DATA COMPILATION REPORT FOR THE BLACK PINE MINE

GRANITE COUNTY, MONTANA

Prepared for:

Montana Department of Environmental Quality

Hydrometrics, Inc.
Consulting Scientists and Engineers

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Prepared for:

Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901

Prepared by:

Hydrometrics, Inc.
3020 Bozeman Avenue
Helena, MT 59601

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1.0 INTRODUCTION

The Black Pine Mine is located approximately eight miles northwest of Philipsburg in Granite County, Montana (Figure 1-1). Although the term Black Pine Mine refers to a specific historic mine dating back to the late 1800s, the term also refers to a wider area of historic and more recent mining activity in the immediate area of the historic Black Pine Mine. Unless specified otherwise, the term Black Pine Mine as used in this report refers to the general area of historic and more recent mining activity, near the historic Black Pine Mine.

The Black Pine Mine (BPM) area includes approximately 1,056 acres of patented mining claims and surrounding National Forest System Lands located primarily in Sections 7, 8, 9, 16, 17, 18, 20, and 21 in Township 8 North, Range 14 West (Figure 1-1). Primary features at the BPM include the modern day Combination and Tim Smith Mines, the Lewis Shaft headframe, and remnants of the historic Combination Mill and tailings impoundment. The current and historic mine features are shown on Figure 1-2 and are discussed further in Section 1.2. The site currently holds an active permit for hardrock mining (Permit #00063), although the mine has been inactive and on standby status since the early 1990s.

1.1 SCOPE AND PURPOSE

This report presents a compilation of environmental monitoring data and other relevant information from the BPM. The report is intended to provide an overview of past monitoring activities\results and current site conditions to aid in future site use and reclamation planning. This report has been prepared for the Montana Department of Environmental Quality (MDEQ) Remediation Division under MDEQ Contract 407034. As specified in the project

Task Order, the report includes:

- Copies of mine maps showing historic and current mine workings;
- A summary of environmental data collected at the site and maps of monitoring locations;
- A summary of monitoring activities and results tracking groundwater elevations over time in the inactive Combination Mine underground workings;
- A summary of mine waste volumes and characteristics at the BPM;
- A summary of active permits and reporting requirements;
- Identification of data gaps that could affect preliminary reclamation planning and recommendations for addressing data gaps.

This data compilation for the BPM is based on information collected or compiled by Hydrometrics over the past 10+ years, as well as information collected by others and provided by MDEQ to aid in this effort. The report represents a comprehensive summary of past environmental monitoring activities at the BPM, although certain monitoring data could not be obtained for inclusion. It is hoped that at least some of this information, or other sampling data the authors may not be aware of, will become available through agency review of this report.

1.2 SITE BACKGROUND AND FEATURES

Large-scale mining began at the BPM around 1885 with the discovery of silver-bearing vein deposits (Volin et al, 1952). In 1887, a 10-stamp mill was constructed on South Fork Lower Willow Creek, with the mill operating until 1897 when mining ceased due to a depressed metals market. Between 1887 and 1897, additional stamps were added to the mill along with concentrators, roasters and a pan amalgamation process (Black Pine Mining Company, 1981). According to Volin et al. (1952), 2,135,00 ounces of silver were produced from 100,000 tons of ore during this period. The mine was idle until 1928, with various exploration activities and limited processing of primarily tailings and waste rock occurring up to 1947. Mining activities resumed from 1974 to 1980 by the Black Pine Mining

Company with the ore shipped to the Anaconda Smelter for use as siliceous flux and for recovery of silver and copper. Mining activities were last conducted by ASARCO, Inc., with the mine on temporary shutdown status since the early 1990s.

Four distinct mineral veins have been identified at the BPM including from highest to lowest (elevation-wise), the Upper, Tim Smith, Combination and Onyx Veins. All four veins generally conform to bedding within the Spokane formation bedrock, striking N 10º to 30º W and dipping 10º to 30º SW. Past mining has focused on the Combination Vein.

Figure 1-2 shows all identified mine openings and other features at the BPM. Primary current mine features include the Combination Mine portal (and auxiliary adit), Combination Mine waste rock pile, and the Tim Smith Mine portal and waste rock pile. Related features include a soil borrow area utilized as a source for coversoil during the Combination Mine reclamation activities in the mid-2000s, and the Combination Soils removal area and seepage collection/pumpback system located downgradient (east) of the Combination Mine waste rock pile (Figure 1-2).

Historic mine features include numerous mine adits and shafts, and the Combination Mill and tailings impoundment. The historic mine openings, including seven shafts and three adits (Figure 1-2) were utilized for accessing and extracting ore from the historic Black Pine Mine underground workings. All historic mine openings are now caved with the exception of the Lewis Shaft. During a 1957/58 site reconnaissance, Walker (1960) noted that all mine openings were caved at that time with the exception of the Lewis Shaft and Combination Adit #2 (Figure 1-2), although the #2 Adit has since collapsed. Walker reports a total of 1,000 feet of shafts and 14,000 feet of drifts and declines associated with the historic Black Pine Mine as of 1958. Volin et al. (1952) note that the historic underground mine workings include 22 levels, and that as of 1947, the mine was flooded up to Level 15. Historic and current mine water levels are discussed further in Section 4.0.

Remnants of the former Combination Mill are still visible along the South Fork Lower Willow Creek. As described above, the mill processed ore from the historic Black Pine Mine through a combination crushing, roasting and mercury amalgamation process. Tailings from the mill were stored in an adjacent earthen impoundment, with an estimated 70,000 cubic yards (cy) of tailings placed in the impoundment (Koerth, 2008). The tailings impoundment was partially reclaimed in the mid 1990s.

Numerous prospects pits, trenches and tunnels exist throughout the area although they are relatively minor in extent and were not used for extraction or processing of ore. Walker (1960) reports 10,732 linear feet of bulldozer trenching and 3,119 feet of diamond drilling from a post-WW II mineral reserve investigation program conducted by the U.S. Federal Bureau of Mines. Environmental monitoring associated with current and historic mine features is discussed in relevant sections of this report.

The remainder of this report presents relevant information and data from the BPM. Section 2.0 provides an overview of past water and soil/sediment monitoring programs, with the monitoring programs segregated by performing entity. Section 3.0 provides an overview of the monitoring results by geographic area. Section 4.0 includes information on mine waste volumes, mine water level monitoring and past reclamation activities at the BPM, and Section 5.0 includes a summary of data needs by site.

2.0 DATA COLLECTION PROGRAMS

Various entities have conducted environmental monitoring at the Black Pine mine over the past few decades. In general, past monitoring activities at the BPM fall under the following general categories or programs:

1. Baseline Hydrologic Data Collection: Hydrometrics conducted an investigation of water resources in 1981 at the BPM as part of a baseline data collection program associated with a hardrock mine proposed in the area.
2. Environmental Assessment and Reclamation Planning (2000-2010): Surface water, groundwater and soil sampling has been conducted at the BPM to assess environmental conditions and reclamation needs. This sampling focused on properties formerly owned by ASARCO (now owned by the Montana Environmental Custodial Trust), including the current Combination Mine and Tim Smith Mine. Hydrometrics conducted the majority of monitoring on behalf of ASARCO or MDEQ, with additional sampling conducted by ASARCO.
3. MDEQ Hardrock Mining Program Oversight Monitoring: The MDEQ Hardrock Mining Program has conducted periodic sampling events as part of their site compliance inspections conducted under the BPM operating permit. Sampling typically included surface water, spring/seep or soil sampling with samples collected during a total of eight inspections between 1995 and 2010.
4. MDEQ Total Maximum Daily Load (TMDL) Program: MDEQ conducted environmental monitoring events in the vicinity of the BPM in 2005, 2007, 2008 and 2009. Each sampling event included collection of surface water samples for analysis of trace metals and/or nutrients, with stream sediment, chlorophyll *a* and biological samples collected during select events. This information is being used to assess impairment conditions and for TMDL development in the Flint Creek drainage.
5. Historic Combination Mill Investigations: A number of sampling programs have been completed over the past several years to assess environmental conditions at the historic Combination Mill site. The Combination Mill investigations have generally

included soil sampling, surface water sampling, and/or stream sediment sampling in the South Fork Willow Creek. The primary monitoring programs focusing on the former mill have been conducted by Pioneer Technical Services, U.S. Forest Service and Schafer Associates.

The scope of these monitoring programs is described below. Monitoring results are described in Sections 3.1 (water resources data) and 3.2 (soils data). Water resources monitoring sites are shown on Exhibit 1 and Figures 2-1, 2-2 and 2-3. Soil sampling sites are shown on Exhibit 2 and Figures 2-4 and 2-5.

2.1 BASELINE HYDROLOGIC STUDIES

Hydrometrics completed water resources monitoring near the Black Pine Mine as part of a 1981 baseline data collection program. In addition to a review of existing information, the baseline monitoring program included collection of hydrologic data in the Smart Creek, Willow Creek and Marshall Creek drainages. The results of the baseline hydrologic study were presented in the *Baseline Water Resources Investigation for a Proposed Expansion of the Black Pine Min*e (Hydrometrics, 1981).

To obtain background water quality data, Hydrometrics sampled eight sites in the Black Pine Mine vicinity in July 1981. Laboratory analyses included specific conductance, turbidity, total suspended solids (TSS), total dissolved solids (TDS), pH, common ions, nutrients, and metals (both total and dissolved fractions). The baseline sampling activities are summarized in Table 2-1, and sampling locations are shown on Exhibit 1 and Figures 2-1, 2-2, and 2-3.

2.2 ENVIRONMENTAL ASSESSMENT/RECLAMATION PLANNING MONITORING

An extensive hydrologic monitoring and soil sampling program has been implemented at the BPM between 2000 and 2010. The purpose of this monitoring was; (1) to document recognized or potential impacts from mining disturbances associated with the current mine operating permit (#00063), with monitoring focused on the current Combination Mine portal/waste rock pile and the Tim Smith Mine, and (2) to provide information for the design and implementation of reclamation activities. The vast majority of this monitoring has been conducted by Hydrometrics on behalf of ASARCO or MDEQ, with some monitoring conducted by ASARCO. Portions of the MDEQ oversight monitoring discussed in Section 2.3 also contributed to the environmental assessment/reclamation planning program. Following is a chronological description of monitoring activities and associated documents.

2.2.1 Water Resources Monitoring

Routine collection of water samples from surface water, spring, and groundwater monitoring sites at the Black Pine Mine for environmental assessment/reclamation planning purposes was initiated in 2000. Water samples were generally collected in accordance with approved project-specific Sampling and Analysis Plans (SAPs) and Quality Assurance Project Plans (QAPPs), to ensure data quality. Field and laboratory quality control (QC) samples, including field duplicates and blanks, were collected and analyzed as part of most monitoring events, to allow assessment of data accuracy and precision. Sampling methodologies followed Hydrometrics' Standard Operating Procedures (SOPs), including measurement of field parameters (pH, specific conductance, water temperature, and dissolved oxygen) using field meters calibrated daily and checked periodically for instrument drift, and flow measurement using standard portable flumes (for smaller flows) or wading rods and current velocity meters (for larger streams). Static water levels were measured in wells with electric probes, and groundwater samples were collected using portable submersible pumps or bailers, depending on well yields. Sampling activities were fully documented in dedicated project field notebooks and on field sampling forms, and sampling locations were typically documented with photographs and GPS coordinates during each monitoring event. Samples were stored on ice in coolers, and were transferred to the analytical laboratory under standard chain-of-custody protocols.

The typical suite of analytical parameters used for environmental assessment and reclamation planning water resources monitoring at the Black Pine Mine is shown in Table 2-2, and includes the field parameters noted previously, along with laboratory analysis of major cations (calcium, magnesium, sodium, potassium), general water quality parameters (total dissolved solids, total suspended solids, total alkalinity/acidity), sulfate, and dissolved or total recoverable metals. Occasional modifications were made to this routine parameter list to support specific objectives; for example, initial monitoring events included additional metals such as silver, mercury and antimony, along with nitrate + nitrite, to fully evaluate water quality conditions.

An overall summary of the water resources monitoring conducted by Hydrometrics/ASARCO from 2000 – 2010 is in Table 2-3. Monitoring locations are shown on Exhibit 1 and Figures 2-1, 2-2, and 2-3. The monitoring events summarized in Table 2-3 are briefly described below, along with references to pertinent reports discussing monitoring results.

- <u>September-November 2000</u> – Initial site reconnaissance and a spring/seep inventory were conducted to assess existing water quality in drainages below the Combination and Tim Smith mine sites, and the quality of water pooled within the mine workings. Several of the 1981 baseline hydrological monitoring sites were resampled, including sites on Smart Creek (SCSW-1), a tributary to Smart Creek (SCTSW-1), South Fork Lower Willow Creek (WCSW-1), and Mill Creek (MCSW-1). Fall 2000 monitoring results were discussed in the *Preliminary Groundwater Report for the Black Pine Mine* (January 2001), included as part of the *Revised Reclamation Plan and Water Management Plan for the Black Pine Mine* (Hydrometrics, 2003).
- <u>2001 Monitoring Events</u> – Multiple sampling events were conducted in 2001 to continue the water resources evaluation initiated in 2000, and to evaluate potential seasonal variability in water quality at the Combination and Tim Smith mine sites. Primary monitoring events were conducted in May, June, and July 2001, with additional sampling performed in January, April, October, and November (Table 2-3). In January 2001, samples were collected from the mine pools for nitrate + nitrite analysis only. In April 2001, samples were collected at selected spring sites for metals analysis only. Groundwater monitoring wells CMMW-1, -2, -3, and -4 were

installed in October 2001, and wells CMMW-1, -3, and -4 were sampled in November 2001 (well CMMW-2 was dry). Other 2001 monitoring events consisted of sampling at established spring/seep and surface water sites. No summary report was prepared for the 2001 monitoring, but the data were reviewed, validated, and summarized in subsequent reports.

- April 2004 – At the request of MDEQ, established sites in the Combination and Tim Smith areas were sampled on April 23, 2004, to allow for continued evaluation of temporal water quality trends. A sample of inflow to the new seepage collection pond (constructed by ASARCO in 2004 at the upper end of the northern devegetated area below the Combination mine waste pile) was also collected at this time. Results of the April 2004 monitoring were reported in a July 11, 2004 letter from Mark Walker (Hydrometrics) to George Furniss (MDEQ).
- May 2005 – MDEQ requested additional water resources monitoring in 2005 as a continuation of the program conducted in 2004. Seepage collection pond inflow was sampled in May 2005, along with samples from previously established sites. In addition, three samples of runoff flow from the northern and southern soil removal areas below the Combination dump were collected during this monitoring event (designated North Drainage Runoff, North Removal Area Drainage, and South Removal Area Drainage in Table 2-3). Results of the May 2005 monitoring were reported in an August 29, 2006 letter from Mark Walker (Hydrometrics) to Herb Rolfes (MDEQ).
- 2006 Monitoring Events – Monitoring in 2006 was conducted in accordance with the 2006 Work Plan to document current water quality conditions peripheral to the mine, to assess potential water quality changes in response to mine reclamation activities, and to identify remaining potential sources of metals loading to water resources downgradient of the Combination Mine. Monitoring in September and November 2006 was restricted to the Combination Mine area (no samples from the Tim Smith area were collected); the mine pool, established spring sites, and three monitoring wells were sampled during this period. Results of the 2006 monitoring were presented in the *Interim Status Report for the Black Pine Mine* (Hydrometrics, 2007).

- 2007 Monitoring Events –Water resources monitoring at the Black Pine Mine in 2007 was a continuation of the 2006 monitoring program, and was intended to document current water quality conditions in the vicinity of the Combination Mine, and evaluate water quality trends over time and potential water quality improvements resulting from site reclamation activities. Monitoring events were conducted in March, April, May, and October 2007 at established surface water, groundwater, and spring locations below the Combination Mine. Runoff/drainage from the north and south soil removal areas was also sampled during the spring 2007 monitoring events. Shallow piezometers CMPZ-3S, CMPZ-3D, and CMPZ-4 were installed in April 2007; only CMPZ-4 yielded sufficient water for sampling in May 2007. Results of the 2007 monitoring were reported in the *2007 Monitoring Report for the Asarco Black Pine Mine* (Hydrometrics, 2008).
- 2008 Monitoring Events – 2008 water resources monitoring was a continuation of the 2007 monitoring program. Sampling was conducted in April, May, June, and October 2008 at routine monitoring sites below the Combination Mine. Additional springs appeared in the north soil removal area during 2008 (North Area Spring (N) and North Area Spring (S)), and were sampled in May 2008. Additional monitoring wells CMMW-5, -6, -7, -8, and -9 were installed during October 2008.
- May 2009 – New monitoring wells CMMW-5, -6, -7, -8, and -9 were sampled on May 14, 2009, along with existing well CMMW-2 and spring sites CPS-1, CPS-10B, and North Area Spring (N) (Table 2-3). A more comprehensive monitoring event was conducted on May 29, 2009, including collection of samples from all site monitoring wells, the Combination Mine pool, established spring and surface water sites below the Combination Mine, and site TSP-9 near the Tim Smith Mine. Monitoring results for 2009 were reviewed and tabulated but have not been previously reported.
- April 2010 – Monitoring of seven routine Combination area spring, surface water, and runoff sites was conducted by Hydrometrics on April 27, 2010. These monitoring results have not previously been reported.
- May 2010 – MDEQ conducted a groundwater monitoring event on May 18, 2010. All nine Combination site monitoring wells (CMMW-1 through CMMW-9) were

sampled during this event; these monitoring results have not previously been reported.

2.2.2 Soil Sampling

Soil sampling activities conducted at the Black Pine Mine site by Hydrometrics have consisted of an evaluation of the devegetated area downhill of the Combination Mine, characterization of mine waste at the Combination and Tim Smith mine sites, and an assessment of potential borrow soil sources for potential reclamation activities. All soil sampling by Hydrometrics was conducted in 2000 and 2001. Soil sampling activities are summarized in Table 2-4, and are briefly described below. Soil sampling locations are shown on Exhibit 2 and Figure 2-4.

<u>October 2000 Combination Soils Sampling</u> – As part of a revision to the Black Pine Mine Reclamation Plan submitted by ASARCO to MDEQ in October 2000, a field sampling and analysis program was designed and implemented to characterize an area of impacted soils downgradient (east) of the Combination Mine area, and to provide information necessary for evaluation of potential reclamation alternatives. The soil characterization program consisted of a GPS survey of the devegetated zone and collection of surface and subsurface soil samples from hand-dug test pits within and adjacent to the impacted area. A total of 24 surface soil samples were collected (generally from the 0 to 2-inch or 0 to 6-inch depth interval), including samples of the following visually distinctive soil types:

- Discolored (yellowish) devegetated soils (5 samples);
- Non-discolored devegetated soils (9 samples);
- Peripheral unimpacted soils (9 samples); and
- Background soil uphill of the impacted area (1 sample).

Twelve subsurface soil samples were collected (from the 2 to 8-inch or 6 to 8-inch depth interval), including:

- Native-appearing samples below discolored devegetated soils (4 samples) and
- Native-appearing samples below non-discolored devegetated soils (8 samples).

In addition to these samples, two five-spot composite samples of Combination Mine waste rock were collected, one from the northern portion of the pile and one from the southern portion. Waste rock samples were collected from the 0 to 2-foot depth interval.

Soil and waste rock samples were analyzed for total arsenic, cadmium, copper, lead, manganese, silver, and zinc using X-ray fluorescence (XRF), and for pH and acid-base accounting (including SMP lime requirements and sulfur fractionation). Specific parameters analyzed for each sample were dependent on the location and appearance of samples. The results of the 2000 Combination Soils investigation were reported in the *Preliminary Evaluation of the Combination Soils at the Black Pine Mine* (January 2001), included as part of the *Revised Reclamation Plan and Water Management Plan for the Black Pine Mine* (Hydrometrics, 2003).

October 2000 Borrow Soils Investigation – Concurrent with the Combination Soils investigation described above, Hydrometrics conducted an investigation of potential borrow soil sources at the Black Pine Mine, in anticipation of future reclamation activities and the need for a suitable source of soil for use as cover material and as growth medium.

A review of available soil survey information and a site reconnaissance identified ten potential coversoil borrow source areas in the vicinity of the mine on ASARCO-owned patented mine claims. Each area was delineated on a topographic map base, with approximate surface areas, slope position, and aspect recorded. Nineteen test pits were excavated on October 24-25, 2000 in these ten potential borrow areas, to depths of approximately 3 to 11 feet. Field observations were recorded at each pit, including existing vegetation, soil horizons, and estimated percent coarse fragments. A minimum of two composite samples were also collected from each pit for further evaluation.

Subsoil samples from borrow areas BPB-2, BPB-4, BPB-5, BPB-8, and BPB-10 were submitted to the laboratory for analysis of pH, sodium adsorption ratio (SAR), soil texture, and saturation percentage. Topsoil samples were analyzed for these same parameters plus organic matter, coarse fragment content, and N-P-K content. Clay-rich subsoil samples from BPB-2 and BPB-10 were tested for pH, grain size, and Atterberg limits.

The results of the borrow soils investigation were reported in the *Assessment of Potential Borrow Soil Sources at the Black Pine Mine* (January 2001), included as part of the *Revised Reclamation Plan and Water Management Plan for the Black Pine Mine* (Hydrometrics, 2003).

<u>July 2001 Test Pits</u> – Based on the results of the October 2000 investigation, further soil sampling and analysis was conducted in 2001 in the Combination Soils area in accordance with the 2001 Work Plan. Sampling activities were intended to fully delineate the lateral and vertical extent and estimated volume of impacted soils, in order to evaluate reclamation and site closure options.

Fourteen test pits were excavated at the Combination site, including eight within the north impacted area (NTP-1 through NTP-8), four within the south impacted area (STP-1 through STP-4), and two in peripheral (background) areas (BGTP-1 and BGTP-1). Samples were collected from each test pit at 1-foot intervals, to a maximum depth of 4 feet. Samples were analyzed for pH and total arsenic, cadmium, copper, lead, manganese, and zinc using XRF analysis, with split samples submitted for wet chemistry confirmation analysis.

In addition to the investigation of Combination Soils in 2001, samples were collected from the Combination and Tim Smith mine waste rock piles to provide further characterization of these potential sources of impacts. At the Combination site, five composite mine waste samples were collected as follows:

- 5-spot composite from 5 small test pits (0-18 inches) on the north portion of the pad;
- 5-spot composite from similar depths on the south portion of the pad; and
- Three separate composites collected along three trenches (about 25 feet long and 3 feet to 6 feet deep) excavated into the pad.

At the Tim Smith site, four composite mine waste samples were collected, two 5-spot composites from the east and west portions of the pad, and two trench composites collected along trenches excavated into the east and west portions of the pad. Mine waste samples were analyzed for total metals (XRF), acid-base accounting, pH, and sulfur forms. Results of the July 2001 Combination Soils investigation were reported in the *Revised Reclamation and Water Management Plan for the Black Pine Mine* (Hydrometrics, 2003).

The majority of water and soil sites sampled under the Environmental Assessment/Reclamation Planning monitoring programs at the Black Pine Mine were surveyed using resource-grade GPS equipment. Coordinates for all sites that were surveyed using GPS (latitude/longitude, WGS84 datum) are collected in Table 2-5 for reference.

2.3 MDEQ HARDROCK MINING PROGRAM OVERSIGHT MONITORING

The MDEQ Hard Rock Program has performed compliance inspections at the Combination Mine since at least 1995. Documented inspections included the collection of sixteen surface water samples and three water samples from the Combination Mine underground workings. Sample locations varied as many were selected in response to spring runoff and ephemeral flow patterns. In addition to water sampling, eight soil samples were collected during a 2008 inspection. Soil samples were analyzed for saturated paste pH, along with total arsenic, cadmium, copper, lead, and zinc. Table 2-6 summarizes water and soil sampling conducted as part of MDEQ inspections. Locations are shown on Exhibit 1 and Figure 2-1 (water samples) and Exhibit 2 and Figure 2-4 (soil samples) for those samples with available location data.

As discussed above in Section 2.2, the MDEQ Mine Waste Cleanup Bureau also conducted a groundwater monitoring event on May 18, 2010. Groundwater was collected from nine established monitoring wells at the Combination Mine site (Figure 2-1), and samples were submitted to the laboratory for analysis of dissolved metals, sulfate, sodium, pH, and TDS.

2.4 MDEQ TOTAL MAXIMUM DAILY LOAD MONITORING

The MDEQ Total Maximum Daily Load (TMDL) program has conducted periodic water sampling of streams within the watershed containing the Black Pine Mine since 2005. Water sampling data from these events is stored in the MDEQ STORET database. Table 2-7 summarizes sampling events within the area of interest along Smart Creek and the South Fork of Lower Willow Creek. Three sites on Smart Creek (C02SMRTC02/upstream, SMARTC03, C02SMRTC03/downstream) and six sites on South Fork Lower Willow Creek (SFLWILLOWC05/upstream, SFLWILLOWC04.5, SFLWILLOWC04, SFLWILLOWC03, SFLWILLOWC02, C02WLSFC01/downstream) were selected for inclusion in this data compilation due to their proximity to the Black Pine Mine. TMDL monitoring locations are shown on Exhibit 1.

2.5 HISTORIC COMBINATION MILL INVESTIGATIONS

The historic Combination Mill and associated tailings impoundment was located in the South Fork Willow Creek drainage (Figure 1-2). The former mill has been the focus of multiple site investigations over the past 20 years, with an emphasis on potential impacts to South Fork Willow Creek. The tailings impoundment located adjacent to South Fork Willow Creek was partially reclaimed in the mid-1990s. Sampling activities related to the Combination Mill and tailings impoundment are summarized in Table 2-8, with sampling locations shown on Exhibit 1and Figure 2-3 (water sites) and Exhibit 2 and Figure 2-5 (soil/sediment sites). A brief description of these sampling activities follows.

2.5.1 U.S. Forest Service Sampling

The USFS collected several sets of water quality samples in the South Fork Lower Willow Creek drainage in the vicinity of the Combination Mill site from 1988-1990. Sample locations were generally described as South Fork Lower Willow Creek above the mill and South Fork Lower Willow Creek below the mill, so exact locations are unknown. Surface water samples were collected in July 1988 and May 1990, and sediment samples (bedload and/or suspended sediments) were collected in June and July 1989 and May 1990 (Table 2-8). Laboratory analyses included metals (both water and sediment samples) along with nutrients (all water samples) and common ions (July 1998 water samples only)

2.5.2 ASARCO Sampling

ASARCO collected surface water and soil/tailings samples in the South Fork Lower Willow Creek in September 1990 for comparison with the USFS data (see in Section 2.5.1). The September 1990 sampling included collection of six water samples and four soil/tailings samples in the vicinity of the historic Combination Mill and tailings impoundment; exact sample locations are unknown (Table 2-8). Laboratory analyses included metals, TDS and TSS (water samples) and total metals (soil/tailings samples).

2.5.3 Schafer Associates

In the early 1990s, Schafer and Associates was contracted by the USDA Forest Service (USFS), Philipsburg Ranger District to complete a Phase I Stabilization Project at the historic Combination Mill Site. The project was initiated due to concerns that erosion and surface runoff of metals contaminated soils and tailings from the mill site and floodplain of South Fork Lower Willow Creek were being deposited onto adjacent USFS lands and into surface waters. The objectives of the project were to determine the degree and extent of contamination and evaluate potential reclamation and tailings stabilization options (Schafer and Associates, 1992).

Field activities were conducted by Schafer Associates on August 26-28, 1991, including:

- Collection of tailings, soil, water, and channel sediment samples;
- Measurement of soil/tailings pH;
- Mapping the extent and thickness of tailings within the floodplain and the extent of tailings migration downstream;
- Excavation of soil pits and collection of detailed soil profile descriptions; and
- Documentation of streambank and channel condition.

As shown in Table 2-8, Schafer and Associates collected a total of four water samples, 10 stream sediment samples, and 15 soil/tailings samples in August 1991 for analysis of metals and (for some soil/tailings samples) acid-base accounting. In addition, 80 pH measurements were recorded at 52 test pits located randomly on transects across the floodplain in tailings, soil, and soil/tailings substrates (Figure 2-5).

The *Final Report for the Combination Mill Site Stabilization Project, Black Pine Mining District, Montana* (Schafer, 1992) described field procedures, project results, and provided a list of nine reclamation options. Reclamation options identified varied from removal of tailings, to regrading and revegetation, to the addition of soil amendments.

2.5.4 Pioneer Technical Services Inc.

On July 21, 1993 and October 19, 1995, Pioneer Technical Services Inc. (Pioneer) conducted site investigations at the Combination Mill for the *Montana Department of Environmental Quality Hazardous Materials Inventory* (Pioneer, 1993 and 1995). Sampling event details are in Table 2-8, and locations are shown on Exhibits 1 and 2, along with associated Figures.

The July 1993 Pioneer site visit included collection of seven surface water samples, five stream sediment samples, one groundwater sample from seepage into a test pit, one "background" (unimpacted) soil sample, and soils/tailings samples from four test pits. Soil/tailings samples were analyzed for total metals in the field using XRF, with a composite sample submitted to the laboratory for total metals and ABA analysis (Table 2-8). Water samples were analyzed for metals, common ions, and nutrients, with selected samples analyzed for field parameters only. Stream sediment samples were analyzed for total metals.

The October 1995 Pioneer site visit targeted the area downstream of the historic mill and tailings impoundment. Samples collected in October 1995 included four surface water samples, four stream sediment samples, and soil/tailings samples from 12 test pits. Similar to July 1993, soil/tailings samples were analyzed in the field using XRF, and composite samples were prepared for laboratory analysis of total metals, along with ABA and cyanide (Table 2-8). Water samples were analyzed for common ions and metals, and stream sediment samples were analyzed for total metals.

3.0 REVIEW OF EXISTING DATA

Historically, data collection in the vicinity of the Black Pine Mine has focused on the following general areas:

1. Combination Mine Area – this area consists of the Combination mine portal (pooled water within the mine workings), the Combination waste rock dump, and hydrologic features/sampling locations and soils downslope (east) of the mine, including groundwater monitoring wells, springs, and the upper reach of Smart Creek and associated tributaries (Exhibits 1 and 2, Figures 2-1 and 2-4).
2. Tim Smith Mine Area – this area consists of the Tim Smith mine portal (pooled water within the mine workings), the Tim Smith waste rock dump, and hydrologic features/sampling locations both upslope (east) and downslope (west) of the mine, including springs and the reach of South Fork Lower Willow Creek above and below the unnamed ephemeral drainages below the mine (Exhibits 1 and 2, Figure 2-2).
3. Combination Mill Area – this area consists of the historical Combination Mill and tailings impoundment location near the confluence of South Fork Willow Creek and Mill Creek, including both these water bodies and their floodplains (Exhibits 1 and 2, Figures 2-3 and 2-5).
4. Other Areas – samples have been collected peripheral to these three primary investigation areas during baseline and TMDL-related monitoring, and as part of an investigation of potential reclamation-related borrow soil locations (Exhibits 1 and 2).

Existing water resources (Section 3.1) and soil (Section 3.2) results for each of these general investigation areas are discussed briefly below. Available analytical results for water resources and soil sampling conducted in the vicinity of the Black Pine Mine have been collected in Appendix A (water data) and Appendix B (soils data).

3.1 WATER RESOURCES MONITORING DATA

The primary source of relevant water resources monitoring data for the Black Pine Mine for environmental assessment and reclamation planning purposes is the database developed during 2000-2010 by Hydrometrics at the direction of ASARCO and MDEQ (see Section 2.2). Established monitoring locations were routinely sampled during this period, although monitoring frequencies varied from year to year.

3.1.1 Combination Mine Area

Spring sampling location CPS-1 is of particular interest since it is located directly downgradient of the Combination Mine portal and waste rock pile (Figure 2-1), and is where elevated trace metal concentrations were first detected at the Black Pine Mine in 2000. Beginning in 2001, flow from CPS-1 has been captured in a seepage collection and pumpback system (see Section 4.0). Water at CPS-1 has historically shown low pH (ranging from 3.3-4.5) and elevated metals concentrations, particularly cadmium (0.1 to 1.1 mg/L), copper (7.7 to 105 mg/L), and zinc (8.2 to 81 mg/L). Reported arsenic and lead concentrations are nearly always below analytical detection limits (Appendix A).

Concentrations of metals and other parameters at CPS-1 have decreased significantly since initial monitoring of the site in 2000-2001. For example, copper concentrations have decreased from a maximum of 105 mg/L in October 2001 to 7.71 mg/L in April 2010, a reduction of more than 90%. Decreasing trends over time are also apparent for other metal parameters, and for sulfate, which decreased from 1770 mg/L to 180 mg/L over the same time period. The onset of concentration reductions at CPS-1 is most apparent in 2006, and the trends may therefore be related to 2003-2006 reclamation activities, including capping the Combination waste rock pile and removal of the metals-bearing Combination Soils (Section 4.0).

Other springs in the area downgradient of the Combination portal and waste rock pile also show elevated metals concentrations, although concentrations have historically been somewhat lower than those observed at CPS-1. The following table summarizes observed copper concentration ranges for several of the Combination Mine area spring and surface water monitoring sites shown on Figure 2-1.

Site	Range of Observed Copper Concentrations (mg/L)
CPS-1	7.7 – 105
CPS-2	<0.001 – 0.033
CPS-7/7A	2.7 – 81
CPS-8	0.017 – 0.159
CPS-10B	3.3 – 13.0
CPSW-1	<0.001 – 0.578
CPSW-2	0.055 – 0.372

Concentration trends at CPS-7/7A have generally mirrored those at CPS-1, with sulfate and most metals concentrations decreasing significantly since 2001. Trends at the sites with lower metals concentrations (e.g., CPS-2 and CPS-8) are less clear, and tend to vary by parameter. At site CPS-8, for example, cadmium and zinc concentrations have exhibited decreases over time, although these trends appear to have moderated recently. Copper concentrations, however have been variable but have shown no long-term decreasing trend at CPS-8. Similarly, trends at site CPS-2 do not correlate well in terms of chemistry or hydrology with metals-bearing springs CPS-1 and CPS-7A. These differences in water quality trends suggest that the metals loading sources affecting CPS-1 and -7A are not present at other area springs such as CPS-8 and CPS-2.

Downstream monitoring sites CPSW-1 and CPSW-2 are monitoring points along the seasonal drainage stream flowing eastward from the Combination Mine (Figure 2-1). Water quality at these locations is seasonally variable, and depends to a large extent on the relative contribution of runoff from the north and south devegetated areas downgradient of the Combination waste rock pile. Copper concentrations at these two sites have ranged from <0.001 to 0.578 mg/L over the period of record, with sulfate values over the same period ranging from 6 to 281 mg/L. The data in Appendix A indicate that concentrations of metals and stream flow rates are often higher at the further downstream location (CPSW-2) compared with the upstream location CPSW-1. Similar to spring sites CPS-2 and CPS-8, site

CPSW-2 appears to show decreasing concentrations of cadmium and zinc over time, but relatively consistent copper concentrations. Slight decreases in concentrations of total dissolved solids and metals have also been observed at CPSW-1.

Water sampled from the Combination Mine pool has historically shown pH values from 3.3 to 5.4, sulfate concentrations in the 90 to 330 mg/L range, and 5.5 to 49.5 mg/L copper (Appendix A). The mine pool is also the only monitoring site in the Combination portal area to consistently exhibit elevated lead concentrations, which have ranged from 0.13 to 1.37 mg/L. Parameter trends in Combination mine pool water are variable, with no clear long-term increases or decreases apparent. Since the mine pool water sample has always been collected as a single grab from the edge of the pool in the Combination portal, it is also not entirely clear to what extent the samples are representative of the large volume of water (millions of gallons) contained within the Combination workings. Water chemistry at the mine pool surface is undoubtedly affected by the pumpback of downgradient seepage waters to the mine workings (Section 4).

Runoff and drainage from the devegetated areas east of the Combination waste rock pile have been sampled since 2005 (see North Removal and South Removal Area drainage sites on Figure 2-1). Runoff at these locations is typically elevated in metals concentrations, particularly in the northern area. Comparison of dissolved and total recoverable metals concentrations suggest that, at least in the Northern Removal area, elevated metals concentrations are largely related to the water source, rather than to erosion and entrainment of removal area soils. Metals concentrations in the South Removal Area drainage are about an order of magnitude lower than those in the North Removal Area drainage.

Groundwater quality in the vicinity of the Combination Mine and waste rock pile, assessed through sampling of area monitoring wells, shows considerable spatial variability. The following list of average observed copper concentrations at these wells illustrates the range of groundwater quality:

Well	Average Cu (mg/L)
CMMW-1	0.002
CMMW-2	0.699
CMMW-3	6.4
CMMW-4	4.6
CMMW-5	1.7
CMMW-6	0.015
CMMW-7	23.5
CMMW-8	1.4
CMMW-9	0.044

Overall, current water quality conditions and trends documented through past sampling show that infiltration/runoff from the waste rock pile has been a significant source of metals loading to downgradient seeps and springs in the past, but impacts from this source appear to have been reduced through capping of the pile. Groundwater flow through the lower portions of the waste rock pile and recharge from naturally mineralized bedrock remain potential sources of metals loading to springs/seeps and groundwater at the Combination Mine (Hydrometrics, 2008).

3.1.2 Tim Smith Mine Area

Based on the limited available data, water quality in the vicinity of the Tim Smith mine appears generally good, with metals concentrations near or below detection limits and pH values ranging from about 6.5 to 8.8 at spring and surface water monitoring sites (Figure 2-2). Water within the Tim Smith mine workings shows slightly elevated metals concentrations and a slightly acidic pH (5.9 to 6.7), but the mine pool water is of much better quality than the Combination Mine pool (Appendix A). Tim Smith Mine pool copper concentrations have ranged from 0.5 to 2 mg/L, with zinc concentrations of 0.31 to 0.74 mg/L, TDS of 86 to 135 mg/L, and low sulfate concentrations (16 to 28 mg/L).

Water quality at spring sites upgradient of the Tim Smith portal and waste rock pile (TSP-9 and TSP-10; see Figure 2-2) has shown low but detectable concentrations of metals, including copper (<0.001 to 0.017 mg/L), manganese (<0.01 to 0.27 mg/L), and cadmium (<0.0001 to 0.0021 mg/L), along with low sulfate (<5 mg/L) and TDS concentrations (97 to

165 mg/L). Sites downgradient of the mine portal and waste rock pile show some variability in water quality, with site TSP-1 slightly higher in TDS (165 to 233 mg/L) than other sites (53 to 152 mg/L). Site TSP-1 also shows moderate nitrate + nitrite concentrations (1.27 to 5.48 mg/L) and low but detectable concentrations of copper and cadmium. Average metals concentrations for samples from the monitoring site nearest to the waste rock pile (TSP-8) include 0.017 mg/L copper, 0.22 mg/L iron, and 0.03 mg/L zinc. Concentrations of other metals are largely below reporting limits. Site TSP-8 is ephemeral, and typically only flows during the spring runoff period.

Site TSP-6 in the lower Tim Smith drainage (Figure 2-2) was also sampled as baseline site 013 during the 1981 baseline study. A comparison of July 1981 (site 013) and July 2001 (site TSP-6) sampling results shows that water quality at the lower end of the Tim Smith drainage has remained consistent over this time period.

Metals Concentrations (mg/L) near Mouth of Tim Smith Drainage		
Parameter	**013 (1981)**	**TSP-6 (2001)**
Copper	<0.01	0.002
Cadmium	<0.001	<0.0001
Zinc	<0.01	0.01
Sulphate	11	5

3.1.3 Combination Mill Area

Water quality data from the South Fork Lower Willow Creek monitoring sites (Figure 2-3) indicate historic and ongoing impacts to the creek from the historic Combination Mill, located near the mouth of Mill Gulch. Recent data collected by MDEQ in support of TMDL development indicates that metals loads continue to increase in South Fork Lower Willow Creek through the historic Combination Mill and tailings impoundment area. For example, copper loads in the South Fork Lower Willow Creek upstream and downstream of the mill area, as well as in Mill Gulch (tributary to South Fork Lower Willow Creek in this reach), are presented below for May and August 2009. As shown by the data, copper loads downstream of the mill are significantly higher than the combined loads in South Fork Lower

Willow Creek and Mill Gulch upstream of the mill. The unaccounted for load increase, approximately 1.0 lbs/day in May and 0.49 lbs/day in August, is most likely attributable to surface runoff from or shallow groundwater flow through the mill and tailings impoundment area.

SF Lower Willow Cr Copper Loads (lbs/day)			
Location	Site Name	5/27/2009	8/20/2009
SFLWC upstream of Combination Mill	SFLWILLOWC05	0.56	0.032
Lower Mill Gulch	SFLWILLOWC04.5	0.37	DRY
SFLWC downstream of Combination Mill	SFLWILLOWC04	1.9	0.52

In addition to the documented load increases through the mill area, the available data was evaluated to assess metals concentration trends over time in lower Mill Gulch and in South Fork Lower Willow Creek upstream and downstream of the Combination Mill area. The available data show that water quality has remained relatively stable over the period of record both upstream and downstream of the mill. Copper concentrations over the period 1981 through 2009 upstream and downstream of the Combination Mill are summarized in the following table.

Copper Concentration (mg/L) Temporal Trends Upstream and Downstream of the Combination Mill			
Date	Lower Mill Gulch	SF Lower Willow Ck Upstream of Mill	SF Lower Willow Ck Downstream of Mill
7/17/81	NA	<0.010	NA
8/28/1991	0.010	0.010	NA
7/21/1993	0.0172	0.0019	0.022
10/19/95	NA	NA	0.024
10/4/2000	0.024	0.002	NA
6/7/2001	0.025	<0.005	NA
7/18/2001	0.017	0.003	NA
7/8/2008	0.021	0.001	0.017
8/11/2008	0.020	0.001	0.018
5/27/2009	0.020	0.002	0.02
8/18/2009	Dry	0.001	0.019

Lower Mill Gulch data from sites 2A, SW-2, MCSW-1, SFLWILLOWC04.5.
SF Lower Willow Creek Upstream data from sites 022, 1A, SW-3, WCSW-1 and SFLWILLOWC05.
SF Lower Willow Creek Downstream data from sites SW-1 and SFLWILLOWC03.
Site Locations shown on Exhibit 1 and Figure 2-3.
NA – No Data Available.

In summary, surface water quality data collected in the vicinity of the Combination Mill by various entities over the last 20 to 30 years has consistently shown metals concentration and/or loading increases in South Fork Willow Creek as it traverses the historically impacted area. These increases are likely attributable to the elevated concentrations in area soils, as noted below in Section 3.2.3. The available data also indicates that metals concentrations have remained relatively stable over the past 20+ years both upstream and downstream of the mill.

3.2 SOIL SAMPLING DATA

Much of the available soil data for the Black Pine Mine consists of results from samples of impacted soils and tailings that have subsequently been removed or reclaimed. These results are briefly discussed below, along with the results of waste rock sampling at the Combination and Tim Smith mine sites, and recent post-reclamation soil sampling conducted by MDEQ in 2008 at the Combination Mine soil removal areas below the Combination waste rock pile.

3.2.1 Combination Mine Area

Investigation of the area of barren soils downgradient (east) of the Combination Mine waste rock pile (referred to as the Combination Soils) in 2000 and 2001 showed that these soils contained elevated concentrations of some metals, including copper, zinc, lead and manganese, compared with peripheral soils outside of the barren area. Elevated metals concentrations in these soils were attributed to metals loading via runoff from the Combination waste rock pile and/or from a series of both intermittent (seasonal) and perennial (flowing year-round) metals-bearing seeps emanating from the slope below the waste rock pile. Evaluation of the 2000 and 2001 test pit sampling results for the Combination Soils led to the following conclusions:

- The “yellow silty” soils identified during the 2000 sampling showed high average concentrations of arsenic (1,355 mg/kg), lead (9,068 mg/kg), and zinc (6,484 mg/kg) compared with devegetated but native-appearing soils, which showed higher concentrations of copper (3,169 mg/kg in surface soils, compared with 1,054 mg/kg for the "yellow silty" soils).

- Excavation of test pits in 2001 showed that, on average, soil metals concentrations were highest in the area below perennial spring CPS-1, with lower but still elevated concentrations in the north barren area uphill of CPS-1 and in the south barren area. Average copper concentrations in surface soils (0 to 1-foot depth interval) were 1,680 mg/kg in the north area below CPS-1, 373 mg/kg in the north area above CPS-1, and 250 mg/kg in the south area, compared with 12 mg/kg in the background areas.
- While soil metals concentrations showed significant decreases with depth, observed concentrations at depths as great as 3 to 4 feet were still greater than background concentrations for copper, lead, and zinc. For example, in the north barren area below CPS-1, average copper concentrations of 1,680 mg/kg in the 0 to 1-foot depth interval decreased to 53 mg/kg at the 3 to 4-foot depth interval, compared with an observed range of 12 to 19 mg/kg at the background test pits.

Sampling of waste rock from the Combination Mine waste rock pile occurred in October 2000 and July 2001 concurrently with the investigation of the Combination Soils. Results for the Combination Mine waste rock samples showed a low to moderate acid-generating potential (acid-base potentials as $CaCO_3$ of +1 to -23 tons per 1,000 tons), slightly acidic pH values (5.1 to 6.6), and elevated metals concentrations, including averages of 425 mg/kg arsenic, 1,430 mg/kg copper, 2,923 mg/kg lead, and 1,259 mg/kg zinc. On average, Combination Mine waste rock appeared to have lower arsenic concentrations and higher zinc concentrations than Tim Smith Mine waste rock (discussed below).

Reclamation of the Combination Soils and regrading/revegetation of the Combination waste rock pile was conducted from 2003 to 2006 (see Section 4.0). Subsequent to these remedial activities, MDEQ collected eight soil samples (0 to 2-inch depth interval) in the area below the reclaimed Combination waste rock dump in 2008 to assess soil metals concentrations in areas visually identified as affected by runoff from the reclaimed dump.

The 2008 MDEQ soil sampling results for the area below the reclaimed Combination waste rock pile showed that elevated metals concentrations in surface soils remain in portions of the Combination Soils area, although on average the concentrations observed in 2008 were lower than previous results. The following table compares average soil metals concentrations obtained by Hydrometrics during the October 2000 surface soil sampling (native-appearing barren soils from the 0 to 2-inch interval) with the range and averages of concentrations obtained by MDEQ in 2008.

Parameter	October 2000 Average (mg/kg)	July 2008 Average (mg/kg)	July 2008 Range (mg/kg)
Arsenic	74	8	<5 – 25
Cadmium	14	6.4	<1 – 40.5
Copper	3169	697	51 – 1850
Lead	443	52	7 – 183
Zinc	537	387	91 – 1520

The highest soil metals concentrations observed in 2008 were obtained from samples collected at sites S-1 (east end of the north soil removal area), S-4 (downslope of seepage collection system overflow in the north soil removal area), and S-7 (accumulated sediment above a slash filter in the south soil removal area) (see Figure 2-4).

3.2.2 Tim Smith Mine Area

Existing and available soils data for the vicinity of the Tim Smith Mine consists of four composite waste rock samples collected by Hydrometrics in July 2001. The Tim Smith waste rock samples showed limited potential for acid generation (acid-base potential as $CaCO_3$ of 0 to -7 tons per 1,000 tons, pH values from 5.0 to 5.5) and moderate metals concentrations. Average total metals concentrations included 532 mg/kg arsenic, 1,165 mg/kg copper, 2,280 mg/kg lead, and 123 mg/kg zinc. Compared with Combination Mine waste rock, Tim Smith Mine waste rock appeared to have higher arsenic concentrations, lower zinc concentrations, and slightly lower acid-generating potential.

3.2.3 Combination Mill Area

Numerous investigations of soil chemical and physical properties in the vicinity of the historic Combination Mill have been conducted since the early 1990s. These investigations have uniformly reported low pH values and elevated metals concentrations in soils and stream sediments throughout the investigation area, extending for some distance downstream of the property boundary as far as 1995 Pioneer sites SE-1 and TP-4B (Figure 2-5 and Exhibit 2).

During the August 1991 investigation, Schafer and Associates recorded 80 field pH measurements at 52 test pits located randomly on transects across the floodplain in tailings, soil, and soil/tailings substrates. Measurements ranged from pH 2.33 (location 126) to pH 7.25 (location 178). Most field pH measurements ranged between 4 and 5 across the site, generally trending toward pH 4 downstream to the north boundary with lower pH 2 to 3 readings in the area of the main mill site in the southeast corner of the site. Schafer also reported arsenic concentrations ranging from 187 to 1,150 ppm; copper concentrations ranging from 591 to 8,650 ppm; lead concentrations ranging from 1,940 to 21,300 ppm; mercury concentrations ranging from 2 to 393 ppm; and silver concentrations ranging from 14 ppm to 573 ppm. The metals data indicate a general increase in metals levels from upstream to downstream locations, with the lowest concentrations found in the upper half of the site (Soil Samples 88-1B, 88-3B and 88-11A) and the highest concentrations generally found in the lower third of the site along the north (Soil Sample 88-8B) and east (Soil Sample 88-10A) study area boundaries (Figure 2-5).

Similar to Schafer, site investigations by Pioneer in 1993 and 1995 indicated the presence of elevated metals concentrations in soils and sediments throughout the area near and downstream of the historic Combination Mill. Field XRF results and laboratory analysis of soils and sediments yielded average concentrations of 380 ppm arsenic, 1,953 ppm copper, 3,508 ppm lead, and 116 ppm mercury (Appendix B). Although higher concentration soils were generally located closer to the presumed source (the historic mill and tailings impoundment), elevated concentrations persisted downstream as noted previously. Field

XRF concentrations at 1995 Pioneer site TP-4B included 730 ppm arsenic, 4,420 ppm copper, and 396 ppm mercury, and laboratory results for 1995 site SE-1 included 286 ppm arsenic, 1,270 ppm copper, and 47 ppm mercury (Appendix B, Exhibit 2).

3.2.4 Other Areas

Soil sampling activities peripheral to the Combination Mine, Tim Smith Mine, and Combination Mill areas of the Black Pine Mine site consisted of an assessment of potential borrow soil sources conducted in October 2000 by Hydrometrics. The borrow soil investigation was completed to identify potential sources of cover soil and/or growth medium, to be utilized during planned reclamation activities at the Combination and Tim Smith waste rock piles and the Combination Soils area downgradient of the waste rock pile.

Topsoil depths identified during the borrow soils investigation ranged from six inches to three feet, with the deepest topsoils observed in areas BPB-4, BPB-5, and BPB-10 (Exhibit 2). Topsoil composition consisted primarily of loam to silt loam textures, with moderate to high coarse fragment content (37% average), moderate water holding capacity (35% average), and organic matter contents of 1 to 5%. Nitrogen and potassium contents were generally low. Subsoil thicknesses ranged from two to eight feet in the borrow soil test pits, with the thickest subsoil deposits present at BPB-2, BPB-3, and BPB-4 (Exhibit 2). Considerable clayey material was encountered at depth in source areas BPB-2, BPB-3, BPB-6, and BPB-10. Subsoils encountered consisted of loams, silt loams, and sandy loams, with high coarse fragment content and low water holding capacities.

The report prepared for the borrow soils investigation concluded that soils from areas BPB-2, BPB-4, BPB-5, BPB-8, and BPB-10 were of acceptable quality for proposed reclamation efforts, with areas BPB-4 and BPB-10 proposed for reclamation of the Combination and Tim Smith mine areas, respectively, due to their proximity to the waste rock piles and other disturbances.

4.0 MISCELLANEOUS INFORMATION

This section presents miscellaneous information on the Black Pine Mine stipulated in the Task Order for inclusion in this report. The requested information includes estimates of mine waste volumes at the site, monitoring of mine water levels in the Combination Mine underground workings, and past reclamation-related activities at the BPM.

4.1 MINE WASTE VOLUMES

Mine waste volumes and areas have been estimated for those features at the BPM where sufficient information is available, including the Tim Smith Mine waste rock piles, Combination Mine waste rock pile, and the Combination Soils area. The mine waste volumes are discussed below and are summarized in Table 4-1.

4.1.1 Tim Smith Mine

The Tim Smith mine includes the main Tim Smith waste rock pile (Tim Smith #1) and the smaller Tim Smith #2 dump (Figure 1-2). The Tim Smith #1 pile is located at the main Tim Smith Portal (Figure 1-2) and is comprised of waste rock removed from the Tim Smith underground workings. Based on a detailed topographic survey conducted in 2001, the Tim Smith #1 pile has an estimated footprint area of 1.9 acres and is estimated to contain 23,500 cy of waste rock. Based on the footprint area, over-excavation of one foot of underlying soil would equate to an additional 3,000 cy of excavation material if the waste rock pile were moved to a different location. Chemical characteristics of the waste rock material are discussed in Section 3.2.2.

The Tim Smith #2 is a smaller waste rock pile located near the portal to a secondary access tunnel (Figure 1-2). The #2 dump has not been surveyed or sampled. Based on a review of aerial photos and maps, the #2 pile has an estimated footprint area of 0.25 acres and a fill volume of 9,200 cy. If the pile were to be excavated and relocated, over-excavation of one foot of underlying soil would equate to an additional 370 cy.

4.1.2 Combination Waste Rock Pile

The Combination waste rock pile was regraded in the mid-2000s to reduce the slope grade, and covered with a synthetic liner/soil cap (see Section 4.3). Based on a 2001 (pre-regrading) topographic survey, the Combination waste rock dump contains approximately 220,000 cy of waste rock. In it's current configuration, the dump footprint covers approximately 9.4 acres. Over-excavation of one foot of subsoil over this area would result in an additional removal volume of 15,150 cy. Based on current knowledge however, over-excavation of more than one foot of subgrade soils would likely be required if the Combination waste rock pile was relocated to an engineered repository. Chemical characteristics of the waste rock material are discussed in Section 3.2.3.

In addition to the waste rock volumes presented above, specifications for the Combination dump reclamation plan included placement of three feet of clean coversoil over the entire regarded surface. Based on the current dump configuration, a 3-foot soil cover would equate to approximately 25,500 cy of salvageable coversoil.

4.1.3 Combination Soils

As described in Section 2.2.2, the Combinations Soils area refers to an area of impacted soils downhill (east) of the Combination waste rock pile. Soils in this area are devoid of vegetation and contain elevated concentrations of some metals. The Combination Soils area encompasses two linear strips of land extending from the toe of the Combination waste rock pile downhill (eastward) several hundred feet.

The impacted Combination Soils were partially addressed during the mid-2000s reclamation program, including removal of an undetermined volume of soils and placement of the excavated soils beneath the Combination waste rock pile cap. To date, the area remains largely devoid of vegetation, and recent soil sampling by MDEQ (see Section 3.2.1) indicates that elevated concentrations of certain metals persist in the area. Based on a combined length of 2,500 feet and average width of 100 feet for the two impacted areas (Figure 1-2), the Combination Soils area covers approximately 5.5 acres. If additional soil removal were required in this area, the removal volume would be about 9,300 cy for each foot of soil removed.

4.2 MINE POOL ELEVATION MONITORING

The Combination Mine underground workings extend from the Combination Adit (and historic No. 1, No. 2 and Beunveneutra adits, Figure 1-2), southwestward at a 20-degree grade towards the South Fork Willow Creek. The mine workings are partially flooded due to a combination of groundwater inflow and pumping of shallow groundwater and springs/seep waters from the Combination Mine seepage collection system into the mine workings. The elevation of the mine pool has been monitored intermittently since 2000, with the frequency of monitoring increased in 2007. The elevation of the mine pool, or water surface within the underground mine workings, is important for two reasons. First, the mine pool has been recognized as a potential source of metals loading to springs and seeps located east of the Combination Mine, including spring CPS-1. Therefore, knowledge of the elevation and seasonal trends in the mine pool level is important to assess potential recharge relationships and correlations between the mine pool and the springs/seeps[1]. Second, since the Combination Mine seepage collection and pumpback system discharges to the mine pool, the current elevation and relative change in the mine pool elevation since pumpback was initiated is important in assessing the mine pool response to the pumpback discharge, and in assessing the storage capacity of the mine workings.

Starting in 2000, the mine pool elevation has been estimated periodically by recording the water surface location relative to various reference points of known elevation in the mine. Due to the significant distances between these reference points, elevations determined in this manner are considered to be rough estimates only (generally within about 10 feet of actual elevations). In order to increase measurement accuracy, Hydrometrics completed a topographic survey in November 2006 along the Combination Mine decline tunnel extending

[1] Note that the large seasonal variation in spring/seep discharge rates (3 gpm to 25 gpm at spring CPS-1) indicates seepage from the mine pool is not the sole source of recharge to these features, since the mine pool level does not exhibit similar seasonal trends.

from the mine portal to the location of the mine pool at that time. The distance from the portal and corresponding elevation of the decline tunnel floor were used to develop a topographic profile of the decline tunnel (Figure 4-1). During the survey, reference marks were placed along the tunnel wall at approximate 50-foot intervals denoting the distance from the mine portal. Using the reference marks, the distance from the top of the mine pool to the portal can be closely estimated and the corresponding elevation obtained from the elevation profile. Mine pool elevations recorded since 2007 in this manner are considered to be accurate to within +/- one foot.

Mine pool elevations recorded to date are summarized in Table 4-2. The pool elevation in 2000 and 2001, prior to the onset of the seepage pumpback to the mine workings, was approximately 6000 feet with little seasonal or yearly fluctuation observed. As noted in Section 1.2, Volin et al. (1952) report that the historic mine workings were flooded up to the 15 Level during a 1947 mine investigation. Based on an approximate 20-foot vertical spacing between mine levels as reported by Emmons and Caulkins (1913), and an approximate elevation of 6300 feet for Level No. 1 (the elevation of No.1, No. 2 and Beunveneutra adits, Figure 1-2), the mine pool elevation was approximately 6000 feet in 1947 as well. The corresponding mine pool elevation in 1947 and in 2000/2001 suggests that the equilibrium water level in the mine (absent mine dewatering or seepage pumpback) is approximately 6000 feet.

From 2001 to 2006 the mine pool elevation increased from 6000 feet to about 6060 feet, and to 6090 feet in July 2010. The July 2010 mine pool level is approximately 120 feet below the mine portal. The pool elevation trends since 2000 are shown in Figure 4-2.

The mine pool elevation monitoring is one component of regular site inspections conducted at the Combination Mine since 2008. Other components of the inspections include groundwater elevation monitoring in the Combination Mine area monitoring wells, monitoring of seepage flow rates, and monitoring of seepage collection and pumpback rates to the Combination Mine workings. Information collected through the seasonal inspections is summarized in Appendix C.

4.3 COMBINATION MINE RECLAMATION PROGRAM

In 2000, a distinct area of dead vegetation (the Combination Soils) was identified at the toe of the Combination waste rock pile and extending about 600 feet downslope (east). Based on subsequent field investigations, including soil sampling and water quality monitoring at a number of springs/seeps located within the area of dead vegetation, runoff of metals-bearing water from the waste rock pile was identified as a potential cause of the vegetation die-off (Hydrometrics, 2003). In response, ASARCO conducted reclamation activities at the Combination Mine from 2004 through 2006. The reclamation design included regrading the waste rock pile from its original 2:1 slope to a more stable 3.5:1 slope, and capping the pile with a composite engineered cap (PVC liner and drain layer overlain by approximately three feet of earthen material). The purpose of the cap is to minimize contact of incident precipitation and run-on water with the mineralized waste rock within the dump, thus reducing impacts to downgradient water quality and vegetation. In addition, several thousand cubic yards of metals-impacted soil were removed from the barren Combination Soils area and placed beneath the waste rock pile cap. Overall, the Combination Mine reclamation program included the following elements:

- Relocation of a portion of U.S. Forest Service Road 448.
- Construction of a lined containment pond to store runoff water from the mine area for pumpback to the mine.
- Regrading the Combination waste rock pile from its current configuration to a less steep 3.5 to 1.0 slope.
- Construction of storm water run-on diversion and run-off collection ditches around the waste rock pile.
- Excavation of contaminated soils (Combination Soils) located downhill (east) of the Combination Mine and placement beneath the Combination waste rock pile cap.

The reclamation activities were conducted under the Black Pine Mine operating permit with the reclamation design and specifications included in the *Revised Black Pine Mine Reclamation Plan* (Hydrometrics, 2003). The reclamation activities were completed by ASARCO in coordination with the MDEQ Hard Rock Mine Permitting Bureau and the U.S. Forest Service. No final reclamation reports or as-built surveys are known to exist.

ASARCO also constructed a seepage collection and pumpback system downgradient of the Combination Mine in 2001. The purpose of the seepage collection system is to minimize offsite migration of metals-bearing surface runoff and shallow groundwater. The system collects flows from two discrete spring/seep areas (springs CPS-1 and CPS-7), as well as diffuse surface seepage and shallow groundwater. The captured water gravity drains to two concrete pumpback sumps from where it is pumped directly uphill to the Combination Mine underground workings or (during periods of higher seepage flow rates) to a lined water collection/storage pond for subsequent pumping to the mine workings. The storage/collection pond also receives seasonal inflow from a series of seepage collection pipes buried beneath the regraded Combination waste rock pile. The current collection system configuration, including modifications made in 2003 (prior to regrading of the waste rock pile), is shown in Figure 4-3.

In addition to the Combination Mine reclamation activities, the Combination Mill tailings impoundment located adjacent to the South Fork Lower Willow Creek was partially reclaimed by ASARCO in the mid 1990s. Attempts to located project design plans, reclamation reports or other information related to the tailings reclamation have been unsuccessful to date.

5.0 SUMMARY AND PRELIMINARY RECOMMENDATIONS

Following is a summary of each area of the BPM and recommendations for filling identified data gaps.

5.1 COMBINATION MINE

Considerable information is available for the Combination Mine area due to the site characterization and reclamation activities conducted in this area since 2000. Currently, metals-bearing seepage and shallow groundwater downslope (east) of the Combination waste rock pile continues to be captured and pumped back through the Combination Adit to the underground mine workings. The source of, and long-term remedies for this seepage are the primary environmental issue to be addressed at the Combination Mine. Potential sources of metals-bearing seepage may include:

1. Runoff and infiltration of incident precipitation on the waste rock pile and associated metals leaching;
2. Potential seasonal flow of shallow groundwater through the bottom portions of the waste rock pile;
3. Leakage of water from the mine pool (water within the underground mine workings) to the surrounding groundwater system; and
4. Naturally elevated metals concentrations due to groundwater flow through mineralized bedrock.

5.1.1 Recommendations for Combination Mine

Recommendations for data collection and evaluation at the Combination Mine include:

- <u>Continue monitoring the elevation of the mine pool</u>: It may be possible to install an automated transducer into the mine pool through the Lewis Shaft to avoid the need to enter the mine for water level measurements.

- Monitor Seepage Pumpback Volumes to Mine Workings: Currently, the seepage pumpback volumes are estimated through periodic recording of the pump hour meters, and multiplying the pumping time by the pumping rate. Pumping rates should be verified periodically through volumetric flow measurements of the pumpback line discharge or totalizing flow meters placed on the pumpback lines.

- Calculate Workings Storage Capacity and Leakage Rates: The mine pool elevation and pumpback volumes can be used to estimate the mine storage capacity and net leakage rates from the underground workings (see Hydrometrics, 2008 for example). Based on previous evaluations of pumpback rates and mine pool levels, as well as review of the mine workings maps (Attachment 1), current estimates of the mine void volume between 6000 feet (the mine pool equilibrium elevation) and 6100 (the current level), is estimated to range from 25 million to 30 million gallons.

- Groundwater Data Evaluations: Five additional monitoring wells were drilled at the Combination Mine in fall 2008 (see well logs, Appendix D). The monitoring well locations and completion details are intended to provide information on potential seasonal groundwater flow through the Combination Mine waste rock pile, and potential recharge and metals loading sources to downgradient springs and seeps. The 2008 wells have been sampled twice, once in 2009 and again in 2010, with limited evaluation of this data. The following tasks should be completed to better characterize groundwater conditions at the Combination Mine, and metals-loading sources to the springs/seeps downgradient of the mine.
    - Water quality and general chemistry data from all nine Combination Mine area monitoring wells should be evaluated to identify similarities and differences in water types and contaminant concentrations between various wells. Previous analyses show stark differences in general chemistry between well MW-1 and MW-3, located relatively close to each other. This, and other hydrogeologic data from the site suggest that groundwater flow is strongly influenced by local faulting (Figure 1-2).

- Groundwater level data from individual wells should be compared to further evaluate areas of similar or differing hydrogeologic conditions. Water level and temperature recording transducers should be placed in a number of wells to provide continuous hydrographs.

- Watershed Analysis: The Combination Mine is situated close to Black Pine Ridge, resulting in a relatively small surface drainage area upgradient of the mine. A watershed analysis should be performed to determine if annual precipitation within and upgradient of the mine might account for the volume of downgradient seepage currently being pumped back to the mine workings, or if groundwater conveyed through bedrock structures from outside the surface drainage area contributes to the spring/seep flow.

- Additional Monitoring Wells: Completion of additional monitoring wells peripheral to the Combination Mine workings should be considered to better assess groundwater conditions and flow patterns in the bedrock peripheral to the workings. A minimum of three additional wells would be required to define the groundwater potentiometric surface and generalized areas of potential inflow to or outflow from the workings. Aquifer testing should also be conducted to determine the bedrock hydraulic conductivity, and ultimately to estimate groundwater flux rates into or out of the mine workings. Ultimately, the mine pool may need to be pumped down to 6000 feet or lower. The availability of groundwater level data peripheral to the mine during pumpdown would provide useful information on the mine pool/ bedrock groundwater interactions.

5.2 TIM SMITH MINE

Relatively little sampling has been conducted at the Tim Smith Mine as compared to the Combination Mine due to the relative lack of environmental impacts at the Tim Smith. Past water sampling has shown some relatively low level detections in the Tim Smith drainage, although the drainage water is of relatively good quality as compared to the Combination Mine area. Recommendations for the Tim Smith Mine include:

- Conduct a detailed synoptic streamflow and water sampling event on the Tim Smith drainage. The sampling event should include the same sites sampled during previous sampling events as described in Section 2.
- The Tim Smith portal collapsed sometime between 2002 and 2007 precluding safe access to the mine workings. The portal should be rehabilitated and the Tim Smith mine pool inspected to determine if the water level or water chemistry within the mine has changed significantly since last inspected in 2001.
- The Tim Smith #2 waste rock should be sampled for chemistry, acid-base accounting and physical parameters to for development of suitable disposal or closure plans.

5.3 COMBINATION MILL AREA

Significant sampling and other investigative work was completed at the Combination Mill and tailings impoundment area in the 1980s and early 1990s as described in Sections 2 and 3. The tailings impoundment was also partially reclaimed in the mid 1990s. Based on the considerable time since last investigated, and possible changes in conditions resulting from reclamation activities, additional soil, mine waste, sediment and water monitoring is warranted at the Combination Mill site. Recommendations include:

- Repeat soils and tailings sampling and testing at a subset of sites included in the Shafer and Pioneer studies described in Sections 2 and 3. The information would be used to document changes in site conditions in the past 10+ years.
- Conduct stream sediment sampling in South Fork Willow Creek to assess metals concentrations in the stream sediments for comparison to sediment benchmark values for protection of aquatic life. The sediment sampling should be coupled with the synoptic surface water sampling described below and should include previous sampling sites to allow for comparison to previous results.

- Conduct a detailed synoptic streamflow and water quality survey in the South Fork Lower Willow Creek to assess water quality changes and loading sources to the stream. The survey should extend from well upstream of the Combination Mill, and extend downstream beyond the reported amalgamation plant on South Fork Lower Willow Creek. Metals concentrations in the creek will help document current water quality conditions above and below the mill, and the streamflow and metals load data would help identify potential sources of metals loading to the creek. The survey should extend far enough upstream to span the stream reach most likely to be impacted from potential seepage from the Combination Mine workings.

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TABLES

TABLE 2-1. 1981 BASELINE HYDROLOGIC EVALUATION MONITORING SITES AND SCHEDULE

					Parameters				
Site Designation	**Other Designations***	**Site Description**	**Location**	**Sample Date**	**Flow**	**Field Parameters**	**Common Ions**	**Trace Metals**	**Nutrients**
W-01	Black Pine Well	Black Pine Mine Office Water Supply Well	T8N, R14W, Sec DDA	7/27/1981		**X**	**X**	**X**	**X**
001	Marshall	Central Marshall Spring	T8N, R14W, Sec 32AC	7/20/1981	**X**	**X**	**X**	**X**	**X**
NA	Marshall Ck	Marshal Creek Trib	T7N, R14W, Sec 6DCD	7/21/1981	**X**	**X**	**X**	**X**	**X**
010	Smart Ck	Unnamed trib of Smart Ck	T8N, R14W, Sec 22ACB	7/21/1981	**X**	**X**	**X**	**X**	**X**
011	Smart Ck	Smart Creek	T8N, R14W, Sec 22ACB	7/21/1981	**X**	**X**	**X**	**X**	**X**
012	Lower Willow	Unnamed Trib to Combination Tailings Area (Mill Gulch)	T8N, R14W, Sec 8CBC	7/21/1981	**X**	**X**	**X**	**X**	**X**
013	Willow Ck	Unnamed Trib to S.Fork Lower Willow Ck (Tim Smith Drainage)	T8N, R14W, Sec 18DAB	7/21/1981	**X**	**X**	**X**	**X**	**X**
020	Section 5 Ck	Unnamed tributary of Marshall Ck	T7N, R14W, Sec 5DDC	7/22/1981	**X**	**X**	**X**	**X**	**X**
022	S Lower Willow	South Fork Lower Willow Ck above Combination Tailings Area	T8N, R14W, Sec 07DDA	7/17/1981		**X**	**X**	**X**	**X**

Site Descriptions and Locations from Hydrometrics, 1981.

*Refers to other designations used in 1981 report.

1981 Baseline Investigation also included inventory/flow monitoring of 32 springs/seeps in BPM area.

TABLE 2-2. STANDARD BLACK PINE MINE WATER SAMPLE ANALYTICAL PARAMETER LIST

Parameter	Analytical Method	Project Required Detection Limit (mg/L)
pH	Field SOP	None
Specific conductance	Field SOP	None
Dissolved oxygen	Field SOP	None
Water temperature	Field SOP	None
Flow/Static Water Level	Field SOP	None
Calcium (Ca)	215.1/200.7	5
Magnesium (Mg)	242.1/200.7	5
Sodium (Na)	273.1/200.7	5
Potassium (K)	258.1/200.7	5
Sulfate (SO4)	300.0	1
Total alkalinity as $CaCO_3$	310.1	5
Total acidity as CaCO3	305.1	5
Total dissolved solids	160.1	10
Total suspended solids	160.2	10
Arsenic (As)	206.3/200.9/200.8	0.003
Cadmium (Cd)	213.2/200.7/200.8	0.0001
Copper (Cu)	220.2/200.7/200.8	0.001
Iron (Fe)	236.1/200.7	0.01
Lead (Pb)	243.1/200.7/200.8	0.003
Manganese (Mn)	239.2/200.7/200.8	0.01
Zinc (Zn)	289.1/200.7/200.8	0.01

Table 2-3. Summary of Environmental Assessment/Reclamation Planning Water Resources Monitoring at the Black Pine Mine (2000 - 2010)

Monitoring Location	Monitoring Date																							
	Sep-Nov 2000	Jan 2001	Apr 2001	May 2001	Jun 2001	Jul 2001	Oct 2001	Nov 2001	Apr 2004	May 2005	Sep 2006	Nov 2006	Mar 2007	Apr 2007	May 2007	Oct 2007	Apr 2008	May 2008	Jun 2008	Oct 2008	May 2009 (5/14)	May 2009 (5/29)	Apr 2010	May 2010
Combination Mine Area																								
CM Pool	WQ	WQ		WQ*		WQ				WQ	WQ	WQ		WQ		WQ	WQ	WQ		WQ		WQ		
CPS-1	WQ			WQ*		WQ	WQ		WQ	WQ	WQ	WQ	WQ	WQ		WQ	WQ	WQ	WQ	WQ	WQ	WQ	WQ	
CPS-2	WQ			WQ		WQ			WQ	WQ	WQ			WQ		WQ		WQ	WQ	WQ		WQ	WQ	
CPS-3	FP			FP		FP																		
CPS-4	FP			FP		FP																		
CPS-5	FP			FP		FP																		
CPS-6	FP			FP		FP																		
CPS-7				WQ*		WQ	WQ																	
CPS-7A									WQ					WQ								WQ		
CPS-8						WQ			WQ	WQ	WQ	WQ		WQ		WQ		WQ	WQ	WQ		WQ		
CPS-9			WQ																					
CPS-10A			WQ		WQ																			
CPS-10B													WQ	WQ				WQ			WQ		WQ	
CPS-11				WQ																				
CPSW-1	WQ			WQ		WQ			WQ	WQ				WQ				WQ	WQ	WQ		WQ	WQ	
CPSW-2	FP			WQ		WQ			WQ	WQ	WQ			WQ		WQ		WQ	WQ	WQ		WQ	WQ	
CPSW-3				WQ																				
SCTSW-1	WQ			WQ*		WQ																		
SCSW-1	WQ			WQ		WQ																		
North Area Spring (N)																		WQ			WQ		WQ	
North Area Spring (S)																		WQ						
North Drainage Runoff										WQ			WQ	WQ			WQ	WQ				WQ	WQ	
North Removal Area Drainage										WQ			WQ	WQ			WQ	WQ	WQ			WQ		
South Removal Area Drainage										WQ				WQ			WQ	WQ						
Groundwater Sites																								
CMMW-1								WQ			WQ				WQ	WQ		WQ	WQ	WQ		WQ		WQ
CMMW-2															WQ	WQ		WQ	WQ		WQ	WQ		WQ
CMMW-3								WQ			WQ				WQ	WQ		WQ	WQ	WQ		WQ		WQ
CMMW-4								WQ			WQ				WQ	WQ		WQ	WQ	WQ		WQ		WQ
CMMW-5																					WQ	WQ		WQ
CMMW-6																				WQ	WQ	WQ		WQ
CMMW-7																					WQ	WQ		WQ
CMMW-8																					WQ	WQ		WQ
CMMW-9																					WQ	WQ		WQ
CMPZ-4															FP			WQ	WQ	WQ		WQ		
Tim Smith Mine Area																								
TS Pool	WQ	WQ		WQ		WQ																		
TSP-1	FP				WQ	WQ																		
TSP-2	FP				FP	FP																		
TSP-3	FP				FP																			
TSP-4	FP				FP	FP																		
TSP-5	FP				FP																			
TSP-6	WQ				WQ	WQ																		
TSP-7	FP				FP	FP			WQ	WQ														
TSP-8			WQ		WQ					WQ														
TSP-9			WQ		WQ	WQ			WQ	WQ												WQ		
TSP-10			WQ																					
Combination Mill Area																								
MCSP-1					WQ	WQ			WQ	WQ														
MCSW-1	WQ				WQ	WQ																		
WCSW-1	WQ				WQ	WQ																		

NOTES: Monitoring events conducted by Hydrometrics and/or Asarco personnel.
Monitoring locations are shown on Exhibit 1 and Figures 2-1, 2-2, and 2-3.
WQ = sampled for field parameters and laboratory analytical parameters. Typical suite of water quality parameters included common ions, TDS and TSS, and dissolved or total recoverable metals (see Table2-2).
FP = sampled for field parameters only (typically pH, specific conductance, dissolved oxygen, water temperature).
*Multiple samples were collected from this site during May 2001.

Table 2-4. Summary of Environmental Assessment/Reclamation Planning Soil Sampling at the Black Pine Mine

October 2000 Combination Soil Sampling						
Sampling Location	Sample #	Depth Interval	Field Description	Analytical Parameters		
				Total Metals (XRF)	Acid-Base Accounting	Wet Chemistry Metals (Split)
CMSS-1	BPMS-0010-100	0-6"	Brown to tan silty sand w/ 10% gravels (0-6"); Grasses and lodgepole pine regrowth. East of barren area;**Visually Unimpacted.**	X		
CMSS-2	BPMS-0010-101	0-2"	Yellow silty material (0-2"), sporadic isolated pods; Minor lodgepole regrowth, but mostly non-vegetative.	X	X	X
	BPMS-0010-102	2-6"	Dark brown silty sand (2-6"), fine grained, organic, 10% gravels; Minor lodgepole regrowth, but mostly non-vegetative.	X		
	BPMS-0010-103	0-2"	Dark brown silty sand (0-2"), fine grained, organic, 10% gravels; Grasses and lodgepole pine regrowth.Lateral to barren area; **Visually Unimpacted.**	X		
CMSS-3	BPMS-0010-104	0-2"	Yellow silty material (0-2"), areally extensive; No regrowth, barren.	X	X	
	BPMS-0010-105	2-6"	Dark brown silty sand, fine grained, organic (2 - 6"); No regrowth, barren.	X		
	BPMS-0010-106	2-3"	Yellow silty material (2-3"), discontinuous, above historic forest floor; No regrowth, barren.	NO ANALYSIS -- SAMPLE ARCHIVED		
	BPMS-0010-107	4-6"	Dark brown clayey silty sand (4-6"), organic, 10% gravels; No regrowth, barren.	NO ANALYSIS -- SAMPLE ARCHIVED		
	BPMS-0010-108	0-2"	Dark brown silty sand (0-2"), fine grained, organic, 10% gravels; Grasses and lodgepole pine regrowth. Lateral to barren area; **Visually Unimpacted.**	X		
CMSS-4	BPMS-0010-109	0-6"	Yellow silty material, 2 - 6 inches thick, areally extensive; No regrowth, barren.	X	X	
	BPMS-0010-110	6-8"	Brown silty sand (6-8"), root fibers, 10% gravels; No regrowth, barren.	X		
CMSS-4/5	BPMS-0010-111	0-2"	Light brown silty sand (0-2"), fine grained, root fibers, 10% gravels; Grasses and lodgepole pine regrowth. Lateral to barren area;**Visually Unimpacted.**	X		
CMSS-5	BPMS-0010-112	0-6"	Dark brown silty sand (0-6"), fine grained, 10% gravels, discontinuous clay stringers; Minor lodgepole regrowth, but mostly non-vegetative.	X		
CMMS-1	BPMS-0010-116	0-2"	Dark brown silty sand (0-2"), fine grained, root fibers, 10% gravels; Grasses and lodgepole pine regrowth. Lateral to barren area; **Visually Unimpacted.**	X		
	BPMS-0010-117	0-2"	Dark gray brown silty sand (0-2"), fine grained, <5% gravels; No regrowth, barren.	X		
	BPMS-0010-118	6-8"	Dark brown silty sand (6-8"), fine grained, 25% gravels; No regrowth, barren.	X		
CMMS-2	BPMS-0010-119	0-2"	Dark brown to black silty sand (0-2"), fine grained, <10% gravels; Moist to saturated; No regrowth, barren.	X		
	BPMS-0010-120	6-8"	Dark brown to black silty sand (6-8"), fine grained, <10% gravels; Moist to saturated; No regrowth, barren.	X		
CMMS-3	BPMS-0010-121	0-2"	Dark brown silty sand/sandy silt (0-2"), <10% gravels; Grasses and lodgepole pine regrowth. Lateral to barren area;**Visually Unimpacted.**	X		X
	BPMS-0010-122	0-2"	Dark gray brown silty sand (0-2"), fine grained, <10% gravels; Lodgepole pine regrowth after 1988 fire, however, new growth currently dead and area is barren.	X		X
	BPMS-0010-123	6-8"	Light reddish brown silty sand (6-8"), fine grained, <10% gravels; Lodgepole pine regrowth after 1988 fire, however, new growth currently dead and area is barren.	X		
CMMS-4	BPMS-0010-125	0-2"	Brown silty sand (0-2"), fine grained; Minor deciduous regrowth of aspens and willows.	X		
	BPMS-0010-126	6-8"	Brown silty sand (6-8"), fine grained, <10% gravels; Minor deciduous regrowth of aspens and willows.	X		
CMMS-5	BPMS-0010-129	0-2"	Brown sand with minor silts (0-2"), fine grained, <10% gravels, organic; Grasses and lodgepole pine regrowth. Lateral to barren area;**Visually Unimpacted.**	X		
CMMS-5	BPMS-0010-130	0-2"	Brown silty sand (0-2"), fine grained, 20% gravels, root fibers; Sporadic grasses and minor deciduous regrowth .	X		
	BPMS-0010-132	6-8"	Brown silty sand (6-8"), fine grained, 10% gravels, root fibers; Sporadic grasses and minor deciduous regrowth .	X		
CMNS-1	BPMS-0010-200	0-2"	Tan sand (0-2") with silt, fine grained; No regrowth barren.	X		
	BPMS-0010-201	6-8"	Tan sand (6-8") with silt, fine grained; No regrowth, barren.	X		
	BPMS-0010-128	0-2"	Brown sand with minor silts (0-2"), fine grained, <10% gravels, organic; Grasses and lodgepole pine regrowth. Lateral to barren area near road;**Visually Unimpacted.**	NO ANALYSIS -- SAMPLE ARCHIVED		
	BPMS-0010-127	0-2"	Brown sand w/ silts (0-2"), fine grained, <5% gravels; Grasses and lodgepole pine regrowth. Lateral to barren area, middle northern finger;**Visually Unimpacted.**	X		
CMNS-2	BPMS-0010-202	0-2"	Brown sand (0-2") with silt, fine grained; Minor deciduous regrowth of aspens and willows.**Visually Unimpacted.**	X		X
	BPMS-0010-203	6-8"	Brown sand (6-8") with silt, fine grained; Minor deciduous regrowth of aspens.**Visually Unimpacted.**	X		
	BPMS-0010-124	0-2"	Dark brown silty sand (0-2"), fine grained, root fibers; Grasses and lodgepole pine regrowth.Lateral to Barren area, **Visually Unimpacted.**	NO ANALYSIS -- SAMPLE ARCHIVED		
CWD-N	BPMS-0010-113	0-6"	Composite of north side of waste rock dump; No vegetation.	X	X	
CWD-S	BPMS-0010-114	0-6"	Composite of north side of waste rock dump; No vegetation.	X	X	
BACKGROUND	BPMS-0010-115	0-2"	Dark brown silty sand, fine grained, <10% gravels; Area north of waste dump; Grasses and lodgepole pine regrowth. Background area,**Visually Unimpacted.**	X		

NOTES: Monitoring locations are shown on Exhibit 2 and Figure 2-4.

Table 2-4 (cont.) Summary of Environmental Assessment/Reclamation Planning Soil Sampling at the Black Pine Mine

October 2000 Borrow Soil Sampling									
						Analytical Parameters			
Sampling Location	Test Pit #	Depth Interval (ft)	General Soil Horizon	Sample #	Field Description	pH	SAR, texture, saturation percentage	coarse fragment content, organic matter, N-P-K	grain size, Atterberg limits
BPB-1	BPB-1.1	0 - 1	Topsoil	Archived	Dark brown; silty fine sand; 10% gravel coarse fragments; abundant roots.				
		1 - 4	Subsoil	Archived	Light brown; fine silty sand; 75% coarse fragments, gravel to cobble size; few coarse roots.				
		4 - 6	Subsoil	Archived	Orange brown; very fine grained sand; 75% coarse fraction up to cobble size.				
	BPB-1.2	0 - 1	Topsoil	Archived	Dark reddish brown; silty sand; 25% angular gravel coarse fragments; many fine roots.				
		1 - 4	Subsoil	Archived	Light brown; fine silty sand; 75% coarse fragments up to cobble size, few coarse roots.				
BPB-2	BPB-2.1	0 - 1	Topsoil	BPBS-0010-300	Dark brown; silty sand; <10% gravel-size coarse fragments; few roots.	X	X	X	
		1 - 4	Subsoil	BPBS-0010-301	Light brown; fine silty sand; 50% coarse fragments to cobble size; few coarse roots.	X	X		
		4 - 7	Clay Subsoil	BPBS-0010-302	Orange brown; sandy clay; 50% gravel to cobble coarse fragments.	X			X
	BPB-2.2	0 - 1	Topsoil	BPBS-0010-303	Brown; fine silty sand; <10% gravel coarse fragments; abundant roots.	X	X	X	
		1 - 4	Subsoil	BPBS-0010-304	Light brown; fine silty sand; 50% coarse fragments to cobble size; few fine to coarse roots.	X	X		
		4 - 9	Clay Subsoil		Light orange brown; fine sandy clay; 50% coarse fragments to cobble size.				
BPB-3	BPB-3.1	0 - 1	Topsoil	Archived	Brown to dark brown; silty fine sand; 20% angular gravels; abundant roots.				
		1 - 4	Subsoil	Archived	Light brown; fine silty sand; 50% coarse fragments to cobble size; few coarse roots.				
		4 - 11	Clay Subsoil	Archived	Orange brown; fine sandy clay; 75% coarse fragments to cobble size.				
	BPB-3.2	0 - 0.5	Topsoil	Archived	Dark brown to brown; fine silty sand; 25% gravel coarse fraction; abundant roots.				
		0.5 - 4	Subsoil	Archived	Light brown; fine silty sand; 50% coarse fragments to cobble size; few roots.				
		4 - 10	Subsoil	Archived	Orange brown; fine silty sand; 50% coarse fragments to cobble size, few coarse roots.				
BPB-4	BPB-4.1	0 - 1	Topsoil	BPBS-0010-305	Dark brown; fine silty sand; 25% gravel to cobble coarse fragments, angular; abundant roots.	X	X	X	
		1 - 3.5	Subsoil	BPBS-0010-306	Light brown; fine silty sand; 50% gravel to cobble coarse fragments, angular; few coarse roots.	X	X		
		3.5 - 9	Subsoil	Archived	Light brown; fine sand; 50% gravel to cobble coarse fragments, angular.				
	BPB-4.2	0 - 3	Topsoil	BPBS-0010-307	Brown; fine silty sand; 25% gravel to cobble coarse fragments, angular; many fine to coarse roots.	X	X	X	
		3 - 11	Subsoil	BPBS-0010-308	Reddish brown; fine silty sand with a minor clay component; 50% coarse fragments, angular gravels to cobbles.	X	X		
	BPB-4.3	0 - 2	Topsoil	BPBS-0010-309	Dark brown; fine silty sand; 25% angular gravels; many fine to coarse roots.	X	X	X	
		2 - 4.5	Subsoil	BPBS-0010-310	Light brown; fine silty sand; 50% angular gravels to cobbles, few coarse roots.	X	X		
		4.5 - 7.5	Subsoil		Orange brown; fine clayey sand; 50% coarse fragments, angular gravels and cobbles; very hard.				
BPB-5	BPB-5.1	0 - 1.5	Topsoil	BPBS-0010-311	Dark brown; moist; fine silty sand; 50% coarse fraction, subangular gravels and cobbles; many fine to coarse roots.	X	X	X	
		1.5 - 5	Subsoil	BPBS-0010-312	Light brown; dry; fine silty sand; 50% coarse fraction, subangular gravels to cobbles; few coarse roots.	X	X		
BPB-6	BPB-6.1	0 - 1	Topsoil	Archived	Brown; fine silty sand with minor clay component; 25% angular gravels; common fine to coarse roots.				
		1 - 3.5	Subsoil	Archived	Light brown; fine silty sand; 50% coarse fragments to cobble size; few fine to coarse roots.				
		3.5 - 4.5	Clay Subsoil	Archived	Orange brown; fine sandy clay, very hard; 50% coarse fragments to cobble size.				
	BPB-6.2	0 - 1	Topsoil	Archived	Dark brown; fine silty sand with minor clay component; <10% angular gravels; many fine to coarse roots.				
		1 - 2	Subsoil	Archived	Light brown; fine silty sand; 75% coarse fragments to cobble size; few coarse roots.				
		2 - 3	Clay Subsoil	Archived	Orange brown; fine sandy clay, very hard; 75% coarse fragments to cobble size.				
BPB-7	BPB-7.1	0 - 1	Topsoil	Archived	Dark brown; fine silty sand with minor clay component; <10% angular gravels; many fine to coarse roots.				
		1 - 2	Subsoil	Archived	Brown; fine silty sand; 50% coarse fragments to cobble size; common fine to coarse roots.				
		2 - 4	Subsoil	Archived	Orange brown; fine silty sand; 50% coarse fragment content to cobble size.				
BPB-8	BPB-8.1	0 - 1	Topsoil	BPBS-0010-313	Brown; fine silty sand; 10% gravel coarse fragments; many fine to coarse roots.	X	X	X	
		1 - 2.5	Subsoil	BPBS-0010-314	Light brown; fine silty sand; 50% coarse fragments to cobble size; few coarse roots.	X	X		
		2.5 - 3	Clay Subsoil		Orange brown; fine sandy clay, very hard; 50% coarse fragments to cobble size.				
	BPB-8.2	0 - 1	Topsoil	BPBS-0010-315	Brown; fine silty sand; 25% angular gravels; many fine to coarse roots.	X	X	X	
		1 - 3	Subsoil	BPBS-0010-316	Light brown; fine silty sand; 50% angular gravels and cobbles; few coarse roots.	X	X		
		3 - 3.5	Clay Subsoil	Archived	Orange brown; fine sandy clay, very hard; 50% coarse fragments to cobble size.				
BPB-9	BPB-9.1	0 - 1.5	Topsoil	Archived	Dark brown; fine silty sand; 25% gravels, many fine to coarse roots.				
		1.5 - 4	Subsoil	Archived	Light brown; fine silty sand; 75% angular gravel to cobble size coarse fragments; few coarse roots.				
	BPB-9.2	0 - 1	Topsoil	Archived	Dark brown; fine silty sand; 25% angular gravel coarse fragments; many fine to coarse roots.				
		1 - 2	Subsoil	Archived	Light brown; fine silty sand; 75% angular gravel to cobble size coarse fragments; few coarse roots.				
		2 - 5	Subsoil	Archived	Orange brown; fine clayey sand; 50% coarse fragments, angular gravels and cobbles.				
BPB-10	BPB10.1	0 - 1	Topsoil	BPBS-0010-317	Brown; fine silty sand; 25% gravel coarse fragments; many fine to coarse roots.	X	X	X	
		1 - 3	Subsoil	BPBS-0010-318	Light brown; fine silty sand; 50% coarse fragments to cobble size; few fine to coarse roots.	X	X		
		3 - 4	Subsoil	BPBS-0010-320	Orange brown; fine silty sand; 50% gravel and cobble coarse fragments.	X			X
	BPB10.2	0 - 1.5	Topsoil	BPBS-0010-319	Dark brown; fine silty sand; 25% gravel coarse fragments; many fine to coarse roots.	X	X	X	
		1.5 - 3.5	Subsoil	BPBS-0010-321	Light brown; silty fine sand; 50% coarse fragments to cobble size; few fine to coarse roots.	X	X		

NOTES: Monitoring locations are shown on Exhibit 2.

Table 2-4 (cont.) Summary of Environmental Assessment/Reclamation Planning Soil Sampling at the Black Pine Mine

July 2001 Soil Sampling					
Sampling Location	Sample #	Depth Interval (ft)	Analytical Parameters		
			Total Metals (XRF)	Acid-Base Accounting	Wet Chemistry Metals
NTP-1	BPMS-0107-327	0-1	X		
	BPMS-0107-328	1-2	X		
	BPMS-0107-329	2-3	X		
NTP-2	BPMS-0107-323	0-1	X		X
	BPMS-0107-325	1-2	X		
	BPMS-0107-326	2-3	X		
NTP-3	BPMS-0107-317	0-1	X		
	BPMS-0107-318	1-2	X		
	BPMS-0107-319	2-3	X		
NTP-4	BPMS-0107-314	0-1	X		
	BPMS-0107-315	1-2	X		
	BPMS-0107-316	2-3	X		
NTP-5	BPMS-0107-311	0-1	X		
	BPMS-0107-312	1-2	X		
	BPMS-0107-313	2-3	X		X
NTP-6	BPMS-0107-307	0-1	X		
	BPMS-0107-308	1-2	X		
	BPMS-0107-309	2-3	X		
	BPMS-0107-310	3-4	X		
NTP-7	BPMS-0107-303	0-1	X		
	BPMS-0107-304	1-2	X		
	BPMS-0107-305	2-3	X		
	BPMS-0107-306	3-4	X		
NTP-8	BPMS-0107-300	0-1	X		
	BPMS-0107-301	1-2	X		X
	BPMS-0107-302	2-3	X		
STP-1	BPMS-0107-343	0-1	X		X
	BPMS-0107-345	1-2	X		
	BPMS-0107-346	2-3	X		
STP-2	BPMS-0107-339	0-1	X		
	BPMS-0107-340	1-2	X		
	BPMS-0107-342	2-3	X		
STP-3	BPMS-0107-333	0-1	X		
	BPMS-0107-334	1-2	X		
	BPMS-0107-335	2-3	X		X
STP-4	BPMS-0107-330	0-1	X		
	BPMS-0107-331	1-2	X		
	BPMS-0107-332	2-3	X		
BGTP-1	BPMS-0107-336	0-1	X		
	BPMS-0107-337	1-2	X		
	BPMS-0107-338	2-3	X		
BGTP-2	BPMS-0107-320	0-1	X		
	BPMS-0107-321	1-2	X		
	BPMS-0107-322	2-3	X		
Combination Pad South Composite	BPMS-0107-400	0-1.5	X	X	
Combination Pad North Composite	BPMS-0107-401	0-1.5	X	X	
Combination Pad North Trench	BPMS-0107-402	0-6	X	X	
Combination Pad Center Trench	BPMS-0107-403	0-6	X	X	
Combination Pad South Trench	BPMS-0107-404	0-6	X	X	
Tim Smith Pad East Composite	BPMS-0107-405	0-1.5	X	X	
Tim Smith Pad West Composite	BPMS-0107-406	0-1.5	X	X	
Tim Smith Pad East Trench	BPMS-0107-407	0-6	X	X	
Tim Smith Pad West Trench	BPMS-0107-408	0-6	X	X	

NOTES: Monitoring locations are shown on Exhibit 2 and Figure 2-4.

TABLE 2-5. BLACK PINE MINE MONITORING SITE DESCRIPTIONS AND COORDINATES

Site	Description	Latitude (°N)	Longitude (°W)
Surface water/Springs and Seeps/Runoff			
CPS-1	Spring directly downslope (east) of Combination Portal and waste rock pile	46°26'27.4205"	113°21'33.0430"
CPS-2	Spring 750' NE of CPS-1 in drainage bottom	46°26'28.7808"	113°21'18.1230"
CPS-7A	Spring south of south barren area, 300' SE of waste rock dump toe	46°26'24.1934"	113°21'41.9930"
CPS-8	Spring 200' S of CPS-7A, 500' SE of waste rock dump toe	46°27'07.4965"	113°22'27.6842"
CPSW-1	Surface flow 0.3 miles downslope (east) of CPS-1; represents combined flow of CPS-1 and CPS-2 drainages.	46°26'23.1340"	113°21'09.4497"
CPSW-2	Surface flow 0.25 miles downslope (east) of CPSW-1; continuation of intermittent flow from CPS-1 and CPS-2.	46°26'22.4699"	113°20'49.5702"
CPS-10	Spring 50' NW of CMMW-4	46°26'27.3984"	113°21'36.0648"
North Removal Area Drainage	Surface runoff from north Combination Soils removal area; sampled near downgradient (east) property boundary. Includes CPS-1 collection sump overflow.	46°26'25.7460"	113°21'30.8808"
South Removal Area Drainage	Surface runoff from south Combination Soils removal area; sampled near downgradient (east) property boundary.	46°26'24.2628"	113°21'31.6116"
North Runoff	Mid-slope runoff from north Combination Soils removal area; approx. 75' NE of CMMW-4. Includes CPS-10 flow plus snowmelt runoff from collection pond area.	46°26'27.370"	113°.21' 34.942"
Groundwater			
CMMW-1	200 feet east of original waste rock pile toe; completed in quartzite bedrock.	46°26'25.859"	113°21'41.398"
CMMW-2	In Combination Mine waste rock pile; completed in native soil/colluvium.	46°26'28.006"	113°21'48.124"
CMMW-3	350 feet east of original waste rock pile toe; completed in siltstone bedrock.	46°26'29.021"	113°21'38.310"
CMMW-4	100 feet west of CPS-1 collection system; completed in native soils (silt).	46°26'26.999"	113°21'35.736"
Other Sites			
Combination Mine Pool	Pooled water within underground workings	na	na
Collection Pond Inflow	Inflow to Combination Mine capture from PVC pipe; drains former storm water pond seepage area.	46°26'28.720"	113°21'40.359"

Na-not available

Site Locations shown on Exhibit 1.

TABLE 2-6. SUMMARY OF MDEQ HARD ROCK PROGRAM SITE INSPECTIONS AND SAMPLING ACTIVITIES

Inspection Date	Water Samples	Analyses	Soil Samples	Analyses
9/13/1995	Ck below Tim Smith**	Metals, Common Ions, Nutrients	None	---
5/6/1998	BPM Seep	Metals, Common Ions, Nutrients	None	---
4/6/2002	BP Pond Outfall to USFS**	Metals	None	---
5/3/2002	CPS-1*	Metals	None	---
10/24/2002	BP Low Pump Outfall**	Metals, Hardness	None	---
4/21/2006	Sample-1, Sample-2, Sample-3**	Metals	None	---
5/11/2006	BP060511, BP060511***		None	---
7/11/2008	W1, W2, W3, W4, W5	Metals, Common Ions	S1, S2, S3, S4, S5, S6, S7, S8	Total Metals, pH

Sample locations shown on Exhibit 1 and 2 except as noted below.
* Sample identified on inspection form but no data available.
** Data included in inspection report but location not provided or illegible on map.
*** No data or locations available

TABLE 2-7. SUMMARY OF MDEQ TMDL PROGRAM MONITORING IN VICINITY OF BLACK PINE MINE

Date	8-17-05	7-11-07	7-15-07	8-29-07	9-1-07	5-22-08	6-9-08	7-8-08 / 7-10-08	8-11-08	8-22-08	5-27-09	8-18-09 / 8-20-09
Smart Ck												
CO2SMRTC02	SW-Metals, FP Biological	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CO2SMRTC03	NS	Biological	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
SMARTC03	NS	NS	NS	SW-Nutrients, FP	NS	SW-Nutrients, FP	NS	NS	NS	SW-Nutrients, Chl-a, FP	SW-Metals, Nutrients, FP	SW-Metals, Nutrients, FP
South Fork Lower Willow Creek												
CO2WLSFC01	NS	NS	Biological	NS	NS	NS	NS	NS	NS	NS	NS	NS
SFLWILLOWC02	NS	NS	NS	NS	SW-Metals, FP	NS	SW-Metals, FP	SW-Metals, FP	SW-Metals, FP	NS	SW-Metals, Nutrients, FP	SW-Metals, Nutrients, FP
SFLWILLOWC03	NS	NS	NS	NS	NS	NS	NS	SW-Metals, FP	SW-Metals, FP	NS	SW-Metals, Nutrients, FP	SW-Metals, Nutrients, FP
SFLWILLOWC04	NS	NS	NS	NS	SW-Metals, FP, Sed-Metals	NS	NS	SW-Metals, FP	SW-Metals, FP	NS	SW-Metals, Nutrients, FP	SW-Metals, Nutrients, FP
SFLWILLOWC04.5	NS	NS	NS	NS	NS	NS	NS	SW-Metals, FP	SW-Metals, FP	NS	SW-Metals, Nutrients, FP	SW-Metals, Nutrients, FP
SFLWILLOWC05	NS	NS	NS	NS	NS	NS	NS	SW-Metals, FP	SW-Metals, FP	NS	SW-Metals, Nutrients, FP	Dry

FP - Field Parameters; SW - Surface Water; Sed - Sediment
NS - Not Sampled
Site Locations shown on Exhibit 1.

TABLE 2-8. SUMMARY OF COMBINATION MILL AREA SAMPLING PROGRAMS

	Sample Designation	Media	Sample Date	Location	Parameters
U. S. Forest Service					
	Above Combination Mill	Water	Jul-88	NA	Metals, Common Ions, Nutrients
	Below Combination Mill	Water	Jul-88	NA	Metals
	Above Combination Mill	Sediment	Jun-89	NA	Metals
	Below Combination Mill	Sediment	Jun-89	NA	Metals
	Below Combination Mill	Sediment	Jul-89	NA	Metals
	Below Combination Mill	Sediment	Jul-89	NA	Metals
	Above Combination Mill	Water	May-90	NA	Metals, Nutrients
	Below Combination Mill	Water	May-90	NA	Metals, Nutrients
	Below Combination Mill	Sediment	May-90	NA	Total Metals
	Below Combination Mill	Sediment	May-90	NA	Total Metals
	Additional data presented in Wintergerst, 1989 referred to as "Final", but not date provided				
Asarco, Inc.					
	BP-1A	Water	Sep-90	NA	Metals, TDS, TSS
	BP-2A	Water	Sep-90	NA	Metals, TDS, TSS
	BP-3A	Water	Sep-90	NA	Metals, TDS, TSS
	BP-1B	Water	Sep-90	NA	Metals, TDS, TSS
	BP-2B	Water	Sep-90	NA	Metals, TDS, TSS
	BP-3B	Water	Sep-90	NA	Metals, TDS, TSS
	BP Tailings	Soil	Sep-90	NA	Metals
	BP-1	Soil	Sep-90	NA	Metals
	BP2	Soil	Sep-90	NA	Metals
	BP-3	Soil	Sep-90	NA	Metals
Schafer and Associates					
	1a	Water	Aug-91	Upper Willow	Metals
	1b	Water	Aug-91	Lower Willow	Metals
	2a	Water	Aug-91	Upper Mill	Metals
	2b	Water	Aug-91	Lower Mill	Metals
	201 to 205	Sediment	Aug-91	1000 ft upstream of bridge	Metals
	206 to 210	Sediment	Aug-91	1500 ft north of property boundary	Metals
	88-1 through 88-11	Soil	Aug-91	15 samples throughout tailings impoundment area	Metals and/or ABA
	101-180	Soil	Aug-91	Throughout Tailings Impoundment area (not shown on Exhibit 2)	pH
Pioneer Technical Services					
	SW-1	Water	Jul-93	Downstream of Mill/Willow Ck conf.	Metals, Commons, Nutrients
	SW-2	Water	Jul-93	Upstream in Mill Ck	Metals, Commons, Nutrients
	SW-3	Water	Jul-93	Upstream in S.F. Willow Ck	Metals, Commons, Nutrients
	SWA	Water	Jul-93	Mill/Willow Ck confluence	Field Parameters
	SWB	Water	Jul-93	Mill Ck at confluence	Field Parameters
	SWC	Water	Jul-93	S.F. Lower Willow Ck at confluence	Field Parameters
	SWD	Water	Jul-93	Willow Creek overflow over tails	Field Parameters
	SE-1	Sediment	Jul-93	Downstream of Mill/Willow Ck conf.	Total metals
	SE-2	Sediment	Jul-93	Upstream in Mill Ck	Total metals
	SE-3	Sediment	Jul-93	Upstream in S.F. Willow Ck	Total metals
	SE-500	Sediment	Jul-93	500' downstream of main tails	XRF Metals
	SE-1000	Sediment	Jul-93	1000' downstream of main tails	XRF Metals
	TP-1A	Soil/Tails	Jul-93	See Exhibit 2	XRF Metals
	TP-1B	Soil/Tails	Jul-93	See Exhibit 2	XRF Metals
	TP-1C	Soil/Tails	Jul-93	See Exhibit 2	XRF Metals
	TP-1D	Soil/Tails	Jul-93	See Exhibit 2	XRF Metals
	TP-1 Composite	Soil/Tails	Jul-93	See Exhibit 2	Metals/ABA
	TP-1A	Water	Jul-93	See Exhibit 2	Field Parameters
	SS-1	Soil	Jul-93	Background soil; location unknown	Total Metals
	SW-1	Water	Oct-95	S.F.L. Willow Ck at downstream USFS boundary	Metals, Commons
	SW-2	Water	Oct-95	6000' downstream of Comb. Mill-below amalgamation mill	Metals, Commons
	SW-3	Water	Oct-95	5500' downstream of Comb. Mill-above amalgamation mill	Metals, Commons
	SW-4	Water	Oct-95	Just below Combination Mill	Metals, Commons
	SE-1	Sediment	Oct-95	S.F.L. Willow Ck at downstream USFS boundary	Total metals
	SE-2	Sediment	Oct-95	6000' downstream of Comb. Mill-below amalgamation mill	Total metals
	SE-3	Sediment	Oct-95	5500' downstream of Comb. Mill-above amalgamation mill	Total metals
	SE-4	Sediment	Oct-95	Just below Combination Mill	Total metals
	TP-2A through F	Soil/tails	Oct-95	1000' intervals downstream from Combination Mill	XRF Metals
	TP-3A through D	Soil/tails	Oct-95	Tailings at amalgamation mill; 6000' downstream of Combination Mill.	XRF Metals
	TP-4A and B	Soil/tails	Oct-95	1000' intervals downstream from amalgamation mill	XRF Metals
	TP-2 Composite	Soil/tails	Oct-95	Composite from TP-2 samples	Total metals, ABA, cyanide
	TP-3 Composite	Soil/tails	Oct-95	Composite from TP-2 samples	Total metals, ABA, cyanide
	TP-4B	Soil/tails	Oct-95	1000' downstream of amalgamation mill	Total metals, ABA, cyanide

Water sampling locations shown on Exhibit 1 and associated Figures; soil/sediment locations on Exhibit 2 and associated Figures.
NA- Sites lacking detailed location descriptions not shown on Exhibits or Figures.

TABLE 4-1. MINE WASTE AREAS AND VOLUMES

Site	Footprint Acres	Fill Volume cy	Subgrade Volume cy	Comments
Tim Smith #1	1.9	23,500	3,000	Based on detailed topo survey and assumed subgrade surface.
Tim Smith #2	0.25	9,260	370	No survey data; estimated from amps and aerial photos.
Combination Waste Rock Pile	9.4	220,000	15,150	Based on detailed pre-regrade topo survey and assumed subgrade surface. Does not include coversoil; coversoil volume estimated at 25,500 cy based on 3-ft thickness.
Combination Soils	5.5	na	na	Based on site recon and aerial photos. Includes south and north area downhill to CPSW-1. Removal volume equals 9,300 cy for each 1-ft removal depth.

TABLE 4-2. MINE POOL ELEVATION READINGS FOR THE COMBINATION MINE WORKINGS

DATE	POOL ELEVATION feet AMSL		DATE	POOL ELEVATION feet AMSL
9/1/00	6000		6/30/09	6091
5/30/01	6000		7/13/2009	6091
11/2/06	6059		7/19/2009	6091
4/25/07	6064		7/27/09	6090
10/11/07	6066		8/2/2009	6091
3/26/08	6062		8/8/2009	6090
4/9/08	6062		8/17/2009	6090
4/18/08	6061		8/31/2009	6090
4/29/08	6063		9/9/2009	6089
5/7/08	6069		9/14/2009	6058
5/15/08	6072		9/21/2009	6090
5/21/08	6075		9/28/09	6089
5/28/08	6076		10/5/2009	6088
6/4/08	6076		10/12/2009	6088
6/11/08	6081		10/21/2009	6088
6/17/08	6084		10/28/2009	6088
6/25/08	6084		11/5/2009	6088
7/3/08	6085		11/11/2009	6088
7/8/08	6085		11/18/2009	6088
7/16/08	6085		11/25/09	6084
7/25/08	6085		2/6/2010	6084
8/2/08	6085		2/13/2010	6084
8/8/08	6085		2/20/2010	6084
8/24/08	6085		2/28/2010	6083
9/6/08	6085		3/6/2010	6083
9/29/08	6085		3/14/2010	6083
10/22/2008	6084		3/21/2010	6088
10/30/08	6084		3/27/2010	6083
11/9/2008	6083		4/3/2010	6083
11/30/08	6084		4/18/2010	6083
3/21/09	6076		5/1/2010	6085
4/13/09	6076		5/8/2010	6085
4/19/09	6076		5/16/2010	6085
4/26/09	6084		5/23/2010	6084
5/9/09	6088		5/31/2010	6084
5/17/09	6089		6/5/2010	6084
5/25/09	6090		6/12/2010	6084
5/29/09	6090		6/21/2010	6089
6/7/09	6090		6/26/2010	6090
6/13/09	6090		7/10/2010	6090
6/22/09	6091			

FIGURES

FIGURE 4-1. COMBINATION MINE DECLINE ELEVATION PROFILE

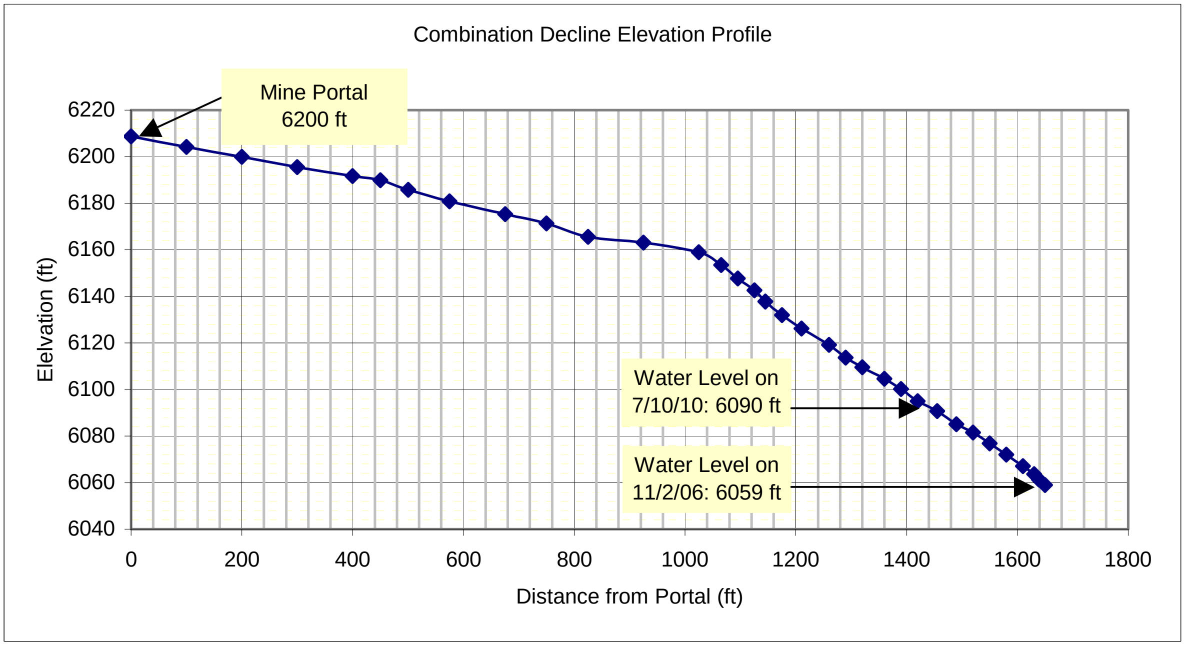
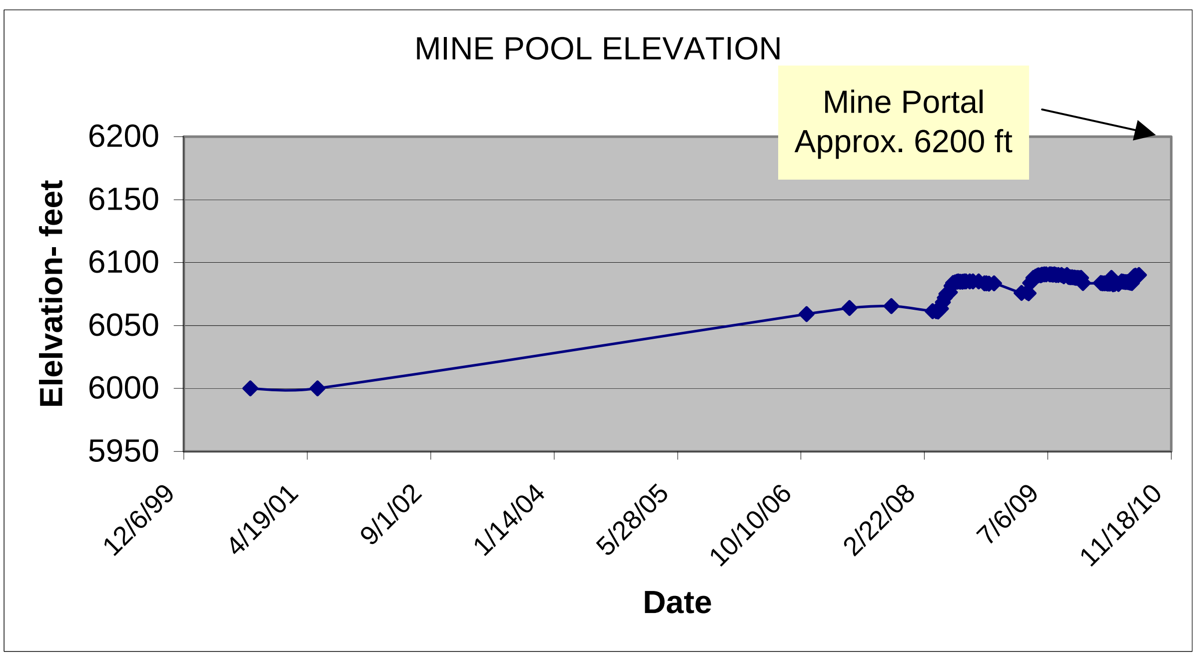


FIGURE 4-2. MINE POOL ELEVATION TRENDS FOR 2000-2010



APPENDIX A

COMPREHENSIVE WATER QUALITY DATABASE
(INCLUDED ELECTRONICALLY ONLY ON ATTACHED CD)

APPENDIX B

COMPREHENSIVE SOIL CHEMISTRY DATABASE
(INCLUDED ELECTRONICALLY ONLY ON ATTACHED CD)

APPENDIX C

COMBINATION MINE REGULAR INSPECTION DATA

APPENDIX D

COMBINATION MINE MONITORING WELL COMPLETION LOGS

EXHIBITS