phone

Primary check-in person: Bill Craig

Alternate check-in person: Don May

Check-In Schedule

X	Initial Check-In:	When leaving the office
X	Periodic Check-In:	Check in periodically throughout work week
X	Final Check-Out:	When employee returns to the office

HEALTH AND SAFETY PLAN (HASP)

Butte Area One - Silver Bow Creek and Black Tail Creek Corridors AT Butte, Montana

Tetra Tech Compliance Agreement Form

PROJECT SCOPE: Conduct a soils/mine waste investigation to better define the aerial and vertical extent of tailings. Conduct a limited groundwater and surface water evaluation to determine the current water quality condition, and perform an aquifer test to determine the near surface aquifer properties.

PROJECT NUMBER: 114-570956

I have read, understood, and agree with the information set forth in this Health and Safety Plan along with any related attachments and discussed in the Personnel Health and Safety briefing.

NAME	SIGNATURE	DATE

Subcontractor Notification of Hazards Acknowledgement Form

PROJECT SCOPE: Conduct a soils/mine waste investigation to better define the aerial and vertical extent of tailings. Conduct a limited groundwater and surface water evaluation to determine the current water quality condition, and perform an aquifer test to determine the near surface aquifer properties.

PROJECT NUMBER: 114-570956

I am aware that Tetra Tech has provided this Health and Safety Plan for my review to inform me of the hazards identified with the project site and tasks that Tetra Tech will perform. I understand that this Health and Safety Plan does not fulfill requirements for subcontractor health and safety plans related to the tasks which they will perform.

NAME	SIGNATURE	DATE

Tetra Tech

Safety Excellence

Butte Area One - Parrot Tailings Complex AT Civic Center Rd. Butte, Montana

Worker / Visitor Log

PROJECT SCOPE: Conduct a soils/mine waste investigation to better define the aerial and vertical extent of tailings. Conduct a limited groundwater evaluation to determine the current water quality condition, and perform an aquifer test to determine the near surface aquifer properties.

PROJECT NUMBER: 114-570956

Name	Company / Organization	Date	Time In	Time Out

TETRA TECH
Safety Excellence

utte Area One - Parrot Tailings Complex AT Civic Center Rd. Butte, Monta

Daily Tailgate Meeting Form

PROJECT SCOPE:	Conduct a soils/mine waste investigation to better define the aerial and vertical extent of tailings. Conduct a limited groundwater evaluation to determine the current water quality condition, and perform an aquifer test to determine the near surface aquifer properties.	**PROJECT NUMBER:** 114-570956

Topics Discussed	Meeting Facilitator
	Meeting Date / Time

MEETING ATTENDEES

Name	Signature	Company / Organization

Project Name: ______________________ Number: ________________ Location: ______________________________

Project Manager: ________________________________ Site Safety Coordinator: ___________________________

Completed by: __________________________________ Date: ___________________________________

Subcontractors on Site: ☐ yes ☐ no Subcontractor Company ____

Subcontractor Company ____

Note: Tetra Tech includes subcontracted personnel in all field audits.

General Items		In Compliance?		
Hazard Assessment and General Site Conditions		**Yes**	**No**	**NA**
1	Approved health and safety plan (HASP) on site or available	☐	☐	☐
2	If non-HAZWOPER site, is there an accident prevention plan or job safety analysis (JSA)	☐	☐	☐
3	Names of on-site personnel recorded in field logbook or daily log	☐	☐	☐
4	HASP compliance agreement form signed by all on-site personnel	☐	☐	☐
5	Material Safety Data Sheets on site or available	☐	☐	☐
6	Designated site safety coordinator present	☐	☐	☐
7	Daily tailgate safety meetings conducted and documented	☐	☐	☐
8	Site personnel meet medical exams, fit test, training requirements (including subs)	☐	☐	☐
9	Documentation of training, medical exams, and fit tests available from employer	☐	☐	☐
10	Compliance with specified safe work practices	☐	☐	☐
11	Exclusion, decontamination, and support zones delineated and enforced	☐	☐	☐
12	Windsock or ribbons in place to indicate wind direction	☐	☐	☐
13	Barricades used in areas where appropriate	☐	☐	☐
14	Proper signage and postings in place	☐	☐	☐
Emergency Planning		**Yes**	**No**	**NA**
15	Emergency telephone numbers posted or available	☐	☐	☐
16	Emergency route to hospital posted or available	☐	☐	☐
17	Local emergency providers notified of site activities	☐	☐	☐
18	Adequate safety equipment inventory available	☐	☐	☐
19	First aid provider and supplies available	☐	☐	☐
20	Eyewash stations in place	☐	☐	☐
Air Monitoring		**Yes**	**No**	**NA**
21	Monitoring equipment specified in HASP available and in working order	☐	☐	☐
22	Monitoring equipment calibrated and calibration records available	☐	☐	☐
23	Personnel know how to operate monitoring equipment / equipment manuals available on site	☐	☐	☐
24	Environmental and personnel monitoring performed as specified in HASP and documented	☐	☐	☐

Project Name: ______________________ Number: ________________ Location: ______________________________

Project Manager: ________________________________ Site Safety Coordinator: ___________________________

Inspected by: ___________________________________ Date: __________________________________

Rig Type: ☐ Rotary/Auger Year/Make/Model: ____

☐ Direct Push Rig Owner: _________________ Mileage: ___________________

Inspector to initial columns below as appropriate

Categories and Inspection Items		Pass	Fail	NA
Emergency Switches	Kill switches are located and accessible to workers on both sides of the rotating stem. (**NOTE**: Location and number of switches depends on rig – refer to manual).	☐	☐	☐
	Kill switches verified to be operable and all workers familiar with location and operation. **NEVER BYPASS, DISABLE, OR REMOVE KILL DEVICES.**	☐	☐	☐
Protective Guards	Drive shafts, belts, chain drives, and universal joints are guarded to prevent accidental insertion of hands, fingers and tools.	☐	☐	☐
Cables	Cables on drill rig are free of kinks, frayed wires, birdcages, flat spots, grease and worn or missing sections.	☐	☐	☐
	Cables are terminated at the working end with a proper eye splice; either swaged, coupled, or using cable clamps.	☐	☐	☐
	Cable clamps are installed with the saddle on the live or load side. Clamps are not alternated and are of the correct size and number for the cable size.	☐	☐	☐
	Wire ropes are not allowed to bend around sharp edges without cushion material.	☐	☐	☐
Pulleys	Pulleys are not to be bent, cracked, or broken.	☐	☐	☐
	Pulleys operate smoothly and freely, without resistance.	☐	☐	☐
Cable Winches	Motor is mounted in correct location and tightly secured to drill rig.	☐	☐	☐
	Winch is capable of being placed in the free spool (unwind smoothly) and locked position correctly, demonstrating that the cable is suitable for lifting during drilling operations.	☐	☐	☐
Safety Latches	Hooks installed on hoist cables are the safety type with a functional latch to prevent accidental separation.	☐	☐	☐
	Safety latches are functional and completely span the entire throat of the hook and have positive action to close the throat except when manually displaced for connecting or disconnecting a load.	☐	☐	☐

Project Name___________________________________ Project #________________

Categories and Inspection Items		Pass	Fail	NA
Flights / Augers	Flights/Augers should not be bent, cracked, or broken. **NOTE:** Flights/Augers failing inspection must be removed from jobsite.	☐	☐	☐
	Flights should be blunt to prevent the risks of cuts.	☐	☐	☐
	Auger keys should not be bent, have any cracks/fractures, be excessively worn, or otherwise damaged.	☐	☐	☐
	Auger bolt holes and threads should not be damaged.	☐	☐	☐
	Inspect flights/augers for metal burrs. **NOTE:** Burrs must be filed to flat surface.	☐	☐	☐
	Avoid stacking augers; all should lay flat on ground.	☐	☐	☐
	Avoid manually lifting/moving augers. Should be lifted/moved with cable lines, or, at a minimum, by two persons.	☐	☐	☐
Drill String	Drill string should not be bent or have any cracks/fractures.	☐	☐	☐
	Drill string connecting pins should not be bent, have any cracks/fractures, or be excessively worn.	☐	☐	☐
Mast	Mast is free of bends, cracks, or broken sections.	☐	☐	☐
	All mounting hardware (pins, bolts, etc.) should be in place.	☐	☐	☐
	No moving of drill rig while mast is in vertical position.	☐	☐	☐
	Maintenance/repairs to be performed on mast only in horizontal position.	☐	☐	☐
Hammering Device	Hammer free of cracks, fatigue, or other signs of excessive wear.	☐	☐	☐
	Hammer connections are secure.	☐	☐	☐
Leveling Devices	Outriggers move in/out and up/down smoothly and freely while using controls on drill rig, with no hydraulic leaks.	☐	☐	☐
	Outriggers are extended prior to and whenever the mast is raised off its cradle. Outriggers must maintain pressure to continuously support and stabilize the drill rig (even while unattended).	☐	☐	☐
	Outriggers are properly supported on the ground surface to prevent settling into the soil (use of outrigger support pads).	☐	☐	☐
Controls	Controls are intact, properly labeled, have freedom of movement, and have no loose wiring or connections.	☐	☐	☐
	Controls are not blocked or locked into an operating position.	☐	☐	☐
	Installed lights, signals, gauges, and alarms operate properly.	☐	☐	☐

Project Name___________________________________ Project #___________________

Categories and Inspection Items		Pass	Fail	NA
Lifting Devices	Slings, chokers, and lifting devices are inspected before using and are in proper working order. **NOTE:** Damaged units are to be labeled and removed from jobsite.	☐	☐	☐
	Shackles/Clevises are in proper working order with pins/screws in place that is to be used while lifting.	☐	☐	☐
	Cables and lifting devices are not operated erratically or with a jerking action to overcome resistance.	☐	☐	☐
Hydraulic System	Hydraulic lines are secure, in good condition with no signs of excessive wear, and not leaking. **NOTE:** Check while pressurized.	☐	☐	☐
	Hydraulic lines are not in a bent or pinched position causing additional fluid restrictions/pressures.	☐	☐	☐
	Hydraulic oil reservoir has appropriate amount of oil and not leaking.	☐	☐	☐
	Documentation available to confirm that pressure relief valve was checked during shop maintenance activity and noted on maintenance log.	☐	☐	☐
Pump Lines (water, grout, etc.)	Suction/Discharge hoses, pipes, valves, and fittings are secured and not leaking.	☐	☐	☐
	High pressure hoses have a safety chain, cable, or strap at each end to prevent whipping in the event of a failure.	☐	☐	☐
Fire Prevention	A fire extinguisher of appropriate size is located on drill rig and readily available/accessible for drilling crew (recommended 20 lb.).	☐	☐	☐
	Documentation available to confirm that the drilling crew has received training on proper use of fire extinguishers.	☐	☐	☐
Ladders	Drill rig has a permanently attached or proper portable ladder to be used for access to drilling platform.	☐	☐	☐
Tracks	Tracks on rig are not excessively worn and free of any debris or foreign material.	☐	☐	☐
General	Drill rig meets regulations for transport on state/federal highways (inspection sticker, license plate, etc.).	☐	☐	☐
	Documentation available to verify that rig was inspected prior to arriving at Exxon/Mobil job sites.	☐	☐	☐
	Does the rig size meet job requirements?	☐	☐	☐
	Maintenance log available for previous 3 months to confirm proper maintenance/inspection.	☐	☐	☐
Exhaust	Exhaust system should be free from defect and routes engine exhaust away from drill rig workers.	☐	☐	☐
Fuels	Fuel stored in an approved and properly labeled container.	☐	☐	☐
	Fuel transfer lines free from signs of excessive wear and not leaking.	☐	☐	☐
	Refueling and transferring of fuel is performed in an approved area with sufficient containment to prevent spillage.	☐	☐	☐
Exclusion / Work Zones	The exclusion/work zone is centered over the borehole and the radius equal to or greater than the height of the mast (measured from ground level.).	☐	☐	☐
	The exclusion / work zone should be clear of tripping hazards.	☐	☐	☐

Project Name________________________________ Project #________________

Categories and Inspection Items		Pass	Fail	NA
Overhead Obstruction	Except where electrical lines have been de-energized and visibly grounded, drill rigs can be operated at the following distances: • 50 KV or less – minimum clearance of 10 feet • 50 KV or greater – add 0.4 inches for every KV over 50 KV • If voltage unknown – at least 25 feet of clearance	☐	☐	☐
	During rig transit clearance from energized power lines can be maintained as follows: • Less than 50 KV – 4 feet • 50 thru 365 KV– 10 feet • Greater than 365 KV – 16 feet	☐	☐	☐
Rig Repairs	Repairs, when possible, will be conducted offsite to reduce the risk of any onsite injuries	☐	☐	☐
Specialized PPE	Workers are equipped with appropriate fall restraining devices and positioning devices if the need arises to work at elevated heights (6 feet or greater).	☐	☐	☐
	When working in wet/slippery conditions, all workers are equipped with lug-type soles or similar slip resistant soles, on their safety footwear to prevent slipping.	☐	☐	☐

RECOMMENDED SPARE PARTS OR ITEMS TO BE SENT WITH DRILL CREW

Rotary/Auger Rig

- Emergency switch
- Drive Couple
- Shear pins/keys (for drive coupling)
- Pump packing and hoses
- Auger bolts
- Rod to cap pins
- Cutter head
- Safety latches, hooks, clamps
- Split spoon cutter head
- Spill kit (5 gal bucket with oil dry/pads)

Direct Push Rig

- Emergency switch
- Drive Caps
- Cutter head
- Pull cap
- Liner cutter
- Rod to cap pins
- Line holder (used while cutting)
- Spill kit (5 gal bucket with oil dry/pads)

Results and Corrective Actions Summary

Comments:

Corrective Action Taken:

________________________________ ________________________________
Inspector's Signature Date

NOTE: This checklist provides a list of general items to check. It should not be considered all encompassing as operations and equipment may vary. Additional items can be addressed in the comments and corrective actions sections or on an additional sheet. All "fail" items should be detailed in the comments and corrective action sections.

Project Name___________________________________ Project #______________________

Safety Items		In Compliance?		
Personal Protection (Specify)		**Yes**	**No**	**NA**
25	Splash suit	☐	☐	☐
26	Chemical protective clothing	☐	☐	☐
27	Safety glasses, goggles or face shield	☐	☐	☐
28	Gloves	☐	☐	☐
29	Steel-Toed Boots	☐	☐	☐
30	Chemical Resistant Overboots	☐	☐	☐
31	Hard hat	☐	☐	☐
32	Dust mask	☐	☐	☐
33	Hearing protection	☐	☐	☐
34	Respirator	☐	☐	☐
35	Other: (describe)	☐	☐	☐
Instrumentation		**Yes**	**No**	**NA**
36	Combustible gas meter	☐	☐	☐
37	Oxygen meter	☐	☐	☐
38	Organic vapor analyzer	☐	☐	☐
39	Other: (describe)	☐	☐	☐
Supplies		**Yes**	**No**	**NA**
40	Decontamination equipment and supplies	☐	☐	☐
41	Fire extinguishers	☐	☐	☐
42	Spill cleanup supplies	☐	☐	☐
43	First Aid Kit	☐	☐	☐
44	Other: (describe)	☐	☐	☐
Comments:				
Corrective Action Taken During Audit:				
Corrective Action Still Needed:				

NA = Not applicable

______________________________ ______________________________

Auditor's Signature Date

NOTE: This checklist provides a list of general items to look for during the field audit. It should not be considered all encompassing as each site and project is unique. The auditor should look for and address all safety and health issues associated with the site and tasks being performed. Additional items can be addressed in the comments and corrective actions sections or on an additional sheet.

APPENDIX C – SOIL BORING LOGS FROM PREVIOUS SITE INVESTIGATION

MONTANA WELL LOG REPORT

This well log reports the activities of a licensed Montana well driller, serves as the official record of work done within the borehole and casing, and describes the amount of water encountered. This report is compiled electronically from the contents of the Ground Water Information Center (GWIC) database for this site. Acquiring water rights is the well owner's responsibility and is NOT accomplished by the filing of this report.

Other Options

Return to menu
Plot this site in State Library Digital Atlas
Plot this site in Google Maps
View hydrograph for this site
View field visits for this site
View water quality for this site
View scanned well log (11/1/2011 3:28:22 PM)

Site Name: ANACONDA MINERALS CO * AMC-23
GWIC Id: 5018

Section 1: Well Owner(s)

1) ANACONDA MINERALS COMPANY (MAIL)
N/A
BUTTE MT 59701 [10/06/1982]

Section 2: Location

Township	Range	Section	Quarter Sections
03N	08W	24	NE¼ NE¼ SE¼

County	Geocode
SILVER BOW	

Latitude	Longitude	Geomethod	Datum
45.996141351	112.530120068	SUR-GPS	NAD83

Ground Surface Altitude	Method	Datum	Date
5448.26			

Measuring Point Altitude	Method	Datum	Date Applies
5448.26			1/1/1983

Addition	Block	Lot

Section 3: Proposed Use of Water

MONITORING (1)

Section 4: Type of Work

Drilling Method: CABLE TOOL
Status: NEW WELL

Section 5: Well Completion Date

Date well completed: Wednesday, October 06, 1982

Section 6: Well Construction Details

Borehole dimensions

From	To	Diameter
0	31	6

Casing

From	To	Diameter	Wall Thickness	Pressure Rating	Joint	Type
0	33.5	6	0.25			STEEL

Completion (Perf/Screen)

From	To	Diameter	# of Openings	Size of Openings	Description
19	29	6			PERFORATED CASING

Annular Space (Seal/Grout/Packer)

There are no annular space records assigned to this well.

Section 7: Well Test Data

Total Depth: 33.5
Static Water Level: 3
Water Temperature:

Bailer Test *

10 gpm with _ feet of drawdown after _ hours.
Time of recovery _ hours.
Recovery water level _ feet.
Pumping water level 20 feet.

** 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.*

Section 8: Remarks

2 FOOT SAND PLUG IN BOTTOM OF CASING

Section 9: Well Log

Geologic Source

110ALVM - ALLUVIUM (QUATERNARY)

From	To	Description
0	1	TOPSOIL
1	6	RED SAND WITH CLAY
6	14	BLACK SWAMP MUD AND SAND
14	20	SAND AND CLAY
20	23	SAND AND GRAVEL WITH CLAY
23	26	FINE SAND
26	31	SAND AND GRAVEL--WATER

Driller 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:	W. F. KENTFIELD
Company:	OKEEFE DRILLING CO
License No:	WWC-459
Date Completed:	10/6/1982

O'KEEFE DRILLING COMPANY
P.O. BOX 3810 - 4 MILE ROAD
BUTTE, MONTANA 59702
494-3310

03N 08W 24 DAD

NAME: ANACONDA MINERALS COMPANY

WELL NUMBER: 24
WELL LOCATION: Butte, Montana
LEGAL DESCRIPTION: SW ¼ SW ¼ SW ¼, SEC. 24, RANGE 3-N, TOWNSHIP 8-W

DATE: STARTED 10/5/82
COMPLETED 10/5/82

DRILLER: W. F. KENTFIELD
DRILL RIG: Bucyrus-Erie 22W
METHOD: Percussion cable tool
BITS:

M: 5034

03N 08W 24 DAD

DIAMETER	6"			
DEPTH	25'			
CASING 6 5/8" x .250	FROM	0'	TO	28'
PLASTIC LINER	FROM	--	TO	--
DRIVE SHOE	6"			
PERFORATIONS	FROM	13'	TO	23'
WELL SCREEN	--			
GALLONS PER MINUTE	40			
STATIC WATER LEVEL	6½'			
PUMPING LEVEL	15'			

FROM	TO	FORMATION		SWL
0'	10'	Old dump, fill		
10'	15'	Black swamp and sand	Water	
15'	20'	Red sand and clay		
20'	25'	Sand and gravel	Water	

DEVELOPED BY: bailing
VOLUME HELD BY BAILER: 15 gallons
DEPTH TO WATER WHILE BAILING: 6½ feet
VOLUME OF WATER BAILED: 15 gallons
PRODUCTION RATE: 40 gallons-per-minute
REMARKS: 2' sand plug in bottom of casing

M: 5034

Buckley, Luke

From: Smith, Garrett
Sent: Tuesday, August 24, 2010 3:51 PM
To: Buckley, Luke
Cc: Tucci, Nicholas
Subject: New Well Logs
Attachments: BPS New Well Logs.pdf

Hi Luke-
I have some new well logs that need to be entered into GWIC (see attached pdf).
I have included the GWIC numbers below, as well as the total depth, screen interval, and the elevations are converted to NGVD29 (since they're NAVD88 on the logs).
Thanks

Garrett

		NGVD29			
Well Name	*GWIC ID*	*TOC Elev*	*Ground Elev*	*TD (ft)*	*Screen Int. (ft)*
AMC-24C	**255974**	**5450.417**	**5448.47**	**83.5**	**69-79**
AMW-13C	**255975**	**5449.958**	**5448.338**	**84**	**60-70**
BPS07-21C	**257404**	**5452.471**	**5452.801**	**87**	**65-80**
BPS07-24	**257403**	**5451.721**	**5450.331**	**71**	**58-68**

MONTANA WELL LOG REPORT

This well log reports the activities of a licensed Montana well driller, serves as the official record of work done within the borehole and casing, and describes the amount of water encountered. This report is compiled electronically from the contents of the Ground Water Information Center (GWIC) database for this site. Acquiring water rights is the well owner's responsibility and is NOT accomplished by the filing of this report.

Other Options

Return to menu
Plot this site in State Library Digital Atlas
Plot this site in Google Maps
View hydrograph for this site
View field visits for this site
View water quality for this site
View scanned well log (11/1/2011 3:29:25 PM)

Site Name: ARCO * AMW-13
GWIC Id: 137597

Section 1: Well Owner(s)

1) ARCO (MAIL)
N/A
N/A N/A N/A [08/25/1993]

Section 2: Location

Township	Range	Section	Quarter Sections
03N	08W	24	NW¼ SW¼ NE¼ SE¼

County	Geocode
SILVER BOW	

Latitude	Longitude	Geomethod	Datum
45.993589459	112.533094451	SUR-GPS	NAD83

Ground Surface Altitude	Method	Datum	Date
5454.97	SUR-GPS	NGVD29	3/8/2005

Measuring Point Altitude	Method	Datum	Date Applies
5450.39			3/4/1994

Addition	Block	Lot

Section 3: Proposed Use of Water

MONITORING (1)

Section 4: Type of Work

Drilling Method: HOLLOWSTEM AUGER
Status: NEW WELL

Section 5: Well Completion Date

Date well completed: Wednesday, August 25, 1993

Section 6: Well Construction Details

Borehole dimensions

From	To	Diameter
0	16	4

Casing

From	To	Diameter	Wall Thickness	Pressure Rating	Joint	Type
-2.5	2	0				STEEL
-2	15.5	4				PVC

Completion (Perf/Screen)

From	To	Diameter	# of Openings	Size of Openings	Description
5	15	4		0.010 IN	SCREEN-CONTINUOUS-PVC
15	15.5	4			BOTTOM CAP

Annular Space (Seal/Grout/Packer)

From	To	Description	Cont. Fed?
0	3	BENTONITE	
3	3.5	100 MESH COLORADO SILICA SAND	
3.5	16	16/30 COLORADO SILICA SAND	

Section 7: Well Test Data

Total Depth: 16
Static Water Level: 10.4
Water Temperature:

** 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.*

Section 8: Remarks

CASING ELEVATION: 5450.39' LOGGED BY: RICHARD GRAF MSPC N741488.51149 / E1229400.09438

Section 9: Well Log

Geologic Source

111FILL - HOLOCENE MAN-DEPOSITED FILL MATERIALS

From	To	Description
0	0.5	SANDY SILT DARK BROWN (10YR 3/3) 55% FINES 40% FINE SAND 5% MED SAND SOFT LOW PLASTICITY MOIST ROOTLETS FILL
0.5	2.5	SILTY SAND BROWN (10YR 5/3) 40% FINES 30% FINE SAND 15% MED SAND 10% COARSE SAND TRACE FINE GRAVEL LOOSE MOIST FILL MATERIAL (CHARCOAL GLASS WOOD TAILINGS?) OXIDATION ZONES IN COARSE FRACTION. FILL
2.5	3	NO RECOVERY
3	5.2	SILTY SAND AS ABOVE FILL
5.2	16	NO RECOVERY SOIL TOO LOOSE TO STAY IN SAMPLER RESIDUE ON SAMPLER INDICATES FINE BLACK SOIL WITH "REDUCING" ODOR
16	20	FROM CUTTINGS OF AUGER FLIGHTS: SILTY CLAY BLACK (10YR 2/1) 755 FINES 10% FINE SAND 5% MED TO COARSE SAND VERY SOFT WET IN REDUCING IN ODOR HIGH ORGANIC CONTENT 10% FIBERIOUS PLANT MATERIAL

Driller 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:
Company: OKEEFE DRILLING CO
License No: -
Date Completed: 8/25/1993

MONTANA WELL LOG REPORT

This well log reports the activities of a licensed Montana well driller, serves as the official record of work done within the borehole and casing, and describes the amount of water encountered. This report is compiled electronically from the contents of the Ground Water Information Center (GWIC) database for this site. Acquiring water rights is the well owner's responsibility and is NOT accomplished by the filing of this report.

Other Options

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Plot this site in Google Maps
View hydrograph for this site
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Site Name: ATLANTIC RICHFIELD * AMW-13B
GWIC Id: 240863

Section 1: Well Owner(s)
1) ATLANTIC RICHFIELD (MAIL)
317 ANACODA RD
BUTTE MT 59701 [12/07/2007]

Section 2: Location

Township	Range	Section	Quarter Sections
03N	08W	24	SW¼ SW¼ NE¼ SE¼

County	Geocode
SILVER BOW	

Latitude	Longitude	Geomethod	Datum
45.993623385	112.533136476	SUR-GPS	NAD83

Ground Surface Altitude	Method	Datum	Date
5449.44	SUR-GPS	NGVD29	11/17/2008

Measuring Point Altitude	Method	Datum	Date Applies
5450.79	MAP	NGVD29	11/17/2008

Addition	Block	Lot

Section 3: Proposed Use of Water
MONITORING (1)

Section 4: Type of Work
Drilling Method: ROTARY
Status: NEW WELL

Section 5: Well Completion Date
Date well completed: Friday, December 07, 2007

Section 6: Well Construction Details

Borehole dimensions

From	To	Diameter
0	40	7

Casing

From	To	Diameter	Wall Thickness	Pressure Rating	Joint	Type
0	27	2	0.154		FLUSH THREAD	PVC

Completion (Perf/Screen)

From	To	Diameter	# of Openings	Size of Openings	Description
27	28.5	2		0.020 IN	SCREEN-CONTINUOUS-PVC

Annular Space (Seal/Grout/Packer)

From	To	Description	Cont. Fed?
0	25	BENTOINTE	
25	40	SILICA SAND	

Section 7: Well Test Data

Total Depth: 40
Static Water Level: 10
Water Temperature:

** 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.*

Section 8: Remarks

Section 9: Well Log
Geologic Source
111SNGR - SAND AND GRAVEL (HOLOCENE)

From	To	Description
0	7	SAND AND SILT
7	22	CLAY AND SILT
22	25	GRAVEL
25	35	GRAVEL WITH SAND AND SILT
35	40	MEDIUM GRAVEL

Driller 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:	CLAY PARSONS
Company:	PARSONS DRILLING
License No:	MWC-362
Date Completed:	12/7/2007

MONTANA WELL LOG REPORT

This well log reports the activities of a licensed Montana well driller, serves as the official record of work done within the borehole and casing, and describes the amount of water encountered. This report is compiled electronically from the contents of the Ground Water Information Center (GWIC) database for this site. Acquiring water rights is the well owner's responsibility and is NOT accomplished by the filing of this report.

Other Options

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View scanned update/correction (11/1/2011 3:30:35 PM)

Site Name: ATLANTIC RICHFIELD BPSOU * AMW-13C
GWIC Id: 255975

Section 1: Well Owner(s)

1) ATLANTIC RICHFIELD (MAIL)
N/A
N/A N/A N/A [No Date]

Section 2: Location

Township	Range	Section	Quarter Sections
03N	08W	24	NW¼ SW¼ NE¼ SE¼

County	Geocode
SILVER BOW	

Latitude	Longitude	Geomethod	Datum
45.993654902	112.533157883	SUR-GPS	NAD83

Ground Surface Altitude	Method	Datum	Date
5452.547			

Addition	Block	Lot

Section 3: Proposed Use of Water

MONITORING (1)

Section 4: Type of Work

Drilling Method: HOLLOWSTEM AUGER
Status: NEW WELL

Section 5: Well Completion Date

Date well completed: Wednesday, May 12, 2010

Section 6: Well Construction Details

Borehole dimensions

From	To	Diameter
0	84	8

Casing

From	To	Diameter	Wall Thickness	Pressure Rating	Joint	Type
-1.6	71.7	2				PVC

Completion (Perf/Screen)

From	To	Diameter	# of Openings	Size of Openings	Description
71.7	81.7	2		0.020 IN	SCREEN-CONTINUOUS-PVC

Annular Space (Seal/Grout/Packer)

From	To	Description	Cont. Fed?
0	2	QUICKRETE	
2	67.8	GROUT WITH BENTONITE	
67.8	84	10-20 COLORADO SILICA SAND	

Section 7: Well Test Data

Total Depth: 84
Static Water Level: 10.42
Water Temperature:

** 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.*

Section 8: Remarks

Section 9: Well Log

Geologic Source

Unassigned

From	To	Description
0	4	TOPSOIL, BLACK, DAMP
4	6	SAND AND SILT, FILL
6	14	GRAVEL, COBBLES, POOR RETURNS, FILL, TRASH, GLASS MINIMAL RETURNS
14	15.5	ORGANIC SILT, WET, SLIGHTLY COHESIVE, BLACK, ODOR
15.5	19	NO RETURNS
19	20	SPT SILT, SANDY, WET, BLACK ML
20	21	SAND, MED, WET, OX, RED SP
21	24	NO RETURNS
24	25.5	SPT SAND, WELL GRADED SW
25.5	26	GRAVEL FRAGMENT AND SAND SP
26	29	NO RETURNS
29	31	SPT SAND, COARSE TO FINE LIGHT BROWN, ? HEAVE SP
31	34	SILTY SAND SLURRY, BLACK SM
34	35.5	SPT SAND, SILTY SP-SM
35.5	36	GRAVEL IN SILTY MATRIX

Driller 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: STEVE MALKOVICH
Company: OKEEFE DRILLING CO
License No: MWC-380
Date Completed: 5/12/2010

Site Name: ATLANTIC RICHFIELD BPSOU
GWIC Id: 255975
Additional Lithology Records

From	To	Description
36	39	NOTE: AUGER CHATTER 34' - 37'BGS GRAVEL OR COBBLES NO RETURNS
39	41	SPT 39'-40'3" ?HEAVE/SLOUGH SAND WITH GRAVEL SP
41	44	AUGER - MINIMAL RETURNS, SOME BLACK SLURRY
44	47	SPT SAMPLES - HEAVE/SLOUGH 45'2"-46', GRAVEL AND SAND GP-SP, GRAVEL, SOME BROKEN SOME SUBROUNDED
47	49	AUGER, 12 GALLONS SLURRY RETURNS
49	51	SPT SAMPLES, HEAVE/SLOUGH 1.5' CLAY, DENSE COHESIVE, BROWN
51	54	AUGER - NO RETURNS
54	57	SPT CLAY, DENSE, COHESIVE BROWN, ORANGE STREAK AT 55' CL-CH
57	59	AUGER 7 GALLONS SLURRY
59	60	SPT CLAY, DENSE, COHESIVE
60	61	SAND, SILTY SP-SM
61	61.5	ROCK FRAGMENT WITH SILT
61.5	64	AUGER 5 GALLONS SLURRY 61'5"-63' GRAVEL - RIG CHATTER
64	66	SPT INTERBEDDED SANDY SILT AND CLAY ML-CL, DENSE BROWN
66	68	SPT SILTY SAND TO SANDY SILT DENSE, BROWN, SLIGHTLY COHESIVE SM-ML
68	69	AUGER 13 GALLONS SLURRY
69	70.5	SPT SILT SANDY, DENSE, RED BROWN ML
70.5	71	CLAY, DENSE, COHESIVE BROWN CL-CH
71	71.5	SAND WITH SOME SILT SP
71.5	72.5	SAND, SILTY SM-ML
72.5	73	CLAY, DENSE, COHESIVE CL-CH
73	74	AUGER
74	75.4	CLAY, SANDY DENSE, COHESIVE CL. AUGER, HARDER DRILLING
75.4	76	SAND, SILTY, MICA HIGHLY OXIDIZED. AUGER, HARDER DRILLING.
76	76.2	SIH2 OXIDATION. AUGER, HARDER DRILLING
76.2	76.5	SILT TO GRAVEL SIZE PARTICLES, CAN CRUSH WITH FINGERS. AUGER, HARDER DRILLING.
76.5	79	AUGER, HARDER DRILLING.
79	80.4	COARSE SAND AND FINE GRAVEL WITH SOME 1/2 INCH SW
80.4	81.6	SAND, SP
81.6	82.4	SILT, SANDY, DENSE, OXIDATION ML
82.4	84	15 GALLONS SLURRY FROM 79-84
84	85.7	SILT DENSE, OXIDIZED ML, ABUNDANT MICA
85.7	87.2	ROCK FRAGMENTS, OXIDIZED MICA AND QUARTZ IN CRYSTALLINE MATRIX BEDROCK 86' BGS

MONTANA WELL LOG REPORT

This well log reports the activities of a licensed Montana well driller, serves as the official record of work done within the borehole and casing, and describes the amount of water encountered. This report is compiled electronically from the contents of the Ground Water Information Center (GWIC) database for this site. Acquiring water rights is the well owner's responsibility and is NOT accomplished by the filing of this report.

Other Options

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Plot this site in Google Maps
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View field visits for this site
View water quality for this site

Site Name: ATLANTIC RICHFIELD * AMC-24B
GWIC Id: 240858

Section 1: Well Owner(s)

1) ATLANTIC RICHFIELD (MAIL)
317 ANACONDA RD
BUTTE MT 59701 [12/04/2007]

Section 2: Location

Township	Range	Section	Quarter Sections
03N	08W	24	NE¼ SE¼

County	Geocode
SILVER BOW	

Latitude	Longitude	Geomethod	Datum
45.994440078	112.529674107	SUR-GPS	NAD83

Ground Surface Altitude	Method	Datum	Date

Addition	Block	Lot

Section 3: Proposed Use of Water

MONITORING (1)

Section 4: Type of Work

Drilling Method: ROTARY
Status: NEW WELL

Section 5: Well Completion Date

Date well completed: Tuesday, December 04, 2007

Section 6: Well Construction Details

Borehole dimensions

From	To	Diameter
0	50.5	7

Casing

From	To	Diameter	Wall Thickness	Pressure Rating	Joint	Type
0	39	2	0.154		FLUSH THREAD	PVC

Completion (Perf/Screen)

From	To	Diameter	# of Openings	Size of Openings	Description
39	49	2		0.020 IN	SCREEN-CONTINUOUS-PVC

Annular Space (Seal/Grout/Packer)

From	To	Description	Cont. Fed?
0	37	BENTONITE	
37	50.5	SILICA SAND	

Section 7: Well Test Data

Total Depth: 50.5
Static Water Level: 8.9
Water Temperature:

** 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.*

Section 8: Remarks

Section 9: Well Log

Geologic Source

111SNGR - SAND AND GRAVEL (HOLOCENE)

From	To	Description
0	1.5	BROWN LOAMY SAND
1.5	4	CONCRETE, BRICK RUBBLE
4	28	BROWN FINE SAND
28	50.5	COARSE SAND AND GRAVEL, OXIDIZED WET

Driller 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:	CLAY PARSONS
Company:	PARSONS DRILLING
License No:	MWC-362
Date Completed:	12/4/2007

MONTANA WELL LOG REPORT

This well log reports the activities of a licensed Montana well driller, serves as the official record of work done within the borehole and casing, and describes the amount of water encountered. This report is compiled electronically from the contents of the Ground Water Information Center (GWIC) database for this site. Acquiring water rights is the well owner's responsibility and is NOT accomplished by the filing of this report.

Other Options

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Plot this site in Google Maps
View hydrograph for this site
View field visits for this site
View water quality for this site

Site Name: ATLANTIC RICHFIELD * BPS07-08A
GWIC Id: 240866

Section 1: Well Owner(s)

1) ATLANTIC RICHFIELD (MAIL)
317 ANACONDA RD
BUTTE MT 59701 [01/07/2008]

Section 2: Location

Township	Range	Section	Quarter Sections
03N	08W	24	SE¼ NW¼

County	Geocode
SILVER BOW	

Latitude	Longitude	Geomethod	Datum
45.996943507	112.540476327	SUR-GPS	NAD83

Ground Surface Altitude	Method	Datum	Date
5446.16	SUR-GPS	NGVD29	2/11/2008

Addition	Block	Lot

Section 3: Proposed Use of Water

MONITORING (1)

Section 4: Type of Work

Drilling Method: ROTARY
Status: NEW WELL

Section 5: Well Completion Date

Date well completed: Monday, January 07, 2008

Section 6: Well Construction Details

Borehole dimensions

From	To	Diameter
0	20	7

Casing

From	To	Diameter	Wall Thickness	Pressure Rating	Joint	Type
0	7.5	2	0.154		FLUSH THREAD	PVC

Completion (Perf/Screen)

From	To	Diameter	# of Openings	Size of Openings	Description
7.5	17	2		.020	SCREEN-CONTINUOUS-PVC

Annular Space (Seal/Grout/Packer)

From	To	Description	Cont. Fed?
0	7.5	BENTOINTE	
7.5	20	SILICA SAND	

Section 7: Well Test Data

Total Depth: 20
Static Water Level: 10
Water Temperature:

** 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.*

Section 8: Remarks

Section 9: Well Log

Geologic Source

110SNGR - SAND AND GRAVEL (QUATERNARY)

From	To	Description
0	6.5	FILL, SAND, COBBLES ASPHALT,CONCRETE
6.5	15	COARSE SAND AND FINE GRAVEL,MOIST
15	20	NO RETURNS

Driller 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: CLAY PARSONS
Company: PARSONS DRILLING
License No: MWC-362
Date Completed: 1/7/2008

MONTANA WELL LOG REPORT

This well log reports the activities of a licensed Montana well driller, serves as the official record of work done within the borehole and casing, and describes the amount of water encountered. This report is compiled electronically from the contents of the Ground Water Information Center (GWIC) database for this site. Acquiring water rights is the well owner's responsibility and is NOT accomplished by the filing of this report.

Other Options

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Plot this site in State Library Digital Atlas
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Site Name: ATLANTIC RICHFIELD * BPS07-14A
GWIC Id: 248555

Section 1: Well Owner(s)

1) ATLANTIC RICHFIELD (MAIL)
317 ANACONDA RD
BUTTE MT 59701 [06/11/2008]

Section 2: Location

Township	Range	Section	Quarter Sections
03N	08W	24	NE¼ NE¼

County	Geocode
SILVER BOW	

Latitude	Longitude	Geomethod	Datum
45.996523731	112.542975733	SUR-GPS	NAD83

Ground Surface Altitude	Method	Datum	Date

Addition	Block	Lot

Section 3: Proposed Use of Water

MONITORING (1)

Section 4: Type of Work

Drilling Method: ROTARY
Status: NEW WELL

Section 5: Well Completion Date

Date well completed: Wednesday, June 11, 2008

Section 6: Well Construction Details

Borehole dimensions

From	To	Diameter
0	31.5	7

Casing

From	To	Diameter	Wall Thickness	Pressure Rating	Joint	Type
2	16	2	0.154		FLUSH THREAD	PVC-SDR 17

Completion (Perf/Screen)

From	To	Diameter	# of Openings	Size of Openings	Description
16	26	2		.020	SCREEN-CONTINUOUS-PVC

Annular Space (Seal/Grout/Packer)

From	To	Description	Cont. Fed?
2	14	BENTONITE	
14	26	SILICA SAND	

Section 7: Well Test Data

Total Depth: 26
Static Water Level: 17.5
Water Temperature:

Air Test *

5 gpm with drill stem set at 26 feet for _ hours.
Time of recovery _ hours.
Recovery water level _ feet.
Pumping water level _ feet.

** 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.*

Section 8: Remarks

Section 9: Well Log

Geologic Source

Unassigned

From	To	Description
0	15	SLAG, BLACK TO DARK BROWN
15	20	SLAG BLACK
20	25	SLAG
25	31.5	MIXED SLAG AND SAND

Driller 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: CLAY PARSONS
Company: PARSONS DRILLING
License No: MWC-362
Date Completed: 6/11/2008

MONTANA WELL LOG REPORT

This well log reports the activities of a licensed Montana well driller, serves as the official record of work done within the borehole and casing, and describes the amount of water encountered. This report is compiled electronically from the contents of the Ground Water Information Center (GWIC) database for this site. Acquiring water rights is the well owner's responsibility and is NOT accomplished by the filing of this report.

Other Options

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Site Name: ATLANTIC RICHFIELD * BPS07-15A
GWIC Id: 248557

Section 1: Well Owner(s)

1) ATLANTIC RICHFIELD (MAIL)
317 ANACONDA RD
BUTTE MT 59701 [06/13/2008]

Section 2: Location

Township	Range	Section	Quarter Sections
03N	08W	24	NE¼ SW¼

County	Geocode
SILVER BOW	

Latitude	Longitude	Geomethod	Datum
45.996255074	112.541749813	SUR-GPS	NAD83

Ground Surface Altitude	Method	Datum	Date
5455.07	SUR-GPS	NGVD29	

Addition	Block	Lot

Section 3: Proposed Use of Water

MONITORING (1)

Section 4: Type of Work

Drilling Method: ROTARY
Status: NEW WELL

Section 5: Well Completion Date

Date well completed: Friday, June 13, 2008

Section 6: Well Construction Details

Borehole dimensions

From	To	Diameter
0	36	7

Casing

From	To	Diameter	Wall Thickness	Pressure Rating	Joint	Type
-2	15	2	0.154		FLUSH THREAD	PVC-SDR 17

Completion (Perf/Screen)

From	To	Diameter	# of Openings	Size of Openings	Description
15	35	2		020	SCREEN-CONTINUOUS-PVC

Annular Space (Seal/Grout/Packer)

From	To	Description	Cont. Fed?
2	12	BENTONITE	
12	35	SIICA SAND	

Section 7: Well Test Data

Total Depth: 36
Static Water Level: 16
Water Temperature:

Air Test *

_5_ gpm with drill stem set at _36_ feet for _ hours.
Time of recovery _ hours.
Recovery water level _ feet.
Pumping water level _ feet.

** 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.*

Section 8: Remarks

Section 9: Well Log

Geologic Source

111FILL - HOLOCENE MAN-DEPOSITED FILL MATERIALS

From	To	Description
0	10	NO RETURN
10	12	BLACK SLAG
12	15	DARK GRAY SLAG
15	20	DARK GRAY SLAG
20	30	NO RETURNS
30	34	GRAVELS
34	35	CLAYS

Driller 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:	CLAY PARSONS
Company:	PARSONS DRILLING
License No:	MWC-362
Date Completed:	6/13/2008

MONTANA WELL LOG REPORT

This well log reports the activities of a licensed Montana well driller, serves as the official record of work done within the borehole and casing, and describes the amount of water encountered. This report is compiled electronically from the contents of the Ground Water Information Center (GWIC) database for this site. Acquiring water rights is the well owner's responsibility and is NOT accomplished by the filing of this report.

Other Options

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View field visits for this site
View water quality for this site

Site Name: ATLANTIC RICHFIELD * BPS07-21B
GWIC Id: 253710

Section 1: Well Owner(s)

1) ATLANTIC RICHFIELD (MAIL)
307 ANACONDA RD
BUUTE MT 59701 [12/18/2009]

Section 2: Location

Township	Range	Section	Quarter Sections
03N	08W	24	NW¼ SE¼

County	Geocode
SILVER BOW	

Latitude	Longitude	Geomethod	Datum
45.994844226	112.533986415	SUR-GPS	NAD83

Ground Surface Altitude	Method	Datum	Date

Addition	Block	Lot

Section 3: Proposed Use of Water

MONITORING (1)

Section 4: Type of Work

Drilling Method: ROTARY
Status: NEW WELL

Section 5: Well Completion Date

Date well completed: Friday, December 18, 2009

Section 6: Well Construction Details

Borehole dimensions

From	To	Diameter
0	47	7

Casing

From	To	Diameter	Wall Thickness	Pressure Rating	Joint	Type
0	33	6	0.25		WELDED	A53B STEEL
0	35.5	0.8			FLUSH THREAD	PVC-SCHED 120

Completion (Perf/Screen)

From	To	Diameter	# of Openings	Size of Openings	Description
35.5	45.5	2		0.020 IN	SCREEN-CONTINUOUS-PVC

Annular Space (Seal/Grout/Packer)

From	To	Description	Cont. Fed?
0	33	BENTONITE	
33	47	SILICA SAND	

Section 7: Well Test Data

Total Depth: 47
Static Water Level:
Water Temperature:

** 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.*

Section 8: Remarks

33 FT CASING LEFT IN THE GROUND BENTONITE CHIPS TO SURFACE AND OUTER ANNULAS OF CASING FLUSH MOUNT CEMENTED IN

Section 9: Well Log

Geologic Source

Unassigned

From	To	Description
0	2	FILL LTERED QTZ MONZONITE TO 3
2	7	FILL SAND AND GRAVEL,METAL,GLASS
7	10	FILL,FINEGRAINED,LOOSE SOIL,BLACK,MOIST,MINOR PAPER DEBRIS
10	15	ROCK FRAGMENTS,ANGULAR WITH SAND AND SILT,WET,BLACK SM WITH GRAVEL
15	20	SILT AND SAND,WET BLACK ML
20	25	SILT AND SAND,WET BLACK ML
25	30	SILT AND SAND,WET BLACK SM-ML
30	35	SILT,COHESIVE,WET BROWN ML-MH
35	40	GRAVEL,SUB ROUNDED TO SUBGRANULAR,WET,BROWN SP
40	45	SAND,FINE GRAINED WET,BROWN GP
45	47	SAND WITH SOME SILT SP-ML

Driller 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: CLAY PARSONS
Company: PARSONS DRILLING
License No: MWC-362
Date Completed: 12/18/2009

03N 08W 24 BD

PIONEER TECHNICAL SERVICES, INC.
BUTTE, MONTANA

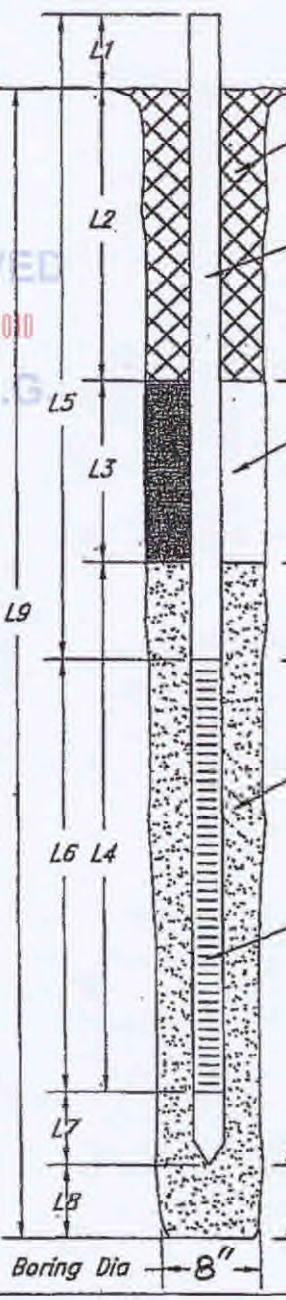
SOIL BORING LOG & WELL CONSTRUCTION DETAILS

Project: BPSOU Groundwater Deep Wells Soil Boring/Well Number: BPS07-21C
Location: 651095.71 N ; 1197903.98E Date: 8/3/10 - 8/4/10 Time Start/Finish: 0925/1130
Driller: Steve Malkovich Drilling Company: O'Keefe Drilling
Drilling Method: Hollow Stem Auger with Split Spoon Sampler

Depth to Water: ______ Logged By: Will Goldberg (PTS)

Depth	Soil Boring Log	PID READING (PPM)
0	Water Knife to 6' bgs Sand, gravel, wood and assorted debris	
5		
6	no auger returns	
9	SPT 2-1-2 0.1' recovery grass, sand, glass	
10	no auger returns	
14	SPT 7-13-9, 1.3' recovery Peat, dark gray to black interbedded sand & silty sand	
15	no auger returns	
19	SPT 4-4-5 Clay, cohesive wet, roots, trace mica CH-OH	
20	no auger returns	
24	SPT 5-10-17 0.9' recovery Sand, medium, minor ox, SP	
25	no auger returns	
29	3" split spoon; sand, fine to medium, trace gravel, wet, SW	
30	sand, silty, dense, ox, red brn, SP	
	2" SPT Sand, med to coarse, some sub angular to sub rounded gravel, SP pH 6.6, SC 484	
33	no auger returns	
	SPT Sand, silty, SM	

Well Type: ______



L1= -0.33
L2= 4.5
L3= 58.0
L4= 17.5
L5= 65.0
L6= 15.0
L7= 0.5
L8= 6.5
L9= 87.0

Ground elev.= 5457.01
TOC elev.= 5456.68
Backfill/Grout Type: Bentonite chips with concrete at surface
Casing Type/Size/Dia.: PVC/blank/2 inch
Seal elev.= 5452.51
Seal Type: Bentonite Grout
Filter Pack elev.= 5394.51
Top of Screen elev.= 5392.01
Filter Pack Type/Size: 10-20 Colorado Silica Sand
Screen Type/Size/Dia: PVC/20 slot/2 inch
Bottom of Well elev.= 5376.51
Bottom of Boring elev.= 5370.01

Remarks: Driller 1st reported water at 14'
Note: Flush Mount Casing; PVC 0.33' below top flush mount cover

Signature: ______

M: 257404

PIONEER TECHNICAL SERVICES, INC.

SOIL BORING LOG & WELL CONSTRUCTION DETAILS

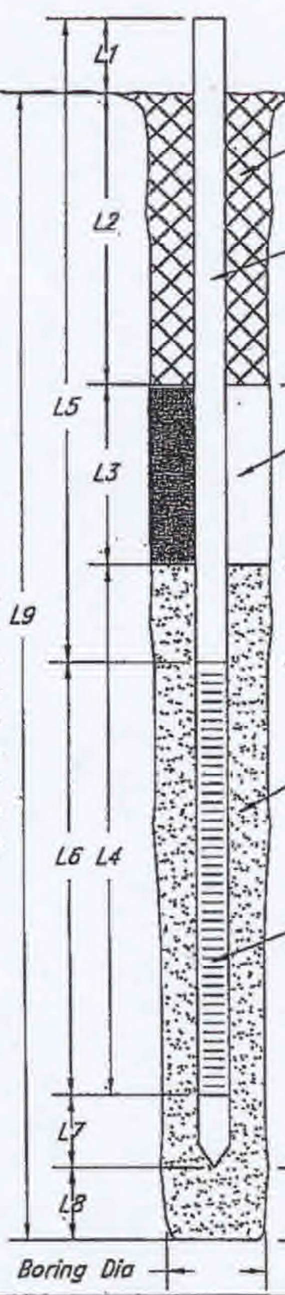
Project: BPSOU Groundwater Deep Wells Soil Boring/Well Number: BPS07-21C
Location: ______ Date: ______ Time Start/Finish: ______
Driller: Steve Malkovich Drilling Company: O'Keefe Drilling
Drilling Method: Hollow Stem Auger with Split Spoon Sampler

Depth to Water: ______ Logged By: Will Goldberg (PTS)

Soil Boring Log | PID READING (PPM)

Depth	Soil Boring Log
	pH 6.67, SC 422
35–38	Sand, med grain with sub angular to subrounded gravel to 3/4" Interbeds of magnetite SP
38	no auger returns
40–40.4	Medium subrounded gravel in silty sand matrix, very dense. Cohesive fine fraction pH 6.54 SC 384
	no auger returns
44–47	Sand, silty, dense, brown some mica, trace fine gravel, to 1/2" size, SM
47	no auger returns pH 6.31, SC 438
49–51	Silt, sandy, cohesive, dense light brown
51	Sand, silty, w angular gravel very loose, wet, brown, SM
52.3	Sand, silty, dense to v dense SM
53	No auger returns
54–58	Sand, silty, dense, with 1 2" gravel SM probable some sample is caved/heave pH 6.73 SC 772
58	No auger returns
59–61	Interbedded gray silt and oxidized fine sand, dense SM – ML
61	No auger returns
64	Sand, medium, some silt SP
65.2	sand, silty with gravel SM-SP medium to fine gravel, GP Fine to medium sand SW
67.7	Sand, silty with gravel SM pH 6.79. SC 800
	Sand, fine to med. with trace

Well Type: ______



L1= ______
L2= ______
L3= ______
L4= ______
L5= ______
L6= ______
L7= ______
L8= ______
L9= ______

Ground elev.= ______
TOC elev.= ______
Backfill/Grout Type ______
Casing Type/Size/Dia. ______
Seal elev.= ______
Seal Type ______
Filter Pack elev.= ______
Top of Screen elev.= ______
Filter Pack Type/Size ______
Screen Type/Size/Dia ______
Bottom of Well elev.= ______
Bottom of Boring elev.= ______

Remarks: ______

Signature: ______

45.99484028?
112.533966792
03N 08W 24

PIONEER TECHNICAL SERVICES, INC.
BUTTE, MONTANA

SOIL BORING LOG & WELL CONSTRUCTION DETAILS

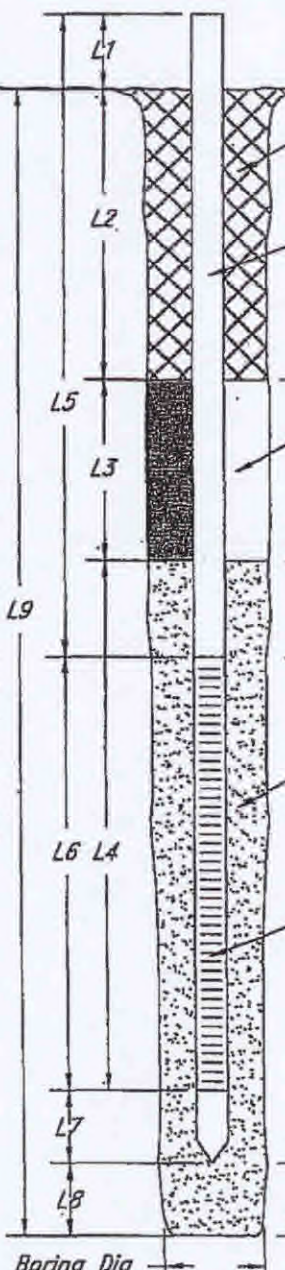
Project: BPSOU Groundwater Deep Wells Soil Boring/Well Number: BPS07-21C
Location: ______ Date: ______ Time Start/Finish: ______
Driller: Steve Malkovich Drilling Company: O'Keefe Drilling
Drilling Method: Hollow Stem Auger with Split Spoon Sampler

Depth to Water: ______ Logged By: Will Goldberg (PTS)

Soil Boring Log

Depth	Soil Boring Log	PID READING (PPM)
70–71	medium to coarse sub. angular gravel, trace silt	
71–72	Sand, fine to med, dense SP	
72–74	Driller reports harder drilling at 73' bgs	
74–75	Sand, medium, light brown SP	
75	Sand, fine to med., OX, mica red brown SW	
76.5	Sand, fine to med, with angular to subrounded gravel PH 6.87 SC 731	
	No Auger Returns	
79–80	Sand, medium, black OX, SP	
80–81	silt, dense, cohesive, ML-MH	
81	Large quartz fragment	
83	Sand, fine-medium ? cave, SW pH 6.90 SC 740	
85–86	Sand, silty, brown SM	
86–88	Sand, silty, SM-ML ? cave	
88–89	Some slurry at collar	
89–91	Silt, with some zones of sandy silt, cohesive, med. dense ML-MH	
91	cave 1.5 ft; Large fine grained qtz fragment (? aplite); Sand at bottom sampler	

Well Type: ______



L1= ______
L2= ______
L3= ______
L4= ______
L5= ______
L6= ______
L7= ______
L8= ______
L9= ______

Ground elev.= ______
TOC elev.= ______
Backfill/Grout Type ______
Casing Type/Size/Dia. ______
Seal elev.= ______
Seal Type ______
Filter Pack elev.= ______
Top of Screen elev.= ______
Filter Pack Type/Size ______
Screen Type/Size/Dia ______
Bottom of Well elev.= ______
Bottom of Boring elev.= ______

Remarks: Drilling finished 8/3 & well constructed 8/4. TD on 8/4 97' bgs

Signature: Will Goldberg

Buckley, Luke

From: Smith, Garrett
Sent: Tuesday, August 24, 2010 3:51 PM
To: Buckley, Luke
Cc: Tucci, Nicholas
Subject: New Well Logs
Attachments: BPS New Well Logs.pdf

Hi Luke-
I have some new well logs that need to be entered into GWIC (see attached pdf).
I have included the GWIC numbers below, as well as the total depth, screen interval, and the elevations are converted to NGVD29 (since they're NAVD88 on the logs).
Thanks

Garrett

		NGVD29			
Well Name	*GWIC ID*	*TOC Elev*	*Ground Elev*	*TD (ft)*	*Screen Int. (ft)*
AMC-24C	**255974**	**5450.417**	**5448.47**	**83.5**	**69-79**
AMW-13C	**255975**	**5449.958**	**5448.338**	**84**	**60-70**
BPS07-21C	**257404**	**5452.471**	**5452.801**	**87**	**65-80**
BPS07-24	**257403**	**5451.721**	**5450.331**	**71**	**58-68**

MONTANA WELL LOG REPORT

This well log reports the activities of a licensed Montana well driller, serves as the official record of work done within the borehole and casing, and describes the amount of water encountered. This report is compiled electronically from the contents of the Ground Water Information Center (GWIC) database for this site. Acquiring water rights is the well owner's responsibility and is NOT accomplished by the filing of this report.

Other Options

Return to menu
Plot this site in State Library Digital Atlas
Plot this site in Google Maps
View hydrograph for this site
View field visits for this site
View water quality for this site
View scanned well log (11/1/2011 3:35:44 PM)

Site Name: ARCO * AMW-11
GWIC Id: 161962

Section 1: Well Owner(s)

1) ARCO (MAIL)
N/A
BUTTE MT 59701 [09/14/1993]

Section 2: Location

Township	Range	Section	Quarter Sections
03N	08W	24	SE¼ SE¼ NW¼ SE¼

County	Geocode
SILVER BOW	

Latitude	Longitude	Geomethod	Datum
45.994037881	112.53512929	SUR-GPS	NAD83

Ground Surface Altitude	Method	Datum	Date
5449.81	SUR-GPS		3/9/2005

Measuring Point Altitude	Method	Datum	Date Applies
5445.14			7/30/2004

Addition	Block	Lot

Section 3: Proposed Use of Water

MONITORING (1)

Section 4: Type of Work

Drilling Method: HOLLOW STEM AUGER
Status: NEW WELL

Section 5: Well Completion Date

Date well completed: Tuesday, September 14, 1993

Section 6: Well Construction Details

Borehole dimensions

From	To	Diameter
0	15.5	2

Casing

From	To	Diameter	Wall Thickness	Pressure Rating	Joint	Type
-2	14	2				PVC

Completion (Perf/Screen)

From	To	Diameter	# of Openings	Size of Openings	Description
4	14	2		0.010 IN	SCREEN-CONTINUOUS-PVC

Annular Space (Seal/Grout/Packer)

From	To	Description	Cont. Fed?
0	3	BENTONITE	
3	3.5	100 MESH SILICA SAND	
3.5	15.5	16/30 COLORADO SILICA SAND	

Section 7: Well Test Data

Total Depth: 14
Static Water Level: 5.54
Water Temperature:

** 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.*

Section 8: Remarks

Section 9: Well Log

Geologic Source

111SNGR - SAND AND GRAVEL (HOLOCENE)

From	To	Description
0	1.2	SANDY SILT - DARK BROWN (10YR 4/3) 75% NONPLASTIC FINES 25% FINE TO COARSE ANGULAR SAND SOFT SLIGHTLY MOIST TO MOIST FILL
1.2	1.8	SILTY CLAY - GRAYISH BROWN (10YR 5/2) 100% MODERATELY PLASTIC FINES SOFT MOIST TO WET MODERATELY OXIDIZED - FILL
1.8	2	NO RECOVERY
2	4	NO RECOVERY - OUTSIDE OF SPOON APPEARS TO BE SMEARED WITH CLAY
4	4.8	SANDY SILT - DARK BROWN (10YR 4/3) 75% NONPLASTIC FINES 25% FINE TO COARSE ANGULAR SAND SOFT MOIST TO WET - FILL?
4.8	5.9	CLAY - VERY DARK GRAY (10YR 3/1) 95% MODERATELY PLASTIC CLAY 5% FINE SAND ABUNDANT ORGANICS ALLUVIUM?
5.9	6	SILT - GRAY (10YR 5/1) 95% NONPLASTIC FINES 5% FINE ANGULAR SAND SOFT WET ABUNDANT ORGANICS ALLUVIUM OR FILL?
6	6.8	SAND - REDDISH BROWN 10% FINES 30% MEDIUM SUBANGULAR SAND 30% COARSE SUBANGULAR SAND WELL GRADED POORLY SORTED LOOSE WET FILL?
6.8	7.5	SILT AND SLAG - DARK GRAY (10YR 4/1) 50% NONPLASTIC FINES 50% BROKEN SLAG FILL
7.5	8	NO RECOVERY
8	9	SILTY SAND - DARK GRAY (10YR 4/1) WITH REDDISH MOTTLING 25% FINES 40% FINE SUBANGULAR SAND 15% MEDIUM SUBROUND SAND 20% COARSE SUBROUND SAND WELL GRADED POORLY SORTED LOOSE WET - ALLUVIUM?
9	12	NO RECOVERY
12	12.3	SILTY SAND - DARK GRAYISH BROWN (10YR 5/2) 20% FINES 60% FINE ANGULAR SAND 10% MEDIUM SUBANGULAR SAND 10% COARSE SUBROUND SAND POORLY SORTED

		MODERATELY TO POORLY GRADED LOOSE WET - ALLUVIUM
12.3	14	NO RECOVERY

Driller 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:	
Company:	OKEEFE DRILLING CO
License No:	-
Date Completed:	9/14/1993

MONTANA WELL LOG REPORT

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Other Options

Return to menu
Plot this site in State Library Digital Atlas
Plot this site in Google Maps
View hydrograph for this site
View field visits for this site
View water quality for this site

Site Name: ATLANTIC RICHFIELD * BPS07-16A
GWIC Id: 248566

Section 1: Well Owner(s)

1) ATLANTIC RICHFIELD (MAIL)
317 ANACONDA RD
BUTTE MT 59701 [06/17/2008]

Section 2: Location

Township	Range	Section	Quarter Sections
03N	07W	19	SW¼ SW¼

County	Geocode
SILVER BOW	

Latitude	Longitude	Geomethod	Datum
45.992065694	112.525227866	SUR-GPS	NAD83

Ground Surface Altitude	Method	Datum	Date

Addition	Block	Lot

Section 3: Proposed Use of Water

MONITORING (1)

Section 4: Type of Work

Drilling Method: ROTARY
Status: NEW WELL

Section 5: Well Completion Date

Date well completed: Thursday, June 19, 2008

Section 6: Well Construction Details

Borehole dimensions

From	To	Diameter
0	24	7

Casing

From	To	Diameter	Wall Thickness	Pressure Rating	Joint	Type
-2	10	2	0.154		FLUSH THREAD	PVC-SDR 17

Completion (Perf/Screen)

From	To	Diameter	# of Openings	Size of Openings	Description
10	20	2		0.020 IN	SCREEN-CONTINUOUS-STAINLESS

Annular Space (Seal/Grout/Packer)

From	To	Description	Cont. Fed?
0	8	BENTOINTE	
8	20	SILICA SAND	

Section 7: Well Test Data

Total Depth: 20
Static Water Level: 7.5
Water Temperature:

Air Test *

_2_ gpm with drill stem set at _20_ feet for _ hours.
Time of recovery _ hours.
Recovery water level _ feet.
Pumping water level _ feet.

** 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.*

Section 8: Remarks

Section 9: Well Log

Geologic Source

Unassigned

From	To	Description
0	7	NO RETURNS
7	10	FINE SAND
10	20	COARSE SAND

Driller 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: CLAY PARSONS
Company: PARSONS DRILLING
License No: MWC-362
Date Completed: 6/19/2008

MONTANA WELL LOG REPORT

This well log reports the activities of a licensed Montana well driller, serves as the official record of work done within the borehole and casing, and describes the amount of water encountered. This report is compiled electronically from the contents of the Ground Water Information Center (GWIC) database for this site. Acquiring water rights is the well owner's responsibility and is NOT accomplished by the filing of this report.

Other Options

Return to menu
Plot this site in State Library Digital Atlas
Plot this site in Google Maps
View hydrograph for this site
View field visits for this site
View water quality for this site

Site Name: ATLANTIC RICHFIELD * BPS07-16B
GWIC Id: 248565

Section 1: Well Owner(s)

1) ATLANTIC RICHFIELD (MAIL)
317 ANACONDA RD
BUTTE MT 59701 [06/16/2008]

Section 2: Location

Township	Range	Section	Quarter Sections
03N	07W	19	SW¼ SW¼

County	Geocode
SILVER BOW	

Latitude	Longitude	Geomethod	Datum
45.992109077	112.525228459	SUR-GPS	NAD83

Ground Surface Altitude	Method	Datum	Date

Addition	Block	Lot

Section 3: Proposed Use of Water

MONITORING (1)

Section 4: Type of Work

Drilling Method: ROTARY
Status: NEW WELL

Section 5: Well Completion Date

Date well completed: Monday, June 16, 2008

Section 6: Well Construction Details

Borehole dimensions

From	To	Diameter
0	40	7

Casing

From	To	Diameter	Wall Thickness	Pressure Rating	Joint	Type
-2	30	2	0.154		FLUSH THREAD	PVC-SDR 17

Completion (Perf/Screen)

From	To	Diameter	# of Openings	Size of Openings	Description
30	40	2		0.020 IN	SCREEN-CONTINUOUS-PVC

Annular Space (Seal/Grout/Packer)

From	To	Description	Cont. Fed?
-2	28	BRNTONITE	
28	40	SILICA SAND	

Section 7: Well Test Data

Total Depth: 40
Static Water Level: 7.15
Water Temperature:

Air Test *

5 gpm with drill stem set at 40 feet for _ hours.
Time of recovery _ hours.
Recovery water level _ feet.
Pumping water level _ feet.

** 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.*

Section 8: Remarks

Section 9: Well Log

Geologic Source

Unassigned

From	To	Description
0	10	NO RETURN
10	15	COARSE AND FINE SAND
15	20	FINE GRAVEL AND SAND
20	30	FINE GRAVEL AND SAND
30	35	SANDY SILT
35	40	FINE GRAVEL AND FINE SAND

Driller 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: CLAY PARSONS
Company: PARSONS DRILLING
License No: MWC-362
Date Completed: 6/16/2008

MONTANA WELL LOG REPORT

This well log reports the activities of a licensed Montana well driller, serves as the official record of work done within the borehole and casing, and describes the amount of water encountered. This report is compiled electronically from the contents of the Ground Water Information Center (GWIC) database for this site. Acquiring water rights is the well owner's responsibility and is NOT accomplished by the filing of this report.

Other Options

Return to menu
Plot this site in State Library Digital Atlas
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View hydrograph for this site
View field visits for this site
View water quality for this site
View scanned well log (8/27/2010 1:18:35 PM)

Site Name: BUTTE PRIORITY SOILS * BPS07-24
GWIC Id: 257403

Section 1: Well Owner(s)

1) BUTTE PRIORITY SOILS OPERABLE UNIT (MAIL)
N/A
BUTTE MT N/A [No Date]

Section 2: Location

Township	Range	Section	Quarter Sections
03N	07W	19	

County	Geocode
SILVER BOW	

Latitude	Longitude	Geomethod	Datum
45.995811629	112.526570706	SUR-GPS	NAD83

Ground Surface Altitude	Method	Datum	Date
5454.54			

Addition	Block	Lot

Section 3: Proposed Use of Water

MONITORING (1)

Section 4: Type of Work

Drilling Method: HOLLOW STEM AUGER WITH SPLIT SPOON SAMPLER
Status: NEW WELL

Section 5: Well Completion Date

Date well completed: Thursday, August 05, 2010

Section 6: Well Construction Details

Borehole dimensions

From	To	Diameter
0	71	8

Casing

From	To	Diameter	Wall Thickness	Pressure Rating	Joint	Type
-1.4	59.4	2				PVC

Completion (Perf/Screen)

From	To	Diameter	# of Openings	Size of Openings	Description
59.4	69.4	2		20	SCREEN-CONTINUOUS-PVC

Annular Space (Seal/Grout/Packer)

From	To	Description	Cont. Fed?
0	2	CONCRETE	N
2	54.7	BENTONITE GROUT	N
54.7	71	COLORADO SILICA SAND / 10-20	N

Section 7: Well Test Data

Total Depth: 71
Static Water Level: 6
Water Temperature:

** 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.*

Section 8: Remarks

Section 9: Well Log

Geologic Source

Unassigned

From	To	Description
0	8.5	WATER KNIFE - FILL SOIL, ROCK, CONCRETE, WOOD, ASSORTED DEBRIS. PH 6.16, SC 2024, WL 6' BGS
8.5	10.5	ORGANIC CLAY, COHESIVE, WET BLACK SANDY CLAY, COHESIVE GREEN ABUNDANT MICA
10.5	13.5	NO AUGER RETURNS
13.5	15	SAND, SILTY, WET, BLACK SIN SAND WITH SILT, SP-SM LIGHT BROWN
15	18.5	PH 6.8, SC 916. NO AUGER RETURNS
18.5	20.5	CLAY WITH SOME SAND, COHESIVE BLACK CH-, 0.1 FOOT SILTY SAND, HIGHLY OXIDIZED, NO PYRITE, MICA, RED BROWN
20.5	23.5	PH 6.41, SC 847, NO AUGER RETURNS
23.5	24.5	SPT 1.4' RECOVERY, VERY LOOSE SAND - PROBABLE HEAVE 0.1' SILTY SAND IN SITU RECOVERED
24.5	28.5	NO AUGER RETURNS
28.5	29	SPT REFUSAL AT 30.2', 1.5' RECOVERY. SAND WITH BROKEN GRAVEL, SP
29	33.5	PH 6.47, SC 960.6. NO AUGER RETURNS
33.5	33.8	SPT SAMPLE 24" RECOVERY 1.7' HEAVE SAND SW, MED-COARSE GRAVEL, BROKEN INTACT WELL-ROUNDED, GP. PH 6.3, SC 1634
33.8	38.3	NO AUGER RETURNS
38.3	39	SAND, SILTY, OXIDIZED SM
39	39	CLAY, DENSE, COHESIVE, GRAY CH-CL

Driller 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: STEVE MALKOVICH
Company: OKEEFE DRILLING CO
License No: MWC-380
Date Completed: 8/5/2010

Site Name: BUTTE PRIORITY SOILS
GWIC Id: 257403
Additional Lithology Records

From	To	Description
39	40	BROKEN LARGE GRAVEL
40	43.5	PH 6.38, SC 1619 NO AUGER RETURNS
43.5	44	SPT SAMPLE 0.4' HEAVE SAND, ANGULAR, STRONG, OXIDATION, RED BROWN
44	44.5	SILT, SANDY, DENSE, NON-COHESIVE, ML
44.5	48.5	PH 6.26, SC 1850, NO AUGER RETURNS
48.5	50	LARGE SPT SAMPLE 0.8' CAVE, 1.2' NATIVE SOIL SILT WITH SAND, COHESIVE
50	53.5	PH 6.36, SC 1719, NO AUGER RETURNS
53.5	56.5	LARGE SPT AND SMALL SPT. SILT, SANDY, DENSE, COHESIVE, DRY IN CENTER, BROKEN, ML
56.5	58.5	PH 6.36, SC 1650, NO AUGER RETURNS
58.5	59.5	FINE SAND, SOME SILT, LOOSE SP
59.5	60.5	SAND, SOME SILT, TRACE GRAVEL, DENSE, LIGHT BROWN, SW
60.5	61.5	FINE SAND TO SILTY SAND, DENSE NON-COHESIVE, ML - SM
61.5	63.5	@58.5, PH 6.37, SC 2025, NO AUGER RETURNS
63.5	64	SAND, SILTY, MED DENSE, SM
64	64.5	SAND WITH GRAVEL, SOME SILT, VERY DENSE SP
64.5	65.6	SAND, SILTY TO SILT, SANDY DENSE, COHESIVE BROWN
65.6	68.5	PH 6.5, SC 1845 @65.6' NO AUGER RETURNS
68.5	69.6	FINE SAND WITH SILT, SM
69.6	70.5	SILT AND FINE SAND, SLIGHTLY COHESIVE, MED DENSE ABUNDANT MICA, ML
70.5	71	PH 6.44, SC 2006 @68.5' BGS. SAND, SILTY, DENSE, TRACE FINE GRAVEL, SUB ROUNDED SM-SP
71	73.5	NO AUGER RETURNS

03N 08W 24 BDC

PIONEER TECHNICAL SERVICES, INC.

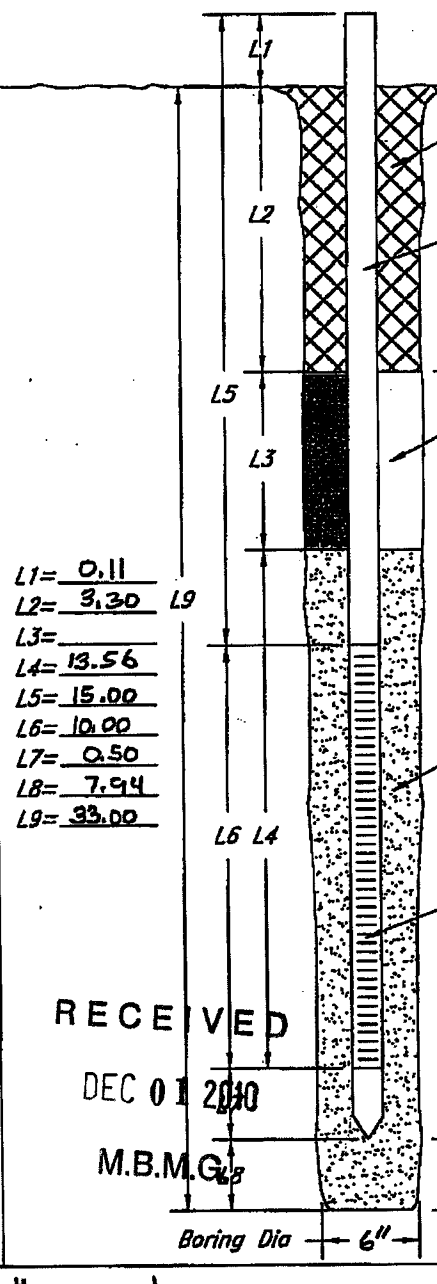
SOIL BORING LOG & WELL CONSTRUCTION DETAILS

Project: Butte Reduction Works Well Soil Boring/Well Number: BPS07-25
Location: 742781.6N, 1227090E NAD27 Date: 10/9/10 Time Start/Finish: 1000/1430
Driller: Clay Parsons Drilling Company: Parsons Drilling Inc
Drilling Method: Air Rotary with casing hammer
JEFFERSON Co.
Depth to Water: 9.3' bgs Logged By: Will Goldberg

Soil Boring Log

Depth (ft)	Soil Boring Log	PID Reading (PPM)
0–2	Fill, brown sandy loam	
2–15	Mill tailings, soft gray, wet SM-ML	
	More cohesive at depth ML	
15–26	Coase sand and fine to medium gravel, subangular to subrounded, wet SP-GP	
26–30	Fine sand, abundant mica, wet;	
30–33	possible bedrock hard to advance casing	

Well Type: Monitor Well AF



L1= 0.11
L2= 3.30
L3=
L4= 13.56
L5= 15.00
L6= 10.00
L7= 0.50
L8= 7.94
L9= 33.00

Concrete elev.= 5448.92
TOC elev.= 5449.03
Backfill/Grout Type Open Annulus between 6" steel and PVC
Casing Type/Size/Dia. PVC/Blank/2 inch
Seal elev.= 5445.29
Seal Type 3/8 inch bentonite chips
Filter Pack elev.= 5437.59
Top of Screen elev.= 5434.03
Filter Pack Type/Size 10-20 Colorado Silica Sand
Screen Type/Size/Dia PVC 20 slot/2 inch
Bottom of Well elev.= 5423.53
Bottom of Boring elev.= 5415.59

Remarks: 8 feet steel casing in the ground
Bottom of hole is filled with cave & heaving sand and gravel
Elevations NAVDD 88

Signature: Will Goldberg

M: 259208

Well Log

PIONEER TECHNICAL SERVICES, INC.

Well Name: BPS11-19A2

Project: 2011 BPSOU MWIP	Location: Butte, Montana
Well Owner: Atlantic Richfield Co.	Depth to Water: 4.53 ft — Date: 2/15/2012 Time: 10:47

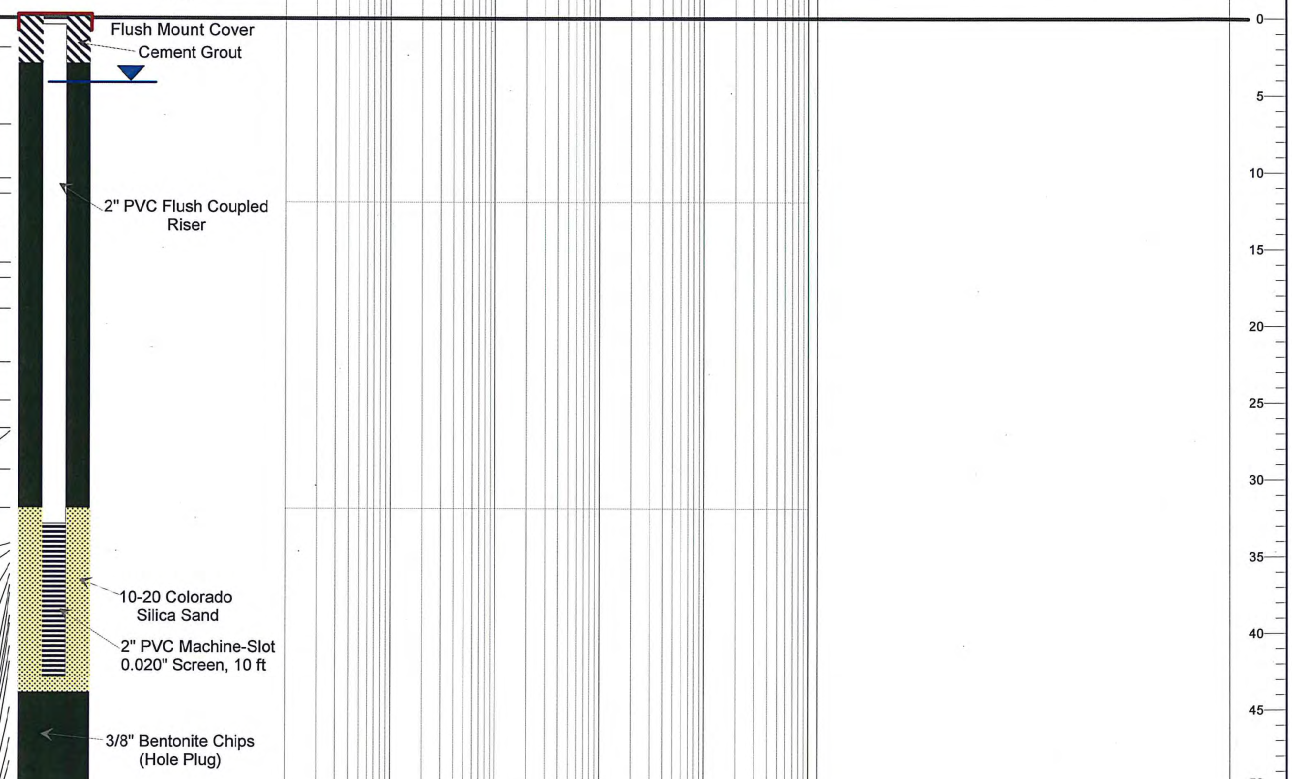
Drilled by: Environmental West	Silica Sand Size: 10-20	Casing Type/Dia: PVC/2.0"	Screen Slot Size: 0.020"
Drilling Method: Roto-Sonic	Bentonite Seal: 3/8" chips	Screen Type/Length: PVC Machine Slot/10'	Borehole Dia: 6.0"

Well Construction
TOC Elevation: 5445.55 ft (NGVD 29)
5449.91 ft (NAVD 88)

Logged by: W. Goldberg
Stickup: 0.49 ft
Surface Completion: Flush
Ground Level

Lithology Description

- FILL, TRASH, SAND, GLASS, WOOD
- NO RECOVERY
- WELL GRADED SAND, VERY CLEAN, SW, SUBANGULAR TO SUBROUNDED GRAINS. WATER BEARING AS PER C. COOVER
- SANDY SILT, ML
- WELL GRADED SAND, WITH 6" SANDY SILT LAYER AT 12.5'. WATER BEARING AS PER C. COOVER
- NO RECOVERY
- FINE TO MEDIUM SAND, ABUNDANT MICA, SW. WATER BEARING AS PER C. COOVER
- COHESIVE CLAY, OLIVE
- FINE TO MEDIUM SAND, SUBANGULAR TO SUBROUNDED, TRACE SILT, SOME OXIDATION. WATER BEARING AS PER C. COOVER
- CLAY WITH TRACE SAND, COHESIVE, OLIVE
- HIGHLY OXIDIZED FINE SAND. WATER BEARING AS PER C. COOVER
- WELL GRADED SAND WITH TRACE FINE GRAVEL AND TRACE SILT, ORANGE BROWN. WATER BEARING AS PER C. COOVER
- GRAVELY SAND, MEDIUM SUBROUNDED GRAVEL, SP-GP. WATER BEARING AS PER C. COOVER
- FINE TO COARSE SAND AND GRAVEL, LIGHT BROWN TO RUSTY, SUBANGULAR TO SUBROUNDED. ARGON PRESERVED CORE. WATER BEARING AS PER C. COOVER
- SILTY CLAY, LIGHT BROWN TO RUSTY. ARGON PRESERVED CORE
- SILTY CLAY WITH FINE SAND AND SOME GRAVEL, LIGHT BROWN TO OLIVE. ARGON PRESERVED CORE
- CLAYEY SILT WITH SOME FINE SAND, LIGHT OLIVE GREEN. ARGON PRESERVED CORE
- FINE TO MEDIUM SILTY SAND, SUBANGULAR TO SUBROUNDED, WITH FINE TO COARSE SUBANGULAR TO SUBROUNDED GRAVEL, LIGHT BROWN TO RUSTY. ARGON PRESERVED CORE. WATER BEARING AS PER C. COOVER
- SAND MEDIUM GRAINED BROWN ONE COBBLE 3 INCHES WITH IRON STAINING ON COBBLE. ARGON PRESERVED CORE
- SANDY SILTY CLAY BROWN. ARGON PRESERVED CORE
- SILTY CLAY GREENISH BROWN. ARGON PRESERVED CORE
- SILTY SAND FINE GRAINED - WATER. ARGON PRESERVED CORE
- SAND MEDIUM TO COARSE GRAINED TRACE GRAVEL WITH IRON STAINING - WATER. ARGON PRESERVED CORE
- SAND AND GRAVEL BROWN SAND IS MEDIUM GRAINED GRAVEL IS 1/2 TO 2-1/2 INCHES NO FINES - WATER. ARGON PRESERVED CORE
- SILTY CLAY BROWN STIFF SAND STRINGERS AT 46.5' AND 47'. ARGON PRESERVED CORE



Concrete Collar Elevation: 5446.04 ft. (NGVD 29)
5450.4 ft. (NAVD 88)
Well Completion Date: 2/3/2012
Screen Interval: 33-43 ft. Filter Pack Interval: 32-44 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):45.99361299 (Dec. Degrees)
Longitude (NAD83):-112.52982096 (Dec. Degrees)
Northing (SP-N83):650609.23 ft. (IF)
Easting (SP-N83):1198941.55 ft. (IF)
T3N R8W S24

GWIC ID # 265010

PIONEER TECHNICAL SERVICES, INC.

Well Log

Well Name: BPS11-19A2

Project: 2011 BPSOU MWIP	Location: Butte, Montana	
Well Owner: Atlantic Richfield Co.	Depth to Water: 4.53 ft	Date: 2/15/2012 Time: 10:47

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

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

Particle Size Distribution

1"=30%

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

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

Depth (ft)	Elevation (NGVD 29)	Lithology Log	Lithology Description	Well Construction
	5,395		SILTY CLAY BROWN STIFF. ARGON PRESERVED CORE	3/8" Bentonite Chips (Hole Plug)
			SILTY SAND FINE GRAINED BROWN SLIGHT PURPLE STAINING. ARGON PRESERVED CORE	
			SAND MEDIUM TO FINE GRAINED TRACE SILT TRACE GRAVEL SLIGHT PURPLE STAINING AT 51.8' ORANGE STAINING AT 51'. ARGON PRESERVED CORE	
55			SAND MEDIUM GRAINED BROWN. ARGON PRESERVED CORE	
	5,390		SAND WITH SILT FINE GRAINED WITH SOME MEDIUM GRAINED AND TRACE COARSE DENSE. ARGON PRESERVED CORE	TD: 57'

Well Construction: TOC Elevation: 5445.55 ft (NGVD 29), 5449.91 ft (NAVD 88)

Concrete Collar Elevation: 5446.04 ft. (NGVD 29)
5450.4 ft. (NAVD 88)
Well Completion Date: 2/3/2012
Screen Interval: 33-43 ft. Filter Pack Interval: 32-44 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):45.99361299 (Dec. Degrees)
Longitude (NAD83):-112.52982096 (Dec. Degrees)
Northing (SP-N83):650609.23 ft. (IF)
Easting (SP-N83):1198941.55 ft. (IF)
T3N R8W S24

GWIC ID # 265010

No Core Recovery
2’ to 7’

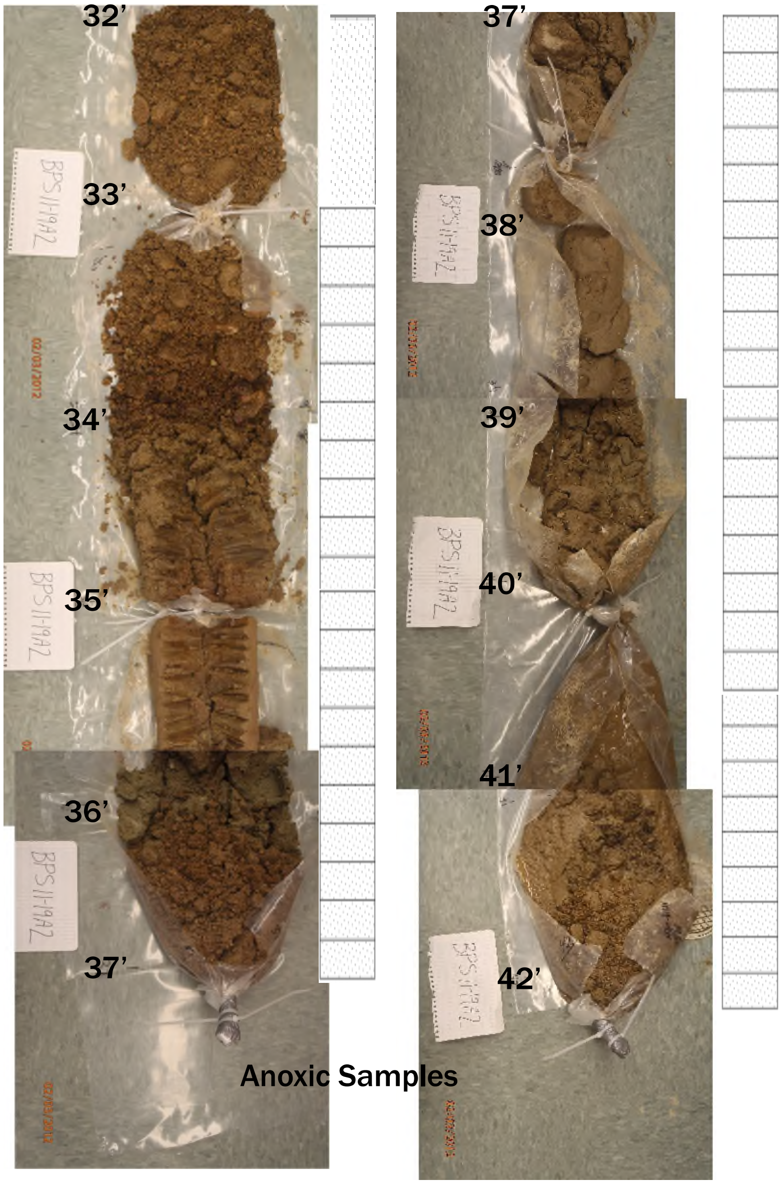
No Core Recovery
16’ to 17’

Anoxic Samples Collected
from 32’ to 42’
See Page 2

LEGEND:
SAND PACK

SCREEN WITH SAND PACK

BPS11-19A2



Anoxic Samples Collected
From 42’ to 57’
No Photo Taken

BPS11-19A2

Page 2

Well Log

Well Name: BPS11-19B

PIONEER TECHNICAL SERVICES INC.

Project: 2011 BPSOU MWIP	Location: Butte, Montana
Well Owner: Atlantic Richfield Co.	Depth to Water: 2.87 ft — Date: 2/15/2012 Time: 11:05

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/15'	Borehole Dia: 6.0"

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

Well Construction
TOC Elevation: 5445.56 ft (NGVD 29)
5449.92 ft (NAVD 88)

Logged by: W. Goldberg

Stickup: 0.45 ft

Surface Completion: Flush

Ground Level

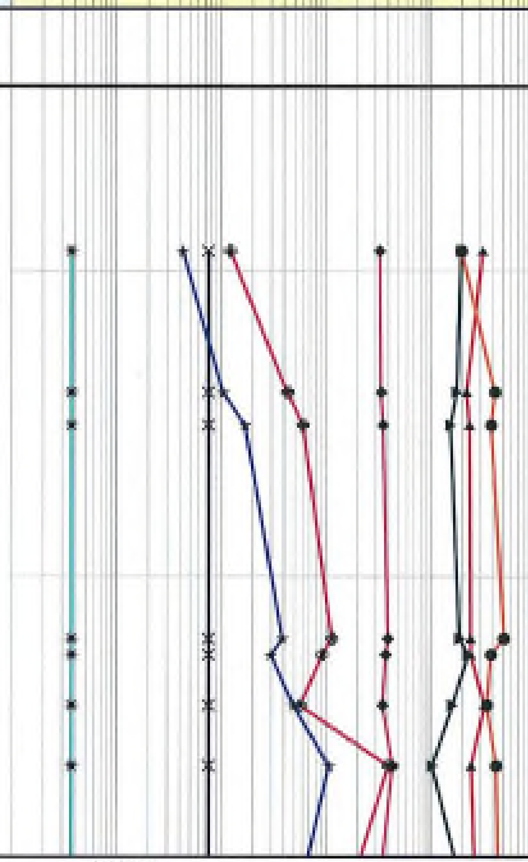
- 5,445 — FILL, SAND, DEBRIS, GLASS, FINE GRAVEL OXIDIZED, ORGANICS, SOIL WITH ROOTS AT 2.5'
- FINE TO MEDIUM SAND, BROWN, SUBANGULAR TO SURROUNDED
- 5,440
- WELL GRADED SUBANGULAR TO SURROUNDED SAND WITH SOME FINE SUBANGULAR GRAVEL. SOME OXIDATION THROUGHOUT WITH STRONG BANDS AT 12', 13', AND 14.5'. 2" SILT BANDS AT 10.5' AND 12.5'.
- 15 Gray clay
- 5,430 — NO RECOVERY
- WELL GRADED SAND WITH TRACE SUBANGULAR TO SURROUNDED GRAVEL, REDDISH BROWN
- SANDY SILT, SOME OXIDATION
- 5,425 — SILT AND CLAY, COHESIVE, GRAY. 2" SILTY SAND BED AT 21.7'-21.9'
- SANDY SILT, PINK COLORATION AT BOTTOM FINE TO MEDIUM SAND WITH SOME MEDIUM SUBROUNDED GRAVEL, OLIVE AT TOP, ORANGE BROWN AT BOTTOM
- 5,420
- SILT, OLIVE WITH SOME OXIDATION ML SAND, WELL GRADED, SUBANGULAR WITH SOME GRAVEL BECOMING MORE ABUNDANT WITH DEPTH. GRAVEL IS SUBANGULAR TO WELL ROUNDED, ABUNDANT MICA
- 5,415 — CLAY WITH TRACE SAND, LIGHT
- SAND AND GRAVEL, SUBANGULAR TO SUBROUNDED, GRAVEL TO 2", MINOR OXIDATION, BROWN
- 5,410 — DENSE SANDY SILT, LIGHT BROWN
- SANDY SILT ML
- SAND AND GRAVEL, SW-GW, SUBANGULAR TO SURROUNDED, LIGHT OLIVE WITH MINOR
- 5,405
- CLAY AND SILT WITH TRACE SAND, COHESIVE, REDDISH-BROWN
- 5,400 — DENSE SANDY SILT, OLIVE
- SANDY SILT, LIGHT OLIVE WITH OXIDATION CLAY AND
- CLAY, COHESIVE DENSE OLIVE TRACE SAND

Flush Mount Cover

Cement Grout

2" PVC Flush Coupled Riser

XRF Data From Collected Core



Particle Size Distribution

Concrete Collar Elevation: 5446.01 ft. (NGVD 29) 5450.37 ft. (NAVD 88)	
Well Completion Date: 1/24/2012	
Screen Interval: 52-87 ft.	Filter Pack Interval: 51-72 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 at El; Fill; Granite; No Recovery; Organic; Weathered granite; Sand, oxidized; Sand and gravel; Sand and gravel, oxidized; Sand, some gravel; Sandy silt; Sandy silt, some gravel; Silt; Silt, oxidized; Silty Clay; Silty Clay, some gravel; Silty sand; Silty Sand some gravel; Slag; Tailings; Topsoil; Weathered

Latitude (NAD83): 45.99359654 (Dec. Degrees)
Longitude (NAD83): -112.52982407 (Dec. Degrees)
Northing (SP-N83): 650803.27 ft. (IF)
Easting (SP-N83): 1198940.53 ft. (IF)
T3N R8W S24

GWIC ID # 265011

MONTANA WELL LOG REPORT

This well log reports the activities of a licensed Montana well driller, serves as the official record of work done within the borehole and casing, and describes the amount of water encountered. This report is compiled electronically from the contents of the Ground Water Information Center (GWIC) database for this site. Acquiring water rights is the well owner's responsibility and is NOT accomplished by the filing of this report.

Other Options

Return to menu
Plot this site in State Library Digital Atlas
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View hydrograph for this site
View field visits for this site
View water quality for this site
View scanned well log (9/20/2011 7:42:02 AM)
View scanned published report (9/20/2011 7:42:29 AM)

Site Name: MBMG MONITOR WELL * BT-98-01
GWIC Id: 171295

Section 1: Well Owner(s)

1) MONTANA BUREAU OF MINES AND GEOLOGY (MAIL)
N/A
N/A N/A N/A [08/11/1999]

Section 2: Location

Township	Range	Section	Quarter Sections
03N	07W	19	SE¼ SW¼ SE¼ SW¼

County	Geocode
SILVER BOW	

Latitude	Longitude	Geomethod	Datum
45.989659995	112.522459755	SUR-GPS	NAD83

Ground Surface Altitude	Method	Datum	Date
5445.99	SUR-GPS	NGVD29	5/3/2010

Measuring Point Altitude	Method	Datum	Date Applies
5457.1			8/11/1999 1:05:00 PM

Addition	Block	Lot

Section 3: Proposed Use of Water

MONITORING (1)

Section 4: Type of Work

Drilling Method:
Status: NEW WELL

Section 5: Well Completion Date

Date well completed: Monday, October 19, 1998

Section 6: Well Construction Details

Borehole dimensions

From	To	Diameter
0	25	10

Casing

From	To	Diameter	Wall Thickness	Pressure Rating	Joint	Type
0	25	4				PVC-SCHED 40

Completion (Perf/Screen)

From	To	Diameter	# of Openings	Size of Openings	Description
15	25	4		20 SLOT	SCREEN-CONTINUOUS-PVC

Annular Space (Seal/Grout/Packer)

From	To	Description	Cont. Fed?
9	14	BENTONITE CHIPS	
14	25	10-20 SILICA SAND	

Section 7: Well Test Data

Total Depth: 25
Static Water Level:
Water Temperature:

** 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.*

Section 8: Remarks

4" PVC INSIDE 6" STEEL CONDUCTOR WITH LOCKING LID

Section 9: Well Log

Geologic Source

Unassigned

From	To	Description
0	5	FILL MATERIAL DARK BROWN SANDY
5	7	BLACK SILT AND CLAY WITH ORGANIC DEBRIS
7	8	GRAVEL ROUGH DRILLING
8	10	BLACK SILT AND CLAY WITH ORGANIC DEBRIS
10	25	SILT AND CLAY

Driller 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:
Company:
License No: -
Date Completed: 10/19/1998

MONTANA WELL LOG REPORT

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Other Options

Return to menu
Plot this site in State Library Digital Atlas
Plot this site in Google Maps
View hydrograph for this site
View field visits for this site
View water quality for this site

Site Name: ATLANTIC RICHFIELD * BT-98-02B
GWIC Id: 240865

Section 1: Well Owner(s)

1) ATLANTIC RICHFIELD (MAIL)
317 ANACONDA RD
BUTTE MT 59701 [12/13/2007]

Section 2: Location

Township	Range	Section	Quarter Sections
03N	07W	19	NW¼ SW¼

County	Geocode
SILVER BOW	

Latitude	Longitude	Geomethod	Datum
45.993388706	112.525103946	SUR-GPS	NAD83

Ground Surface Altitude	Method	Datum	Date

Addition	Block	Lot

Section 3: Proposed Use of Water

MONITORING (1)

Section 4: Type of Work

Drilling Method: ROTARY
Status: NEW WELL

Section 5: Well Completion Date

Date well completed: Thursday, December 13, 2007

Section 6: Well Construction Details

Borehole dimensions

From	To	Diameter
0	45	7

Casing

From	To	Diameter	Wall Thickness	Pressure Rating	Joint	Type
0	29.5	2	0.154		FLUSH THREAD	PVC

Completion (Perf/Screen)

From	To	Diameter	# of Openings	Size of Openings	Description
29.5	39	2		0.020 IN	SCREEN-CONTINUOUS-PVC

Annular Space (Seal/Grout/Packer)

From	To	Description	Cont. Fed?
0	29.5	BENTOINTE	
29.5	45	SILICA SAND	

Section 7: Well Test Data

Total Depth: 39
Static Water Level: 9.69
Water Temperature:

** 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.*

Section 8: Remarks

Section 9: Well Log

Geologic Source

Unassigned

From	To	Description
0	14	WELL GRADED SAND, DAMP, TAN TO MOIST TO WET
14	18	FINE TO MEDIUM GRAVEL
18	20	COARSE SAND
20	30	CLEAN SAND AND FINE GRAVEL
30	40	SILTY SAND, SOME SILT
40	45	MEDIUM SAND CLEAN

Driller 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: CLAY PARSONS
Company: PARSONS DRILLING
License No: MWC-362
Date Completed: 12/13/2007

MONTANA WELL LOG REPORT

This well log reports the activities of a licensed Montana well driller, serves as the official record of work done within the borehole and casing, and describes the amount of water encountered. This report is compiled electronically from the contents of the Ground Water Information Center (GWIC) database for this site. Acquiring water rights is the well owner's responsibility and is NOT accomplished by the filing of this report.

Other Options

Return to menu
Plot this site in State Library Digital Atlas
Plot this site in Google Maps
View water quality for this site
View scanned well log (5/25/2007 8:56:22 AM)

Site Name: MBMG MONITOR * WELL BT-98-04
GWIC Id: 169068
DNRC Water Right:

Section 1: Well Owner(s)

Section 2: Location

Township	Range	Section	Quarter Sections
03N	07W	30	NE¼ NW¼ NE¼ NE¼

County	Geocode
SILVER BOW	

Latitude	Longitude	Geomethod	Datum
45.987726	112.520054	MAP	NAD83

Ground Surface Altitude	Method	Datum	Date
5465			10/27/1998

Addition	Block	Lot

Section 3: Proposed Use of Water
MONITORING (1)

Section 4: Type of Work
Drilling Method: HOLLOW STEM AUGER
Status: NEW WELL

Section 5: Well Completion Date
Date well completed: N/A

Section 6: Well Construction Details

Borehole dimensions

From	To	Diameter
0	15	10

Casing

From	To	Diameter	Wall Thickness	Pressure Rating	Joint	Type
-2	15	4				PVC-SCHED40

Completion (Perf/Screen)

From	To	Diameter	# of Openings	Size of Openings	Description
10	15	4		0.020	SCREEN

Annular Space (Seal/Grout/Packer)

From	To	Description	Cont. Fed?
0	1	CEMENT	
1	8	??	
8	9	BENTONITE	
9	15	10/20 SAND	

Section 7: Well Test Data

Total Depth: 15
Static Water Level:
Water Temperature:

Unknown Test Method *

Yield _ gpm.
Pumping water level _ feet.
Time of recovery _ hours.
Recovery water level _ feet.

** 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.*

Section 8: Remarks

Section 9: Well Log

Geologic Source
110ALVM - ALLUVIUM (QUATERNARY)

From	To	Description
0	3	SOIL - BACKFILL
3	5	BLACK ORGANIC SOIL - CREOSOTE SMELL
5	7	BACKFILL
7	8	BLACK CLAY - PEAT
8	11	BROWN CLAY WITH SAND
11	15	TAN CLAY WITH SAND

Driller 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:
Company:
License No: -
Date Completed:

MONTANA WELL LOG REPORT

This well log reports the activities of a licensed Montana well driller, serves as the official record of work done within the borehole and casing, and describes the amount of water encountered. This report is compiled electronically from the contents of the Ground Water Information Center (GWIC) database for this site. Acquiring water rights is the well owner's responsibility and is NOT accomplished by the filing of this report.

Other Options

Return to menu
Plot this site in State Library Digital Atlas
Plot this site in Google Maps
View hydrograph for this site
View field visits for this site
View water quality for this site
View scanned well log (9/20/2011 7:41:33 AM)
View scanned published report (9/20/2011 7:41:42 AM)

Site Name: MBMG MONITOR WELL * BT-98-05
GWIC Id: 171288

Section 1: Well Owner(s)

1) MONTANA BUREAU OF MINES AND GEOLOGY (MAIL)
N/A
N/A N/A N/A [03/11/1999]

Section 2: Location

Township	Range	Section	Quarter Sections
03N	07W	19	SW¼ SW¼ SE¼ SW¼

County	Geocode
SILVER BOW	

Latitude	Longitude	Geomethod	Datum
45.98977324	112.522453857	SUR-GPS	NAD83

Ground Surface Altitude	Method	Datum	Date
5446.1	SUR-GPS	NGVD29	5/3/2010

Measuring Point Altitude	Method	Datum	Date Applies
5455.8			8/11/1999 1:00:00 PM

Addition	Block	Lot

Section 3: Proposed Use of Water

MONITORING (1)

Section 4: Type of Work

Drilling Method:
Status: NEW WELL

Section 5: Well Completion Date

Date well completed: Friday, November 06, 1998

Section 6: Well Construction Details

Borehole dimensions

From	To	Diameter
0	25	10

Casing

From	To	Diameter	Wall Thickness	Pressure Rating	Joint	Type
0	15	4				PVC-SCHED 40

Completion (Perf/Screen)

From	To	Diameter	# of Openings	Size of Openings	Description
15	25	4		20 SLOT	SCREEN-CONTINUOUS-PVC

Annular Space (Seal/Grout/Packer)

From	To	Description	Cont. Fed?
6	10	BENTONITE CHIPS	

Section 7: Well Test Data

Total Depth: 19
Static Water Level:
Water Temperature:

** 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.*

Section 8: Remarks

MONITOR WELL FOR BASEMENT FLOODING. 4" PVC INSIDE 6" STEEL CONDUCTOR WITH LOCKING CAP DRILLED SUMMER 1998

Section 9: Well Log

Geologic Source

110ALVM - ALLUVIUM (QUATERNARY)

From	To	Description
0	5	SANDY FILL
5	20	BLACK SILT AND CLAY WITH ORGANIC MATERIAL
20	25	SILTY MEDIUM TO COARSE SAND; HEAVING

Driller 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:
Company:
License No: -
Date Completed: 11/6/1998

MONTANA WELL LOG REPORT

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View scanned well log (5/25/2007 8:57:28 AM)

Site Name: MBMG MONITOR * WELL BT-99-01
GWIC Id: 171289
DNRC Water Right:

Section 1: Well Owner(s)

1) WILEY, ROBIN (MAIL)
1440 EVANS
BUTTE MT N/A [08/11/1999]

Section 2: Location

Township	Range	Section	Quarter Sections
03N	07W	30	NW¼ NW¼ SW¼ NE¼

County	Geocode
SILVER BOW	

Latitude	Longitude	Geomethod	Datum
45.985570215	112.51737791	SUR-GPS	NAD83

Ground Surface Altitude	Method	Datum	Date
5454.64	SUR-GPS	NGVD29	4/21/2010

Measuring Point Altitude	Method	Datum	Date Applies
5458.6			6/10/1999 2:45:00 PM

Addition	Block	Lot

Section 3: Proposed Use of Water

MONITORING (1)

Section 4: Type of Work

Drilling Method:
Status: NEW WELL

Section 5: Well Completion Date

Date well completed: Thursday, April 08, 1999

Section 6: Well Construction Details

Borehole dimensions

From	To	Diameter
0	12.5	10

Casing

From	To	Diameter	Wall Thickness	Pressure Rating	Joint	Type
0	12.5	4				PVC-SCHED40

Completion (Perf/Screen)

From	To	Diameter	# of Openings	Size of Openings	Description
7.5	12.5	4		0.020	SCREEN

Annular Space (Seal/Grout/Packer)

From	To	Description	Cont. Fed?
5.5	6.5	BENTONITE CHIPS	
6.5	12.5	10-20 SILICA SAND	

Section 7: Well Test Data

Total Depth: 12.5
Static Water Level:
Water Temperature:

Unknown Test Method *

Yield _ gpm.
Pumping water level _ feet.
Time of recovery _ hours.
Recovery water level _ feet.

** 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.*

Section 8: Remarks

4" PVC INSIDE 6" STEEL WITH LOCKING CAP. MONITOR WELL FOR BASEMENT FLOODING.

Section 9: Well Log

Geologic Source

110ALVM - ALLUVIUM (QUATERNARY)

From	To	Description
0	1	SOIL
1	6	SANDY SILT
6	11.5	SILTY SAND
11.5	12.5	SILT

Driller 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:
Company:
License No: -
Date Completed: 4/8/1999

MONTANA WELL LOG REPORT

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View water quality for this site

Site Name: FP98-1
GWIC Id: 249081

Section 1: Well Owner(s)

1) FP98-1 (MAIL)
N/A
BUTTE MT 59701 [02/09/2009]

Section 2: Location

Township	Range	Section	Quarter Sections

County	Geocode
SILVER BOW	

Latitude	Longitude	Geomethod	Datum
45.995581741	112.5446298	SUR-GPS	NAD83

Ground Surface Altitude	Method	Datum	Date

Addition	Block	Lot

Section 3: Proposed Use of Water

MONITORING (1)

Section 4: Type of Work

Drilling Method:
Status: NEW WELL

Section 5: Well Completion Date

Date well completed: Monday, February 09, 2009

Section 6: Well Construction Details

There are no borehole dimensions assigned to this well.
There are no casing strings assigned to this well.
There are no completion records assigned to this well.

Annular Space (Seal/Grout/Packer)

There are no annular space records assigned to this well.

Section 7: Well Test Data

Total Depth:
Static Water Level:
Water Temperature:

** 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.*

Section 8: Remarks

Section 9: Well Log

Geologic Source

Unassigned

Lithology Data

There are no lithologic details assigned to this well.

Driller 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:	
Company:	
License No:	-
Date Completed:	2/9/2009

Well Log

PIONEER TECHNICAL SERVICES, INC.

Well Name: FP98-01B

Project: 2011 BPSOU MWIP	Location: Butte, Montana		
Well Owner: Atlantic Richfield Co.	Depth to Water: 23.78 ft	Date: 2/14/2012 Time: 14:01	
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"

Well Construction

TOC Elevation: 5456.98 ft (NGVD 29)
5461.34 ft (NAVD 88)

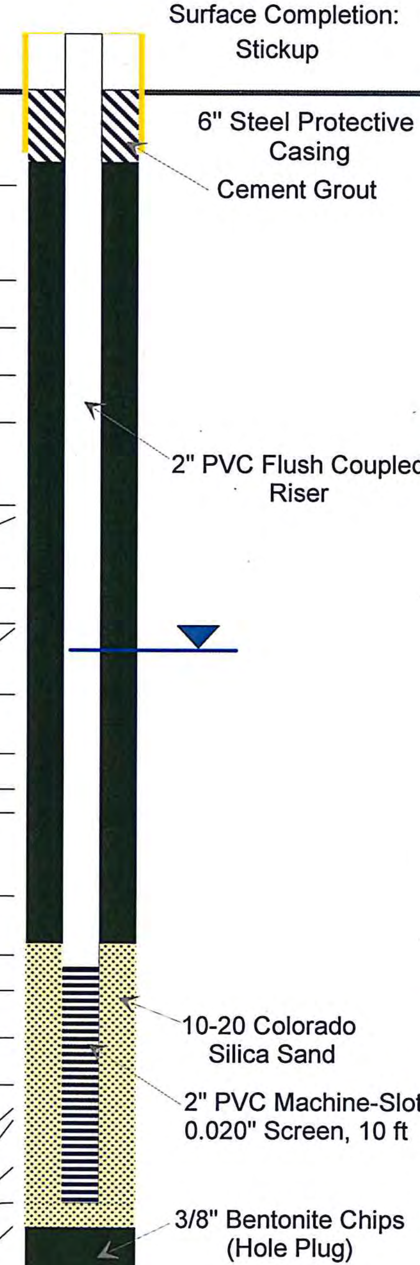
Logged by: W. Goldberg

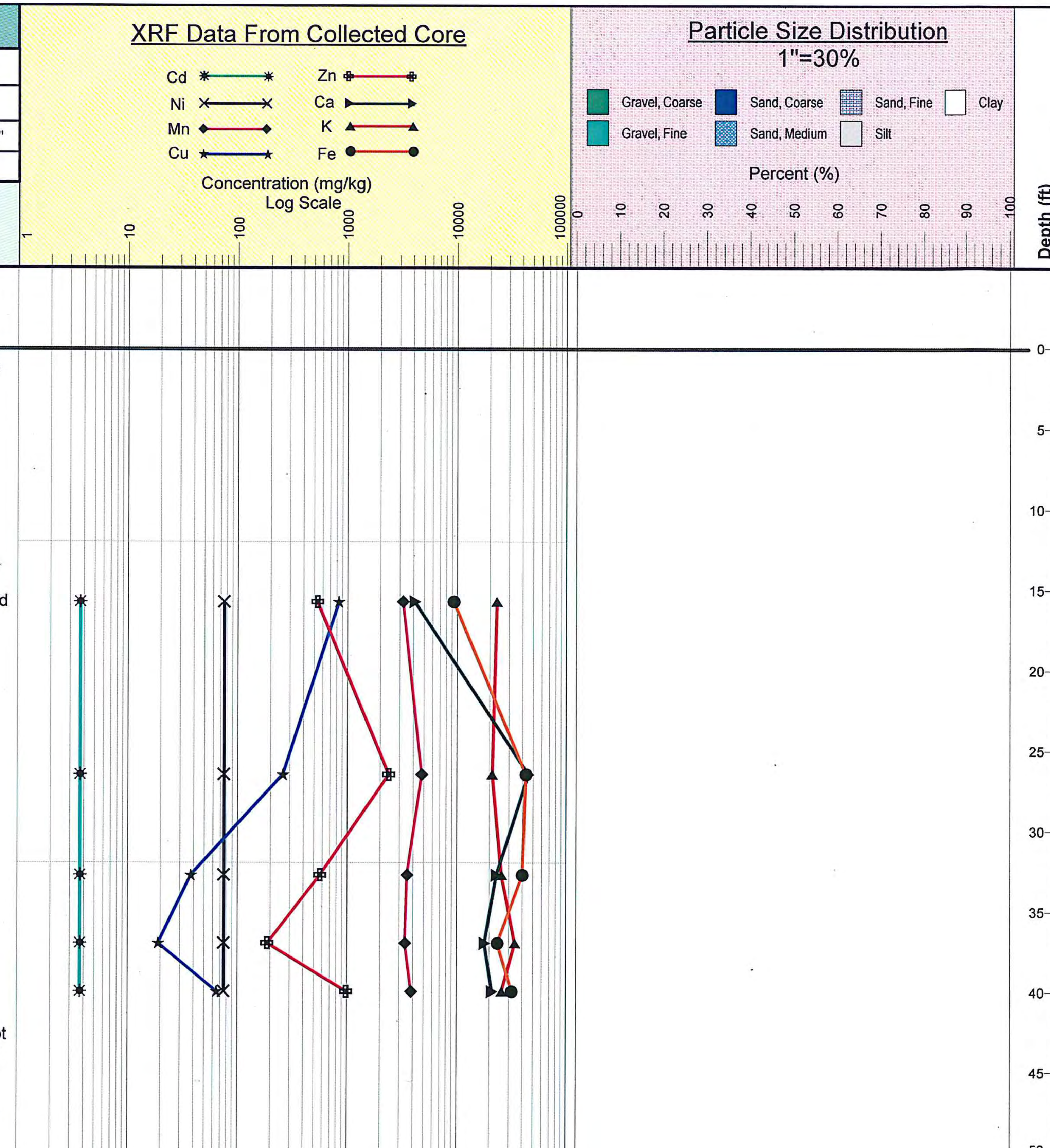
Stickup: -2.4 ft

Surface Completion: Stickup

Ground Level

Depth (ft)	Elevation (NGVD 29)	Lithology Description
0	5,455	FILL. SAND, SILT, ONE LARGE PIECE OF SLAG AT END OF RUN
5	5,450	NO RECOVERY
		SLAG
10	5,445	NO RECOVERY
		SLAG
15	5,440	TAILINGS, YELLOW, FINE SAND SIZE
		GRANULAR SLAG
20	5,435	TAILINGS, FINE SAND SIZE, YELLOW GREEN
		TAILINGS, INTERBEDDED YELLOW AND GRAY WITH SOME OXIDATION
		COHESIVE CLAY, GRAY
25	5,430	SAND, WELL GRADED, SUBANGULAR, HIGHLY OXIDIZED
		ORGANIC SILT, DARK GRAY TO BLACK, HIGHLY ORGANIC FROM 27.5' - 28'
		ORGANIC SILT, BLACK, VISIBLE FIBERS
30	5,425	SILTY SAND, SM, DARK GRAY, CAPILLARY FRINGE
		SILTY SAND WITH SUBROUNDED MEDIUM TO COARSE GRAVEL, DARK GRAY TO GRAY GREEN. WATER BEARING AS PER C. COOVER
35	5,420	WELL GRADED SAND WITH SUBANGULAR TO SUBROUNDED MEDIUM GRAVEL, OXIDIZED TO ORANGE. WATER BEARING AS PER C. COOVER
		NO RECOVERY
		SILTY SAND WITH TRACE OF MEDIUM SUBROUNDED GRAVEL, BROWN. WATER BEARING AS PER C. COOVER
40	5,415	SANDY SILT, ML, GRAY GREEN
		SAND AND GRAVEL MEDIUM TO COARSE SAND, GRAVEL UP TO 2" SUBANGULAR - WATER
		SANDY SILT DARK BROWN
45	5,410	SAND WITH GRAVEL MEDIUM GRAINED GRAVEL TO 1.5 INCHES SUBANGULAR LOTS OF MICA
		SAND WITH GRAVEL MEDIUM GRAINED GRAVEL TO 1.5 INCHES SUBROUNDED
		WEATHERED BEDROCK, FELDSPARS ALTERED, CRYSTALLINE QUARTZ WITH MICA
50	5,405	





Concrete Collar Elevation: 5454.58 ft. (NGVD 29)
5458.94 ft. (NAVD 88)
Well Completion Date: 11/30/2011
Screen Interval: 37-47 ft. Filter Pack Interval: 36-48 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):45.9956952 (Dec. Degrees)
Longitude (NAD83):-112.54437903 (Dec. Degrees)
Northing (SP-N83):651511.01 ft. (IF)
Easting (SP-N83):1195275.21 ft. (IF)
T3N R8W S24

GWIC ID # 264095

Well Log

PIONEER TECHNICAL SERVICES, INC.

Well Name: FP98-01B

Project: 2011 BPSOU MWIP	Location: Butte, Montana		
Well Owner: Atlantic Richfield Co.	Depth to Water: 23.78 ft	Date: 2/14/2012 Time: 14:01	
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, Ni, Mn, Cu, Zn, Ca, K, Fe

Concentration (mg/kg) Log Scale

Particle Size Distribution

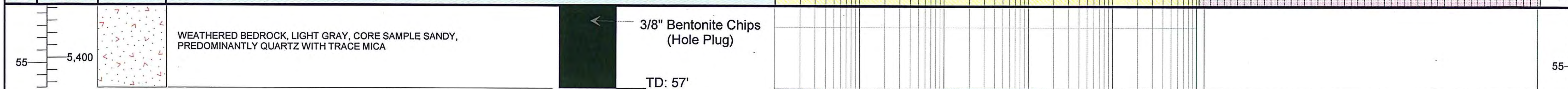
1"=30%

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

Percent (%)

Depth (ft)	Elevation (NGVD 29)	Lithology Log	Lithology Description	Well Construction
55	5,400		WEATHERED BEDROCK, LIGHT GRAY, CORE SAMPLE SANDY, PREDOMINANTLY QUARTZ WITH TRACE MICA	3/8" Bentonite Chips (Hole Plug); TD: 57'

Well Construction: TOC Elevation: 5456.98 ft (NGVD 29) 5461.34 ft (NAVD 88)



Concrete Collar Elevation: 5454.58 ft. (NGVD 29) 5458.94 ft. (NAVD 88)
Well Completion Date: 11/30/2011
Screen Interval: 37-47 ft. Filter Pack Interval: 36-48 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

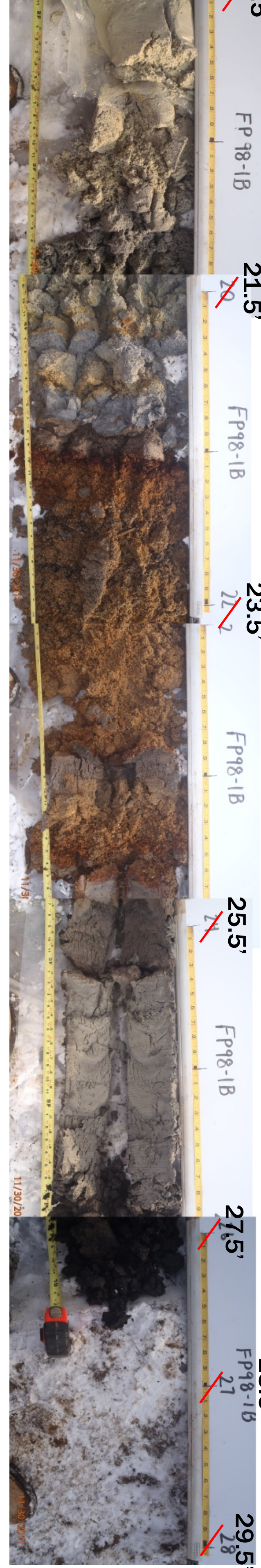
Latitude (NAD83):45.9956952 (Dec. Degrees)
Longitude (NAD83):-112.54437903 (Dec. Degrees)
Northing (SP-N83):651511.01 ft. (IF)
Easting (SP-N83):1195275.21 ft. (IF)
T3N R8W S24

GWIC ID # 264095

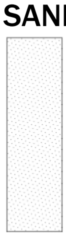
No Core Recovery
4' to 8'

No Core Recovery
10' to 12'

No Core Recovery
18' to 19.5'



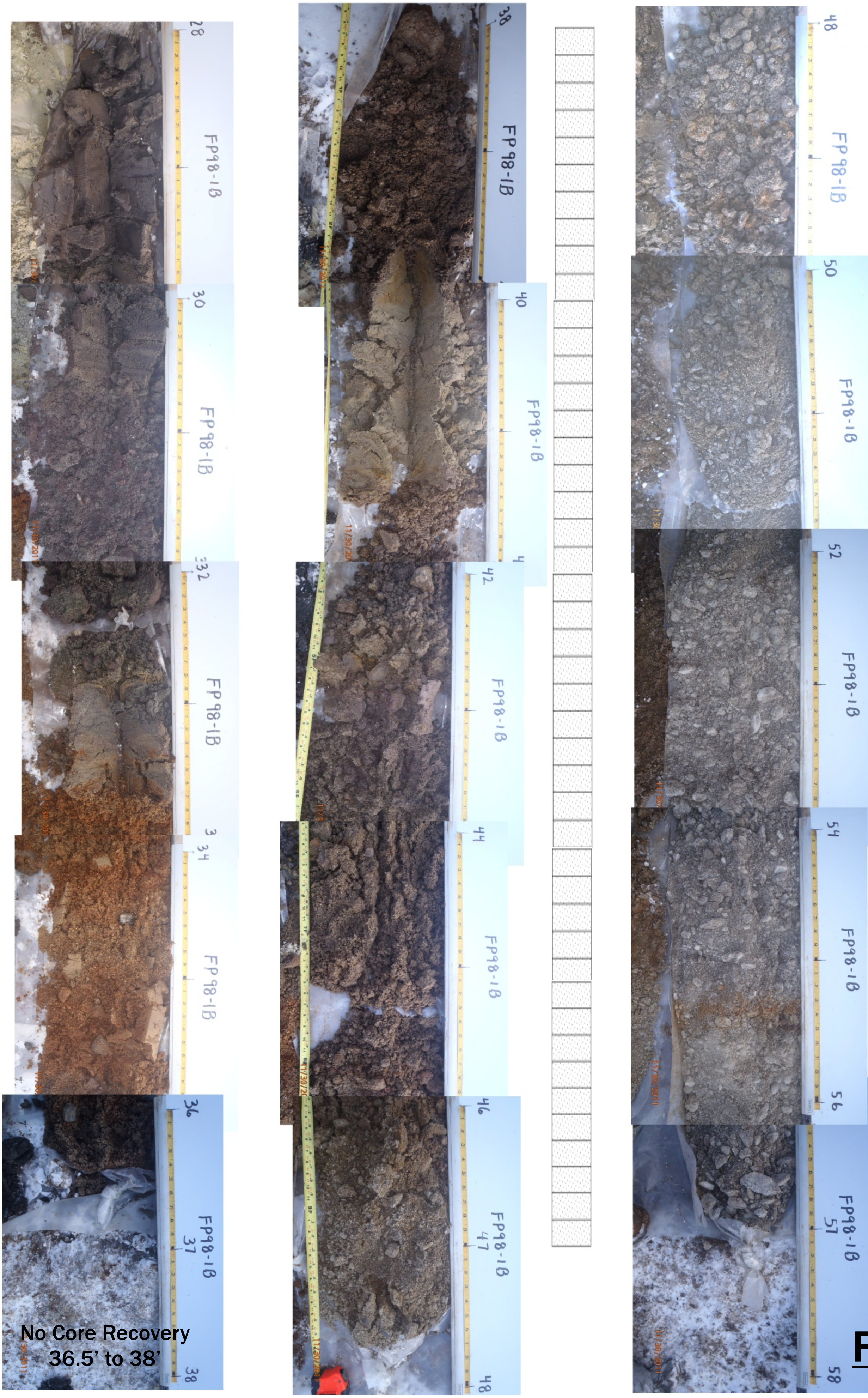
LEGEND:
SAND PACK



SCREEN WITH SAND PACK

FP98-01B

Page 1



FP98-01B

Page 2

Butte

3N08W24 DBB

SILVER BOW

086420

TEST HOLE LOG

State: Montana County: Silver Bow Project: SBC CERCLA Hole Name or Number: AI-GS-GW-29S

Legal Location: T 3N R 8W Sec 24 Tract DBB Descriptive Location: 70' N of MSD; 100' E of RR bridge over MSD

Recorded By: ME Hole Started: Time: 1530 Date: 07/07/89 Hole Completed: Time: ______ Date: 07/08/89 Driller: Butch Drilling Company: CNI

Drill Method: Auger Drilling Fluids Used: N/A Pilot Hole Diameter: 9" Reamed Hole Diameter: N/A

Total Depth Drilled: 13.5' Total Depth Reamed: N/A Total Depth Cased Below G.S.: 13' Diameter and Type of Casing: 2" Flush Threaded PVC

Weight or Gage of Casing: Sch. 40 Interval Perforated or Screened Below G.S.: 8.0-13.0' Target Aquifer: Alluvium Packer Type and Depth Below G.S.: N/A

DURING INSTALLATION WAS:	YES	NO
Well Developed?	X	
Well Test Pumped?		X
Water Samples Taken?	X	
Material Samples Taken?		X
E-Logs?		X

Method Perforated or Screened

- ______ No casing in hole
- ______ Open bottom
- ______ Slotted with Mill's Knife
- ______ Slotted with a torch
- ______ Screened by pulling casing
- ______ Field saw cut Hacksaw
- ______ Mechanical slots ______ (size)
- X Other (specify) Factory .02

Static Water Level: 4.80' Date/Time Measured: 8/23/89

Measuring Point Description/Elevation: Top of steel (N side) 5443.26' MP Height Above (+/-) or Below G.S.: + 2.29'

Well Annulus Completion Description: 10-20 Colorado Silica Sand 6.5-13.5'; 1/4" Bentonite pellets 5.5-6.5'; Pure Gold grout 0-5.5'; concrete with locked steel well head protector.

Remarks:

From	To	DRILLING LOG Geological, Drilling, and Water Conditions and Sampling
0	1.75	Sandy, minor pebbles tailings; Yellow orange to light brown.
1.75	7	Minor clay, silty sand, Dark gray. Water at 6'.
7	13.5	Minor clayey, silty, sandy, cobbley fill; Dark gray fines; <200 - 30%

PA

M:126154

03N 07W 19 CB

03N 07W 19 CBBA
MF-8 CALIFORNIA & SILVER BOW CREEK 4700

0-3	FILL, SANDY
3-5.5	ORGANIC CLAY
5.5-6.5	SAND, SATURATED
6.5-8	SILTY CLAY, SATURATED
8-13	WATER, CLAY (ORGANIC)
13-18	SAND, GRAVEL (1")

TD-14' 9-14' PERFORATED

03N 07W 19 CABB
MF-9

4692

0-3	SAND, GRAVEL
3-5	SILTY CLAY
5-8	SAND
8-13	SAND, WATER
13-18	DECOMPOSED GRANITE

TD-16' 11-16' PERFORATED

03N 07W 19 CB
MF-10 4695

0-3	FILL, SILT & SAND
3-6	SAND
6-8	SAND
8-13	SAND, SATURATED, 12' HARD DRILLING
13-16	SAND, SATURATED, 16' SOFT
16-18	CLAY
18-23	CLAY, SAND

TD-17' 12-17' PERFORATED

03N 07W 19 BDCD
MF-11 4687

0-3	FILL MATERIAL (BLACK DIRT)
3-8	ORGANIC MATERIAL (PEAT)
8-13	CLAY, SATURATED, 1' OUT OF PEAT
13-18	SAND

TD-15.5' 10.5-15.5' PERFORATED

4695

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Site Name: MBMG MONITORING WELL * MT98-05
GWIC Id: 261583

Section 1: Well Owner(s)

Section 2: Location

Township	Range	Section	Quarter Sections
03N	07W	19	

County	Geocode
SILVER BOW	

Latitude	Longitude	Geomethod	Datum
45.989552	112.52254	NAV-GPS	NAD83

Ground Surface Altitude	Method	Datum	Date

Addition	Block	Lot

Section 3: Proposed Use of Water
There are no uses assigned to this well.

Section 4: Type of Work
Drilling Method:
Status: NEW WELL

Section 5: Well Completion Date
Date well completed: N/A

Section 6: Well Construction Details
There are no borehole dimensions assigned to this well.
There are no casing strings assigned to this well.
There are no completion records assigned to this well.
Annular Space (Seal/Grout/Packer)

There are no annular space records assigned to this well.

Section 7: Well Test Data

Total Depth: 13
Static Water Level:
Water Temperature:

** 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.*

Section 8: Remarks

Section 9: Well Log
Geologic Source
Unassigned

From	To	Description
0	10	BROWN-BLACK CLAY WITH MEDIUM SAND
10	12	BROWN WET CLAY WITH SAND
12	13	BLACK CLAY

Driller 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:
Company:
License No: -
Date Completed:

MONTANA WELL LOG REPORT

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Site Name: MT98-06
GWIC Id: 260255

Section 1: Well Owner(s)

Section 2: Location

Township	Range	Section	Quarter Sections
03N	07W	19	

County	Geocode
SILVER BOW	

Latitude	Longitude	Geomethod	Datum
45.989444	112.522563	NAV-GPS	NAD83

Ground Surface Altitude	Method	Datum	Date

Addition	Block	Lot

Section 3: Proposed Use of Water
There are no uses assigned to this well.

Section 4: Type of Work
Drilling Method:
Status: NEW WELL

Section 5: Well Completion Date
Date well completed: N/A

Section 6: Well Construction Details
There are no borehole dimensions assigned to this well.
There are no casing strings assigned to this well.
There are no completion records assigned to this well.
Annular Space (Seal/Grout/Packer)

There are no annular space records assigned to this well.

Section 7: Well Test Data

Total Depth: 13
Static Water Level:
Water Temperature:

** 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.*

Section 8: Remarks

Section 9: Well Log
Geologic Source
Unassigned

From	To	Description
0	3	DARK BROWN SILTY CLAY
3	11	LIGHT BROWN MEDIUM SAND WITH GRAVEL
11	13	TAN GRAVEL WITH CLAY

Driller 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:
Company:
License No: -
Date Completed: