Appendix E
Revised Interim Ground Water Monitoring Plan, 2011

Partial Remedy Implementation Work Plan

For the Butte Priority Soils Operable Unit/Butte Site

EPA June 2011

Butte Priority Soils Operable Unit
Revised Interim Ground Water Monitoring Plan
Silver Bow Creek/Butte Area NPL Site
Butte-Silver Bow County, Montana

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Appendix A MAROS Program User Manual

List of Acronyms and Abbreviations

µg/L	micrograms per Liter
AR	Atlantic Richfield
ARARs	Applicable or Relevant and Appropriate Requirements
ARM	Administrative Rules of Montana
BLTS	Butte Lagoons Treatment System
BMFOU	Butte Mine Flooding Operable Unit
BPSOU	Butte Priority Soils Operable Unit
BSB	Butte-Silver Bow County
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act, as amended
CFRSSI	Clark Fork River Superfund Site Investigations
CGWA	Controlled Ground Water Area
CLP	Contract Laboratory Program
COCs	Contaminants of Concern
COV	Coefficient of Variation
DEQ-7	Montana Numeric Water Quality Standards Circular DEQ-7
DNRC	Department of Natural Resources & Conservation
DO	dissolved oxygen
DQOs	Data Quality Objectives
DSR	Data Summary Report
Eh	redox potential
EPA	Environmental Protection Agency
ERA	Expedited Response Action
FS	feasibility study
GWMP	Ground Water Monitoring Plan
HCC	Hydraulic Control Channel
ICs	institutional controls
LAO	Lower Area One
LAO ERA	Lower Area One Environmental Remediation Area
MAROS	Monitoring and Remediation Optimization Software
MCLs	Maximum Contaminant Level
MSD	Metro Storm Drain
NPL	National Priorities List
OU	Operable Unit
POC	Point of Compliance
PRP Group	Potentially Responsible Parties
QAPP	Quality Assurance Project Plan
RAOs	Remedial Action Objectives
RD/RA	remedial design/remedial action
RGs	remedial goals
RI	remedial investigation
ROD	Record of Decision
RP	responsible parties
SAP	Sampling and Analysis Plan
SBC	Silver Bow Creek
SC	Specific Conductance
SOP	Standard Operating Procedures
TI	Technical Impracticability

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Section 1 Introduction and Background

This revised, interim ground water monitoring plan (GWMP) has been prepared for the Butte Priority Soils Operable Unit (BPSOU) of the Silver Bow Creek (SBC)/Butte Area National Priorities List (NPL) Site to address the ground water monitoring requirements specified in the September 2006 Record of Decision (ROD) for the BPSOU (the U.S. Environmental Protection Agency [EPA] with partial concurrence by Montana Department of Environmental Quality [DEQ] 2006). In brief, the ROD specifies the following ground water monitoring requirements for the BPSOU:

> *A comprehensive groundwater monitoring plan shall be prepared and implemented for the entire alluvial aquifer to ensure that groundwater capture systems are effective; to determine that contaminated groundwater is not leaving the TI [Technical Impracticability] Zone or discharging to surface water; to provide additional information as necessary on the movement, quality, and quantity of groundwater; and to provide data for review of the groundwater remedy. The groundwater monitoring program will include installing additional monitoring wells, regular measurement of water quality and water levels in a monitoring network, and shall provide thorough monitoring that includes, but is not limited to, groundwater in upper and lower MSD, groundwater near the southern extent of the TI zone, between the MSD and LAO ground water capture systems, and in the area adjacent to, and downgradient of the lagoon treatment system.*

This GWMP provides a description of an effective ground water monitoring program for the BPSOU. Because the full ground water component of the BPSOU ROD has not been fully designed, it is an interim plan, meant to update ground water monitoring requirements to meet current conditions but not meant to be the final ground water monitoring plan.

The GWMP provides an overview of history and features of the BPSOU, provides a brief site characterization, reviews the ROD requirements and standards and status of implementation, and outlines the tasks to be completed to comply with certain ROD requirements. Periodically, the ground water monitoring program should be examined to assess its overall effectiveness in achieving the objectives of the BSPOU ROD, to identify new monitoring needs as they arise, and to take advantage of opportunities to reduce or modify monitoring requirements as justified by data analysis or site conditions.

1.1 Overview

The BPS OU is one of seven remedial operable units (OUs) within the Silver Bow Creek/Butte Area Superfund Site (Figure 1-1). The BPSOU is centered on “Butte Hill”, which is the location of the historic Butte Mining District. Silver Bow Creek is a small stream that flows along the base of Butte Hill. The BPSOU is situated in a predominantly urban setting and includes residential neighborhoods, schools and

parks, as well as commercial and industrial areas. The BPSOU also includes the alluvial aquifer underneath the BPSOU surface area.

EPA designated the original Silver Bow Creek Site as a Superfund site in September 1983. The Silver Bow Creek Site was expanded by EPA to include the Butte Area in 1987. Since then, the alluvial aquifer in the BPSOU has been the subject of multiple, extensive detailed investigations and evaluations. Fourteen separate investigations have focused on characterizing the BPSOU alluvial aquifer and limited portions of the bedrock aquifer. The majority of the bedrock aquifer has been characterized under the Butte Mine Flooding Operable Unit (BMFOU).

Ground water contaminants of concern (COCs) within the BPSOU include arsenic, cadmium, copper, lead, mercury and zinc. Ground water has been contaminated by both past release of mine process water and by precipitation infiltrating through mine wastes.

As a result of the extensive ground water contamination found in these investigations, EPA completed a Technical Impracticability (TI) evaluation for the alluvial aquifer within the BPSOU in April 2006 (EPA 2006). The purpose of this TI evaluation was to determine if it is technically impracticable to remediate the BPSOU alluvial aquifer to applicable and relevant and appropriate (ARAR) standards in a reasonable time frame. In accordance with the Comprehensive Environmental Response, Compensation, and Liability Act as amended (CERCLA), Section 121(d)(4)(C), EPA may waive ARARs if compliance with these ARARs is technically impracticable from an engineering perspective.

After reviewing the TI evaluation and all relevant data and reports, EPA determined that a TI ARAR waiver for the BPSOU alluvial aquifer was required for the following general reasons:

- A large volume of widely distributed mine wastes (i.e., primary sources) exists and impacts ground water quality in the BPSOU. Given the totality of circumstances and the conditions at the BPSOU site, the ability to completely remove these primary sources of contaminants is not feasible.

- In addition, secondary sources of contaminants to ground water (adsorbed and precipitated metal phases within the alluvial aquifer) exist over a widely distributed area within the aquifer and cannot be completely removed from the aquifer.

- The BPSOU alluvial aquifer is heterogeneous both in terms of physical (grain size and chemical makeup of alluvial soils) and hydraulic properties, making it difficult to precisely predict the aquifer's response to source removal. The substantial weight of evidence from numerous aquifer evaluations and the scientific understanding of contaminant migration principles in heterogeneous aquifers lead to the conclusion that meeting ARARs within the BPSOU alluvial aquifer will not be possible in a reasonable time frame.

- The BPSOU alluvial aquifer is located in an urban area covered with municipal infrastructure, historic mining features, and commercial and residential structures that limit options to remove or remediate sources of metals and arsenic to ground water.

The TI Zone boundary is shown on Figure 1-2. Based on conclusions presented in the TI evaluation and other information, EPA determined that the water quality in the BPSOU alluvial aquifer could not be improved to the extent necessary to meet ARAR standards by remedial action within a reasonable time frame, even assuming implementation of the most extensive and costly mine waste removal alternatives. The evaluation demonstrated that regardless of the remedy selected by EPA and implemented at the BPSOU, ground water concentrations of COCs in the alluvial aquifer will remain above ARAR standards for the reasonably foreseeable future.

However, EPA's BPSOU remedy required the capture and treatment of contaminated ground water. The BPSOU ROD established remedial goals and ARARs for surface water base flow in Silver Bow Creek, the major area where contaminated ground water could be expressed.

While EPA made the determination that meeting ground water ARARs was technically impracticable, achieving surface water ARARs (i.e., meeting water quality standards in Silver Bow Creek) remains a remedial requirement. The remedy for surface water, during normal flow conditions (i.e., not during storm water runoff events) is directly linked to the ground water remedy. Among other things, ground water control, capture, and treatment must be implemented and maintained to protect surface water quality. In other words, contaminated BPSOU ground water must be prevented from discharging to Blacktail Creek and Silver Bow Creek in quantities or concentrations that cause exceedances of surface water ARARs.

A major objective of this GWMP is to provide the necessary information to ensure the ground water remedy is protective of surface water in Blacktail Creek and Silver Bow Creek and will remain protective for the long-term, as described in the BPSOU ROD.

In September 2006, EPA, with partial concurrence by the DEQ, issued the ROD for the BPSOU. The Selected Remedy, described in the BPSOU ROD fully, includes components to address contaminated solid media (mine waste, soil, and residential soil and dust), surface water contamination (base flow and storm water runoff), and ground water. The Selected Remedy formally waived ARAR standards for the alluvial ground water at the BPSOU. A description of the Selected Remedy for ground water is presented in summary below[1].

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[1] The 2006 BPSOU ROD should be consulted for a complete description of the remedial requirements for ground water and all other components.

1.2 Description of the Selected Remedy for Ground Water

The Selected Remedy for ground water includes the following components:

1. ***Waste Left in Place***. Many areas of contamination at BPSOU were removed or capped in pre-ROD actions and the ROD describes other required cleanup actions addressing contaminated areas. Certain areas of remaining waste and contaminated, saturated soils will be left in place in Lower Area One (LAO) and MSD. To reduce the loading of metals to ground water in the area overlying the Parrott Tailings (e.g., the ball fields and BSB County Shops), the Diggings East and Northside Tailings, infiltration barriers shall be considered during remedial design and implemented if determined to be appropriate by EPA, in consultation with DEQ.

2. ***Wetland Demonstration Area Remediation***. The sedimentation basin/former wetland demonstration project area near the intersection of Kaw Avenue and George Street shall also be reclaimed according to the intended future land use and may be used as a potential storm water retention/detention basin under the Surface Water Management Program.

3. ***Ground Water Capture and Treatment – MSD Area.*** Contaminated ground water in the MSD shall be captured with the subdrain under the MSD channel and/or another appropriate ground water collection system as determined under remedial design. The captured ground water shall continue to be pumped from the terminal vault in the MSD to the treatment facility at LAO. The captured and pumped water will be treated by lime precipitation technology as described below in subparagraph 4 before being discharged to Silver Bow Creek. However, because issues regarding long-term performance of the subdrain have not been fully addressed to date, the Selected Remedy also includes a 5-year shakedown period to evaluate the reliability of the MSD subdrain collection system. During this shakedown period, an approved operation and maintenance plan shall be developed for the collection system. If, during the shakedown period, monitoring data demonstrate that the subdrain is not effectively collecting contaminated ground water, or is spreading contamination downgradient, a new or modified ground water collection system will be designed and built.

4. ***Ground Water Capture and Treatment – LAO.*** Contaminated ground water at LAO and base flow from Missoula Gulch shall be intercepted in an hydraulic control channel, which runs parallel to Silver Bow Creek, and routed to the treatment lagoon facility described below. If ground water inflow between the MSD and LAO capture systems (i.e., between the end of the MSD subdrain and the start of the hydraulic control channel) is found to adversely affect surface water quality, additional ground water capture and hydraulic control systems

shall be implemented. In addition, water from the BMFOU West Camp System will be routed to the hydraulic control channel at Lower Area One for treatment through the treatment facility described below.

5. ***Ground Water Treatment Facility.*** As part of the RI/FS and the LAO removal action, Atlantic Richfield (AR) constructed a lagoon treatment system at Lower Area One. Treatment discharge data suggest that the system has been meeting state water quality standards for copper, cadmium, and zinc at the point of discharge. Arsenic standards have been met on all but a few occasions. These data are especially encouraging for cadmium discharges – conventional treatment systems have had problems meeting the cadmium standard because of reduced holding times in such facilities. The lagoon treatment system's longer holding times appear to be effective in the treatment of cadmium. Accordingly, the Selected Remedy includes retention and continued operation of the lagoon system for treating captured and routed ground water, and certain captured surface water, prior to discharge to Silver Bow Creek. However, because issues regarding long-term performance and sludge removal and disposal have not been fully addressed to date, the Selected Remedy also includes the following:

   a. A 5-year shakedown period will be in place for the lagoon treatment system. The captured ground water will be treated to DEQ-7 standards (Table 1-1) prior to discharge. The lagoon treatment system must demonstrate successful water treatment and full compliance with the standards when operating at designed capacity and when operating under a wide range of conditions. Also, it must be demonstrated that sludge removal and sludge management can be performed effectively without causing system upsets. Responsible parties made modifications to expand the capacity of the treatment lagoons that did not go through the formal EPA design, review, and approval process. Therefore, those modifications and any additional design of the expanded treatment lagoon system will need to go through the formal EPA review and approval process. The lagoon treatment system shall be designed to prevent the release of untreated contaminated waters into Silver Bow Creek as a result of upset periods due to flooding, equipment malfunction or failure, or extended periods of cold, etc. ARAR compliant sludge removal, management, and disposal plans must be developed and approved.

   b. Using the Butte Reduction Works area near the lagoon treatment system for sludge drying and sludge management is not allowed, since it is a dedicated open space area more suitable for public use.

   c. If at any time during the shakedown period, or thereafter, the system fails to meet discharge standards and cannot be adjusted or modified to meet standards, or if sludge removal, management, and disposal cannot be done in

compliance with ARARs and in a protective manner, a conventional lime treatment system shall be designed and built at Lower Area One. The conventional system shall use lime treatment technology to treat the captured contaminated water and meet all discharge standards.

d. To prevent the discharge of untreated water into Silver Bow Creek, the design will be required to include contingencies for how to manage and store collected ground water during extended periods of upset (e.g., flooding, equipment malfunction or failure, extended periods of freezing, etc.)

6. ***Ground Water Monitoring.*** A comprehensive ground water monitoring plan shall be prepared and implemented to ensure that ground water capture systems are effective; to determine that contaminated ground water is not leaving the TI Zone or discharging to surface water; to provide additional information as necessary on the movement, quality, and quantity of ground water; and to provide data for review of the ground water remedy. The ground water monitoring program will include installing additional monitoring wells, regular measurement of water quality and water levels in a monitoring network, and shall provide thorough monitoring that includes, but is not limited to, ground water in upper and lower MSD, ground water near the southern extent of the TI zone, between the MSD and LAO ground water capture systems, and in the area adjacent to and downgradient of the lagoon treatment system. An initial outline of ground water monitoring requirements was included in the ROD.

7. ***6.Controlled Ground Water Area.*** A Controlled Ground Water Area (CGWA) shall be established ground water in the area, may also be required.

The Selected Remedy for ground water will be implemented primarily in the MSD and LAO areas. Under the Selected Remedy, buried and partially saturated wastes that currently exist in these areas will be left in place with appropriate ground water monitoring and institutional controls. This will provide a continued understanding of the extent of ground water contamination and long-term protection of human health and surface water resources.

Although previous response actions have removed a substantial quantity of waste material from LAO, wastes remain beneath the Municipal Sewage Treatment Plant, structures such as the aqueduct and slag walls being retained for their historic value, and below the vertical excavation limits established during the design of LAO ERA. Existing hydraulic controls constructed during the LAO removal action to capture, control, and extract contaminated ground water and to prevent ground water discharge to Silver Bow Creek are incorporated into the Selected Remedy.

As more fully described in the BPSOU ROD and summarized above, under the Selected Remedy, ground water captured in the interception and collection systems at

LAO and MSD will be combined with contaminated base flow from Missoula Gulch and the ground water from the West Camp bedrock system of the Mine Flooding OU for combined treatment in the treatment lagoon facility. If monitoring data demonstrate that the current subdrain is not capturing the contaminated ground water, or contaminated ground water is leaving the site, or the system is not otherwise effective, additional ground water capture systems and/or extraction wells will be implemented to ensure full effectiveness of the system. The treated water shall be subsequently discharged to Silver Bow Creek or used for other beneficial purposes. Treatment capacity for the treatment lagoon system will be evaluated and finalized during remedial design.

1.3 Overall Remedial Action Objectives, Remedial Goals, and Performance Standards for Ground Water

Ground water COCs are arsenic, cadmium, copper, lead, mercury, and zinc.

1.3.1 Remedial Action Objectives

The remedial action objectives established by the BPSOU ROD for contaminated ground water are:

- Prevent ingestion of or direct contact with contaminated ground water that would result in unacceptable risk to human health.
- Prevent ground water discharge that would lead to violations of surface water ARARs and RGs for the BPSOU.
- Prevent degradation of ground water that exceeds current standards.

1.3.2 Remedial Goals/Performance Standards

RGs/Performance Standards for contaminants in ground water and protection of ground water resources within the BPSOU were established in the BPSOU ROD based on the applicable State of Montana numeric water quality standards for human health. Montana classifies ground water into Classes I through IV based upon its specific conductance and establishes the ground water quality standards applicable with respect to ground water classification under these standards. Concentration of dissolved substances in Class I or Class II ground water may not exceed the human health standards listed in the current Montana Numeric Water Quality Standards Circular DEQ-7 (DEQ-7) and shown in Table 1-1. The federally promulgated Maximum Contaminant Levels (MCLs) or non-zero Maximum Contaminant Level Goals (MCLGs) for these contaminants are identical, so those standards are the ARARs for ground water.

Table 1-1
Standards for Ground Water

COC	Standard (Dissolved)[1]
Arsenic	10 µg/L
Cadmium	5 µg/L
Copper	1,300 µg/L
Lead	15 µg/L
Mercury	2 µg/L
Zinc	2,000 µg/L

1 As presented in the BPRSOU ROD, these are equal to the DEQ-7 standards published in February 2006.

For concentrations of parameters for which human health standards are not listed in DEQ-7, ARM 17.30.1006 allows no increase of a parameter to a level that renders the waters harmful, detrimental, or injurious to the beneficial uses listed for Class I or Class II water. RGs for ground water may be revised downward, in order to achieve surface water quality standards and RGs. For arsenic, the current Federal MCL of 10 µg/L is the appropriate RG for arsenic in ground water, along with the recently promulgated State standard of 10 µg/L.

As noted earlier, the BPSOU ROD waived the contaminant-specific ARARs for ground water within the designated TI Zone. The ground water ARARs identified in Table 1-1 therefore apply only to ground water outside of the designated TI Zone, which will be further defined during remedial design.

The Selected Remedy requires capturing and treating ground water to prevent the spread of contaminant plumes and to prevent the discharge of contaminated ground water into Blacktail and Silver Bow Creeks. The treated ground water must meet water quality standards prior to discharging it into surface water. As noted above, ground water standards have been waived within the designated TI Zone. The TI zone boundary is shown in Figure 1-2. Since the Selected Remedy requires that contaminated plumes be prevented from migrating outside the established TI zone, the boundary for the TI zone represents the Point of Compliance (POC) boundary for ground water. The RGs discussed earlier have been adopted as performance standards for the BPSOU. Thus, ground water quality standards in Table 1-1 will apply to ground water at and beyond the edge of this boundary. An exception lies at the downgradient edge of the OU where contaminated ground water is hydraulically prevented from moving off-site, but ground water is contaminated in the adjacent Streamside Tailings OU.

Based on the data collected during this ground water monitoring program, additional points of compliance may be determined necessary by EPA during remedial design (e.g., southern edge of the MSD). Additionally, ground water quality within the TI Zone will be evaluated using the statistical analysis described in Section 4.0. If select

wells (Early Warning Wells) within the TI zone are shown to have a definite increasing trend in COC concentration, indicating that a contamination plume is expanding, it will require a re-assessment of the ground water collection component of the Selected Remedy (e.g., use of additional subdrains, hydraulic control channels, or extraction wells), and will require additional remedy measures to protect the future surface water.

Ground water contamination outside the boundary of the TI zone in excess of ground water performance standards identified in Table 1-1 shall constitute a violation of Performance Standards triggering one or more of the following actions by EPA: 1) re-assess ground water collection and treatment effectiveness components of the Selected Remedy (e.g., use of additional subdrains, hydraulic control channels, or extraction wells); or 2) complete a TI evaluation for the aquifer in areas of ground water contamination located outside the compliance boundary. An exception applies at the downgradient OU boundary as described above.

1.3.3 Ground Water Use

BPSOU site ground water is not currently a municipal source of drinking water. The City of Butte obtains drinking water from sources outside of the immediate area. Current drinking water sources for residents within the BPSOU are Moulton Reservoir, Basin Creek Reservoir, the Big Hole River, and two bottled water companies. These water sources are located outside of the BPSOU and are not impacted by site contamination.

There are private wells located in the BPSOU, but these are used primarily for irrigation. Local ordinance requires residents to be connected to the municipal domestic water supply system if they are within 300 feet of the supply system. Properties connected to the water system are prohibited from using ground water for any purpose other than sprinkling or irrigation. Butte-Silver Bow County has an ordinance that states it "...is required at the owner's expense to install suitable water service facilities therein, and to connect such facilities directly to the water main within sixty days after date of official notice to do so, provided that a water main is located within a distance of three hundred feet from the owner's property line." The ordinance goes on to state that "... the occupants of property connected to the water system may not use water provided by wells for any purpose other than sprinkling or irrigation." If irrigation return flow poses a threat to surface water, those practices will be reassessed.

As further response to ongoing COC impacts, two control ground water areas (CGWA) exist in BPSOU: the Old Butte Landfill/Clark Tailings CGWA (established in 1999) and the Butte Alluvial and Bedrock CGWA (established in 2009). The CGWA boundaries are shown on Figure 1-3.

Under the Butte Alluvial and Bedrock CGWA, existing wells that exceed numeric water quality standards may not be used as a drinking water source and a replacement water source will be provided. The aquifer is closed to domestic use, and the installation of new domestic wells is prohibited. Environmental monitoring and

treatment wells are allowed in the CGWA provided the wells conform to applicable statutes. New or replacement industrial/irrigation wells may be allowed, providing the owner of the proposed well provides data to demonstrate that use of the well will not be detrimental to human health or the environment. The Butte/Silver Bow Water Quality district, in conjunction with the USEPA and MDEQ, will review proposals for new well installation (DNRC 2009).

The Old Butte Landfill/Clark Tailings CGWA is located south of and adjacent to the Butte Alluvial and Bedrock CGWA. Similar to the Butte Alluvial and Bedrock CGWA, the Old Butte Landfill CGWA does not allow the use of contaminated wells for drinking water purposes, and does allow for properly installed environmental monitoring wells. The CGWA is subdivided into four zones (Zone 1 through Zone 4), with no new well installation allowed in Zones 1 and 2. New drinking water and industrial wells may be installed in Zone 3 (up 10 to gallons per minute pumping rate) and Zone 4 (up to 200 gallons per minute) subject to DNRC approval and the following criteria (DNRC 2003):

- All wells must be tested for VOCs, chlorinated acid herbicides, phthalate esters, and Table 1 constituents from the Landfill Groundwater Monitoring Analysis List.
- Based on the analyses, drinking water wells must meet current human health standards (i.e. DEQ-7).

1.3.4 Ground Water Remedial Component Implementation

Since issuance of the 2006 BPSOU ROD, EPA has ordered and overseen remedial design of the ground water component of the ROD. That component is partially designed, and some elements (such as the controlled ground water area institutional control) have been implemented. But the full ground water remedy components have not been fully implemented.

Nevertheless, EPA has determined that the monitoring component must be implemented now. This will enable EPA to complete remedial design and remedy implementation, as well as ensure the protectiveness of the remedy in general. This interim ground water plan may be revised into a final ground water monitoring plan although still subject to ongoing assessment and changes) as remedial design and remedy implementation are more fully implemented.

Section 2 Comprehensive Ground Water Monitoring Plan

This section of the GWMP describes the overall implementation of the ground water monitoring program. The elements discussed in this section are as follows:

- Monitoring Objectives and Requirements
- Program Roles and Responsibilities
- Ground Water Monitoring Areas of Interest
- Ground Water Monitoring Network
- Program Reporting
- Data Management
- Quality Assessment

The GWMP requires planning and implementing the following major tasks:

1. Sampling and Analysis
2. Well Installation
3. Upper MSD Pumping Test
4. Data Management
5. MSD Subdrain Load Monitoring

2.1 Ground Water Monitoring Program Objectives and Requirements

2.1.1 Monitoring Objectives

The GWMP will address the following general concerns:

- Ensure that existing ground water capture and treatment systems are effective.
- Determine that contaminated ground water is not leaving the TI Zone or discharging to surface water.
- Provide additional information as necessary on the movement, quality, and quantity of ground water to assure that ground water contamination plumes are not spreading and ground water quality is not degrading and that surface water is not threatened.

- Provide data for review of the ground water remedy.

As stated in the ROD, this monitoring system shall "include expanded wells and measurements from the existing system and shall provide for the careful and thorough monitoring that includes, but is not limited to, ground water near Blacktail Creek, the ground water between the MSD and LAO ground water capture systems, ground water adjacent to the lagoon treatment system, and ground water downgradient (west) of the BPSOU." Additionally, "the monitoring plan will also include wells downgradient of BPSOU to gather information on the characteristics of the ground water and to assure that downstream waters are not being affected by ground water leaving BPSOU."

The specific objective of this GWMP is to provide a detailed description of the components of the comprehensive ground water monitoring program, including new well installation, for the BPSOU. These specific components are as follows:

1. Identify existing and new wells, and contain an initial list of wells within and adjacent to the BPSOU that will be monitored.

2. Describe the data to be collected and the frequency with which each well will be monitored.

3. Describe how the wells meet the ROD-mandated objectives.

4. Describe reporting and data management requirements.

5. Identify and scope the tasks related to ground water monitoring that must be completed.

If the statistical analysis (presented in Section 4) demonstrates that the contaminant plume(s) are a threat to surface water or clean ground water, the remedy will be enhanced to address the threat. The selection of engineering improvements to enhance the Selected Remedy shall be based on thorough evaluation and interpretation of the data collected under this ground water monitoring plan and any other additional data or information (e.g., data collected during operations and maintenance of the capture and treatment systems).

2.1.2 ROD Ground Water Monitoring Requirements

An initial outline of the minimum requirements of the ground water monitoring program was provided in the ROD. These minimum monitoring components are described below. Following each component is text in *italics* describing how these requirements will be met.

1. All monitoring wells in the BPSOU aquifer (MSD, LAO, and between) will be sampled every 5 years. Additionally, EPA in consultation with DEQ will identify a network of wells for annual water quality sampling.

A ground water monitoring network is presented in Table 2-1 and shown on Plate 1. The monitoring schedule is presented in Table 4-1.

2. Water levels will be measured in all wells and certain surface water locations twice per year. Water levels will be measured in a select network on a monthly basis, or more frequently if necessary for operation of the capture and treatment system.

Water levels will be monitored according to the schedule presented in Table 2-1. Water levels were required to be monitored on a monthly basis for one year (2008). Water levels are currently required to be measured annually for all wells and more often for certain wells associated with the capture systems. Some of the critical wells will be monitored continuously using dataloggers.

3. Ground water monitoring will be coordinated with the BMFOU monitoring program managed by the Montana Bureau of Mines and Geology as there is overlap in the monitoring well networks.

Table 2-1 and Plate 1 identify wells that shall be monitored under both BMFOU and BPSOU ground water monitoring programs. The Montana Bureau of Mines and Geology will review and comment on the monitoring well list before the monitoring SAP is finalized. Responsibility for monitoring wells in both programs and for coordinating the data will be determined at that time.

4. Additional monitoring wells will be installed throughout the MSD as needed to determine flow direction, gradients, and ground water quality. Additional monitoring wells will be installed in areas where the extent(s) of ground water plumes are uncertain. These will also include additional nested well sets in key areas of the floodplain, additional mid-level and deep wells, and possibly bedrock wells.

As presented in Table 2-1 and shown on Plate 1, several new wells were installed between 2007 and 2010 in the MSD and are now incorporated into the BPSOU monitoring network.

5. Wells will also be installed, as necessary, to monitor the subdrain performance.

As presented in Table 2-2 and shown on Plate 1, additional monitoring wells shall be installed in the MSD and incorporated into the BPSOU monitoring network. Based on ongoing work in the vicinity of the MSD pump vault, additional new monitoring wells will be installed to supplement the existing network.

6. One pumping test will be conducted on a mid-level well (AMW-1B) in upper MSD to determine if the subdrain will influence flow in the mid-level portion of the aquifer.

The aquifer test was conducted from January to February 2010. Pumping test results are summarized in the Draft Final 2010 Metro Storm Drain (MSD) Mid-Level Aquifer Pumping Test Technical Memorandum *(ARCO 2010).*

7. The ground water loads entering the MSD subdrain will be monitored annually in the fall (base flow) using dye tracer methods to determine flow and standard sampling to measure metals and arsenic concentrations. Load monitoring will assure that the subdrain continues to operate as expected and is not fouling or clogging. In addition, the mass balance will be used to determine if the pumping rate is matching the ground water collection rate and assure that the subdrain is not adding contaminated ground water back into the aquifer in the vicinity of the pump vault. In addition, two monitoring wells will be installed adjacent to MSD just downgradient of the pump vault to assure that captured ground water is not leaving the capture system.

Ground water loading evaluations for MSD are discussed in Section 3, Task 5 - MSD Subdrain Load Monitoring Plan. The additional wells adjacent to the MSD are discussed in Section 3 Task 2 - Well Installation.

8. A network of nested wells will be installed between the MSD and Blacktail Creek.

The network of nested wells is identified in Table 2-1 and shown on Plate 1 and shall be installed.

9. At least two nested well groupings (three wells each grouping) will be installed at the very west end of the BPSOU as POC wells. Each well group will consist of a shallow well, a deeper weathered bedrock well, and a deep solid bedrock well.

The POC wells at the west end of BPSOU are identified in Table 2-1 and shown on Plate 1.

10. There is no ground water capture system between the end of the MSD subdrain and the start of the hydraulic control channel. If ground water inflow between the MSD and LAO capture systems is found to adversely affect surface water quality, additional ground water capture and hydraulic control shall be developed and implemented in this area.

RD investigations identified a source of ground water inflow to surface water containing high concentrations of metals between the capture systems. A design for partially extending the HCC has been submitted and approved. Construction was initiated in November 2010. Following completion of the HCC extension, the extent of uncaptured ground water will be slightly smaller. The wells needed to monitor this are identified in Table 2-1 and shown on Plate 1. The wells are co-located with existing surface water monitoring stations. The stage

data will be obtained from the surface water monitoring program to delineate three-dimensional flow directions. The flow directions and water quality data will be used to evaluate interaction between surface and ground waters.

2.2 Monitoring Program Roles and Responsibilities

The primary entities of the BPSOU ground water monitoring team consist of EPA (the lead agency for the site), the Montana Department of Environmental Quality (DEQ, support agency for the site), and the PRP Group. Other stakeholders or program participants include the Montana Bureau of Mines and Geology (BMFOU monitoring program). The roles and responsibilities of the primary team members follow.

2.2.1 EPA and DEQ

The agencies' responsibilities include:

- Providing overall direction for the ground water monitoring activities.
- Reviewing, providing comments on, and EPA, in consultation with DEQ, approving plans, data summary reports, and other submittals, and implementing and documenting the monitoring work.
- Preparing, evaluating and interpreting data for annual assessments and the five-year review process (EPA, in consultation with DEQ).
- Providing oversight of field efforts.
- Providing community relations and other public information resources.
- Facilitating and coordinating activities with local, state, responsible parties (RPs), and other federal entities as needed.
- Maintaining records of site activities.

2.2.2 PRP Group

The PRP Group is responsible for implementing all remedial action and monitoring activities at the BPSOU. Under the GWMP, these responsibilities include:

- Organizing and arranging field planning meetings and scheduling, conducting, and documenting field work.
- Procuring technical services support and implementing activities for well drilling, sampling, laboratory analysis, drilling contractor oversight, surveying, and other similar activities.
- Preparing data summary reports and submitting to EPA/DEQ for review.
- Identifying and acquiring necessary permits (e.g., drilling) and utility clearances.

- Maintaining communication with EPA/DEQ regarding the status of this project.
- Coordinating with EPA/DEQ and the laboratory regarding the analytical, data validation, and QA issues related to sample analysis.
- Notifying EPA/DEQ immediately of significant problems affecting the quality of data or the ability to meet project objectives.
- Ensuring that sampling is conducted in accordance with procedures detailed in the governing field documents and that the quantity and location of all samples meet the requirements of the governing field documents.
- All other activities described in this document, unless specifically noted for other parties.

2.3 Monitoring Well Network

The required, current monitoring well network is presented in Table 2-1 and shown on Plate 1. The network will be reviewed and may be revised based on the annual BPSOU GWMP Data Summary Reports (DSR). A SAP for expanding the network was approved in 2007 and implemented in 2007-2010. Further expansion of the network will be conducted using this SAP as part of Task 1 (see Section 3.1 below).

2.3.1 Water Quality and Water Level Monitoring

As specified in the ROD, the ground water COCs are arsenic, cadmium, copper, lead, mercury, and zinc. These are the primary analytes that will be monitored under the ground water monitoring program. The wells to be sampled and the frequency of sample collection are specified in Table 2-1. Additionally, all new monitoring wells will be sampled quarterly for the first two years and then will be sampled semi-annually or every five years. Ground water field parameters include pH, temperature, redox potential (Eh), specific conductance (SC), dissolved oxygen (DO), and water levels. A number of wells are slated to have only water level information collected and will not be sampled.

As part of any Five-Year Review for BPSOU or any other comprehensive review as determined by EPA, general chemistry analysis shall be conducted for all wells sampled and include, at a minimum, the following analytes: potassium, sodium, calcium, magnesium, manganese, iron, sulfate, chloride, bicarbonate, carbonate, pH, SC, hardness, and total dissolved solids.

2.4 Ground Water Monitoring Areas of Interest

The monitor wells identified in Table 2-1 have been divided into separate areas of interest to aid in the evaluation and interpretation of site data and to ensure that the needs and objectives of each area of interest are being met. The following areas of interest have been established for this purpose:

- Technical Impracticability Zone
- MSD Capture System
- Lower Area One Capture System
- Ground water area between MSD and LAO capture systems
- Private Wells

Each of these areas of interest has been developed with a specific purpose, as discussed below.

2.4.1 Technical Impracticability Zone Monitoring

The boundary of the TI Zone is shown on Figure 1-2. This boundary was derived in the *Final Technical Memorandum, Technical Impracticability Evaluation for Alluvial Ground Water, Butte Priority Soils Operable Unit, Silver Bow Creek/Butte Area NPL Site, Butte, Montana,* April 2006 (EPA 2006) and adopted in the BPSOU ROD. This evaluation addressed the alluvial aquifer within the BPSOU and a small section southeast of the eastern BPSOU boundary extending south to the area of Clark Park. Ground water contamination in the bedrock aquifer, which lies beneath and north of the alluvial aquifer, has been addressed by EPA as part of the BMFOU. A TI determination for the bedrock aquifer was made and, as a result, an ARARs waiver for the bedrock aquifer was invoked in the Mine Flooding operable unit ROD.

Much of the TI Zone is located in an urban area covered with municipal infrastructure, historic mining features, railroad lines, and commercial and residential structures that limit options to remove or remediate sources of metals and arsenic to ground water. Purpose

The purpose of TI Zone ground water monitoring includes the following objectives:

- Determine if contaminated ground water is leaving the TI Zone. Coordinate Controlled Ground Water Area monitoring among other sites or OUs particularly Butte Mine Flooding Operable Unit and Montana Pole and Treating Plant NPL Site

2.4.1.1 Sampling Locations and Frequency

The wells included in the TI Zone monitoring network are listed in Table 2-1 and shown on Plate 1. This network includes the point of compliance wells located along the south boundary between the MSD and Blacktail Creek and the west boundary of BPSOU. In addition, this network includes wells within the TI Zone boundary, and a limited number of wells adjacent to the TI Zone boundary. The sampling and water level frequencies for TI Zone wells are shown on Table 2-1.

2.4.1.2 Point of Compliance Monitoring

The implementation of contingency remedy measures may occur with consecutive exceedances in the point of compliance wells above the arsenic, copper, cadmium,

lead, mercury, or zinc performance standards outlined in Section 1.3. Upon exceedance of a performance standard in any of the point of compliance wells, the EPA /DEQ shall be specifically notified and the well or wells in question will be resampled. Should resampling confirm the results, a draft contingency plan shall be prepared. Upon the confirmed exceedance in the same point of compliance well, this shall constitute a violation triggering one or more of the following contingency measures as determined by EPA in consultation with DEQ. Ground water within the interior of the TI zone will be monitored for trends to evaluate if conditions are changing which may lead to a point of compliance violation.

2.4.2 MSD Ground Water Capture System Monitoring

Ground water capture by the subdrain is intended to prevent contaminated ground water from entering Silver Bow or Blacktail Creeks. This component of the Selected Remedy removes a significant source of contaminant loading to Silver Bow Creek during base flow conditions.

2.4.2.1 Purpose

The MSD ground water capture system will be monitored to determine its effectiveness. The capture system monitoring includes analysis of the following:

- Water levels, including nested well pairs, to determine whether contaminated ground water in the shallow and deeper portions of the aquifer is flowing toward, or being captured by, the subdrain.
- Water levels in the MSD hydraulic control channel.
- Subdrain load monitoring to determine the effectiveness of the subdrain and changes in the effectiveness.

2.4.2.2 Sampling Locations and Frequency

The wells included in the MSD capture system monitoring network are listed in Table 2-1. This network includes wells following the MSD corridor and extends to Blacktail Creek in the area of the pump vault. The monitoring wells will be sampled and water level information collected on various schedules as presented in Table 2-1.

2.4.2.3 MSD Subdrain Load Monitoring

The ROD states that flows in the MSD subdrain will be measured in the fall, during base flow, using dye tracer methods to determine flows and metals loading entering the subdrain. Load monitoring in the MSD Subdrain was completed once in 2009 and was presented in the Draft Final Metro Storm Drain (MSD) 2009 Tracer-Dilution Study Technical (Atlantic Richfield 2010). This investigation concluded that alternative methods of measuring flows and loading would be equally effective and easier to implement than dye tracer methodology. As a result, the requirement for load monitoring using a dye tracer will be waived and replaced by an alternate monitoring method. Flumes shall be installed within manholes in the subdrain and a load monitoring plan will be developed as a part of O&M of the subdrain to

determine whether the subdrain continues to operate as expected and is not fouling or clogging. This plan is further discussed as *Task 5 - MSD Subdrain Monitoring Procedures*.

2.4.3 Lower Area One Capture System Monitoring

Hydraulic controls constructed during the Lower Area One Expedited Response Action (ERA) capture contaminated ground water and prevent it from discharging to Silver Bow Creek. Contaminated ground water is captured in the hydraulic control channel (HCC) and routed to the Butte Treatment Lagoon System.

2.4.3.1 Purpose

The purpose of LAO capture system monitoring is to determine the effectiveness of this capture system and ensure that contaminated ground water is not leaving BPSOU or discharging to Silver Bow Creek at levels causing performance standard violations. Actual operation and maintenance of the Butte Treatment System Lagoons, including operating water levels, will be provided in a separate operations and maintenance plan prepared by the PRP Group. The monitoring program shall include at a minimum:

- Water levels, including nested well pairs, to determine whether contaminated ground water in the shallow and deeper portions of the aquifer is flowing toward the capture system, and including staff gages in the HCC and D2, D3, D4 Cells and water level monitoring in several monitoring wells to determine whether ground water is leaving the capture system.`

- Water quality, including nested well pairs, to evaluate water quality in the vicinity of the ground water divide caused by the capture system.

2.4.3.2 Sampling Locations and Frequency

The wells and surface water staff gages included in the LAO capture system monitoring network are listed in Table 2-1. Well sampling and water level monitoring frequencies are presented in Table 2-1. Water-level measurements from wells in Montana Pole and Treating Plant Site may be used to expand the potentiometric surface map. Water levels from within the Montana Pole Site will be coordinated with their operations.

2.4.4 Monitoring Ground Water between LAO and MSD Capture Systems

Between the expanded LAO and MSD ground water capture systems, there are approximately two thousand feet of uncaptured ground water. Recent stream monitoring data indicate that contaminated ground water does not consistently impact Silver Bow Creek through this reach. Unlike the reconstructed stream channel and floodplain in LAO which is elevated above the water table, this reach is in hydraulic contact with the water table making it vulnerable to contaminated ground

water inflow. In order to evaluate the ground water quality trends in this area, surface water and ground water monitoring shall be coordinated in this area.

2.4.4.1 Purpose

Ground water shall be monitored in this area to determine ground water quality and hydraulic factors that control ground water-stream interaction. Monitoring shall consist of the following:

- Water level monitoring, including nested well pairs, to determine horizontal and vertical hydraulic gradients.
- Wells linked to surface water stations to determine hydraulic gradient between the stream and the aquifer.
- Ground water quality sampling, including nested well pairs, to determine ground water quality in the shallow and deeper portions of the aquifer.

2.4.4.2 Sampling Locations and Frequency

The wells and surface water staff gages included in the monitoring network for this area between capture systems are listed in Table 2-1. Well sampling and water level monitoring frequencies are presented in Table 2-1.

2.4.5 Private Well Monitoring

Private wells include those used for irrigation and industrial purposes. Private wells within the TI zone will be inventoried, sampled and monitored. There are no known publicly-owned production wells within the BPSOU.

2.4.5.1 Purpose

The purpose of monitoring domestic and irrigation wells is to ensure that the public and the environment are being protected from contaminated ground water underlying the TI Zone. Monitoring private wells will also help document changes in water quality within contaminant plumes. To the extent a Controlled Ground Water Area will not prevent the use of existing wells, the PRP Group will be implementing, after Agency review and approval, an education and well abandonment program. The program will persuade owners not to use contaminated water and to take existing wells out of service in exchange for public water service.

2.4.5.2 Sampling Locations and Frequency

An inventory of existing private wells and their current use will be completed as part of Task 6 detailed in Section 3.6. Access agreements to sample private wells will be obtained as needed. All private wells with access agreements will be sampled at a minimum of every five years. Wells used for drinking water will be sampled annually if water quality exceeds or approaches those drinking water quality standards specified in the ROD.

2.5 Reporting

2.5.1 Annual Reports

All data collected under this GWMP will be validated and reported in annual DSRs. The format of these reports shall follow the format provided in the *Clark Fork River Superfund Site Investigations, Pilot Data Report Addendum* (ARCO 2000), but may incorporate data analysis and interpretation as needed. Additionally, EPA may analyze data, as necessary, to assess current site conditions.

The annual DSR will compile the data and information collected during the course of the calendar year (January 1 through December 31). The purposes for preparing the annual report are as follows:

- Provide an annual summary of ground water data and information collected each year
- Summarize QA/QC issues
- Document deviations from the SAP
- Summarize the changes made to the ground water monitoring network.
- Note and highlight the wells that exceed performance standards
- Provide all data in a digital electronic format (e.g., electronic database or Microsoft Excel spreadsheet; pdf is not considered a digital electronic format)

The annual DSR will be submitted to EPA and DEQ by the end of the first quarter of the following calendar year (March 31). All data generated may be subject to Agency data validation.

2.5.2 Private Well Owner Reports

Reporting results to individual well owners is also required. The well owner, EPA, and DEQ should be notified immediately of any exceedance in a domestic or irrigation well. Reporting to the well owner shall include a cover letter that includes a discussion of the analytes exceeded (if any) and a copy of the analytical report with the laboratory results. Submission of this correspondence shall be in coordination with EPA and DEQ.

2.6 Data Management

Data collected during implementation of the BPSOU GWMP will be compiled in a long-term ground water monitoring database. The BPSOU ground water database will be updated with the monitoring data on an annual basis. All data generated will be managed according to the procedures developed in *Task 4 – Data Management Plan*.

2.7 Plan Revision

At least every five years, the EPA in consultation with the State, will review the ground water monitoring program's completeness. This Plan may be modified by EPA and the State, including, without limitation, contractors, monitoring locations, and analytical methods or parameters which may be added or deleted from the program, or adjustments to monitoring frequency. The five-year review will be used to analyze and if necessary adjust the requirements of the monitoring program as determined by EPA and the State.

Section 3 Ground Water Monitoring Program Tasks

This section of the GWMP describes the tasks that shall be completed by the PRP Group.

3.1 Task 1 - Ground Water Sampling and Analysis

A Sampling and Analysis Plan (SAP) for ground water monitoring shall be prepared. This section outlines the methods and procedures to be included in the SAP used to monitor ground water quality and flow within BPSOU. Ground water monitoring wells shall be monitored as described in this GWMP.

3.1.1 Monitoring Network

The monitoring well network and schedule of sampling and water level measurements, as presented in Table 2-1, will be incorporated into the SAP. The SAP should specify that the well network and monitoring program may be revised depending on the results of the monitoring.

3.1.2 Data Quality Objectives

The preparation of data quality objectives (DQOs) is required on Clark Fork River Superfund Site Investigation (CFRSSI) projects. The DQO process is a series of planning steps that is designed to ensure that the type, quantity, and quality of environmental data used in decision-making are appropriate for the intended purpose. Please refer to *Guidance on Systematic Planning Using the Data Quality Objectives Process, EPA QA/G-4,* February 2006 (United States Environmental Protection Agency, Office of Environmental Information Washington, DC 20460, EPA/240/B-06/001).

3.1.3 Standard Operating Procedures

Ground water sampling identified in this GWMP will be performed in accordance with the general *CFRSSI Standard Operating Procedures (SOPs)* (ARCO 1992a) and the *CFRSSI Quality Assurance Project Plan (QAPP)* (ARCO 1992b). The CFRSSI SOPs applicable to this monitoring program include, but may not be limited to, the following:

- Document Control (G-3)
- Field Logbook/Photographs (G-4)
- Sample Packaging and Shipping (G-5)
- Field Quality Control Samples (G-6)

- Sample Custody (G-7)
- Decontamination of Equipment used to Sample Soil and Water (G-8)
- Identification of Samples and Analytical Results (G-11)
- Data Security and Data Transfer (G-12)
- Measurement of Field Parameters (HG-6, HG-7, HG-8)
- Ground Water Sampling for Inorganics (GW-1)
- Field Procedure for Non-Steady State Aquifer Test Using Constant Discharge Rate and Multiple Wells (GW-2)
- Monitor Well Design and Construction (GW-3)
- Well Development (GW-4)
- Measurement of Water Elevation, Floating Product Thickness, and Determination of Well Casing Volume (GW-5)
- Continuous Ground Water Level Monitoring (GW-8)

Since the time the CFRSSI SOPs were developed in 1992, technological improvements have been made to monitoring equipment and procedures. For example, a variety of all-in-one instruments are now available for the collection of field parameters. Updated or amended SOPs will be included in the SAP prepared for BPSOU ground water monitoring.

3.1.4 Ground Water Sampling Procedures

Monitoring well sampling and sample handling, preservation, custody, and other associated activities will be performed according to the applicable *CFRSSI SOPs* (ARCO 1992a) for ground water sampling and sample water filtration. Ground water sampling is to be conducted with equipment consistent with *CFRSSI SOPs* (ARCO 1992a). Field parameters to be measured and documented at the time of sampling are included in Table 2-1. Ground water samples will be field-filtered and preserved at the time of sample collection to allow for laboratory analysis of the dissolved concentrations of selected parameters.

3.1.5 Ground Water Level Measurements

Ground water level measurements will be taken with a water level measuring device, consistent with CFRSSI SOP GW-5 (ARCO 1992a). The SOP for continuous ground water level monitoring (CFRSSI SOP GW-8) shall be followed, but the SOP will require updating to take into account the equipment that is actually used.

3.1.6 Laboratory Analysis

Table 2-1 presents the list of laboratory parameters that will be measured and documented under the BPSOU GWMP. Samples will be analyzed using methods consistent with the EPA *Contract Laboratory Program (CLP) Statement of Work ILM05.3* (EPA 2004). Analyses will be completed by a certified or EPA-approved laboratory. These analytical method and detection limit requirements will be updated as this CLP Statement of Work is updated by EPA. A table listing analytes, analytical methods, and detection limits will be included in the sampling and analysis plan.

3.2 Task 2 –Well Installation

As specified in the ROD, new monitoring wells shall be installed to supplement the existing ground water monitoring network. The locations of additional wells are specified in Table 2-1 and Plate 1. At a minimum, the new well installation plan will include the following elements:

- Contact person(s) for the new well installation
- A map showing the proposed new well locations
- A table showing proposed depths and screened intervals
- Proposed well construction diagrams and materials
- Well log form and well logging procedures
- Soil samples, if any, to be collected and analytes
- Well installation schedule
- Well installation completion report details
- Health and safety plan

3.3 Task 3 – Data Reporting and Management

Given the large amount of data that will be collected during monitoring, a data management program is required. It is anticipated that preparing a data management plan will be a collaborative effort among EPA, DEQ, and the PRP Group. The data management plan should address, at a minimum, the following elements:

- Electronic format of data packages
- Database management
- Data accessibility
- Quality control procedures

- Roles and responsibilities of system managers and data users
- The data manager must incorporate relevant Butte Mine Flooding data into the BPSOU data set
- The plan must specify that locations are to be recorded in NAD 83 State Plane Feet (FIPS 2500) for horizontal coordinates and NAVD 29 Feet for vertical elevations.

3.4 Task 4 – MSD Subdrain Load Monitoring

Although the ROD required load monitoring using dye tracer flow measurement and standard water sampling to determine whether the subdrain continues to operate as expected and is not fouling or clogging, the requirement for dye tracer methodology has been waived. A replacement method of load monitoring using flumes installed in manholes and conventional flow monitoring and sampling shall be developed. A plan for monitoring flow and loading in the MSD will be developed to ensure the subdrain is operating optimally. At a minimum, the load monitoring plan should address the following elements:

- Determine a pumping level in the vault that ensures that the subdrain is not adding contaminated water back into the aquifer in the vicinity of the pump vault
- Establish flumes or weirs and totalizers within the subdrain to continuously monitor flow
- Identify monitoring wells adjacent to the subdrain to be monitored that will signify when subdrain cleanouts are needed
- Overall description of flow measurement and monitoring procedures
- Location and description of monitoring points
- Description of flow measurement techniques
- Developing an SOP for the flow measurement and water sampling within the subdrain
- Monitoring schedule

Section 4 Performance Evaluation

Post-ROD monitoring of ground water at the BPSOU has been conducted since 2007. Many of the wells within the BPSOU have a longer monitoring history, with analytical results dating back to 1982. Additionally, remedial actions have altered conditions at the site with major changes in the vicinity of the capture systems.

The challenge in interpreting the analytical data is to determine if the monitoring objectives set forth in the ROD (refer to Section 2.1.1) are being met. Due to the variability in the data for a given well from quarter to quarter or year to year, it is not always evident if the increasing trend that would be expected to be associated with impacts to areas of interest is occurring. Therefore, analysis of the data using statistical methods is warranted. The trend of the onsite well concentrations will be the earliest indication of the water quality that will eventually appear in the contingency wells.

4.1 Overview

The software program *Monitoring and Remediation Optimization System* (MAROS) shall be used to perform statistical evaluation of the monitoring data. The MAROS program is a public domain program developed by the Air Force Center for Environmental Excellence (AFCEE). An explanation of the MAROS software and the calculations used by the software is included in **Appendix A**. The MAROS methodology pertinent to BPSOU includes the following tests:

Test	Purpose
Mann-Kendall Trend Test	To determine the trend of the data over time. Gives only the direction and probability of a trend, and not the magnitude.
Linear Regression Analysis	To verify and visually evaluate the magnitude of any trend predicted by the Mann-Kendall Test.

4.2 Mann-Kendall Trend Test

The first step in evaluating long-term ground water monitoring data will be to determine if the trend is increasing. The Mann-Kendall Test Statistic (S) is a value that when positive indicates an increasing trend and when negative a decreasing trend. The larger the S statistic and the greater the number of samples used in the calculation, the higher the statistical probability (confidence) that the trend is real and not due to chance. The Coefficient of Variation (COV) measures the degree of variation of individual data points from the mean. A low COV can be an indicator of

a stable concentration trend as opposed to an indefinable trend. The MAROS program designates the following general trend classifications with respect to COV and percent confidence:

Mann-Kendall Statistic	Confidence in Trend	Trend Designation
S > 0	> 95%	Increasing
S > 0	90 - 95%	Probably Increasing
S > 0	< 90%	No Trend
S ≤ 0	< 90% and COV ≥ 1	No Trend
S ≤ 0	< 90% and COV < 1	Stable
S < 0	90 - 95%	Probably Decreasing
S < 0	95%	Decreasing

4.3 Linear Regression

The linear regression method is used by MAROS to provide an alternate method of determining trends. Based on the slope of the linear regression, the magnitude of the trend can be evaluated as well. Linear regression is an evaluation of the log slope of concentration versus time. Confidence limits and COV are measured in a similar manner to the Mann-Kendall analysis. The MAROS program designates the following general trend classifications for regression analyses with respect to COV and percent confidence:

Confidence in Ln Slope	Trend	
	Positive	**Negative**
<90%	No Trend	COV < 1 Stable COV > 1 No Trend
90% – 95%	Probably Increasing	Probably Decreasing
> 95%	Increasing	Decreasing

If an increasing trend is identified but concentrations of the evaluated constituent remain below RGs, the magnitude of the linear regression slope will be considered when determining the need for further action.

4.4 Response to Increasing Trends

Increasing statistical trends are defined for the purposes of this GWMP as a positive Mann-Kendall S value or a positive linear regression slope. If an increasing trend in a COC is indentified with 90 percent or greater confidence (i.e. designated as "increasing" or "probably increasing" by the MAROS program), in an Early Warning Well, it will require a re-assessment of the ground water collection component of the Selected Remedy (e.g., use of additional subdrains, hydraulic control channels, or extraction wells), and may require additional remedy measures to protect the future surface water. Examples of causes of increasing statistical trends include, but are not limited to, incomplete system capture or an expanding plume (i.e., ground water leaving the TI zone). Monitoring objectives and appropriate measures to ensure those objectives are achieved are set forth in the ROD and summarized in Section 2.1.1. Further information on contingencies required to ensure the objectives are being met will be included in the final Remedial Design/ Remedial Action Work Plan for the Silver Bow Creek/ Butte Area.

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Section 5 Schedule

Sampling of monitoring wells will be completed such that the seasonal fluctuation of the water table is captured by the low and high water sampling events. The BPSOU high-water sampling event will be completed in July, and the low-water event will be completed in January. Timing of sampling may be altered based on additional data collection.

Each ground water sampling event will start by collecting synoptic water levels. The water level at each monitoring well in the network will be collected during the first two days of each monitoring event prior to the collection of any ground water samples. The water level at each well will also be measured just prior to purging and sampling the well.

The ground water monitoring program schedule is shown in Table 5-1. This schedule is provided only as a planning tool and as a basis for subsequent, more refined schedules.

Table 5-1
BPSOU Ground Water Monitoring Program Schedule

Task	Description	Responsibility	Schedule
---	Community Relations	EPA/DEQ	Ongoing
GWMP	GWMP	EPA/DEQ	March 31, 2011
1	Ground Water Sampling and Analysis Plan	PRP Group	May 31, 2011
2(a)	Well Installation Plan	PRP Group	Plan – May 31, 2011
2(b)	Install Monitoring Wells	PRP Group	July 15, 2011
3	Data Management Plan	EPA/DEQ PRP Group	January 15, 2012
4	MSD Subdrain Load Monitoring	EPA/DEQ PRP Group	December 21, 2011
Annual Report	Annual Data Summary Report	PRP Group	By March 31 of the following year
Private Well Owner Reports	Provide sample results to private owners of domestic or irrigation wells	PRP Group	Within 45 days of receipt of data

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Section 6 References

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Figures

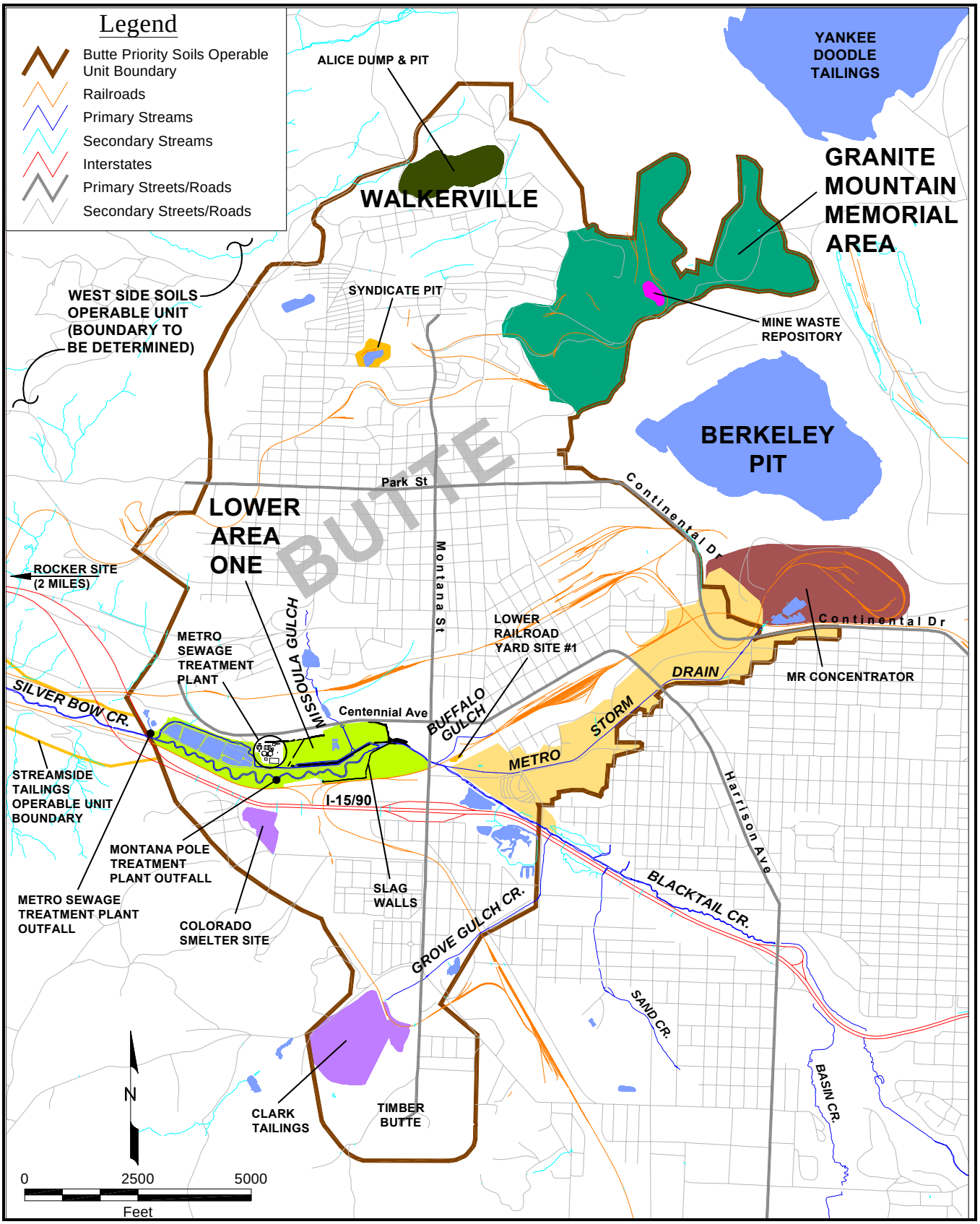

Figure 1-1
Site Map
Interim Ground Water Monitoring Plan
Butte Priority Soils Operable Unit
Silver Bow Creek/Butte Area NPL Site

Montana Department of Environmental Quality

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

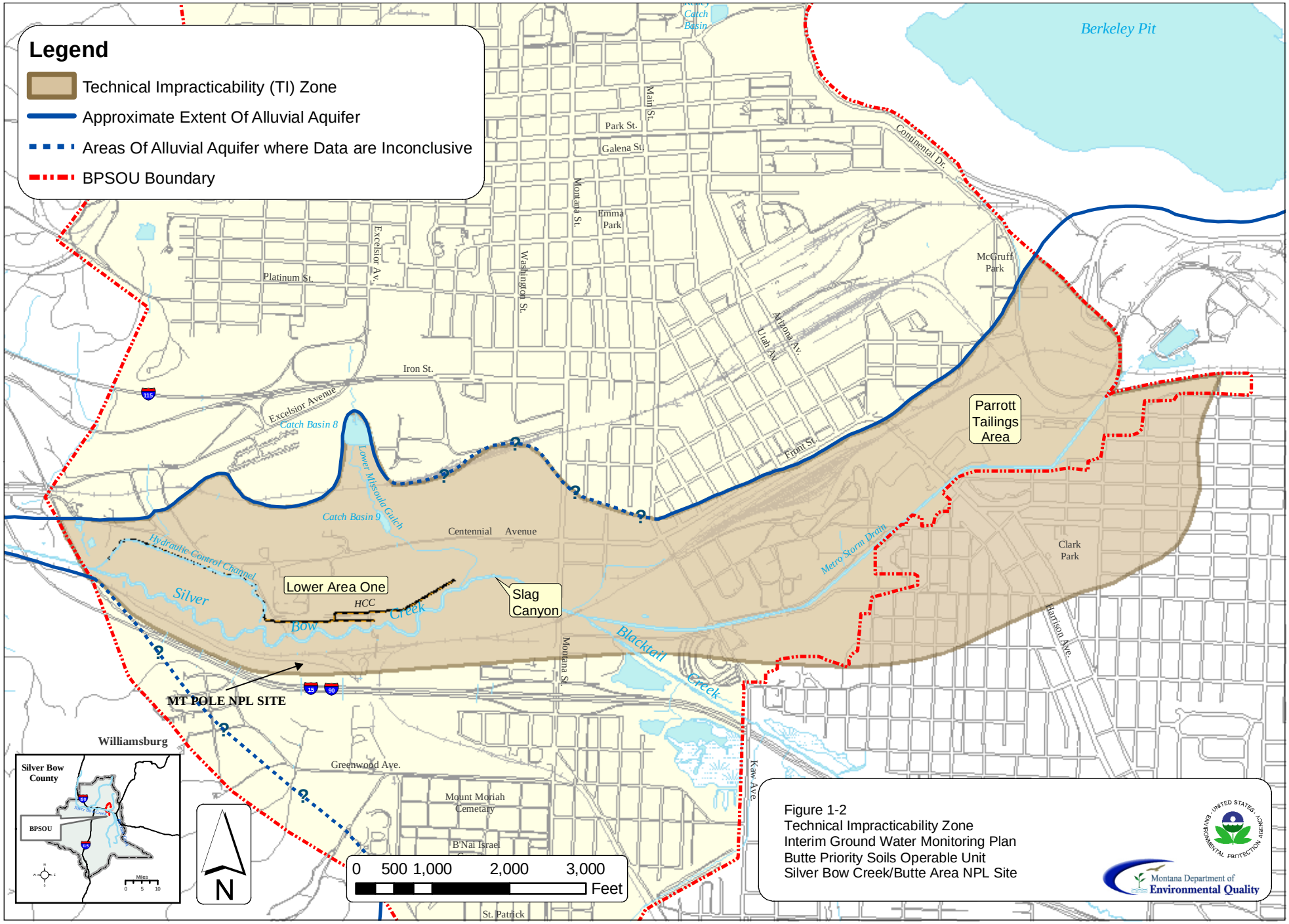

Figure 1-2
Technical Impracticability Zone
Interim Ground Water Monitoring Plan
Butte Priority Soils Operable Unit
Silver Bow Creek/Butte Area NPL Site

Montana Department of Environmental Quality

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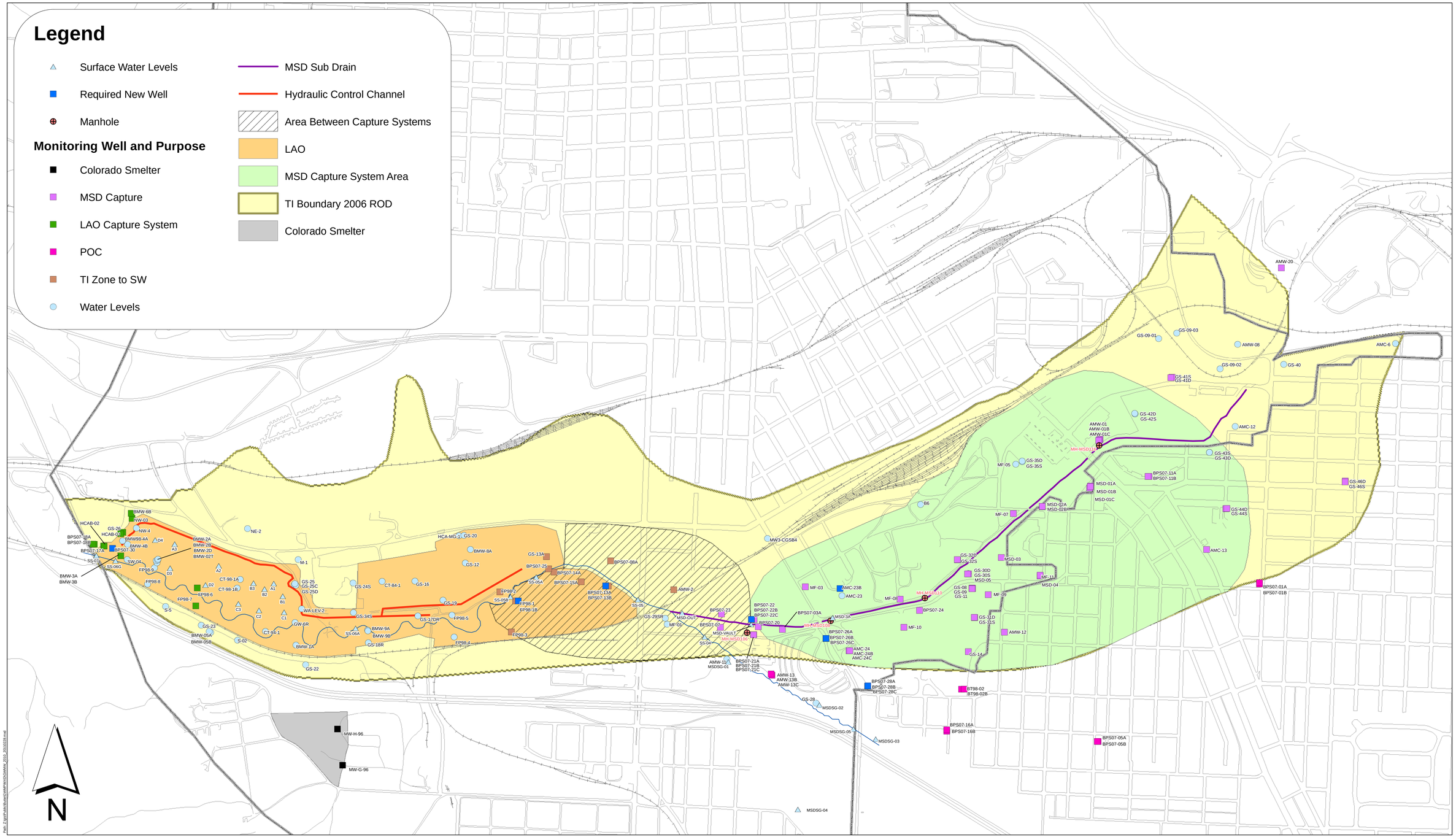

Plate 1
Ground Water Monitoring Wells

Butte Priority Soils Operable Unit
Revised Interim Ground Water Monitoring Plan
Silver Bow Creek / Butte Area NPL Site
Butte / Silver Bow County, Montana

0 500 1,000 2,000 3,000 4,000 Feet

Tables

TABLE 2-1. BUTTE PRIORITY SOILS GROUND WATER MONITORING NETWORK

Well ID		Multi/Single Depth	Purpose	Water Level	Chemistry	Location	Screened Interval (feet)	Aquifer
Alluvial Aquifer Technical Impracticability Zone Network								
AMW-13A		Multiple Depth	POC	Continuous	Semi-annual	South of Visitor Center	5-15	UAU
AMW-13B		Multiple Depth	POC	Continuous	Semi-annual	South of Visitor Center	33-43	MAU
AMW-13C		Multiple Depth	POC	Continuous	Semi-annual	South of Visitor Center	70.5-80.5	LAU
BPS07-01A		Multiple Depth	POC	Monthly	Semi-annual	Clark Park	12.5-22.5	UAU
BPS07-01B		Multiple Depth	POC	Monthly	Semi-annual	Clark Park	29-39	MAU
BPS07-05A		Multiple Depth	POC	Monthly	Semi-annual	Southwest of Clarks Park	25-35	UAU
BPS07-05B		Multiple Depth	POC	Monthly	Semi-annual	Southwest of Clarks Park	69-79	MAU
BPS07-16A		Multiple Depth	POC	Monthly	Semi-annual	SW Corner Nevada and Majors	10-20	UAU
BPS07-16B		Multiple Depth	POC	Monthly	Semi-annual	SW Corner Nevada and Majors	30-40	MAU
BPS07-28A	New Required Well	Multiple Depth	POC	Monthly	Semi-annual	Corner of Kaw and Cobben	Shallow	UAU
BPS07-28B	New Required Well	Multiple Depth	POC	Monthly	Semi-annual	Corner of Kaw and Cobben	Mid-Level	MAU
BPS07-28C	New Required Well	Multiple Depth	POC	Monthly	Semi-annual	Corner of Kaw and Cobben	Deep	LAU
Metro Storm Drain Capture System Monitoring Network								
AMC-12		Multiple Depth	MSD Capture	Monthly	Qrtrly then semi-Annual	East of Parrot	water table	UAU
AMC-13		Single Depth	MSD Capture	Monthly	BMFOU	Clark Park	47-55	MAU
AMC-23B	New Required Well	Multiple Depth	MSD Capture	Monthly	Semi-annual	East of Kaw Ave.	Mid-Level	MAU
AMC-24		Multiple Depth	MSD Capture	Continuous	Semi-annual	KOA	13-23	UAU
AMC-24B		Multiple Depth	MSD Capture	Monthly	Semi-annual	KOA	40.5-50.5	MAU
AMC-24C		Multiple Depth	MSD Capture	Monthly	Semi-annual	KOA	69.5-79.5	LAU
AMW-01A		Multiple Depth	MSD Capture	Continuous	Semi-annual	Civic Center	3-13	UAU
AMW-01B		Multiple Depth	MSD Capture	Continuous	Semi-annual	Civic Center	33-43	MAU
AMW-01C		Multiple Depth	MSD Capture	Monthly	Semi-annual	Civic Center	87-97	LAU
AMW-12		Single Depth	MSD Capture	Monthly	Semi-annual	Utah St	7-22	UAU
AMW-20		Single Depth	MSD Capture/GW Divide	Monthly	Semi-annual	Ecology Ponds	23-38	UAU
AMW-8		Multiple Depth	MSD Capture/GW Divide	Monthly	Semi-annual	North of Texas and Continental	water table	UAU?
BPS07-03A		Multiple Depth	MSD Capture	Monthly	Semi-annual	South of Pump Vault	9-19	UAU
BPS07-07		Single Depth	MSD Capture	Continuous	Semi-annual	West of MSD Pump Vault	5-15	UAU
BPS07-11A		Multiple Depth	MSD Capture	Monthly	Semi-annual	Between Parrott Tailings - Clark Park	12-24	UAU
BPS07-11B		Multiple Depth	MSD Capture	Monthly	Semi-annual	Between Parrott Tailings - Clark Park	34-44	MAU
BPS07-20		Single Depth	MSD Capture	Monthly	Semi-annual	N of MSD Vault	5-8	UAU
BPS07-21A		Multiple Depth	MSD Capture	Continuous	Semi-annual	S of MSD Vault	13-23	UAU
BPS07-21B		Multiple Depth	MSD Capture	Continuous	Semi-annual	S of MSD Vault	36-46	MAU
BPS07-21C		Multiple Depth	MSD Capture	Continuous	Semi-annual	S of MSD Vault	60.5-70.5	LAU
BPS07-22		Single Depth	MSD Capture	Continuous	Semi-annual	S of MSD Vault	5-15	UAU
BPS07-22B	New Required Well	Multiple Depth	MSD Capture	Continuous	Qrtrly then semi-Annual	N of MSD Vault	Mid-Level	MAU
BPS07-22C	New Required Well	Multiple Depth	MSD Capture	Continuous	Qrtrly then semi-Annual	N of MSD Vault	Deep	LAU
BPS07-23		Single Depth	MSD Capture	Continuous	Semi-annual	N of MSD Vault	5-15	UAU
BPS07-24		Single Depth	MSD Capture	Continuous	Qrtrly then semi-Annual	S of George St / East of KOA	58.5-68.5	MAU
BPS07-26A	New Required Well	Multiple Depth	MSD Capture	Continuous	Qrtrly then semi-Annual	E of KOA/ S of MSD-3A	Shallow	UAU
BPS07-26B	New Required Well	Multiple Depth	MSD Capture	Continuous	Qrtrly then semi-Annual	E of KOA/ S of MSD-3A	Mid-Level	MAU
BPS07-26C	New Required Well	Multiple Depth	MSD Capture	Continuous	Qrtrly then semi-Annual	E of KOA/ S of MSD-3A	Deep	LAU
BPS07-27A	New Required Well	Multiple Depth	MSD Capture	Monthly	Qrtrly then semi-Annual	KOA	Shallow	UAU
BPS07-27B	New Required Well	Multiple Depth	MSD Capture	Monthly	Qrtrly then semi-Annual	KOA	Mid-Level	MAU
BPS07-27C	New Required Well	Multiple Depth	MSD Capture	Monthly	Qrtrly then semi-Annual	KOA	Deep	LAU
BT98-02A		Multiple Depth	MSD Capture	Monthly	Semi-annual	South of Diggings East	14-19	UAU

TABLE 2-1. BUTTE PRIORITY SOILS GROUND WATER MONITORING NETWORK

Well ID	Multi/Single Depth	Purpose	Water Level	Chemistry	Location	Screened Interval (feet)	Aquifer
BT98-02B	Multiple Depth	MSD Capture	Monthly	Semi-annual	South of Diggings East	32-42	MAU
GS-09-01	Single Depth	MSD Capture	Monthly	Semi-annual	Parrott Tailings	30.6-40.6	UAU
GS-09-02	Single Depth	MSD Capture	Monthly	Semi-annual	Parrott Tailings	26-36	UAU
GS-09-03	Single Depth	MSD Capture	Monthly	Semi-annual	Parrott Tailings	34-44	UAU
GS-11	Multiple Depth	MSD Capture	Continuous	Semi-annual	Diggings East	8-18	UAU
GS-30D	Multiple Depth	MSD Capture	Monthly	Semi-annual	Northside Tailings	28.5 - 30.5	UAU
GS-30S	Multiple Depth	MSD Capture	Continuous	Semi-annual	Northside Tailings	14-20	UAU
GS-31D	Multiple Depth	MSD Capture	Monthly	Semi-annual	Diggings East	29-39	UAU
GS-31S	Multiple Depth	MSD Capture	Continuous	Semi-annual	Diggings East	15-20	UAU
GS-32D	Multiple Depth	MSD Capture	Monthly	Semi-annual	Northside Tailings	27-37	UAU
GS-32S	Multiple Depth	MSD Capture	Monthly	Semi-annual	Northside Tailings	27-37	UAU
GS-40	Multiple Depth	MSD Capture/GW Divide	Monthly	Semi-annual	Continental and Texas		MAU
GS-41d	Multiple Depth	MSD Capture	Monthly	5-year (2013)	Parrott Tailings	51 - 61	MAU
GS-41s	Multiple Depth	MSD Capture	Monthly	5-year (2013)	Parrott Tailings	34 - 39	UAU
GS-44D	Multiple Depth	MSD Capture	Monthly	Semi-annual	Clark Park	50 - 60	MAU
GS-44S	Multiple Depth	MSD Capture	Monthly	Semi-annual	Clark Park	20 - 25	UAU
GS-45	Multiple Depth	MSD Capture	Monthly	Semi-annual	Parrot Tailings	49-59	UAU
GS-46d	Multiple Depth	MSD Capture	Monthly	Semi-annual	East of Clark Park	51 - 61	MAU
GS-46s	Multiple Depth	MSD Capture	Monthly	Semi-annual	East of Clark Park	25 - 30	UAU
GS-8	Multiple Depth	MSD Capture	Continuous	Semi-annual	Diggings East	127-145	LAU
GS-9	Multiple Depth	MSD Capture	Continuous	Semi-annual	Diggings East	60-75	MAU
MF-07	Single Depth	MSD Capture	Continuous	Semi-annual	Casey St at MSD	13-18	UAU
MF-08	Single Depth	MSD Capture	Continuous	Semi-annual	End of Delaware St.	9-14	UAU
MF-09	Single Depth	MSD Capture	Monthly	Semi-annual	Diggings East	11-16	MAU
MF-10	Single Depth	MSD Capture	Continuous	Semi-annual	Diggings East	12-17	UAU
MF-11	Multiple Depth	MSD Capture	Monthly	Semi-annual	Oregon and George	10-15	UAU
MSD01A	Multiple Depth	MSD Capture	Monthly	5-year (2013)	SW of Harrison Ave	6-16	UAU
MSD01B	Multiple Depth	MSD Capture	Monthly	Semi-annual	SW of Harrison Ave	40-45	MAU
MSD01C	Multiple Depth	MSD Capture	Monthly	Semi-annual	SW of Harrison Ave	110-115	LAU
MSD-02A	Multiple Depth	MSD Capture	Continuous	Semi-annual	Casey St at MSD	Shallow	UAU
MSD-02B	Multiple Depth	MSD Capture	Continuous	Semi-annual	Casey St at MSD	35-45	MAU
MSD-03	Single Depth	MSD Capture	Continuous	Semi-annual	NE of Diggings	40-50	MAU
MSD-04	Multiple Depth	MSD Capture	Monthly	Semi-annual	Oregon and George	45-55	MAU
MSD-05	Multiple Depth	MSD Capture	Continuous	Semi-annual	Northside Tailings	50-55	MAU
MSD-HCC			Flow Continuous	Monthly			
Subdrain Flumes	Single Depth	MSD Capture	Flow Continuous	Annually	MSD		Drain Rock

TABLE 2-1. BUTTE PRIORITY SOILS GROUND WATER MONITORING NETWORK

Well ID		Multi/Single Depth	Purpose	Water Level	Chemistry	Location	Screened Interval (feet)	Aquifer
Monitor Area Between Ground Water Capture Zones								
AMW-2			Uncaptured	Monthly	Semi-annual	Buffalo Gulch - Mouth	10-20	UAU
BPS07-08A		Single Depth	Uncaptured	Monthly	Semi-annual	Next to SS-05	9-19	UAU
BPS07-13A		Single Depth	Uncaptured	Monthly	Semi-annual	S of Blacktail Creek- concrete yard	23-33	UAU
BPS07-13B	New Required Well	Multiple Depth	Uncaptured	Monthly	Semi-annual	S of Blacktail Creek- concrete yard	Mid-Level	
BPS07-14A		Single Depth	Uncaptured	Monthly	Semi-annual	S of Blacktail Creek- concrete yard	16-26	UAU
BPS07-15A		Single Depth	Uncaptured	Monthly	Semi-annual	S of Blacktail Creek- concrete yard	25-35	UAU
BPS07-25A		Single Depth	Uncaptured	Continuous	Semi-annual	Next to SS-05a	10.5-20.5	UAU
FP98-1			Uncaptured	Monthly	Semi-annual	LAO	4 - 6	UAU
FP98-1B	New Required Well	Multiple Depth	Uncaptured	Monthly	Qrtrly then semi-Annual	LAO	Mid-Level tag BR	MAU
FP98-2			Uncaptured	Monthly	Semi-annual	LAO	3 - 18	UAU
FP98-3			Uncaptured	Monthly	Semi-annual	LAO	3 - 5	UAU
GS-13A		Single Depth	Uncaptured	Continuous	Semi-annual	West end of Slag Canyon	8 - 18	UAU
Lower Area One Capture System Monitoring Network								
BMW-3A		Multiple Depth	LAO Capture	Continuous	Semi-annual	Near SS07	14-19	Weathered Bedrock ?
BMW-3B		Multiple Depth	LAO Capture	Continuous	Semi-annual	Near SS07	36-50	Bedrock
BMW-6B		Single Depth	LAO Capture	Continuous	5-year (2013)	West End HCC	59-79	Bedrock
BPS07-17A		Single Depth	LAO Capture	Continuous	Semi-annual	West End LAO	10-20	UAU
BPS07-18A		Multiple Depth	LAO Capture	Continuous	Semi-annual	West End LAO	30-40	UAU
BPS07-18B		Multiple Depth	LAO Capture	Continuous	Semi-annual	West End LAO	8-18	UAU
FP98-6		Single Depth	LAO Capture	Continuous	Semi-annual	New SBC Floodplain	5-15	UAU
FP98-7		Single Depth	LAO Capture	Continuous	5-year (2013)	New SBC Floodplain	5-15	UAU
GS-26		Multiple Depth	LAO Capture	Continuous	5-year (2013)	West End HCC	9-14	UAU
HCAB-01		Multiple Depth	LAO Capture	Continuous	Semi-annual	West End HCC	40-50	Bedrock
HCAB-02		Single Depth	LAO Capture	Continuous	Semi-annual	West End HCC	25-35	Bedrock
NW-03		Single Depth	LAO Capture	Continuous	5-year (2013)	West End HCC	No Log	No Log
Colorado Smelter Repository Monitoring Network								
MW-G-96		Single Depth	Colorado Smelter Repository	Monthly		East of repository	19-29	
MW-H-96		Single Depth	Colorado Smelter Repository	Monthly		Northeast of repository	16-26	

TABLE 2-1. BUTTE PRIORITY SOILS GROUND WATER MONITORING NETWORK

Well ID	Multi/Single Depth	Purpose	Water Level	Chemistry	Location	Screened Interval (feet)	Aquifer
Water Levels Only - Site Wide							
BMF96-02			Monthly		Community Health Center	149-169	Bedrock
BMF96-03			Monthly		BSB Health Department	145-165	Bedrock
BMF96-04			Monthly		Charlie Judd Park	167-187	Bedrock
Staff gages along Silver Bow Creek			Monthly	None			
Staff gages in the Hydraulic Control Channel			Monthly	None			
Staff gages Treatment Lagoons A2 and A3			Monthly	None			
Staff gages Treatment System D2, D3 and D4 Cells			Monthly	None			
AMC-23			Continuous	BMFOU	East of Kaw Ave.	19-29	UAU
BMW-1A			Quarterly		LAO	22-32	UAU
BMW-2A			Quarterly		LAO	13-19	UAU
BMW-2B			Quarterly		LAO	45-55	Bedrock
BMW-2D			Quarterly		LAO	186-196	Bedrock
BMW-4B			Quarterly		LAO	27-37	Bedrock
BMW-5A			Quarterly		LAO	5-8	UAU
BMW-5B			Quarterly		LAO	37-57	Bedrock
BMW-8A			Quarterly		LAO	5-11	UAU
BMW-9A			Quarterly		LAO	15-25	UAU
BMW-9B			Quarterly		LAO	44-54	Weathered Bedrock
CT-84-1			Quarterly		LAO	11-16	UAU
CT-94-1			Quarterly		LAO	11-24	UAU
FP98-4			Quarterly		LAO	5-15	UAU
FP98-5			Quarterly		LAO	5-15	UAU
FP98-8			Quarterly		LAO	2.25-4.25	UAU
FP98-9			Quarterly		LAO	5-15	UAU
GS-12			Quarterly		LAO	19-29	UAU
GS-16			Quarterly		LAO	11-16	UAU
GS-17D			Quarterly		LAO	18-28	UAU
GS-18			Quarterly		LAO	11-16	UAU
GS-19			Quarterly		LAO	13-18	UAU
GS-20			Quarterly		LAO	18-23	UAU
GS-22			Quarterly		LAO	5-15	UAU
GS-23			Quarterly		LAO	14-19	UAU
GS-25			Quarterly		LAO	4-9	UAU
GS-25C			Quarterly		LAO	84-94	Weathered Bedrock
GS-25D			Quarterly		LAO	166-176	Bedrock
GS-29S			Quarterly		Visitor's Center	8-13	UAU
GS-34S			Quarterly		LAO	12-17	UAU
GW-6			Quarterly		LAO	10-20	UAU
HCA-MG1 (ALT FOR HCA-MG3)			Quarterly		LAO	17-27	UAU
M-1			Quarterly		LAO	5-8	UAU
MF-01			Continuous		George St. and Montana Ave.		UAU

TABLE 2-1. BUTTE PRIORITY SOILS GROUND WATER MONITORING NETWORK

Well ID	Multi/Single Depth	Purpose	Water Level	Chemistry	Location	Screened Interval (feet)	Aquifer
Water Levels Only - Site Wide (continued)							
MF-05			Quarterly		Northside Tailings	12-17	UAU
MW-3 (MPC)			Quarterly		West of Kaw Ave. at RR	3-13	UAU
MW-3			Quarterly		North of Montana Pole		
MW-3 (CGSB-4)			Quarterly		East of Kaw Ave. N. of MSD	T.D. 24.4	UAU
NE-2			Quarterly		LAO	15-20	Weathered Bedrock
NW-4			Quarterly		LAO	10-20	UAU
S-2			Quarterly		LAO	25-28	UAU
S-5			Quarterly		LAO	16-23	Weathered Bedrock
AMC-12			Continuous		East of Parrott Tailings	35-45	UAU
AMC-6			Continuous	BMFOU	East of Parrott Tailings	53-63	MAU
AMW-11			Quarterly		Visitor's Center	4-14	UAU
GS-28			Monthly		South of KOA	6-11	UAU
GS-10A(D)			Quarterly		South of Parrot Tailings	100-110	LAU
GS-42S			Continuous	BMFOU	East of Parrott Tailings	13-18	UAU
GS-42D			Continuous	BMFOU	East of Parrott Tailings	47-57	MAU
GS-30D			Quarterly		Diggings East	28-38	UAU
BPS07-30	New Required Well		Continuous		West End HCC	Shallow	UAU

Notes:

MSD Capture System Wells	These wells evaluate the effectiveness of the MSD ground water capture system at controlling the movement of contaminated ground water in the MSD area.
GW Divide	These wells evaluate the location of the groudn water divid in the vicinity of the Parrot Tailings.
TI Zone POC Wells	POC wells are uncontaminated and will remain uncontminated as long as the remedy is effective. Increases in COC concentrations will trigger an action.
Uncaptured	Thes wells evaluate condition in the area between the capture systems.
LAO Capture System Wells	These wells evaluate the effectiveness of the LAO ground water capture system at controlling the movement of contaminated ground water in the LAO area.
Colorado Smelter Repository	These wells evaluate the hydrologic and water quality conditions at the Colorado Smelter repository.
Butte Mine Flooding Well	These wells are currently monitored by the BMFOU. Monitoring data should be included as an appendix in the BPSOU ground water moinitoring DSRs.
New Required Well	Wells designated as new wells to be installed after 2010.

TABLE 2-2. BPSOU NEW MONITORING WELLS

Required New Monitoring Wells

Well ID	Purpose	Location	Aquifer
BPS07-22B	MSD Capture	N of MSD Vault	MAU
BPS07-22C	MSD Capture	N of MSD Vault	LAU
BPS07-26A	MSD Capture	E of KOA/ S of MSD-3A	UAU
BPS07-26B	MSD Capture	E of KOA/ S of MSD-3A	MAU
BPS07-26C	MSD Capture	E of KOA/ S of MSD-3A	LAU
AMC-23B	MSD Capture	East of Kaw Ave.	MAU
BPS07-13B	Area Between Capture Systems	S of Blacktail Creek- concrete yard	MAU
BPS07-30	Compliance West End	Old SBC Channel beyond HCC	UAU
FP98-1B	Area Between Capture Systems	LAO	MAU
BPS07-28A	POC Boundary	Corner of Kaw and Cobben	UAU
BPS07-28B	POC Boundary	Corner of Kaw and Cobben	MAU
BPS07-28C	POC Boundary	Corner of Kaw and Cobben	LAU

Appendix A
MAROS Software User Manual

The MAROS software manual is available for download at the following link:

http://www.gsi-net.com/software/free-software/maros.html#MAROS_Download